Predicting Household Poverty: A Methodological Note with a Kenyan Example

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Abstract

Household surveys provide data for identifying and measuring poverty status of households and individuals. However, carrying out such surveys is expensive, especially in poor developing countries. Thus, it is important to make maximum use of the available survey data in developing countries, especially in sub-Saharan Africa, where such data are expensive to collect and analyse. This paper develops a simple method for using poverty indices derived from survey data for a given year to predict poverty rates for subsequent periods without having to conduct a new household survey. We illustrate the workings of the method with data from Kenyan household surveys for 1994 and 1997.

Abbreviations

GDP	gross domestic product
GoK	Government of Kenya
PRSPs	poverty reduction strategy papers
SSA	sub-Saharan Africa
UNDP	United Nations Development Programme

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1 Introduction

Identifying and measuring poverty require data on economic conditions of households and individuals. Such data are typically gathered through household surveys. Household surveys collect data on demographics, incomes, expenditure, and other characteristics such as area of residence and participation in the labour force. Data from household surveys are suitable not only for identifying and aggregating poverty but also for constructing poverty profiles. A poverty profile shows how aggregate poverty indices differ according to various household characteristics (Foster et al. 1984).

Household surveys have two shortcomings: first, they require considerable expertise to conduct, and second, they involve large expenditures to collect and analyse. For these reasons, household surveys are conducted only occasionally. Moreover, there is usually a long time interval between one survey and the next, except when the survey is designed to collect panel data. As a consequence, household surveys cannot be used to construct annual or high frequency poverty indices or profiles. Yet, such indices and profiles are key in evaluating the effectiveness of poverty reduction strategies. Indeed, the performance of these strategies cannot be monitored without periodic information on changes in poverty indices and profiles.

Poverty reduction strategy papers (PRSPs) have become a requirement for foreign assistance for developing countries, especially in Africa (see e.g., GoK 2000a), and many countries have invested substantial resources in preparing them. Moreover, greater amounts of resources are sure to be invested in programmes to achieve the poverty reduction objectives of the strategy papers. There is need, therefore, to develop a workable method for predicting poverty rates for periods covered by poverty reduction strategy papers so that the effects of poverty reduction policies can be monitored. Fortunately, it

is possible to develop a simple statistical method for predicting poverty rates on the basis of rates computed from some reference household survey data.

To motivate the development of the model, we start by indicating why there is need to predict poverty. First, predicting poverty helps to monitor the performance of national poverty reduction strategies. Second, in order to tell whether an antipoverty programme has been effective over a given period, the government must have information on poverty rates for the *starting* and the *ending* of the programme. Third, for an active programme, the government needs information on the poverty status of the population over at least two time periods covered by the programme in order to evaluate its effectiveness. Key to the evaluation exercise is information on the poverty status at some reference time period; that is, at the start of an antipoverty programme and at some later date. If such a programme is considered to be the main factor influencing poverty, the task of the evaluation is to determine the extent of poverty reduction following the implementation of the programme. This requires determining the poverty level when the programme started and comparing it with the level at a subsequent point, that is, the evaluation date.

The remainder of this paper outlines a methodology for determining poverty rates at a given year and in subsequent periods, and shows how the information obtained can be used to assess the effectiveness of antipoverty programmes.

2 Problem and Methodology

The problem involves calculating poverty rates for years t and t + j, given that household survey data are available for only year t – j (note that for year t, the present period, j = 0). To concretize the problem, we suppose that the government wants

to establish the poverty rates for 2000 (the implementation date of the pro-poor reforms) and 2004 (the year when the performance of the reforms is evaluated). How should the government proceed, given that it has data for only the period before 2000, for example, for 1997?

The poverty rate for time t, that is 2000, is easy to establish, at least in theory. If the government has the required expertise and resources, it can conduct a household survey for 2000 and compute the poverty rate for that year. However, if the government does not have the resources to mount the survey, then the task of calculating the poverty rate for 2004 is the same as that for 2000 (the present period), given that the only household data available are for 1997. The following demonstration will show how this problem can be resolved.

The method we develop is based on the idea that changes in poverty over time and space are determined mainly by changes in economic growth and distribution of income (see for example, Ravallion 1994, Ali and Thorbecke 2000, Oyugi et al. 2001). As economic growth increases, poverty decreases, and as inequality worsens, poverty increases. Formally, this idea can be expressed as

$$\text{Poverty rate for year j} = \alpha + \beta\,(\text{GDP growth}) + \delta\,(\text{Gini coefficient}) + \varepsilon_j \qquad (1a)$$

Where β and δ are the effects of growth and distribution, respectively, on poverty for year j; α is a constant term; and ε is the error term, which has a mathematical expectation of zero.

Note from equation (1a) that to compute the poverty rate for year j, information is needed on the gross domestic product (GDP) growth rate and the Gini coefficient for that year. Given the preceding information, and noting that α is a constant, the

change in poverty rate from one year to the next can be stated as

$$\Delta(\text{Poverty rate}) = \beta\,\Delta(\text{GDP growth}) + \delta\,\Delta(\text{Gini coefficient}) \quad (1b)$$

Once the change (Δ) in poverty for adjacent periods has been computed, the poverty rate for the terminal period can be obtained by updating the base year figure (the poverty rate for the previous year) using a simple equation:

$$\text{Poverty rate for year } j = \text{poverty rate year } (j-1) + (\text{poverty year } j - \text{poverty year } (j-1)) \quad (2)$$

From equations (1a), (1b) and (2) we have

$$\text{Poverty year } j - \text{poverty year } (j-1) = \beta\,\Delta(\text{GDP growth}) + \delta\,\Delta(\text{Gini coefficient}) \quad (3)$$

To apply equation (3), information is needed on the values for coefficients α, β and δ, GDP growth rates, and income distribution (see equation (1a)).

Obtaining data on the values for α, β and δ for a given country is not an easy matter. There are two ways of doing this. The first method involves estimating regression coefficients for equation (1a) using time series data for the country. However, this approach is unfeasible, because data on annual poverty rates are not available, particularly in Africa. The second approach, which is used here, involves borrowing the values for α, β and δ from cross-country poverty regressions for sub-Saharan Africa. For Kenya, we borrowed these values from the results of poverty regressions in Ali and Thorbecke (2000), who

estimated equation (1a) for a sample of sub-Saharan African countries, including Kenya (see appendix 1). Equation (1a) shows that the average values for α, β and δ are the same for all the sample countries. That is, the effect of growth on poverty, for example, is the same for each country in the sample.

We make a strong assumption that the estimated coefficients apply outside the sample period. The sample data used by Ali and Thorbecke (2000) were collected during the early 1990s. We assume that the parameters for α, β and δ obtained with these data are relevant for the early years of the 21st century (that is, 2000–2005). Since the elasticities of poverty with respect to GDP growth and income distribution appear to be of the same order of magnitude across regions of the same country (Mwabu et al. 2000) and across different countries (Ravallion 1994), the constancy assumption we make with respect to α, β and δ is reasonable.

The data on GDP growth and income distribution were obtained from government documents and published literature (GoK 1998, 2000). As already noted, we used the Gini coefficient as the measure of income distribution. Since change in income distribution over time is very slow, it is reasonable in the absence of annual data to assume that a given Gini coefficient is valid for several years. However, attempts have been made in this study to provide estimates of Gini coefficient for each year.

Data on GDP growth rates are easily available from government documents. In Kenya, this information is available in the government's *Economic Survey* published by the Central Bureau of Statistics of the Ministry of Finance and Planning, and the *Statistical Abstract* and the *Development Plan*, also published by the same ministry. Another reliable source of such data on Kenya is the Central Bank of Kenya, which predicts fairly accurately the short-term growth rates of the economy. We used the GDP growth rates provided in economic surveys.

To provide a concrete illustration of the application of equation (2) in the Kenyan context, we use poverty rates obtained using the 1997 household survey (the most recent survey) to calculate the poverty rates for 2000. Poverty values for 1997 are updated to 2000 values using the formula

$$\text{Poverty\_2000R}_i = \text{Poverty\_1997Ri}*(1 + \tau_i) \quad (4a)$$

$$\text{Poverty \_2000R}_i = \text{Poverty\_1997Ri} + \Psi_I \quad (4b)$$

where Poverty_2000R_i is the headcount index for region i (province or district) in 2000; Poverty_1997R_i is the headcount index for region i (province or district) in 1997; τ_i is the percentage change in the poverty index for region i (nation, province or district) over the period 1997–2000; and Ψ is the level of change in the poverty index for region i (nation or rural or urban area).

Equation (4a) was used to obtain headcount poverty indices for provinces and districts, while (4b) was used to obtain national, rural and urban indices. Equations (4a) and (4b) differ in the following respects. In (4b), Ψ is the level of change in the poverty index as indicated in equation (3); Ψ can be computed uniquely for each region (nation or rural or urban area), because, according to equation (1a), different values for α, β and δ are available for all these areas. In Ali and Thorbecke's (2000) regressions for sub-Saharan Africa (from which we borrowed the coefficients), equation (1a) was separately run for urban and rural areas. National-level values for α, β and δ were computed as simple averages of these same parameters for urban and rural areas. For example, if we let 'n = nation', 'r = rural' and 'u = urban', then $\beta_n = (\beta_r + \beta_u)/2$; and similarly for the other parameters.

Equation (4a) was used to obtain poverty indices for provinces and districts. The rural values for α, β and δ were used to compute poverty indices for provinces and districts; that is, all provinces and districts had the same values for α, β and δ. This was so because there were no coefficients to borrow for provinces and districts.

The term τ in equation (4a) is the percentage change in the rural poverty index over 1997–2000. This change is assumed to apply to all rural provinces and districts. However, since the base poverty indices for provinces and districts differ, *the percentage change* in *base* poverty indices over a specified time period (for example, 1997–2000) also will differ, except where the bases happen to be the same. The provincial and district base poverty rates were adjusted assuming that each rate changed by a percentage, τ, over the period 1997–2000.

From the above discussion, if rural poverty increased by 20 percentage points, for example from 50% in 1997 to 70% in 2000, it would not be correct to adjust provincial and district poverty rates by adding 20% to the 1997 poverty rates. The correct procedure involves setting τ to 40% (20/50*100), and then using equation (4a) to adjust the base poverty rate. It is easily checked that the resultant level changes in provincial and district poverty rates *do* differ despite the uniform τ. This is because the poverty indices change from different bases.

3 Data and Results

Poverty estimates for 2000 were obtained by adjusting 1997 estimates using the methodology described above. We used growth in GDP as a proxy of economic growth. The Kenyan economy has been declining since 1995. In 1997, the growth rate was 2.4%, but it declined to –0.3% in 2000 (see table 1). The Gini coefficient increased from 0.445 in 1994 to 0.57 in

1997 (UNDP 1999). The coefficients borrowed for the growth and distribution in equation (1a) are provided in appendix 1.

Table 1. GDP growth rates and Gini coefficients for Kenya

Year	GDP growth rate (%)	Gini coefficient estimates
1997	2.4	0.570
1998	1.8	0.612*
1999	1.4	0.653*
2000	–0.3	0.695*

*Predicted values of Gini coefficient

Source: GoK Economic Survey (various issues); World Bank (2000).

The information presented in table 1 and the regression coefficients in appendix 1 were used along with equations (1 to 4) to obtain poverty estimates for 2000 (see Kimalu et al. 2002 for additional information).

Our estimates show that the national headcount index increased from 52.32% in 1997 to 56.78% in 2000. This can be attributed to the decline in economic growth and to a worsening in income distribution over the period analysed. During the same period, rural poverty increased by 6.63 percentage points, from 52.9% to 59.56%, while urban poverty increased by 2.28 percentage points, from 49.2% to 51.48%. Table 2 shows the changes in poverty measures over 1997–2000.

The results show great regional variation in poverty rates. North Eastern was the poorest province, with 73.06% of its rural population living below the poverty line. At 35.32%, Central Province's poverty rate was the lowest. The poverty rate for North Eastern Province for 2000 was estimated from the predicted 1997 poverty rate using 1994 estimates, as the province was not covered in the 1997 survey.

Table 2. Headcount poverty indices, 1997–2000

Region	1997 (Actual poverty indices)	2000 (Predicted poverty indices)
Central	31.39	35.32
Coast	62.10	69.88
Eastern	58.56	65.90
North Eastern	65.48	73.06
Nyanza	63.05	70.95
Rift Valley	50.10	56.38
Western	58.75	66.11
Rural	52.93	59.56
Nairobi	50.24	52.56
Urban	49.20	51.48
National	52.32	56.78

Source: GoK (2000b) and own estimates

To check whether the predicted poverty rates for 2000 (based on the 1997 survey) were reasonable, we used the same methodology to predict poverty rates for 1997 based on the 1994 survey. In this case, the poverty rates data for 1994 and 1997 were obtained from the Central Bureau of Statistics (see GoK 1998, 2000b). Thus, it is possible to check whether the *predicted* values for 1997 (based on the 1994 survey) are close enough to the *actual* values. If they are close, it means that our methodology was highly accurate in predicting poverty rates for 1997 based on the poverty rates computed using the 1994 survey. A correspondence of the predicted and the actual poverty indices for 1997 would provide support for the reliability of the poverty rates predicted for 2000 using poverty rates for 1997 (table 2). Table 3 shows that in most cases the predicted and the actual values for 1997 are very close.

Columns 2 and 3 of table 3 show that most of the predicted poverty rates mimic actual rates quite closely. For example, the predicted poverty rate for the Coast Province is 62.27%, while the actual rate is 62.1%. Similarly, the predicted rates for Central, Eastern, Rift Valley and Western provinces are not far

from the actual rates, and the 1997 estimate for rural poverty is 52.33%, compared with the actual rate of 52.93%.

An anomaly exists only with regard to the predicted and the actual rates for Nyanza and Nairobi provinces. The actual poverty rate for Nairobi in 1997 is 50.24%, whereas the predicted rate is about 27.49%, which compares favourably with 25.9%, the actual poverty rate for 1994. If the 1994 poverty rate for Nairobi was actually 25.9%, it is unlikely that it had increased to 50.24% by 1997. It appears that the actual poverty rate for 1997 was not calculated correctly, or that there were changes in data coverage. Thus, the large difference between predicted and actual poverty rates for 1997 is attributed to an unbelievable increase in the poverty rate for Nairobi between 1994 and 1997.[1]

We can conclude that the methodology we have developed predicts poverty quite accurately; however, it works better when prediction is done within short time intervals (see Kimalu et al. 2002). The further the evaluation date is from the *reference* household survey date, the less precise the poverty estimates for that date become.

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[1] When we apply the methodology using 1994 as the starting period, the predicted poverty rate for Nairobi in 1997 is 27.49% (as compared with the actual rate of 50.24%). This is a more realistic poverty rate. Thus, using the actual 1997 poverty rate for Nairobi to predict the city's 2000 poverty rate could be misleading if the 1997 estimates are wrong. If, on the other hand, we use 1994 as the starting period, the predicted poverty rate for Nairobi in 2000 would be 28.17%, which is largely consistent with the change in poverty across the country between 1997 and 2000. The methodology for predicting poverty presented in this note is therefore also a powerful tool for checking anomalies such as the one we have unearthed in the case of Nairobi.

Table 3. Headcount poverty indices by province, 1994–1997

Province or region	1994 (Actual poverty indices)	1997 (Actual poverty rates)	1997 (Predicted poverty rates)
Central	31.93	31.39	35.74
Coast	55.63	62.10	62.27
Eastern	57.75	58.56	64.64
North Eastern	58.00	na	64.92
Nyanza	42.21	63.05	47.25
Rift Valley	42.87	50.10	47.99
Western	53.83	58.75	60.25
Nairobi	25.90	50.24	27.49
Rural	46.75	52.93	52.33
Urban	28.95	49.20	30.73
National	43.84	52.32	47.52

Source: GoK (1998, 2000b) and own estimates.

Appendix 2 reports poverty predictions for provinces and districts. Kiambu District had the lowest poverty rate in 2000 with only 28.22% of its population living below the poverty line (appendix table 3). Homa Bay District had the highest poverty rate (87.2%), followed by Mandera District (85.69%).

Table 4 presents poverty profiles by social group. Estimates for 2000 were projected using 1997 poverty profiles (see GoK 2000b). As expected, all social groups experienced deterioration in well-being between 1997 and 2000, with poverty increasing more in rural than urban areas.

Education emerges as the most important determinant in poverty. In 2000, poverty rates among household heads without education were 72.02% and 69.05% in rural and urban areas, respectively, which were the highest among all groups. This is a clear indication of the inverse relationship between poverty and education level. Moreover, people with at least secondary school education were less affected by the increase in poverty between 1997 and 2000 than those with lower levels of schooling.

Table 4. Poverty headcount indices by social characteristics, 1997–2000

Social characteristics	1997 (Actual poverty rates)		2000 (Predicted poverty rates)	
	Rural	Urban	Rural	Urban
Household head				
Male	52.50	45.90	59.08	48.02
Female	54.10	63.00	60.88	65.92
Marital status				
Male married	52.70	46.20	59.31	48.34
Male other	48.40	42.40	54.47	44.36
Female married	52.30	56.00	58.86	58.59
Female other	56.10	64.90	63.13	67.90
Education				
None	64.00	66.00	72.02	69.05
Primary	53.60	63.90	60.32	66.86
Secondary	33.40	38.80	37.59	40.60
Higher (form 5–university)	6.80	14.30	7.65	14.96
Higher (technical)	38.90	42.40	43.78	44.36
Household size				
1–3 persons	35.50	37.80	39.95	39.55
4–6 persons	49.60	53.70	55.82	56.18
7 persons plus	61.70	56.70	69.43	59.32
Age group of head				
15–29	37.90	53.60	42.65	56.08
30–44	49.10	49.60	55.25	51.90
45–55	58.10	47.00	65.38	49.17
56 plus	57.70	37.80	64.93	39.55

Note: Headcount indices for 1997 are from GoK (2000b).

On average, women are the hardest hit by poverty, and female-headed households have the highest poverty rates in both rural and urban areas (table 4). One of the explanations for this is that women household heads (single, separated, divorced or widowed women), especially in rural areas, are largely solely responsible for family upkeep, without much support from absent husbands (table 4). However, the rate of increase in poverty is the same for men and women.

Household-size data were grouped into three categories for ease of analysis. The results in table 4 indicate that households with seven or more members were the poorest. In rural and urban areas, these households had poverty rates of 69.43% and 59.32%, respectively in 2000. Households with four to six members had average poverty rates of 55.82% and 56.18% in rural and urban areas, respectively.

The data for 2000 show that in rural areas, poverty levels increase with age, but in urban areas, poverty is lowest among the elderly (over 56 years). In rural areas, the age group of 45–55 years has the highest level of poverty. Only 39.55% of the urban households headed by people aged 56 years or older are poor, compared with nearly 64.93% for the rural areas. Over the period, the older groups had higher increases in poverty levels than the younger groups.

4 Conclusion

This paper has developed a methodology for updating poverty rates based on the most recent household survey. In particular, we have demonstrated that poverty rates from the most recent household survey can be used to predict poverty rates for subsequent years using information external to the survey. Using poverty rates from the 1997 welfare monitoring survey, we have predicted poverty rates for 2000 and shown how these rates vary by region and by social characteristics of households.

The novelty of our approach is that no additional household data are required for the predictions, as predictions can be made for any year after 1997, provided that information is available on growth rates and income distribution. Since growth rate data are easily available from routine predictions of government planning units, our methodology can be used to readily assess the effects of antipoverty programmes. For

example, if the antipoverty programmes were expected to improve *growth* and income *distribution* by certain magnitudes over subsequent years, our methodology would assess the poverty reduction effects of such programmes without the necessity for a household survey. That is why this methodology is a convenient and important tool for monitoring and evaluating the success of such programmes.

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Appendices

Appendix 1. Sensitivity of Rural and Urban Poverty to Growth and Distribution in sub-Saharan Africa, 1990s

Appendix Table 1. Sensitivity of SSA rural poverty to growth and distribution

Dependent variable	Constant	Log income	Log Gini coefficient	R^2
Log head-count ratio	5.2175	–0.5028	0.4792	0.93
	(14.33)	(–10.75)	(7.61)	
Log poverty-gap ratio	2.5105	–0.7648	1.3801	0.96
	(4.6)	(10.92)	(14.63)	
Log squared poverty gap ratio	0.2894	–0.9585	2.1116	0.96
	(0.35)	(–9.0)	(14.72)	

Source: Ali and Thorbecke (2000).

Appendix Table 2. Sensitivity of SSA urban poverty to growth and distribution

Dependent variable	Constant	Log income	Log Gini coefficients	R^2
Log head-count ratio	1.5195	–0.2389	0.8977	0.76
	(3.563)	(–4.419)	(6.048)	
Log poverty-gap ratio	2.8133	–0.4264	2.1186	0.85
	(3.933)	(–4.703)	(8.534)	
Log squared poverty gap ratio	4.0465	–0.585	3.1553	0.79
	(3.121)	(–3.559)	(7.0109)	

Source: Ali and Thorbecke (2000).

Appendix 2. Poverty Rates by Province and District, 1997–2000

Appendix Table 3. Headcount poverty indices by district, 1997–2000

Region	1997 (Actual poverty rates)	2000 (Predicted poverty rates)
Central (rural)	31.39	35.32
Kiambu	25.08	28.22
Kirinyaga	35.70	40.18
Muranga	38.62	43.46
Nyandarua	26.95	30.33
Nyeri	31.05	34.94
Coast (rural)	62.10	69.88
Kilifi	66.30	74.61
Kwale	60.55	68.14
Lamu	39.35	44.28
Taita-Taveta	65.82	74.07
Tana River	34.22	38.51
Eastern (rural)	58.56	65.90
Mbeere	51.36	57.80
Embu	55.76	62.75
Isiolo	–	–
Kitui	64.91	73.05
Machakos	62.96	70.85
Marsabit	–	–
Meru	40.96	46.09
Makueni	73.51	82.72
Tharaka Nithi	55.58	62.55
Nyambene	47.29	53.22
North Eastern (rural)	65.48*	73.06
Garissa	54.43*	60.73
Mandera	76.81*	85.69
Wajir	64.40*	71.85
Nyanza (rural)	63.05	70.95
Kisii	57.22	64.39
Kisumu	65.44	73.64
Siaya	58.02	65.29

Homa Bay	77.49	87.20
Migori	57.63	64.85
Nyamira	66.74	75.11
Rift Valley (rural)	50.10	56.38
Kajiado	27.87	31.36
Kericho	52.42	58.99
Laikipia	33.88	38.13
Nakuru	45.08	50.73
Nandi	64.15	72.19
Narok	52.17	58.71
Bomet	61.80	69.55
Transmara	56.59	63.68
Baringo	36.95	41.58
Elgeyo Marakwet	47.82	53.81
Samburu	–	–
Trans Nzoia	54.83	61.70
Turkana	–	–
Uasin Gishu	42.22	47.51
West Pokot	68.46	77.04
Western (rural)	58.75	66.11
Bungoma	55.21	62.13
Busia	65.99	74.26
Kakamega	56.69	63.80
Vihiga	61.97	69.74
Total rural	52.93	59.56
Urban centres	49.20	51.48
Nairobi	50.24	52.56
Mombasa	38.32	40.09
Kisumu	63.73	66.68
Nakuru	40.58	42.46
Other urban	52.38	54.80
National	52.32	56.78

Note: *Predicted headcount indices. The headcount indices for 1997 are from GoK (2000b).

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