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8

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8.1 Introduction

Many countries around the world have implemented subsidies for utility consumption, especially in the case of water and electricity. Most subsidies take the form of a lifeline or increasing block tariff, whereby households that consume less pay less on a unit basis. The idea is that households with low consumption levels are likely to be poor, and some intervention is warranted to enable them to meet their basic needs (the lifeline) at an affordable cost. Whether such subsidies are successful at helping the poor is not clear, as illustrated by the experience of a number of Central American and Latin American countries.

Gómez-Lobo and Contreras (2000) suggested that in Chile and Colombia, errors of exclusion (poor households not benefiting from the subsidy) and inclusion (nonpoor households benefiting from the subsidy) for water and electricity subsidies are large (for a review of this and other studies, see Estache, Foster, and Wodon 2002). In Colombia, dwelling and neighborhood characteristics are used as proxies for income in a six-tier classification of households. Households classified as belonging to the lower strata get a percentage reduction in their water and energy bills that is financed by a surcharge for households from the upper strata. Subsidization takes place primarily within each utility, that is, the subsidies are financed by higher tariffs on unsubsidized customers, but the government also provides public funds to utilities in areas with few high-income households. Because eligibility rules are not stringent, the subsidy reaches a large share of the poor, that is, the rate of errors of exclusion is low, but this leads to large errors of inclusion: up to 80 percent of beneficiaries are nonpoor households, depending on the definition of who is poor.

In Chile eligible households receive a subsidy of 20 to 85 percent of the water bill for the first 15 cubic meters of monthly consumption. The targeting mechanism is based both on regional data on water consumption and tariffs and on household characteristics as measured by a national means-testing system. While errors of inclusion for nonpoor households are lower than in Colombia, the errors of exclusion are much higher at up to 80 percent. In addition, research by Clert and Wodon (2001) suggests that the

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water subsidy's overall performance in reducing poverty and inequality is substantially weaker than that of other social programs targeted using the national means-testing system. These other programs include noncontributory pensions for the elderly poor, family allowances for poor families with children or pregnant women, subsidized child care centers, and housing subsidies. Given that their impact on poverty and inequality tends to be larger than that of utility subsidies, this raises the question of whether keeping these subsidies is worthwhile, or whether the funds used for the subsidies should be invested in these other programs.

In Guatemala, following reform of the electricity sector, prices for residential customers increased after 1998, in some case by up to 85 percent over a three-year period. To ensure affordability for poor customers, the government introduced a social tariff for those consuming less than 500 kilowatt hours (kWh) per month. In January 2001 the government reduced the lifeline to 300 kWh per household per month. This threshold, which is similar to the threshold in Honduras examined in this chapter, is still high, because an average household consumes only 102 kWh per month. An evaluation by Foster and Araujo (forthcoming) suggests that two-thirds of beneficiaries are not poor, and because the nonpoor consume more electricity, 90 percent of the funds go to the nonpoor.

Finally, in El Salvador, until recently, the Electricity-Telephone Investment Fund subsidized residential electricity consumption for households consuming less than 200 kWh per month. The subsidy was a flat 75 percent reduction on the bill, paid by the fund to the electricity company every six months. An additional subsidy came from the payment of the consumption tax (13 percent) on that share of the household's consumption. As in other countries, this lifeline subsidy had high leakage rates to the nonpoor, and it benefited mostly urban households. The subsidy was recently terminated.

In this chapter we assess the targeting performance of a similar subsidy for electricity implemented in Honduras. Honduras is the second largest country in Central America and one of the poorest in the Western Hemisphere (World Bank 2001). The country has 6.5 million inhabitants. As part of its efforts to reduce poverty, the government is funding two large subsidies for basic infrastructure services. The first subsidy is for electricity consumption, which in 1998 cost the government L 259 million (or US$17.5 million at an exchange rate at that time of L 14.80 to the U.S.

dollar). The second subsidy, with a cost of L 114 million in 1990, is for bus transportation in the capital city of Tegucigalpa. These subsidies are large in comparison with other social programs, because only one—the Honduras Social Investment Fund—has a larger budget. Here we focus on the electricity subsidy, which the state paid to the national electric utility on behalf of beneficiaries.

The subsidy is targeted through the lifeline principle; however, because the consumption threshold for eligibility is relatively high (300 kWh per month), and because those with access to electricity tend to be less poor than those without access, the program's overall performance is low in terms of poverty reduction. Targeting through means-testing rather than a lifeline, or at least a lower threshold for the lifeline, could help improve the impact of the subsidy, and based on experience in other countries, would not necessarily imply high administrative costs.

The rest of the paper is structured as follows. Section 8.2 describes the subsidy scheme and assesses its performance. Section 8.3 illustrates how simple techniques based on so-called receiver operating characteristics (ROC) curves can be used to show how much improvement might come from an alternative way of targeting the subsidy. Section 8.4 concludes.

8.2 Targeting Performance of Honduras's Electricity Subsidy

Electricity access rates in Honduras can be estimated using the Permanent Multiple Purpose Household Survey (Encuesta Permanente de Hogares de Propósitos Múltiples or EPHPM). This is a nationally representative labor force survey implemented with support from the U.S. Agency for International Development and conducted by the General Directorate for Statistics and Censuses. The sample consists of 6,423 households stratified into four geographic regions: Tegucigalpa, San Pedro Sula, other urban, and rural.

As table 8.1 reveals, Empresa Nacional de Energía Eléctrica (ENEE), the public provider of electricity, is by far the predominant provider of electricity for households. A few households obtain their electricity from collectives or privately owned electricity generators. Clearly access to electricity varies a good deal by income group and location. As expected, higher-income households have higher access rates than lower-income

TABLE 8.1. Access to Electricity by Income Group, Honduras, 1999 (percent)

	Income decile										
Location and source	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
National											
None	75.0	65.3	46.5	33.5	25.9	20.4	16.1	9.7	6.6	4.7	30.4
ENEE	24.5	34.7	53.2	65.7	73.9	78.7	82.1	89.9	91.9	93.3	68.8
Collective	0.0	0.1	0.3	0.5	0.0	0.7	0.7	0.3	0.4	0.5	0.4
Individual[a]	0.5	0.0	0.0	0.3	0.2	0.2	1.1	0.1	1.1	1.5	0.5
Urban											
None	31.0	16.6	10.0	9.0	4.0	1.9	1.4	0.4	0.2	0.4	7.5
ENEE	69.1	83.4	90.1	90.7	96.0	98.1	98.6	99.6	99.7	99.4	92.5
Collective	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1	0.2	0.1
Individual[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rural											
None	80.2	76.7	59.4	50.8	50.0	46.8	40.7	33.8	23.3	25.8	48.8
ENEE	19.3	23.2	40.1	48.0	49.6	50.8	54.7	64.8	71.5	63.3	48.5
Collective	0.0	0.1	0.4	0.6	0.0	1.8	1.8	1.1	1.1	1.9	0.9
Individual[a]	0.6	0.0	0.0	0.6	0.4	0.6	2.9	0.3	4.1	9.0	1.9

a. Small privately owned generators.

Source: Authors' estimates using March 1999 EPHPM survey.

households. For instance, 24.5 percent of all households in the 1st or poorest decile have access to electricity provided by ENEE compared with 93.3 percent of households in the 10th richest decile. Also as expected, households in urban areas have higher access rates than households in rural areas. The fact that richer households have higher rates of access to electricity than poorer households is one of the reasons why from the point of view of poverty reduction, and in comparison with other programs that could be implemented to fight poverty, electricity subsidies may not be well targeted.

The design of the electricity subsidy in Honduras follows a basic self-targeting structure, that is, households self-select themselves for inclusion in the subsidy scheme by not consuming more than a certain amount. This implies that neither the utility nor the government needs to design a more complex targeting mechanism based on means-testing, whereby they use household characteristics as proxies to identify who is poor and who is not, and thereby who is eligible to receive the subsidy and who is not. As of July 2002 the subsidy was provided to all households that purchased electricity from ENEE and consumed less than 300 kWh per month, the electricity consumption lifeline. Specifically, households consuming less than 300 kWh paid the price of electricity at the 1994 rate plus an increase of 16.31 percent approved in 2000. Households that consumed more than 300 kWh per month paid the full price at the 1997 rate plus the same 16.31 percent increase. The government paid the difference between the 1994 and 1997 prices (L 23.8 million per month in mid-2002) directly to ENEE.[1]

To assess the targeting performance of the subsidy, that is, what share of the subsidy goes to the poor, we combine administrative information with household survey data. On the administrative data side we rely on information provided by ENEE. This information includes (a) the percentage of residential clients by consumption level, (b) the average amount of electricity consumed by clients at each level, (c) the total electricity bill without subsidy by level, and (d) the total subsidy paid by level.

On the household data side, to estimate the proportion of poor households at the various consumption levels we use data from a survey implemented in 1999 by the Family Assistance Program (Programa de Asignación Familiar or PRAF), with financing from the Inter-American Development Bank and assistance from the International Food Policy Research Institute. The survey was implemented in the bottom half of Honduras's municipalities in terms of malnutrition as measured by the Ministry of Education's annual census of weight and height during the first year of primary school. The survey has modules on expenditures, education, health, and the impact of Hurricane Mitch. The advantage of this survey is that it includes data on electricity consumption, which are not available in the labor force survey. The disadvantage is that the survey is not nationally representative, but we assume that the results obtained here would also apply if the survey were nationally representative.[2]

Table 8.2 provides the results. For example, according to ENEE's administrative records, the share of households connected to its network with monthly consumption below 20 kWh is 20.31 percent (115,723 households). Of these we estimate from the PRAF survey that 44.93 percent are poor. That is, among all households that consume less than 20 kWh according to the PRAF survey, about 45 percent have a level of per capita consumption that is below a reasonable poverty line for Honduras. With average consumption of 3.36 kWh per household per month, the total consumption for this group is 388,626 kWh. Without the subsidy this group would have to pay a total bill of L 929,256, but this bill is reduced to L 333,282 when the subsidy of L 595,973 is taken into account.

Presenting statistics on errors of inclusion and exclusion is common when assessing the targeting performance of a subsidy (see, for example, Cornia and Stewart 1995). There are various ways to present these two types of errors. The simplest way, used in table 8.2, consists of computing the share of households in poverty and receiving the subsidy as well as the share of households not in poverty that are also receiving the subsidy. In general, as errors of inclusion increase, errors of exclusion decrease, and vice versa. If all households receive the subsidy, there are no errors of exclusion, but the errors of inclusion will likely be large because all nonpoor households benefit from the subsidy.

In table 8.2, among those households that are connected to ENEE, 60.19 percent are nonpoor and receive the subsidy. By contrast, only 1.68 percent are poor and do not receive the subsidy (nationally, the share of the population in poverty not receiving the subsidy is larger, because many poor households are not connected to the grid). In addition, 23.28 percent of households that are poor receive the subsidy and 14.85 percent of households that are nonpoor do not receive the subsidy. From these results we can estimate that the ratio of poor versus nonpoor beneficiaries

TABLE 8.2. Targeting Performance for the Electricity Subsidy, Honduras, Mid-2002

Consumption level (kWh per) month)	Share of clients (%) (1)	Share of clients in poverty based on 1999 data (%) (2)	Error of inclusion, (1)*[1-(2)] (%)	Error of exclusion, (1)*(2) (%)	Average consumption (kWh per month)	Total bill without subsidy by category (L thousands)	Total subsidy by category (L thousands)	Share of subsidy spent on nonpoor households (%)
0–20	20.31	44.93	11.18	n.a.	3.36	929	596	1.38
20–100	22.69	35.66	14.60	n.a.	58.67	5,096	2,717	7.34
100–150	12.63	16.82	10.50	n.a.	125.09	7,387	3,762	13.14
150–200	11.16	10.98	9.94	n.a.	175.35	10,314	5,149	19.24
200–250	9.25	15.64	7.81	n.a.	224.54	11,618	5,746	20.35
250–300	7.43	17.09	6.16	n.a.	275.77	11,896	5,851	20.36
300+	16.53	10.15	n.a.	1.68	—	—	—	—
Total	100	24.96	60.19	1.68	108.58	47,241	23,820	81.81

— Not available.

n.a. Not applicable.

Source: Authors' estimates using ENEE (2002) and the 1999 PRAF survey data.

is 0.39 (23.28/60.19), and so the number of nonpoor households receiving the subsidy is more than twice as large as the number of poor households receiving the subsidy.[3]

The most important statistic, however, is the share of the subsidy given to the nonpoor. This tells us how much poverty reduction is obtained (in terms of the poverty gap as defined in appendix 8.1) for each lempira spent on the subsidy. As computed in the last column of table 8.2, this share is above 80 percent. Part of the reason for the subsidy's poor targeting performance is related to the level of the lifeline threshold, which is set too high. Some 83.5 percent of households with access to electricity consume less than 300 kWh per month, and hence qualify for the subsidy. Furthermore, while the level of poverty is higher among households that consume less than 100 kWh, most of the subsidy is spent on households that consume between 100 and 300 kWh per month, but these households are less likely to be poor.

In part because the subsidy is not well targeted, its impact on poverty is small. This is illustrated in table 8.3 which provides poverty measures with and without incorporating the value of the electricity subsidy in the overall consumption aggregate. The table provides three measures of poverty: the headcount index (the share of the population in poverty), the poverty gap (the distance separating the poor from the poverty line), and the squared poverty gap (appendix 8.1 provides a formal definition of these poverty measures). The measures are provided for two alternative poverty lines corresponding roughly to the extreme poor (L 400 per person per month) and the poor (L 600 per person per month). Overall the changes in poverty when subsidies are taken into account are small, and these changes are likely to be slightly overestimated, because we do not take substitution effects due to the subsidy into account (if the subsidy were eliminated, electricity prices would go up and households would substitute consumption toward other goods).

Although this is not reported here, we carried out additional simulations to assess if the results are sensitive to the choice of the PRAF survey for the analysis. That is, using a large set of variables common to both the PRAF and the nationally representative EHPHM survey, and fitting a predictive model of electricity consumption in the PRAF survey, we obtained a prediction for electricity consumption in the EHPHM survey, and redid estimations regarding targeting performance and the impact of the subsidy on poverty

TABLE 8.3. Impact of the Electricity Subsidy on Poverty, Honduras, 1999

	Without subsidy			*With subsidy*		
kWh consumed/ month	**Headcount (%)**	**Poverty gap (%)**	**Squared pov. gap**	**Headcount (%)**	**Poverty gap (%)**	**Squared pov. gap**
Poverty line of L 400/person/ month						
0–20	44.93	12.42	5.99	44.93	12.29	5.92
20–100	36.00	10.45	4.26	35.66	10.19	4.11
100–150	20.57	6.06	2.61	16.82	5.60	2.35
150–200	10.98	2.67	0.93	10.98	2.24	0.72
200–250	15.64	5.32	2.00	15.64	4.56	1.51
250–300	17.09	3.06	1.02	17.09	2.38	0.79
More than 300	10.15	2.70	1.12	10.15	2.19	0.87
Poverty line of L 600/person/ month						
0–20	71.01	29.00	14.56	71.01	28.85	14.44
20–100	63.47	23.70	11.60	63.47	23.36	11.36
100–150	44.74	13.97	6.75	43.39	13.29	6.34
150–200	31.26	8.19	3.35	27.45	7.47	2.95
200–250	35.80	13.15	6.05	34.16	11.88	5.21
250–300	29.15	10.41	4.37	29.15	9.36	3.73
More than 300	17.97	6.33	3.03	17.97	5.65	2.60

Source: Authors' estimates using 1999 PRAF survey data.

with these predictive values for electricity consumption in the EHPHM survey. The results obtained using this procedure were fairly similar.

8.3 Alternative Targeting Indicators

The evidence suggests that Honduras's lifeline subsidy is badly targeted and therefore fails to benefit the poor very much. In this section we compare the lifeline targeting technique to other means of targeting that could use more and better information to determine eligibility for utility subsidies.

As mentioned in the previous section, investigators often analyze the targeting performance of any given indicator, such as the lifeline level of electricity consumption used in Honduras, using simple summary statistics such as the errors of inclusion and exclusion for a given targeting mechanism. A generalization of this approach consists of using ROC curves to assess which indicator—in our case lifeline versus various potential means-testing mechanisms—has the best performance in identifying the poor. More precisely, the idea is to use simple categorical regressions to assess how various targeting indicators predict the probability of being poor, and to see how the two types of errors (exclusion of some poor households and inclusion of some nonpoor households) vary with the choice of a particular level of the indicator to determine eligibility. In some cases one can find a best overall eligibility criterion independently of the weighting of the two types of errors in policymakers' objective function. In other cases some weighting scheme is needed, and for any given weighting scheme, the ROC curve can help select the best indicator.

Our objective here is not to discuss the method in detail (see appendix 8.2 for an outline of the basic idea behind the ROC curve). Rather, we focus on the empirical results for Honduras's electricity subsidy. For each indicator that can be used for targeting (lifeline or other), one associates a curve that plots the probability that a poor household will be classified as poor against the probability that a nonpoor household will be classified as poor for every possible value given to the indicator. Note that the indicator can be complex, that is, it can consist of a combination of indicators, as the regression can be multivariate. If the ROC curve lies on the 45 degree line, the model has no predictive power, because the probability that a poor household would be classified as poor is no higher than the probability that a nonpoor household would be classified as poor. The more the ROC curve bows upward, the greater the model's predictive power. A summary measure of predictive power is the area underneath the ROC curve. If the area is above 50 percent, then the model has some predictive power. An area of 100 percent implies that the model predicts poverty perfectly.

We used the methodology to assess how well various indicators performed for identifying the poor among the sample of households with a connection to the electricity grid in Honduras. We employed poverty lines of L 400 (extreme poverty) and L 600 (poverty) to define the poor. The first model in table 8.4 (household characteristics) combines infor-

TABLE 8.4. Areas under ROC Curves for Alternative Targeting Mechanisms, Honduras

Model	Performance in identifying the extreme poor (area under ROC curve, percent)	Performance in identifying the poor (area under ROC curve, percent)
Household characteristics	87	83
Demographics	72	71
Educational attainment	71	72
Employment status	69	66
Geographic location (department)	66	63
Housing characteristics	82	81
Size of house	77	77
Quality of house	72	72
Access to water and sanitation	61	58
Electricity consumption	70	73

Note: A larger area indicates better targeting performance.

Source: Authors' estimation.

mation on a number of household characteristics, including demographics, education, employment status, and geographic location. The model is better at identifying the extreme poor (area under the ROC curve of 0.87) than the poor (area of 0.83). Within these household characteristics (that is, with separate models with subsets of variables), demographics and education variables are better than employment and location variables at identifying the poor. Housing characteristics can also be used to identify the poor, with a similar level of performance (area under the ROC curve of 0.82 for the extreme poor and 0.81 for the poor). Within housing characteristics, the size and quality of the house are better at identifying the poor than other characteristics. Finally, the lifeline threshold (related to the level of energy consumption in the household) has some predictive power (the area under the ROC curve is above 0.5), but less so than some other easily identifiable variables. The bottom line is that if the objective is to target the poor, variables are available that are better at doing so than the level of energy consumption (see appendix 8.2 for examples of actual ROC curves).

While it is not surprising that household or housing-based targeting indicators would be better at identifying the poor than households' level of energy consumption, one might believe that for a service provider or utility to gather such information could be difficult or expensive. Clearly means-testing (using correlates of poverty for targeting) requires information, and gathering this information requires effort. However, experiences in other countries suggest that the cost of doing so need not be very high if the same type of information is used for targeting a range of social programs rather than utility subsidies only.

More specifically, one clear possibility for reducing the administrative cost of means-testing is to use a single system of means-testing at the national level for many different programs. In Latin America this has been done with some success in Colombia (the System for Selection of Beneficiaries) and in Chile (the Committee for Social Municipal Assistance or CAS), among others. In Chile, for example, as documented by Clert and Wodon (2001), the CAS system is used as a targeting instrument not only for water subsidies, but also for the family income subsidy, the social housing subsidy, and the pension subsidy scheme. Because the fixed administrative costs are spread across several programs, the CAS is cost-effective. In 1996, for example, administrative costs represented a mere 1.2 percent of the benefits distributed using the CAS score. If the administrative costs of the CAS system had had to be borne by the water subsidy scheme alone, they would have represented 17.8 percent of the value of the subsidies. The cost of interviews for determining eligibility for the subsidies was US$8.65 per household, and the Ministry of Planning estimates that 30 percent of Chilean households underwent interviews, which seems reasonable given that the target group for the subsidy programs is the poorest 20 percent of the population.

8.4 Conclusion

Governments have a range of options for helping to reduce poverty. Similarly, private utilities have a number of options for helping their low-income customers. While decisions about the choice of a specific instrument are based on various criteria, interventions whose benefits are immediate, visible, and administratively easy to implement and are supported not only by the poor, but also by the nonpoor or not as poor, are attractive from a political economy point of view.[4]

Lifeline subsidies for basic infrastructure or utility services have all these characteristics. The subsidies may take various forms, but their key characteristic is that they are provided to all customers with a consumption level below a minimum threshold considered necessary for meeting basic needs, hence the use of the "lifeline" expression. Lifeline subsidies have an immediate impact by reducing beneficiaries' expenditures for a given level of provision. The benefits of the subsidies are easily understood (even though their costs may not be). Lifeline subsidies often enjoy widespread political support, especially when the lifeline threshold is set sufficiently high so as to benefit the less poor as well as the poor or the median consumer as well as the low-income customer. The subsidies are easy to implement at relatively low administrative cost because no means-testing is involved.

For poverty reduction, however, while the characteristics of lifeline subsidies help to muster support, they may not ensure effectiveness or a good cost-benefit ratio. Indeed, one of the major drawbacks of lifeline subsidies is that they may not be well targeted. When they are well designed, lifelines can reach the poor through self-targeting. That is, if the lifeline threshold is low enough, only those who consume little will be eligible, and these customers may be comparatively poor. In many instances, however, the leakage of lifeline subsidies to the nonpoor is such that it dilutes the effectiveness of the policy for poverty reduction.

In this chapter we provided a partial evaluation of the lifeline or increasing block tariff electricity subsidy in Honduras. With funding from the government, the public utility is offering electricity at greatly subsidized rates for those households with monthly consumption below 300 kWh. Because the lifeline threshold is set so high, 83.5 percent of the utility's residential clients benefit from the subsidy. At the same time, 81.8 percent of the subsidy may well be spent on nonpoor households. While this last statistic could be lower if we were using a different method for measuring poverty, it remains true that the impact on poverty of the subsidy is rather small in comparison to its cost. The fact that the current subsidy is badly targeted does not mean that it could not be improved by reducing the lifeline threshold. A lower lifeline subsidy as currently being considered by the government would have the potential of being more effective. Alternative proxy means-testing targeting mechanisms based on household or housing characteristics could also be used to improve targeting. Nevertheless, experience in other countries such as Chile suggests that even with better means-testing, other types of interventions would probably have a better impact on poverty per dollar spent than utility subsidies.

Appendix 8.1: Definition of Poverty Measures

This appendix, which is reproduced with minor changes from Coudouel, Hentschel, and Wodon (2002), provides mathematical expressions for the poverty measures used in table 8.3.

Poverty Headcount

This is the share of the population that is poor, that is, the proportion of the population for whom consumption or income y is less than the poverty line z. Suppose we have a population of size n in which q people are poor. Then the headcount index is defined as

$$H = \frac{q}{n}.$$

Poverty Gap

The poverty gap, which is often considered as representing the depth of poverty, is the mean distance separating the population from the poverty line, with the nonpoor being given a distance of zero. The poverty gap is a measure of the poverty deficit of the entire population, where the notion of poverty deficit captures the resources that would be needed to lift all the poor out of poverty through perfectly targeted cash transfers. It is defined as follows:

$$PG = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right],$$

where y_i is the income of individual i, and the sum is taken only on those individuals who are poor. The poverty gap can be written as being equal to the product of the income gap ratio and the headcount index of poverty, where the income gap ratio is itself defined as

$$PG = I * H, \quad with$$

$$I = \frac{z - y_q}{z} \quad where\ y_q = \frac{1}{q}\sum_{i=1}^{q} y_i\ is\ the\ average\ income\ of\ the\ poor.$$

Squared Poverty Gap

This is often described as a measure of the severity of poverty. While the poverty gap takes into account the distance separating the poor from the poverty line, the squared poverty gap takes the square of that distance into account. When using the squared poverty gap, the poverty gap is weighted by itself, so as to give more weight to the very poor. Said differently, the squared poverty gap takes into account the inequality among the poor. It is obtained as follows:

$$P2 = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^2.$$

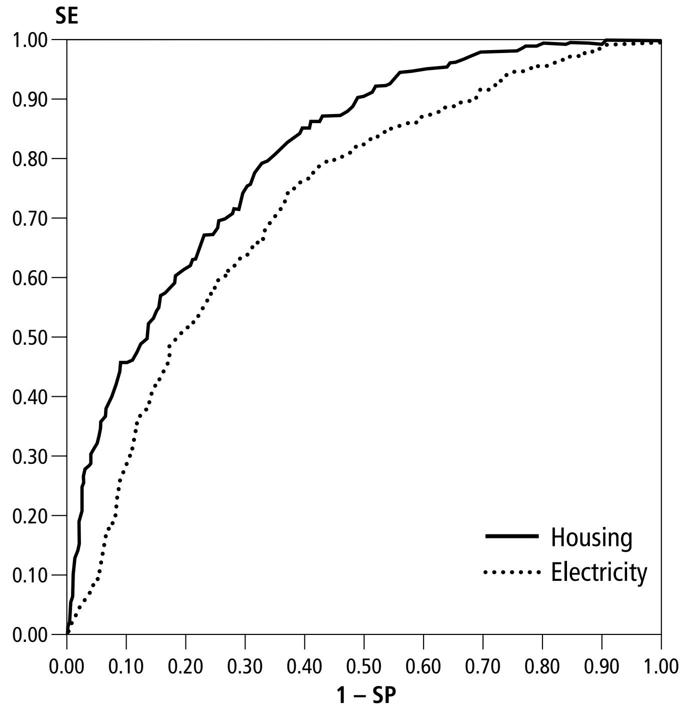
It is important to use the poverty gap or the squared poverty gap in addition to the headcount for evaluation purposes, since these measure different aspects of income poverty. Indeed, basing evaluation on the headcount ratio would consider as more effective those policies that lift the richest of the poor (those close to the line) out of poverty. Using the poverty gap *PG* and the squared poverty gap *P2,* on the other hand, puts the emphasis on helping those who are further away from the line, the poorest of the poor.

Appendix 8.2: Identifying the Targeting Performance of Various Indicators Using ROC Curves

Following Wodon (1997), denote by P, P^-, and P^+ the number of the poor, the number of the poor classified as nonpoor, and the number of the poor classified as poor by a model. Also denote by NP, NP^-, and NP^+ the number of the nonpoor, the number of the nonpoor classified as nonpoor, and the number of the nonpoor classified as poor. Sensitivity $SE = P^+/(P^- + P^+) = P^+/P$ is the fraction of poor households classified as poor. Specificity $SP = NP^-/(NP^- + NP^+) = NP^-/NP$ is the fraction of nonpoor households classified as nonpoor. The errors of inclusion and exclusion can be defined as 1 minus SP and 1 minus SE (other definitions could be used as well, but ROC curves are based on these definitions).

	Nonpoor	Poor
Predicted nonpoor	$SP = NP^-/(NP^- + NP^+)$	$1 - SE = P^-/(P^- + P^+)$
Predicted poor	$1 - SP = NP^+/(NP^- + NP^+)$	$SE = P^+/(P^- + P^+)$

FIGURE A2.1. ROC Curves Using Housing and Electricity Consumption Models (poverty line at L 600 per person per month)



Source: Authors.

When using a statistical package and running a probit or logit regression for poverty, each observation is given an index value equal to the predicted right-hand-side of the regression. This predicted value is used to classify the households as poor or nonpoor, with the computer typically using one-half as the cutoff point, which we will denote by c (those above the cutoff point are classified as poor). However, this cutoff point can be changed. A ROC curve is a graph that plots SE as a function of $1 - SP$ for alternative values of the cutoff point. Figure A2.1 shows the ROC curves estimated for those with access to electricity in Honduras with two different models: the housing model and the level of electricity consumption of the households (which is a generalization of the lifeline used for targeting the subsidy by ENEE). At the origin, $c = 1$, $SE = 0$, and $SP = 1$. At the upper right corner, $c = 0$, $SE = 1$, and $SP = 0$. The higher the ROC curve, the better its predictive power (a 45 degree line has no predictive power while a vertical line from the origin to the top of the box followed by a horizontal line until the upper right corner has perfect predictive power). Clearly the housing model performs better than the level of electricity consumption of households in identifying the poor.

The area below a ROC curve provides a summary statistic of the predictive value of the underlying model. An area of 0.5 corresponds to the 45 degree line, which has no explanatory power. An area of 1 corresponds to perfect prediction. If the ROC curve of one targeting indicator or set of indicators lies above the ROC curves of all the alternatives at all points, that indicator will typically be the best to target the poor for the class of social welfare functions based on the two types of errors that can be committed through targeting. If two ROC curves intersect, the choice of the best indicator will depend on the normative weights the policymaker attaches to the two types of errors.

Notes

1. The tariff structure for 1997 distinguishes between households consuming more or less than 500 kWh per month. For those households that consume less than 500 kWh per month, the price is a flat rate of L 6.9 for the first 0 to 20 kWh. Thereafter the unit price per kWh is L 0.6979 for 20 to 99 kWh, L 1.0173 from 100 to 299 kWh, and L 1.1829 from 300 to 499 kWh. For households consuming more than 500 kWh per month, the flat rate for the first 20 kWh is 7.0800 Lempiras. Then the unit rate per kWh is L 0.7161 for the next 80 kWh, L 1.0438

for the next 200 kWh, L 1.2137 for the next 200 kWh, and L 1.3352 above 500 kWh.

2. Using variables common to the PRAF survey and the nationally representative EHPHM labor force survey, we predicted energy consumption in the EHPHM using a model fitted in the PRAF survey. The results obtained with the EHPHM survey for the assessment of the targeting performance of the subsidy and its impact on poverty were similar.

3. Another way of defining the errors of inclusion and exclusion consists of considering the fraction of subsidy recipients that are nonpoor as errors of inclusion and the fraction of households that are not recipients but are poor as errors of exclusion. According to this alternative definition, the errors of inclusion are equal to 0.72 [60.19/(60.19 + 23.28)], while the errors of exclusion are equal to 0.10 [1.68/(1.68 + 14.85)].

4. For issues relating to targeting, its costs, and the interplay with the political economy, see, for instance, Besley and Kanbur (1993); Sen (1995).

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