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FINAL REPORT

An Evaluation of the Selection of Beneficiary Households in the Education, Health, and Nutrition Program (PROGRESA) of Mexico

by

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EXECUTIVE SUMMARY

The objective of this report is to evaluate the targeting method used by PROGRESA in identifying beneficiary households. PROGRESA's methodology consists of three stages: (1) the selection of localities; (2) the selection of beneficiary households within selected localities, and (3) finalizing the list of beneficiaries after feedback from the community assemblies about families excluded or included incorrectly.

We evaluate in detail the first two stages of the selection process. We do not provide an evaluation of the third stage of selection as the number of households whose selection into PROGRESA was disputed at this stage of the selection process was minute (0.1% of the total number of selected households).

Our evaluation is based on a framework consisting of three key elements: (i) a social objective, (ii) a set of economic, political and social constraints under which policy has to operate, and (iii) a range of instruments available to attain these objectives. Although PROGRESA has a number of interlinked objectives with respect to health, education and nutrition, we will measure the benefits of PROGRESA's targeting solely in terms of its potential impact on poverty alleviation. Even by limiting the objectives of PROGRESA to alleviating poverty, our analysis highlights that the relative efficiency of transfer schemes depends on whether the government is concerned about the number of poor households as a percentage of the total population (that is, the headcount index) or the depth or severity of poverty among poor households.

The economic, social and political constraints under which policy has to operate are partly reflected in the amount of budget available for PROGRESA. The budget is assumed to be fixed and limited in the sense that it is not sufficient to eliminate poverty completely.

Policy instruments for poverty alleviation range from uniform transfers that apply no selection criteria to other schemes involving more strict selection criteria. Each of these instruments has different costs and benefits associated with it. The primary benefit derived from targeting at the household level, is that classifying households into those eligible and ineligible for receiving benefits from PROGRESA and giving benefits to those who are eligible, is a more effective way of using the limited funds towards the achievement of the social objective. This, however, is done at a cost. As discussed in the report, the PROGRESA targeting mechanism involves the collection of a household survey within all the localities selected as marginal (or as more likely to contain poor households). Such costs are taken into account by appropriately reducing the fixed budget available for poverty alleviation.

Within this framework our evaluation of PROGRESA's targeting can be formulated as providing an answer to the following question: How well does PROGRESA's targeting perform in terms of its objective after taking into account the costs and the constraints (financial and political) of achieving these objectives?

We answer this question in two steps. First, we evaluate PROGRESA's accuracy in targeting by comparing PROGRESA's selection to an alternative selection of households based on consumption. Secondly, and more importantly, we evaluate PROGRESA's targeting performance in terms of its impact on poverty alleviation relative to other feasible targeting and transfer schemes assuming the same total budget. The list of feasible alternatives includes uniform transfers that involve no targeting at all, targeting based on consumption (or "perfect" targeting), and geographic targeting (that is, targeting at the locality level rather than at the household level). The targeting costs associated with these some of these schemes reduce the budget available for poverty alleviation.

We do not claim to have a perfect way of determining which households should be considered poor. Rather, we adopt an indicator that we consider sensible for classifying households into poor and nonpoor. The indicator we use to examine PROGRESA's targeting is predicted household consumption. We estimate consumption for households contained in PROGRESA's sample (beneficiaries and non-beneficiaries) using the 1996 ENIGH (see Appendix E). We assess the accuracy of PROGRESA's targeting using a 2x2 matrix that compares the classification obtained from PROGRESA's targeting with the classification obtained from our methodology. Households are divided into four groups: (i) Households considered poor by our methodology who are PROGRESA beneficiaries (considered a targeting success), (ii) Households considered nonpoor by our methodology who are non-PROGRESA beneficiaries (also considered a targeting success), (iii) Households considered poor by our methodology and are non-PROGRESA beneficiaries (exclusion error or undercoverage), and (iv) Households considered nonpoor by our methodology and are PROGRESA beneficiaries (inclusion error or leakage).

Our evaluation of the first step of PROGRESA is based on the set of localities with a marginality index. The ultimate test of the how well the marginality index performs is whether it is an effective method of identifying where the poor households are. The restrictions imposed on localities for being candidates for selection based on the marginality index (for example, access to a school or health center) are more than likely to have excluded the localities where the poorest households may be located. We take the view that these restrictions are necessary to the operation of PROGRESA as it was conceived, and do not consider this latter aspect as mistargeting but rather view it as a consequence of the nature of the program. Our evaluation consists of constructing a consumption-based criterion for identifying the localities where poor households are located and then contrasting it to the selection made by PROGRESA.

Based on all of our results we conclude that PROGRESA's marginality index performs quite well when contrasted to a consumption-based model of locality selection. The consumption-based model results in a more precise categorization of poverty which implies that geographic targeting based on the marginality index is more likely to result in leakage rather than undercoverage. The fit between the two methods is particularly tight for the Low and Very High marginality categories, and is more diffuse in the middle categories. This suggests that the PROGRESA marginality index loses its power of distinction between medium marginality localities precisely at a time when PROGRESA is expanding into less marginal communities. This will introduce a measure of arbitrariness into the selection of these communities. One way to counteract this

problem would be to incorporate information from other alternative marginality indices, such as the method presented in our report.

PROGRESA's household selection method consists of three steps: (1) Use income to perform a first and preliminary classification of households into poor and nonpoor. A household is classified as poor if its income was below the poverty line and as nonpoor otherwise. (2) Perform discriminant analysis to incorporate other household characteristics into the determination of the poverty status of households. The underlying motive, as stressed by PROGRESA, is to use a multi-dimensional approach to poverty. The index "puntaje" obtained from the discriminant analysis is then used to determine who is poor and who is not. (3) Finalize the list of beneficiaries after getting feedback from the community.

As can be seen in Table 5, for our preferred 52nd percentile poverty line, the undercoverage and leakage rates are approximately equal to 26 percent. We find that PROGRESA's targeting works better at identifying extremely poor households but is more likely to make errors in identifying correctly households that are moderately poor (that is, households closer to the poverty line). This finding raises some serious concerns about the use of PROGRESA's current targeting method in the less poor areas (that is, marginal urban areas).

We also examine how serious PROGRESA's targeting errors are in comparison to the targeting errors of other schemes. We apply a weighting scheme similar to the FGT family of poverty measures that gives more importance to the undercoverage (leakage) of poorer (richer) households for three alternative transfer schemes: a uniform transfer (that is, no targeting), PROGRESA's targeting, and locality-level targeting. As can be seen in Table 6, PROGRESA's targeting misses fewer of the extreme poor households in comparison to other schemes. In other words, other targeting schemes miss more of the extreme poor households. Similarly in Table 7 we can see that the households that are included erroneously in the list of beneficiaries are households that are closer to the poverty line (less rich) than the households that are included incorrectly by the other methods. In short, the errors of exclusion and inclusion occurring with PROGRESA's targeting are less serious than those occurring with other feasible target and transfer schemes.

To complete our evaluation we then include a budgetary constraint and targeting costs into the picture. The cost of targeting at the household level is assumed to be the full cost of conducting a household survey. We conduct a number of simulations to compare the performance of PROGRESA's targeting in terms of its impact on poverty alleviation relative to other feasible targeting and transfer schemes assuming the same total budget. For the social objectives of reducing the depth of poverty measured by the Poverty Gap index (P1), or reducing the severity of poverty measured by the Severity index P(2), we find that PROGRESA's targeting is the second most effective scheme to "perfect" targeting based on consumption (see Table 8). Geographic or locality targeting has a lower impact than targeting by PROGRESA, while uniform transfers are the least efficient scheme for reducing the depth of poverty or the severity of poverty in Mexico. Similar results are obtained comparing the impact of these transfer schemes on indices of inequality instead of poverty (see Appendix H).

We conclude with suggestions about how the information already collected by PROGRESA could possibly be used to improve PROGRESA's selection of beneficiary households. First, based on the method of Relative Operating Characteristics curves, we suggest a few improvements in the variables used in PROGRESA's discriminant analysis methods to predict the poverty status of households (see Appendix I). Second, we confirm empirically that the discriminant score (puntaje) generated by the methods of PROGRESA can act as a substitute, albeit imperfect, for the "true" but generally unobserved depth of poverty (see Table 9 and Appendix J). This information could be used to increase the cost-efficiency of PROGRESA through changes in the structure of benefits in favor of the extreme poor.

1. METHODOLOGY OF EVALUATING PROGRESA's TARGETING

In 1997, the government of Mexico embarked on a new program aimed at alleviating extreme poverty in the country. PROGRESA, the Education, Health and Nutrition Program, adopts an integrated approach to combating the different causes of poverty. A distinguishing characteristic of the program is that the benefits are targeted directly to households in extreme poverty in rural areas.

In this report we conduct an evaluation of the method used for selecting beneficiary households in the PROGRESA program. Our evaluation of PROGRESA's selection method is based on a framework consisting of three key elements: (i) a social objective, (ii) a set of economic, political and social constraints under which policy has to operate, and (iii) a range of instruments available to attain these objectives. A clear identification of these three elements is essential for a meaningful evaluation of any social development program such as PROGRESA (see, for example, van de Walle, 1998).

We begin with a discussion of the social objective. PROGRESA has the following objectives:

- To substantially improve the conditions of education, health and nutrition of poor families, particularly children and their mothers, by providing sufficient quality services in the areas of education and health, as well as providing monetary assistance and nutrition supplements
- To integrate these actions so that educational achievement is not affected by poor health or malnutrition in children and young people, or because they carry out work that makes school attendance difficult
- Ensure that households have sufficient means and resources available so that their children can complete their basic education
- Encourage the responsibility and active participation of parents and all family members in improving the education, health and nutrition of children and young people
- Promote community participation and support for the actions of PROGRESA, so that educational and health services benefit all families in the localities where it operates, as well as uniting and promoting community efforts and initiatives in actions that are similar or complementary to the Program.

Upon selection into the program, the PROGRESA benefits provided to households are made up of three components that are closely linked to each other:

- Educational grants to facilitate and encourage the educational aspirations of children and young people by fostering their enrollment and regular school attendance, and promoting parents' appreciation of the advantages of their children's education. At the same time, actions will be carried out to improve the quality of education
- Basic health care for all members of the family and strengthening the quality of services as well as reorienting individuals and health services towards taking preventive actions towards health care and nutrition
- Monetary transfers and nutrition supplements to improve the food consumption and nutritional state of poor families, emphasizing that the purpose of this is to improve the

family's food intake, particularly of children and women, who are generally the members of households who suffer most from nutritional deficiencies.

As it can be seen from the objectives of the program outlined above, PROGRESA has multiple objectives regarding education, health and nutrition. As Atkinson (1995) points out, with less sharp or clearly defined objectives, common to most social development programs, the relative efficiency of different transfer schemes may be hard to pin down. Given that all of the interlinked objectives of PROGRESA relate directly or indirectly to poverty and its alleviation in the long-run, for the purposes of our report the benefits of PROGRESA's targeting will be measured in terms of its potential impact on poverty alleviation. Even by limiting the objectives of PROGRESA to alleviating poverty, our analysis highlights that the relative efficiency of transfer schemes depends on whether the government is concerned about the number of poor households as a percentage of the total population (that is, the headcount index) or the depth or severity of poverty among poor households.

The economic, social and political constraints under which policy has to operate are reflected in the amount of budget available for PROGRESA. The budget is assumed to be fixed and limited in the sense that it is not sufficient to eliminate poverty completely.

There is also a wide variety of instruments for the attainment of this social objective. Policy instruments range from uniform transfers that apply no selection criteria at all to other schemes that involve varying degrees of selection criteria. Each of these instruments has different costs and benefits associated with it. The primary benefit derived from targeting at the household level, is that classifying households into those eligible and ineligible for receiving benefits from PROGRESA and giving benefits to those who are eligible, is a more effective way of using the limited funds towards the achievement of the social objective (Besley and Kanbur, 1993). This, however, involves a variety of costs including administrative (targeting and service delivery) costs, incentive costs and socio-political costs. For example, the mechanism used to identify the poor so that they can be given the benefits incurs costs. As discussed in further detail below, in the case of PROGRESA this mechanism involves the collection of a household survey within all the localities selected as marginal (or as more likely to contain poor households). Such costs are taken into account appropriately reducing the fixed budget available for poverty alleviation.[1]

Having described the framework guiding our evaluation of PROGRESA's targeting we can formulate the objective of our report as providing an answer to the following question: How well does PROGRESA's targeting perform in terms of its objective after taking into account the costs and the constraints (financial and political) of achieving these objectives?

Our answer to this question consists of two parts. First, we evaluate PROGRESA's accuracy in targeting. Secondly, and more importantly, we evaluate the performance of PROGRESA's targeting in terms of its impact on poverty alleviation relative to other feasible methods and

[1] We assume that the budget is fixed although we do recognize the possibility that the instruments used, such as targeting, may affect the degree of political support for the program and hence the funds available for poverty alleviation. In Section 4 of the report, we discuss our simulations with locality-based targeting in relation to the political economy aspects of targeting.

transfer schemes assuming the same total budget. The first step is accomplished by comparing PROGRESA's method to an alternative selection method based on household consumption which is our preferred measure of welfare. For the second task the list of feasible alternatives includes uniform transfers that involve no targeting at all, targeting based on consumption, and geographic targeting (that is, targeting at the locality level rather than at the household level). The costs associated with these different schemes reduce the budget available for poverty alleviation.

Targeting accuracy is only a necessary condition towards achieving the social objective of reducing poverty. It is not, however, a sufficient condition. For it may be possible to identify poor households correctly but at a great cost. In other words, once costs and budget limitations are taken into consideration it may be that PROGRESA's targeting method does not turnout to be as effective in terms of poverty alleviation in comparison to alternative transfer schemes.

2. USEFUL CONCEPTS AND MEASURES

Before we can begin to address the question of how well PROGRESA's targeting works, we need to introduce a few important formulas and concepts used extensively throughout the report. These include the measurement of the standard of living of households, the measurement of poverty, the measurement of targeting accuracy (that is, inclusion and exclusion errors of targeting) and the determination of a poverty line.

2. 1 Household Welfare

There is a widespread view in the economics literature that expenditure-based or consumption-based standard-of-living measures are preferable to income-based measures. This is true for both theoretical and practical reasons (Deaton and Zaidi, 1999). The main theoretical reason is that according to the permanent income theory of consumption, estimates of current consumption are likely to provide a more reliable estimate of the household's permanent income (sustainable standard of living) than are estimates of current income. Current income may be much more volatile and subject to shocks from period to period, especially if the household engages predominantly in agricultural or self-employment activities. In contrast, for consumption there is wide evidence that it can be smoothed at least to some extent, by saving and borrowing. If this argument is true then an estimate of current income, even if it is reliably measured at the precise point in time, is not a particularly good measure of the household's general or longer-term standard-of-living. Consumption measures what people actually get so that if one is interested in measuring the living standards of individuals then this is a better measure than income.

Related to this are some more practical considerations: Income may exhibit higher seasonal variability compared to consumption. So to get a measure of the annual or (average over the year) income of the household would require multiple visits. To the extent that consumption is smoothed over the seasons, then consumption is easier to collect with fewer visits. Finally, it is

also generally thought that income is a more sensitive topic than consumption so that deliberate under-reporting is likely to be greater for income than consumption.[2]

2.2 Poverty Measures

There is a number of alternative approaches regarding the definition of poverty. The "basic needs" approach stresses "…human needs in terms of health, food, education, water, shelter, transport" (Streeten et al. (1981)). Two main arguments have been advanced for tracking poverty reduction by observing basic needs, rather than income or consumption. First, increases in real income, especially in rural or sparsely populated areas, may be unable to command better health care, education, safe drinking water, sanitation, or other commodities with public good characteristics such as police protection. Second, households vary greatly in their ability to convert commodities into well-being.

Closely related to the basic needs approach in motivation, but with a more fundamental definition of poverty and its reduction is Sen's (1985, 1987) "capabilities" approach". Its roots lie in the rejection of the welfarist paradigm in which individual utility is taken to be the sole metric of welfare. In this approach commodities matter as one determinant of people's capabilities to function rather than as a source of utility. The strength of this view is its emphasis on commodities not as ends but as means to desired activities. What commodities do for well-being depends on a host of factors, including the circumstances-personal and environmental-of an individual. In focusing on commodities and utilities (but not capabilities) we may thus be focusing at the wrong thing.

Unfortunately, focusing on capabilities creates a whole new set of problems. We rarely observe capabilities, but rather certain achievements. The relationship between achievements and capabilities is not unique but depends on preferences. For example, to conclude that a person was not capable of living a long life we must know more than just how long he lived; perhaps he/she preferred a short but happy life. The role attributed to preferences in basic needs and capabilities approaches is not entirely convincing; it is one thing to reject the view that only utilities matter, and quite another to claim that utility is not at least part of the objective. The capabilities approach has not established why higher consumption (especially for the poor) should not remain an objective of policy, even if it does nothing for capabilities. There is also an unresolved issue of how one should aggregate over capabilities or basic needs. Most of the indexes constructed based on these two approaches, such as the UNDP's Human Development Index, are arbitrary in what they include and in the weights attached to the included terms. [3]

[2] We have also verified that there are substantial differences between income and consumption per capita in the households in the 1996 ENIGH survey and the ENCASEH97/ENCEL98M survey. Invariably, consumption was higher for households at the bottom part of the distribution (see the graphs in pages 34-39 in the Proceedings of the Second IFPRI-PROGRESA Workshop, February 26, 1999).

[3] See for example, Kanbur (1990) and Anand (1991). For a more detailed discussion of the various approaches to poverty measurement the reader is referred to Lipton and Ravallion's (1995) survey.

As economists we tend to emphasize the consumption (or income) based measures of poverty.[4] The Foster-Greer-Thorbecke (1984) or FGT family of poverty measures is highly regarded because it meets all the axioms desirable in consumption-based poverty measures and contains a parameter α that can be set according to society's sensitivity to the income distribution among the poor. Specifically the FGT family of poverty measures is summarized by the formula:

$$P(a) = \left(1/N\right)\sum_{i=1}^{q}\left(\frac{z - c_i}{z}\right)^{a},$$

where N is the number of households, c_i is the per capita consumption (or income) of the i'th household, z is the poverty line, q is the number of poor individuals, and α is the weight attached to the severity of household poverty (or the distance from the poverty line). When $\alpha = 0$, the FGT measure collapses to the Headcount Index, or the percentage of the population that is below the poverty line. This measure while useful for general poverty comparisons, is insensitive to differences in the depth of poverty. When $\alpha = 1$ the FGT measure gives the poverty gap, a measure of the average depth of poverty.

Suppose the poverty line is 100. There are ten people in the economy and two are poor. The headcount index will give the same result P(0) = 0.20 if there are two poor people with consumption levels of $90 as it would with two poor people each with consumption of $10, yet clearly, in the latter case poverty is more severe. When $\alpha = 1$, the FGT index becomes the Poverty Gap, a measure of the depth of poverty in terms of the distance of the consumption of the person from poverty line as a percentage of the poverty line. Thus in the case of two poor people with consumption of $90, P(1) = 0.020. With two poor people each consuming $10, P(1) = 0.18.

The drawback of the Poverty Gap measure is that it will estimate poverty to be the same when one poor person consumes $90 and the other consumes $10, as it would when both have consumption of $50. Yet most people would agree that the suffering of the extremely poor person with only $10 is worse than that of the poor person with $50 or $90. This is overcome for $\alpha > 1$. When $\alpha = 2$, for example, the FGT index becomes the Severity of Poverty index. The P(2) measure assigns more weight to individuals that are further away from the poverty line and thus in more severe poverty. Then the first case gives P(2) = 0.082 and the second gives P(2) = 0.050. In short, using this measure, a one-dollar benefit that reaches the extreme poor (those far from the poverty line) will matter more than one dollar reaching the less poor (those closer to the poverty line). Thus, for the purposes of our evaluation, given the concern of policy makers for the headcount measure or the depth or severity of poverty (that is, for a given value of α), the social objective can be formulated as reducing the FGT poverty index.

[4] Money-metric representations of utility such as the consumption-based measure of welfare can be regarded as implicitly taking into consideration a person's capabilities (see Ravallion, 1998).

2.3 Errors of Exclusion and Inclusion (Undercoverage and Leakage)

Two measures are commonly used as a means of measuring the accuracy of a targeting program. The undercoverage rate (henceforth denoted by U) is the percentage of those meant to be reached by the program who are not reached. It is calculated by dividing the number who should but do not receive benefits (exclusion error) by the number who should receive benefits (the target population).

The leakage rate (henceforth denoted by L) is the percent of beneficiaries who should not be receiving any benefits. It is calculated by dividing the error of inclusion by the number of persons served by the program. Table 1 provides and illustration of these measures.

Table 1— Leakage and Undercoverage Rates

	Alternative Criterion for Selecting Households		
	NonPoor	**Poor**	**Total**
Households excluded from PROGRESA benefits **(NonPoor)**	40	10 (U=25%) (Exclusion error)	50
Households selected for PROGRESA benefits **(Poor)**	20 (L=40%) (Inclusion error)	30	50
Total	60	40	100

There are four groups in Table 1. There are poor households who are not beneficiaries of the PROGRESA program and nonpoor households who benefit from the program. Both groups are indicative of successful targeting. The nonpoor households who participate, 20% of the population, are counted as an error of inclusion (leakage). The poor households that do not participate, 10% of the population, are counted as an error of exclusion (undercoverage). Given the numbers in the table, the undercoverage rate is U = 25% (=10/40) and the leakage rate L = 40% (=20/50).

In general, the higher the priority assigned to raising the welfare of the poor the more important it is to reduce undercoverage. Conversely, the higher the priority assigned to saving limited budget funds, the more important it is to reduce leakage, than it is to minimize undercoverage. There is a temptation on the part of project administrators to think of targeting issues in terms of the trade-offs between leakage and undercoverage rates. One might be tempted to assume that the objective is to minimize the sum of leakage and undercoverage. This is incorrect because such an objective implicitly measures the success of targeting not in terms of its impact on poverty, but instead on the identity of the recipients. As we have stated from the beginning of this report, although project

managers should keep a watchful eye on undercoverage and leakage rates, the evaluation of PROGRESA's targeting should be based on its potential impact on poverty alleviation as opposed to how high or low is the leakage and undercoverage rate. In terms of our adopted framework, inclusion errors or leakages contribute the costs of the program and nothing to the benefits of the program. On the other hand, from the viewpoint of the social objective of PROGRESA's impact on poverty alleviation, exclusion errors, or high undercoverage rates reduce both costs and benefits.

2.4 Choice of Poverty Line

Given our preferred indicator of welfare based on consumption we also have to devise a method by which we classify a household as poor or nonpoor (or beneficiary and nonbeneficiary). We follow Ravallion's (1998) recommendation that the "poverty line should always be absolute in the space of welfare," which in our case is consumption. Such a poverty line guarantees that the poverty comparisons made are consistent in the sense that two individuals or households with the same level of consumption are treated the same way irrespective of the region or the state they located. However, if the poverty line we pick results in a poverty rate that is very different than the poverty rate resulting from PROGRESA's method, then the undercoverage and leakage rates obtained based on our consumption-based method and PROGRESA's method are not likely to be very informative. That is because high undercoverage rates or low leakage rates and vice versa may simply be a reflection of the differences in the poverty line used by the two methods. For example, if with our consumption-based criterion we used a poverty line such as the 75^{th} percentile of the distribution of consumption, which implies that 75% of the households are poor, and if PROGRESA's poverty line resulted in a poverty rate of 50% of the households, then the undercoverage rate of PROGRESA is by construction forced to be at a minimum equal to 33.33%. That is even though PROGRESA's targeting method may actually be classifying correctly as poor the same households as the consumption-based targeting method. Given the sensitivity of the estimated leakage and undercoverage rates to the poverty line or cut-off value used in determining the poverty status of a household and thus the relative success or failure of PROGRESA's targeting, we have decided to adopt a dual approach and base the rest of our analysis on two different poverty lines.

1. A very strict poverty line based on the 25^{th} percentile of consumption per adult equivalent. This poverty line implies that 25% of the households are poor and 75% are nonpoor and is an attempt to capture PROGRESA's stated objective that it aims to reach households in <u>extreme</u> poverty. The reader is cautioned that with this strict poverty line, the undercoverage rate is the more (if not the only) relevant measure for evaluation of PROGESA's targeting. Given PROGRESA's objectives, the critical question is whether PROGRESA's classification has left out any of the households that according to our indicator are extremely poor. When we impose a poverty rate of 25%, but PROGRESA's methods results in a poverty rate of 52%, then the leakage rate is going to be high by construction .

2. A poverty line based on the 52^{nd} percentile of the consumption per adult equivalent. This amounts to assuming that 52% of the households are poor. This equals the average poverty rate in our sample derived from PROGRESA's classification methods discussed in more detail

below. It provides PROGRESA's targeting with the best chances of achieving leakage and undercoverage rates that would be approximately equal to zero, if its targeting were totally accurate (that is, identical to the consumption-based targeting). For these reasons this is our preferred poverty line and we use it in the simulations in the latter part of the report.

Throughout our analysis we use a poverty line as a tool for judging PROGRESA's targeting method. We do not provide any suggestions about what the poverty line is or should be in Mexico.

3. DESCRIPTION OF PROGRESA'S TARGETING METHODS AND EVALUATION OF TARGETING ACCURACY

The selection of households as PROGRESA beneficiaries is accomplished in three stages. First, communities are selected using a marginality index based on census data. Second, within the selected communities, households are chosen using survey data collected at the household level. Third, the list of potential beneficiaries is presented to the community assemblies for review and discussion and the list is changed according to established criteria for the selection of beneficiary families.

In this section we describe and evaluate the first and second stages of PROGRESA's targeting. A more detailed description of the three stages of PROGRESA and of the household survey used for our evaluation can be found in Appendix A. We are unable to provide an evaluation of PROGRESA's third step. In principle all members of the community are invited, selected as a beneficiary or not. At this assembly comments and suggestions are welcomed as to whether households on the list should not be there, or whether other households not on the list should be. These comments are then referred back to the PROGRESA central office for revision of the original ENCASEH questionnaire and a decision. In practice, the number of households whose selection into PROGRESA is questioned is minute. Of almost 341,000 selected households, only 1.5 % were not incorporated, and the vast majority of these for reasons of having moved from the locality. Only 423 households, or 0.1% of the total number of selected households, were disputed and left out of the program. Also, we did not have access to data on the numbers of households added as beneficiaries due to feedback from the local assemblies.

3.1 Description of Community Selection by PROGRESA

Communities were brought into PROGRESA using the following process. Two data sources were utilized: the 1990 population census (Censo) and the 1995 population count (Conteo).[5] According to the 1995 Conteo, Mexico has 104,029 localities with more than two dwellings (covering 90,052,660 inhabitants), on which population and housing data was collected. Adding 1,720 localities from Chiapas that were excluded from the 1995 Conteo, a marginality index was created for a total of 105,749 communities.[6]

[5] The Conteo is a census, but with a shorter questionnaire then the 1990 Censo.

[6] The staff involved had participated in the development of the most complete marginality index available in Mexico (the CONAPO index), based on the 1990 Censo.

The marginality index was developed using the method of principal components, based on seven variables. Four came from the 1995 Conteo:[7]

1. Share of illiterate adults (> 14 years) in the locality
2. Share of dwellings without water
3. Share of dwellings without drainage systems
4. Share of dwellings without electricity

Three variables came from the 1990 Censo:

1. Average number of occupants for room
2. Share of dwellings with dirt floor
3. Share of population working in the primary sector

Of the 105,749 localities, only 74,994 had data on all seven variables described above. Thus the principal components analysis was run directly only on these 74,994 localities, and the marginality index was taken from the first principle component (see Appendix A for short description of the principal components method). For the remaining 29,698 localities, regression techniques were used to estimate the marginality index. A different equation was used to estimate the marginality index for the 1,720 localities in Chiapas.

Thus, overall, the numbers are as follows:

Index	**No. of Localities**	**Population Covered**
Without index	94,401	585,944
With index	105,749	90,606,766
Total	200,151	91,192,710
Of those with index:		
Index Calculated	74,994	88,437,736
Index Estimated	30,752	2,169,030

Once this index was created, localities could be ranked by marginality. However, communities were not chosen strictly on the basis of marginality. The other elements considered included geographical location, distance between localities, and the existence of health and school infrastructure. The reasons for the inclusion of these other criteria stem from logistical and financial considerations as well as the program components that require the use of school and health services. Combining data from the Public Health and Education Secretariats with computerized geographical information, service zones were established, whereby localities were characterized by their access to these required services, taking into account the availability and quality of roads where the services were not located in the same community. Access to these services (primary school, secondary school, and health clinics) was distributed as follows:

[7] For the first round of PROGRESA in 1996, the Conteo data was not yet available. All seven variables came from the 1990 Censo.

Facility	No. of Localities	Population Covered
Primary, secondary, and clinic	119,143	86,180,107
Primary and secondary	5,328	869,373
Primary and clinic	3,343	497,633
Secondary and clinic	9,353	618,406
Primary	21,389	1,099,874
Secondary	3,121	49,648
Clinic	2,742	122,678

Localities deemed to have a high or very high degree of marginality[8] (76,098 localities covering 14,751,628 people) were considered priorities to be included in the program. These were taken as a group to be included in Phase I of PROGRESA. For these, access to services was distributed in the following manner:

Facility	No. of Localities	Population Covered
Primary, secondary, and clinic	48,501	12,047,450
Primary and secondary	5,328	869,373
Primary and clinic	3,343	497,633
Secondary and clinic	1,890	130,333
Primary	10,308	888,070
Secondary	705	40,607
Clinic	808	69,046
No services	5,215	209,116

Those localities with access to all three services were considered as candidates for selection (seleccionables) and used in the next phase of selection. These localities were then grouped to form what were called "marginality zones." Two steps were followed to form the marginality zones. First, localities with less than 50 or more than 2500 inhabitants were excluded. Second, using Geographic Information System software, remaining localities were grouped based on geographical proximity using a routine that identified relatively isolated communities. These localities were then excluded from the selection process.

For the record, the Phase I of PROGRESA was implemented in 1996 in nine states (Campeche, Coahuila, Chihuahua, Guanajuato Hidalgo, Puebla, Queretaro, San Luis Potosi, and Veracruz). Selecting only among localities that had all three services, 3,461 localities in 202 municipalities were chosen. Phase II of PROGRESA was implemented in 1997. This involved two steps. First, the requirement that localities have access to health clinics was dropped, allowing additional localities to be included in the original 202 municipalities. Second, new municipalities and States were added. Overall, 8,749 localities in 483 municipalities (including the states of Chiapas, Guerrero, Michoacan, Nuevo Leon and Oaxaca) were added to the program. Phase III of PROGRESA was implemented in 1998. With the exception of the Baja Californias, Aguascalientes, and the Districto Federal, the remaining states were brought into the program, including an additional 23,478 localities in 1,311 municipalities. Furthermore, in this phase a

[8] The marginality index was divided into five groups based on the degree of marginality. The cutoff points were determined by the Dalenious -Hodges statistical procedure (for details, see de la Vega, 1994).

number of localities previously excluded due to geographical isolation were brought into the program. Overall, PROGRESA covers 35,688 localities in 1,488 municipalities and 28 states.

3.2 Evaluation of the Selection of Localities

The restrictions imposed on localities for being candidates for selection based on the marginality index are more than likely to have excluded the localities where the poorest households may be located. We take the view that these restrictions are necessary to the operation of PROGRESA as it was conceived, and do not consider this latter aspect as mistargeting but rather as a consequence of the nature of the program.[9] Thus our evaluation of the first step of PROGRESA will be based on the set of localities with a marginality index.

The main objective of constructing a marginality index is for identifying the poor households or more specifically, for identifying the localities where most of the poor households are more likely to be located. Thus the ultimate test of the how well the marginality index performs is whether it is an effective method of identifying where the poor households are (Baker and Grosh, 1994; Hentschel et al., 1998). In short, our evaluation consists of constructing a consumption-based criterion of identifying the localities where poor households are and then contrasting it to the selection made by PROGRESA.

In constructing the marginality index that was used to identify the localities where most of the poor households are likely to be found, PROGRESA relied on information available at the locality level from the Census. Unfortunately, census data contain little direct information on household resources and by default, preclude the use of any information at the household level such as consumption per adult equivalent, which is our preferred measure of household welfare. We adopt the following approach. Using the 1996 Mexican National Survey of Income and Expenditures (ENIGH) which is nationally representative at the state level, we first construct household level consumption per adult equivalent, classify households as poor or nonpoor using the 25^{th} percentile as the poverty line, and then estimate a simple probit model of poverty status, restricting the set of explanatory variables to those which are also available in the census data used by PROGRESA. Next, we take the coefficients from the poverty probit and apply them to the 1990 and 1995 population census data at the locality level. Using out of sample prediction, each community is assigned a predicted probability of being poor. Based on the predicted probabilities, we use statistical method developed by Dalenius and Hodge to separate communities into five groups, from low to high marginality. This classification of communities is then compared to the PROGRESA marginality index by creating a 5x5 matrix. With this matrix we evaluate the principal components method of PROGRESA using the concepts of undercoverage and leakage discussed earlier. Leakage occurs if localities under the principal components method are classified as more marginal compared to the probit method. Conversely, undercoverage occurs if localities under the principal components method are classified as less marginal compared to the consumption-based method. The 5x5 matrix can be found in Table 2.

[9] PROGRESA is primarily aimed at increasing household usage of existing health and schooling facilities. Some could argue that a better way to alleviate poverty could be achieved through building new school and health facilities in localities where these do not exist. Although such arguments may have some merit, we consider them as outside the scope of our evaluation of PROGRESA's targeting.

Table 2— Distribution of Localities by Principal Components and Poverty Methods

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	613	3473	3			4089	5
	Low		5361	250			5611	7
	Medium		5390	7088	3		12481	17
	High		83	15819	682		16584	22
	Very High			6104	27770	2357	36231	48
	Total	613	14307	29264	28455	2357	74996	100
	%	1	19	39	38	3	100	

Localities that fall on the diagonal indicate that both methods coincide in the allocation of localities to a particular category. We consider localities off the diagonal, but with just one level of difference, as an acceptable boundary of misclassification. From Table 2 it is evident that the consumption-based probit model results in a stricter classification then the principal components method. In general, one can observe a shift downwards and to the left in the categorization of localities. For example, while the principal components method allocates almost half of all localities to the Very High category, the probit method has only 3% in this category. The bulk of localities under the principal components method are in the Medium, High, and Very High (88%) categories, while the consumption-based probit model allocates them primarily to the Low, Medium and High categories. In terms of undercoverage and leakage, this means that the principal components method has high levels of leakage. Undercoverage is minimal with the principal components method compared to the probit method. On the other hand, the probit method is less apt to classify localities in the Very Low category as well. While the principal components method puts over 4,000 localities in this category, the probit model puts only 613 localities.

Overall the down and leftwards shift does not appear too serious. The off diagonal corner cells remain empty. The majority of localities remain within at least one category distance. However, those who do shift more than one category present a problem. Most significant are those localities that are considered High or Very High marginality under principal components, and that are reclassified by the probit as medium (6,104 localities) or Low (83). PROGRESA initially incorporated localities in the two highest marginality categories, beginning with the most marginal first. The probit would entail a fairly significant number of these localities from being excluded in the initial stages of PROGRESA. On the other hand, the probit method allocated only approximately 30,812 localities to these categories, while the principal components brought in over 52,000. Assuming a similar budget constraint, the localities classified as Medium by the

consumption-based probit would also have been brought in, greatly minimizing the problem of undercoverage.

As a better test of the accuracy of the marginality index in identifying the poor households (rather than just the localities where they may be located) we repeat the exercise conducted above, though this time applying the principal components weights to the ENIGH households. Specifically, we take the seven weights (or coefficients) obtained from the principal components method used by PROGRESA and using these coefficients together with the characteristics of the households in the ENIGH survey derive a new predicted probability for each household being poor. We then classify these new predicted probabilities into five groups and derive a new 5x5 matrix this time at the household level. The purpose is to test how the marginality index method distributes the households in the different categories compared to the probit method.

Table 3— Distribution of Households by Principal Components and Poverty Methods

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	4365	1771	113			6249	47
	Low	110	624	407			1141	9
	Medium		346	1185	79		1610	12
	High		84	728	685	8	1505	11
	Very High		1	397	1432	873	2703	20
	Total	4475	2826	2830	2196	881	13208	100
	%	34	21	21	17	7	100	

The results appear similar to those in Table 2. The marginality index method tends to include Low and Medium poverty households in the High and Very High classes. Few households are reclassified by more than two groups, and particular coincidence is found in the lowest and highest categories. Once again, the probit model appears more precise, though less so than in the previous exercise.

In Appendix B we also discuss and report our results from a number of similar exercises. These exercises use: (a) the full census of localities (that is, including the 30,000 localities with partially missing data); (b) localities converted into the population they represent; and (c) the first 36,006 localities that were selected as PROGRESA communities. Given that the results were quite similar we do not discuss them here but refer the reader to Appendix B .

Based on all of our results we conclude that, for the most part, PROGRESA's marginality index performs quite well when contrasted to a consumption-based probit model. The probit model

results in a more precise categorization of poverty which implies that geographic targeting based on the marginality index is more likely to result in leakage rather than undercoverage. The fit between the two methods is particularly tight for the Low and Very High marginality categories, and is more diffuse in the middle categories. This suggests that the PROGRESA marginality index loses its power of distinction between medium marginality localities precisely at a time when PROGRESA is expanding into less marginal communities. This will introduce a measure of arbitrariness into the selection of these communities. One way to counteract this problem would be to incorporate information from other alternative marginality indices, such as the consumption-based probit method presented here.[10]

3.3 How PROGRESA Identifies the Beneficiary Families

After having identified the marginal localities based on the method described in Section 3.1, PROGRESA proceeds with the selection of the beneficiaries. The characteristics of the families selected as beneficiaries are described in detail in Appendix C. Here we outline the steps followed by PROGRESA in classifying households as poor or nonpoor.

1. Carry out a census of all the households residing in the marginal localities selected. That is the ENCASEH survey described in more detail in Appendix A.
2. Construct total household income based on the individual income data contained in the ENCASEH survey.
3. Subtract child income (from children between ages 8 and 18, the age group covered by PROGRESA) from total household income. The reasoning behind is that in order to identify the poverty status of the household it is necessary to exclude the income obtained from child labor since this income would be lost if children were to enroll in school.
4. Construct per capita income by dividing the value of income in step 3 above by the number of household members
5. Compare the measure of income obtained from step 4 above with the *Standard Food Basket* (which is equivalent to an average aggregate income of approximately two minimum wages) of 320 Pesos per capita per month in order to create a new binary variable taking the value of 1 for poor households (if income is less than the poverty line) and 0 for nonpoor (if income is greater than or equal to the poverty line).
6. Use discriminant analysis, separately for each region, in order to: (a) identify the variables that discriminate best between poor and nonpoor households as originally classified in step 3 above; (b) use the identified variables to develop an equation for computing an index (discriminant score) that represents parsimoniously the differences between the poor and nonpoor households; and (c) use the identified variables or the computed index to develop a rule to classify future observations as poor or nonpoor households.

The steps outlined above indicate that the classification of a household as poor or nonpoor has taken into account a variety of household characteristics that capture the "multidimensional" nature of poverty, meaning that the poverty status of a household is not based solely on reported household income. One of the main advantages of the discriminant analysis is that it allows a variety of ways for classifying observations into groups, such as the "cutoff-rate method" and a

[10] This finding is similar to that in Section 3.4 of the report, where we find that as the poverty line is increased the targeting accuracy of PROGRESA at the household level also decreases.

statistical method based on Bayes rule (Sharma, 1996). The method used by PROGRESA was the Bayesian method since it offers the user the option to incorporate prior probabilities and misclassification costs in the determination of the final cut-off value that is used to classify households as poor or nonpoor. To our knowledge, the prior probabilities used by PROGRESA were 58% for poor and 42% for nonpoor for most of the regions.

For example, using data from two regions (regions 3 and 28) from the 1997 ENCASEH (Phase II), steps 1-4 above resulted in the simple poverty rate (based on income alone) of 74%. By using the prior poverty rate of 58%, the classification method ended up yielding a poverty rate within the interval bounded by the simple (or initial) poverty rate and the prior poverty rate (for example, 65% of the households were classified as poor and 35% as nonpoor). It also should be noted that the poverty rate estimated by PROGRESA's methods generally varies from region to region, though the average poverty rate according to PROGRESA's methods in the 507 localities contained in the 1997 ENCASEH is 52%.[11]

We compared the classification based on discriminant analysis with the classification obtained from a probit method. Although the probit method itself involves a number of questionable assumptions and is not necessarily superior to the method of discriminant analysis, it is the standard econometric method used in targeting studies (for example, see Wodon, 1997, and Minot, 1998). In short, we followed steps 1 through 4 as PROGRESA but in step 5 we run a probit regression instead of discriminant analysis and used the predicted probability from the probit regression in order to classify households as poor or nonpoor. The classification matrices based on the two different approaches in two different regions are presented in Appendix D. The very low leakage and undercoverage rates obtained suggest to us that there is no substantial difference between the classifications obtained by the use of the discriminant analysis and alternative statistical methods such as probit.

3.4 Evaluation of PROGRESA's Selection of Families

In this section we first summarize our evaluation of the use of a per capita measure of welfare as done by PROGRESA. Next, we discuss the construction of the consumption-based measure, the "gold-standard" used to evaluate the targeting accuracy PROGRESA. We conclude by comparing the targeting accuracy of PROGRESA as measured by undercoverage and leakage rates against consumption-based targeting.

In the initial stages of the selection process, PROGRESA utilizes an individual level, or per capita, welfare measure by dividing household income by the number of household members. This measure of welfare requires the following set of assumptions: (a) everyone in the household receives an equal allocation; (b) everyone in the household has the same needs; and (c) the increase in the minimum cost or level of income for an additional member in the household is the same irrespective of family size. The first assumption is defendable due to lack of information on

[11] At earlier stages of this report we also conducted a detailed examination of the sensitivity of the number and characteristics of beneficiaries to changes in PROGRESA's cut-off line. Though not surprising, we find that since the cut-off line is near the mean of the distribution of puntajes, small changes in the cut-off line lead to large changes in the number of beneficiaries (also see Figures 1-6 in Appendix C).

consumption at the individual level. Individual needs, however, usually vary by gender and age, and economies of scale of living together may exist.

These assumptions may have important consequences on the poverty status of large families. For example, the use of a per capita measure of welfare typically results in larger households having a higher probability of being classified as poor. The dominant role played by family size and dependency ratios in the PROGRESA selection process is discussed in Appendix I. The extent to which this is correct depends on whether the marginal increase in the cost of living associated with an extra person in the household is equal to or lower than the cost of living increase assumed by the per capita measure.

For these reasons, we experimented with alternative individual level welfare measures. We first construct an equivalence scale that accounts for different nutritional needs by gender and age. As seen in Table 2 in Appendix E, this adult equivalent welfare measure does not lead to major changes in the selection of beneficiary households, as compared to the per capita measure. Due to its conceptual advantages, however, we utilize the adult equivalent measure throughout most of this report.

Second, we examine the impact of taking into account economies of scale. While the results, presented in Appendix E, suggest that economies of scale are present and significant, the point estimates are well outside of acceptable ranges calculated for other countries. We thus ignore economies of scale in the rest of the analysis. Simulation results, however, with typical values of economies of scale parameters, result in high leakage rates, suggesting that many large families would no longer be selected as beneficiaries if economies of scale were taken into account.

To construct our measure of welfare based on consumption we use the 1996 ENIGH household survey, which contains more reliable consumption data than those available from other sources, to estimate the parameters of the relationship between consumption and household characteristics. We then use these estimated parameters to obtain predicted consumption for the 24,077 households in the 1997 ENCASEH data set. Finally, we use predicted consumption per adult equivalent to compare the targeting of PROGRESA against this alternative method of targeting.

Specifically, our method (described in detail in Appendix E) consist of the following steps:

1) Restrict the ENIGH sample to rural localities so as to meet some of the PROGRESA requirements for inclusion into the program (such as having less than 2,500 inhabitants).
2) Construct a measure of total consumption and use an equivalence scale to derive consumption per adult equivalent
3) Regress the logarithm of total consumption per adult equivalent on household characteristics (size, composition, assets, etc). These household characteristics must also be present in the 1997 ENCASEH set. (that is, $\ln C_{ENIGH96} = a + bX_{ENIGH96} + e$ where lnC is the logarithm of consumption per adult equivalent, a and b are parameters to be estimated, X is a vector of household characteristics and state dummy variables, and ε is the error term of the regression).
4) Derive the Predicted Consumption per adult equivalent (*PlnC*) for households in the 1997 ENCASEH survey, using the same household characteristics as PROGRESA (for example, size, composition, assets, etc) and coefficients estimated from step 3, that is,

$$P \ln C_{ENCASEH97} = \hat{a} + \hat{b}X_{ENCASEH97}$$

5) Derive the two poverty lines discussed above (the 25th and 52nd percentiles) from the distribution of the predicted measure of consumption in the sample of households.

In Tables 4 and 5 below we present the 2x2 classification matrices obtained using the two poverty lines.

Table 4—PROGRESA's Selection versus Consumption-Based Targeting
Poverty line = 25th Percentile of Consumption per Adult Equivalent

	Consumption-Based Criterion for Selecting Households		
	NonPoor	**Poor**	**Total**
Households excluded from PROGRESA benefits **(NonPoor)**	10405	1153 (U=19.15%)	11558 (48%)
Households selected for PROGRESA benefits **(Poor)**	7652 (L=61.12%)	4867	12519 (52%)
Total	18067 (75%)	6020 (25%)	24077 (100%)

Table 5— PROGRESA's Selection versus Consumption-Based Targeting
Poverty line = 52nd Percentile of Consumption per Adult Equivalent

	Consumption-Based Criterion for Selecting Households		
	NonPoor	**Poor**	**Total**
Households excluded from PROGRESA benefits **(NonPoor)**	8246	3312 (U=26.45%)	11558 (48%)
Households selected for PROGRESA benefits **(Poor)**	3310 (L=26.44%)	9209	12519 (52%)
Total	11556 (48%)	12521 (52%)	24077 (100%)

As Table 4 reveals the undercoverage rate is 19.15%when the extreme poverty line is used.[12] In other words, approximately 2 out of 10 households classified as extreme poor by the "perfect" targeting method based on consumption are not classified as poor by PROGRESA. Since PROGRESA is using a poverty line that yields on average a poverty rate of 52%, that means that these extreme poor households are assigned a discriminant score that is high enough to disqualify them from PROGRESA benefits (i.e places them in the upper half of the puntaje distribution). This is evidence of some substantial difference between PROGRESA's selection method and consumption-based targeting. These exclusion errors are probably a reflection of the tendency of the discriminant analysis method to classify as beneficiaries households with more children and to exclude smaller households or older households that have no young children (see discussion in Appendix I). It is our understanding that PROGRESA recently made some minor adjustments in the procedures used to select beneficiary households through a process called "densification". The adjustments are aimed mainly at including additional households that were originally left out. According to some back of the envelope calculations we have made in the localities where PROGRESA operates, the densification process has made as beneficiaries approximately 38% of the extreme poor households originally excluded[13]

[12] Interestingly, very similar rates of undercoverage and leakage were obtained with the same methods but coefficients obtained from rural households in the 1994 ENIGH survey.

[13] As of the date of this report, the densification process was not yet been applied to revise the poverty status of households in the control localities contained in the 1997 ENCASEH sample of households. Therefore we have opted to proceed with our evaluation based on the original classification of households into beneficiaries and non-beneficiaries. After the densification process the beneficiary rate in localities where PROGRESA operates has increased to 65%.

Also, the increase in the undercoverage rate of PROGRESA to 26.45% when the poverty line is higher and equal to PROGRESA's average poverty rate, suggests that the targeting accuracy of PROGRESA is lower for the moderately poor households, that is, the group of households between the 25th and 52nd percentile of consumption[14]. Put differently, PROGRESA's targeting works better at identifying extremely poor households. This raises some serious concerns regarding the use of PROGRESA's current targeting method during the next phase of the program, as PROGRESA expands in less poor areas (that is, marginal urban areas).

As mentioned above, when the low poverty line is applied the leakage rate is high by construction. That explains the 61% leakage rate obtained with low poverty line. This leakage rate reduces to 26.4% when the poverty line used is the higher. Since the poverty line used by PROGRESA is approximately equal to the median, with 52% of the households on average across regions classified as beneficiaries, the leakage rate turns out to be equal to the undercoverage rate.

3. 5 PROGRESA's Leakage and Undercoverage Rates Relative to Alternative Targeting Methods and Transfer Schemes

The question remains, however, as to whether the leakage and undercoverage rates of 26% under PROGRESA are a serious cause for concern. For example, if the majority of the poor households excluded from participation by the PROGRESA targeting method are close to the poverty line then there would be less cause for concern compared to the case if they were far below the poverty line. For this reasons we applied a weighting scheme along the lines of the FGT poverty measures. Specifically, we calculated undercoverage rates using the formula,

$$U(a) = \left(1 / N_{PC} \right) \sum_{i=1}^{q} \left(\frac{z - c_i}{z} \right)^a ,$$

where N_{PC} is the total of households categorized as poor according to the consumption-based criterion and q is the total number of households classified as non poor by PROGRESA. When $a = 0$, this expression collapses to the undercoverage rate (see, for example, the undercoverage rate calculated in Table 5 above). When $a = 2$ more weight is given to households that are further away from the poverty.

Along the same lines, the leakage rate is defined as

$$L(a) = \left(1 / N_{PRO} \right) \sum_{i=1}^{q} \left(\frac{c_i - z}{z} \right)^a$$

[14] The undercoverage rate of 26.45 percent with the poverty line for consumption set at the 52nd percentile may be expressed as a weighted average of the undercoverage rates of the extreme poor and the moderately poor. Since the weights are approximately the same, the higher undercoverage obtained with the higher poverty line implies that the undercoverage rate of the moderately poor is higher than that for the extreme poor.

where N_{PRO} is the total of households covered by the transfer program examined (for example, PROGRESA), and q is the total number of households classified as nonpoor by the consumption-based targeting scheme.

However, the undercoverage (or leakage) rates for different values of a are not comparable within a given transfer or targeting scheme. To get a sense of how high or low the leakage rates of PROGRESA are we need to compare them with the undercoverage and leakage rates obtained with other targeting and transfer schemes. We compare PROGRESA's targeting accuracy to that of two other schemes.

The first scheme is a uniform transfer. The full sample of 24,077 households is treated as poor. In this transfer scheme, every household is covered and as a result undercoverage is zero. In fact it is the implicit desire to minimize undercoverage rates that in many occasions has been used as an argument in favor of uniform transfers. The major problem with a uniform transfer scheme is leakage.

The second scheme examined is targeting at the locality level.[15] This is a geographic targeting scheme of the type surveyed by Baker and Grosh (1994). At present, PROGRESA's beneficiary selection method selects firstly the localities that are to be covered using the marginality index discussed earlier and, secondly, based on the results of the discriminant analysis for the population of households in these localities it constructs cut-off lines at the regional level. These region-specific cut-off points may result in some households within a certain locality being excluded from the program while a significant fraction of the households in that same locality are covered by the program. Alternatively there are localities where only a few households are covered while most households are not.

Within the subset of localities selected by PROGRESA as marginal, it is still possible, with the use of the continuous marginality index constructed by PROGRESA, to rank localities as more or less marginal. Beginning with the most marginal locality, we started classifying as poor (or beneficiaries) all the households residing in that locality and then repeated these steps for the households in the locality with the next value of marginality index until the total number of poor households is equal to 52% of all the households in the sample. As discussed earlier when comparing leakage and undercoverage rates either with consumption-based targeting or with PROGRESA's targeting it is essential to have a poverty line that yields the same poverty across schemes.

In all of our calculations, consumption-based targeting with the higher poverty line (the 52nd percentile) is treated as the "perfect" targeting scheme meaning that the undercoverage and leakage rates with consumption-based targeting are zero. Also, at this point we abstract from issues related to budgetary constraints or costs of targeting, but take these into account later.

[15] An in depth comparison of this geographic targeting scheme to PROGRESA's targeting at the household level is presented in Appendix G. All of our simulations here based on localities from the pool of localities already selected as marginal by the first step of PROGRESA's selection method. In principle, however, the same method could be applied to the full of set of localities in Mexico.

Table 6—Undercoverage Rates using the FGT Weighting Scheme (Percentage Change in Index in Reference to Transfers with PROGRESA Targeting)

	U(0)	U(1)	U(2)
Uniform transfer (i.e. no targeting)	0	0	0
Transfers with PROGRESA targeting	0.264	0.063	0.022
Locality targeting (based on marginality index)	0.383 (44.96)	0.101 (60.00)	0.037 (69.59)

Tables 6 and 7 contain the undercoverage and leakage rates, respectively, estimated for the various targeting schemes.

Table 6 reveals, that PROGRESA's undercoverage rate is much lower than the undercoverage rate obtained if targeting were at the locality level based on the marginality index. Moreover, PROGRESA undercoverage rate is even lower if we were to focus on the severity of poverty of those excluded from the program. Put differently, locality-based targeting would have left out of the program many more of the extreme poor compared to PROGRESA.

Table 7—Leakage Rates using the FGT Weighting Scheme (Percentage Change in Index in Reference to Uniform Transfers)

	L(0)	L(1)	L(2)
Uniform transfer (i.e., no targeting)	0.4799	0.239	0.228
Transfers with PROGRESA targeting	0.264 -(44.99)	0.066 -(72.22)	0.033 -(85.70)
Locality-level targeting (based on marginality index)	0.383 -(20.19)	0.152 -(36.28)	0.115 -(49.47)

Table 7 also reveals a generally favorable picture of PROGRESA. With PROGRESA's targeting the leakage rate is generally much lower than the leakage rate obtained with a uniform transfer, as well as lower than the leakage rate obtained with targeting at the locality level.[16] The households leaking into the program with PROGRESA's targeting are much closer to the poverty line (less well-off) compared to the households leaking into the program with uniform targeting or locality based-targeting.

4. EVALUATION OF PROGRESA'S IMPACT ON POVERTY ALLEVIATION RELATIVE TO ALTERNATIVE TARGETING METHODS AND TRANSFER SCHEMES

The preceding analysis suggests that PROGRESA's targeting method is generally good. So far, however, we have ignored the costs of targeting. In this section we set the budget of the program at a fixed amount and simulate the impact of the different targeting and transfer schemes inclusive of targeting costs on the indices of poverty. We do not provide an evaluation of whether the size of the budget is appropriate or too high or too low. Such issues can only be addressed later when more detailed data become available on the constraints, the incentives and opportunity costs faced by rural families and policy makers.

We compare the impact of PROGRESA's targeting methods on the various poverty measures against a number of alternatives. We start from the case where there is no cash transfer program and a fixed budget, and examine the decrease in the poverty rate if the cash transfers were uniform in the sense that the full budget available is allocated to all households without distinguishing between poor and nonpoor households. Then we also investigate how PROGRESA's impact, given its beneficiary selection method, compare to the impact of a cash transfer program that has the same benefit structure (that is, based on gender and age) and distributes the same funds but selects households based on an alternative indicator.

In the simulation assuming a uniform transfer scheme, each household gets the same absolute amount as a cash transfer. The cash transfer received by each household is the ratio of the total budget and the total number of households in the sample. The post-transfer consumption of the household (which equals the pre-transfer level of consumption and the cash transfer received) is then divided by the number of adult equivalent units of the household.

For the case of consumption-based targeting, we first identify who are the poor households based on the comparison of the household-specific consumption per adult equivalent and the 52^{nd} percentile of the distribution of consumption per adult equivalent in the full sample of households. By construction the poverty line used results in the same total number of poor households with PROGRESA's criterion. This facilitates the comparison between PROGRESA's targeting method and the consumption-based method by checking whether the same households are classified as poor or not.

[16] It is worth noting that the leakage rate and undercoverage rate, L(0) and U(0) for locality level targeting are almost equal to the corresponding rates of locality level targeting for Mexico obtained from the simulations of Baker and Grosh (1994).

Households classified as nonpoor by the consumption-based criterion receive no benefits while households classified as poor are assumed to receive benefits according to the structure of benefits of the PROGRESA program outlined in Appendix F. As with the uniform transfer case, the post-transfer consumption of the household (which equals the pre-transfer level of consumption and the cash transfer received) is transformed into adult equivalent units. However, a rule needs to be adopted regarding how the limited budget is allocated to the households selected as participants into the program. In simple terms the rule adopted consists of giving benefits first to the neediest households and then moving progressively up the ranking of households until the budget is exhausted. A household is classified as having more need in the sense that its level of consumption per adult equivalent is further away from the poverty line. Since the budget is lower than the total poverty gap, this implies that certain poor households do not receive any benefits. The level of the budget and the budget allocation rule adopted imply that 24.5% of the poor households do not get any benefits. Moreover, the poor households that do not receive benefits are closer to the poverty line compared to the ones that do receive benefits.

It is very important to clarify the implications of this budgetary allocation rule. By construction, it is likely to result in a very small (or zero impact) on the poverty rate most people are accustomed to, that is the headcount rate P(0). If the PROGRESA benefits are given first to those who are far away from the poverty line and not to those close to the poverty line, the headcount rate is not likely to change, unless the benefit given to a very poor household is high enough to cover the poverty gap. Note also that if the budgetary allocation rule were to be reversed in the sense that the limited budget were first allocated to the households closer to the poverty line moving down progressively to households further and further away from the poverty line then the impact on the headcount rate of poverty are likely to be much higher. We are of the opinion that the latter budget allocation rule does not reflect accurately the key objectives of PROGRESA and that is why we adopt the rule of giving the money to the neediest first.

The preceding discussion also implies that in comparing the relative targeting success or failure of PROGRESA to alternative methods of selection, it is imperative to focus on the higher order measures of poverty such as P(1) or P(2). For it is only the higher order measures of poverty that can provide an estimate of the relative effectiveness of PROGRESA's methods in identifying the poorest of the poor households in comparison to other targeting methods such as the consumption-based targeting method advocated in this report.

Similar steps are followed in allocating benefits to the households selected as poor by the PROGRESA targeting method. The only difference is that since the budget is by construction equal to the total amount of benefits that would be distributed to all the poor households under PROGRESA's selection method, there are no poor households under the PROGRESA selection method that receive no benefits.

Targeting necessitates the collection of information of a number of variables at the household level that are useful at identifying the poor and nonpoor households. Such variables include the income of each household by source or the consumption expenditures over a reference period, household assets, etc. According to information provided by PROGRESA officials, the average

cost of the household census survey (ENCASEH) is 170P per household. Although a large component of the information collected by the ENCASEH survey is really essential for the administration of the program rather than for targeting, we run three separate simulations using a zero cost, a low-cost and a high-cost estimate for the cost of targeting. The low estimate is based on the estimate given to us by PROGRESA officials that the cost of collecting all the information that is relevant for targeting is only 60P per household out of the total of 170P per household for the whole ENCASEH survey. For the high estimate for the cost of targeting we use the full cost of the ENCASEH survey.

Using these estimates of the cost of targeting per household, we then adjust the original budget used in our earlier simulation by subtracting the cost of surveying all the households in the sample with all costs deflated to June 1994 prices. Given that this survey costs are one-time costs in the sense that they are incurred only at the start of the program and since PROGRESA plans to review the status of all households three years after the initiation of the program, we distribute these costs equally over time by dividing them by 36 (the total number of months of the duration of the program). It turned out that the administrative costs of targeting made very little difference in the estimates obtained for the impact of PROGRESA on poverty. Therefore we report the estimates obtained assuming the high costs of targeting.

For the case of locality-level targeting we use an analogous method and simulate the scenario of what if PROGRESA used its limited budget to provide benefits to all households starting from the most marginal localities and then moving down to the less marginal localities until the budget is exhausted. In this manner we can get a sense of the impact of PROGRESA on the various poverty indicators without having to do targeting at the household level and thus with out incurring any of the administrative and other non-economic costs associated with targeting. Non-economic costs include the potential conflicts and problems that can arise within small communities where households in many respects similar to households selected as beneficiaries are excluded from the program. Such conflicts could work against the original objectives of the program, as communities may end up being more divided after the initiation of the program than before. In addition, the possible emergence of conflict within communities may give rise to criticisms about the targeting method of the program that may be accompanied by calls for universal coverage or elimination of inequities. If the impact of PROGRESA's second step on the poverty indices were to be approximately the same as that of locality-based targeting, then we could safely conclude that targeting at the household-level is not a worthwhile effort given the objective of maximizing poverty reduction.

In our simulations we do not consider problems related to program take-up or incentives effects. For example, households selected as potential beneficiaries may not have enough information nor find it in their interest to adhere to the requirements of the program. Also, targeting programs can have incentive effects that are side effects of their goal of sorting the poor from the nonpoor. These incentive effects arise from the behavioral responses of households or individuals as they attempt to become eligible for the program. For example, the presence of the program may induce some households to reduce their work effort and thus their income so as to become eligible for program benefits (Kanbur, Keen and Tuomala, 1995).

In Table 8 below we present the results of our simulations on the impact on poverty indices. The figures in Appendix F displaying how the various schemes impact on the distribution of our welfare measure provide some useful insights as to whether or why the indices of poverty are affected. The reader is cautioned that for any given transfer scheme the alternative poverty indices are not comparable. Comparisons are only meaningful for a given poverty index (that is, a given value of α) across transfer and targeting schemes.

Table 8 —Poverty Indices Under Various Targeting/Transfer Schemes with a Fixed Budget and Including Administrative Costs of Targeting (Percentage Change in Poverty Index from Case of No Transfer)

	P(0) (Headcount Index)	P(1) (Poverty Gap)	P(2) (Severity Index)
No transfer (no anti-poverty program)	0.5200	0.1514	0.0588
Uniform transfer (i.e., no targeting)	0.4682 -(9.95)	0.1273 -(15.94)	0.0470 -(20.11)
Transfers with consumption-based targeting	0.5188 -(0.23)	0.1114 -(26.42)	0.0340 -(42.22)
Transfers with PROGRESA targeting	0.4776 -(8.16)	0.1157 -(23.61)	0.0385 -(34.52)
Locality targeting (based on marginality index)	0.4757 -(8.51)	0.1187 -(21.61)	0.0406 -(30.99)

For the reasons discussed above, both "perfect" targeting based on household consumption and PROGRESA's targeting, appear to have no impact on poverty as measured by the headcount ratio. These results highlight the point that the social objective assumed is crucial in determining which transfer or targeting scheme is the most efficient If the social objective of the government were to decrease the number of poor households as a percentage of the total population (that is, the headcount rate), then according to our simulations, a uniform transfer is the most effective way. Locality targeting comes second, PROGRESA targeting a close third and perfect targeting last. This is because with uniform transfers more households close to the poverty line receive benefits that are sufficiently high to make them cross over the poverty line. Since the headcount index of poverty simply indicates the proportion of households below the poverty line after the transfer without any regard of how poor these households were before the transfers it is the uniform transfer scheme that shows up as being the most efficient in decreasing the headcount index.

The picture changes dramatically if the social objective were to have concern for the depth of poverty as measured by the Poverty Gap index (P1), or the severity of poverty as measured by the Severity index P(2). Given either one of these social objectives, we can see that PROGRESA's targeting is the second most effective scheme to "perfect" targeting based on consumption. Uniform transfers now end up as being the least efficient scheme for reducing the depth of poverty or the severity of poverty in Mexico. Moreover, since we have accounted for the administrative costs of targeting, the higher impact of PROGRESA's targeting on the depth and severity of poverty than locality-based targeting implies that targeting by PROGRESA has benefits associated with it. Whether these benefits exceed the non-economic costs associated with targeting is hard to determine.

In addition to the FGT poverty indices we have also examined the impact of the different transfer and targeting schemes of inequality. Thus the social objective is now considered to be the minimization of inequality instead of poverty alleviation. The main shortcoming of the FGT poverty indices is that they assign weights only to the poor households. Thus households just above the poverty line, though for all practical purposes identical to households just below the poverty line, receive no weight. Inequality indices provide an alternative means of evaluating the impact of various targeting and transfer schemes by comparing their impact on inequality in the total population of households not just those below the poverty line. In this manner, the benefits accruing to households just above the poverty line do not necessarily have to be considered as leakage and be assigned a weight similar to that assigned for households receiving benefits just below the poverty line. Our calculations for the Generalized Entropy and the Atkinson indices of inequality are contained in Appendix H. The results regarding PROGRESA's performance are very similar to those obtained with the severity of poverty index P(2).

5. POSSIBLE IMPROVEMENTS IN PROGRESA'S TARGETING

In this section we examine ways in which the information already collected by PROGRESA can be used to improve the targeting of households. First, we consider whether the variables used by PROGRESA's discriminant analysis methods to predict the poverty status of households could be improved upon. We explore this question using the Relative Operating Characteristics curves introduced to the poverty literature by Wodon (1997). Second, we explore whether the discriminant score (puntaje) generated by the methods of PROGRESA can be considered as analogous to the "true" depth of poverty given by the distance of household consumption from the poverty line. Evidence that the discriminant score can act as a substitute, albeit imperfect, to the "true" but generally unobserved depth of poverty could be used to increase the cost efficiency of PROGRESA through changes in the structure of benefits in favor of the extreme poor.

5.1 ROC Curves

Relative operating characteristics (ROC) curves can be used to assess the predictive power of poverty targeting indicators. This technique allows us to comment on which groups or individual targeting indicators have the most predictive power on whether a family is poor or not. We compare the variables actually used by PROGRESA with an alternative set of variables. First, we

judge the robustness of the weighting scheme implicit in PROGRESA's discriminate analysis procedure. Second, we test whether the alternative set of variables performs better than the variables used by PROGRESA, allowing us to suggest new variables for PROGRESA's use. Third, by varying the poverty line, we evaluate the sensitivity of the variables used to changes in the poverty line. Fourth, since PROGRESA performed an exhaustive testing of possible variables, most of these alternative variables are likely to have been discarded by the discriminate analysis procedure. Thus our comparison provides an explicit test of the effectiveness of using discriminate analysis to discard possible explanatory variables.

Details of our analysis are presented in Appendix I. Our results suggest that the discriminant analysis method is generally robust but that PROGRESA's targeting would improve by taking into account the labor activities of all adult members of the family instead just of the family head. Also the role of different variables or sets of variables in predicting poverty seems to change with the poverty lines used. Household composition, as well as the ratio of family members to the number of rooms in the dwelling (hacinamiento), has more predictive power with a moderate poverty line. Labor activities, on the other hand, perform better with extreme poverty. This is relevant to PROGRESA's targeting as it expands in marginal zones in urban areas.

5.2 Tailoring Benefits in Favor of the Extreme Poor

The present structure of benefits in PROGRESA can also be interpreted as an attempt to tailor benefits based on the poverty gap. To the extent that the poorest households have more school-aged children, then the benefits received by the poorest households are likely to be bigger and thus cover a larger fraction of the poverty gap. It is quite conceivable that the effectiveness of PROGRESA in alleviating extreme poverty could improve further by distinguishing among potential PROGRESA beneficiaries.[17] For example, beneficiary households could be divided into two groups, the extreme poor and the moderately poor depending on their distance from the "cutoff" point. One of many possible ways of restructuring the benefits of the program is to double the level of benefits for the extreme poor and reduce to half the benefits given to the moderately poor households. This revised benefit structure would increase the cost efficiency of the program, by minimizing the losses incurred from providing full benefits that are in excess of the poverty gap to households closer to the poverty line (see the discussion in Atkinson, 1995).

A better targeting of households and the restructuring of benefits in favor of the extreme poor such as the one considered here can only be achieved if it is possible, one way or another, to measure the severity of poverty among eligible households. Having data on the value of consumption of all households would be ideal. However, the collection of consumption data for targeting purposes for a program of the magnitude and coverage of PROGRESA is prohibitively costly and thus impractical.

[17] As we have stated from the outset we are abstracting here from the potential effects of changing the structure of benefits on the schooling or the health of the moderately poor household members. It may be that the relative efficiency of schemes may be quite different if we consider increasing schooling attendance or health as the social objective.

An unused by-product of the current targeting method of PROGRESA is the discriminant score (puntaje) constructed from the application of the discriminant analysis at the regional level. One intriguing question is whether this measure could be of use as a measure of the depth or severity of poverty. In order to address this question we run a set of simulations using data for the region of Sierra Gorda that contains the largest number of households in our sample (10,800 households). The details of our simulations an the associated kernel density graphs are contained in Appendix J. In Table 9 we present the results of our simulations on the three indices of poverty. For comparison we have also calculated PROGRESA's impact on poverty in the Sierra Gorda region assuming the current benefit structure.

Table 9 — Poverty Indices with a Fixed Budget and Targeting Costs Excluded
Sierra Gorda Region
(Percentage Change in Poverty Index from the Case of No Transfer)

	P(0) (Headcount Index)	P(1) (Poverty Gap)	P(2) (Severity Index)
No transfer (no anti-poverty program)	0.4899	0.1356	0.0504
Uniform transfer (i.e., no targeting)	0.4210 -(14.06)	0.1063 -(21.60)	0.0387 -(23.30)
Transfers with consumption-based targeting and the revised benefit structure	0.4819 -(1.63)	0.0872 -(35.69)	0.0206 -(59.10)
Transfers with PROGRESA targeting and the revised benefit structure	0.4232 -(13.62)	0.0870 -(35.89)	0.0264 -(47.74)
Locality targeting (based on marginality index)	0.4233 -(13.59)	0.09586 -(29.32)	0.03039 -(39.75)
Transfers with PROGRESA targeting and the current benefit structure	0.44161 -(9.86)	0.10084 -(25.65)	0.03217 -(36.22)

As Table 9 reveals, with the revised benefit structure PROGRESA's impact on the severity of poverty index P(2) would increase by 11.52 percentage points compared to the current benefit structure. Also, the impact of PROGRESA on the poverty gap P(1) would increase by 10.24 percentage points and end up being equal to the impact of perfect targeting.

Based on these results we conclude that treating the discriminant score index constructed by PROGRESA's method would serve as an adequate though imperfect indicator of the depth of poverty of households. As we have also noted in Section 3.4 of the report, PROGRESA's

targeting is more accurate at identifying the extreme poor than the moderate poor. A restructuring of benefits in a way similar to the one experimented with in this section of the report, would also serve to increase the cost efficiency of the program. However, it should be pointed out that since the derivation of the discriminant score takes place at the regional level, the depth of poverty measure in one region is not comparable to the depth of poverty in another region.

6. CONCLUSIONS

Our principal conclusion is that overall PROGRESA uses an effective method of selecting households into the program. The accuracy of PROGRESA's targeting both in terms of selecting localities where poor households are more likely to be found and in terms of selecting poor households within these localities is good.

Our investigations of the targeting accuracy of PROGRESA in selecting localities reveal that it is very effective in identifying the extremely poor localities but less so when it comes to distinguishing between localities in the middle of the scale. This implies that as PROGRESA expands into less marginal communities the chances of selection errors are higher. A similar conclusion is derived from our evaluation of the targeting of households within localities. PROGRESA's targeting is not perfect but relatively more effective at identifying the extremely poor households within localities but less so when it comes to selecting households that are moderately poor.

Thus, as PROGRESA expands into less marginal communities targeting inaccuracies are likely to increase at both the locality and household level. Whether or not the current methods of beneficiary selection should continue to be applied into the next phase of PROGRESA is not for us to determine. However, according to our simulations, PROGRESA's targeting as practiced during the second phase of the program is likely to be the most effective among the set of feasible targeting and transfer schemes in reducing the depth of poverty and the severity of poverty in Mexico. PROGRESA performed closer to the ideal of "perfect" targeting than any of the alternative transfer and targeting schemes examined in our report.

Our evaluation of the selection of beneficiaries into PROGRESA is not equivalent to making evaluating the program as a whole. It remains to be determined whether the interlinked objectives of PROGRESA with respect to health, education, and nutrition are achieved by the level and structure of benefits of the program.

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APPENDIX A

Selection of PROGRESA Beneficiary Households: A Three Stage Process[1]

This appendix describes in detail the selection process of beneficiary families in PROGRESA. The selection of beneficiary families in PROGRESA has three stages. In the first stage, a geographic targeting is carried out in which the localities with the highest marginalization are selected, taking into account access to basic education and health services. In the second stage, in all of the selected localities, a survey of socio-economic information is carried out which is used to identify the beneficiary families to be identified. Finally, the list of selected families is presented to the community. An assembly is arranged in the community where the list of selected families is made public, and an agreement is reached among all families in the community.

1. Geographic Targeting: Selection of PROGRESA Localities

The criteria for the selection of localities is first based on the level of marginalization in the community, where PROGRESA gives priority to the selection of localities with high levels of marginalization, thereby demonstrating a high proportion of households in extreme poverty. In specific cases, some zones are identified which have high levels of marginalization within localities with low levels of marginalization.

Along with the analysis of marginalization of each locality, geographic and statistical data is compared which allows areas with the highest level of marginalization to be identified, in terms of both numbers of localities and population density. The purpose of this process is to identify groups of communities where the maximum benefit for households in extreme poverty can be reached.

Once the geographic distribution of marginalized localities has been established, regions are identified (which do not necessarily coincide with state or local boundaries).

1.1 Marginalization Index

The selection of localities according to their level of marginalization is based on homogenous criteria at the national level and follows a standardized process, from which is calculated a Basic Index of Marginalization for all localities that have census information. The index is constructed through the use of principal components analysis where the product is a summary variable which captures as much variation as possible between the localities. The values of the index can be interpreted through comparative analysis between localities.

[1] This document is a summary of Sections 3, 4, and 5 from the publication Lineamientos Generales para la Operación del Programa de Educación, Salud y Alimentación, PROGRESA, 1999.

The information base for identifying the characteristics of marginalization are the data from the XI General Population and Housing Census of 1990, the Population and Housing Count 1995 and the Geographic Integration Catalog, all constructed and carried out by the National Institute of Statistics, Geography and Information (INEGI).

The indicators which are used to construct the marginalization index for each locality are the following:

- Percentage of illiterate population aged 15 or more
- Percentage of dwellings without running water
- Percentage of household dwellings without drainage
- Percentage of household dwellings without electricity
- Average number of occupants per room
- Percentage of dwellings with earth floor
- Percentage of labor force working in agriculture sector

1. 2 Calculation of Marginalization Index

The marginalization index for each locality is calculated based on the formula:

$$MI_j = f_1 \times \left(X_{j1} - X_1 \Big/ S_1 \right) + \ldots + f_N \times \left(X_{jN} - X_N \Big/ S_N \right)$$

where f is the scoring or weighting factor for the first variable s determined by the procedure, Xj_1 is the jth locality's value for the first variable and X_1 and S_1 are the mean and standard deviation of the first variable over all localities.

The marginalization index is classified into 5 categories: very high, high, medium, low and very low level of marginalization. To determine in which group each locality falls, the method of optimal stratification is applied, which permits localities to be grouped based on the density function f(x) defined from the index of marginalization.

Additionally, for the selection of localities where PROGRESA operated, the accessibility to basic education and health services is taken into account, weighting the severe dispersion which characterizes many of the highly marginalized localities. In this way, the operation of PROGRESA is more effective in establishing priority action zones where the beneficiary population has better access to health and education services, independent of the mode used by these sectors to provide services. The access to basic services is a necessary condition in the locality selection process without which it is not possible for the program to be operated.

In this method, a geographic statistical system is used, with integrated digital information on the border of states, municipalities and localities, transportation networks, primary and secondary schools, as well as public health clinics, using the official INEGI locality number. In this manner, consistent information on health and education resources is obtained.

1.3 Locality Access to Education and Health Services

To facilitate the selection of localities, the localities are classified according to zones of influence of the network of federal and state roads, considering that distance from roads indicate different communication possibilities between localities. Federal roads are assumed to have larger zones of influence than state roads. That is, a locality which is located close to a federal road is assigned a radius of influence larger than a locality that is found near a state road, which is in turn higher than a locality which is found far from either of these types of roads.

From the radii of influence of localities according to the distance from different types of roads, areas of influence for education and health services are established, in accordance with information provided by the education and health sectors.

For those localities which do not actually have education and/or health centers in the locality, access to services is defined according to its geographic location within the radii of influence of other localities which have these services, using the following criteria:

- For schools located in localities close to a federal road, five and ten kilometers for primary and secondary schools respectively
- For schools located in localities close to a state road, three and six kilometers for primary and secondary schools respectively
    - For schools located in rural localities without close access to paved roads, two and a half kilometers and five for primary and secondary schools respectively.
    - For health centers located in localities close to a federal road, a state road, or in rural localities, fifteen, ten, and five kilometers respectively

These areas of influence have been calculated and updated with availability of new information on the use of services by the population in marginalized areas, in accordance with the reported distance to the health and education services which are closest to the communities.

All marginalized localities with basic services in the locality or with access to them within the proposed distances described above are eligible to be incorporated in PROGRESA. Using dispersion analysis of this group of localities, areas of high density of marginalized localities are identified and those localities which are found in this conglomeration are selected to be incorporated in PROGRESA in its phases of increasing program coverage.

2. Criteria for Identification of PROGRESA Beneficiary Families

In the process of identifying beneficiary households, PROGRESA begins from the idea that extreme poverty is essentially the result of inadequate individual and family capabilities, which result in very low levels of social functioning. The method which is utilized has the objective of identifying the set of socio-economic characteristics of the household and its members in order to define whether or not the household lives in conditions of extreme poverty.

2.1 Collection of Socio-Economic Household Information

The selection of beneficiary families is based on the analysis of socioeconomic information of each household in the selected marginalized community. This information is obtained through a questionnaire, ENCASEH (Encuesta de Características Socioeconómicas de los Hogares, or Socio-economic Characteristics Household Survey) designed for this purpose through which data is obtained on household characteristics and well being of its members.

PROGRESA provides benefits to the household, which is defined as the set of persons who live together inside the dwelling (whether or not they are related), share household expenditures and prepare food in the same kitchen.

The information is provided by a usual resident of the household at least 15 years of age, who can provide information on other household members. Each informant or interviewee, at the end of the interview, either signs the questionnaire or puts his/her fingerprint as a certification that the questionnaire was carried out. Additionally, as evidence the dwelling was visited, a sticker is attached to the household dwelling, and a copy is given to the informant.

The information is input and saved in magnetic files for processing. Each household and its members are assigned an identification number which allows confidentiality of the information collected whereas Conprogresa stores the actual documents.

The process of data collection is supervised through control of sample mechanisms of coverage and quality control, carried out by groups independent from those in charge of carrying out the questionnaire. Additionally, the municipal authorities and the local representative provide support in the process, helping to identify the geographic borders of the locality and authorizing the activities of the groups in charge of carrying out the questionnaires.

2.2 Household Socio-Economic Questionnaire

The information obtained from the questionnaire of household socio-economic characteristics was designed taking into account the multiple factors which intervene in the determination of whether or not a household is poor. These variables were defined with detailed analysis of socio-economic data sources at the national level. The information included in the questionnaire is the following:

<u>Household structure</u>

- Number of persons
- Identification of household head
- Attributes of household headship, decision-making, principal contributor of income, person responsible for attending to children when sick
- Age and sex of each household member
- Relationship of each individual with head of household
- Identification of father of each member of the household
- Identification of mother of each member of the household
- Marital status for each household member age 12 or older

- Identification of spouses or partners of household members

Individual characteristics

- Literacy:
  If individual can read and write a message, for each household member 5 years or older
- Schooling:
  Ever attended school, for each household member 5 years or older
  Highest grade and level of studies completed, for each household member 5 years or older
  Current school attendance, for each household member 5 years or older
- Indigenous languages:
  Individuals who speak an indigenous language, for each household member 5 years or older
  Individuals who do not speak Spanish, for each household member 5 years or older

Occupation

- Work status
- Work status with the following categories: work, retired, disabled, not working, days worked the previous week, for each household member 8 years or older.
- Occupation
  For each household member 8 years or older, classification of type of worker in the following categories: salaried, self-employed, non-remunerated family workers, owner, and agricultural day worker.

Income of household members

- Income from work:
  Amount of income from principal work, for each household member 8 years or older
  Amount of income from other jobs, for each household member 8 years or older
- Income from work:
  Income from other sources (up to 2 additional sources):
  Retirement pension, other pensions, grants, rent income, for each household member 8 years or older

Benefits from social program

- Social program benefits received from household members
- Basic Education Grants
- Benefits from the National Indigenous Institute
- Worker training grant - PROBECAT
- Temporary Employment Program
- Benefits to rural areas - PROCAMPO
- Subsidized milk - Liconsa o Conasupo
- Distribution of basic food baskets - DIF
- Subsidized tortilla program - Fidelist

Migration

- Permanent
  Age and sex of individuals who previously lived in the household but left in the previous 5

years and have not returned
Place where individual migrated for those individuals who previously lived in the household but left in the previous 5 years and have not returned
Amount of remittances received in the previous year from individuals who previously lived in the household but left in the previous 5 years and have not returned

- Migration for temporary work
  Where the person went to work in the previous 12 months, for household members 8 years or older
  Length of temporary absence, for household members 8 years or older
  Amount of remittances received from each migrant, for household members 8 years or older

Health and access to services of household members

Social security coverage

Access to social security services, for each working household member 8 years or older

- Health services
- Services which household members usually use
- Disabilities
- Number and ages of household members with one of the following disabilities: blindness, muteness, deafness, missing limb, mental difficulties, needs to use device to move around.

Dwelling characteristics

- Composition of the dwelling
- Main material of floors, roof and walls
- Number of rooms in the dwelling, number of rooms used for sleeping
- Services
- Availability of water inside dwelling, on property, running water in bathroom, electricity.
- Ownership and payment status of property.
- Rented or borrowed dwelling, whether fully paid if owned.
- Ownership of domestic and durable goods
  blender, refrigerator, gas stove, gas heater, radio, tape or compact disk player, television, video, washing machine, electric fan, car, truck.

Land and animals

- Number of plots of land and size
- Use of land for agriculture, livestock or forestry
- Type of land - irrigation etc.
- Ownership of livestock and work animals, number and type

During the collection of household data, information is also collected on numerous characteristics of the locality using a questionnaire which obtains information on education services, health, neighboring localities with contact with the locality, transportation used by residents and its cost, supply of basic goods and their prices. This information is obtained through interviewing one or more local representatives.

2.3 Point System

Once information for each household has been obtained, the evaluation of socio-economic characteristics takes place, which is a standardized process at the national level. The socio-economic data is analyzed using a system of points. This system allows for the identification of PROGRESA beneficiary households based on objective criteria which are the same all over the country, and which insure the equal treatment of the population in extreme poverty, independent of the state of residence of the family. This procedure is documented and saved for all the stages of identification of PROGRESA beneficiary families.

The point system which identifies which households will be beneficiaries is the result of the analysis of socio-economic household data in each one of the regions where marginalized localities are found. The points reflect the precarity of the economic resources of the family according to a set of basic indicators. The points take values between 0 and 100, where the lowest value is always associated with a higher tendency to be poor (although the lowest value is not always 0) and are obtained through the method of discriminant analysis, which reflects the distance between poor and non-poor families according to each one of the indicators used.

The method of selecting PROGRESA beneficiary households begins with an initial approximation of poverty condition through the use of the poverty line. This poverty line is obtained through the evaluation of monthly income per-capita compared with the cost of a basic food basket.

Monthly per capita income corresponds to total monetary income of households members aged 15 or more, with respect to all household members. The cost of the basic food basket corresponds to the Normative Food Basket, defined by the General Coordination of the National Plan for Depressed Areas and Marginalized groups (COPLAMAR), and satisfies the minimum requirements to prevent malnutrition, diseases and anthroprometric deficiencies. An expansion factor is applied to this cost to take into account minimum irreducible expenditures on non-food items. The extreme poverty line is adjusted for inflation using the National Consumer Price Index, published by the Bank of Mexico.

A first approximation to the families who live in extreme poverty is done using family income and the poverty line, which classifies households into two groups. After this preliminary classification, a second classification is carried out using a set of social and economic indicators derived from information obtained from the households. The purpose is to construct a multi-dimensional approximation to the poverty condition, for this a discriminant analysis is used, through which it is possible to classify a household either in extreme poverty or not in extreme poverty, according to the household's characteristics.

The discriminant analysis characterizes the multi-dimensional profiles (using numerous socio-economic characteristics) of families in extreme poverty and those who are not in extreme poverty, and using this characterization determines a rule which permits households to be assigned into one of the two groups, as a function of each profile.

Income is used only as a preliminary indicator of the poverty condition of households; the final classification is realized using the entire profile of socio-economic characteristics of each household.

Given the regional heterogeneity of the country, the analysis takes into account regional characteristics, and groups marginalized localities which share similar geographic characteristics. This criterion, while taking into account regional differences, in no way affects the principle of consistency and homogeneity of the analysis, as the same procedure is used based on a set of comparable household characteristics.

The socio-economic characteristics selected to evaluate the poverty condition is carried out through an exhaustive process in which the discriminating power of each variable is analyzed and the best set of variables which identify the poverty condition is retained. In general, this set of characteristics does not change significantly within regions.

2.4 Characteristics of the Procedure for Identifying Beneficiary Families

The method of selecting PROGRESA beneficiary families follows transparent operating methods which are rigorous and objective, and which avoid discretionality in the allocation of benefits of the program to the beneficiary families.

Additionally, it avoids the one dimensional determination (based only on one criterion such as income) of the poverty condition and uses a method which simultaneously considers multiple characteristics.

The procedure uses a classification rule which is largely endogenous and is derived from the information of the households to be classified. Additionally, it permits the classification of new households which did not report their income level, according to their other socio-economic characteristics.

The methodology used increases the trust-worthiness of the selection process of the households, by reducing the risk of errors in the classification of households due to erroneous or imprecise income measurement.

The procedure is applied using consistent and homogenous criteria, without establishing a pre-determined number of families who "should" be PROGRESA beneficiaries either at the locality, municipality or state level. On the contrary, these numbers are derived from the procedure of identification of households in extreme poverty.

3. Incorporation of PROGRESA Beneficiary Families

3.1 Incorporation Process of Beneficiary Families

As a result of the selection of the PROGRESA beneficiary families, the Base Relation of Beneficiary Families is formed. This information is the starting point for the process of the

incorporation of families and contains the following information of the beneficiary family: identification code, name of person who receives benefits, age, date of birth and sex of all household members.

In the incorporation of the families, formal contact is established by PROGRESA with the person (woman) who will be responsible for receiving benefits. PROGRESA informs them of their selection as PROGRESA beneficiaries, explains how the program operates, and distributes material, official identification, and the registration forms for schools and clinics. Each beneficiary must sign or put her fingerprint on a copy of the original documents.

The incorporation of the families is realized in community a meeting, where all beneficiaries are convened. In this meeting, PROGRESA explains the objectives and benefits of PROGRESA as well as the responsibilities which the beneficiary families incur as part of program participation.

Beneficiaries are informed of their responsibility to go to the closest health sector clinic to register and receive the programmed set of clinic visits they must keep to continue receiving benefits. At this time, the process of certification of their children in school is also explained and the appropriate forms are distributed.

They are also informed that PROGRESA beneficiaries cannot receive benefits from any other Federal program that provides equivalent benefits in the areas of education, health or nutrition.

Additionally, the community is presented the list of family beneficiaries who have been selected. In case of particular observations, these cases may be reviewed and changed according to the established criteria for the selection of beneficiary families. This may include a new visit to the household to obtain the socio-economic information necessary.

In the community meeting, cases may arise where the information for families was not obtained during the visit where the socio-economic questionnaire was carried out. In these cases, Conprogresa will review the request for their incorporation into the Program.

Each household selected as beneficiary is notified and is incorporated into the Program. At the end of the meting, an Act of Agreement of the Community Assembly is carried out, with the agreement of the municipal authorities.

In special cases, in which it is not possible to carry out a community meeting, the incorporation is realized through meeting with each individual family beneficiary in the locality.

3.2 New Requests for Incorporation in PROGRESA in Localities where the Program is in Operation

Families which live in a selected locality where PROGRESA operates and which have not been selected as beneficiaries may solicit that their case be reviewed. In these cases, the socio-economic information collected is reanalyzed, and when necessary, the relevant household is visited.

In cases where families were not selected because their socio-economic information was not collected (whether due to absence of household members in the period of the survey, failure to provide information or whether due to migration) the questionnaire is carried out followed by the analysis of whether the household has the necessary characteristics to be a PROGRESA beneficiary household.

Each household selected is notified and their incorporation is carried out through a visit to the household or a letter soliciting that they go to a PROGRESA Attention Module (MAP) to be incorporated in the Program.

Table 1 — PROGRESA, Incorporation Report

Region Code	Name of the Region	Households Incorporated	Households Not Incorporated	Households Disputed
1	Los Altos			
2	Sierra			
3	Sierra Negra-Zongolica-Mazateca	32,964	2,211	6
4	Otomi-Tepehua-Sierra Norte	14,607	382	111
5	Sierra Gorda	31,405	484	303
6	Montaha		4,240	
7	Tarahumara-Las Quebradas-Indigena	18,005		
8	Desierto-Semidesierto	22,404	78	4
9	Campeche rural	940	4	3
10	Costa	22,513		
11	Maya	1,983	9	
12	Huasteca		80	
13	Mixteca-Costa-Chatina	3,786	78	9
14	Suroeste-Norte	6,327	158	
15	Norte-Selva			
16	Pochutla			
27	Tierra Caliente-México	74,768	324	107
28	Altiplano	3,937	19	1
31	Serrana-Sierra de Alamos	3,867	168	154
32	Tamaulipas	2,419		
33	Sierra Norte-Sierra del Nayar	10,574	47	30
34	Sierra Tapalpa	2,278		
35	Meseta Purepecha-Sierra de las bufas	9,583	9	4
36	Costa-Colima	4,489	19	19
37	Microregiones	19,036	49	
38	Morelos	3,804	1	1
39	Frontera Sur	393	1	33
40	Centro-Sierra-Chotalpan-Costa	20,457	103	6
41	Sierra Juarez-Sierra de Soteapan-Valle de Uxpanapa	3,269	14	
42	Huasteca-Otros (Veracruz)	1,864		
43	Norte (Jalisco)	2,658		
44	Mixteca (Puebla)	9,056	1,104	
45	Valle de San Quintin	1,037		
46	Baja California Sur	1,245		
47	Frontera (Coahuila)	133	1	1
48	Frontera (Tamaulipas)	2,456		
49	Frontera (Sonora)			
50	Istmo	1,591	6	3
51	Sierra Norte (Veracruz)	2,805		
Total		340,973	5,269	795

Table 2 —PROGRESA Incorporation

	Number	Percentage
Total number of incorporated families	340,973	100.00
Households not incorporated:	5269	1.55
Moved to another locality	4259	1.25
Duplicate id number	89	0.03
Death	3	0.00
Disputed	423	0.12
Rejected PROGRESA	93	0.03
Already has PROGRESA	30	0.01
Observed	371	0.11
Total	5269	1.55

APPENDIX B

Evaluating the Effectiveness of PROGRESA's Marginality Index in Identifying the Poor

In this appendix we examine in detail the first stage of targeting, the construction of the marginality index with which PROGRESA communities are chosen.

1. Methodology

1. 1 Estimating a Probit Model

Using data from the 1996 ENIGH survey, covering 13,208 observations, we divide households into poor and non-poor. The poverty line was set at the 25^{th} percentile of per adult equivalent household consumption. The probit model evaluates the impact of a vector of explanatory variables on the probability of living in poverty, and the technique (along with that of its cousin the logit) has been explained in detail in the notes on the one step experiment and the relative operating characteristics (ROC) analysis. These seven explanatory variables are similar to those used by PROGRESA in the construction of the marginality index. They include illiteracy of the household head, lack of running water, use of drainage system, access to electricity, crowding (ratio of household members to rooms), dirt floor, and agricultural labor activity. Note that the direction of some of these variables is opposite to that of their counterparts from the census data.

The probit model builds a measure, which we call zeta and which is assumed to have a normal distribution. Each value of zeta is associated with a predictive probability. In order to achieve comparability with the PROGRESA marginality index, we need to divide households into five groups. Four transition points are thus necessary, which we determine with the Dalenius and Hodge method.[1] These transition points will serve to classify localities after we have applied the out of sample prediction to the census data.

The model formula is

$$zeta = a + \sum b \bullet x$$

where α is a constant and the β's are coefficients, or weights, for the seven variables.

[1] See de la Vega, 1994, for a description of this method.

These values are:

constant	-1.67
illiteracy	.29
no running water	.52
sewage	-.19
with electricity	-.28
crowded dwelling	.32
dirt floor	.27
agricultural labor activity	.44

The signs of the coefficients are as expected. The higher the value of the coefficient, the larger the probability of living (or not living) in poverty. For example, having an illiterate household head increases the probability of living in poverty by 29%, controlling for the impact of the other variables. The most influential variables are lack of running water and working in agriculture. The former is associated with a 52% increase in the probability of living in poverty, and the latter a 44% increase.

Zeta ranges from –2.1 to 4.8. The transition points for the five group classification are -1.59, -.94, -.22, and .73. The fourth and fifth groups are considered high and very high poverty, which would correspond to the high marginality and very high marginality classifications of the PROGRESA marginality index, from which communities were brought into the PROGRESA program. From this grouping the predicted probability cut off for poverty is .41, giving a proportion of poor households of 59 percent. ENIGH households are thus distributed as follows among the five groups:

Very Low	5,322
Low	1,972
Medium	2,166
High	1,736
Very High	2,012
Total:	**13,208**

1.2 Principal Components and the PROGRESA Marginality Index

The PROGRESA marginality index for 74,996 localities nationwide was built using the first principal component of the seven aforementioned variables, using data from the 1990 and 1995 population census. This index is a linear combination of the variables. The results of the principal components analysis are as follows:

illiteracy	.22
no running water	.20
no sewage	.21
no electricity	.22
crowded dwelling	.21
dirt floor	.26
agricultural labor activity	.16

Note that the principal components results differ from the probit in that there is no constant term. The interpretation of the weights is straightforward. The absence of a particular variable indicates a higher contribution to marginality. The index ranges from –2.6 to 3.9, with transition points at –1.6, -1.2, -.6, .03. Again, the Dalenius and Hodge method was used to determine these transition points. The distribution of the localities into the five groups can be seen below:

Very Low	4,089
Low	5,611
Medium	12,481
High	16,584
Very High	36,231
Total:	**74,996**

1.3 Probit Model and Localities

The application of the probit weights to localities allows us to compare the probit classification of localities with the principal components classifications, thus providing a test of the robustness of the latter. By creating a 5x5 matrix, we can analyze the distribution of localities given by each method, and we can evaluate the principal components method based on the concepts of undercoverage and leakage. Leakage occurs if localities under the principal components method get classified as more marginal compared to the probit method. Conversely, undercoverage occurs if localities under the principal components method get classified as less marginal compared to the probit method. The 5x5 matrix can be found in Table 1.

Thus, the objective is to give some insights on whether PROGRESA targeting method at the locality level is excluding (respectively including) localities that would have been included (respectively excluded) using the probit method.

Localities that fall in the diagonal indicate that both methods coincide in the allocation of localities to a particular category. We consider localities off the diagonal, but with just one level of difference, as an acceptable boundary of misclassification.

From Table 1 it is evident that the probit method results in a stricter classification then the principal components method. In general, one can observe a shift downwards and to the left in the categorization of localities. For example, while the principal components method allocates almost half of all localities to the Very High category, the probit method

has only 3% in this category. The bulk of localities under the principal components method are in the Medium, High, and Very High (88%) categories, while the probit allocates them primarily to the Low, Medium and High categories. In terms of undercoverage and leakage, this means that the principal components method has high levels of leakage. Undercoverage is minimal with the principal components method compared to the probit method. On the other hand, the probit method is less apt to classify localities in the Very Low category as well. While the principal components method puts over 4,000 localities in this category, the probit model puts only 613 localities.

Overall the down and leftwards shift does not appear too serious. The off diagonal corner cells remain empty. The majority of localities remain within at least one category distance. Those who do shift more then one category present a problem, however. Most significant are those localities that are considered High or Very High marginality under principal components, and that are reclassified by the probit as medium (6,104 localities) or Low (83). PROGRESA initially incorporated localities in the two highest marginality categories, beginning with the most marginal first. The probit requested would entail a fairly significant number of these localities from being excluded in the initial stages of PROGRESA. Moreover, the probit method allocated only approximately 30,812 localities to these categories, while the principal components brought in over 52000. Assuming a similar budget constraint, probit Medium localities would also have been brought in, greatly minimizing the problem of undercoverage.

1.4 Marginality Index and Households

In Table 2 we repeat the exercise conducted above, though this time applying the principal components weights to the ENIGH households.

The purpose is to test how the marginality index method distributes the households in the different categories compared to the probit method. Over all the localities, is PROGRESA targeting method at the locality level excluding (respectively including) households that would have been included (respectively excluded) using the probit method?

At first glance the results appear similar to those in Table 1. The marginality index method tends to include Low and Medium poverty households in the High and Very High classes. Few households are reclassified by more than two groups, and particular coincidence is found in the lowest and highest categories. Once again, the probit model appears more strict, though less so than in the previous exercise.

1.5 In Terms of Population: The Probit Method on the Full Census of Localities

In addition to the 74,996 localities discussed above, in the final version of the PROGRESA marginality index another 30,000 localities with partially missing census data were added. Regression analysis was used to fit the missing data and adjust the marginality index.

In Table 3 we present a new 5x5 matrix taking into account these additional communities, and applying the probit weights. The trends do not change substantially from Table 1. From this table, however, we can convert localities into the population they represent. This can be found in Table 4.

In general the results are similar to the locality tables. It is clear that less marginal localities tend to have larger populations, and more marginal communities, smaller populations. The reclassification of the principal components method High as probits Low may raise concern; however, this involves only 16,000 individuals. The reclassification of Very High as Medium is less problematic given the tendency we discussed earlier of the reduced numbers of probit High and Very High. Given a fixed budget, most of the probit medium households would be brought in as well.

1.6 Comparison of the Distribution of PROGRESA Beneficiary Localities by the Principal Component Method and the Probit Method

Finally, in Tables 5 and 6 we restrict our attention to the first 36,006 localities that were selected communities that PROGRESA would reach first. Table 5 presents the localities, while Table 6 the population represented. The undercoverage and leakage tendencies are similar to those described in other tables. Somewhat disconcerting, however, is that 8% of the almost 1.8 million potential PROGRESA beneficiaries are located in communities put in the Low category by the probit model.

2. Conclusion

The methodology developed in this note has permitted us to test the robustness of the PROGRESA marginality index, which is based on principal components analysis. We find that, for the most part, PROGRESA's marginality index holds out well to the probit model. The probit model results in a stricter categorization of poverty. After constructing a 5x5 matrix of marginality categories, the distribution of localities by the principal components method is down and to the left of the probit distribution. As a result, leakage is more of a problem than undercoverage. The fit between the two methods is particularly tight for the Low and Very High marginality categories, and is more diffuse in the middle categories. This suggests that the PROGRESA marginality index loses its power of distinction between medium marginality localities precisely at a time when PROGRESA is expanding into less marginal communities. This will introduce a measure of arbitrariness into the selection of these communities. One way to counteract this problem would be to incorporate information from other alternative marginality indices, such as the probit method presented here.

Table 1— Distribution of Localities by Principal Components and Poverty Methods

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	613	3473	3			4089	5
	Low		5361	250			5611	7
	Medium		5390	7088	3		12481	17
	High		83	15819	682		16584	22
	Very High			6104	27770	2357	36231	48
	Total	613	14307	29264	28455	2357	74996	100
	%	1	19	39	38	3	100	

Table 2— Distribution of Households by Principal Components and Poverty Methods

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	4365	1771	113			6249	47
	Low	110	624	407			1141	9
	Medium		346	1185	79		1610	12
	High		84	728	685	8	1505	11
	Very High		1	397	1432	873	2703	20
	Total	4475	2826	2830	2196	881	13208	100
	%	34	21	21	17	7	100	

Table 3—Distribution of Localities by Principal Components and Poverty Methods (Full Census)

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	613	4790	3			5406	5
	Low		6488	474			6962	7
	Medium		6327	9236	5		15568	15
	High		87	21142	837		22066	21
	Very High		2	8110	43797	3837	55746	53
	Total	613	17694	38965	44639	3837	105748	100
	%	1	17	37	42	4	100	

Table 4—Distribution of Population by Principal Components and Poverty Methods (Full Census in thousands)

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*	40356	19312	0			59668	66
	Low		7469	72			7541	8
	Medium		3873	4276	1		8150	9
	High		16	6383	180		6579	7
	Very High		0	1848	6462	359	8669	10
	Total	40356	30670	12579	6643	359	90607	100
	%	45	34	14	7	0	100	

Table 5—Distribution of Localities by Principal Components and Poverty Methods (PROGRESA Universe)

Probit Model

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*							
	Low							
	Medium		1644	2488			4132	11
	High		42	9910	351		10303	29
	Very High			3769	16608	1194	21571	60
	Total		1686	16167	16959	1194	36006	100
	%		5	45	47	3	100	

Table 6 —Distribution of Incorporated Families by Principal Components and Poverty Methods (PROGRESA Universe in thousands)

Probit Model (Thousands)

		Very Low	*Low*	*Medium*	*High*	*Very High*	*Total*	*%*
Principal Components	*Very Low*							
	Low							
	Medium		137	186			323	18
	High		2	568	15		585	33
	Very High			185	654	35	874	49
	Total		139	939	669	35	1782	100
	%		8	53	38	2	100	

APPENDIX C

Description of Evaluation Sample of Households and PROGRESA Beneficiaries

1. Introduction

In this section we analyze the characteristics of the households that are included in the evaluation sample. Our goal is to judge whether the PROGRESA targeting mechanism selects households in accordance with the objectives of the program. We do this through two different lenses. First we will order households by quintiles of puntaje, which is the score given by the statistical procedure PROGRESA utilizes to select beneficiaries. We then analyze the distribution of household characteristics across these quintiles. Second, we will compare the characteristics of those households that are selected as beneficiaries of PROGRESA with those who have been excluded. These characteristics include demographic, school attendance, asset holdings, ownership of consumer durables, labor market participation, and income and consumption levels variables.

This note is ordered as follows. First, we briefly describe the puntaje system and present some graphs of the distribution of puntajes by region and locality. Second, we proceed to show the distribution of a variety of household characteristics by puntaje quintiles. Third, we estimate a probit model on selection as a PROGRESA beneficiary in order to ascertain which household characteristics are significantly associated with effecting the probability of selection, while controlling for other variables.

2. Distribution of Puntajes

The statistical procedure used by PROGRESA to select beneficiaries gives as an output a puntaje, or score.[1] The puntaje obtained from the discriminant analysis estimation can be interpreted as a measure of welfare, which takes into account a variety of household characteristics and assets, as well as per capita income. This estimation is conducted by region. The puntaje orders households from less welfare to more welfare, and follows a normal distribution. A cut off point is chosen by further manipulation of the mechanism and households below the cut off line are selected as beneficiaries.[2]

In Figures 1 to 6, we graph the distribution of puntajes for six of the seven regions of the evaluation sample. The corresponding names of each region, along with the number of households, are found in Table 1. Though the original estimation was carried out with the total PROGRESA population, of which our evaluation households are only a small subsample, the distributions are essentially normal. The vertical line on the graph, with

[1] See appendix A for a more detailed description of the selection mechanism.
[2] In this appendix we are not considering changes to household puntajes that may have occurred in the densification phase.

its corresponding quantity on the horizontal axis, is the cut off line for that region. This line is found near the center of each of the distributions.

In Figures 7 to 12 we graph the distribution of puntajes on a random selection of six communities. While most of the localities no longer have a normal distribution, the allotment of beneficiaries and non-beneficiaries is more or less equal. It should be noted, however, that in some communities of the evaluation sample all households are beneficiaries, while in others less then 10% may be beneficiaries.

3. Distribution of Household Characteristics by Puntajes

In this section we attempt to gauge whether the puntaje system correctly orders households, in terms of the objectives of the PROGRESA program. The goal of PROGRESA is to target households living in extreme poverty, though defining poverty from a multidimensional perspective. This entails using a variety of household characteristics instead of just the traditional welfare indicators, such as income or consumption. Overall, the puntajes "reflect the level of family economic resources according to a group of basic indicators" (PROGRESA, 1999). In practice, a number, but not all, of the household characteristics we use in this section form part of the statistical routine for selecting beneficiaries. While no ready definitive answer is available on what a PROGRESA beneficiary—or someone in extreme poverty—should look like, and indeed there is disagreement, common sense can serve as a first step.

Figures 13 to 16 present basic demographic variables by puntaje quintiles, for Regions 3 through 6. Puntaje increases with the age of the head of household. Those households in the lowest puntaje quintiles average less then 40 years of age, while in the highest puntaje over 50 years. The share of households with a male head decreases with increasing puntaje scores, though in all cases heads of households are predominately male (over 80%). The average years of education for adults increases with puntajes, though Region 6, Guerrero, has significantly lower levels of education than the other three regions presented. Finally, the share of indigenous households decreases with puntaje.

In Figures 17 to 19, we focus on the share of households with children in different age groups who do not attend school, conditional on having children in each age group. This involves one of the key policy interventions of PROGRESA, trying to provide incentives so that school age children return to, or stay in, school. The share of households with children ages 6 to 11 who do not go to school decreases with increasing puntaje. This trend weakens for children ages 12 to 14, and no trend is found for children ages 15 to 16.

Similar trends can be seen in Figures 20 to 22, which show the average number of children per household in different age categories. In this case, the number of children ages 6 to 11 per household decrease with increasing puntaje. Children age 12 to 14 show a similar trend, though at approximately half the absolute level. Finally, once again, no trend is found for children ages 15 to 16.

Bringing together the results presented thus far, it is not clear, a priori, that these are all desirable tendencies. Younger household heads, with more small children and higher dependency ratios, are associated with poverty, when defined on a per capita basis, due to their place in the life cycle. Some argue that having large numbers of children, and the concomitant high dependency ratios, which play key roles in weighing the puntaje[3], is an endogenous decision that should be treated like any other consumer durable, instead of serving to bias towards being selected as poor, as in per capita measures.[4] While this particular position would be difficult to defend politically, PROGRESA has moved to correct bias against older, childless households, in the densification phase.[5]

Though the result that the share of female headed households increases with increasing puntaje is somewhat disconcerting, different levels of economic status may be reflected in the age and other characteristics of female heads, and thus we will wait for the econometric analysis to sort out the differences. Ethnicity is not the exclusive purview of extreme poverty as in a number of regions (Guerrero with 49%, and the Sierra Gorda (5) with 28%) an important share of the wealthiest households are indigenous. Further, the results of the one step experiment show that inclusion of non-poor indigenous households, at the expense of poor non-indigenous households, significantly recasts the characteristics of beneficiary households in an undesirable manner.

The average holdings of productive assets by puntaje quintiles are found in Figures 23 to 5. Average cattle herd size increases with puntajes, though the wealthiest households in Region 5, the Sierra Gorda, have two to three times the heads of cattle as the other regions. The land variables, however, are not so straightforward. While for most of the regions irrigated land—a powerful productive asset in most of rural Mexico—increases with puntaje distribution, in Guerrero the trend is V-shaped, with the poorest households having significant amounts of irrigated land. In terms of rainfed land, while there is a certain upward trend among all regions, Guerrero is an inverted V. In both cases, Guerrero households have significantly more land than the other regions, more than double across quintiles in the case of rainfed land.[6] With the exception of the puzzling Guerrero results, these are the expected, and desirable, trends.

In terms of durables and housing characteristics, the results are presented for Regions 3 and 6 in Figures 26 and 27. In both Regions, the variables of interest follow similar trends. While the percentage of households with dirt floors decreases with increasing puntaje, the opposite is true for consumer durables and electricity. The percentage of households with electricity, radios, running water, blenders and refrigerators increases with increasing puntaje. This is the desirable, and expected, result given that a number of these variables were used in the PROGRESA selection procedure.

[3] See Appendix I on ROC curves, for a discussion of the role of different variables.
[4] See Jere Behrman's argument, referred to in "Evaluation of Selection of PROGRESA Beneficiaries," Proceedings of the Second IFPRI-PROGRESA Workshop, February 26, 1999, Mexico City.
[5] The densification phase involved a second wave of targeting of beneficiaries in communities already incorporated into PROGRESA. The objective was to correct for biases in the selection mechanism against households with older heads and fewer younger children.
[6] One caveat is that we are unable to control for rainfed land quality.

The number of family members involved in different labor activities is presented in Figures 28 through 31. The average number of family members working as agricultural wage laborers is constant across the first four quintiles (or increasing in the case of Guerrero), then drop for the last quintile. This is not surprising, as participation in agricultural wage labor markets is generally not associated with wealth. Conversely, the number of family members engaged in non-agricultural wage labor increases with puntaje, as this type of labor is associated with escape from poverty and higher levels of welfare. Similarly, the number of family members engaged in self-employment activities also increases. Finally, Region 6 contrasts with the other regions in terms of participation in family labor (principally farm) activities. While farm labor increases with the puntaje for most regions, it decreases drastically in Guerrero. This, combined with the land results, paints a picture of either generally poor returns to agriculture in a region highly dependent on agriculture, or problematic gathering of this type of income.

Finally, the distribution of two measures of welfare, average per capita income and consumption, are found in Figures 32 and .33.[7] In both cases, the measures of welfare increase with the puntaje. Region 6, however, once again is set apart from the other regions. Across the board Region 6 has lower levels of both income and consumption. Two reasons for this difference can be surmised. First, Guerrero is a significantly poorer region than the others, with lower average incomes and levels of consumption. We do not adjust for differences in prices between regions, which could contribute to the different levels. To a certain extent this is implicitly recognized by PROGRESA, as Guerrero has the highest share of beneficiaries out of all the regions. Second, given the higher dependency on agriculture in Guererro, and the built in underestimate of agricultural income in ENCASEH97, and of home produced consumption in ENCEL98m, both income and consumption may be underestimated. In Figure 34, however, we graph consumption from ENCEL98O, which more completely captures household consumption. Here also Region 6 is consistently below the other regions, lessening the likelihood of underestimation in the collection of the consumption data.

4. Econometrics

We complement the descriptive statistics presented above with a Probit equation on selection as a PROGRESA beneficiary.[8] The probit regression permits us to isolate the impact of each variable over the probability of selection as a beneficiary, while controlling for the rest of the explanatory variables. We run this regression for Region 5, since the PROGRESA selection process is conducted by regions. If we ran a probit on the full sample and used dummies to control for regional variation, we would be assuming that the coefficient on the other explanatory variables do not vary by region. The results can be seen in Table 2.

In terms of the demographic variables, the results confirm, for the most part, our conclusions from the descriptive statistics. Having a younger household head, more

[7] Income comes from ENCASEH97, while consumption comes from ENCEL98m.
[8] In the discussion of the one step experiment we provide a description of the Probit technique.

small children, a higher dependency ratio, and lower levels of education all are associated with a significantly higher probability of selection. Similarly, not having children aged 12 to 14 and 15 to 16 is also associated with a higher probability. Fortunately as well, having children aged 12 to 14 and 15 to 16 not in school, when drop out rates are highest, is associated with a significantly higher probability of selection.

Being indigenous is associated with only a 4.5% increase in the probability of selection. Having a family member who is disabled, a variable we did not analyze in the descriptive statistics, is associated with a large 10% increase in the probability. Contrary to the descriptive statistics, however, having a male head of household is associated with a 4% decrease in the probability of selection. This is comforting, as both politically and in principal, female headed households should have a higher probability of selection into the program.

Productive assets present a mixed picture. The coefficient on irrigated land is associated with a decreased probability of inclusion in PROGRESA, while the coefficient rainfed land is neither significant nor large. Irrigated land is of superior quality to rainfed land, whose profitability may be more influenced by factors for which we are unable to control, including credit constraints, transaction costs, and land quality. Both cattle and pig holdings are both associated with a lower probability of inclusion into the program.

Ownership of durables and dwelling characteristics followed desirable patterns. Again many of these variables are used in the PROGRESA selection process. All of the durables included in the equation, including blenders, gas stove, radio, television and refrigerators, are associated with a lower probability of selection. For the larger durables these effects are important; ownership of televisions lowers the probability 31% and refrigerators 55%. Similarly, having running water and electricity also have large and negative effects on the probability of selection. Finally, having a dirt floor and higher housing density ratio (family members to number of rooms) are associated with higher probabilities.

The labor activity variables confirm the story presented in the description section. The number of family members involved in agricultural wage labor activities is associated with a higher probability of inclusion in PROGRESA, though the coefficient is not quite significant. Self-employment, on the other hand, is associated with a lower probability. Differences also emerge in migration, variables that we did not include in the descriptive analysis. In this case either temporary (a current family member) or permanent (who has left in last five years) migration to the United States, which is generally considered to have higher returns than migration to other parts of Mexico, is associated with a lower probability of selection.

5. Conclusion

Based on the evidence presented above, the PROGRESA targeting procedure appears to correctly order households according to a multidimensional definition of poverty. The

incidence or levels of variables of interest increase or decrease in an expected fashion with the puntaje quintiles. Using the Probit technique we were able to determine that the household characteristics associated with selection into PROGRESA are in accordance to the objectives of the program. This is true for both variables used in the selection process as well as those that are not. It is worth noting, however, that the bias towards larger, younger families has been met with some disagreement, and that in fact PROGRESA has moved to partially counteract this bias through the densification process.

On the other hand, the role of land assets, particularly in Guerrero, is curious and merits further investigation. This, combined with the labor activity trends and significantly lower income and consumption levels in Guerrero, raises the question of whether due to survey design these two welfare measures were underestimated in this region, and perhaps others where households are highly dependent on subsistence agriculture. More likely, given the updated evidence provided in ENCEL98O, confounding factors may exist which make subsistence agriculture less profitable in Guerrero than in the other regions of the survey. The probit results from Region 5, the Sierra Gorda, for example, show that irrigated land is indeed associated with a lower probability of selection into PROGRESA.

Finally, though the targeting method appears valid, it is only as good as the data upon which it is based. Anecdotal evidence and field experience show that better off households are not always completely straightforward in responding to the implementation of ENCASEH. Recent changes to the ENCASEH format may make it easier to identify households providing false information.

Table 1—ENCEL Regions, with Number of Households

3	Sierra Negra-Zongolica-Mazateca	3031
4	Sierra Norte-Otomí Tepehua	4559
5	Sierra Gorda	10790
6	Montaña (Guerrero)	1907
12	Huasteca (San Luis Potosi)	383
27	Tierra Caliente (Michoacan)	2935
28	Altiplano (San Luis Potosi)	472
Total		24077

Figures 1—6 —Regions

Figure 1. Region 3

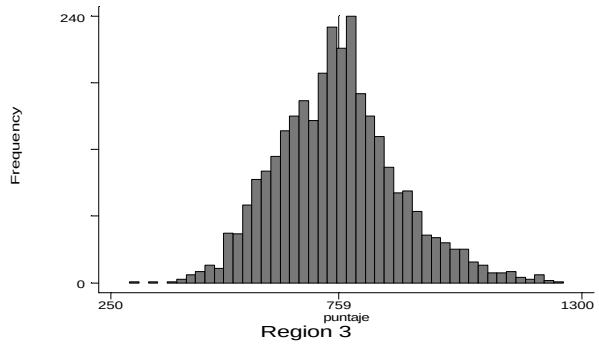


Figure 2. Region 4

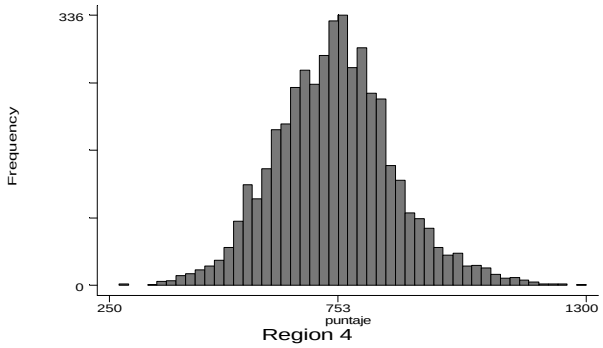


Figure 3. Region 5

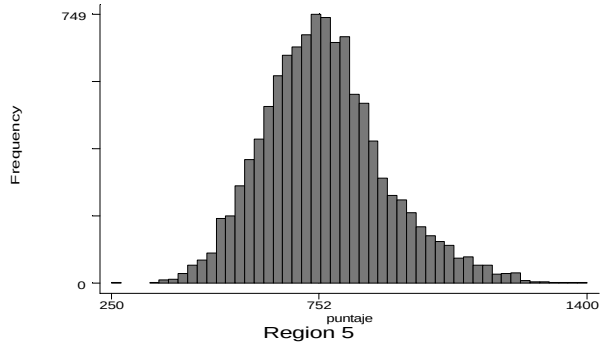


Figure 4. Region 6

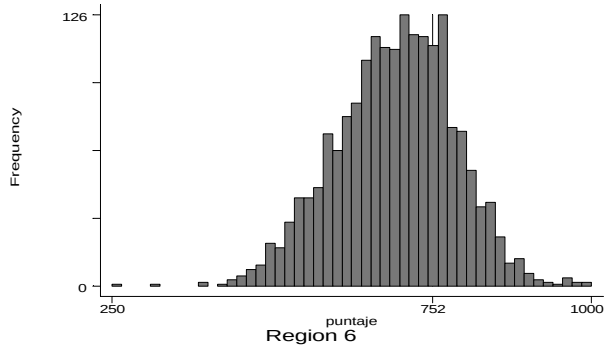


Figure 5. Region 12

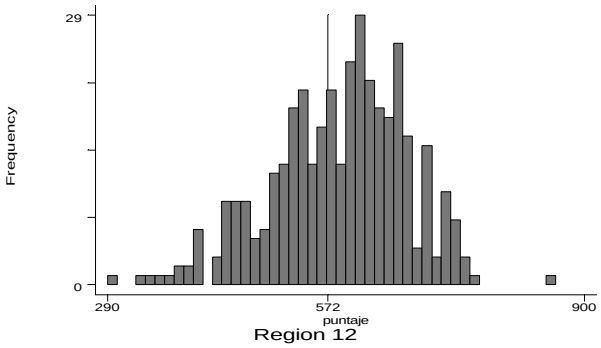
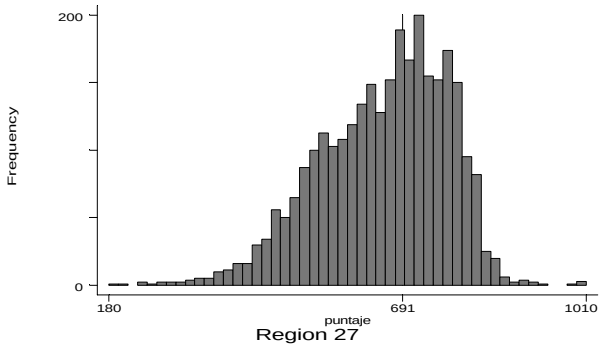


Figure 6. Region 27



Figures 7—12 — Localities

Figure 7

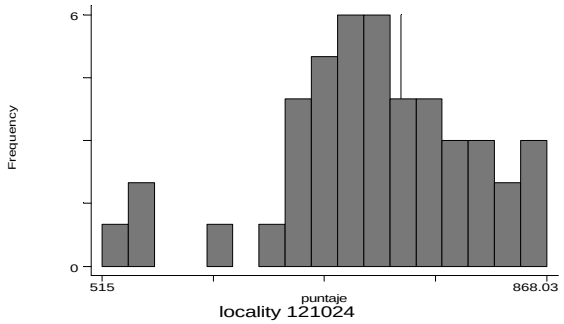


Figure 8

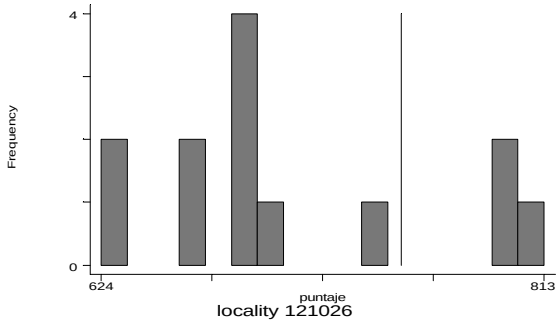


Figure 9

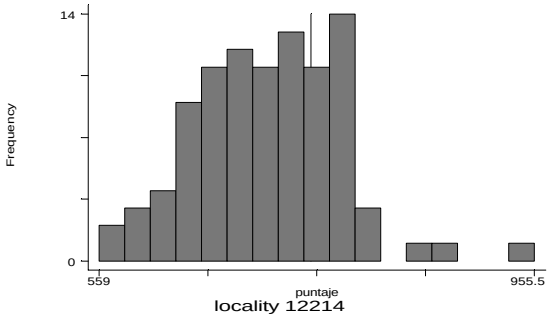


Figure 10

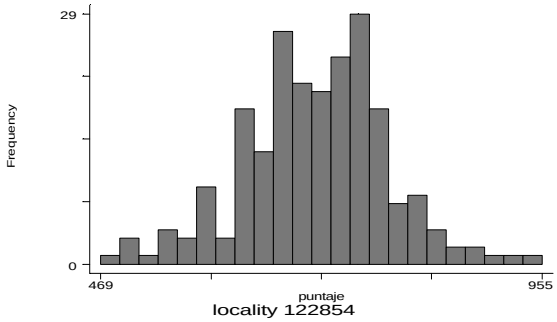


Figure 11

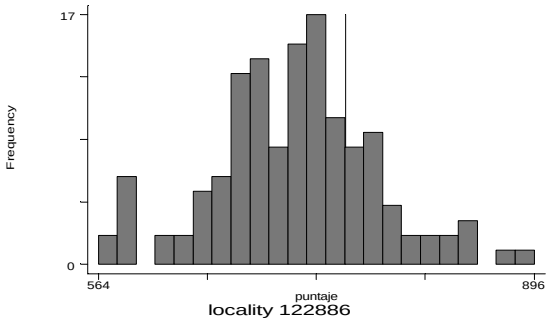
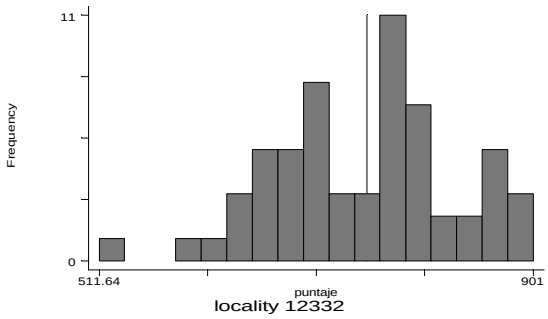


Figure 12



Figures 13—34 —Variation in household characteristics across quintiles of the puntaje.

Figure 13. Age,head of household, by region

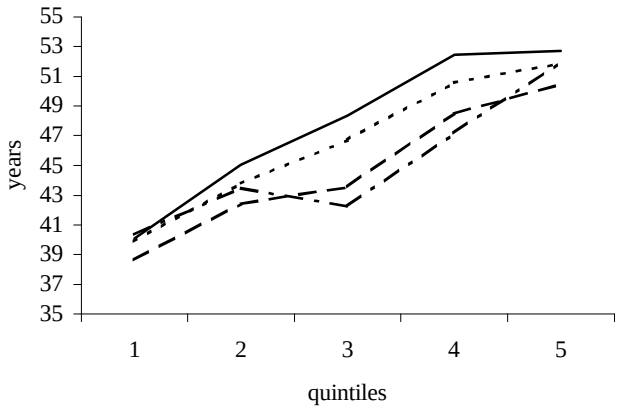


Figure 14. Male head of household, by region

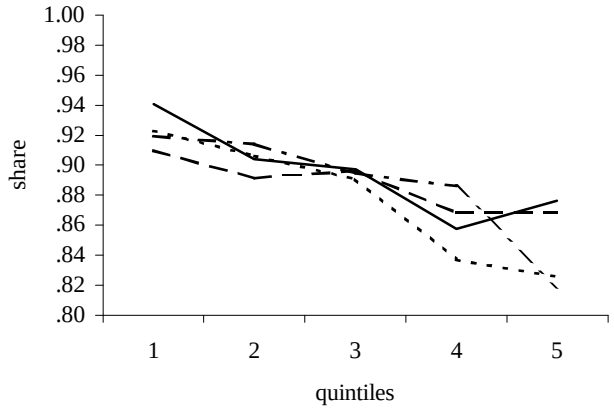


Figure 15. Years of education, adults by region

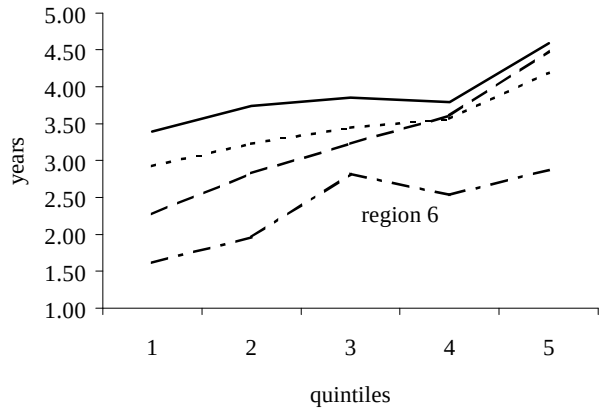


Figure 16. Share of indigenous households, by region

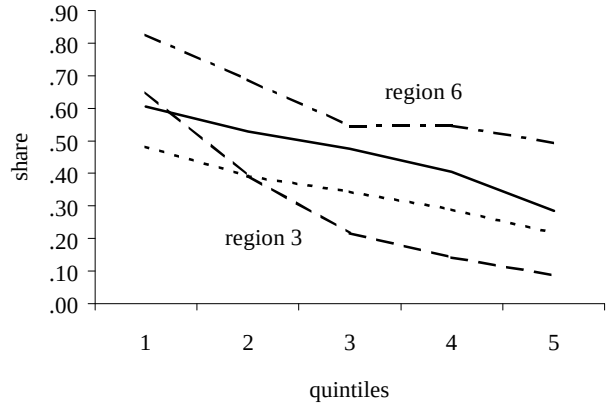


Figure 17. Share of households with children ages 6-11 who do not go to school, by region, conditional on having children

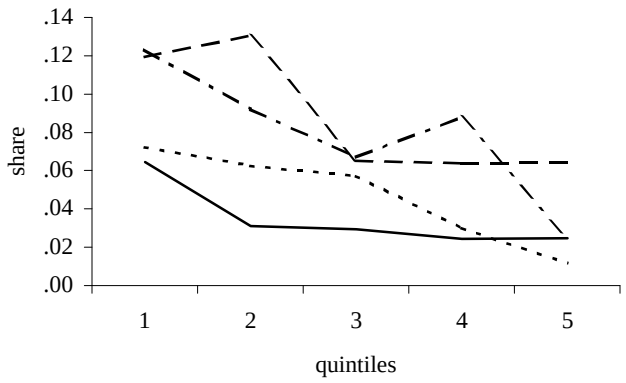


Figure 18. Share of households with children ages 12-14 who do not go to school, by region, conditional on having children

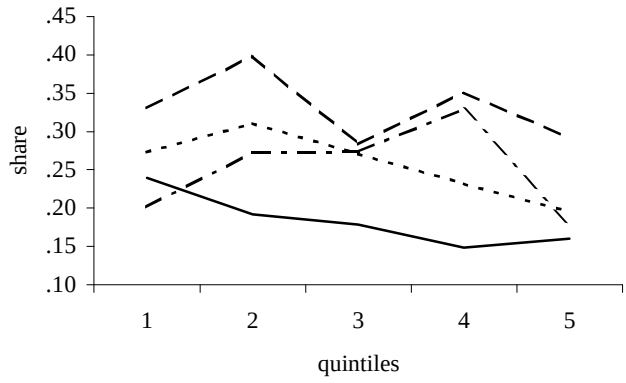


Figure 19. Share of households with children ages 15-16 who do not go to school, by region, conditional on having children

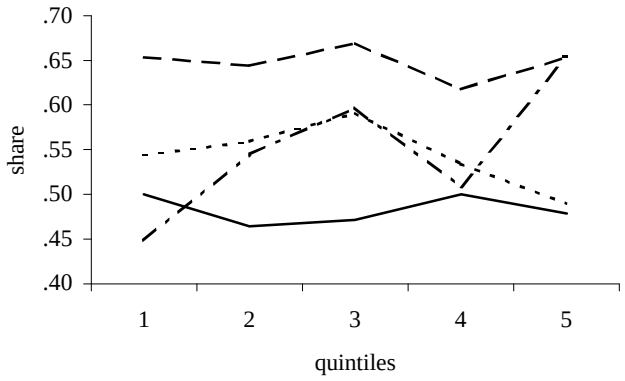


Figure 20. Number of children ages 6-11, by region

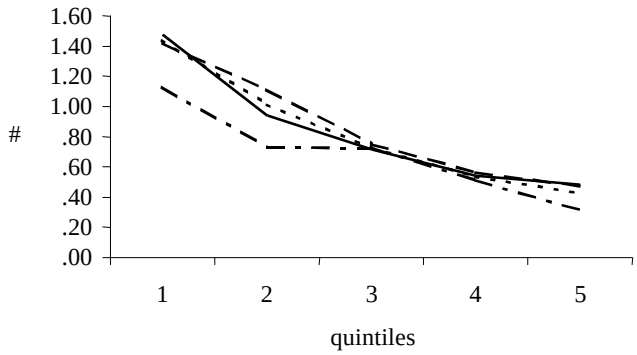


Figure 21. Number of children ages 12-14, by region

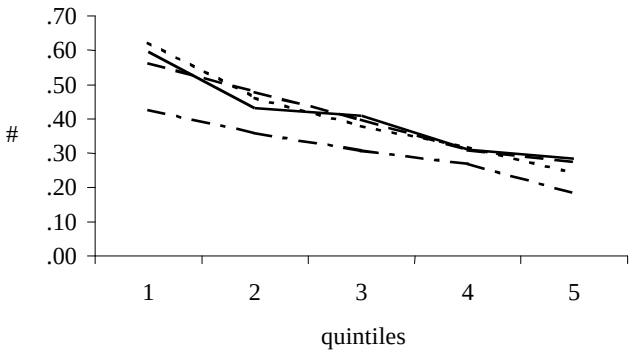


Figure 22. Number of children ages 15-16, by region

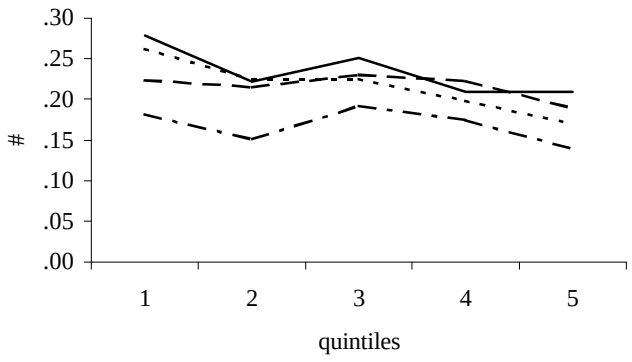


Figure 23. Heads of cattle, by region

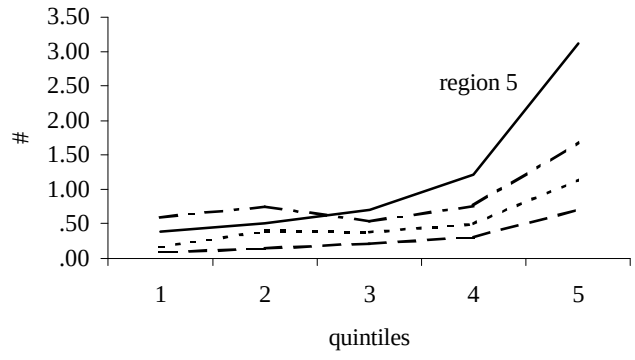


Figure 24. Has of irrigated land, by region

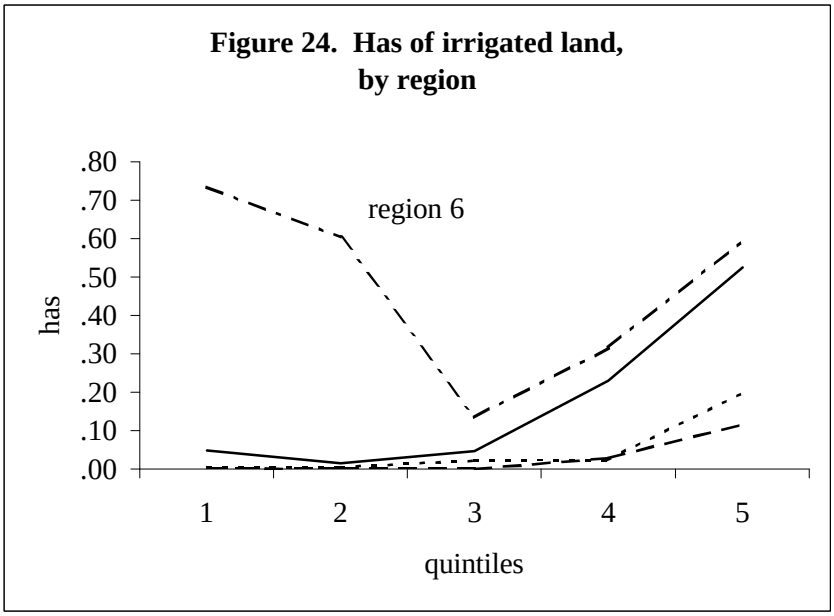


Figure 25. Has of rainfed land, by region

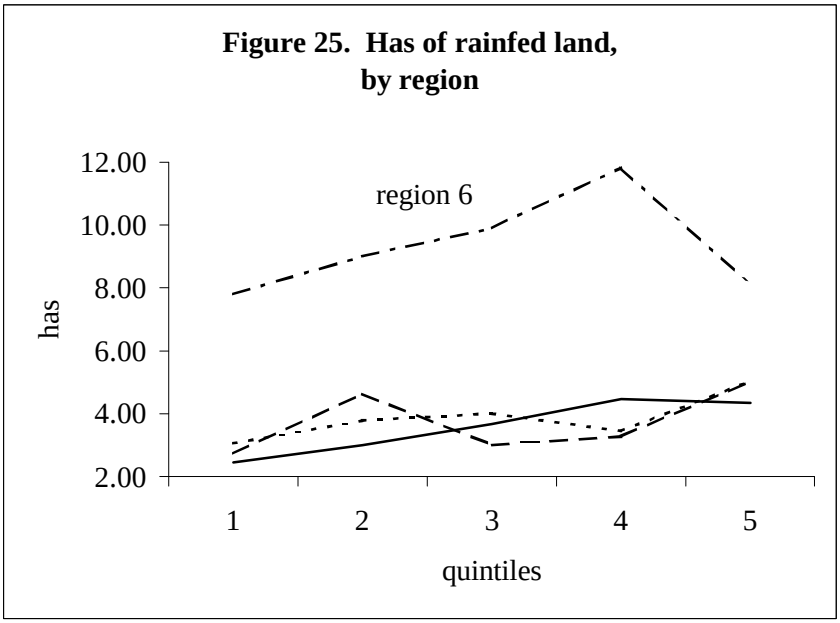


Figure 26. Durables and housing characteristics, Region 3

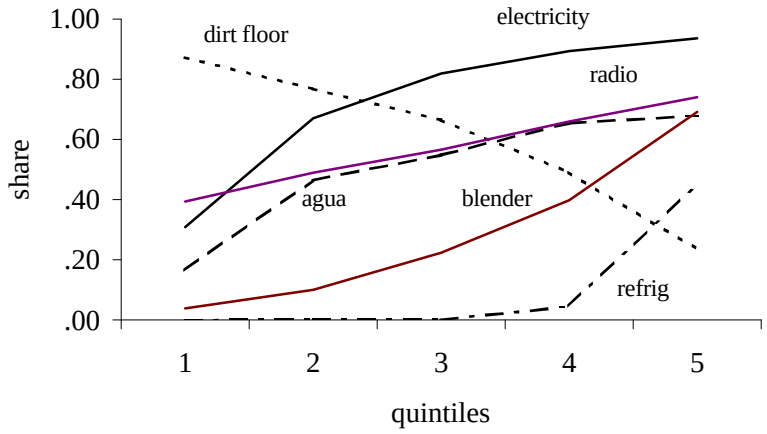


Figure 27. Durables and housing characteristics, Region 6

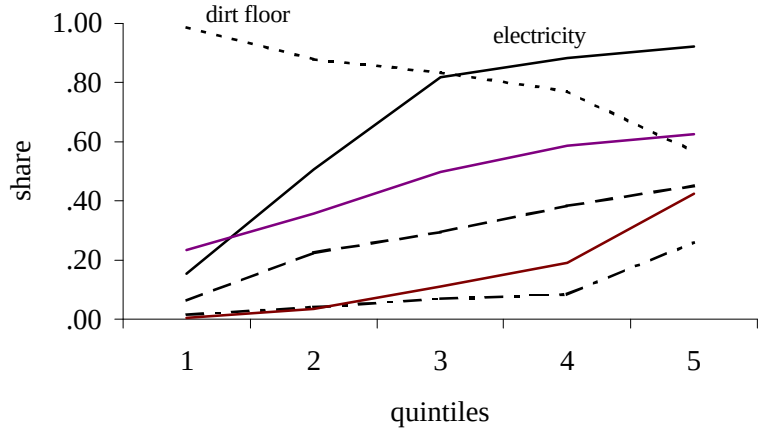


Figure 28. Number of agricultural wage laborers, by region

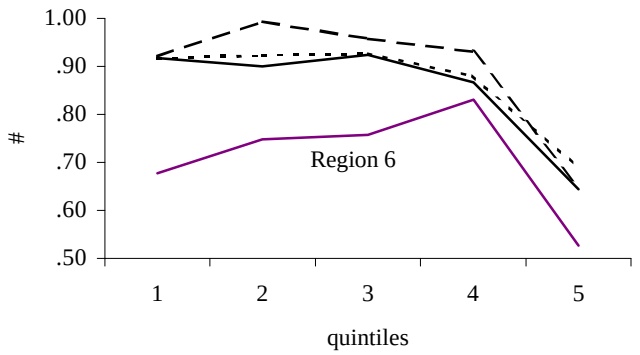


Figure 29. Number of non agricultural wage laborers, by region

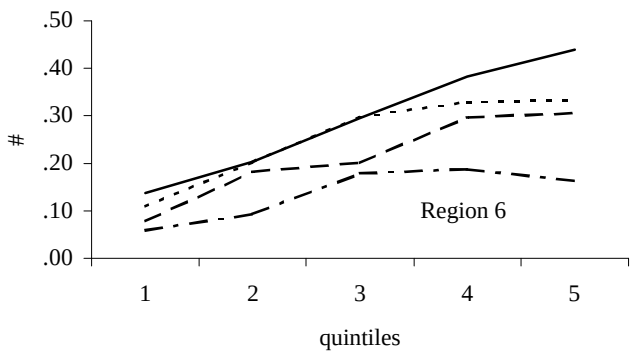


Figure 30. Number of self employed commerce, by region

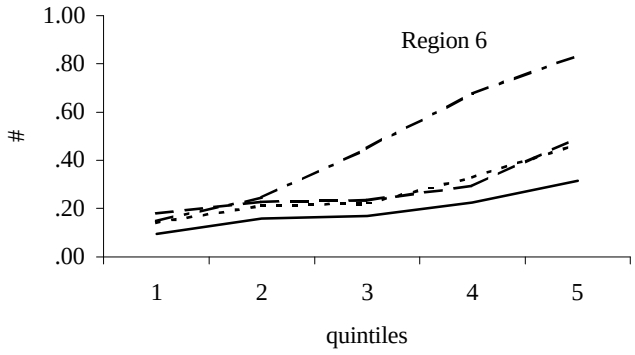


Figure 31. Number of family employed, by region

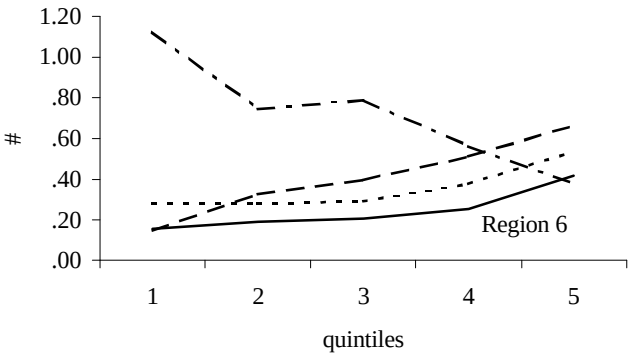


Figure 32. Per capita income, by region

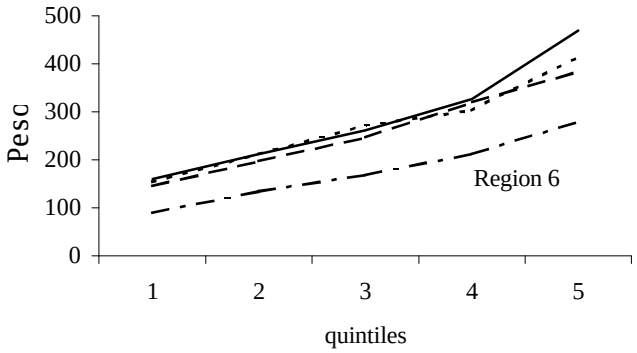


Figure 33. Per capita consumption, by region

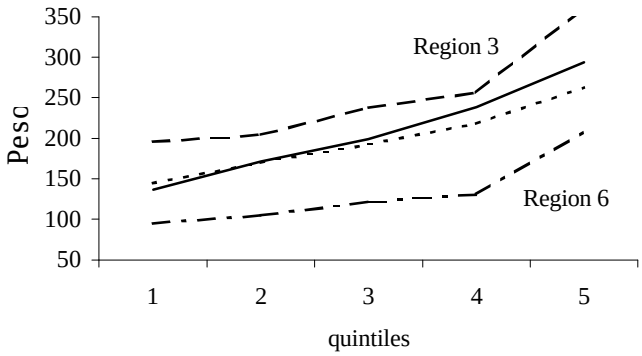


Figure 34. Per adult equivalent consumption (Encel98o), by region

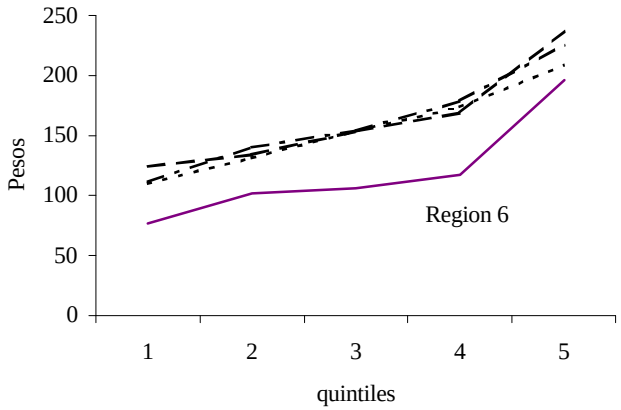


Table 2—Probit on Selection as PROGRESA Beneficiary

Determints of the probability of selection into Progresa		**Region 5**	
	# obs	10449	
Probit analysis	chi2(46)	9035	
	prob > chi2	.00	
***significant at 1% level	obs. P	.49	
**significant at 5% level	pred. P	.41	
*significant at 10% level			
	dF/dX	**z**	**P>|z|**
Demographics			
age, head of household	-.007	-11.96	.00 ***
sex, head of household	-.041	-1.53	.13
years of education, head of household	-.009	-2.73	.01 ***
member of indigenous ethnic group	.045	2.77	.01 ***
gender ratio	.050	1.25	.21
children 0-5	.025	2.43	.02 **
children 6-11	.007	.69	.49
children 12-14	.015	.98	.33
children 15-16	-.058	-2.57	.01 ***
dependency ratio	.250	29.19	.00 ***
disability	.098	2.90	.00 ***
Labor activities			
# ag wage laborers	.018	1.43	.15
# non ag wage laborers	.002	.13	.90
# sellers	-.047	-2.55	.01 ***
# family laborers	.054	3.86	.00 ***
Migration			
# temp mig mexico	-.003	-.22	.83
# temp mig usa	-.074	-2.54	.01 ***
# perm mig mexico	.028	.96	.34
# perm mig usa	-.090	-2.07	.04 **
Assets			
has irrigated land	-.027	-6.90	.00 ***
has rainfed land	-.001	-1.24	.22
yes/no cattle	-.031	-8.51	.00 ***
yes/no pigs	-.017	-5.95	.00 ***
Subsidy			
received subsidy	.006	.32	.75
Dwelling characteristics			
housing density ratio	.037	7.39	.00 ***
dirt floor	.225	13.16	.00 ***
running water, on land	-.282	-17.13	.00 ***
letrine	-.037	-2.27	.02 **
electricity	-.313	-16.88	.00 ***
Durables			
blender	-.205	-10.12	.00 ***
gas stove	-.153	-6.87	.00 ***
radio	-.172	-9.96	.00 ***
tele	-.310	-17.38	.00 ***
refrigerator	-.551	-19.50	.00 ***
School attendence			
yes/no children 6-11 not in school	.032	.50	.61
yes/no children12-14 not in school	.054	1.59	.11
yes/no children 15-16 not in school	.066	2.00	.05 **
left school	.054	.68	.49
missed days of school	-.045	-1.55	.12
Consumption			
total consumption, per capita	.000	-3.19	.00 ***

APPENDIX D

Discriminant Analysis versus the Probit Method

In this appendix we investigate whether the discriminant analysis method used by PROGRESA yields results that are generally equivalent to the more commonly used method of probit. This exercise also serves the purpose of an informal test of whether the assumptions necessary for the application of discriminant analysis as a method for classifying households into poor or nonpoor play an important role in the final classification of housheolds. The key assumptions include: 1) that the data come from a multivariate normal distribution; and 2) the covariance matrices of the two groups are equal.

We use the concepts of leakage and undercoverage as discussed in the main report, but the reader should take note that in this appendix we do not attempt to evaluate PROGRESA's targeting method. Our objective is to simply compare the differences in classification that would occur if an alternative statistical method were used instead of discriminant analysis.

Tables 1 and 2 below are constructed by using the same explanatory variables used by PROGRESA. The number in each cell is based on the cut-off value ("poverty line") equal to the 35th percentile of the predicted probability of the probit regression. This cut-off value is identical to the final proportion of poor (65%) and nonpoor (35%) households obtained by PROGRESA's Bayesian classification method.[1]

Table 1—Discriminant Analysis Criterion vs. a Probit-Based Criterion
Sierra Negra-Zongilica-Mazateca Region

	Probit-Based Criterion for Selecting Households		
	NonPoor	**Poor**	**Total**
Households excluded from PROGRESA benefits **(NonPoor)**	1257	60 (U=4.56%)	1317 (35%)
Households selected for PROGRESA benefits **(Poor)**	48 (L=1.99%)	2356	2413 (65%)
Total	1305 (35%)	2425 (65%)	3730 (100%)

[1] The poverty rates of 65% are higher than the poverty rates of 52% discussed throughout this report because of the recent addition of households into the poor Densification process.

Table 2— Discriminant Analysis Criterion vs. Probit-Based Criterion
Altiplano (San Luis Potosi) Region

	Probit-Based Criterion for Selecting Households		
	NonPoor	**Poor**	**Total**
Households excluded from PROGRESA benefits **(NonPoor)**	1705	69 (U=2.08%)	1774 (35%)
Households selected for PROGRESA benefits **(Poor)**	77 (L=2.32%)	3241	3318 (65%)
Total	1782 (35%)	3310 (65%)	5092 (100%)

The very low leakage and undercoverage rates obtained suggest that there is no substantial difference between the classifications obtained by the use of the discriminant analysis or other alternative statistical methods such as probit or logit.

APPENDIX E

Description of the Consumption Measure Used and Consumption-Based Targeting

The advantages of using consumption as a measure of household welfare are outlined in the main report. In this appendix we describe in detail the methods and variety of tests used in constructing the consumption-based welfare measure used as the "gold-standard" to evaluate PROGRESA's selection of beneficiaries.

In Section 1, we describe the construction of the consumption measure obtained from the 1996 Mexican National Survey of Income and Expenditures (ENIGH). In Section 2, we discuss the investigations we conducted regarding the use of equivalence scales and economies of scale. In Section 3, we report the equation for consumption per adult equivalent estimated with household data from the 1996 ENIGH and used to predict consumption for the sample of households in the 1997 ENCASEH survey.

1. Constructing Household Consumption

For a start we contrast PROGRESA's criterion with a consumption-based selection using consumption data collected from the same households as part of the March 1998 evaluation questionnaire (ENCEL98M). In Table 1 below we contrast PROGRESA's classification against the classification of households obtained using consumption. As explained in the main report, we use two different poverty lines. If we were to rely on the numbers reported in this table, then PROGRESA's targeting results in an undercoverage rate of 36.05%, meaning that 36% of the households classified as poor by the consumption criterion are not classified as poor by PROGRESA.

It is our view that the undercoverage rate obtained from Table 1 should be taken with caution since there are some serious shortcomings associated with the consumption module of the ENCEL98M survey. Primary among these is that the value of consumption out of own production (auto-consumption) was not collected. As a result much of the consumption of households cultivating their own crops may be underestimated. Under these circumstances the fact that many of the households classified as having low consumption per capita (i.e., poor) by the consumption-based criterion and not by PROGRESA, should be seen as a strength of PROGRESA's selection method rather than as a failure to correctly classify households as poor.

Table 1— PROGRESA's Criterion vs. Consumption-Based Criterion

ENCEL March 1998

	Consumption-Based Criterion for Selecting Households		
	NonPoor	**Poor**	
Households excluded from **PROGRESA** benefits **(NonPoor)**	8966 6730	1728 (U=31.42%) **3964 (U=36.05%)**	10694 10694
Households selected for PROGRESA benefits **(Poor)**	7525 (L=66.62%) **4265 (L=37.76%)**	3771 7031	11296 11296
Total	16491 (75%) 10995 (50%)	5499 (25%) 10995 (50%)	21990 21990

Notes:

1. Numbers in the first row of each cell are obtained using as a poverty line the 25th percentile of log per capita consumption from ENCEL98M.
2. Numbers in second row of each cell (in bold) are obtained using as a poverty line the 50th percentile of log per capita consumption from ENCEL98M.

For these reasons we have decided to make use of the 1996 Mexican National Survey of Income and Expenditures (ENIGH). This a nationally representative data set including detailed information on all types of income and expenditures for approximately 13,000 households, as well as socioeconomic and demographic characteristics of the individual members. Each household reports expenditures, auto-consumption and in-kind transactions for more than 200 food items and nonfood items.

Since the Mexican economy is characterized by substantial inflation from month to month we decided to deflate expenditures in all items in the ENIGH survey by the consumer price index (CPI) reported by the Central Bank of Mexico.[1] For most food items the reference period is 1 month while for most non-food items the reference period varies from 1 month to 6 months. Expenditures on food items and auto-consumption of each of item were deflated by the value of the CPI during the month of the interview. For items having as reference period the last month we used the value of the CPI from the month previous to the month of the survey. If the reference period were the last 3 (or 6) months we used the average of the CPI for the 3 (or 6) months prior to the survey.

We then transformed all expenditures into a monthly basis and aggregated into one measure the expenditures and value of auto-consumption on: cereals, meat, milk and

[1] We used June 1994 as our base for the CPI. Thus all expenditures are transformed into June 1994 prices.

eggs, fruits and vegetables, legumes and tubers, prepared food, food consumed outside the household, non-alcoholic drinks, other food, alcohol and tobacco, transportation and communication, cleaning services, personal hygiene, transfers to others, education, culture and recreation, housing (actual and imputed rent if owned) fees and utilities, clothing, shoes and repairs, domestic utensils, health, home furnishings, purchases of audio visual equipment, home repairs and other items (such as sugar, coffee, etc.). We excluded expenditures on vehicle acquisition, asset purchases and loans to others.

2. Family Size and Poverty

Having constructed a measure of welfare at the household level we now need to make a conversion from a household to an individual basis. In practice most studies of individual welfare usually have income or consumption expenditures at the household level and make the conversion to the individual level by dividing total expenditures or income by the number of people (N) in the household. Explicitly or implicitly such per capita measures of welfare make the following set of assumptions: (a) everyone in the household receives an equal allocation irrespective of age or gender; (b) everyone in the household has the same needs irrespective of age or gender; and (c) the cost for two (or three or more) people living together is the same as the cost of each person living separately. Although the first assumption could be easily defended based on the constraints imposed by lack of information on consumption or income at the individual level, the other two assumptions deserve further scrutiny. It is possible that not everyone in the household has the same needs and in particular that needs vary based on gender and age. It is also possible that there are economies of scale to living together, perhaps because family members benefit from each other's consumption, or because there are public goods that can be used by all family members at no additional costs. Under both of these circumstances, starting with a one-person household, the increase in the minimum cost of living associated with an extra person in the household may not be the same for a two-person or a three-person family.

These implicit assumptions separately and in combination have important consequences on the poverty status of large families. For example, it is often the case that the use a per capita measure of welfare, such as the per capita income measure used by PROGRESA, typically results in larger households commonly classified as poor. The extent to which this is correct or not depends on whether the marginal increase in the cost of living associated with an extra person in the household is equal to or lower than the cost of living increase assumed by the per capita measure.

2.1 Equivalence Scale

One way to addressing some of these problems is to construct an equivalence scale that takes into consideration the different needs of different age and gender groups. In Table 2, using the sample of households in the 1997 ENCASEH survey, we examine how the selection of beneficiaries using PROGRESA's method would be affected if we were to

use family size in adult equivalent units instead of the total number of household members.

Family size in adult equivalent units is constructed using different weights for different age and gender groups as derived by the Instituto Nacional de Nutrition (1987). Specifically the Adult Equivalent Family Size (AEFS) is constructed using the following formula: AEFS=(0.41)*children 0-4 +(0.80)*children 5-10 + (1.15)*males11-14 + (1.05)*females11-14 +(1.38)*males15-19 + (1.05)*females15-19 + (1.26)*males20-34 + (0.92)*females20-34 + (1.15)*males35-54 + (0.85)*females35-54 + (1.03)*males>=55 + (0.78)*females>=55

Table 2 —Discriminant Analysis: Per Capita Versus Adult Equivalent Units

Family size in Adult Equivalent Units				
		Nonpoor	**Poor**	Total
Per Capita	**Nonpoor**	7311	448 (U=3%)	7759
	Poor	464 (L=3%)	13394	13858
	Total	7752	13842	21617

Inspection of Table 2 reveals that holding everything else equal the switch from using total family size to family size in adult equivalent units does not result in major changes in the selection of poor households. At most 3% of the poor households using the income to family size per adult equivalent are incorrectly classified as nonpoor using income per capita measure of welfare.

2.2 Economies of Scale

We also examined the alternative method for accounting for differences in the cost of living for families of different size (see Deaton, 1997). First, we examined whether accounting for economies of scale results in significant differences in the classification of households as poor or nonpoor using PROGRESA's methods. In Table 3 we assumed a reasonable value for the parameter characterizing economies of scale (i.e., $\theta = 0.5$) and examined how the classification of households into poor and nonpoor would change compared to the per capita method currently used by PROGRESA.[2]

[2] In classifying households as poor and nonpoor using PROGRESA's method we adjusted the value of the Standard Food Basket (Canasta Basica) which is on a per capita basis, by multiplying by $N^{1-\theta}$ where N is the average family size assumed in the construction of the Standard Food Basket.

Table 3 —Discriminant Analysis: Per Capita Versus Economies of Scale (q = .5)

		Economies of Scale		
		Nonpoor	**Poor**	Total
Per Capita	**Nonpoor**	7114	645 (U=6%)	7759
	Poor	3784 (L=27%)	10074	13858
	Total	10898	10719	21617

The high leakage rate in Table 3 suggests that the per capita measure of welfare used by PROGRESA is more likely to classify large families as poor. Correcting for the presence of economies of scale many of these families would not be classified as poor thus yielding the high leakage rate observed.

Instead of guessing the value of the economies of scale parameter we also tried to estimate it. We briefly discuss the various methods we used to identify if economies of scale are important, and refer the reader to the recent study by Lanjouw and Ravallion (1995) for more details. According to their study the issue of whether there are economies scale in household consumption can be reduced to that of whether or not the value of a parameter θ, summarizing the economies of scale in household consumption, exceeds a critical value θ^*. Specifically they propose two alternative methods of estimating the critical value θ^*:

- Use a graphical method to check visually at what value of θ^* the relationship between the poverty rate and the size of the household size vanishes or reverses from positive to negative.
- Use data to estimate the critical value of the parameter θ^*.

We have applied both of these methods to our data from ENIGH. Figures 1 and 2 below (for rural and urban areas in the 1996 ENIGH, respectively) are constructed based on the normalizing assumption that the poverty line pertains to a household of average size (5 persons), so that a household of average size has the same poverty index for all values of θ.[3] As it can be easily observed, the percent of poor generally increases with household size when $\theta = 1$. Moreover, the correlation vanishes when the critical value of θ (i.e. θ^*) is in the interval between 0.1 and 0.3.

[3] The average family size in Mexico is five and the average total expenditure of a family of five is 1,920P in July 1994 pesos. Then, for each value of θ, the poverty line is $1{,}920/ N^{\theta}$.

Figure 1—Percentage of Poor Based on Consumption (Rural)

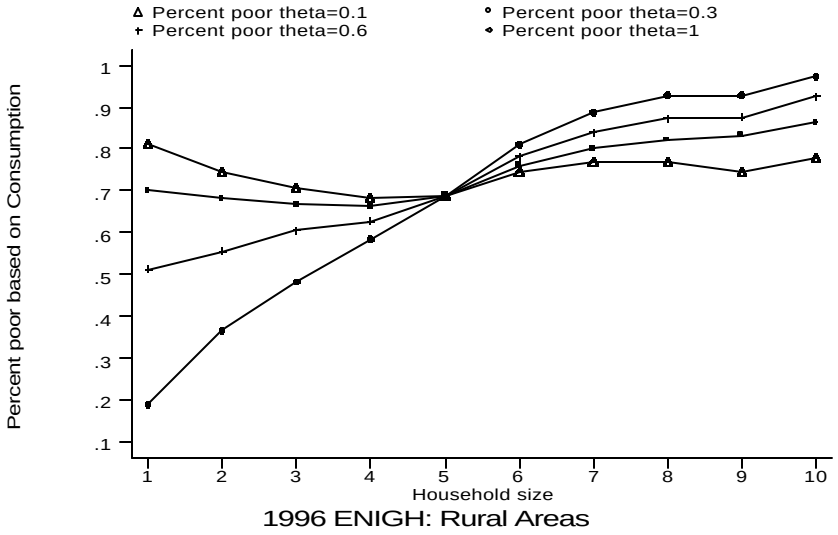
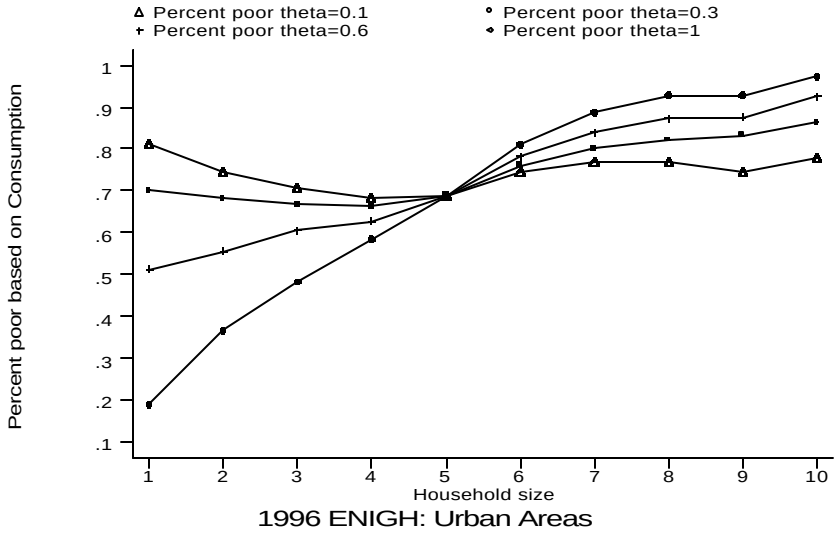


Figure 2 —Percentage of Poor Based on Consumption (Urban)



In order to narrow down the value of θ^* further we also used regression methods that correlate the logarithm of total household expenditures to the family size. Our regressions yielded for following estimates of θ^* in Mexico:

$\theta^* = 0.25$ (standard error =0.0112)
In rural areas: $\theta^* = 0.275$ (standard error =0.0169)
In urban areas: $\theta^* = 0.235$ (standard error =0.0147)

After taking into account differences in prices within urban and rural areas within each state (i.e. after including state and urban/rural interaction terms) then $\theta^* = 0.277$ with a standard error =0.0108. If in addition we account for demographic composition, such as the number of adults, children and infants then $\theta^* = 0.141$ (standard error =0.022)
In rural areas: $\theta^* = 0.260$ (standard error =0.039)
In urban areas: $\theta^* = 0.092$ (standard error =0.027)

Thus it appears that in the rural areas of Mexico the critical value θ^* ranges between 0.25 and 0.28 while in the urban areas it ranges between 0.092 and 0.235.

Next we run a regression of the form:

$$W_i = a + b \ln x_i - bq \ln N + \sum_{j=1}^{J} d_i h_{ji}$$

where W_i is the share of food expenditures in total expenditures of household i, x_i is total household expenditures, N is total household size and $\boldsymbol{h}$ is the number of household members in demographic age group j. This specification allows us to obtain a direct estimate of the value of parameter θ, that could be compared with the critical value of θ^* estimated earlier.

Our regression estimates of the equation above suggest that the value of θ in our sample is $\theta = 0.1547$. Separate estimates for rural and urban areas where $\theta = 0.313$ and $\theta = .089$, respectively. These estimates imply that economies of scale are present and significant and thus deserving of serious consideration when classifying households as poor or nonpoor. The estimated values of θ suggest that if we double household size and double household resources, the households in rural (urban) areas of Mexico have effectively had a 69 (91) percent increase in per capita resources. Unfortunately, these values of θ are too high to be believable and well outside the range of values estimated from other countries. Estimated values of θ in most other countries lie in the range between 0.6 to 0.8. Since it is very difficult to come up with acceptable explanations as to why such strong economies of scale might arise in a region where a private good such as food constitutes approximately 47% of the total household budget, we are forced to leave this issue unsettled. As the recent cross-country study of economies of scale by Deaton and Paxson (1998) also indicates that our results from Mexico are not the only paradoxical case, but one of many.

In light of these considerations we think it is wise to abstain from making any recommendations to PROGRESA on corrections for economies of scale and are forced to settle with the use of an adult equivalence scale instead of a per capita measure.

3. Predicted Consumption per Adult Equivalent

After dividing household consumption expenditures with adult equivalent family size, we run a regression that correlates the logarithm of consumption per adult equivalent with a set of household characteristics such as the age and the education level of the household head, the gender and age composition of the family and other variables such as characteristics of the dwelling, ownership of various key assets and dummy variables for the state of in which the household resides. One key requirement for selecting variables used in the right hand side of the regression was each of the variables were also available in the 1997 ENCASEH survey.

Since the PROGRESA program is aimed at reaching the poorest of the poor households in the rural areas in Mexico we opted to apply the method of quantile regression rather than estimate a conditional mean regression, i.e., an ordinary least squares.[4] Quantile regression allows a more flexible characterization of the determinants of the logarithm of consumption per adult equivalent especially when there is interest at the lower (or higher) tails of the distribution.

The linear specification of the .25 conditional quantile of the logarithm of consumption per adult equivalent (lnC), estimated may be denoted as:

$$Q_{.25}(\ln C \mid X) = \beta_{.25} X \,,$$

where β is a vector of coefficients, and X is a vector of explanatory variables. Table 4 below reports the estimated coefficients of the variables included in the regression using the sub-sample of households in the rural areas of Mexico. We have also included a set of dummy variables for state of residence so as to account for differences in the cost of living at the state level.

We then use the estimated coefficients listed in Table 4 below and the corresponding values of the right-hand side variables from the households in our 1997 ENCASEH sample to derive the predicted value of the logarithm of consumption per adult equivalent for each household.

[4] At the early stages of our report we also estimated an ordinary least squares regression. Although there were no major changes in the results obtained, we opted to use the quantile regression estimates as they are more robust than ordinary least squares estimators to outliers and the presence of heteroskedasticity in the data.

Table 4 —Consumption Equation Estimated from ENIGH 1996
Dependent Variable: Log(Consumption/Adult Equivalent)
.25 Quantile Regression

Number of observations	4472
Pseudo R2	0.3470
Min. sum of deviations	1268.793

	Coeff.	Std. Err.	t-value	P>|t|
Age of household head	0.004	0.001	3.793	0.000
Incomplete primary education	-0.003	0.021	-0.162	0.872
Completed primary education	0.064	0.028	2.318	0.021
Incomplete secondary education	-0.043	0.060	-0.713	0.476
Completed secondary education	0.148	0.039	3.755	0.000
Preparatory/vocational/NB incomplete	0.184	0.095	1.939	0.053
Preparatory/vocational/NB completed	0.301	0.074	4.094	0.000
Post-graduate education completed	0.786	0.272	2.889	0.004
Dependency ratio	-0.435	0.038	-11.506	0.000
No. of children < = 4 yrs.	-0.038	0.012	-3.139	0.002
No. of children 5-10 yrs.	-0.082	0.010	-8.354	0.000
No. of male children 11-14 yrs.	-0.130	0.017	-7.593	0.000
No. of female children 11-14 yrs.	-0.071	0.018	-4.051	0.000
No. of males 15-19 yrs.	-0.153	0.016	-9.316	0.000
No. of females 15-19 yrs.	-0.064	0.017	-3.903	0.000
No. of males 20-34 yrs.	-0.141	0.014	-9.767	0.000
No. of females 20-34 yrs.	-0.069	0.016	-4.219	0.000
No. of males 35-54 yrs.	-0.163	0.022	-7.382	0.000
No. of females 35-54 yrs.	-0.104	0.022	-4.745	0.000
No. of males > = 55 yrs.	-0.164	0.026	-6.281	0.000
No. of females > = 55 yrs.	-0.115	0.025	-4.646	0.000
Percentage of children working	-0.008	0.092	-0.084	0.933
Percentage of children not attending school	-0.219	0.046	-4.717	0.000
Ratio of Family Size to Number of Rooms	-0.029	0.006	-5.005	0.000
Dirt floor	-0.125	0.022	-5.547	0.000
Wall material1	-0.062	0.274	-0.225	0.822
Wall material3	0.076	0.059	1.300	0.194
Wall material4	-0.073	0.054	-1.366	0.172
Wall material6	-0.021	0.111	-0.191	0.848
Wall material8	0.005	0.042	0.111	0.912
Wall material11	0.059	0.167	0.350	0.726
Wall material 12, 13	0.045	0.036	1.226	0.220
Watertub	0.021	0.039	0.546	0.585
Bath has water	0.108	0.044	2.453	0.014

Table 4 —Consumption Equation Estimated from ENIGH 1996
Dependent Variable: Log(Consumption/Adult Equivalent)
.25 Quantile Regression

Number of observations	4472
Pseudo R2	0.3470
Min. sum of deviations	1268.793

	Coeff.	Std. Err.	t-value	P>|t|
Radio	-0.024	0.020	-1.186	0.236
Television	0.072	0.022	3.302	0.001
Blend	0.070	0.022	3.179	0.001
Refrigerator	0.083	0.025	3.373	0.001
Wash	0.076	0.026	2.861	0.004
Gas stove	0.156	0.025	6.223	0.000
Air fan	0.057	0.023	2.423	0.015
VCR	0.134	0.031	4.382	0.000
Stereo	0.030	0.026	1.174	0.240
Heat	0.168	0.041	4.086	0.000
Own car	0.186	0.039	4.826	0.000
state2	0.319	0.102	3.119	0.002
state3	0.353	0.091	3.884	0.000
state4	-0.008	0.071	-0.113	0.910
state5	0.109	0.073	1.494	0.135
state6	0.044	0.086	0.516	0.606
state7	-0.145	0.077	-1.875	0.061
state8	0.312	0.090	3.464	0.001
state9	0.570	0.111	5.151	0.000
state10	0.071	0.082	0.862	0.389
state11	-0.002	0.069	-0.025	0.980
state12	0.009	0.079	0.112	0.911
state13	-0.058	0.067	-0.867	0.386
state14	0.047	0.071	0.657	0.511
state15	0.036	0.092	0.395	0.693
state16	-0.047	0.081	-0.579	0.563
state17	0.086	0.098	0.879	0.380
state18	0.021	0.077	0.274	0.784
state19	0.354	0.096	3.709	0.000
state20	-0.014	0.067	-0.214	0.831
state21	-0.030	0.080	-0.373	0.709
state22	-0.073	0.081	-0.903	0.366
state23	0.368	0.094	3.910	0.000
state24	0.005	0.080	0.063	0.949
state25	0.121	0.088	1.374	0.169
state26	0.264	0.087	3.033	0.002
state27	0.033	0.067	0.498	0.619

Table 4 —Consumption Equation Estimated from ENIGH 1996
Dependent Variable: Log(Consumption/Adult Equivalent)
.25 Quantile Regression

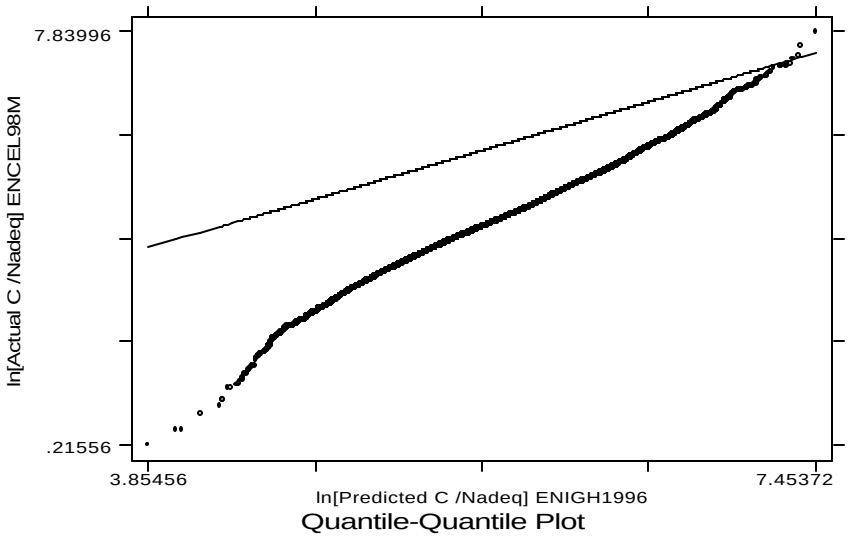
Number of observations	4472
Pseudo R2	0.3470
Min. sum of deviations	1268.793

	Coeff.	Std. Err.	t-value	P>|t|
state28	-0.017	0.090	-0.190	0.849
state29	0.082	0.081	1.013	0.311
state30	0.039	0.081	0.481	0.631
state31	0.293	0.090	3.267	0.001
state32	-0.042	0.076	-0.554	0.580
_cons	6.465	0.089	72.845	0.000

As a means of comparing the distributions of the actual and predicted consumption in our sample we present a quantile-quantile (q-q) plot. The q-q plot in Figure 3 is a graph of the data values of the logarithm of consumption per adult equivalent from the ENCEL98M survey in the vertical axis sorted in ascending order against the data values of the similarly sorted logarithm of predicted consumption in the horizontal axis.[5] Since the plot of points lies below the diagonal line in the box, it can be easily inferred that predicted consumption is generally higher than the consumption measure constructed from the ENCEL98M survey. We view this as a confirmation of our suspicion that the omission of collecting data for auto-consumption in the ENCEL98M survey might decrease the usefulness of the consumption module of that survey in constructing a gold standard for evaluation. Moreover, the difference between the consumption measure from the ENCEL98M survey and the predicted consumption appears to be getting larger as we move from the higher ends of the distributions to the lower ends. This is also consistent with the view that auto-consumption is likely to be a significant component of the total consumption of poorer households that grow their own food crops.

[5] Note that we also deflated total consumption from the ENCEL98M survey to July 1994 prices so that it can be comparable to predicted consumption from the 1996 ENIGH survey.

Figure 3— Quantile-Quantile Plot of Actual and Predicted Consumption



4. The Regional Distribution of Beneficiary Households According to PROGRESA's Targeting and Consumption-Based Targeting

In this section we compare the distribution of beneficiary households across the regions contained in the 1997 ENCASEH survey using the consumption-based targeting method and PROGRESA's targeting method. As explained in the main report and in Appendix A, PROGRESA's targeting method was region-specific meaning that the coefficients of the discriminant analysis models were allowed to differ from region to region. As a result different household characteristics received more or less weight in the construction of the discriminant score in different regions. In principle we could also have adopted a similar approach and attempted to estimate a separate regression for the determinants of consumption such as the one estimated in the previous section, for each region in the ENIGH survey. We did not do that for two main reasons. First, with the geographic identifiers available in the ENIGH survey (such as state and municipality) it was not possible for us to identify exactly the same geographic regions as those used by PROGRESA.[6] Second, we also thought it was necessary to contrast PROGRESA's targeting against a criterion that is not region specific.

Having constructed the consumption-based measure of welfare we first chose a cut-off point (poverty line) that results in the same total proportion of beneficiary households as

[6] For example, a number of the PROGRESA regions had the same state code suggesting that in order to construct region identifiers it would be necessary to have identifiers for the localities in the ENIGH survey. Such information was not available.

with PROGRESA's method, (i.e., the 52nd percentile of consumption per adult equivalent) and evaluate the differences between the two targeting methods. Table 5, for example, shows how the proportions of beneficiaries are distributed across regions using the two different methods.

Table 5— Proportions of Beneficiaries Based on Two Different Criteria

Region	Consumption-Based Criterion	PROGRESA Criterion	No. of Households
Sierra Negra-Zongolica-Mazateca	0.542	0.523	3031
Sierra Norte-Otomí Tepehua	0.530	0.523	4559
Sierra Gorda	0.532	0.490	10790
Montaña (Guerrero)	0.623	0.727	1907
Huasteca (San Luis Potosi)	0.319	0.397	383
Tierra Caliente (Michoacan)	0.408	0.491	2935
Altiplano (San Luis Potosi)	0.443	0.600	472
Total	**0.520**	**0.520**	**24077**

Clearly there are some differences within regions in the proportion of households classified as beneficiaries with the two methods with the greatest difference occurring in the Altiplano region. Such regional differences in the proportions of eligible households need to be taken into account when estimating region-specific undercoverage rates. In Figure 4 below we do exactly that. Based on the PROGRESA region-specific beneficiary rates, we define two region-specific poverty lines for our consumption-based measure of welfare; the first one equal to the 25th percentile of the distribution within the region and the second one equal to the poverty rate or beneficiary rate from PROGRESA's method.

Similarly in Figure 5 we graph the region-specific leakage rates obtained using the region-specific cut-off lines. In this figure we only report the leakage rates obtained using the region-specific poverty line that is equal to PROGRESA's poverty rate.

Further insight into the implications of the misclassification of households by the PROGRESA method, compared to consumption based targeting, can be obtained by analyzing the determinants of undercoverage and leakage. Here, we employ a logit model to examine the characteristics of households that are misclassified by PROGRESA. The results can be found in Tables 6 and 7 below, and they are not surprising given the biases of the PROGRESA model toward young, numerous, durable poor households, as discussed in Appendix H. The misclassification occurs when the PROGRESA selection variables are at odds with household consumption levels.
We find that those households classified as poor by the consumption method, and non poor by PROGRESA, and thus placed in the undercoverage category, have the following characteristics when compared to all other households. These households combine low levels of consumption (the key element associated with poverty in consumption based targeting) with a lower dependency ratio, fewer small children, and larger numbers of

adults and older children (characteristics associated with non poverty in the PROGRESA selection method). These families are also predominantly male. The presence of a male in all age categories leads to twice the probability of undercoverage, as compared to women. Further, while these households have a lower percentage of children working, a higher percentage of children are not attending school. Ownership of certain durables (such as radios, televisions, and blenders) increases the probability of undercoverage, while ownership of others (washing machines, fans, and VCRs) decreases the probability. Important state and regional effects are also evident.

Households in the leakage category flip the characteristics of those in the undercoverage category. These households combine higher consumption levels with larger dependency ratios, more small children, and fewer adults and other children. These families are primarily female. A higher percentage of the children are working as well as in school. The ownership of durables has the opposite effect as in the undercoverage equation, as ownership of radios, televisions, and blenders lowers the probability of leakage, while gas stoves and VCRs increase it. Again, state and regional effects are highly significant, though with opposite signs from the undercoverage equation.

Figure 4—Region-specific Undercoverage rates

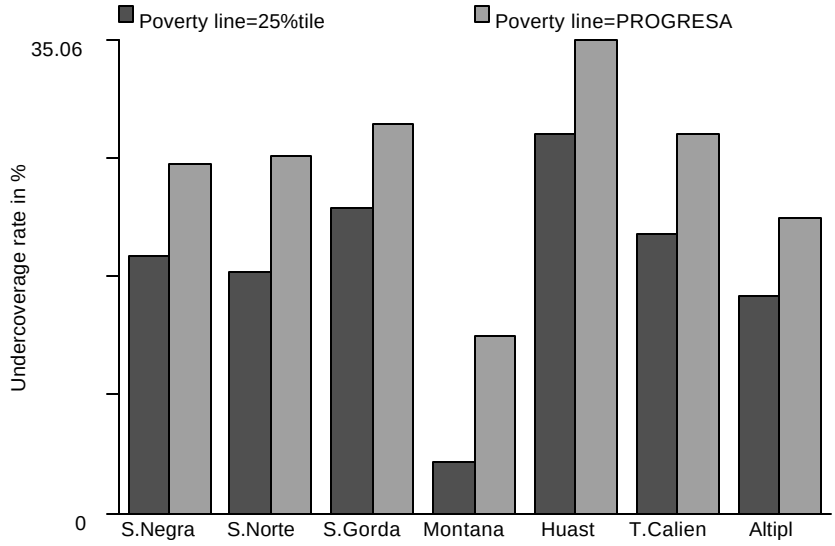


Figure 5—Region-specific Leakage rates

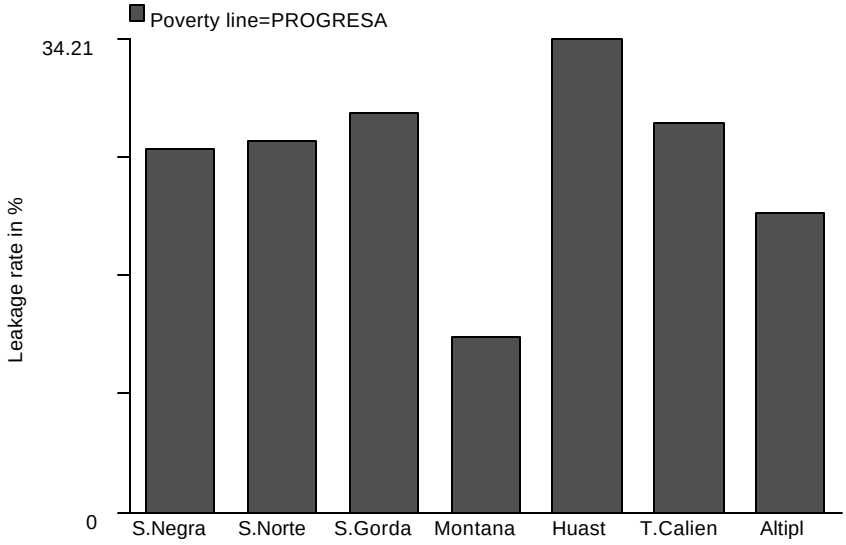


Table 6— Logit Model of the Probability of Undercoverage
Coefficients Reported are in Terms of Marginal Effects on the Probability

Number of observations	24073
Chi2 (54)	2167.40
Prob > chi2	0.0000
Pseudo R2	0.3201

	Coef.	Std. Err.	z	P>|z|
Dependency ratio	-0.041	0.008	-5.125	0.000
No. of children < = 4 yrs.	0.000	0.002	-0.172	0.863
No. of children 5-10 yrs.	-0.008	0.001	-5.587	0.000
No. of male children 11-14 yrs.	0.005	0.002	2.526	0.012
No. of female children 11-14 yrs.	0.001	0.002	0.434	0.664
No. of males 15-19 yrs.	0.045	0.002	21.986	0.000
No. of females 15-19 yrs.	0.020	0.002	10.055	0.000
No. of males 20-34 yrs.	0.046	0.002	21.744	0.000
No. of females 20-34 yrs.	0.023	0.002	10.967	0.000
No. of males 35-54 yrs.	0.054	0.003	17.713	0.000
No. of females 35-54 yrs.	0.031	0.003	10.356	0.000
No. of males > = 55 yrs.	0.040	0.004	10.435	0.000
No. of females > = 55 yrs.	0.022	0.003	6.760	0.000
Percentage of children working	-0.081	0.011	-7.116	0.000
Percentage of children not attending school	0.113	0.004	25.240	0.000
Age of household head	0.000	0.000	-0.052	0.958
Incomplete primary education	0.006	0.003	1.940	0.052
Completed primary education	-0.024	0.005	-5.047	0.000
Incomplete secondary education	0.046	0.010	4.394	0.000
Completed secondary education	-0.031	0.010	-3.206	0.001
Preparatory/vocational/NB incomplete	-0.015	0.018	-0.845	0.398
Preparatory/vocational/NB completed	-0.151	0.041	-3.664	0.000
Family size / no. of rooms	-0.002	0.001	-2.726	0.006
Dirt floor	0.003	0.003	1.091	0.275
Wall material1	-0.002	0.046	-0.046	0.964
Wall material3	-0.022	0.008	-2.858	0.004
Wall material4	0.015	0.006	2.466	0.014
Wall material6	0.005	0.029	0.176	0.860
Wall material8	-0.009	0.006	-1.409	0.159
Wall material11	-0.004	0.007	-0.651	0.515
Wall material 12, 13	-0.007	0.006	-1.206	0.228
Watertub	0.001	0.005	0.195	0.845
Bath has water	-0.041	0.008	-5.351	0.000
Radio	0.034	0.003	11.065	0.000
Television	0.034	0.003	11.769	0.000
Blend	0.018	0.003	6.006	0.000

Table 6— Logit Model of the Probability of Undercoverage
Coefficients Reported are in Terms of Marginal Effects on the Probability

Number of observations	24073
Chi2 (54)	2167.40
Prob > chi2	0.0000
Pseudo R2	0.3201

	Coef.	Std. Err.	z	P>|z|
Refrigerator	0.001	0.004	0.312	0.755
Wash	-0.037	0.007	-4.955	0.000
Gas stove	-0.038	0.003	-11.007	0.000
Air fan	-0.030	0.005	-5.542	0.000
VCR	-0.065	0.009	-7.594	0.000
Stereo	0.004	0.006	0.681	0.496
Heat	-0.043	0.010	-4.318	0.000
Own car	-0.004	0.005	-0.798	0.425
state12	-0.067	0.010	-7.065	0.000
state13	-0.020	0.006	-3.568	0.000
state21	-0.024	0.007	-3.512	0.000
state24	-0.034	0.006	-5.552	0.000
state30	-0.050	0.006	-8.243	0.000
rgn2	-0.007	0.005	-1.577	0.115
rgn3	-0.005	0.005	-0.927	0.354
rgn5	-0.043	0.013	-3.426	0.001
rgn6	-0.062	0.008	-7.550	0.000
Rgn7	-0.059	0.012	-4.901	0.000
_cons	-0.232	0.014	-17.110	0.000

Table 7—Logit Model of the Probability of Leakage
Coefficients Reported are in Terms of Marginal Effects on the Probability

Number of observations	24073
Chi2 (54)	3334.68
Prob > chi2	0.0000
Pseudo R2	0.2344

	Coef.	Std. Err.	z	P>|z|
Dependency ratio	0.053	0.007	7.888	0.000
No. of children < = 4 yrs.	0.019	0.002	7.882	0.000
No. of children 5-10 yrs.	-0.029	0.003	-11.075	0.000
No. of male children 11-14 yrs.	-0.048	0.005	-9.980	0.000
No. of female children 11-14 yrs.	-0.014	0.004	-3.308	0.001
No. of males 15-19 yrs.	-0.049	0.004	-11.137	0.000
No. of females 15-19 yrs.	-0.002	0.004	-0.620	0.535
No. of males 20-34 yrs.	-0.030	0.004	-8.484	0.000
No. of females 20-34 yrs.	-0.003	0.004	-0.738	0.461
No. of males 35-54 yrs.	-0.049	0.004	-11.429	0.000
No. of females 35-54 yrs.	-0.026	0.004	-6.091	0.000
No. of males > = 55 yrs.	-0.020	0.005	-4.254	0.000
No. of females > = 55 yrs.	-0.032	0.004	-7.149	0.000
Percentage of children working	0.138	0.011	12.802	0.000
Percentage of children not attending school	-0.048	0.007	-7.157	0.000
Age of household head	-0.001	0.000	-5.446	0.000
Incomplete primary education	-0.011	0.004	-2.951	0.003
Completed primary education	0.023	0.005	4.618	0.000
Incomplete secondary education	-0.052	0.014	-3.734	0.000
Completed secondary education	0.022	0.007	3.037	0.002
Preparatory/vocational/NB incomplete	-0.009	0.020	-0.458	0.647
Preparatory/vocational/NB completed	0.003	0.016	0.197	0.844
Family size / no. of rooms	-0.013	0.001	-9.677	0.000
Dirt floor	-0.002	0.004	-0.451	0.652
Wall material1	-0.088	0.056	-1.564	0.118
Wall material3	0.042	0.008	5.097	0.000
Wall material4	-0.032	0.008	-3.890	0.000
Wall material6	-0.009	0.041	-0.228	0.820
Wall material8	0.011	0.007	1.574	0.115
Wall material11	-0.002	0.008	-0.251	0.802
Wall material 12, 13	-0.002	0.007	-0.250	0.802
Watertub	-0.033	0.007	-4.797	0.000
Bath has water	0.012	0.008	1.390	0.165
Radio	-0.041	0.003	-12.560	0.000
Television	-0.021	0.004	-5.432	0.000
Blend	-0.034	0.004	-7.590	0.000
Refrigerator	-0.054	0.006	-8.611	0.000

Table 7—Logit Model of the Probability of Leakage
Coefficients Reported are in Terms of Marginal Effects on the Probability

Number of observations	24073
Chi2 (54)	3334.68
Prob > chi2	0.0000
Pseudo R2	0.2344

	Coef.	Std. Err.	z	P>|z|
Wash	0.002	0.009	0.213	0.831
Gas stove	0.030	0.004	6.871	0.000
Air fan	-0.008	0.007	-1.152	0.249
VCR	0.044	0.009	4.940	0.000
Stereo	-0.015	0.008	-1.944	0.052
Heat	0.015	0.009	1.670	0.095
Own car	-0.014	0.007	-2.043	0.041
state12	0.056	0.011	4.995	0.000
state13	0.003	0.008	0.418	0.676
state21	0.013	0.009	1.330	0.184
state24	0.026	0.008	3.144	0.002
state30	0.038	0.008	4.489	0.000
rgn2	0.018	0.006	3.163	0.002
rgn3	0.016	0.006	2.481	0.013
rgn5	0.064	0.013	4.860	0.000
rgn6	0.079	0.010	7.583	0.000
rgn7	0.096	0.012	7.943	0.000
_cons	0.003	0.015	0.192	0.848

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APPENDIX F

Simulating the Impact of the Various Targeting and Transfer Schemes

In this appendix we describe in detail the structure of benefits we have assumed for our simulations and present and discuss a variety of graphs of the impact of the various targeting and transfer schemes on the density of the logarithm of consumption per adult equivalent.

1. Structure of Benefits

In our simulation of the PROGRESA benefit structure we have made the following assumptions. We have assumed that children of primary school age are all attending full time and there are no delayed enrollments. Thus, the level of primary school benefits received by each potentially participating household is determined as follows:

Primary School benefits at the household level =
(number of boys and girls of 8 yrs of age) * 60P/month+
(number of boys and girls of 9 yrs of age) * 70P/month +
(number of boys and girls of 10 yrs of age) * 90P/month +
(number of boys and girls of 11 yrs of age) * 120P/month.

PROGRESA provides increasing cash transfers for teenagers enrolled in the 1st through the 3rd grades of secondary school up to the 18th year of age. Given that we have to attribute child ages to particular grade in school, for children between 12 and 18 years of ages we had to make a few stronger assumptions. Given that the enrollment rates of children begin to decrease at the secondary school level, we have assumed that PROGRESA's program impact will be bringing back to the first grade of secondary school all boys and girls of age 12, 13, and 14. Thus households with boys and girls between 12 and 14 years of age received the corresponding benefits attached to the first grade of secondary school. Along similar lines, boys of ages 15 and 16 are assumed to attend the second grade of secondary school while boys and girls of 17 and 18 years of age are enrolled in the 3rd grade of secondary. Understandably some of our assumptions may be less reasonable than others but at this stage of the evaluation it is too early to tell exactly what age groups are most appropriate to include in the 1st , 2nd , and 3rd grades of secondary school.

Thus, the level of primary school benefits received by each potentially participating household is determined as follows:

Secondary school benefits at the household level =
(number of boys 12-14 yrs of age) * 175P/month+

(number of girls 12-14 yrs of age) * 185P/month+
(number of boys 15-16 yrs of age) * 185P/month +
(number of girls 15-16 yrs of age) * 205P/month +
(number of boys 17-18 yrs of age) * 195P/month +
(number of girls 17-18 yrs of age) * 225P/month

We then summed the benefits from having all children enrolled either in primary and secondary school grades with the allowance of 115P/month given to PROGRESA beneficiaries. For households with total benefits that exceed the maximum of 695P/mo allowed by PROGRESA, we replaced the benefit that could be received with the maximum allowable.

Finally, we added to the total cash transfer the allowances given to households for school utilities of the children, these being equal to the number of children in primary school*(135P/12) + number of children enrolled in secondary school*(170/12). The school allowances were divided by 12 since these are given (with annual frequency), not a monthly basis.

In determining the total budget to be used in all of our simulations, we added all the benefits that would be distributed to PROGRESA beneficiaries with PROGRESA's selection method. All of our monetary values are expressed in July 1994 prices to make all monetary values compatible. According to our estimates the total poverty gap is 8,071,981 pesos in June 1994 dollars. The poverty gap is defined as the sum (across all PROGRESA poor households) of the difference between the poverty line and the per capita consumption expenditure of the household both multiplied by the number of adult equivalents units in the household. The value of the cash transfers given by PROGRESA to the selected households turns out to be 26% of the poverty gap.

2. Impact of the Various Schemes on the Kernel Density of the Log of Consumption per Adult Equivalent

Univariate kernel density estimators, much like histograms, approximate the density of $f(x)$ from observations on x. With histograms the data are divided into nonoverlapping intervals and the number of data points within each interval are counted. The frequency counts within each interval are then typically graphed as bar graphs—bars whose height reflects the average number of data points in the interval. In kernel density estimates, the range is still divided into intervals ad estimates of the density at the center of the interval are produced. One difference is that the intervals are allowed to overlap. One can think of sliding the interval—called a window— along the range of the data and collecting the center-point density estimates. Another difference is that rather than merely counting the number of observations in a window, a weight between 0 and 1 is assigned—based on the distance from the center of the window—and it is the weighted values that are summed. The function that determines these weights is called the kernel. All the univariate kernel density graphs presented here are derived using the Epanechnikov function for the kernel

with the default widths of the statistical software. For more details the reader is referred to the STATA 6.0 (1999) manual and Deaton (1997).

Figures 1-4 display the kernel density functions of the logarithm of consumption per adult equivalent under each transfer and targeting scheme against the baseline case of no transfers at all. In each graph we also draw a vertical line to indicate the position of the cut-off point (or poverty line) for classifying households into beneficiaries and non-beneficiaries. The beneficiary households are those with consumption per adult equivalent to the left of the poverty line.

Figure 1 contains the kernel density functions of consumption under the baseline case of zero transfers and with uniform transfers. Clearly, this transfer scheme shifts to the right the whole density function without changing its shape in any way or form. The leakage associated with it can be seen by the fact that the density shifts to the right even for households that are very well off (i.e., far to the right of the poverty line).

Figure 2 contains a similar graph for the case of consumption-based targeting. The more accurate targeting results in a substantial shrinkage in the lower left tail of the density of consumption and a sharp increase in the peak of the density function just before the poverty line. After receiving the higher benefits many of the poor households move closer to the poverty line but very few above it. That is why the headcount measure of poverty stays practically unchanged with consumption based targeting. Also note that to the right of the poverty line the two densities lie one on top of the other as it should be if targeting were "perfect."

Figure 3 presents the impact of PROGRESA's targeting while Figure 4 compares the densities with consumption-based targeting and PROGRESA's targeting. As with consumption-based targeting PROGRESA targeting shifts the lower left tail of the density closer to the poverty line while the peak of the new density is higher and mostly to the left of the poverty line. Thus, as with consumption-based targeting, the impact of PROGRESA's targeting is likely to appear insignificant if one were to rely on the headcount poverty index. The leakages associated with PROGRESA's targeting can be seen easily by the area contained between the baseline density and the density after transfers with PROGRESA's selection method. Clearly, leakages occur close to the poverty line and dissipate to zero at higher level of consumption. To some extent a large part of these leakages is the result of our use of a single, instead of a region-specific, cut-off line.

Figure 5 contains the case of locality-based targeting. In many respects locality-based targeting seems to have the same general impact as PROGRESA's targeting except that leakages seem to persist for higher levels of consumption compared to PROGRESA's targeting. This indicates that there is considerable heterogeneity among households within villages that PROGRESA's targeting methods manage to capture. This is also verified by looking at Figure 6 that contrasts the densities with locality based targeting and PROGRESA's selection method. Since the non-economic costs of PROGRESA's targeting at the household level can only be speculated there is no way to compare them

to the extra benefit obtained targeting at the household level instead of the locality level. However, as Table 8 in the main report shows, the benefits of PROGRESA's targeting at the household level, as measured by the impact on the higher-order measures of poverty, is greater than that obtained from targeting at the locality level.

Figure 1—No transfers versus Uniform Transfers

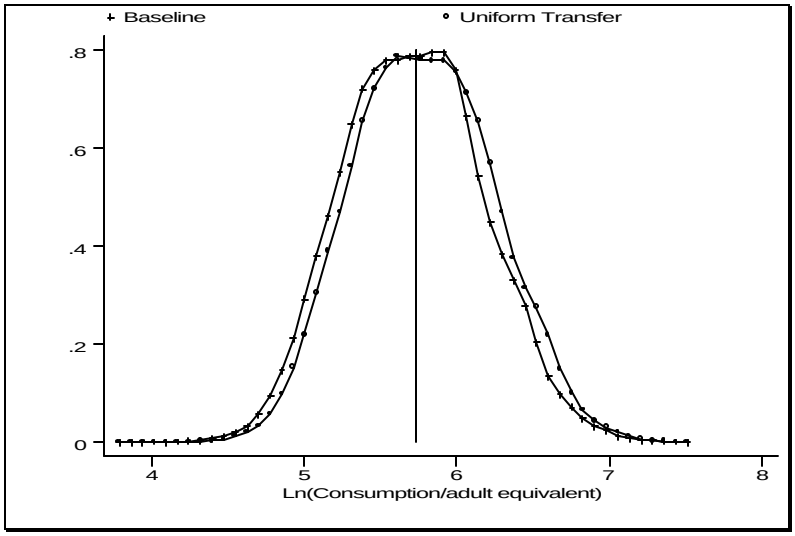


Figure 2—No Transfers Versus Transfers with Consumption-Based Targeting

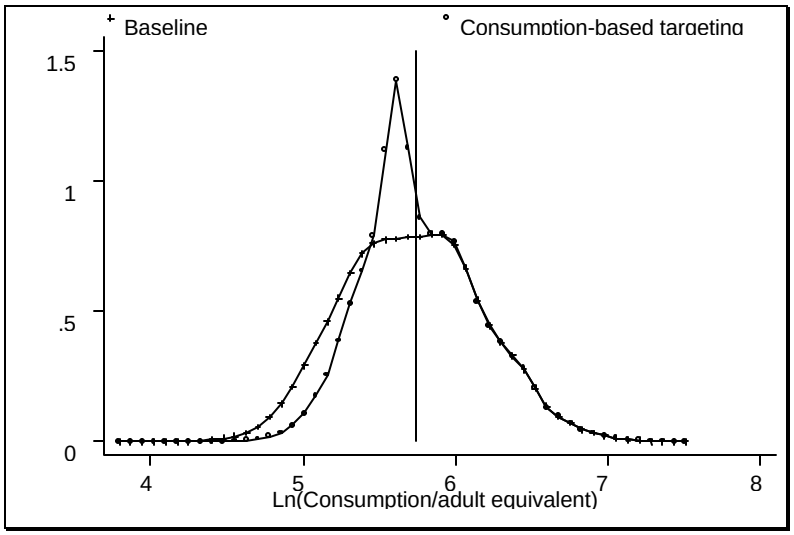


Figure 3—No Transfers versus Transfers with PROGRESA Targeting

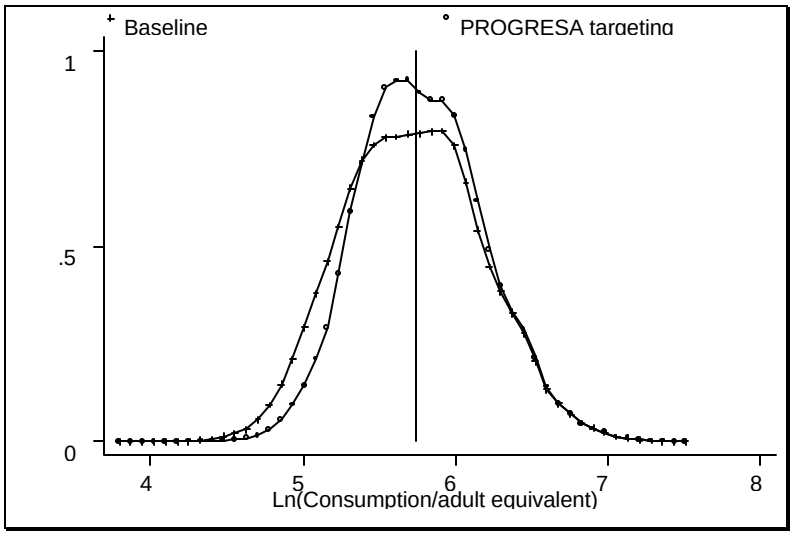


Figure 4—Comparison of Consumption-Based and PROGRESA Targeting

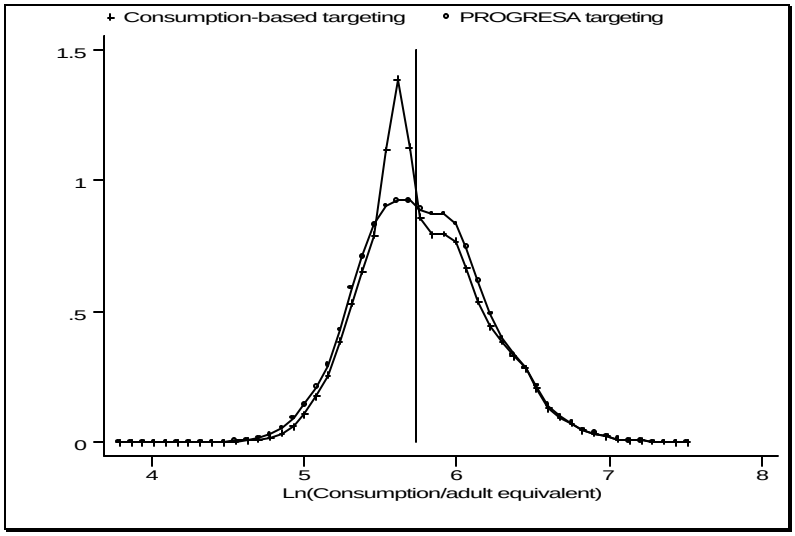


Figure 5—No Transfers Versus Transfers with Locality-Based Targeting

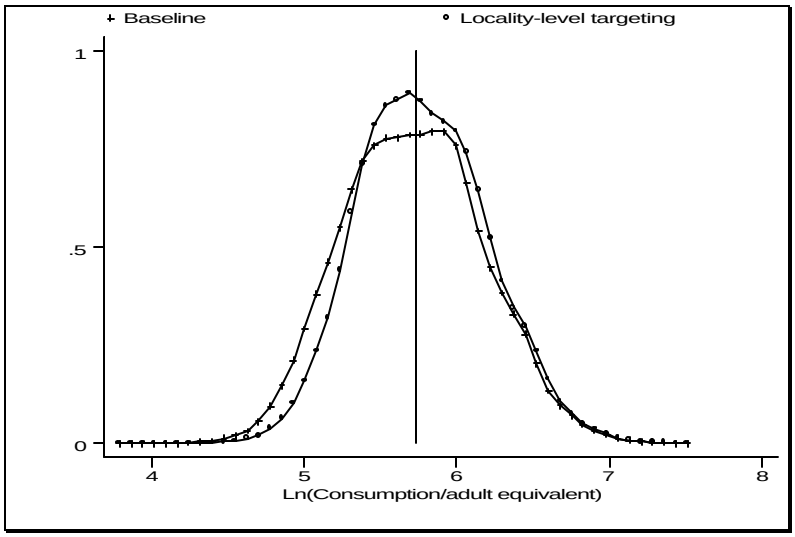
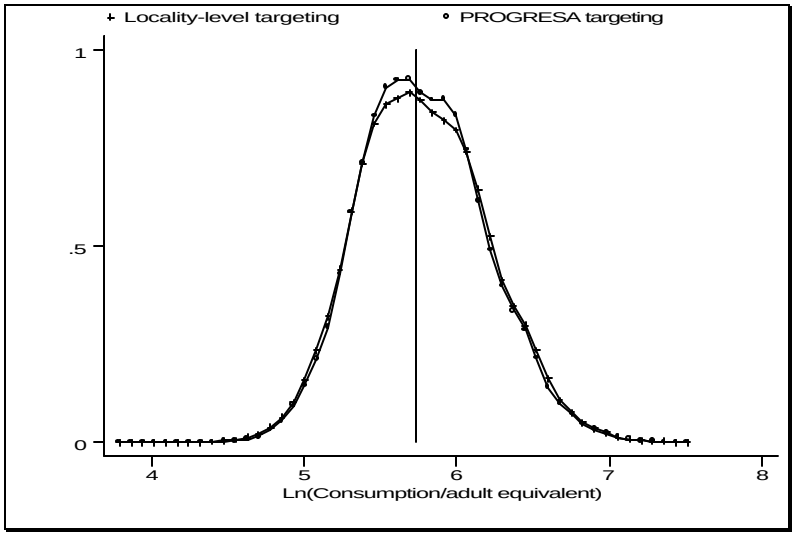


Figure 6—Comparison of Locality-Based and PROGRESA Targeting



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APPENDIX G

Comparing PROGRESA's Household Level Targeting to Locality-Level Targeting

1. Introduction

The PROGRESA procedure for selecting beneficiary households is described in the report and in more detail in Appendix A. Communities are first ranked using a marginality index based on locality level characteristics. Next, within chosen communities, beneficiaries are selected on the basis of a census applied in each community. In most cases, only a fraction of the households in a given community are selected.

Targeting within communities can raise three criticisms. First, selecting only certain households within a community is a waste of resources, since the marginal difference between most households in extremely poor communities is minimal. Second, the selection of individual households within communities is complex, and most beneficiaries do not understand why they, and not their neighbors, have been chosen. Third, such a procedure will lead to, or exacerbate, intra-community divisions between beneficiaries and non beneficiaries, particularly when people do not understand how the selection process works. Similarly, incorporating whole communities would minimize potential abuses in terms of the inclusion or non inclusion of certain members.

One possible alternative to the two-step selection of PROGRESA households is the selection of communities based on the marginality index, then including all inhabitants of the selected communities as PROGRESA recipients. This would reduce the cost of PROGRESA by eliminating the need to collect extensive census data. The expected savings could reach the order of US $16 million.[1] While such a method would reduce intra-community conflicts over who receives benefits, it on the other hand would raise issues of fairness and perhaps lead to other conflicts, as a certain number of clearly nonpoor households would receive benefits.

[1] According to PROGRESA, the application of the ENCASEH census costs approximately US $17 per household. Since a minimum of census data would be needed in any case for the administration of the program, each household would still have to be surveyed, at a cost of US $11 (US $9 to reach the household, and US $2 to collect the minimal amount of information), while the additional questions necessary for targeting would cost approximately US $6 to administer. Considering the 2.1 million households incorporated into PROGRESA, such a method would have saved approximately US $9 million.

2. The Experiment

In this section we will simulate a locality-level selection of all the members of PROGRESA communities as beneficiaries. Using the 505 community evaluation sub-sample, we rank communities based on the marginality index. We then select communities starting with the highest level of marginality and moving downwards, until we have selected a sufficient number of communities so that their cumulative population equals the total number of actual PROGRESA beneficiaries in this sub-sample (59% of the total sub-sample).[2] This process will reclassify some households that were previously nonpoor as poor, and vice-versa. We will thus compare these two sub populations—those households who were poor (that is, PROGRESA beneficiaries) and are now non poor in the locality-level method, with those households who were nonpoor (not PROGRESA beneficiaries) and are poor in the locality-level—in order to ascertain the impact of using the locality-level method. Two techniques are employed: the comparison of differences in means of key household characteristics and probits to identify those variables that determine the probability of selection as a beneficiary under each of the two methods.

3. The Results

3.1 Descriptives

In Table 1, which takes into account the densification phase, and in Table 2, which does not, we compare a variety of household assets, characteristics, and the use of services between the switching poor and non poor under the one step method. Significant differences are evident, though at times contradictory. While on the whole the one step poor appear better off then the old poor, whose spots as beneficiaries they would be taking, they share some household and community level characteristics usually associated with poverty.

The locality-level poor have significantly higher income and of consumption than the locality-level non poor. This is to be expected, as per capita income played an important role in the original selection of beneficiaries. A higher percentage of the new poor have an assortment of consumer durables, such as blenders, refrigerators, and televisions. On average these households have over twice as much rainfed land and livestock then the one step non poor. Similarly, the one step poor have significantly more household members involved in off farm activities such as agricultural and non agricultural wage labor and self employment activities. They have a significantly lower percentage of children, of all ages, who miss school, and have a slightly, though significant, higher percentage of households who have taken preventive health exams such as blood sugar and high blood pressure.

[2] This percentage includes the densificados (the households classified as poor recently following the densification method of PROGRESA) in the localities reached by PROGRESA. Without the densificados, potential beneficiaries comprise 52% of the total.

On the other hand, a higher percentage of the one-step poor switchers lack running water. This can be explained by the fact that the one-step poor are wealthier households from more marginalized communities, and thus one might expect that access would be lower for community level infrastructure variables. This is more evident in Table 2, where a significantly lower percentage of the one step poor have electricity as well.

In demographic terms, these households are later in the life cycle. The head of the household is older, less educated in terms of years of formal education as well as literacy, and has smaller families. The new one-step poor have significantly lower numbers of children in all age groups. A larger percentage of these household heads are female. Further, more then three times as many of these households are indigenous.

Finally, the one-step method implies a significant movement in terms of geographic regions. Regions 4, 5, and 6 are the biggest gainers. The share of households hailing from Region 5, the Sierra Gorda, goes from over one-third in the one-step nonpoor to over half, 52%, in the one step poor. Region 27, Michoacan, drops from 27% to 8%, while the two regions including the State of San Luis Potosi, 12 and 28, drop from 3% and 5% to 1%.

3.2. Econometrics

Using the probit estimation technique, we can evaluate the impact of each variable, holding all other variables constant, on the probability of a household being selected as a beneficiary. We will use three definitions of beneficiary: that produced by the current method, the one step method, and finally just those households switching under the one step method.

The probit is a nonlinear (in the parameters) statistical model that relates the choice probability to explanatory variables in such a way that the predicted probability remains between 0 and 1. One way to view this econometric model is by specifying an unobserved index as a linear function of a set of explanatory variables plus an error term. This is called an index function model.

Thus, the probit on selection as a beneficiary, or switching between beneficiary categories, is:

$$y_i^* = \beta' x_i + \mu$$
$$y_i = 1 \text{ if } y_i^* > 0,$$
$$y_i = 0 \text{ if } y_i^* \leq 0,$$

where y^*_i for a given selection mechanism is the latent index for selection, y indicates selection as a beneficiary, and where x_i is the vector of variables which effect the probability of selection into the respective categories. This can also be written as

$$\text{Prob}(y_i = 1) = f(\beta' x)$$

where ϕ is the standard normal distribution.

The vector of explanatory variables is identical in each equation. The selection as a beneficiary is modeled as a function of household head age, gender, education, and ethnicity; family size and age composition; the dependency ratio; the presence of a disabled family member; productive assets such as participation in labor activities, migration, and land and livestock ownership; previous receipt of a subsidy; dwelling characteristics; ownership of consumer durables; school attendance; per capita consumption; and geographic location.

In Table 3 we compare the determinants of selection into PROGRESA under the current method with the one step alternative. A number of variables which reflect key selection criteria under the current method either switch sign or are no longer significant. Per capita consumption, for example, no longer influences the probability of selection. Under the current method, household heads are younger and more often female, with more younger children, and the dependency ratios (ratio of non workers to workers) plays an important role in increasing the probability of selection. Under the one step method, the dependency ratio is now associated with a lower probability of selection as a beneficiary. Similarly, the number of older children are associated with a higher probability. The number of small children still has a positive effect, though the coefficient is reduced considerably. While an additional child from 0 to 5 and 6 to 11 years of age increases the probability of selection 5.5% and 4% under the current method, these drop to 1.5% and .8% under the one step. The role of a family member with a disability switches sign, and is now associated with a lower probability of selection into the program.

In terms of productive assets, a number of variables again switch signs, with the general trend of increasing productive assets associated with higher probability of inclusion under the one step method. The number of family members involved in self employment activities now increases the probability of inclusion, while the opposite is true of the number of family laborers. The number of temporary and permanent migrants to the United States also now increases the probability of inclusion. Finally, rainfed land and livestock assets are also associated with increased probability of selection, while irrigated land has the opposite effect.

Those variables related to community wide characteristics take on more importance under the one step method. Having an indigenous household head increases the probability of selection from 3% under the current method to 30% under the one step. Utilizing a latrine is now associated with a 13% increase in the probability of selection, and receiving a government subsidy of some kind—generally available at the community level—is now associated with an increased possibility of selection. Conversely, the ownership of consumer durables, in both sign and coefficient size (with the exception of gas stoves), becomes less important.

Certain variables which reflect important program components also switch signs. Having children 12 to 14 and 15 to 16 years of age not attending school is associated with

significantly increased probability of selection under the current method, while children 6 to 11 and 15 to 16 years of age not in school are associated with a lower probability under the one step. Similarly, having a child who has left school is associated with a lower probability.

Finally, as reflected in the descriptive statistics, geographical location now takes on added importance in the selection of beneficiaries. Compared to the default, Region 28, all other regions have a significantly higher probability of selection. Most of these probabilities are in the 30 to 40% range.

In Table 4, we restrict the sample to only those households that switch places between the two methods. In this case the probit analysis provides insight as to the determinants of switching from non-poor to poor under the one step criteria. Contrary to the descriptive statistics, controlling for other variables, these households have heads that are most often male and more educated, as well as older and indigenous. These households tend to have fewer smaller children and more older children, and thus consequently a lower dependency ratio.

These households are also better off economically. They have more productive assets, including temporary migration to the United States, rainfed land, and livestock. The one step have more consumer durables (except gas stoves), and higher per capita consumption levels lead to an increased probability of inclusion in this group.

4. Conclusions

The differences exhibited among the poor and non poor as determined by selection into PROGRESA as beneficiaries is in accordance with the objectives of the program: to target the poorest (in a multi dimensional sense) households. The alternative locality-level method presented above would clearly alter the characteristics of the beneficiary group. These changes may not be desirable given the objectives of the program. The demographic composition would become older, with smaller families and fewer small children. The income generating capacity of beneficiaries would increase, as we include better off households from more marginalized communities, and exclude worse off households from less marginalized communities. Household level differences, such as having a disabled household member, or having a lower level of consumption, would no longer influence inclusion. Thus while the one step method would simplify the rules of selection from the perspective of beneficiaries, and perhaps reduce intra-community conflict, it would incur tangible costs in terms of the characteristics of the resulting beneficiary population.

Table 1—Characteristics of Switching Households, Including Densification Phase

	Units	**Poor to non poor**	**Non poor to poor**	*test of Significance*
Income and consumption				
Total income, per capita	Pesos	228	349	+
Total consumption, per capita	Pesos	190	251	+
Durables				
Blender	%	33	44	+
Refrigerator	%	9	22	+
Gas stove	%	38	29	-
Television	%	49	60	+
Radio	%	61	76	+
Dwelling characteristics				
Dirt floor	%	55	55	
Running water on property	%	52	27	-
Electricity	%	81	85	+
Assets				
Irrigated land	Has	.30	.13	-
Rainfed land	Has	2.30	5.10	+
Heads of cattle	#	.83	1.80	+
Pigs	#	.80	1.55	+
Demographics				
Age, head of household	Years	42	52	+
Sex, head of household	%	91	87	-
Education, head of household	Years	3.08	2.71	-
Literacy, head of household	%	75	67	-
Family size	#	5.95	4.40	-
Children 0-5	#	1.04	.38	-
Children 6-11	#	1.20	.47	-
Children 12-14	#	.53	.29	-
Children 15-16	#	.25	.21	-
Member of indigenous ethnic group	%	13	44	+
Labor activities				
Agricultural wage laborers, hh	#	.69	.86	+
Non agricultural wage laborers, hh	#	.24	.30	+
Self employment, hh	#	.14	.38	+
Family labor, hh	#	.37	.38	
School attendence				
children 6-11 not in school	%	4	1	-
children12-14 not in school	%	12	5	-
children 15-16 not in school	%	14	10	-
Health				
blood sugar test	%	27	30	+
high blood pressure test	%	42	45	+
Regions				
Sierra Negra-Zongolica-Mazateca (3)	%	12	11	
Sierra Norte-Otomi Tepehua (4)	%	15	21	+
Sierra Gorda (5)	%	36	52	+
Montaña-Guerrero (6)	%	2	7	+
Huasteca-SLP (12)	%	3	1	-
Tierra Caliente-Michoacan (27)	%	27	8	-
Altiplano- SLP (28)	%	5	1	-

Table 2—Characteristics of Switching Households, Excluding Densification Phase

	units	**Poor to non poor**	**Non poor to poor**	*test of significance*
Income and consumption				
Total income, per capita	Pesos	216.79	329.98	+
Total consumption, per capita	Pesos	182.73	244.71	+
Durables				
Blender	%	30	37	+
Refrigerator	%	07	19	+
Gas stove	%	34	24	+
Television	%	47	52	+
Radio	%	60	72	+
Dwelling characteristics				
Dirt floor	%	.57	.60	+
Running water on property	%	.50	.26	-
Electricity	%	.80	.80	
Assets				
Irrigated land	Has	.23	.16	
Rainfed land	Has	2.34	5.16	+
Heads of cattle	#	.79	1.67	+
Pigs	#	.79	1.54	+
Demographics				
Age, head of household	Years	42	52	+
Sex, head of household	%	.92	.86	-
Education, head of household	Years	3.20	2.46	-
Literacy, head of household	%	.76	.62	-
Family size	#	6.07	4.29	-
Children 0-5	#	1.10	.39	-
Children 6-11	#	1.26	.48	-
Children 12-14	#	.54	.29	-
Children 15-16	#	.25	.21	-
Member of indigenous ethnic group	%	.16	.46	+
Labor activities				
Agricultural wage laborers, hh	#	.73	.86	+
Non agricultural wage laborers, hh	#	.23	.25	
Self employment, hh	#	.13	.39	+
Family labor, hh	#	.34	.36	
School attendence				
children 6-11 not in school	%	4	1	-
children12-14 not in school	%	12	5	-
children 15-16 not in school	%	14	10	-
Health				
blood sugar test	%	27	28	
high blood pressure test	%	42	43	
Regions				
Sierra Negra-Zongolica-Mazateca (3)	%	13	10	-
Sierra Norte-Otomi Tepehua (4)	%	17	23	+
Sierra Gorda (5)	%	36	50	+
Montaña-Guerrero (6)	%	1	10	+
Huasteca-SLP (12)	%	3	0	-
Tierra Caliente-Michoacan (27)	%	25	7	-
Altiplano- SLP (28)	%	5	1	-

	Current method				1-Step method			
	# obs	23133			# obs	23133		
Probit analysis	chi2(46)	15526			chi2(46)	11245		
	prob > chi2	.00			prob > chi2	.00		
***significant at 1% level	obs. P	.59			obs. P	.59		
**significant at 5% level	pred. P	.68			pred. P	.65		
*significant at 10% level								
	dF/dX	**z**	**P>|z|**		**dF/dX**	**z**	**P>|z|**	
Demographics								
age, head of household	-.004	-12.86	.00	***	.000	-1.22	.22	
sex, head of household	-.039	-2.83	.01	***	.000	.01	.99	
years of education, head of household	-.017	-9.68	.00	***	-.006	-4.02	.00	***
member of indigenous ethnic group	.029	3.01	.00	***	.295	33.48	.00	***
gender ratio	.000	.00	1.00		-.011	-.54	.59	
children 0-5	.055	9.87	.00	***	.015	3.04	.00	***
children 6-11	.040	7.45	.00	***	.008	1.68	.09	*
children 12-14	.014	1.73	.08	*	.008	1.08	.28	
children 15-16	-.023	-1.79	.07	*	.029	2.39	.02	**
dependency ratio	.155	35.70	.00	***	-.010	-3.04	.00	***
disability	.080	4.77	.00	***	-.049	-2.94	.00	***
Labor activities								
# ag wage laborers	-.008	-1.34	.18		-.012	-2.00	.05	**
# non ag wage laborers	-.045	-5.16	.00	***	-.044	-5.59	.00	***
# sellers	-.042	-5.08	.00	***	.039	4.68	.00	***
# family laborers	.039	6.14	.00	***	-.014	-2.31	.02	**
Migration								
# temp mig mexico	.035	4.36	.00	***	.024	3.00	.00	***
# temp usa mexico	-.045	-2.94	.00	***	.054	4.08	.00	***
# perm mig mexico	.017	.90	.37		.037	2.01	.05	**
# perm usa mexico	-.007	-.37	.71		.027	1.66	.10	*
Assets								
has irrigated land	.000	.17	.87		-.005	-3.31	.00	***
has rainfed land	.000	.12	.90		.001	2.59	.01	***
yes/no cattle	-.009	-6.97	.00	***	.007	6.21	.00	***
yes/no pigs	-.005	-3.53	.00	***	.009	6.71	.00	***
Subsidy								
received subsidy	.005	.56	.58		.031	3.64	.00	***
Dwelling characteristics								
housing density ratio	.032	11.53	.00	***	.008	3.25	.00	***
dirt floor	.174	18.76	.00	***	.125	14.77	.00	***
running water, on land	-.116	-13.11	.00	***	-.316	-39.17	.00	***
letrine	-.003	-.31	.75		.132	16.11	.00	***
electricity	-.243	-24.21	.00	***	-.220	-22.44	.00	***
Durables								
blender	-.173	-16.07	.00	***	-.045	-4.48	.00	***
gas stove	-.113	-10.09	.00	***	-.209	-20.30	.00	***
radio	-.106	-11.73	.00	***	.039	4.48	.00	***
tele	-.180	-18.28	.00	***	.000	.04	.97	
refrigerator	-.247	-16.79	.00	***	-.011	-.91	.37	
School attendence								
yes/no children 6-11 not in school	.025	.82	.41		-.043	-1.72	.09	*
yes/no children12-14 not in school	.060	3.48	.00	***	.007	.44	.66	
yes/no children 15-16 not in school	.047	2.67	.01	***	-.025	-1.49	.14	
left school	-.002	-.07	.95		-.072	-2.10	.04	**
missed days of school	.000	.01	.99		.005	.40	.69	
Consumption								
total consumption, per capita	.000	-4.57	.00	***	.000	.04	.97	
Geographic								
region 3	-.130	-3.92	.00	***	.374	17.29	.00	***
region 4	-.058	-1.86	.06	*	.418	18.94	.00	***
region 5	-.169	-5.65	.00	***	.399	14.29	.00	***
region 6	.075	2.33	.02	**	.420	24.74	.00	***
region 12	.070	1.76	.08	*	.169	4.73	.00	***
region 27	.127	4.45	.00	***	.302	12.31	.00	***

Table 4— Determinants of the Probability of Switching into PROGRESA under the One-Stop Method

	# obs	8050
	chi2(46)	5871
	prob > chi2	.00
	obs. P	.50
Probit analysis	pred. P	.48

	dF/dX	z	P>|z|	
Demographics				
age, head of household	.005	8.43	.00	***
sex, head of household	.050	1.85	.06	*
years of education, head of household	.014	4.19	.00	***
member of indigenous ethnic group	.290	14.82	.00	***
gender ratio	-.024	-.56	.58	
children 0-5	-.046	-4.35	.00	***
children 6-11	-.034	-3.41	.00	***
children 12-14	-.020	-1.29	.20	
children 15-16	.047	1.88	.06	*
dependency ratio	-.188	-23.08	.00	***
disability	-.146	-4.35	.00	***
Labor activities				
# ag wage laborers	-.005	-.45	.65	
# non ag wage laborers	.002	.10	.92	
# sellers	.109	6.08	.00	***
# family laborers	-.073	-6.04	.00	***
Migration				
# temp mig mexico	-.018	-1.14	.25	
# temp usa mexico	.131	4.50	.00	***
# perm mig mexico	-.013	-.32	.75	
# perm usa mexico	.036	.95	.34	
Assets				
has irrigated land	-.005	-1.25	.21	
has rainfed land	.003	3.69	.00	***
yes/no cattle	.013	5.84	.00	***
yes/no pigs	.015	4.74	.00	***
Subsidy				
received subsidy	.036	1.98	.05	**
Dwelling characteristics				
housing density ratio	-.033	-6.13	.00	***
dirt floor	-.090	-5.24	.00	***
running water, on land	-.232	-14.28	.00	***
letrine	.139	8.41	.00	***
electricity	-.005	-.23	.82	
Durables				
blender	.133	6.64	.00	***
gas stove	-.062	-3.08	.00	***
radio	.182	10.12	.00	***
tele	.177	9.45	.00	***
refrigerator	.251	10.10	.00	***
School attendence				
yes/no children 6-11 not in school	-.019	-.36	.72	
yes/no children12-14 not in school	-.057	-1.71	.09	*
yes/no children 15-16 not in school	-.038	-1.09	.27	
left school	-.082	-1.20	.23	
missed days of school	.021	.74	.46	
Consumption				
total consumption, per capita	.000	2.37	.02	**
Geographic				
region 3	.511	11.21	.00	***
region 4	.490	10.09	.00	***
region 5	.487	9.51	.00	***
region 6	.524	11.99	.00	***
region 12	-.017	-.22	.83	
region 27	.207	3.67	.00	***

APPENDIX H

The Impact of the Various Targeting and Transfer Schemes on Two Measures of Inequality

In addition to the FGT poverty indices we have also examined the values of inequality indices and how they are affected by different transfer and targeting schemes. The main shortcoming of the FGT poverty indices is that they focus on or assign weights only to the poor households. Thus households just above the poverty line, though for all practical purposes identical to households just below the poverty line, receive no weight. Inequality indices provide an alternative means of evaluating the impact of various targeting and transfer schemes by comparing their impact on inequality in the total population of households not just those below the poverty line. In this manner, the benefits accruing to households just above the poverty line do not necessarily have to be considered as leakage and be assigned a weight similar to that assigned for households receiving benefits just below the poverty line (Deaton, 1997).

We calculated the impact of the targeting and transfer schemes discussed within this report, for two fairly known inequality indices: the Generalized Entropy index GE(a) and the Atkinson index, A(e).

Consider a population of individuals (or households, etc.) $i=1,\ldots,n$ with income y_i and weight w_i. Let $f_i = w_i / N$, where $N = \sum_{i=1}^{n} w_i$. When the data are unweighted $w_I=1$ and $N=n$. Let arithmetic mean income be m. Then Generalized Entropy index GE(a) is given by the expression:

$$GE(\alpha) = \frac{1}{\alpha(1-\alpha)}\left[\left[\sum_{i=1}^{n} f_i \left(y_i / m\right)^{\alpha}\right] - 1\right], \alpha \neq 0, \alpha \neq 1$$ whereas the Atkinson index is

$$A(e) = 1 - \left[Y_{ede}(e) / m\right], \text{ where } Y_{ede}(e) = \left[\sum_{i=1}^{n} f_i (y_i)^{1-e}\right]^{1/1-e}, e > 0, e \neq 1.$$

Both inequality indices involve a parameter that allows the index to be sensitive to different parts of the distribution. For example, for the GE(a) index, the more negative a is, the more sensitive GE(a) is to consumption differences at the bottom of the distribution. The more positive is e>0 is, the more sensitive is A(e) to consumption differences at the bottom of the distribution. In Table 1 we report the values of these two indices with the values of the parameters set to a = - 1 and e = 2 so that both indices are sensitive to differences at the bottom of the distribution of consumption.

Table 1—Inequality Indices

Inequality indices under various targeting/transfer schemes with a fixed budget and including administrative costs of targeting (Percentage change in inequality index from the case of no transfer)

	GE (-1)	A(2)
No transfer (no anti-poverty program)	0.1147	0.18660
Uniform transfer (I.e. no targeting)	0.11567 (0.85)	0.18788 (0.69)
Transfers with consumption-based targeting	0.08263 -(27.96)	0.14182 -(24.00)
Transfers with PROGRESA targeting	0.08943 -(22.03)	0.15173 -(18.69)
Locality-level targeting (based on marginality index)	0.09657 -(15.81)	0.16188 -(13.25)

Inspection of Table 1 reveals the same general patterns observed for the poverty index P(2) in the report. For both inequality indices, uniform transfers have little or no effect on inequality while consumption based targeting has the highest impact on inequality. PROGRESA's targeting runs second to consumption-based targeting but well ahead of the impact of targeting at the locality level.

APPENDIX I

Relative Operating Characteristics (ROC) Analysis and PROGRESA Targeting

1. Introduction

Relative operating characteristics (ROC) curves can be used to assess the predictive power of poverty targeting indicators. This technique will allow us to comment on which groups or individual targeting indicators have the most predictive power on whether a family is poor or not. Our objective is to compare the variables actually used by PROGRESA with an alternative set of variables. First, we will judge the robustness of the weighting scheme implicit in PROGRESA's discriminate analysis procedure. Second, we will test whether the alternative set of variables performs better than the PROGRESA variables, allowing us to suggest new variables for PROGRESA's use. Third, by varying the poverty line, we can evaluate the sensitivity of the variables used to changes in the poverty line. Fourth, since PROGRESA performed an exhaustive testing of possible variables, most of these alternative variables are likely to have been discarded by the discriminate analysis procedure. Thus our comparison will provide an explicit test of the effectiveness of using discriminate analysis to discard possible explanatory variables.[1]

The exercise requires the following steps. First, we present a description of the theory and mechanics of ROC curves. Second, we establish a series of poverty lines. Third, we proceed to estimate a multivariate logit equation for each poverty line and for each set of explanatory variables. The ROC curves and score, or area under the curve, are calculated from the logit results. Fourth, univariate models are also employed to check the predictive power of single or groups of variables across poverty lines. For example we can measure whether landholdings are more important than years of education across regions and poverty lines.

2. What is an ROC Curve?

The ROC curve originated in the signal detection theory in the 1950s and has since been used in psychology and medicine, among other fields. Wodon (1997) made the first application of ROC curves to economics, and more specifically, poverty targeting. As described by Wodon, ROC analysis can be used to assess the predictive power of poverty targeting indicators. Wodon defines two types of targeting errors: sensitivity, or SE, the fraction of households with observed positive (in poverty) outcomes correctly identified (Type II errors = 1-SE); and specificity, or SP, the fraction of households with observed negative outcomes correctly classified as non poor (Type I errors = 1-SP). In other words,

[1] Here we need to keep in mind that a few variables at specific points in time have been kept in the discriminate analysis function for political rather than statistical reasons.

$$SE = \frac{P_{correctly}}{P_{incorrectly} + P_{correctly}}$$

and

$$SP = \frac{NP_{correctly}}{NP_{incorrectly} + NP_{correctly}}$$

where P=poor and NP=non poor.

The ROC curve summarizes SP and SE errors obtained along a continuum of cut off points. One set of targeting indicators is said to dominate another for the class of welfare functions *W*(SE, 1-SP) if for all values of the cut off point representing the trade off between the two types of errors, the probabilities of both errors associated with the first set of indicators can be made smaller than the probabilities of both errors associated with the second.

Figure 1 shows a ROC curve corresponding to one of the models estimated in Section 3. The horizontal axis is 1-specificity (SP) while the vertical axis is sensitivity (SE). The ROC curve plots 1-SP and SE for a continuum of values (bounded by 0 and 1) of the cut off point, *c*. As the *c* moves to 1, fewer households are predicted as poor, increasing SP and reducing the probability of SP error, while SE is reduced, and increasing the probability of SE error. The reverse is true as the *c* moves to 0. When c=1, no one is classified as poor, and thus the probability of a SP error equals zero. On the other hand, all poor are classified as non poor, and thus SE=1. At (1,1), with c=0, all non poor are classified as poor, and thus SP equals one. Similarly, all poor are classified as poor, and thus SE equals zero.

The area under the ROC curve summarizes the predictive power of the model. A model that predicted poverty perfectly would pass through (0,1), the upper left hand corner of the graph. The resulting area would equal one. Thus, a larger area under the ROC curve is a measure of better predictive power. For most of the analysis that follows we will compare the area under the ROC curves of competing models.

3. Setting a Poverty Line

Determinants of poverty may vary depending on the specification of the poverty line. For example, a variable, or group of variables, which is crucial in the identification of the extreme poor, may lose predictive power as the poverty line is increased, and vice versa. For this reason, we experimented with three separate poverty lines—25th percentile, 50th percentile, and 75th percentile. In the discriminate analysis methodology used to identify

beneficiaries, PROGRESA as a first step separates households into poor and non poor based on per capita income. The poverty line is set using the prices of a basket of food goods. This poverty line corresponds approximately to the 75th percentile.

4. Estimation of Logit Models

ROC curves are constructed using the output from a logit equation. This is performed in a canned Stata program (Statacorp, 1999). The logit estimation technique is similar to the probit technique described in the note on the one step experiment, differing only in the probability distribution used. In this case, the logit evaluates the impact of a vector of explanatory variables on the probability of living in poverty. As with the probit, the logit is a nonlinear (in the parameters) statistical model that relates the choice probability to explanatory variables in such a way that the predicted probability remains between 0 and 1. This econometric model can be understood by specifying an unobserved index as a linear function of a set of explanatory variables plus an error term. We define this index as

$$y_i^* = z_i - y$$

where z_i = poverty line i and y = per capita income taken from ENCASEH97.[2] Thus the logit on living in poverty is

$$y_i^* = \beta' x_i + \varepsilon$$

where y^*_i for a given poverty line is the latent index for living in poverty, x is the vector of explanatory variables which determine the probability of living in poverty, and ε is the error term. When we run the logit we do not observe y^*_i but rather a dummy variable y_i, which takes on the following values

$$y_i = 1 \text{ if } y_i^* > 0,$$
$$y_i = 0 \text{ if } y_i^* \leq 0,$$

Thus the probability that the household is poor, for each poverty line, can be written as

$$\Pr(y = 1) = \Pr[\varepsilon > -\beta x] = 1 - F(-\beta x)$$

where F is the cumulative distribution. Beta is estimated using maximum likelihood, which in the case of the logit is

[2] We continue to use ENCASEH97 income data, though incomplete, in order to allow strict comparability with the discriminate analysis results.

$$\Pr(y=1) = \frac{\exp(-\beta x)}{[1-\exp(-\beta x)]}$$

By default the cut off rule, for living in poverty, is

$$\hat{\beta} x > .5$$

The Stata program, however, evaluates the logit for a continuum of cut off points, which allows the tracing out of the ROC curve.

For each of five regions (3, 4, 5, 6, and 27), two models were run for each of the three poverty lines. The first PROGRESA model, employs as explanatory variables the exact set of variables used in a particular region by the PROGRESA discriminate analysis procedure. The second model uses an alternative, unique set of explanatory variables. While the two models may have similar categories of variables, such as household composition or labor activities, the precise variables used are different. For each model we run first a multivariate logit to obtain the area under the ROC curve for the complete set of explanatory variables. Then we run univariate or multivariate models for each category of variables, in order to gauge the relative predictive power of each category.

5. Econometric Results

Overall

The results for each region can be found in Tables 1 to 5. Figure 1 graphs the ROC curves for both the PROGRESA and alternative models in Region 3. Comparing the results across regions, a number of patterns emerge. First, in all regions, under all three poverty lines, the alternative model performs better than the PROGRESA model. The difference between the two models decreases, however, as the poverty line increases from the 25th percentile to the 75th percentile. The difference in areas between the two models ranges from a low of 3% in the 75th percentile in Regions 3, 4, and 6, to 21% in the 25th percentile in Region 27. That the PROGRESA model performance should improve with higher poverty lines is not surprising; this poverty line is closest to that used by PROGRESA to initiate and calibrate its targeting models.

The worst performing model is the 25th percentile PROGRESA in Region 27, with an area of .637 (compared to the alternate score of .803). the best model is the 50th percentile alternative in Region 4, with an area of.860 (compared to.835 for PROGRESA). No one poverty line dominates, across regions, in terms of ROC area. While for the PROGRESA model 50th and 75th percentiles clearly dominate, the scores for the alternative model are more balanced across poverty lines.

By Subgroups

The alternative set of explanatory variables was constructed by using, when possible, reformulations of existing variables. When this was not possible, such as in the age of the head of the household, the variable was excluded from the alternative model. Analyzing ROC curves by subgroups allows us to explain the superiority of the alternative model. Also, it allows us to see the relative predictive power of different variables for sets of variables. Finally, we can see how the predictive power varies across poverty lines.

Household composition and size variables dominate the results, for both the PROGRESA and alternative models. The PROGRESA model used both the dependency ratio (the number of working adults to total family members) and the number of children, while the alternative model used a different dependency ratio (the share of children in total household size) as well as the number of household members in different age categories. In most cases, but not all, the PROGRESA formula outperformed the alternative formulation. The alternative variables, however, are often a better predictor of extreme poverty. For example, in Regions 4, 6, and 27, the alternative variables are better for the extreme poverty line, the 25^{th} percentile, while the PROGRESA variables are better under the 50^{th} and 75^{th} percentile criteria. In all instances, however, in either model, the household composition variables are better predictors of moderate poverty than extreme poverty.

The different formulation of labor activities is the key behind the superior performance of the alternative model. For all regions, the alternative formulation far outperformed the PROGRESA variable. While the PROGRESA model is limited to the labor activities of the household head[3], the alternative model uses a set of labor activities. This set is made up of the number of adult household members participating in one of four specific activities—agricultural wage labor, non agricultural wage labor, self employment, and family (mostly farm) labor. Under the alternative model, labor activities are either first or second in importance for all regions, across all poverty lines. In Regions 4, 6, and 27, labor activities are far superior to household composition in terms of predictive power. In some regions, PROGRESA excluded labor activities, which may not have been the case where the alternative formulation was used. Labor activities are particularly important in predicting extreme poverty. For all regions, under both formulation, labor activities decrease in importance with increasing poverty lines.

Other important variables include the number of family members per room, or "hacinamiento". No alternative specification exists for this variable. Hacinamiento uniformly increases in predictive power across poverty lines. In regions where both hacinamiento and labor activities are included in the model, hacinamiento overcomes the predictive power of labor by the 75^{th} percentile.

Housing characteristics and ownership of durables follow hacinamiento in importance. In most cases the PROGRESA formulation outperforms the alternative model. Except in

[3] PROGRESA converts the ordinal listing of activities to a continuous equivalent by the method of correspondence curves.

Region 27, housing characteristics have increasing predictive power with higher poverty lines. At no point however, do they outperform hacinamiento. Remaining variables are of secondary importance, and are highly variable across regions and poverty lines. In some cases they play significant roles, such as ethnicity in Region 6.

Besides the reformulation of PROGRESA variables, the alternative model also introduced a few variables tested and discarded, in specific regions, by PROGRESA's discriminate analysis procedure. These include ethnicity and gender of the head of the household, migration to the United States and Mexico, livestock ownership, and land. For the most part, the ROC results appear to justify the discriminate analysis selection, especially considering PROGRESA's use of the high poverty line. Contradictions emerge in the case of ethnicity, particularly in Region 6, and land, in Regions 4 and 27. The fact that ethnicity may play a significant role in ROC analysis, and not in discriminate analysis, does not mean that the latter is incorrect, as neither method can be definitively considered the correct method a priori.

Rankings

ROC analysis can also be used to check the robustness of the relative weighting scale produced by PROGRESA´s discriminate analysis. In Tables 6 and 7 we compare the ranking of predictive power produced by univariate ROC analysis with the structure matrix of the discriminate analysis. Both are conceptually similar in that they gauge the relative importance of variables in differentiating between poor and non poor households. In Table 6, corresponding to Region 5, we see that the rankings are remarkably similar. Only disability, which is ranked last in the structure matrix and 5th (of 14) in the ROC analysis, plays a significantly different role.[4] In Table 7, corresponding to Region 6, the rankings are somewhat less similar.

6. Conclusion

The ROC analysis presented above has provided us with another tool with which to gauge the robustness of the PROGRESA discriminant analysis procedure. Differences that emerge do not mean that one method or the other is better, as it is difficult to establish criteria for the superiority of either method a priori. In general, our alternative model performs better, under the ROC analysis, than the PROGRESA model. Differences between the two models reduce, however, as the poverty line increases. This is not surprising, as the 75th percentile corresponds closely to PROGRESA's initial poverty line. For both models, household composition variables have the most predictive power and dominate the results.

A reformulation of labor activities is behind the better performance of the alternative model. PROGRESA used only the labor activities of the head of the household, while the alternative model takes into account the labor activities of all adult members of the

[4] The values are not comparable.

family. This would be one set of variables that PROGRESA might benefit from incorporating into its targeting procedure.

The role of different variables or sets of variables in predicting poverty changes with the poverty lines used. Household composition, as well as hacinamiento, has more predictive power with a moderate poverty line. Labor activities, on the other hand, perform better with extreme poverty.

The ROC results confirm the rankings and weighting of the discriminant analysis procedure, though some ranking reversals do occur when comparing the two models. The discriminant analysis method thus appears generally robust. The ROC results also confirm the discarding of specific variables, with the particular exception of ethnicity in Region 6. Again, this discrepancy does not prove that the discriminant analysis method is incorrect, but simply places limits on the generality of its robustness.

References

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Table 1— Area under ROC Curve, by Poverty Line (Per Capita), Region 3

	Poverty line					
	25th percentile		50th percentile		75th percentile	
	Progresa	*Alternative*	*Progresa*	*Alternative*	*Progresa*	*Alternative*
N=2884						
Full model	.778	.851	.811	.853	.805	.828
Percentage Progresa of alternative		91		95		97
Partial model						
Size/composition of family	.739	.707	.792	.751	.755	.738
Ethnicity		.594		.581		.561
Gender		.516		.526		.540
Education	.556	.596	.509	.561	.490	.546
Age	.534		.575		.606	
Children missing school	.483		.486		.483	
Children working	.508		.507		.505	
Labor activity	.565	.704	.496	.674	.547	.650
Migration		.508		.507		.505
Livestock		.525		.490		.501
Members per room	.632		.675		.682	
Housing characteristics/durables	.587	.569	.589	.570	.612	.578
Disability	.504		.503		.508	
Land	.484	.484	.515	.510	.561	.558

Table 2—Area Under ROC Curve, by Poverty Line (Per Capita), Region 4

	Poverty line					
	25th percentile		50th percentile		75th percentile	
	Progresa	*Alternative*	*Progresa*	*Alternative*	*Progresa*	*Alternative*
N=4332						
Full model	.798	.850	.835	.860	.833	.855
Percentage Progresa of alternative		94		97		97
Partial model						
Size/composition of family	.671	.697	.785	.741	.777	.757
Ethnicity		.521		.518		.534
Gender		.501		.529		.531
Education	.527	.579	.523	.534	.479	.537
Age	.517		.562		.579	
Children missing school	.503		.502		.488	
Children working	.511		.516		.510	
Labor activity	.653	.758	.560	.698	.532	.687
Migration		.505		.507		.509
Livestock		.495		.522		.507
Members per room	.572		.646		.672	
Housing characteristics/durables	.590	.548	.556	.540	.581	.548
Disability	.508		.502		.504	
Land		.558		.507		.528

Table 3— Area Under ROC Curve, by Poverty Line (Per Capita), Region 5

	Poverty line					
	25th percentile		50th percentile		75th percentile	
	Progresa	*Alternative*	*Progresa*	*Alternative*	*Progresa*	*Alternative*
N=10576						
Full model	.768	.847	.816	.858	.814	.852
Percentage Progresa of alternative		91		95		96
Partial model						
Size/composition of family	.740	.713	.787	.745	.771	.742
Ethnicity	.566	.566	.575	.576	.585	.585
Gender		.505		.516		.523
Education	.492	.535	.540	.513	.526	.532
Age						
Children missing school	.497		.497		.490	
Children working	.511		.512		.507	
Labor activity		.710		.686		.667
Migration		.520		.528		.547
Livestock		.535		.543		.556
Members per room	.635		.658		.674	
Housing characteristics/durables	.595	.559	.602	.562	.626	.584
Disability	.507		.503		.505	
Land		.517		.514		.504

Table 4— Area Under ROC Curve, by Poverty Line (Per Capita), Region 6

	Poverty line					
	25th percentile		50th percentile		75th percentile	
	Progresa	*Alternative*	*Progresa*	*Alternative*	*Progresa*	*Alternative*
N=1862						
Full model	.757	.813	.782	.831	.810	.834
Percentage Progresa of alternative		93		94		97
Partial model						
Size/composition of family	.621	.631	.698	.690	.728	.713
Ethnicity		.595		.586		.606
Gender		.504		.507		.520
Education	.544	.561	.537	.570	.552	.590
Age	.502		.531		.555	
Children missing school						
Children working	.513		.522		.513	
Labor activity	.683	.745	.633	.723	.625	.674
Migration		.506		.506		.511
Livestock		.505		.506		.523
Members per room	.554		.608		.654	
Housing characteristics	.591	.567	.579	.563	.606	.587
Disability	.501		.500		.505	
Land		.459		.466		.534

Table 5— Area Under ROC Curve, by Poverty Line (Per Capita), Region 27

	Poverty line					
	25th percentile		50th percentile		75th percentile	
	Progresa	*Alternative*	*Progresa*	*Alternative*	*Progresa*	*Alternative*
N=2866						
Full model	.637	.803	.700	.801	.752	.808
Percentage Progresa of alternative		79		87		93
Partial model						
Size/composition of family	.580	.613	.663	.667	.740	.714
Ethnicity	.501		.501		.502	
Gender		.513		.523		.533
Education	.538	.528	.509	.521	.528	.508
Age						
Children missing school	.536		.541		.526	
Children working	.521		.510		.502	
Labor activity		.764		.704		.651
Migration		.509		.519		.534
Livestock		.551		.540		.509
Members per room	.524		.590		.649	
Housing characteristics	.538	.517	.536	.510	.529	.531
Disability	.512		.511		.507	
Land		.585		.553		.480

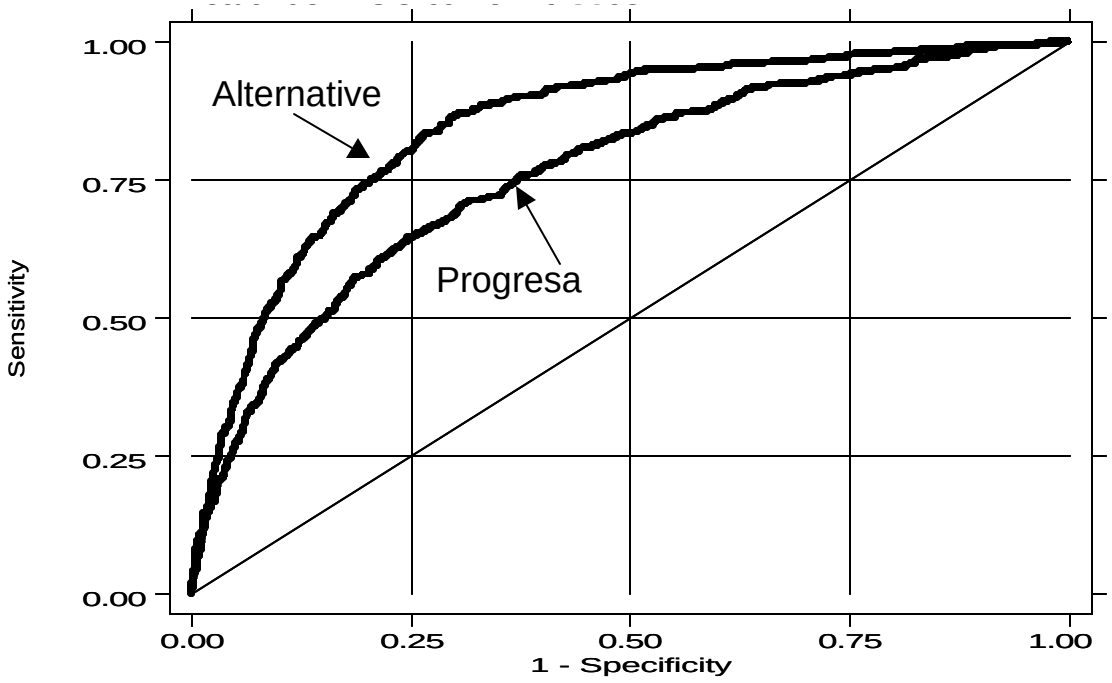
Table 6— ROC vs. Discriminant Analysis, Region 5

	Discriminate analysis		**ROC (75th percentile)**	
	structure matrix	*ranking*	*Area under ROC curve*	*ranking*
N=10576				
Full model (ROC)			.814	
Partial model (ROC)				
Dependency ratio	.704	1	.770	1
Number of children	.600	2	.698	2
Members per room	.527	3	.674	3
Gas stove	.488	4	.598	4
Refrigerator	.450	5	.573	6
Vehicle	.329	6	.538	9
VHS	.327	7	.526	10
TV	.323	8	.569	7
Radio	.200	9	.541	8
Children working	.114	10	.507	12
Children missing school	.092	11	.490	14
Education	-.050	12	.526	11
Ethnicity	.032	13	.505	13
Disability	.015	14	.585	5

Table 7— ROC vs. Discriminant Analysis, Region 6

	Discriminate analysis		**ROC (75th percentile)**	
	structure matrix	*ranking*	*Area under ROC curve*	*ranking*
N=1862				
Full model (ROC)			.810	
Partial model (ROC)				
Number of children	-.522	1	.688	2
Occupation	.418	2	.625	4
Dependency ratio	-.415	3	.715	1
Members per room	-.412	4	.654	3
Education	.401	5	.552	8
Vehicle	-.340	6	.525	11
Blender	-.326	7	.569	5
Wall material	.274	8	.560	6
Refrigerator	-.259	9	.537	10
Dirt floor	.253	10	.538	9
Age	.132	11	.555	7
Disability	-.088	12	.505	13
Children working	-.081	13	.513	12
Washing machine	-.018	14	.504	14

Figure 1—ROC Curve



APPENDIX J

Restructuring the Benefits in Favor of the Extreme Poor

An unused by-product of the current targeting method of PROGRESA is the discriminant score (puntaje) constructed from the application of the discriminant analysis at the regional level. One intriguing question is whether this measure could be of use to restructuring the benefits in favor of more needy households (or the extreme poor) while at the same time minimizing excess payment to households that are close to the poverty line.

In order to address this question we run a set of simulations using data for the region of Sierra Gorda that contains the largest number of households in our sample (10,800 households). We use consumption and its distance from the cut-off point to classify households into two groups: the Moderately Poor and the Extremely Poor households. This is done in the following manner. Moderately poor are the households with consumption level greater than the 24^{th} percentile of consumption and less than or equal to the 49^{th} percentile of consumption, the poverty rate obtained from PROGRESA's cut-off point in the Sierra Gorda region. The Extreme Poor are the households with consumption less than or equal to the 24^{th} percentile.

Next, we restructure benefits so that extremely poor households receive twice the amount of benefits currently provided by PROGRESA to all beneficiary households and Moderately Poor households get half of the current benefits. We also remove the current restriction imposed by PROGRESA that monthly benefits per household cannot exceed 695 pesos. Lastly, we repeat the preceding two steps by comparing the value of the household-specific discriminant score with the two-cut-off values derived in a similar manner from the distribution of discriminant scores. For example, the set of Extremely Poor households now contains the households whose discriminant score is less than or equal to the 26^{th} percentile of the distribution of discriminant scores in the region of Sierra Gorda.

Our objective is to compare the impact on the poverty indices of these two methods of classifying households and get a sense of whether the method based on the information that is available to PROGRESA's yields results that are close to those with full information (i.e., consumption). For comparison purposes, we also recalculate the cases of a uniform transfer scheme, locality-based targeting[1], and transfers with PROGRESA targeting using the current benefit structure, for region of Sierra Gorda only. For all transfer schemes we assumed the same fixed budget. Given the evidence presented in Appendix G about the impact of targeting costs we assumed that the administrative costs of targeting are equal to zero.

[1] For the case of locality-based targeting we used the same benefit structure as that used currently by PROGRESA.

Figures 1-4 display graphs of the kernel density functions of the logarithm of consumption per adult equivalent under each transfer and targeting scheme against the baseline case of no transfers at all.[2] In each graph we also draw with two vertical lines the two cut-off lines for classifying households into Moderately Poor and Extremely Poor. The Moderately Poor households are those with consumption per adult equivalent that falls between the two vertical lines and the Extremely Poor households are those to the left of the first vertical line (moving from left to right).

Figure 1 contains the kernel density functions of consumption under the baseline case of zero transfers and transfers with consumption-based targeting. The higher benefits provided to the extremely poor households result in a substantial shrinkage in the lower left tail of the density of consumption and an sharp increase in the peak of the density function inside the interval contained by the two vertical lines. Thus after receiving the higher benefits many of the extremely poor households move to the level of consumption of the moderately poor households. Figure 2 shows that very much the same changes occur when benefits are restructured in favor of the extreme poor as classified by PROGRESA's discriminant score.

Figure 3 provides a better comparison of the effects of the revised benefit structure using consumption-based targeting and PROGRESA's targeting based on the discriminant score. Thus it appears that the discriminant score can serve quite adequately as a substitute for the information provided by household consumption.

For curiosity's sake, based on PROGRESA's targeting method Figure 4 provides a comparison of the densities obtained with the current structure of benefits and the revised benefit structure experimented with in this appendix. As argued above, the revised benefit structure ends up shifting the lower tail of the density closer to the poverty line and thus moving more of the extreme poor households into the region of moderate poverty.

Similar effects are also apparent by examining the indices of inequality in Table 1 below. Consumption-based targeting has the largest negative impact on inequality with transfers based on PROGRESA's targeting been a fairly close second. Moreover, given the targeting method followed by PROGRESA, the decrease in inequality achieved by the revised benefit structure is considerably higher than that achieved by the current benefit structure.

[2] See Appendix F for a brief description of kernel density estimators.

Figure 1— No Transfers Versus Transfers with Consumption-Based Targeting

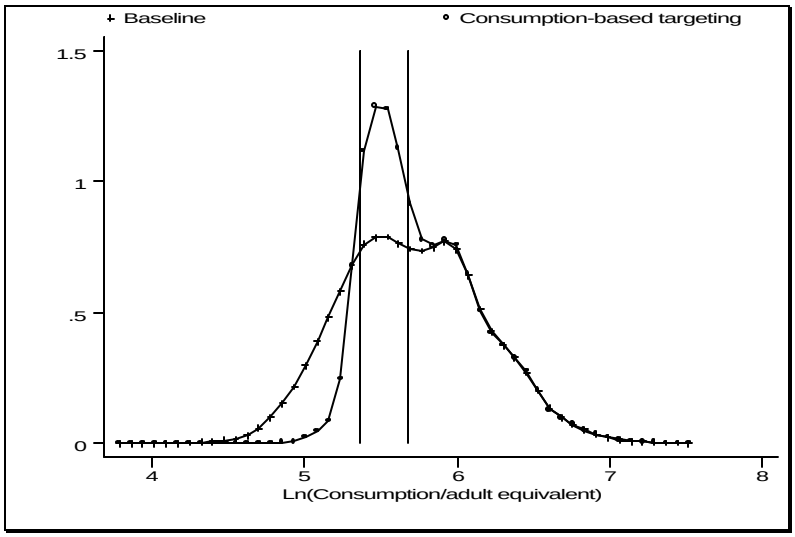


Figure 2— No Transfers Versus Transfers with PROGRESA Targeting

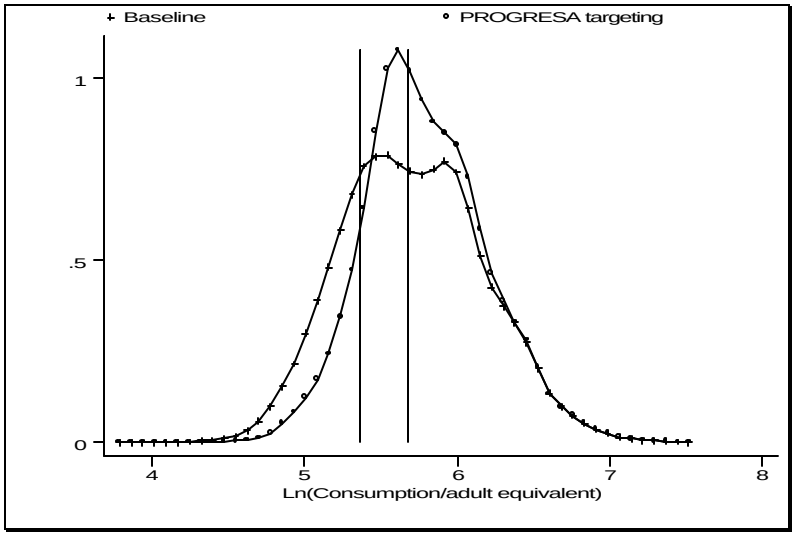


Figure 3—Comparison of Consumption-Based and PROGRESA Targeting

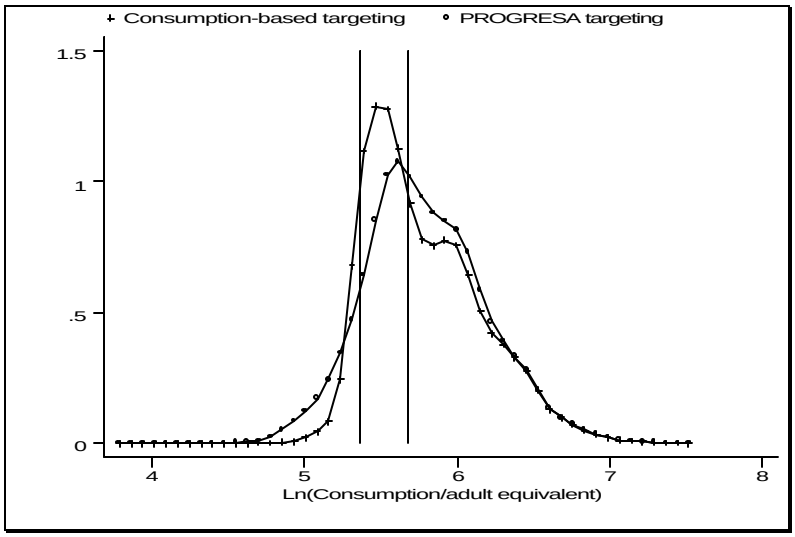


Figure 4—Comparison of the Current and the Revised Benefit Structure Using PROGRESA's targeting

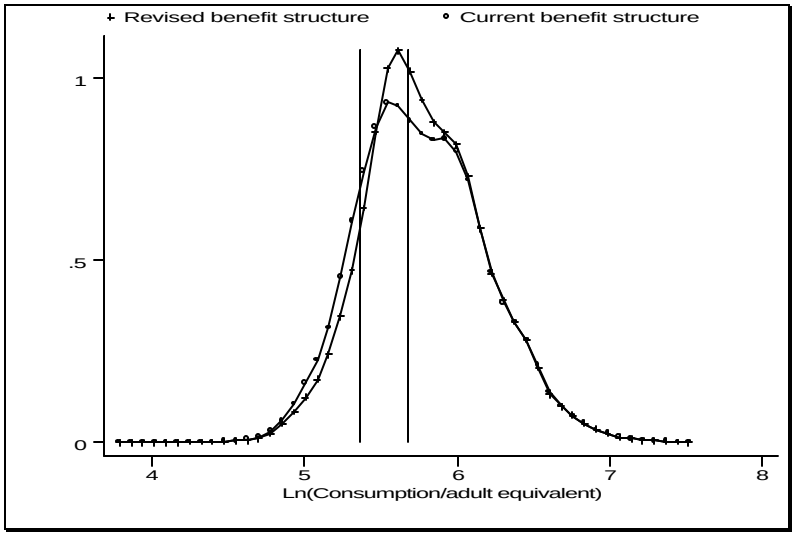


Table 1—Indices of Inequality

Inequality indices with a fixed budget and targeting costs excluded
Sierra Gorda Region
(Percentage change in inequality index)

	GE (-1)	A(2)
No transfer (no anti-poverty program)	0.11825	0.19127
Uniform transfer (i.e. no targeting)	0.11946 (1.02)	0.19285 (0.83)
Transfers with consumption-based targeting and the revised benefit structure	0.07626 -(35.51)	0.13234 -(30.81)
Transfers with PROGRESA targeting and the revised benefit structure	0.08672 -(26.66)	0.14781 -(22.72)
Locality-level targeting (based on marginality index)	0.09719 -(17.81)	0.16275 -(14.91)
Transfers with PROGRESA targeting and the current benefit structure	0.09481 -(19.82)	0.15940 -(16.66)