A Simple Poverty Scorecard for Bolivia

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Abstract

How poor are participants in development projects in Bolivia? This research uses a national survey to construct an easy-to-use, objective scorecard that estimates the likelihood that a person has expenditure below the national poverty line. The scorecard uses 10 simple indicators that field workers can quickly collect and easily verify. Poverty scores can be computed on paper in the field in real time. With 90-percent confidence, a household's estimated poverty likelihood is accurate within +/–9 percentage points, and a group's estimated overall poverty rate is accurate within +/– 1.3 percentage points. The poverty scorecard can help programs to target services, track changes in poverty over time, and report on poverty rates.

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1. Introduction

This paper presents an easy-to-use, objective poverty scorecard to help development programs in Bolivia to target services, track changes in poverty over time, and report clients' poverty rates.

Rather than asking for hours on end about all possible consumption items ("How many carrots did your household eat last week? If you bought the carrots, what price did you pay? If you grew the carrots yourself, what price would they have fetched in the market? Now then, how many cabbages did your household eat last week? . . ."), the scorecard uses 10 simple indicators (such as "Does the household own a television?" or "What is the floor of the house made of?") to produce a score that is highly correlated with poverty status as measured by the exhaustive expenditure survey.

Indicators in the scorecard were derived from an analysis of 5,741 households surveyed in the *2002 Encuesta de Hogares*. Indicators were selected to be:

- Inexpensive to collect, easy to answer quickly, and simple to verify
- Strongly correlated with poverty
- Liable to change over time as poverty status changes

All scorecard weights are positive integers, and scores range from 0 (most-likely "poor") to 100 (least-likely "poor"). Field workers can compute scores by hand, on paper, in real time.

A participant's score corresponds to a "poverty likelihood", that is, the probability of being poor. In a group, the share of clients who are poor is defined as their average poverty likelihood. For a given group over time, progress (or regress) is the change in average poverty likelihood.

The scorecard here was constructed for use in all of Bolivia. Evidence from India and Mexico (Schreiner, 2006 and 2005a) suggests that there are only small returns to segmenting scorecards by rural and urban.

The scorecard can also be used to classify clients as very poor (poorest half in poverty), poor (top half in poverty), or non-poor.

The scorecard accurately and objectively estimates the likelihood that Bolivian households have expenditure below the national poverty line. It should qualify for certification for the reporting required of USAID's microenterprise partners. In particular, the scorecard is accurate. With 90-percent confidence, a household's estimated poverty likelihood is accurate within +/–9 percentage points, and a group's estimated overall poverty rate is accurate within +/–1.3 percentage points.

2. Data and poverty lines

The analysis here uses the 5,741 households in the 2002 *Encuesta de Hogares* conducted by Bolivia's Instituto Nacional de Estadística (INE, Figure 1). This is the best, most recent household survey with expenditure data. A three-fourths random

sample of the surveyed households was used to construct the scorecard, and the remaining one-fourth was used to associate scores with estimated poverty likelihoods.

In addition, the 5,843 households in the 2001 *Encuesta de Hogares* were used for bootstrapping out-of-sample, out-of-time tests of the accuracy of individuals' estimated poverty likelihoods and groups' estimated overall poverty rates.

After Honduras and Nicaragua, Bolivia is the third-poorest Latin American country. The overall poverty rate increased from 63.7 percent in 2001 to 66.1 percent in 2002. The rural poverty rate was about 25 percentage points greater than the urban rate. For 2001–2, Figure 2 shows Bolivia's official poverty line by department. The poverty line based on the cost of a diet of 2,120 calories per day, plus the cost of basic non-food necessities as determined by an estimation of Engle's coefficient (INE, 2003).

An alternative poverty line is the international benchmark of $1/day at purchase-power parity, which works out to 81.87 bolivianos/person/month in 2001 and 92.73 in 2002 (Sillers, 2006). These imply overall poverty rates of about one-quarter those of the official lines. The scorecard here is based on the official line because it provides more realistic poverty head counts and because it adjusts for differences in cost-of-living by department and by urban/rural.

3. Scorecard construction

About 220 potential poverty indicators were prepared, including:

- Household and housing characteristics (such as cooking fuel and type of floor)
- Individual characteristics (such as mother tongue and highest grade completed)
- Household consumption (such as milk and apples)
- Household durable goods (such as electric fans and telephones)

How well each indicator predicts poverty was tested first with the entropy-based "uncertainty coefficient" (Goodman and Kruskal, 1979), with about 120 indicators selected for further analysis. Figures 3 and 4 list (in English and Spanish) the top 50, ranked by their uncertainty coefficients. Responses are ordered by the strength of their association with poverty.

Many indicators in Figures 3 and 4 are similar in terms of their association with poverty. For example, most households who have a bathroom are also remove their waste water via a sewer. If a scorecard already includes "has a bathroom", then "connected to a sewer" is superfluous. Thus, many indicators strongly associated with poverty are not in the scorecard because similar indicators are already included.

The scorecard also aims to measure *changes* in poverty through time. Thus, some powerful indicators (such as education of the female head) that are unlikely to change as poverty changes were omitted in favor of slightly less-powerful indicators that are more likely to change (such as ownership of a television). Some other powerful

indicators (such as "In the past month, did anyone in the household eat an apple") were not selected because they are not verifiable.

The scorecard itself was constructed using Logit regression. Indicator selection combined statistics with the judgment of an analyst with expertise in scoring and development. Starting with a scorecard with no indicators, each candidate indicator was added, one-by-one, to a one-indicator scorecard, using Logit to derive weights. The improvement in accuracy for each indicator was recorded using the "c" statistic.[1]

After all indicators had been tested, one was selected based on several factors (Schreiner *et al.*, 2004; Zeller, 2004). These included the improvement in accuracy, the likelihood of acceptance by users (determined by simplicity, cost of collection, and "face validity" in terms of experience, theory, and common sense), the ability of the indicator to change values as poverty status changes, variety vis-à-vis other indicators already in the scorecard, and observability/verifiability.

The selected indicator was then added to the scorecard, and the previous steps were repeated until 10 indicators were selected. Finally, the Logit coefficients were transformed into non-negative integers such that the lowest possible score is 0 (most likely poor) and the highest is 100.

[1] "c" is a measure of a scorecard's ability to rank-order households. It is equivalent to the area under an ROC curve that plots the share of poor households (vertical axis) versus the share of all households ranked by score (horizontal axis). "c" can also be seen as the share of all possible pairs of poor and non-poor households in which the poor household has a lower score.

The statistical algorithm is the Logit analogue to the stepwise "MAXR" in, for example, Zeller, Alcaraz and Johannsen (2005) and IRIS (2005a and 2005b). Like R^2 in a least-squares regression on expenditure, "c" is a good general measure of general accuracy in a Logit regression on poor/non-poor status. The procedure here diverges from naïve stepwise in that expert judgment and non-statistical criteria were used to select from the most-predictive indicators. This improves robustness and, more importantly, helps ensure that the indicators are simple and sensible and so likely to be accepted by users.

4. Scorecard use

As explained in Schreiner (2005b), the main goal is not to maximize accuracy but to maximize the likelihood of programs' using scoring appropriately. When scoring projects fail, the culprit is usually not inaccuracy but rather the failure of users to accept scoring and to use it properly (Schreiner, 2002). The challenge is not technical but human and organizational, not statistics but change management. "Accuracy" is easier—and less important—than "practicality".

The scorecard here was designed to help users to understand and trust it (and thus use it properly). While accuracy matters, it must be balanced against simplicity, ease-of-use, and "face validity". In particular, programs are more likely to collect data, compute scores, and pay attention to the results if, in their view, scoring avoids creating "extra" work and if the whole process in general seems to make sense.

This "practicality" focus naturally leads to a one-page scorecard (Figures 5 and 6 in English and Spanish) that allows field workers to score households by hand in real time because it features:

- Only 10 indicators
- Only categorical indicators ("flooring material", not "value of house")
- User-friendly weights (non-negative integers, no arithmetic beyond simple addition)

Among other things, this simplicity enables "rapid targeting", such as determining (in a day) who in a village qualifies for, say, work-for-food, or ration cards.

The scorecard in Figures 5 and 6 could be photocopied for immediate use. It can also serve as a template for data-entry screens with database software that records indicators, indicator values, scores, and poverty likelihoods.

A field agent collecting data and computing scores on paper would:

- Read each question off the scorecard
- Circle the response and the corresponding points
- Write the points in the far-right column
- Add up the points to get the total score
- Implement program policy based on the score

4.1 Scores and poverty likelihoods

A score is not a poverty likelihood (that is, the estimated probability of being poor), but each score is associated with a poverty likelihood via a simple table (Figure 7). For example, scores of 20–24 correspond to a poverty likelihood of 96.8 percent.

Scores (sums of scorecard weights) are associated with poverty likelihoods (estimated probabilities of being poor) via the "bootstrap" (Efron and Tibshirani, 1993):

- From the 2002 hold-out sample, draw a new sample of the same size *with replacement*
- For each score range, compute the share of people with the score who are poor
- Repeat the previous two steps 10,000 times
- For a given score range, define the poverty likelihood as the average of the shares of people who are poor across the 10,000 samples

These resulting poverty likelihoods are objective, that is, based on data. This process would produce objective poverty likelihoods *even if the scorecards were constructed without data*. In fact, scorecards of objective, proven accuracy are often constructed *only* with qualitative judgment (Fuller, 2006; Caire, 2004; Schreiner *et al.*, 2004). Of course, the scorecard here used data. Some parties have misunderstood the significance of the fact that some choices in scorecard construction—as in any statistical analysis—are informed by the analyst's judgment. That the use of this judgment is explicitly acknowledged in no way impunes the objectivity of the poverty likelihoods,

which depends on using data to associate scores with poverty likelihoods, not on whether only data was used to construct scorecards.

Figure 8 depicts the precision of estimated poverty likelihoods as point estimates with 90-, 95-, and 99-percent confidence intervals. Confidence intervals are the standard way to measure accuracy, and it is widely understood by lay people.

For example, the average poverty rate across bootstrap samples for people with scores of 30–34 (the poverty likelihood) is 86.0 percent. In 90 percent of the 10,000 samples, this share is between 80.5–91.0 percent. In 95 percent of samples, the share is 79.5–91.9; in 99 percent of samples, the share is 77.1–93.4.

Weighting by the people in each score range, the average 90-percent confidence interval is +/–5.8 percentage points, the 95-percent interval is +/–6.8, and the 99-percent interval is +/–9.0.

For estimated and true poverty likelihoods, Figure 9 depicts mean absolute differences and confidence intervals from 10,000 bootstrap samples on the 2001 survey. Weighting by the people in a score range, the mean absolute difference is 4.3 percentage points, with a 90-percent interval of +/–2.9 percentage points, a 95-percent interval of +/–3.5, and a 99-percent interval of +/–4.6.

This discussion so far looks at whether estimated poverty likelihoods are close to true poverty likelihoods. There is another aspect of accuracy: how well the poor are concentrated in low scores and the non-poor in high scores. A perfect scorecard would

assign all the lowest scores to poor people and all the highest scores to non-poor people. In reality, no scorecard is perfect, so some non-poor have low scores, and vice versa.

ROC curves are standard tools for showing how well scorecards concentrate the poor in lower scores (Baulch, 2003; Wodon, 1997). They plot the share of poor and non-poor households against the share of all households ranked by score.

What does the ROC curve in Figure 10 mean? Suppose a program sets a cut-off so as to target the lowest-scoring x percent of potential participants. The ROC curve then shows the share of the poor and non-poor who would be targeted. Greater ability to rank-order—with less leakage and less undercoverage—is signified by curves that are closer to the northwest and southeast corners of the graph.

In Figure 10, the two northwest (southeast) curves depict accuracy among the poor (non-poor). As a benchmark, the external trapezoid shows the accuracy of a hypothetical perfect scorecard that assigns all of the lowest scores to poor people.

The inner lines represent the actual Bolivia scorecard. They show, for example, that targeting the 30 percent of cases with the lowest scores would target 45 percent of all the poor and 4 percent of all the non-poor.

Figure 10 also reports two other common measures of ability to rank-order. The first is the Kolmogorov-Smirnov statistic, the maximum distance between the poor and non-poor curves (here 60.5). The second is the ratio of the area inside the ROC curves to the area inside the trapezoid of a hypothetical perfect scorecard (here 76.2).

Is this scorecard accurate enough for targeting? The author believes that targeting errors due to scorecard inaccuracy are probably small relative to errors due to other sources (such as mistakes in data collection or fraud) and relative to the accuracy of other feasible targeting tools.

4.2 Estimates of overall poverty rates

The estimated overall poverty rate is the average of the estimated poverty likelihoods of individuals.

For example, suppose a program had three participants on Jan. 1, 2006 who had scores of 20, 30, and 40, corresponding to poverty likelihoods of 96.8, 86.0, and 67.5 percent (Figure 7). The poverty rate is the participants' average poverty likelihood, that is, $(96.8 + 86.0 + 67.5) \div 3 = 83.4$ percent.

As a test, the scorecard was applied to 10,000 bootstrap replicates from the 2001 survey, comparing the estimated overall poverty rates with the true values. The mean difference was 1.10 percentage points, with a standard deviation of 0.48. The 90-percent confidence interval around the mean was +/–0.8 percentage points, the 95-percent interval was +/–1.0 percentage points, and the 99-percent interval was +/–1.2 percentage points.

In practice, this means that subtracting 1.10 percentage points from a group's average poverty likelihood would produce an unbiased estimate that, in 99 of 100 cases, would be within +/–1.2 percentage points of the true overall poverty rate.

4.3 Progress out of poverty through time

For a given group, progress out of poverty over time is estimated as the change in average poverty likelihood.

Continuing the previous example, suppose that on Jan. 1, 2007, the same three people (some of whom may no longer be participants) have scores of 25, 35, and 60 (poverty likelihoods of 95.7, 81.4, and 11.8 percent). Their average poverty likelihood is now 63.0 percent, an improvement of 83.4 – 63.0 = 20.4 percentage points in one year.

In a large group, this means that about 20.4 of every 100 progressed out of poverty. Given that 83.4 percent were poor in the first place, one in four (20.4 ÷ 83.4 = 24.4 percent) of those who were poor left poverty.

Of course, this does not mean that program participation *caused* the progress; the scorecard just measures what happened, regardless of cause.

5. Setting targeting cut-offs

Potential participants with scores at or below a targeting cut-off are labeled *targeted* and treated—for program purposes—as if they were poor. Those with higher scores are *non-targeted* and treated—for program purposes—as if they were non-poor.

Poverty status (expenditure below a poverty line) is distinct from *targeting status* (score below a cut-off). Poverty status is a fact whose determination requires an expensive expenditure survey. In contrast, targeting status is a policy choice whose determination requires a cut-off and an inexpensive estimate of poverty likelihood.

Indeed, the purpose of scoring is to infer poverty status without incurring the high cost of directly measuring expenditure.

No scorecard is perfect, so some of the truly poor may not be targeted, and some of the truly non-poor may be targeted. Targeting is accurate to the extent that poverty status matches targeting status. Accuracy in turn depends in part on the targeting cut-offs; some cut-offs are more accurate for the poor, others for the non-poor.

Setting a cut-off requires trading off accuracy for the poor versus non-poor. The standard technique uses a *classification matrix* and a *net-benefit matrix* (SPSS, 2003; Adams and Hand, 2000; Salford Systems, 2000; Hoadley and Oliver, 1998; Greene, 1993).

5.1 Classification matrix

Given a targeting cut-off, there are four possible classification results:

A. Truly poor	correctly	targeted	(score at or below the cut-off)
B. Truly poor	mistakenly	non-targeted	(score above cut-off)
C. Truly non-poor	mistakenly	targeted	(score at or below cut-off)
D. Truly non-poor	correctly	non-targeted	(score above cut-off)

These four possibilities can be shown as a general classification matrix (Figure 11). Accuracy improves as there are more cases in A and D and fewer in B and C.

Figure 12 shows the number of Bolivians in each classification by score in the 2001 survey. For example, with a cut-off of 40–44, there are:

A. 51.9	truly poor	correctly	targeted
B. 12.8	truly poor	mistakenly	non-targeted
C. 7.3	truly non-poor	mistakenly	targeted
D. 28.0	truly non-poor	correctly	non-targeted

Targeting accuracy (and errors of undercoverage and leakage) depends on the cut-off. For example, if the cut-off were increased to 45–49, more poor (but less non-poor) are correctly targeted:

A. 57.1	truly poor	correctly	targeted
B. 7.7	truly poor	mistakenly	non-targeted
C. 10.7	truly non-poor	mistakenly	targeted
D. 24.6	truly non-poor	correctly	non-targeted

Whether a cut-off of 40–44 is preferred to 45–49 depends on net benefit.

5.2 Net-benefit matrix

Each of the four classification results is associated with a net benefit (Figure 13):

α. Benefit	truly poor	correctly	targeted
β. Cost (negative net benefit)	truly poor	mistakenly	non-targeted
γ. Cost (negative net benefit)	truly non-poor	mistakenly	targeted
δ. Benefit	truly non-poor	correctly	non-targeted

Given a net-benefit matrix and a classification matrix, total net benefit is:

$$\text{Total net benefit} = \alpha \cdot A + \beta \cdot B + \gamma \cdot C + \delta \cdot D.$$

To set an optimal cut-off, a program would:

- Select a net-benefit matrix based on its values and mission
- Compute total net benefits for each cut-off with the net-benefit matrix and Figure 12
- Select the cut-off with the highest total net benefit

The only non-trivial step is selecting a net-benefit matrix. Some common net-benefit matrices are discussed below. In general, however, each program should thoughtfully decide for itself how much it values successful targeting versus errors of undercoverage and leakage. Of course, any program that targets already uses (if only implicitly) a net-benefit matrix. It is healthy to go through a process of thinking explicitly and intentionally about the value of possible targeting outcomes.

5.2.1 "Total Accuracy"

As an example net-benefit matrix, suppose a program selects the net-benefit matrix that corresponds to the "Total Accuracy" criterion (Figure 14, IRIS, 2005b). With this criterion, total net benefit is the number of people correctly classified:

$$\begin{aligned} \text{Total net benefit} &= 1 \cdot A + 0 \cdot B + 0 \cdot C + 1 \cdot D, \\ &= A + D. \end{aligned}$$

Grootaert and Braithwaite (1998) and Zeller, Alcaraz, y Johannsen (2005) use "Total Accuracy" to evaluate the accuracy of poverty scorecards.

Figure 15 shows "Total Accuracy" for all cut-offs of the Bolivia scorecard. Total net benefit is greatest (81.7) for a cut-off of 45–49; at that point, poverty segment matches poverty status for about four in five Bolivians.

"Total Accuracy" weighs correct classifications of the poor and non-poor equally. If most potential participants are non-poor and/or if a scorecard is more accurate for the non-poor, then "Total Accuracy" might be high even if very few poor people are correctly classified. Programs targeting the poor, however, probably value correct classification more for the poor than the non-poor.

A simple, transparent way to reflect this valuation is to increase the relative net benefit of correctly classifying the poor. For example, if a program values correctly targeting the poor twice as much as correctly not targeting the non-poor, then α should be set twice as high as δ in the net-benefit matrix. Then the new optimal cut-off is 55–59, the cut-off point where $2.A + D$ is highest.

5.2.2 "Poverty Accuracy"

A criterion that emphasizes solely the importance of correctly classifying the poor is "Poverty Accuracy" (Figure 16, IRIS, 2005b), which counts only correct classifications of the poor:

$$\begin{aligned} \text{Total net benefit} &= 1 \cdot A + 0 \cdot B + 0 \cdot C + 0 \cdot D, \\ &= A. \end{aligned}$$

Of course, correctly targeting the poor is rarely the sole criteria. In fact, Figure 15 shows that "Poverty Accuracy" is greatest with a cut-off of 95–100. While targeting

everyone does ensure that all poor people are targeted and so minimizes *undercoverage* of the poor (second-to-last column of Figure 15), it also targets all the non-poor and so maximizes *leakage* (the final column of Figure 15). A universal program may or may not be appropriate; the point here is to make explicit the implications of "Poverty Accuracy" as a criterion for choosing a targeting cut-off.

5.2.3 "Non-poverty Accuracy"

"Non-poverty Accuracy" counts only correct classifications of the non-poor (total net benefit is D). This is maximized by setting a cut-off of 0–4 and thus not targeting anyone (minimum leakage but maximum undercoverage).

5.2.4 "BPAC"

IRIS (2005b) proposes a new measure of accuracy called the "Balanced Poverty Accuracy Criterion". BPAC balances two goals:

- Accuracy of the estimated overall poverty rate
- "Poverty Accuracy"

According to IRIS (2005b), the first goal is optimized when undercoverage B is balanced by leakage C, and the second goal is optimized by maximizing A. If B > C, then Figure 17 is BPAC's net-benefit matrix. Thus, BPAC maximizes A while making B as close to C as possible:

$$\begin{aligned} \text{Total net benefit} &= 1\cdot A + 1\cdot B + (-1)\cdot C + 0\cdot D, \\ &= A + (B - C). \end{aligned}$$

If C > B, then total net benefit under BPAC is A + (C – B).

BPAC was invented because IRIS does not estimate poverty likelihoods. Instead, IRIS estimates expenditure and then labels as poor those households with estimated expenditure less than the poverty line. In this set-up, the overall poverty rate is estimated as the share of people targeted, and this estimate is most accurate (that is, it matches the true value) when undercoverage B equals leakage C.

For a scorecard (like the one here) that estimates poverty likelihoods, however, BPAC is not meaningful. This is because the estimated overall poverty rate is the average of participants' estimated poverty likelihoods. These estimates are independent of whatever targeting cut-off a program might set. In contrast, the targeting errors of undercoverage B and leakage C depend directly on the cut-off chosen. Thus, for scorecards that estimate poverty likelihoods, getting B close to C is not related to optimizing the accuracy of the estimated overall poverty rate and so is not related to the goals of BPAC.

6. Training, quality-control, and MIS

The technical aspects of scorecard construction and accuracy just discussed are important, but gaining the trust and acceptance of managers and field workers is even more important (Schreiner, 2002).

In particular, the field workers who collect indicators must be trained. If they put garbage in, the scorecard will put garbage out. To prevent abuse, on-going quality control of data is required.

Programs should record in their MIS at least the poverty likelihood along with an identifier for each client. Ideally, they would also record the score, the indicators, and the values of the indicators. This will allow quick computation of average poverty likelihoods (as well as other analyses), both for a point in time and for changes through time (Matul and Kline, 2003).

7. Calibrating the scorecard for the very poor

The simple poverty scorecard in Figures 5 and 6 can be used to track outreach not only to the poor but also to the *very poor*, that is, the poorest half of the poor.

7.1 Poverty likelihoods

As before, scores are associated with the probability of being very poor by bootstrapping 10,000 samples from the 2002 hold-out sample. The poverty likelihood for a given score is then taken as the average of the shares of people with that score who are very poor across the 10,000 samples.

Columns 2–4 in Figure 18 are the poverty likelihoods for the three classes for all scores. For example, if a potential participant has a score of 25–29, the probability of being very poor is 60.1 percent, the probability of being poor is 35.6 percent, and the probability of being non-poor is 4.3 percent.

Columns 5–7 in Figure 18 are the share of targeted participants by poverty status and by cut-off. For example, for a cut-off of 40–44, 49.0 percent of those targeted would be very poor, 38.8 percent would be poor, and 12.3 percent would be non-poor.

Each person is associated with three poverty likelihoods. For example, a person with a score of 25 may be targeted as very poor, but the likelihood of truly being very poor is not 100 percent but rather 60.1 percent (from Figure 18). The same person has a 35.6-percent likelihood of being truly poor, and a 4.3-percent likelihood of being truly non-poor. Each person has one targeting status (for program purposes), one true poverty status (in reality), and three estimated poverty likelihoods (one for each possible poverty status).

As before, these poverty likelihoods are objective, that is, based on data. They are valid even though the scorecard was not constructed originally to predict the likelihood of being very poor. It works because the likelihood of being very poor is highly correlated with having a low score (high likelihood of being poor). A scorecard could be built specifically for the very poor, but it would add cost and complexity.

Figure 19 shows the precision of estimated poverty likelihoods for being very poor as point estimates with 90-, 95-, and 99-percent confidence intervals. For example, the average poverty rate (the poverty likelihood) across bootstrap samples for people with scores of 40–44 was 24.3 percent. In 90 percent of 10,000 samples from the 2002 hold-out, the share was between 17.8–31.3 percent. In 95 percent of samples, the share was between 16.6–32.7, and in 99 percent of samples, the share was between 14.5–35.5.

Weighting by the people in each score range, the average 90-percent confidence interval is +/–5.6 percentage points, the 95-percent interval is +/–6.7, and the 99-percent interval is +/–8.8.

For estimated and true poverty likelihoods, Figure 20 depicts mean absolute differences and confidence intervals from 10,000 bootstrap samples on 2001 survey. Weighting by the people in a score range, the mean absolute difference is 6.0 percentage points, with a 90-percent interval of +/–3.0 percentage points, a 95-percent interval of +/–3.6, and a 99-percent interval of +/–4.7.

The other aspect of accuracy is how well the very poor are concentrated in low scores. Once again, an ROC curve is a useful way to look at this.

Figure 21 plots the share of the very poor against the share of the not very poor, ranked by score. For example, targeting the 20 percent of cases with the lowest scores would target 47 percent of all the very poor and 7 percent of all the not very poor.

In terms of the Kolmogorov-Smirnov statistic, the maximum distance between the curves is 57.8. In terms of the ratio of the area inside the scorecard curves to the area inside the trapezoid of a hypothetical perfect scorecard, the value is 73.2.

All in all, Figures 19–21 suggest that the estimated likelihoods of being very poor are estimated both accurately and precisely.

7.2 Overall poverty rates for the very poor

The average of estimated poverty likelihoods for a group is their estimated overall (very poor) poverty rate. To measure the accuracy and precision of this estimate, the scorecard was applied to 10,000 bootstrap replicates from the 2001 survey, and then the estimated overall poverty rates were compared with the true values. The mean difference was –1.92 percentage points, with a standard deviation of 0.49. The 90-percent confidence interval around the mean was +/–0.8 percentage points, the 95-percent interval was +/–1.0 percentage points, and the 99-percent interval was +/–1.3 percentage points.

Thus, adding 1.92 percentage points to a group's average poverty likelihood would produce an unbiased estimate that, in 99 of 100 cases, would be within +/–1.3 percentage points of the true overall (very poor) poverty rate. This estimate is both accurate and precise.

7.3 Targeting the very poor

As before, targeting involves using a classification matrix and a net-benefit matrix to select a cut-off. The wrinkle is that there are now three poverty statuses:

- Very poor: Poorest half of those with expenditure at or below the poverty line
- Poor: Least-poor half of those with expenditure at or below poverty
- Non-poor: Expenditure above poverty

There are also three targeting segments:

- Very poor: Score at or below the very poor/poor cut-off
- Poor: Score above the very poor/poor cut-off and at or below the poor/non-poor cut-off
- Non-poor: Score above the poor/non-poor cut-off

There are two cut-offs (very poor/poor and poor/non-poor) and 9 classification results (Figure 22):

A. Truly very poor correctly classified as very poor

B. Truly very poor incorrectly classified as poor

C. Truly very poor incorrectly classified as non-poor

D. Truly poor incorrectly classified as very poor

E. Truly poor correctly classified as poor

F. Truly poor incorrectly classified as non-poor

G. Truly non-poor incorrectly classified as very poor

H. Truly non-poor incorrectly classified as poor

I. Truly non-poor correctly classified as non-poor

The general classification matrix (Figure 22) and the net-benefit matrix (Figure 23) are combined to define total net benefit:

$$\text{Total net benefit} = \alpha \cdot A + \beta \cdot B + \gamma \cdot C + \delta \cdot D + \varepsilon \cdot E + \zeta \cdot F + \eta \cdot G + \theta \cdot H + \iota \cdot I.$$

Figure 24 shows classification results for all possible pairs of cut-off scores in the 2001 survey. For example, suppose a program defined the following:

- Very poor/poor cut-off of 25–29 (so scores of 0–29 are targeted as very poor)
- Poor/non-poor cut-off of 45–49 (so scores of 30–49 are targeted as poor, and scores of 50–100 are targeted as non-poor)

As with any scorecard and cut-offs, there is both successful targeting and errors. For the example cut-offs of 25–29 and 45–49, targeting would be correct for 64 percent of the very poor, 55 percent of the poor, and 79 percent of the non-poor (Figure 25).

The program chooses a set of cut-offs to optimize the benefits of correct classifications, net of the costs (negative benefits) of incorrect classifications. For example, suppose the net-benefit matrix is Figure 26, representing one way to reflect:

- Greater importance of correctly targeting the very poor and poor
- Greater cost of gross errors such as targeting the truly very poor as non-poor

Given the classification results in Figure 25 and net benefits in Figure 26, total net benefit for the cut-off pair of 25–29 and 45–49 is +498 (Figure 27).

Is this the best pair of cut-offs? The answer requires applying the net-benefit matrix to the classification results for all 190 possible pairs (Figure 24). It turns out that total net benefit is indeed highest for cut-offs of 25–29 and 45–29.

8. Conclusion

Bolivia is one of the three poorest countries in Latin America. An easy-to-use, inexpensive tool for identifying the poor could improve targeting and speed progress out of poverty. This paper presents a simple scorecard that estimates the likelihood that a person has expenditure below the national poverty line.

The scorecard is built and tested using data on 11,584 households from the 2001 and 2002 *Encuesta de Hogares*. The scorecard is calibrated to estimate the likelihood of being poor (expenditure below the national poverty line) or very poor (poorest half of the poor).

Out-of-sample, out-of-time bootstrap tests show that the estimates are both accurate and precise. For individual poverty likelihoods (whether poor or very poor), estimates are within 9 percentage points of the true value with 90-percent confidence. For a group's overall poverty rate (again, whether poor or very poor), estimates are within 1.3 percentage points of the true value with 99-percent confidence.

For targeting, programs can use the classification results reported here to select the best choice of cut-off according to their values and mission.

Accuracy is important, but ease-of-use is even more important; a perfectly accurate scorecard is worthless if programs feel daunted by its complexity and so never even try to use it. For this reason, the scorecard here is kept simple, using 10 indicators that are inexpensive to collect and that are straightforward to observe and verify. Indicator weights are all zeros or positive integers, and scores range from 0 (most likely

poor) to 100 (least likely poor). Scores are related to poverty likelihoods via a simple look-up table, and targeting cut-offs are also simple to apply. Thus, field workers not only can understand the scorecard, but they can also use it to compute scores in the field, by hand, in real time.

Overall, the poverty scorecard can help Bolivian development programs to target services to the poor, track participants' progress out of poverty through time, and report on participants' overall poverty rate.

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Figure 1: Households surveyed, people represented, and overall poverty rates

	Year	Households	People	% poor
Constructing scorecards	2002	4,317	6,374,819	66.1
Associating scores with likelihoods	2002	1,424	2,165,391	66.1
Testing accuracy	2001	5,843	8,251,908	63.7

Source: 2002 and 2001 *Encuesta de Hogares*.

Figure 2: Official poverty lines, bolivianos/person/month

	2001		2002	
Department	**Urban**	**Rural**	**Urban**	**Rural**
Beni	343.20	231.47	343.90	233.89
Chuquisaca	333.30	231.47	335.60	233.89
Cochabamba	348.80	231.47	351.30	233.89
La Paz (La Paz city)	326.00	231.47	327.00	233.89
La Paz (El Alto city)	271.50	231.47	272.60	233.89
Oruro	296.40	231.47	297.40	233.89
Pando	343.20	231.47	343.90	233.89
Potosi	272.60	231.47	273.50	233.89
Santa Cruz	343.20	231.47	343.90	233.89
Tarija	348.80	231.47	351.30	233.89

Nominal bolivianos/person/month.

Figure 3: Poverty indicators by uncertainty coefficient

Uncertainty coefficient		Indicator (Answers ordered starting with those most strongly associated with poverty)
1.	176	What is the main material of the house's floors? (Earth or other; Cement, brick, or wooden planks; Tile/parquet, rug/carpet, or ceramic tile)
2.	165	Does the household have a fixed-line telephone or a cellular telephone? (No; Yes)
3.	158	Does the household have a refrigerator? (No; Yes)
4.	154	What was the highest grade completed by the female head/spouse? (Second grade or less; Third to eighth grade; Years 1–4 of high school; More than high school)
5.	153	What was the highest grade completed by a household member? (Seventh grade or less; Eighth grade until year 3 of high school; Year 4 of high school or other courses; More than high school)
6.	146	How is potable water delivered to the house? (Piped inside the house; Piped outside the house but within the yard; Others)
7.	137	What type of drainage do the toilet facilities have? (There are no toilet facilities; Pit or directly to the ground, street, creek, or river; Sewer or septic tank)
8.	133	What was the highest grade completed by the male head/spouse? (Never attended grade school; First to fourth grade; Fifth to eighth grade; Years 1–4 of high school; More than high school)
9.	132	Does the household have a living-room set? (No; Yes)
10.	130	How children aged 0–17 are in the household? (5 or more; 4; 3; 2; 1; 0)
11.	129	How children aged 0–14 are in the household? (4 or more; 3; 2; 1; 0)
12.	117	How children aged 0–11 are in the household? (3 or more; 2; 1; 0)
13.	116	In the past month, has the household bought, acquired, or consumed any apples? (No; Yes)
14.	109	Does the household have a VHS player, Betamax, or DVD? (No; Yes)
15.	103	What is the main material of the house's walls? (Thin partitions/reeds, cane/palm leaves/logs, stones, other, or no data; Adobe or wood; Bricks/cinder blocks/reinforced concrete)
16.	98	Does the household share toilet facilities with others? (There are no toilet facilities; Yes; No)
17.	96	Does the household have a bathroom or a latrine? (No; Yes)
18.	95	Does the household have a television set? (No; Yes)
19.	94	Does the household have a dining-room set (table and chairs)? (No; Yes)
20.	93	In the past month, has the household bought, acquired, or consumed any sausage or luncheon meats? (No; Yes)
21.	90	How many members does the household have? (9 or more; 8; 7; 6; 5; 4; 3; 2; 1)
22.	90	In the past month, has the household bought, acquired, or consumed any jams or jellies? (No; Yes)
23.	87	What type of fuel does the household usually use for cooking? (Wood or guano/dung; Other)
24.	80	Does the household have an automobile for its personal use? (No; Yes)
25.	79	In the past month, has the household bought, acquired, or consumed any chicken? (No; Yes)

Source: 2002 *Encuesta de Hogares* by Bolivia's Instituto Nacional de Estadística.

Figure 3 (cont.): Poverty indicators by uncertainty coefficient

Uncertainty coefficient		Indicator (Answers ordered starting with those most strongly associated with poverty)
26.	77	In the past year, did the household raise any crops? (No, an urban household; Yes; No, a rural household)
27.	76	Where does the household get most of its potable water? (Well with a pump, lake/pool or other; Public tank, water truck, well without a pump, or river/spring/stream; Piped)
28.	76	What is the mother tongue of the female head/spouse? (Quechua; Aymara, Guaraní, or other indigenous language; Spanish or other foreign language; There is no female head/spouse)
29.	75	In the past month, has the household bought, acquired, or consumed liquid milk in any form? (No; Yes)
30.	75	In the past year, did the household raise any onions, peanuts, *oca*, potatoes, plantains, or tapioca? (Yes, a rural household; No, a rural household; No, an urban household)
31.	69	What is the main material of the house's roof? (Straw/cane/palm leaves/mud, others, or no data; Corrigated metal sheets; Reinforced concrete; Cement, clay, or fiberglass tiles)
32.	67	In the past year, did the household pay wages to any domestic servants, chauffuers, etc.? (No; Yes)
33.	67	What languages does the female head/spouse speak? (Only indigenous languages; Indigenous languages and Spanish or foreign languages; Only Spanish or foreign languages; There is no female head/spouse)
34.	66	Does the female head/spouse know how to read and write? (No; Yes; There is no female head/spouse)
35.	66	Does the household have an electric fan? (No; Yes)
36.	66	What type of employment does the male head/spouse have? (Day laborer; Wage or salary employee; Self-employed; Other or there is no male head/spouse)
37.	65	Does the household have a stove (gas, electric, portable ceramic, etc.)? (No; Yes)
38.	65	Do all children ages 6–14 go to school? (No; There are no children in this age range; Yes)
39.	64	Is any household member invested in a pension fund? (No; Yes)
40.	64	Is the household currently raising any cattle (bulls, cows, or calves)? (Yes; No, a rural household; No, an urban household)
41.	62	Does the household have a wardrobe? (No; Yes)
42.	60	How many household members have wage or salary employment? (0; 1; 2 or more)
43.	59	In the past month, has the household bought, acquired, or consumed any bottled soft drinks? (No; Yes)
44.	57	Does the household live in an urban area? (No; Yes)
45.	56	Do all children ages 6–17 go to school? (No; There are no children in this age range; Yes)
46.	45	How many rooms does the household live in, not counting bathrooms and kitchen? (1; 2; 3; 4; 5 or more)
47.	44	Do all girls ages 6–14 go to school? (No; There are no girls in this age range; Yes)
48.	43	Do all girls ages 6–17 go to school? (No; There are no girls in this age range; Yes)
49.	43	Do all boys ages 6–17 go to school? (No; There are no boys in this age range; Yes)
50.	41	Where is the locale of the family business? (No data or there is no family business; House where they live; Fixed or mobile stand, kiosk, home delivery, itinerant, or other; Vehicle; Dedicated locale)

Source: 2002 *Encuesta de Hogares* by Bolivia's Instituto Nacional de Estadística.

Figura 4: Indicadores de pobreza según coeficiente de inciertadumbre

Coeficiente de inciertadumbre		Indicador (Respuestas ordenados comenzando con la cual está más estrechamente vinculado con la pobreza)
1.	176	¿Cuál es el material más utilizado en los pisos de la vivienda? (Tierra u otro; Cemento, ladrillo o tablón de madera; Machihembre/parquet, alfombra/tapizón o mosaíco/baldosas/cerámica)
2.	165	¿Tiene el hogar servicio telefónico fijo o celular? (No; Sí)
3.	158	¿El hogar tiene refrigerador? (No; Sí)
4.	154	¿Cuál fue el ultimo grado escolar completado por la jefa feminina del hogar? (Segundo año de primaria o menor; Años 3–8 de primaria; Años 1–4 de secundaria; Mayor de secundaria)
5.	153	¿Cuál fue el máximo grado escolar completado por un miembro del hogar? (Año 7 de primaria o menor; Año 8 de primaria hasta año 3 de secundaria; Año 4 de secundaria u otros cursos; Mayor de secundaria)
6.	146	El agua para beber y cocinar, ¿se distribuye . . .? (Por cañería dentro de la vivienda; Por cañería fuera de la vivienda, pero dentro del lote o terreno; Otro)
7.	137	El baño, water o letrina, ¿tiene desague . . .? (No hay baño, water o letrina; Pozo ciego o superficie (calle/quebrada/río); Cantarillado o cámera séptica)
8.	133	¿Cuál fue el ultimo grado escolar completado por ej jefe masculino del hogar? (Ni el primer año de primaria; Años 1–4 de primaria; Años 5–8 de primaria; Años 1–4 de secundaria; Mayor de secundaria)
9.	132	¿El hogar tiene un juego de living? (No; Sí)
10.	130	¿Cuántas personas en el hogar tienen menos de 18 años? (5 o más; 4; 3; 2; 1; 0)
11.	129	¿Cuántas personas en el hogar tienen menos de 15 años? (4 o más; 3; 2; 1; 0)
12.	117	¿Cuántas personas en el hogar tienen menos de 12 años? (3 o más; 2; 1; 0)
13.	116	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron manzanas? (No; Sí)
14.	109	¿El hogar tiene un reproductor de video (VHS, Betamax, DVD)? (No; Sí)
15.	103	¿Cuál es el material de construcción más utilizado en las paredes de la vivienda? (Tabique/quinche, cana/palma/tronco, piedra, otro, o sin datos; Adobe/tapial o madera; Ladrillo/bloques de cemento/hormigón)
16.	98	¿El baño, water o letrina es . . .? (No hay baño, water o letrina; Compartido con otros hogares; Usado sólo por su hogar)
17.	96	¿El hogar tiene baño, water o letrina? (No; Sí)
18.	95	¿El hogar tiene un televisor? (No; Sí)
19.	94	¿El hogar tiene juego de comedor (mesa y sillas)? (No; Sí)
20.	93	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron embutidos (salchicha, chorizo)? (No; Sí)
21.	90	¿Cuántas personas viven en el hogar? (9 or more; 8; 7; 6; 5; 4; 3; 2; 1)
22.	90	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron mermeladas o jaleas? (No; Sí)
23.	87	Principalmente, ¿qué tipo de combustible o energía utiliza para cocinar? (Lena, guano/bosta o taquía; Kerosen, gas licuado (garrafa), gas natural por red (cañería), electricidad u otro)
24.	80	¿El hogar tiene automóvil para el uso del hogar? (No; Sí)
25.	79	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron carne de pollo? (No; Sí)

Fuente: 2002 *Encuesta de Hogares* por el Instituto Nacional de Estadística de Bolivia.

Figura 4 (cont.): Indicadores de pobreza según coeficiente de inciertadumbre

Coeficiente de inciertadumbre		Indicador (Respuestas ordenados comenzando con la cual está más estrechamente vinculado con la pobreza)
26.	77	En el último año, ¿sembró el hogar algún cultivo agrícola? (No, hogar urbano; Sí; No, hogar rural)
27.	76	Principalmente, ¿De dónde obtiene el agua para beber y cocinar? (Pozo o noria con bomba, lago/laguna/curiche u otro; Pileta publica, carro repartidor (aguatero), pozo o noria sin bomba, o río/vertiente/acequía; Cañería de red)
28.	76	¿Cuál es el idioma o lengua en el que la jefa feminina del hogar aprendió hablar en su niñez? (Quechua; Aymara, Guaraní u otro idioma nativo; Castellano o extranjero; No hay jefa feminina del hogar)
29.	75	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron leche líquida en cualquier forma? (No; Sí)
30.	75	En el último año, ¿sembró el hogar cebolla, maní, oca, papa, platano o yuca? (Sí; No, hogar rural; No, hogar urbana)
31.	69	¿Cuál es el material más utilizado en los techos de la vivienda? (Paja/cana/palma/barro, otro o sin datos; Losa de hormigón armado; Teja (cemento/arcilla/fibrocemento); Calamina o plancha)
32.	67	En el último año, ¿gastó el hogar en sueldo de empleadas domésticas, chofer, etc.? (No; Sí)
33.	67	¿Cuáles idiomas o lenguas habla la jefa feminina del hogar? (Sólo idiomas nativos; Idiomas nativos y Castellano o extranjero; Sólo Castellano o extranjero; No hay jefa feminina del hogar)
34.	66	¿Sabe leer y escribir la jefa feminina del hogar? (No; Sí; No hay jefa feminina del hogar)
35.	66	¿El hogar tiene ventilador? (No; Sí)
36.	66	¿Qué tipo de empleo tiene el jefe masculino del hogar? (Obrero; Empleado; Trabajador por cuenta propia; Otro o no hay jefe masculino del hogar)
37.	65	¿El hogar tiene cocina (a gas, eléctrica, anafe, etc.)? (No; Sí)
38.	65	¿Asisten todos niños de edad 6–14 a la escuela? (No; No hay niños de edad 6–14; Sí)
39.	64	¿Es algún miembro del hogar suscrito en una AFP? (No; Sí)
40.	64	¿Cria el hogar bovinos (toros, vacas, terneras)? (Sí; No, hogar rural; No, hogar urbano)
41.	62	¿El hogar tiene un ropero? (No; Sí)
42.	60	¿Cuántos miembros del hogar son asalariados? (0; 1; 2 o más)
43.	59	En el ultimo mes en su hogar, ¿compraron, consiguieron o consumieron gaseosa en botella? (No; Sí)
44.	57	¿Reside el hogar en un área urbana? (No; Sí)
45.	56	¿Asisten todos niños de edad 6–17 a la escuela? (No; No hay niños de edad 6–17; Sí)
46.	45	¿Cuántos cuartos ocupa su hogar, sin contar baño y cocina? (1; 2; 3; 4; 5 o más)
47.	44	¿Asisten todas las niñas femininas de edad 6–14 a la escuela? (No; No hay niñas femininas de edad 6–14; Sí)
48.	43	¿Asisten todas las niñas femininas de edad 6–17 a la escuela? (No; No hay niñas femininas de edad 6–17; Sí)
49.	43	¿Asisten todas los niños masculinos de edad 6–17 a la escuela? (No; No hay niños masculinos de edad 6–17; Sí)
50.	41	¿Dónde se ubica el negocio familiar? (Sin datos o no hay negocio familiar; En su vivienda particular; Puesto móvil, quiosco, puesto fijo, servicio a domicilio, ambulante u otro; Vehículo; Local o terreno exclusivo)

Fuente: 2002 *Encuesta de Hogares* por el Instituto Nacional de Estadística de Bolivia.

Figure 5: A simple poverty scorecard for Bolivia

Indicator	Values					Points
1. How many children aged 0 to 17 are in the household?	?5	4	3	2	1	Zero
	0	9	11	16	21	30
2. What is the main material of the house's floors?				Earth or other	Cement, bricks, or wooden planks	Tile/parquet, rug/carpet, or ceramic tile
				0	5	13
3. Does the household own a refrigerator?					No	Yes
					0	8
4. In the past year, did the household raise any crops?				No, urban household	Yes	No, rural household
				0	9	16
5. Does the household have a fixed-line or cellular telephone?					No	Yes
					0	10
6. Does the household own a dining-room set (table and chairs)?					No	Yes
					0	5
7. Do all children ages 6-17 attend school?				No	No school-age children	Yes
				0	2	4
8. Does the household have a bathroom or latrine?					No	Yes
					0	7
9. What type of fuel does the household usually use for cooking?					Wood or guano/dung	Other
					0	5
10. Does the household own a television?					No	Yes
					0	2

Source: Calculations based on the 2002 *Encuesta de Hogares*. Total:

Figura 6: Una indíce sencillo para medir la pobreza en Bolivia

Indicador	Valores					Puntaje
1. ¿Cuántas personas en el hogar tienen menos de 18 años?	?5	4	3	2	1	Zero
	0	9	11	16	21	30
2. ¿Cuál es el material más utilizado en los pisos de la vivienda?				Tierra u otro	Cemento, ladrillo o tablón de madera	Machihembre/parquet, alfombra/tapizón o mosaíco/baldosas/ cerámica
				0	5	13
3. ¿El hogar tiene refrigerador?					No	Sí
					0	8
4. En el último año, ¿sembró el hogar algún cultivo agrícola?				No, hogar urbano	Sí	No, hogar rural
				0	9	16
5. ¿Tiene el hogar servicio telefónico fijo o celular?					No	Sí
					0	10
6. ¿El hogar tiene juego de comedor (mesa y sillas)?					No	Sí
					0	5
7. ¿Asisten todos niños de edad 6–17 a la escuela?				No	No hay niños de esta edad	Sí
				0	2	4
8. ¿El hogar tiene baño, water o letrina?					No	Sí
					0	7
9. Principalmente, ¿qué tipo de combustible o energía utiliza para cocinar?					Leña o guano/bosta o taquía	Otros
					0	5
10. ¿El hogar tiene un televisor?					No	Sí
					0	2
Fuente: Cálculos basados en la *Encuesta de Hogares* de 2002.						Total:

Figure 7: Scores and poverty likelihoods

Score	Poverty likelihood for people with score in range (%)	% of people <=score who are poor	% of people >score who are non-poor
0-4	100.0	100.0	35.3
5-9	100.0	100.0	36.4
10-14	100.0	100.0	37.7
15-19	99.5	99.8	39.5
20-24	96.8	98.5	43.2
25-29	95.7	97.5	48.5
30-34	86.0	94.4	54.5
35-39	81.4	91.8	61.4
40-44	67.5	87.7	68.6
45-49	60.3	84.2	76.2
50-54	33.1	79.4	78.9
55-59	53.7	77.4	90.0
60-64	11.8	73.4	90.7
65-69	18.8	70.4	96.4
70-74	3.4	67.2	96.3
75-79	7.5	66.1	99.7
80-84	0.3	64.8	100.0
85-89	0.0	64.7	100.0
90-94	0.0	64.7	0.0
95-100	0.0	64.7	0.0

Surveyed cases weighted to represent Bolivia's population.

Source: Calculations based on the 2002 *Encuesta de Hogares*.

Figure 8: Confidence intervals for estimated poverty likelihoods

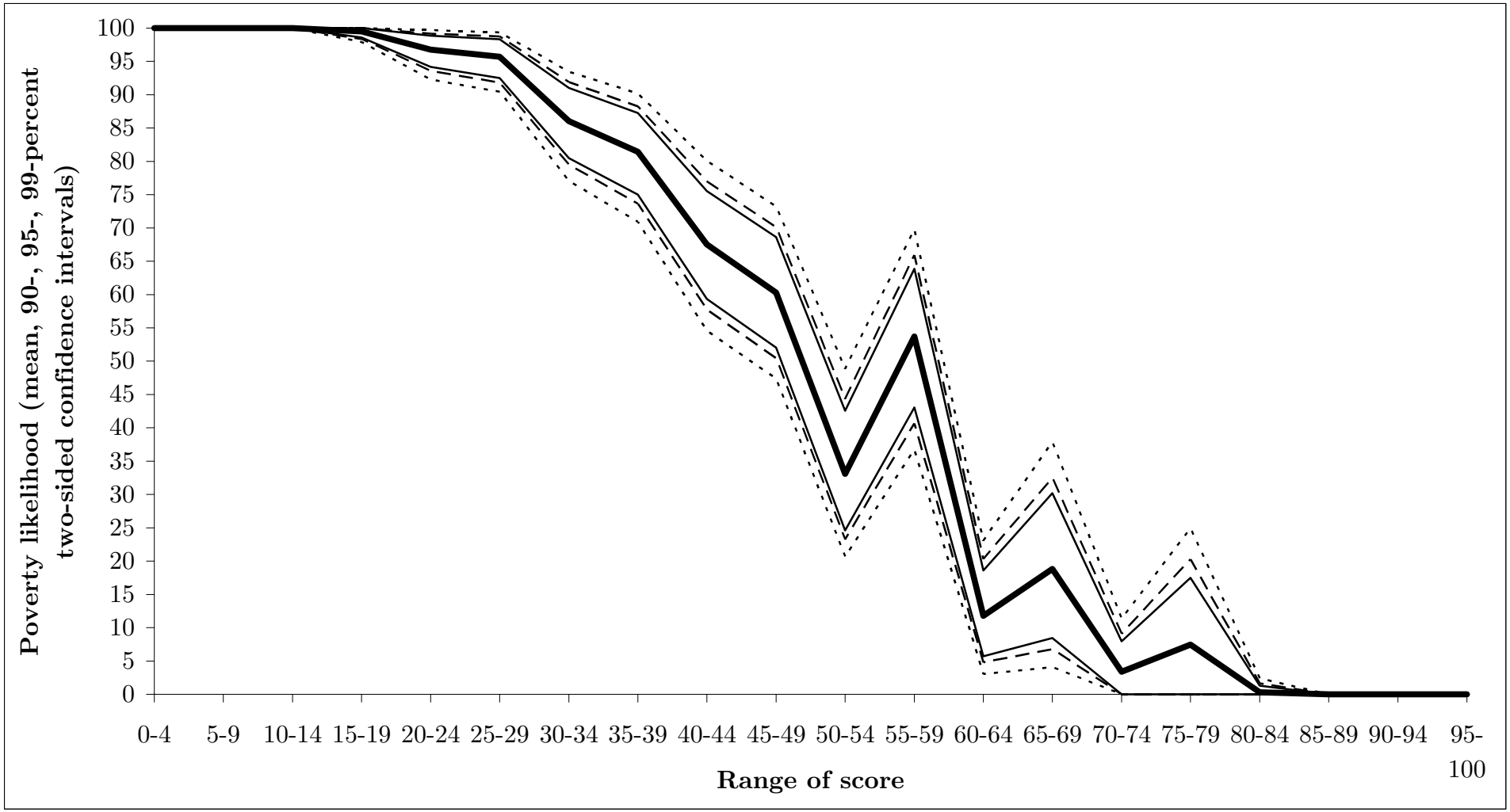

Figure 9: Differences between estimated and true poverty likelihoods

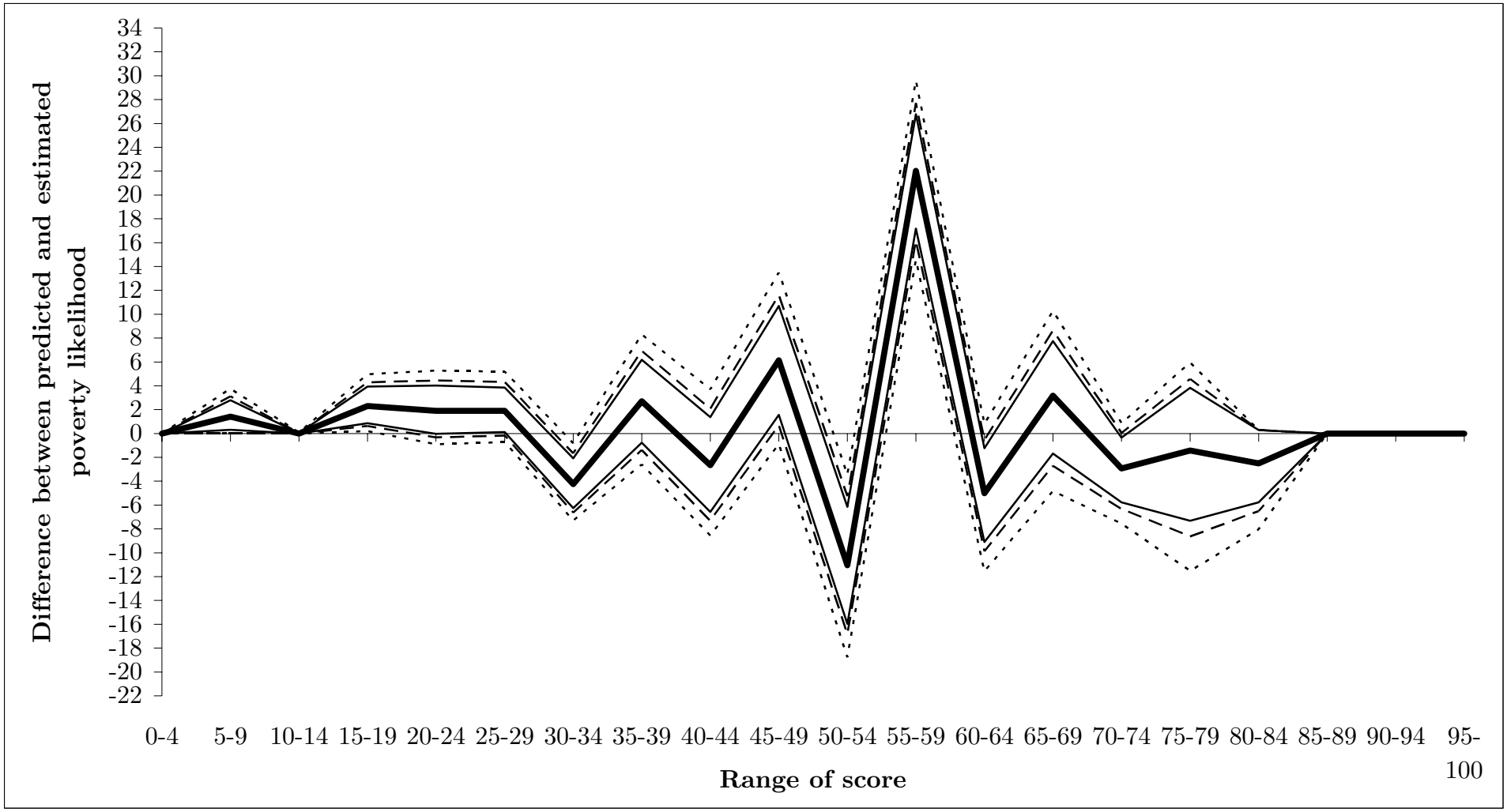

Figure 10: ROC curve of ability to rank-order households by poverty status

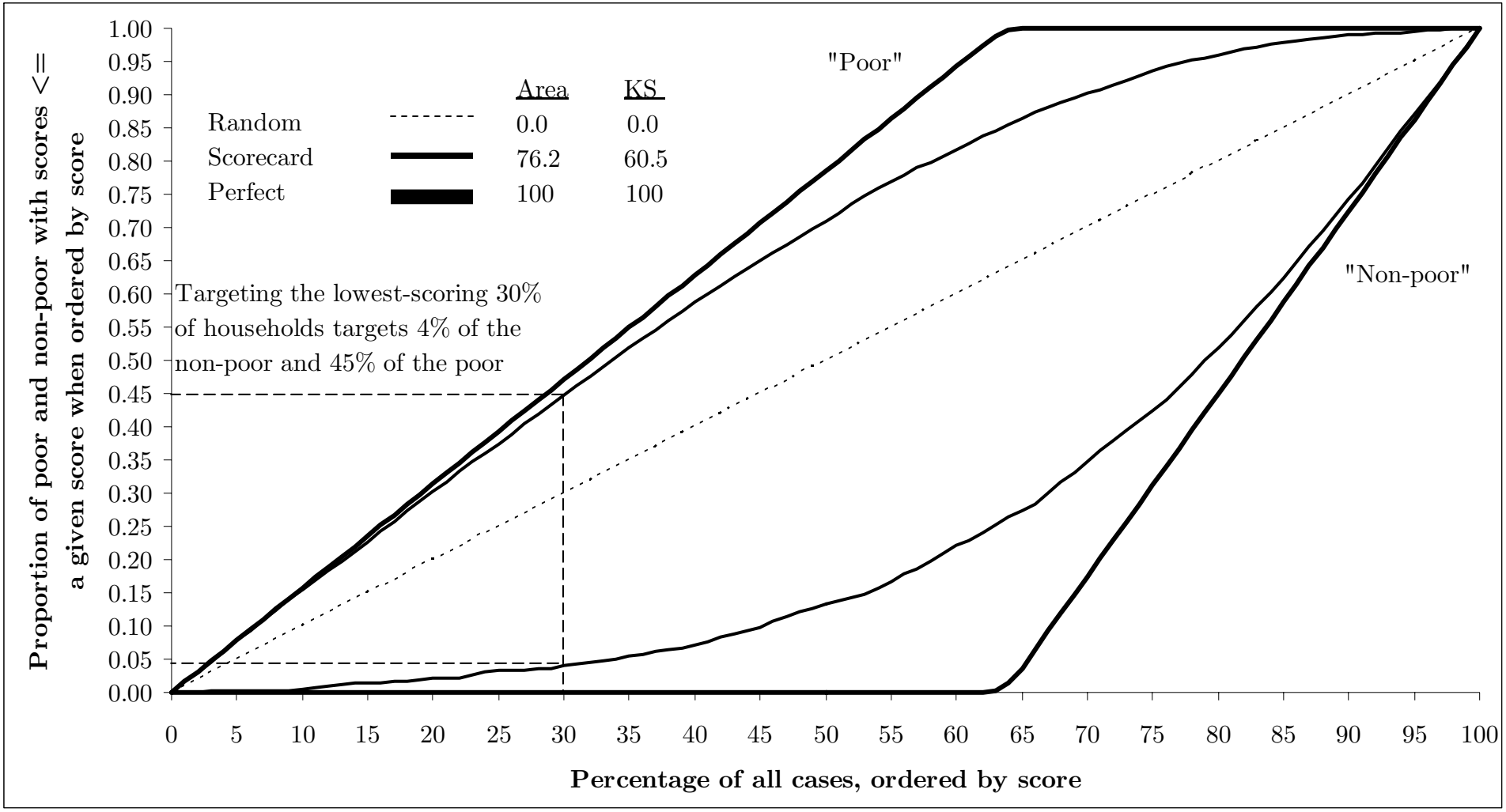

Figure 11: General classification matrix

True poverty status		Targeting segment: Targeted	Targeting segment: Non-targeted
	Poor	**A.** Truly poor correctly targeted	**B**. Truly poor mistakenly non-targeted
	Non-poor	**C**. Truly non-poor mistakenly targeted	**D**. Truly non-poor correctly non-targeted

Figure 12: People by targeting classification and score

Score	A. Truly poor correctly targeted	B. Truly poor mistakenly non-targeted	C. Truly non-poor mistakenly targeted	D. Truly non-poor correctly non-targeted
0-4	0.1	64.6	0.0	35.3
5-9	3.1	61.7	0.0	35.3
10-14	6.4	58.3	0.0	35.3
15-19	10.7	54.0	0.0	35.3
20-24	18.7	46.0	0.3	35.0
25-29	28.0	36.7	0.7	34.6
30-34	37.1	27.6	2.2	33.1
35-39	45.1	19.6	4.0	31.3
40-44	51.9	12.8	7.3	28.0
45-49	57.1	7.7	10.7	24.6
50-54	59.4	5.3	15.4	19.8
55-59	62.9	1.9	18.4	16.9
60-64	63.5	1.3	23.0	12.2
65-69	64.4	0.3	27.1	8.1
70-74	64.6	0.1	31.5	3.8
75-79	64.7	0.0	33.2	2.0
80-84	64.7	0.0	35.2	0.1
85-89	64.7	0.0	35.3	0.0
90-94	64.7	0.0	35.3	0.0
95-100	64.7	0.0	35.3	0.0

Figures normalized to sum to 100.

Source: Calculations based on the 2002 *Encuesta de Hogares*.

Figure 13: General net-benefit matrix

True poverty status	Targeting segment: Targeted	Targeting segment: Non-targeted
Poor	α	β
Non-poor	γ	δ

Figure 14: "Total Accuracy" net-benefit matrix

True poverty status	Targeting segment: Targeted	Targeting segment: Non-targeted
Poor	1	0
Non-poor	0	1

Figure 15: Total net benefit for some common net-benefit matrices

	Total Accuracy (A + B)		Poverty Accuracy 100*A / (A+B)		Non-poverty Accuracy 100*D / (C+D)		Undercoverage 100*B / (A+B)		Leakage 100*C / (A+C)	
	1	0	1	0	0	0	0	-1	0	0
Score	0	1	0	0	0	1	0	0	-1	0
0-4	35.4		0.1		100.0		99.9		0.0	
5-9	38.3		4.7		100.0		95.3		0.0	
10-14	41.7		9.9		100.0		90.1		0.0	
15-19	46.0		16.5		99.9		83.5		0.2	
20-24	53.7		28.9		99.2		71.1		1.5	
25-29	62.6		43.3		98.0		56.7		2.5	
30-34	70.2		57.4		93.8		42.6		5.6	
35-39	76.4		69.7		88.6		30.3		8.2	
40-44	79.9		80.2		79.4		19.8		12.3	
45-49	81.7		88.2		69.7		11.8		15.8	
50-54	79.3		91.8		56.2		8.2		20.6	
55-59	79.7		97.1		47.8		2.9		22.6	
60-64	75.7		98.1		34.7		1.9		26.6	
65-69	72.6		99.5		23.0		0.5		29.6	
70-74	68.4		99.8		10.7		0.2		32.8	
75-79	66.8		100.0		5.8		0.0		33.9	
80-84	64.8		100.0		0.2		0.0		35.2	
85-89	64.7		100.0		0.1		0.0		35.3	
90-94	64.7		100.0		0.0		0.0		35.3	
95-100	64.7		100.0		0.0		0.0		35.3	

All figures in percentage units.

Figure 16: "Poverty Accuracy" net-benefit matrix

True poverty status	Targeting segment: Targeted	Targeting segment: Non-targeted
Poor	1	0
Non-poor	0	0

Figure 17: Net-benefit matrix for BPAC

True poverty status	Targeting segment: Targeted	Targeting segment: Non-targeted
Poor	1	1
Non-poor	-1	0

Figure 18: Poverty likelihoods for the very poor, poor, and non-poor by score

	Poverty likelihood in score range			Share of cases <= score		
Score	**Very Poor**	**Poor**	**Non-poor**	**Very Poor**	**Poor**	**Non-poor**
0-4	100.0	0.0	0.0	100.0	0.0	0.0
5-9	51.5	48.5	0.0	52.8	47.2	0.0
10-14	92.0	8.0	0.0	73.2	26.8	0.0
15-19	63.7	35.8	0.5	69.3	30.4	0.2
20-24	72.6	24.2	3.3	70.8	27.7	1.5
25-29	60.1	35.6	4.3	67.1	30.4	2.5
30-34	34.4	51.6	14.0	58.3	36.1	5.6
35-39	36.7	44.8	18.6	54.0	37.9	8.2
40-44	24.3	43.2	32.5	49.0	38.8	12.3
45-49	4.4	55.9	39.7	43.3	40.9	15.8
50-54	0.1	33.0	66.9	39.2	40.2	20.6
55-59	8.2	45.5	46.3	36.8	40.6	22.6
60-64	0.2	11.6	88.2	34.5	38.8	26.6
65-69	0.0	18.8	81.2	32.6	37.7	29.6
70-74	0.0	3.4	96.6	31.1	36.1	32.8
75-79	0.2	7.3	92.5	30.5	35.6	33.9
80-84	0.0	0.3	99.7	29.9	34.9	35.2
85-89	0.0	0.0	100.0	29.9	34.8	35.3
90-94	0.0	0.0	100.0	29.9	34.8	35.3
95-100	0.0	0.0	100.0	29.9	34.8	35.3

Figure 19: Confidence intervals for estimated poverty likelihoods for being very poor associated with scores

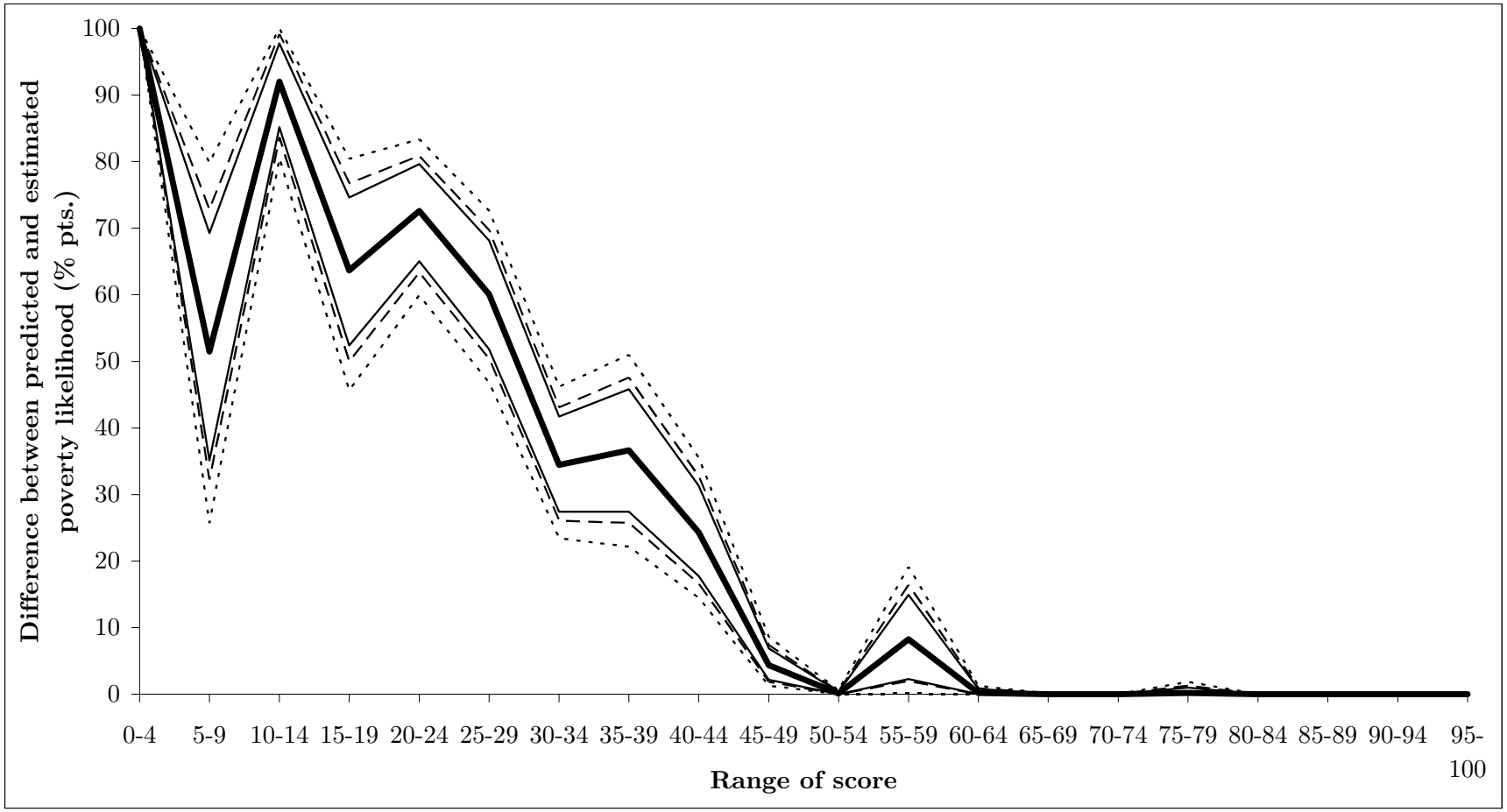

Figure 20: Differences between estimated and true poverty likelihoods for the very poor

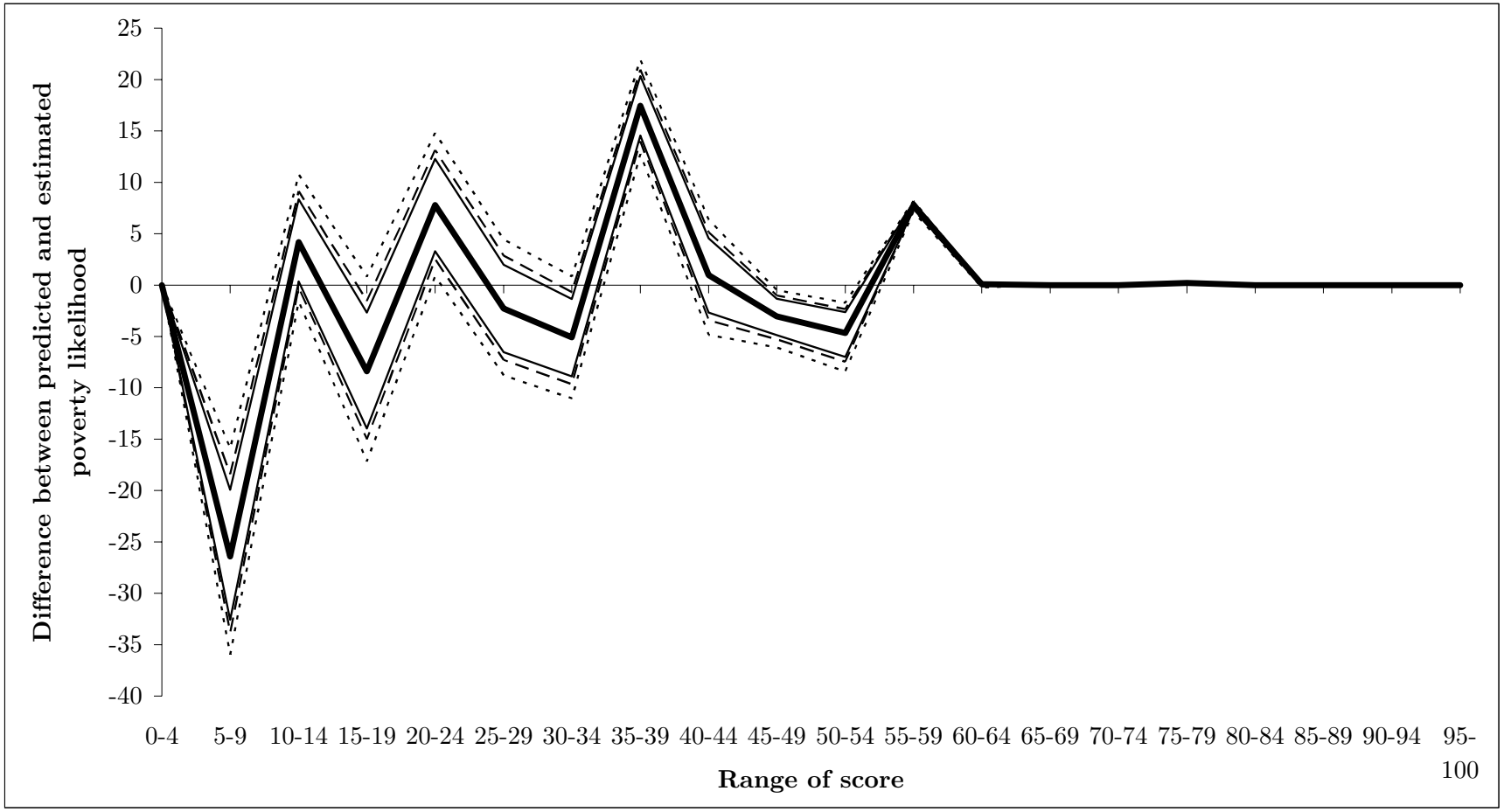

Figure 21: ROC curve of ability to rank-order households by very poor versus not very poor poverty status

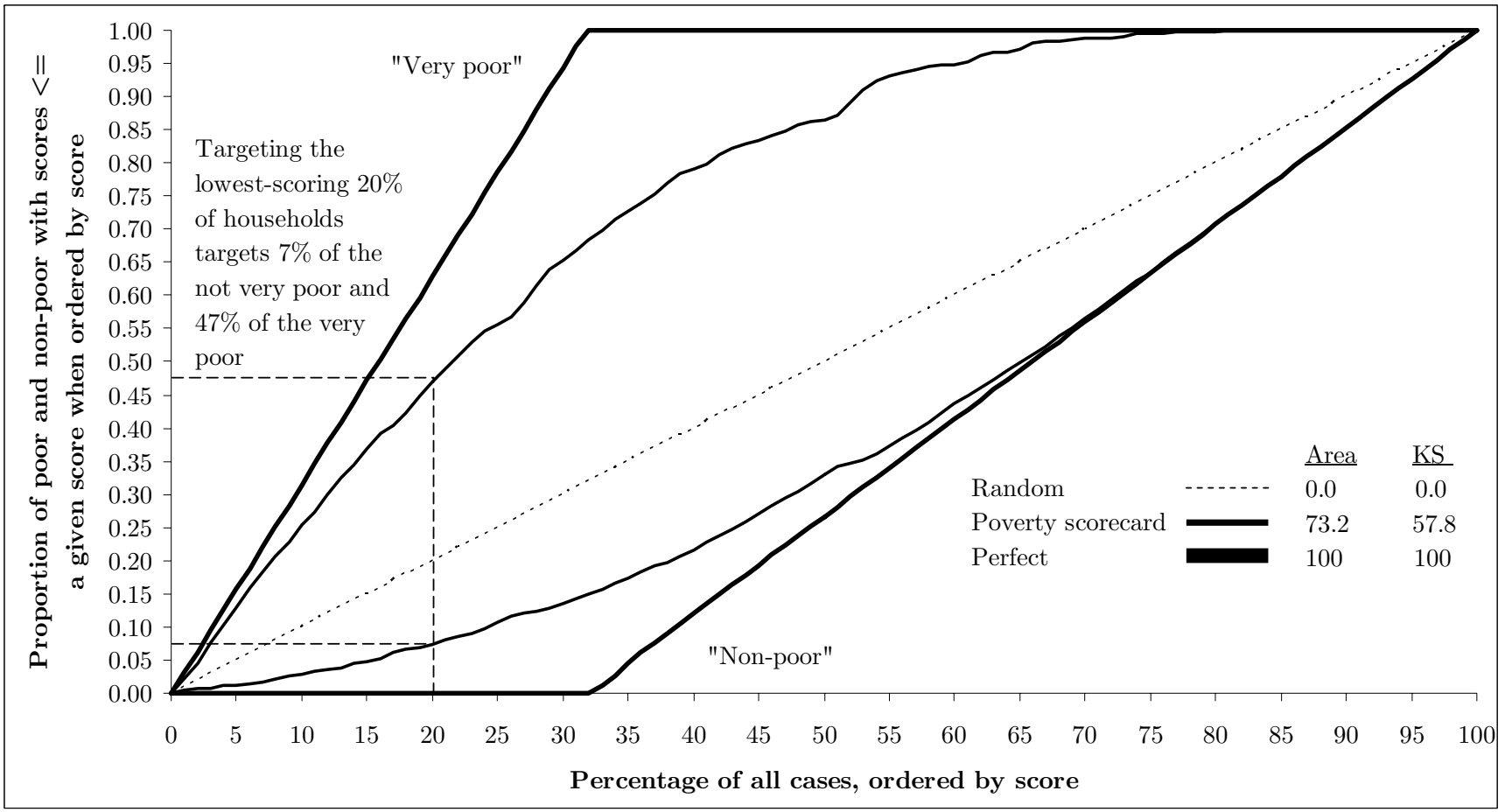

Figure 22: Classification matrix, three segments

True poverty status	Targeting segment: Very Poor	Targeting segment: Poor	Targeting segment: Non-poor
Very Poor	**A.** Truly very poor correctly targeted as very poor	**B.** Truly very poor incorrectly targeted as poor	**C.** Truly very poor incorrectly targeted as non-poor
Poor	**D.** Truly poor incorrectly targeted as very poor	**E.** Truly poor correctly targeted as poor	**F.** Truly poor incorrectly targeted as non-poor
Non-poor	**G.** Truly non-poor incorrectly targeted as very poor	**H.** Truly non-poor incorrectly targeted as poor	**I.** Truly non-poor correctly targeted as poor

Figure 23: Net-benefit matrix, three segments

True poverty status	Targeting segment: Very Poor	Poor	Non-poor
Very Poor	α	β	γ
Poor	δ	ε	ζ
Non-poor	η	θ	ι

Figure 24: Classification results, very poor/poor cut-offs from 0 to 44 and poor/non-poor cut-offs from 5 to 49

		Upper bound, poor segment																					
		5-9			10-14			15-19			20-24			25-29			30-34			35-39			40-44		
Upper bound, very poor segment	0-4	1	13	233	1	38	208	1	61	185	1	110	136	1	158	88	1	189	57	1	218	28	1	238	8
		0	12	276	0	14	273	0	27	261	0	43	244	0	72	215	0	117	170	0	153	134	0	189	98
		0	0	291	0	0	291	0	0	291	0	2	289	0	6	285	0	18	273	0	33	258	0	60	231
	5-9				13	25	208	13	48	185	13	97	136	13	146	88	13	176	57	13	205	28	13	226	8
					12	2	273	12	15	261	12	31	244	12	60	215	12	105	170	12	141	134	12	177	98
					0	0	291	0	0	291	0	2	289	0	6	285	0	18	273	0	33	258	0	60	231
	10-14							39	23	185	39	72	136	39	120	88	39	151	57	39	180	28	39	200	8
								14	13	261	14	29	244	14	58	215	14	103	170	14	139	134	14	175	98
								0	0	291	0	2	289	0	6	285	0	18	273	0	33	258	0	60	231
	15-19										61	49	136	61	98	88	61	128	57	61	157	28	61	178	8
											27	16	244	27	45	215	27	90	170	27	126	134	27	162	98
											0	2	289	0	6	285	0	18	273	0	33	258	0	60	231
	20-24													111	48	88	111	78	57	111	108	28	111	128	8
														43	29	215	43	74	170	43	110	134	43	146	98
														2	3	285	2	16	273	2	31	258	2	58	231
	25-29																159	30	57	159	60	28	159	80	8
																	72	45	170	72	81	134	72	117	98
																	6	12	273	6	27	258	6	54	231
	30-34																			189	30	28	189	50	8
																				117	36	134	117	72	98
																				18	15	258	18	42	231
	35-39																						219	20	8
																							153	36	98
																							33	27	231
	40-44																								
	45-49																								

Figures in units of 10,000 people.

Figure 24 (cont.): Classification results, very poor/poor cut-offs from 0 to 49 and poor/non-poor cut-offs from 50 to 100

		Upper bound, poor segment																					
		50-54			55-59			60-64			65-69			70-74			75-79			80-84			85-89		
Upper bound, very poor segment	0-4	1	241	4	1	246	0	1	246	0	1	246	0	1	246	0	1	246	0	1	246	0	1	246	0
		0	248	39	0	272	15	0	277	10	0	285	2	0	286	1	0	287	0	0	288	0	0	288	0
		0	127	164	0	152	139	0	190	101	0	224	67	0	260	31	0	274	17	0	291	0	0	291	0
	5-9	13	229	4	13	233	0	13	233	0	13	233	0	13	233	0	13	233	0	13	233	0	13	233	0
		12	236	39	12	260	15	12	265	10	12	273	2	12	274	1	12	276	0	12	276	0	12	276	0
		0	127	164	0	152	139	0	190	101	0	224	67	0	260	31	0	274	17	0	291	0	0	291	0
	10-14	39	204	4	39	208	0	39	208	0	39	208	0	39	208	0	39	208	0	39	208	0	39	208	0
		14	234	39	14	258	15	14	263	10	14	271	2	14	272	1	14	273	0	14	273	0	14	273	0
		0	127	164	0	152	139	0	190	101	0	224	67	0	260	31	0	274	17	0	291	0	0	291	0
	15-19	61	181	4	61	185	0	61	185	0	61	185	0	61	185	0	61	185	0	61	185	0	61	185	0
		27	221	39	27	245	15	27	250	10	27	258	2	27	259	1	27	261	0	27	261	0	27	261	0
		0	127	164	0	152	139	0	190	101	0	224	67	0	260	31	0	274	17	0	290	0	0	291	0
	20-24	111	131	4	111	136	0	111	136	0	111	136	0	111	136	0	111	136	0	111	136	0	111	136	0
		43	205	39	43	229	15	43	234	10	43	242	2	43	243	1	43	244	0	43	244	0	43	244	0
		2	125	164	2	149	139	2	188	101	2	222	67	2	258	31	2	272	17	2	288	0	2	289	0
	25-29	159	83	4	159	87	0	159	88	0	159	88	0	159	88	0	159	88	0	159	88	0	159	88	0
		72	176	39	72	200	15	72	205	10	72	213	2	72	214	1	72	215	0	72	215	0	72	215	0
		6	122	164	6	146	139	6	184	101	6	218	67	6	254	31	6	268	17	6	285	0	6	285	0
	30-34	189	53	4	189	57	0	189	57	0	189	57	0	189	57	0	189	57	0	189	57	0	189	57	0
		117	131	39	117	155	15	117	160	10	117	168	2	117	169	1	117	170	0	117	170	0	117	170	0
		18	109	164	18	134	139	18	172	101	18	206	67	18	242	31	18	256	17	18	273	0	18	273	0
	35-39	219	23	4	219	28	0	219	28	0	219	28	0	219	28	0	219	28	0	219	28	0	219	28	0
		153	95	39	153	119	15	153	124	10	153	132	2	153	133	1	153	134	0	153	134	0	153	134	0
		33	94	164	33	119	139	33	157	101	33	191	67	33	227	31	33	241	17	33	258	0	33	258	0
	40-44	239	3	4	239	8	0	239	8	0	239	8	0	239	8	0	239	8	0	239	8	0	239	8	0
		189	59	39	189	83	15	189	88	10	189	96	2	189	97	1	189	98	0	189	98	0	189	98	0
		60	67	164	60	92	139	60	130	101	60	164	67	60	200	31	60	214	17	60	231	0	60	231	0
	45-49	242	0	4	242	4	0	242	5	0	242	5	0	242	5	0	242	5	0	242	5	0	242	5	0
		229	19	39	229	43	15	229	48	10	229	56	2	229	58	1	229	59	0	229	59	0	229	59	0
		88	39	164	88	64	139	88	102	101	88	136	67	88	172	31	88	186	17	88	202	0	88	203	0

Figures in units of 10,000 people.

Figure 24 (cont.): Classification results, very poor/poor cut-offs from 50 to 94 and poor/non-poor cut-offs from 55 to 100

Upper bound, very poor segment	Upper bound, poor segment: 55-59	60-64	65-69	70-74	75-79	80-84	85-89
50-54	242 4 0	242 4 0	242 4 0	242 4 0	242 4 0	242 4 0	242 4 0
	248 24 15	248 29 10	248 37 2	248 38 1	248 39 0	248 39 0	248 39 0
	127 24 139	127 63 101	127 97 67	127 133 31	127 147 17	127 163 0	127 164 0
55-59		247 0 0	247 0 0	247 0 0	247 0 0	247 0 0	247 0 0
		272 5 10	272 13 2	272 14 1	272 15 0	272 15 0	272 15 0
		152 38 101	152 72 67	152 108 31	152 122 17	152 139 0	152 139 0
60-64			247 0 0	247 0 0	247 0 0	247 0 0	247 0 0
			277 8 2	277 9 1	277 10 0	277 10 0	277 10 0
			190 34 67	190 70 31	190 84 17	190 101 0	190 101 0
65-69				247 0 0	247 0 0	247 0 0	247 0 0
				285 1 1	285 2 0	285 2 0	285 2 0
				224 36 31	224 50 17	224 67 0	224 67 0
70-74					247 0 0	247 0 0	247 0 0
					286 1 0	286 1 0	286 1 0
					260 14 17	260 31 0	260 31 0
75-79						247 0 0	247 0 0
						287 0 0	287 0 0
						274 16 0	274 17 0
80-84							247 0 0
							288 0 0
							291 0 0
85-89							
90-94							

Figures in units of 10,000 people.

Figure 25: Classification results, very poor 0–29, poor 30–49, and non-poor 50–100

		People with score in range		
Segment	**Score**	**Very Poor**	**Poor**	**Non-poor**
	0-4	1	0	0
	5-9	13	12	0
Very poor	10-14	25	2	0
0-29	15-19	**159**	**72**	**6**
	20-24	**64%**	**25%**	**2%**
	25-29	49	16	2
		48	29	3
	30-34	30	45	12
Poor	35-39	30	36	15
30-49	40-44	**83**	**157**	**82**
	45-49	**34%**	**55%**	**28%**
		20	36	27
		3	40	28
	50-54	0	19	39
	55-59	4	24	24
	60-64	0	5	38
	65-69	0	8	34
Non-poor	70-74	0	1	36
50-100	75-79	**5**	**59**	**203**
	80-84	**3%**	**34%**	**79%**
	85-89	0	1	14
	90-94	0	0	16
	95-100	0	0	0
		0	0	0
	Total:	247	288	291

Counts of people are in units of 10,000.

Figure 26: An example net-benefit matrix reflecting common values

True poverty status	Targeting segment: Very Poor	Targeting segment: Poor	Targeting segment: Non-poor
Very Poor	+3	-2	-6
Poor	-1	+2	-2
Non-poor	-2	-1	+1

Note: This is an example. Each program should define its own net-benefit matrix.

Figure 27: Computation of total net benefit for a cut-off pair of 25–29 and 45–49

Cell			Persons	Net benefit/person	Net benefit
A.	Truly very poor	as very poor	159	+3	+477
B.	Truly very poor	as poor	83	–2	–166
C.	Truly very poor	as non-poor	5	–6	–30
D.	Truly poor	as very poor	72	–1	–72
E.	Truly poor	as poor	157	+2	+314
F.	Truly poor	as non-poor	59	–2	–118
G.	Truly non-poor	as very poor	6	–2	–12
H.	Truly non-poor	as poor	82	–1	–82
I.	Truly non-poor	as non-poor	203	+1	+203
				Total net benefit:	+514

Note: Persons are counted in units of 10,000.