GHANA CENSUS-BASED POVERTY MAP: District and Sub-District level Results[1]

Harold Coulombe

Ghana Statistical Service
Department for International Development, UK
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Abstract

This paper documents the construction and presents the main results of a Ghanaian poverty map based on the GLSS4 survey and the Census 2000. The methodology takes advantages of detailed information found in the survey and the exhaustive coverage of the census. It permits the calculation of poverty indicators at a very low level of desegregation; sub-district in the case of Ghana. In the current paper district level poverty figures are presented. Council level estimates are also available.

Introduction

1. This paper documents the construction of a poverty map based on data on the fourth round Ghana Living Standards Survey (GLSS4) and the Housing & Population Census 2000. Based on a recently developed methodology, it permits the calculation of poverty indicators at very low levels of aggregation, using the detailed information found in the survey and the exhaustive coverage of the Census. Results at district level as well as at the town and area council level are presented and analyzed.

2. In the past decade poverty profiles have been developed into useful tools to characterize, assess and monitor poverty. Based on information collected in household surveys, including detailed information on expenditures and incomes, those profiles present the characteristics of the population according to their level of - monetary and non-monetary - standard of living, help assessing the poverty reducing effect of some policies and compare poverty level between regions, groups or over time.

3. While these household-based studies have greatly improved our knowledge of welfare level of households in general and of the poorer ones in particular, the approach has a number of constraints. In particular, policy makers and planners have need of finely disaggregated

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information in order to implement their anti-poverty schemes. Typically they need information for small geographic units such as city neighbourhoods, towns or villages. Telling a Ghanaian policy maker the neediest people are in the Savannah region would not be too impressive as that information is well known and not useful since it would be too vague; telling them in which villages or towns or even districts the poorest households are concentrated would be more convincing! Using regional-level information often hides the existence of poverty pockets in otherwise relatively well-off region which would lead to poorly targeted schemes. Having better information at local level would necessarily minimize leaks and therefore permit more cost-effective and efficient anti-poverty schemes. Poverty indicators are needed at a local level as spatial inequalities can be important within a given region.

4. This paper presents results at regional, district and council levels. The methodology used have been developed by Elbers, Lanjouw and Lanjouw (2002, 2003) and should be seen as more sophisticated than other methods as it uses information on household expenditure, is fully consistent with poverty profile figures, and permits the computation of standard errors of those poverty indicators. Since those types of poverty maps are fully compatible with poverty profile results, they should be seen as a natural extension to the Poverty Profile, a way to operationalise poverty profile results. The current poverty map would reach its full potential once a series of applications under consideration would be undertaken.

5. The remaining of this paper is structured as follow: we first present the methodology in layman words, follow by a description of the data used. The paper ends by a discussion of the results and on furthers work to undertake. A more technical presentation of the methodology can be found in annex, along with some detail results.

Methodology

6. The basic idea behind the methodology is rather straightforward. First a regression model of adult equivalent expenditure is estimated using GLSS survey data, limiting the set of explanatory variables to those which are common to both that survey and the latest Census. Next, the coefficients from that model are applied to the Census data set to predict the expenditure level of every household in the Census. And finally, these predicted household expenditures are used to construct a series of welfare indicators (e.g. poverty level, depth, severity, inequality) for different geographical subgroups.

7. Although the idea behind the methodology is conceptually simple, its proper implementation requires complex computations. Those complexities are mainly coming from the need to take into account spatial autocorrelation (expenditure from households within the same cluster are correlated) and heteroskedasticity in the development of the predictive model. Taking into account those econometric issues insure unbiased predictions. A further issue making computation non-trivial is our willingness to compute standard errors for each welfare statistics. Those standard errors are important since they would tell us how low we can disaggregate the poverty indicators. As we disaggregate our results at lower and lower level, the number of households on which our estimates are based decrease as well and therefore yields less and less precise estimates. At a given level, the estimated poverty indicators would become too imprecise to be use with confidence. The computation of those standard errors would help us to decide where to stop the disaggregation process. The methodology used is further discussed in annex 1.

Data

8. The construction of such poverty map is also very demanding in terms of data. The uttermost requirement is a household survey having expenditure modules and a population and housing census. If not already done, a monetary-based poverty profile would have to be constructed from the survey. The household-level welfare index and the poverty line from such poverty profile would be used. Apart from household-level information, community level characteristics is also useful in the construction of poverty map as differences in geography, history, ethnicity, access to markets, public services and infrastructure, and other aspects of public policy can all lead to important differences in standard of living, defined in monetary terms or not. Fortunately all that information was available in the case of Ghana.

Census:

9. The latest Housing and Population Census was conducted in spring 2000. The questionnaire is relatively detailed but does not contain any information on neither incomes nor expenditures. At the individual level, it covers demography, education and economic activities. At the household level, dwelling characteristics are well covered. The Census database turns out more than 18.9 million individuals grouped into 3.7 million households. The Census field work grouped households into around 26,800 enumeration areas (EAs) of 138 households each on average.

10. Along with the housing and population census a *facility census* was conducted in every single locality. Those "localities" go from tiny sub-EAs settlements to large urban neighbourhood having many EAs. There is around 89 000 "localities" in the facility census database. The information collected includes the existence in the locality of a post office, telephone, traditional healing centre, hospital, maternity/clinic, and primary, JSS and SSS schools. If any of those facilities was not found in the locality, the distance to the nearest one was asked.

GLSS4 Survey:

11. The fourth round of the Ghana Living Standard Survey is the latest national survey having collected expenditure data at household level. Having been administrated in 1998/99, it is also the most appropriate survey time wise. The survey dataset was also enhanced by including information from the facility census. This required a tedious matching exercise to link the Enumeration Areas (EAs) used as sampling units (clusters) in the GLSS - which were based on the 1984 Census - with the 2000 Census EAs.

12. The welfare index to be used in our regression models (expenditure per equivalent adult in real terms) is the same as the one used in the Government-sponsored poverty profile based on GLSS4. Using the same welfare index would ensure full consistency between the latest poverty profile (GSS, 2000; Coulombe and McKay, 2003) and the new poverty map. It will also permit to test whether the predicted poverty indicators match those found in the poverty profile at strata level, the lowest statistically robust level achievable in GLSS 4.

13. On the basis of the information collected in the latest Census a number of GLSS 4 localities have been reclassified from rural to urban - an urban location is one with 5,000 or more persons. However the urban/rural variable use in GLSS4 was defined on the basis of information from the 1984 Census. Therefore many EAs (clusters) in GLSS4 had been

considered rural while they surely became urban by 1998/99 when GLSS 4 was conducted. This phenomenon is illustrated by figures in Table 1. Compared to the latest Census the urban localities (outside Accra) are underrepresented in GLSS4 while the rural ones are overrepresented. The problem is particularly important in Coastal and Forest ecological zones. For the current study 24 clusters have been redefined from rural to urban. The last column of Table 1 clearly shows that the new GLSS 4 distribution of clusters across strata is much more similar to the Census one and therefore, closer to the reality at the time of GLSS4 (1998/99).

Table 1: Distribution of households according to strata and ecological zone, GLSS 4 and Census 2000

	GLSS 4		Census 2000	Difference	
	1984 urban/rural definition	2000 urban/rural definition		1984 urban/rural definition	2000 urban/rural definition
GLSS 4 strata					
Accra	10.51	10.51	9.86	+0.65	+0.65
Urban Coastal	8.55	13.44	14.07	-5.52	-0.63
Urban Forest	13.11	18.08	17.98	-4.87	+0.10
Urban Savannah	4.49	6.68	5.26	-0.77	+1.42
Rural Coastal	15.46	10.84	11.58	+3.88	-0.74
Rural Forest	30.55	24.61	26.07	+4.51	-1.46
Rural Savannah	17.33	15.84	15.18	+2.15	+0.66
Ecological zone					
Accra	10.51	10.51	9.86	+0.65	+0.65
Coastal	24.02	24.28	25.65	+0.34	-1.37
Forest	43.66	42.69	44.05	-2.37	-1.36
Savannah	21.82	22.52	20.44	+1.38	+2.08
Total	100.0%	100.0%	100.0%	0.0%	0.0%

Sources: author's calculation based on GLSS4 and Census 2000

Administrative Layers

14. Ghana is currently in the process of an important decentralisation effort which formally started more than ten years ago. The Local Government Act of 1993 and the National Development Planning (Systems) Act of 1994 have defined the current local government structure. The structure consists of four tiers. The top tier is the Regional Coordinating Council, followed by the Metropolitan/Municipal/District Assemblies. The Town/Zonal/Urban/Area Councils and the Unit Committees are the bottom two tiers. However, the implementation of this administrative structure was held back by limited financial and human resources (Awoosah *et al.* 2004). In practice, only regions and districts have been formally defined. In our study, we use the official definitions for the regions and the districts, as well as an unofficial definition of the different type of councils. No attempt was made to define the last tier. Table 2 presents some descriptive statistics on the size of those different administrative levels.

Table 2: Descriptive Statistics on the Ghanaian Administrative Structure

Administrative Unit	# of Units	Number of Households			Number of Individuals		
		Median	Minimum	Maximum	Median	Minimum	Maximum
Region	10	355,263	80,573	680,419	1,810,044	574,918	3,590,511
District	110	24,852	9,912	364,805	133,154	51,918	1,647,202
Council	1,048	2,055	41	48,334	12,258	263	272,208

Source: Author's calculation based on the Census 2000
Note: Although 263 individuals seem rather small for a council, only 8 councils (out of 1048) have less than 1000 people.

15. *Strata*: the GLSS 4 sample design was based on seven strata defined in terms in agro-climatic zones (coastal, forest and savannah) and urban/rural breakdown. Although that level is not an administrative level, poverty estimates were done at this fairly aggregated level mainly to establish the statistical validity of the poverty estimates. Those predicted figures can be compared with actual figures found in the latest Ghana Poverty Profile and statistical tests performed on the equality of those indicators.

16. *Region*: the national territory is divided into 10 regions which are further down divided into districts. No districts overlapped two or more regions.

17. *District*: the lowest administrative level for which a formal geographical definition is currently available is the 110 districts. The importance of the District Assemblies in the on-going decentralisation process makes district-level poverty figures fundamental. Those poverty figures, presented in this report, are the first value-added product coming out from the poverty map. In 2004, a district remapping has yield 28 new districts but unfortunately the information needed to perform the poverty map using this new district definition was not available on time for this study. Once an operational EA-based definition of the 138 districts become available, it would be easy to update the poverty map to reflect the new administrative reality.

18. C*ouncil*: although district-level poverty estimates would surely be useful, that level of politico-geographical breakdown could still be too aggregated to be used for more finely targeted interventions. Currently there is no properly mapped sub-district breakdown. Each District Assembly has created a series of sub-district councils, broadly defined – in words - in a series of Legislative Instruments (LI) from 1988, prior the formal establishment of the current four-tier system. However, those councils do not have formally mapped boundaries. Based on those LI, a Ghana Statistical Service team from cartography and GIS departments has been able to establish the link between those "councils" and the Census 2000 EAs. Although the definition of those councils was not made official, we believe it would be a very decent approximation to an on-going data collection exercise being done by CERSGIS from the University of Ghana at Legon[2]. All together, we defined 1048 councils. These units would be small enough for most decision making while being large enough to enable a statistically robust poverty maps to be computed.

[2] The Centre for Remote Sensing and Geographic Information Services (CERSGIS) is working on a comprehensive project which involves exhaustive data collection and mapping, including the definition of the councils which would eventually be made official by the Government of Ghana. The project, called Establishing a Mapping and Monitoring System for Development Activities in Ghana (EMMSDAG), is co-sponsored by the Ministry of Finance and the European Union. Final results are not expected before a year.

Results

19. In order to maximise accuracy we have estimated the model at the lowest geographical level for which the GLSS survey is representative. In the case of the fourth round of GLSS that level is the sampling strata: Accra, Urban Coastal, Urban Forest, Urban Savannah, Rural Coastal, Rural Forest and Rural Savannah. A household level expenditure model has been developed for each of these strata using explanatory variables which are common to both the GLSS and the Census. Those variables do not need to be causal as we are only interested in their predictive power. The results are presented stage by stage.

Stage 1: Aligning the data

20. The first task was to make sure the variables deemed common to both the census and the survey were really measuring the same characteristics. In the first instance, we compared the questions and modalities in both questionnaires to isolate potential variables. We then compared the means of those (dichotomized) variables and tested whether they were equal using a 95% confidence interval[3]. Restricting ourselves to those variables would ensure the predicted welfare figures would be consistent with survey-based poverty profile. As noted above that comparison exercise was done at strata level. The two-stage sample design of GLSS 4 was taken into account in the computation of the standard errors. The results are not presented here but are available on request.

Stage 2: Survey-based regressions

21. Table in annexe 2 presents the strata-specific regression results based on GLSS 4. The ultimate choice of the independent variables was based on a backward stepwise selection model. A check of the results confirmed that almost all the coefficients are of expected sign. As said earlier, those models are not for discussions. They are exclusively prediction model, not determinant of poverty models that can be analyzed in terms of causal relationships. In the models used for the poverty map we were only concerned by the predictive power of the regressions without regards, for example, for endogenous variables. At that stage, we attempt to control location effect by incorporating cluster average of some of the variables. We also ran a series of regressions using the base model residuals as dependant variables. Those results – not shown here – would be used in the last stage in order to correct for heteroskedasticity.

22. The R^2s of the different regressions vary from 0.27 to 0.60. Although they might appear to be on the low side, they are typical of survey-based cross-section regressions and can be favourably compared with results from other poverty maps. While those coefficients look "credible", it is important to note those models were purely predictive in the statistical sense and should not be view as determinant of welfare or poverty. The relatively low R^2s for some of the models are mainly due to four important factors. First, in many areas households are fairly homogeneous in terms of observable characteristics even if there consumption varies relatively more. That necessarily yields low R^2. Second, a large number of potential correlates are simply not observables using standard closed-questionnaire data collection methods. Third, many good predictors had been discarded at first stage since their

[3] We also deleted or redefined dichotomic variables being less that 0.03 or larger than 0.97 to avoid serious multicollinearity problems in our econometric models.

distributions did not appears to be identical. And finally, many indicators do not take into account the quality of the correlates. Not taking into account the wide variation in quality of the different observable correlates makes many of those potential correlates useless in term of predictive power.

Stage 3: Welfare indicators[4]

23. Based on the results from the previous stage, we applied the estimated parameters[5] to the Census data to compute a series of poverty and inequality indicators: the headcount ratio (P_0), the poverty gap index (P_1), the poverty severity index (P_2), the Gini Index, the mean log deviation and the Theil index[6]. Table 3 presents estimated poverty figures for each stratum and compares them with actual figures from the latest survey-based poverty profiles. For each stratum and poverty indicators, the equality of GLSS 4-based and Census-based indicators cannot be rejected (at 95%)[7]. Apart the case of Urban Forest where the census-based headcount ration is 3.2 points higher, the gaps are always smaller that 1.5% and often minute. Although census-based poverty figures can only be compared with the ones provided by the GLSS survey at stratum level, equality of those poverty figures provided an excellent reliability test of the methodology used here.

[4] The computation of the welfare indicator has been greatly eased thank to PovMap, a software especially written to implement the methodology used here. We used the February 2005 version developed by Qinghua Zhao (2005).

[5] Apart from regression models explaining household welfare level, we also estimated a model for the heteroskedasticity in the household component of the error. We also estimated the parametric distributions of both error terms. See the methodological annexe for further details.

[6] Because of space constraint, only the poverty figures are presented in this paper. The inequality figures would be found in a forthcoming GSS report. That report would be an extended version of the current paper.

[7] It is worth noting that the standard errors of the mean of the Census-based figures are systematically lower that the ones calculated from GLSS 4.

Table 3: Poverty Rates based on GLSS 4 (actual) and Census 2000 (predicted), by strata

	Headcount Incidence (P_0)		Poverty Gap Index (P_1)		Poverty Severity Index (P_2)	
	GLSS4 (Actual)	Census (Predicted)	GLSS4 (Actual)	Census (Predicted)	GLSS4 (Actual)	Census (Predicted)
Accra	0.038	0.052	0.008	0.012	0.002	0.004
	(0.017)	*(0.009)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.001)*
Urban Coastal	0.286	0.280	0.085	0.098	0.035	0.049
	(0.040)	*(0.020)*	*(0.016)*	*(0.009)*	*(0.008)*	*(0.006)*
Urban Forest	0.176	0.208	0.047	0.074	0.018	0.037
	(0.036)	*(0.013)*	*(0.011)*	*(0.007)*	*(0.005)*	*(0.004)*
Urban Savannah	0.518	0.510	0.162	0.183	0.067	0.088
	(0.078)	*(0.041)*	*(0.036)*	*(0.021)*	*(0.018)*	*(0.013)*
Rural Coastal	0.485	0.471	0.152	0.163	0.065	0.076
	(0.046)	*(0.025)*	*(0.023)*	*(0.013)*	*(0.012)*	*(0.008)*
Rural Forest	0.409	0.407	0.117	0.137	0.048	0.064
	(0.025)	*(0.021)*	*(0.012)*	*(0.010)*	*(0.007)*	*(0.006)*
Rural Savannah	0.695	0.690	0.324	0.331	0.181	0.197
	(0.054)	*(0.023)*	*(0.036)*	*(0.018)*	*(0.024)*	*(0.015)*

Sources: author's calculation based on GLSS4 and Census 2000
Notes: Robust standard errors in parentheses. The poverty indicators based on GLSS4 are slightly different from the ones already published by GSS since we used the new definition of the urban/rural breakdown (see table 1).

24. Using the same econometric results, table in annexe 3 presents poverty figures for each of the 10 regions and 110 districts, broken down into urban/rural areas. The standard errors are also presented and are – for most cases – relatively small which make the predicted poverty figures quite reliable. Those district-level estimates are the first ever monetary-based poverty figures available in Ghana. Overall those figures seem to make sense and anecdotal evidences support those results although some results might raise question at first look. In particular, in a few districts the urban population are found to be poorer than the rural population. However those districts tend to be isolated ones where the so-called urban population are likely to live in "big" villages not having the infrastructure usually found in Ghanaian towns.

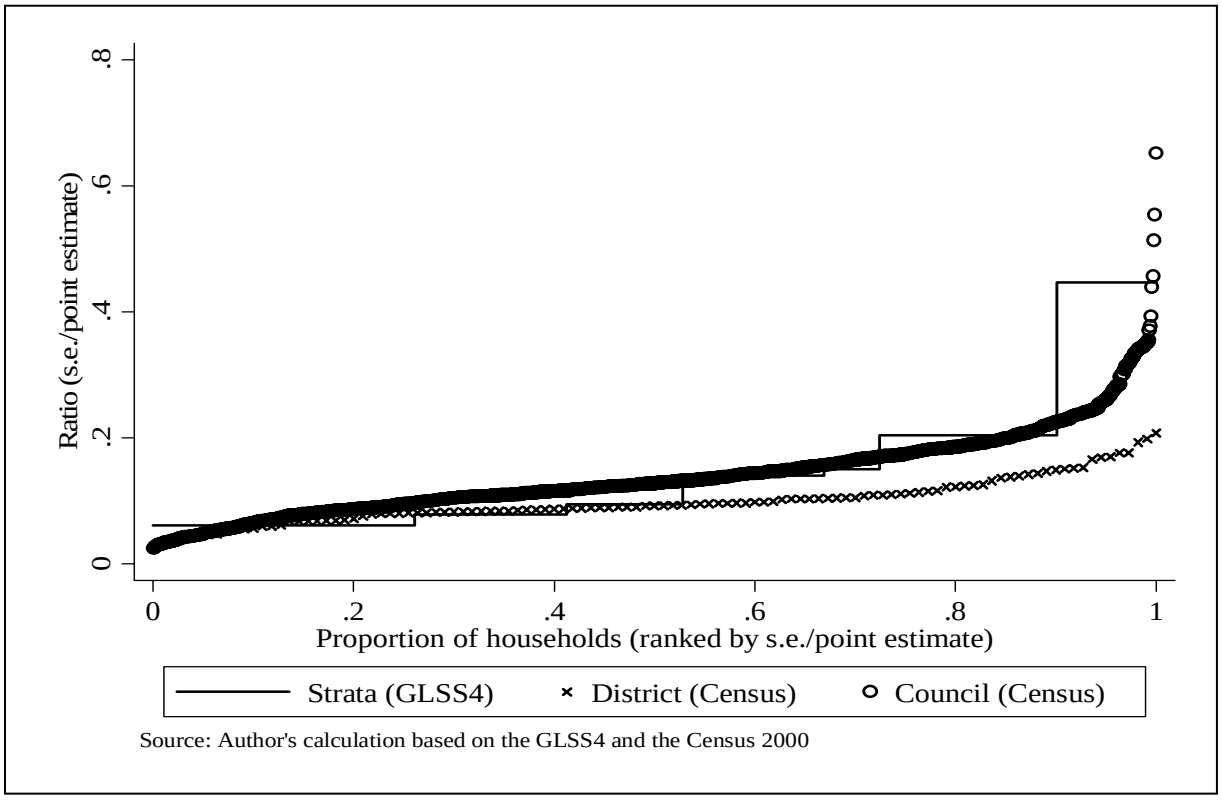
25. Council-level figures were also computed but space constraint does not permit their presentation. Those council-level results are available in an exhaustive companion report published by the Ghana Statistical Service. Nonetheless some analysis concerning the relevancy of those finely disaggregated estimates can be found next.

*How low **can** we go?*

26. Further examination of poverty estimates from the table in annexe 3 reveals that the standard errors - in relation to their associated indicators - seem to indicate our poverty

estimates at district level are fairly precise. However, it is difficult to make an "objective" judgement on the precision of those estimates without some kind of benchmark. To do so, Figure 1 presents the headcount incidence coefficients of variation (inverted) of the district- and council-level estimates and compared them to the ones computed from the GLSS 4 survey. Hence, we use the precision of the GLSS4-based headcount incidence as our benchmark which is represented by the step curve. Those steps represented the different inverted coefficient of variation associated with the different stratum. The curves in Figure 1 clearly show that our district-level headcount incidence estimates does at least as well as GLSS4-based poverty estimates since the district-level curve lie on or below the GLSS4 one. Since council estimates are based on smaller samples, its curve shows that the council-level estimates are not as precise although they compared favourably with the GLSS4 figures. How low can we go? If one take the GLSS 4 benchmark as a good one, it is clear that both district- and council-level poverty estimates would be good guides to policy-makers.

Figure 1: Poverty Headcount Accuracy, by disaggregation level



Source: Author's calculation based on the GLSS4 and the Census 2000

*How low **should** we go?*

27. Although we just demonstrate that we can used the district and council headcount figures with some confidence about their precision level, it might be the case that those disaggregated figures does not yield much information. Within a rather homogenous region, it might be possible that the different districts are not statistically different from each others in terms of monetary poverty. The same question can be raised concerning the use of the council-level figures within a given district. To test whether additional information about the poverty level is gain when we disaggregated from regions to districts and from districts to councils, table 4 gives the proportion of districts (in terms of unit and of population) that are

statistically poorer or richer than their associated regions. We also computed the relationship between districts and councils. Overall, some 36.6% of the different districts have a poverty headcount statistically smaller or higher than their own region. Similarly, 13.7% of councils are different poverty wise from their own district. In terms of population the overall figures are significantly higher at repetitively 45.2% and 13.2%. As expected, those figures show that urban areas are less homogeneous than the rural areas. At least in rural areas, it also clear that the smaller entity the more homogeneous they are. Urban areas are visibly more heterogeneous. Based on those results, it appears that using the results from councils on the top of those from districts should improve the targeting efficiency of any allocation of resources aiming at reducing poverty.

Table 4: Disaggregation and Change in Headcount Incidence, by Region

	% of geographic unit			% of the population	
	Districts different from their **Regions**	**Councils** different from their **Districts**		**Districts** different from their **Regions**	**Councils** different from their **Districts**
Urban	*43.4*	*19.8*		*66.0*	*15.0*
Western	27.3	18.2		16.5	26.5
Central	16.7	16.7		21.5	9.7
Greater Accra	100.0	14.8		100.0	7.3
Volta	33.3	10.0		39.3	8.9
Eastern	40.0	14.7		48.9	10.7
Ashanti	82.4	26.9		87.7	22.2
Brong Ahafo	46.2	33.3		59.8	28.1
Northern	38.5	10.5		20.0	6.6
Upper East	25.0	50.0		5.5	49.2
Upper West	0.0	0.0		0.0	0.0
Rural	*29.9*	*11.9*		*29.1*	*11.7*
Western	30.0	3.4		27.2	1.7
Central	83.3	27.3		85.8	23.1
Greater Accra	25.0	42.1		16.4	54.5
Volta	0.0	14.0		0.0	15.3
Eastern	26.7	9.0		18.8	9.0
Ashanti	11.8	6.9		8.1	7.5
Brong Ahafo	7.7	9.4		8.9	9.7
Northern	53.8	15.8		62.2	12.9
Upper East	66.7	6.9		66.7	5.0
Upper West	0.0	10.9		0.0	14.7
Total	*36.6*	*13.7*		*45.2*	*13.2*

Sources: author's calculation based on GLSS4 and Census 2000
Notes: following Mistiaen *et al.* (2002), those percentages represent difference in headcount incidence that are statistically different (at 95% confidence interval) using the standard errors of the point estimates for the lower level of disaggregation.

Concluding Remarks

28. This paper has documented the construction of a regional-, district- and council-level poverty map for Ghana. The methodology developed by Elbers *et al.* (2003) has permitted to obtain the first ever reliable poverty estimates at the district and council levels. That map reports on 110 districts but it would be easy and straightforward to update it once we obtain the definition (in terms of EAs) of the recently redrawn districts. However, we acknowledge that the definition of the councils is our own and should not be view as official. Those finely disaggregated poverty figures are fully compatible with the latest Poverty Profile (GSS, 2000; Coulombe and McKay, 2003).

29. One of the main advantages of the methodology used here is the possibility of computing standard errors of the different poverty estimates and therefore has an idea of the reliability of those estimates. We viewed that using the precision level of the latest poverty profile as benchmark, both the district- and council- level are precise enough to be useful to planners, policy-makers and researchers.

30. However interesting those results, they would acquire their full potential if they are use. How? Amongst others, those results can be used to design budget allocation rules to be applied by the different administrative levels toward their subdivisions: the central government toward the districts, and the districts toward their councils. That map could become an important tool in support of the decentralization process currently undertaken in Ghana. Obviously such monetary-based target indicators could be used in conjunction with some alternative measures of poverty based on education, health or infrastructure indicators. In particular merging the poverty map with education and health maps would yields powerful targeting tools. Others uses of the poverty map would include the evaluation of locally targeted anti-poverty schemes (Social funds, Town/village development schemes), impact analysis etc. And finally, researchers could use it in a multitude of ways such as the study of relationship between poverty distribution and different socio-economic outcomes

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Annexe 1: Methodology

The basic idea behind the methodology developed by Elbers, Lanjouw and Lanjouw (2002, 2003) is unchallenging. At first a regression model of log of per capita expenditure is estimated using survey data, employing a set of explanatory variables which are common to both a survey and the census. Next, parameters from the regression are used to predict expenditure for every household in the census. And third, a series of welfare indicators are constructed for different geographical subgroups.

The term "welfare indicator" embrace a whole set of indicators based on household expenditures. This note put emphasis on poverty headcount (P_0) but the usual poverty and inequality indicators can be computed (Atkinson inequality measures, generalised Entropy class inequalities index, FGT poverty measures and Gini).

Although the idea is rather simple its proper implementation require complex computation if one want to take into account spatial autocorrelation and heteroskedasticity in the regression model. Furthermore, proper calculation of the different welfare indicators and its standard errors increase tremendously its complexities.

The discussion below is divided into three parts, one for each stage necessary in the construction of a poverty map. This discussion borrows from the original theoretical papers of Elbers, Lanjouw and Lanjouw as well as on Mistiaen *et al.* (2002).

First stage

In the first instance, we need to determine a set of explanatory variables from both databases that are meeting some criteria of comparability. In order to be able to reproduce a poverty map consistent with the associated poverty profile, it is important to restrict ourselves to variables that are fully comparable between the census and the survey. We start by checking the wording of the different questions as well as the proposed answer options. From the set of selected questions we then build a series of variables which would be tested for comparability. Although we might want to test the comparability of the whole distributions of each variable, in practice we restrain ourselves to test only the means. In order to maximise the predictability power of the second-stage models all analysis would be performed at the strata level, including the comparability of the different variables from which the definitive models would be determined.

The list of all potential variables and their equality of means test results are not presented in this note but can be obtained on request.

Second stage

We first model per capita household expenditure[8] using the limited sample survey. In order to maximise accuracy we estimate the model at the lowest geographical level for which the survey is representative. In the case of the fourth round of GLSS that level is the sampling

[8] In our study we used the welfare index constructed for the GLSS4 poverty profile. Although that welfare index is defined in terms of equivalent adults, the demonstration remains unchanged.

strata: Accra, urban costal, urban forest, urban savannah, rural coastal, rural forest and rural savannah.

Let specify a household level expenditure (y_{ch}) model for household *h* in location *c*, $\mathbf{x_{ch}}$ is a set of explanatory variables, and u_{ch} is the residual:

$$\ln y_{ch} = \mathrm{E}[\ln y_{ch} \mid \mathbf{x_{ch}}] + u_{ch} \qquad (1)$$

The locations represent clusters as defined in the first stage of typical household sampling design. It usually also represents census enumeration areas, although it does not have to be. The explanatory variables need to be present in both the survey and the census, and need to be defined similarly. It also needs to have the same moments in order to properly measure the different welfare indicators. The set of potential variables had been defined in the first stage.

If we linearise the previous equation, we model the household's logarithmic per capita expenditure as

$$\ln y_{ch} = \mathbf{x}'_{\mathbf{ch}}\boldsymbol{\beta} + u_{ch}. \qquad (2)$$

The vector of disturbances $\boldsymbol{u}$ is distributed $F(0,\Sigma)$. The model (2) is estimated by Generalised Least Square (GLS). To estimate this model we need first to estimate the error variance-covariance matrix Σ in order to take into account possible spatial autocorrelation (expenditure from households within a same cluster are surely correlated) and heteroskedasticity. To do so we first specify the error terms as

$$u_{ch} = \eta_c + \varepsilon_{ch} \qquad (3)$$

where η_c is the location effect and ε_{ch} is the individual component of the error term.

In practice we first estimate equation (2) by simple OLS and use the residuals as estimate of the overall disturbances, given by $\hat{\mu}_{ch}$. We then decomposed those residuals between uncorrelated household and location components:

$$\hat{u}_{ch} = \hat{\eta}_c + e_{ch} \qquad (4)$$

The location term ($\hat{\eta}_c$) is estimated as cluster means of the overall residuals and therefore the household component (e_{ch}) is simply deducted. The heteroskedasticity in the latest error component is modelled by the regressing its squared (e_{ch}^2) on a long list of all independent variables of model (2), their squared and interactions as well as the imputed welfare. A logistic model is used.

Both error computations are used to produce two matrices which are them sum to $\hat{\Sigma}$, the estimated variance-covariance matrix of the original model (2). That latest matrix permits to estimate the final set of coefficients of the main model (2).

Third stage

To complete the map we associate the estimated parameters from the second stage with the corresponding characteristics of each household found in the census to predict the log of per capita expenditure and the simulated disturbances.

Since the very complex disturbance structure has made the computation of the variance of the imputed welfare index intractable, bootstrapping techniques have been used to get a measure of the dispersion of that imputed welfare index. From the previous stage, a series of coefficients and disturbance terms have been drawn from their corresponding distributions. We then, for each household found in the census, simulate a value of welfare index ($\hat{y}_{ch}^{r}$) based on the predicted values and the disturbance terms:

$$\hat{y}_{ch}^{r} = \exp(\mathbf{x}_{ch}^{'}\tilde{\beta}^{r} + \tilde{\eta}_{c}^{r} + \tilde{\varepsilon}_{ch}^{r}) \qquad (5)$$

That process is repeated 100 times, each time redrawing the full set of coefficients and disturbances terms. The means of the simulated welfare index become our point estimate and the standard deviation of our welfare index is the standard errors of these simulated estimates.

Annexe 2: Survey-Based Regression models

Accra		Urban Coastal	
# of observations	620	# of observations	799
# of clusters	31	# of clusters	40
R^2 (without location means)	0.2444	R^2 (without location means)	0.3924
R^2 (with location means)	0.2659	R^2 (with location means)	0.4179
Variable	Coeff.	Variable	Coeff.
# of boys aged 7-14	-0.168	# of boys aged 7-14	-0.083
	(4.93)		*(2.66)*
# of girls aged 7-14	-0.161	# of girls aged 7-14	-0.100
	(6.51)		*(2.70)*
Head schooled (0/1)	0.199	Proportion of members that went to school	0.414
	(2.83)		*(3.38)*
Head is self-employed, non-agro (0/1)	0.141	# of people that went to school	-0.107
	(3.25)		*(4.62)*
Cement Roof (0/1)	0.143	Other Christian (0/1)	0.171
	(2.25)		*(3.36)*
Has flush toilet (0/1)	0.148	Protestant (0/1)	0.160
	(2.75)		*(3.15)*
Use coal for cooking (0/1)	-0.254	Head reads English and Ghanaian (0/1)	0.184
	(7.00)		*(4.04)*
Accra Metro Assembly no. 5 (0/1)	0.147	Use electricity (0/1)	0.189
	(3.05)		*(4.00)*
Garbage collection (EA average)	0.281	Has flush toilet (0/1)	0.352
	(2.53)		*(5.36)*
Use electricity (EA average)	0.751	# of pc weekly hours worked	0.006
	(2.30)		*(3.89)*
Has flush toilet (EA average)	-0.405	Eastern region (0/1)	-0.221
	(2.40)		*(2.60)*
Constant	14.107	Central region (0/1)	-0.280
	(46.96)		*(4.25)*
		Western region (0/1)	-0.241
			(3.38)
		Shama 1 (0/1)	0.391
			(4.05)
		Hours worked (EA average)	0.014
			(3.87)
		Use water from wells (EA average)	0.630
			(4.81)
		Use pipe water (EA average)	0.514
			(5.61)
		Constant	13.164
			(75.80)

Sources: author's calculation based on GLSS4

Annexe 2: Survey-Based Regression models (continued…)

Urban Forest	
# of observations	960
# of clusters	48
R^2 (without location means)	0.5749
R^2 (with location means)	0.5855
Variable	Coeff.
# of boys aged 7-14	-0.065 *(2.51)*
# of girls aged 7-14	-0.058 *(2.33)*
people that went to school	-0.079 *(6.09)*
Male head (0/1)	-0.104 *(2.77)*
Head age	-0.022 *(3.19)*
Head age squared	0.000 *(2.52)*
Head reads English (0/1)	0.143 *(2.86)*
Head reads English and Ghanaian (0/1)	0.217 *(4.86)*
Catholic (0/1)	0.221 *(3.42)*
Protestant (0/1)	0.086 *(2.48)*
Head is self-employed, non-agro (0/1)	0.291 *(4.54)*
Head does not worked (0/1)	0.169 *(2.25)*
Head is employed (0/1)	0.336 *(4.34)*
pc weekly hours worked in self agro	0.011 *(4.81)*
Use electricity (0/1)	0.245 *(3.64)*
Has flush toilet (0/1)	0.214 *(3.46)*
Use wood for cooking (0/1)	-0.312 *(5.05)*
Post office in EA (0/1)	-0.383 *(6.75)*
Phone in EA (0/1)	0.656 *(8.28)*
Volta Region (0/1)	0.185 *(4.27)*
Western Region (0/1)	0.231 *(3.92)*
Ashanti region (0/1)	0.305 *(8.42)*
Bronga Afaho region (0/1)	0.364 *(8.21)*
Kumasi Metro Assembly 1 (0/1)	0.387 *(4.83)*
Use coal for cooking (EA average)	0.380 *(3.25)*
Use electricity (EA average)	-0.173 *(2.53)*
Constant	14.245 *(68.51)*

Urban Savannah	
# of observations	300
# of clusters	15
R^2 (without location means)	0.5975
R^2 (with location means)	0.5975
Variable	Coeff.
Household size (in log)	-0.478 *(11.35)*
Mole (0/1)	-0.212 *(2.99)*
Islam (0/1)	0.179 *(2.48)*
Thatch roof (0/1)	-0.258 *(5.14)*
No toilet (0/1)	-0.224 *(2.70)*
Use coal for cooking (0/1)	0.154 *(2.55)*
Phone available in EA (0/1)	0.550 *(6.58)*
Upper East region (0/1)	0.149 *(2.63)*
Constant	14.212 *(167.42)*

Sources: author's calculation based on GLSS4

Annexe 2: Survey-Based Regression models (continued…)

Rural Coastal	
# of observations	699
# of clusters	35
R^2 (without location means)	0.5156
R^2 (with location means)	0.5300
Variable	Coeff.
household size (in log)	-0.494 *(9.68)*
# of children aged 0-6	0.072 *(3.71)*
Ga ethnic group (0/1)	0.272 *(3.91)*
Head is unemployed (0/1)	0.437 *(4.92)*
pc weekly hours worked	0.008 *(3.63)*
Use electricity (0/1)	0.425 *(3.91)*
No toilet (0/1)	-0.130 *(2.23)*
Junior secondary school (0/1)	0.193 *(2.98)*
Central region (0/1)	-0.331 *(4.73)*
pschool (EA average)	0.887 *(3.04)*
Cement wall (EA average)	-0.586 *(3.66)*
Use coal for cooking (EA average)	1.102 *(3.71)*
Constant	13.879 *(67.39)*

Rural Forest	
# of observations	1680
# of clusters	84
R^2 (without location means)	0.2819
R^2 (with location means)	0.3011
Variable	Coeff.
# of boys aged 7-14	-0.137 *(7.04)*
# of female adults aged 15-59	-0.147 *(6.61)*
Head reads English (0/1)	0.085 *(2.84)*
Head is self-employed, agro (0/1)	-0.167 *(3.49)*
pc weekly hours worked - formal sector	0.013 *(4.83)*
pc weekly hours worked in self agro	0.011 *(5.21)*
Thatch Roof (0/1)	-0.096 *(1.96)*
Cement wall (0/1)	0.110 *(2.63)*
Use coal for cooking (0/1)	0.276 *(5.56)*
Post office in EA (0/1)	0.214 *(3.02)*
Western region (0/1)	0.292 *(4.34)*
Central region (0/1)	0.397 *(5.18)*
Ashanti region (0/1)	0.126 *(1.99)*
Head reads English (EA average)	0.406 *(2.29)*
No Toilet (EA average)	-0.582 *(5.02)*
Constant	13.822 *(127.64)*

Sources: author's calculation based on GLSS4

Annexe 2: Survey-Based Regression models (continued…)

Rural Savannah	
# of observations	950
# of clusters	47
R^2 (without location means)	0.2496
R^2 (with location means)	0.4400
Variable	Coeff.
# of girls aged 7-14	-0.116 *(4.02)*
# of boys aged 7-14	-0.146 *(6.55)*
Head is employed - formal sector (0/1)	0.361 *(3.16)*
pc weekly hours worked	0.009 *(3.61)*
Upper East Region (0/1)	-0.305 *(4.51)*
pc weekly hours worked (EA average)	0.063 *(4.92)*
# of rooms (EA average)	-0.191 *(6.41)*
Hours worked (EA average)	-0.035 *(3.36)*
Constant	14.255 *(70.79)*

Sources: author's calculation based on GLSS4

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
1	**Western**	**1,919,212**	**0.325**	**0.106**	**0.049**	**692,717**	**0.288**	**0.102**	**0.051**	**1,226,495**	**0.346**	**0.109**	**0.048**
			0.041	***0.018***	***0.010***		***0.039***	***0.019***	***0.012***		***0.041***	***0.017***	***0.009***
101	Jomoro	110,972	0.491	0.176	0.085	32,685	0.412	0.149	0.075	78,287	0.525	0.188	0.090
			0.047	*0.025*	*0.015*		*0.068*	*0.035*	*0.022*		*0.038*	*0.020*	*0.012*
102	Nzema East	142,523	0.446	0.151	0.071	37,716	0.427	0.157	0.079	104,807	0.452	0.149	0.068
			0.046	*0.023*	*0.014*		*0.071*	*0.038*	*0.023*		*0.037*	*0.018*	*0.010*
103	Ahanta West	94,826	0.378	0.126	0.058	18,750	0.297	0.095	0.043	76,076	0.398	0.133	0.062
			0.044	*0.020*	*0.012*		*0.072*	*0.031*	*0.017*		*0.037*	*0.018*	*0.010*
104	Shama-Ahanta E	366,215	0.264	0.090	0.044	366,215	0.264	0.090	0.044	n/a	n/a	n/a	n/a
			0.033	*0.015*	*0.009*		*0.033*	*0.015*	*0.009*				
105	Mpohor-Wassa	122,752	0.292	0.089	0.039	15,664	0.187	0.063	0.030	107,088	0.307	0.093	0.040
			0.045	*0.017*	*0.009*		*0.048*	*0.020*	*0.011*		*0.044*	*0.017*	*0.009*
106	Wassa West	231,952	0.222	0.067	0.030	82,002	0.171	0.056	0.027	149,950	0.250	0.073	0.031
			0.038	*0.014*	*0.007*		*0.036*	*0.014*	*0.008*		*0.039*	*0.014*	*0.007*
107	Wassa Amenefi	234,155	0.324	0.101	0.045	30,996	0.357	0.136	0.072	203,159	0.319	0.096	0.041
			0.044	*0.018*	*0.009*		*0.050*	*0.027*	*0.017*		*0.043*	*0.016*	*0.008*
108	Aowin-Suaman	118,978	0.350	0.113	0.052	18,625	0.323	0.122	0.064	100,353	0.355	0.111	0.049
			0.051	*0.022*	*0.012*		*0.047*	*0.025*	*0.016*		*0.052*	*0.022*	*0.011*
109	Juabeso-Bia	244,456	0.346	0.111	0.051	16,940	0.589	0.261	0.151	227,516	0.328	0.100	0.044
			0.049	*0.021*	*0.011*		*0.087*	*0.058*	*0.041*		*0.046*	*0.018*	*0.009*
110	Sefwi Wiawso	149,247	0.345	0.113	0.053	34,669	0.384	0.150	0.080	114,578	0.333	0.102	0.044
			0.048	*0.021*	*0.012*		*0.055*	*0.030*	*0.020*		*0.046*	*0.018*	*0.009*
111	Bibiani	103,136	0.315	0.102	0.047	38,455	0.278	0.097	0.048	64,681	0.337	0.104	0.046
			0.048	*0.021*	*0.011*		*0.044*	*0.020*	*0.012*		*0.050*	*0.021*	*0.011*
2	**Central**	**1,581,482**	**0.448**	**0.161**	**0.078**	**587,953**	**0.421**	**0.163**	**0.087**	**993,529**	**0.465**	**0.159**	**0.073**
			0.041	***0.020***	***0.012***		***0.039***	***0.020***	***0.013***		***0.042***	***0.019***	***0.011***
201	Komenda	109,940	0.514	0.184	0.087	31,932	0.401	0.145	0.073	78,008	0.561	0.200	0.093
			0.035	*0.019*	*0.012*		*0.040*	*0.019*	*0.012*		*0.033*	*0.019*	*0.012*
202	Cape Coast	114,142	0.273	0.085	0.038	78,358	0.275	0.088	0.041	35,784	0.268	0.079	0.034
			0.039	*0.015*	*0.008*		*0.039*	*0.016*	*0.009*		*0.039*	*0.014*	*0.007*
203	Abura	89,933	0.516	0.181	0.085	26,109	0.495	0.193	0.101	63,824	0.525	0.176	0.078
			0.042	*0.022*	*0.013*		*0.043*	*0.024*	*0.015*		*0.042*	*0.021*	*0.012*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
204	Mfantsiman	152,965	0.473	0.168	0.081	76,107	0.424	0.155	0.078	76,858	0.521	0.181	0.083
			0.038	*0.019*	*0.011*		*0.040*	*0.020*	*0.012*		*0.036*	*0.018*	*0.011*
205	Gomoa	191,824	0.630	0.253	0.132	48,326	0.647	0.320	0.199	143,498	0.625	0.230	0.109
			0.038	*0.026*	*0.018*		*0.043*	*0.036*	*0.030*		*0.036*	*0.022*	*0.014*
206	Awutu	169,084	0.526	0.200	0.101	110,593	0.466	0.181	0.096	58,491	0.641	0.234	0.110
			0.042	*0.024*	*0.016*		*0.043*	*0.024*	*0.016*		*0.040*	*0.025*	*0.016*
207	Agona	158,358	0.471	0.168	0.080	102,562	0.363	0.126	0.062	55,796	0.669	0.244	0.114
			0.042	*0.022*	*0.013*		*0.040*	*0.018*	*0.011*		*0.044*	*0.029*	*0.018*
208	Asikuma	89,237	0.576	0.204	0.095	28,364	0.421	0.154	0.078	60,873	0.648	0.227	0.103
			0.053	*0.029*	*0.017*		*0.063*	*0.031*	*0.019*		*0.049*	*0.028*	*0.017*
209	Ajumako	91,976	0.541	0.188	0.087	16,246	0.426	0.153	0.077	75,730	0.566	0.196	0.089
			0.045	*0.023*	*0.013*		*0.045*	*0.022*	*0.013*		*0.045*	*0.023*	*0.013*
210	Assin	195,792	0.290	0.096	0.046	28,388	0.451	0.205	0.123	167,404	0.263	0.078	0.033
			0.056	*0.022*	*0.012*		*0.049*	*0.031*	*0.023*		*0.057*	*0.021*	*0.010*
211	Twifu	110,215	0.289	0.096	0.046	15,126	0.516	0.238	0.143	95,089	0.253	0.073	0.031
			0.057	*0.023*	*0.013*		*0.062*	*0.043*	*0.033*		*0.056*	*0.020*	*0.009*
212	Upper Denkyira	108,016	0.262	0.081	0.037	25,842	0.320	0.120	0.062	82,174	0.244	0.069	0.029
			0.054	*0.021*	*0.011*		*0.055*	*0.027*	*0.017*		*0.054*	*0.019*	*0.009*
3	**Greater Accra**	**2,889,122**	**0.126**	**0.037**	**0.016**	**2,533,079**	**0.099**	**0.028**	**0.012**	**356,043**	**0.316**	**0.101**	**0.045**
			0.018	***0.007***	***0.003***		***0.016***	***0.006***	***0.003***		***0.035***	***0.015***	***0.008***
301	Accra	1,647,202	0.052	0.012	0.004	1,647,202	0.052	0.012	0.004	n/a	n/a	n/a	n/a
			0.009	*0.002*	*0.001*		*0.009*	*0.002*	*0.001*				
302	Ga	549,049	0.237	0.076	0.035	400,960	0.215	0.069	0.033	148,089	0.297	0.094	0.042
			0.031	*0.014*	*0.008*		*0.032*	*0.014*	*0.008*		*0.030*	*0.013*	*0.007*
303	Tema	503,627	0.154	0.044	0.019	445,372	0.153	0.044	0.020	58,255	0.164	0.044	0.018
			0.027	*0.010*	*0.005*		*0.026*	*0.009*	*0.005*		*0.036*	*0.011*	*0.005*
304	Dangbe West	96,309	0.353	0.119	0.055	22,749	0.270	0.088	0.042	73,560	0.378	0.128	0.060
			0.043	*0.020*	*0.011*		*0.036*	*0.016*	*0.009*		*0.045*	*0.021*	*0.012*
305	Dangbe East	92,935	0.387	0.126	0.057	16,796	0.289	0.096	0.046	76,139	0.408	0.133	0.060
			0.058	*0.025*	*0.013*		*0.041*	*0.018*	*0.011*		*0.062*	*0.026*	*0.014*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
4	**Volta**	**1,629,523**	**0.495**	**0.185**	**0.093**	**436,925**	**0.431**	**0.170**	**0.090**	**1,192,598**	**0.519**	**0.190**	**0.093**
			0.040	***0.023***	***0.015***		***0.046***	***0.027***	***0.018***		***0.038***	***0.021***	***0.013***
401	South Tongu	64,613	0.493	0.178	0.087	7,213	0.388	0.138	0.068	57,400	0.506	0.183	0.089
			0.040	*0.022*	*0.014*		*0.067*	*0.033*	*0.020*		*0.036*	*0.021*	*0.013*
402	Keta	132,800	0.458	0.164	0.080	70,780	0.427	0.153	0.077	62,020	0.494	0.177	0.084
			0.047	*0.025*	*0.015*		*0.049*	*0.025*	*0.016*		*0.045*	*0.024*	*0.014*
403	Ketu	237,457	0.494	0.181	0.089	82,249	0.394	0.143	0.072	155,208	0.547	0.201	0.098
			0.044	*0.025*	*0.015*		*0.043*	*0.020*	*0.012*		*0.044*	*0.027*	*0.017*
404	Akatsi	93,397	0.538	0.191	0.092	19,528	0.501	0.196	0.104	73,869	0.548	0.190	0.089
			0.043	*0.025*	*0.015*		*0.045*	*0.026*	*0.018*		*0.043*	*0.024*	*0.014*
405	North Tongu	130,106	0.511	0.181	0.087	25,239	0.432	0.161	0.083	104,867	0.530	0.186	0.088
			0.044	*0.024*	*0.015*		*0.053*	*0.028*	*0.017*		*0.042*	*0.024*	*0.014*
406	Ho	233,277	0.443	0.167	0.085	79,514	0.298	0.119	0.066	153,763	0.518	0.192	0.095
			0.043	*0.023*	*0.015*		*0.047*	*0.025*	*0.016*		*0.040*	*0.023*	*0.014*
407	Hohoe	112,198	0.501	0.192	0.099	22,380	0.415	0.184	0.108	89,818	0.523	0.194	0.097
			0.042	*0.025*	*0.017*		*0.047*	*0.032*	*0.024*		*0.040*	*0.024*	*0.015*
408	Kpandu	152,453	0.414	0.143	0.068	34,804	0.300	0.113	0.060	117,649	0.447	0.152	0.071
			0.046	*0.022*	*0.012*		*0.049*	*0.024*	*0.015*		*0.045*	*0.021*	*0.012*
409	Jasikan	111,021	0.534	0.210	0.111	22,054	0.574	0.277	0.171	88,967	0.524	0.194	0.097
			0.042	*0.026*	*0.018*		*0.058*	*0.043*	*0.034*		*0.038*	*0.022*	*0.014*
410	Kadjebi	51,918	0.535	0.202	0.102	8,230	0.329	0.087	0.034	43,688	0.574	0.224	0.115
			0.046	*0.024*	*0.015*		*0.063*	*0.022*	*0.010*		*0.043*	*0.025*	*0.016*
411	Nkwanta	150,588	0.631	0.263	0.140	35,262	0.810	0.368	0.203	115,326	0.576	0.230	0.121
			0.046	*0.034*	*0.024*		*0.079*	*0.073*	*0.054*		*0.036*	*0.022*	*0.015*
412	Krachi	159,695	0.474	0.172	0.085	29,672	0.507	0.181	0.087	130,023	0.467	0.170	0.084
			0.041	*0.021*	*0.012*		*0.058*	*0.031*	*0.019*		*0.037*	*0.018*	*0.011*
5	**Eastern**	**2,103,376**	**0.389**	**0.135**	**0.065**	**724,314**	**0.287**	**0.100**	**0.050**	**1,379,062**	**0.443**	**0.153**	**0.073**
			0.035	***0.017***	***0.010***		***0.034***	***0.015***	***0.009***		***0.036***	***0.018***	***0.010***
501	Birim North	124,016	0.471	0.166	0.079	12,124	0.292	0.102	0.050	111,892	0.490	0.172	0.083
			0.042	*0.021*	*0.013*		*0.073*	*0.033*	*0.020*		*0.039*	*0.020*	*0.012*
502	Birim South	178,920	0.421	0.153	0.076	87,490	0.354	0.136	0.072	91,430	0.485	0.169	0.080
			0.035	*0.019*	*0.012*		*0.033*	*0.018*	*0.012*		*0.038*	*0.020*	*0.012*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
503	West Akim	154,107	0.432	0.153	0.074	49,225	0.290	0.104	0.052	104,882	0.498	0.176	0.084
			0.040	*0.021*	*0.012*		*0.037*	*0.018*	*0.011*		*0.042*	*0.022*	*0.013*
504	Kwaebibirem	179,246	0.379	0.132	0.064	69,419	0.319	0.121	0.064	109,827	0.417	0.139	0.064
			0.037	*0.018*	*0.011*		*0.034*	*0.018*	*0.011*		*0.039*	*0.018*	*0.010*
505	Suhum	165,651	0.450	0.161	0.080	35,989	0.343	0.145	0.084	129,662	0.480	0.166	0.078
			0.042	*0.022*	*0.013*		*0.035*	*0.019*	*0.013*		*0.044*	*0.023*	*0.013*
506	East Akim	190,279	0.395	0.138	0.068	70,492	0.396	0.152	0.080	119,787	0.394	0.130	0.060
			0.036	*0.018*	*0.011*		*0.038*	*0.020*	*0.013*		*0.036*	*0.016*	*0.009*
507	Fanteakwa	86,708	0.465	0.166	0.081	15,906	0.443	0.170	0.089	70,802	0.471	0.165	0.079
			0.041	*0.021*	*0.013*		*0.041*	*0.022*	*0.014*		*0.041*	*0.021*	*0.012*
508	New Juaben	135,324	0.158	0.045	0.020	112,647	0.138	0.039	0.017	22,677	0.259	0.077	0.034
			0.026	*0.010*	*0.005*		*0.023*	*0.008*	*0.004*		*0.040*	*0.016*	*0.008*
509	Akwapim South	115,049	0.290	0.088	0.039	52,553	0.181	0.052	0.023	62,496	0.382	0.118	0.052
			0.035	*0.015*	*0.008*		*0.029*	*0.010*	*0.005*		*0.041*	*0.018*	*0.010*
510	Akwapim North	105,538	0.314	0.099	0.045	31,995	0.271	0.087	0.040	73,543	0.333	0.105	0.047
			0.035	*0.016*	*0.009*		*0.035*	*0.016*	*0.009*		*0.035*	*0.015*	*0.009*
511	Yilo Krobo	85,724	0.242	0.068	0.029	15,319	0.190	0.056	0.025	70,405	0.253	0.071	0.029
			0.041	*0.015*	*0.007*		*0.033*	*0.013*	*0.007*		*0.043*	*0.015*	*0.007*
512	Manya Krobo	153,990	0.431	0.147	0.069	61,358	0.291	0.074	0.028	92,632	0.524	0.195	0.097
			0.044	*0.020*	*0.011*		*0.056*	*0.019*	*0.008*		*0.037*	*0.020*	*0.012*
513	Asugyaman	75,523	0.452	0.156	0.074	19,695	0.343	0.091	0.035	55,828	0.491	0.179	0.089
			0.050	*0.022*	*0.012*		*0.066*	*0.023*	*0.010*		*0.045*	*0.022*	*0.013*
514	Afram Plains	135,854	0.462	0.166	0.081	6,885	0.339	0.092	0.036	128,969	0.469	0.170	0.083
			0.041	*0.019*	*0.011*		*0.079*	*0.030*	*0.015*		*0.039*	*0.019*	*0.011*
515	Kwahu South	217,447	0.406	0.145	0.071	83,217	0.314	0.115	0.059	134,230	0.464	0.164	0.079
			0.037	*0.019*	*0.011*		*0.038*	*0.018*	*0.011*		*0.036*	*0.019*	*0.011*
6	**Ashanti**	**3,590,511**	**0.272**	**0.090**	**0.042**	**1,832,441**	**0.141**	**0.047**	**0.023**	**1,758,070**	**0.407**	**0.136**	**0.063**
			0.024	***0.011***	***0.006***		***0.013***	***0.006***	***0.003***		***0.035***	***0.016***	***0.009***
601	Atwima	237,600	0.343	0.112	0.051	49,219	0.170	0.055	0.026	188,381	0.389	0.127	0.058
			0.036	*0.016*	*0.009*		*0.029*	*0.012*	*0.007*		*0.037*	*0.017*	*0.009*
602	Amansie West	108,679	0.437	0.146	0.068	n/a	n/a	n/a	n/a	108,679	0.437	0.146	0.068
			0.039	*0.018*	*0.010*						*0.039*	*0.018*	*0.010*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
603	Amansie East	224,830	0.380	0.121	0.055	27,253	0.259	0.086	0.041	197,577	0.397	0.126	0.056
			0.037	*0.016*	*0.009*		*0.030*	*0.014*	*0.008*		*0.038*	*0.017*	*0.009*
604	Adansi West	229,061	0.225	0.071	0.032	136,172	0.122	0.037	0.017	92,889	0.376	0.121	0.055
			0.024	*0.010*	*0.005*		*0.015*	*0.006*	*0.003*		*0.036*	*0.016*	*0.009*
605	Adansi East	129,249	0.446	0.151	0.071	9,616	0.248	0.078	0.036	119,633	0.462	0.157	0.074
			0.038	*0.018*	*0.010*		*0.036*	*0.015*	*0.009*		*0.039*	*0.018*	*0.010*
606	Ashanti Akim S	96,833	0.383	0.123	0.056	15,965	0.337	0.109	0.051	80,868	0.392	0.126	0.057
			0.042	*0.018*	*0.010*		*0.055*	*0.025*	*0.014*		*0.039*	*0.017*	*0.009*
607	Ashanti Akim N	125,817	0.341	0.116	0.056	70,055	0.316	0.114	0.058	55,762	0.371	0.118	0.053
			0.035	*0.016*	*0.009*		*0.028*	*0.014*	*0.009*		*0.043*	*0.018*	*0.009*
608	Ejisu/Juaben	123,761	0.328	0.105	0.048	32,881	0.265	0.088	0.042	90,880	0.351	0.111	0.050
			0.037	*0.016*	*0.008*		*0.033*	*0.015*	*0.009*		*0.038*	*0.016*	*0.008*
609	Bosomtwi	145,918	0.347	0.109	0.048	7,368	0.321	0.095	0.041	138,550	0.348	0.109	0.049
			0.039	*0.016*	*0.008*		*0.053*	*0.023*	*0.013*		*0.039*	*0.016*	*0.008*
610	Kumasi	1,162,408	0.077	0.022	0.009	1,162,408	0.077	0.022	0.009	n/a	n/a	n/a	n/a
			0.011	*0.004*	*0.002*		*0.011*	*0.004*	*0.002*				
611	Afigya/Kwabre	164,454	0.229	0.071	0.031	63,923	0.094	0.028	0.012	100,531	0.316	0.098	0.044
			0.029	*0.011*	*0.006*		*0.016*	*0.006*	*0.003*		*0.036*	*0.014*	*0.007*
612	Afigya Sekyere	118,775	0.403	0.138	0.066	42,041	0.402	0.144	0.072	76,734	0.404	0.135	0.063
			0.042	*0.020*	*0.011*		*0.040*	*0.020*	*0.012*		*0.043*	*0.020*	*0.011*
613	Sekyere East	156,969	0.430	0.153	0.075	52,738	0.343	0.116	0.056	104,231	0.474	0.172	0.084
			0.039	*0.020*	*0.012*		*0.040*	*0.018*	*0.011*		*0.038*	*0.020*	*0.013*
614	Sekyere West	142,126	0.418	0.158	0.081	54,827	0.336	0.139	0.077	87,299	0.469	0.169	0.083
			0.034	*0.020*	*0.013*		*0.025*	*0.017*	*0.013*		*0.040*	*0.021*	*0.013*
615	Ejura/Sekyedu	80,694	0.397	0.152	0.078	39,206	0.201	0.063	0.029	41,488	0.583	0.236	0.125
			0.038	*0.021*	*0.014*		*0.032*	*0.013*	*0.007*		*0.044*	*0.029*	*0.020*
616	Offinso	137,973	0.444	0.163	0.082	42,661	0.463	0.189	0.104	95,312	0.435	0.152	0.073
			0.037	*0.020*	*0.012*		*0.040*	*0.023*	*0.017*		*0.036*	*0.018*	*0.011*
617	Ahafo Ano South	133,508	0.434	0.147	0.069	12,313	0.543	0.236	0.133	121,195	0.423	0.138	0.063
			0.041	*0.021*	*0.013*		*0.065*	*0.051*	*0.038*		*0.039*	*0.018*	*0.010*
618	Ahafo Ano North	71,856	0.385	0.126	0.057	13,795	0.231	0.074	0.034	58,061	0.422	0.138	0.063
			0.042	*0.019*	*0.011*		*0.027*	*0.011*	*0.006*		*0.045*	*0.021*	*0.012*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
7	**Brong Ahafo**	**1,812,472**	**0.435**	**0.157**	**0.078**	**676,690**	**0.318**	**0.107**	**0.051**	**1,135,782**	**0.504**	**0.188**	**0.094**
			0.037	***0.019***	***0.012***		***0.040***	***0.019***	***0.012***		***0.036***	***0.019***	***0.012***
701	Asunafo	174,096	0.433	0.149	0.070	49,293	0.257	0.079	0.036	124,803	0.502	0.176	0.084
			0.042	*0.021*	*0.012*		*0.048*	*0.020*	*0.011*		*0.040*	*0.021*	*0.012*
702	Asutifi	83,979	0.457	0.160	0.076	12,903	0.296	0.087	0.038	71,076	0.487	0.173	0.083
			0.039	*0.019*	*0.011*		*0.054*	*0.022*	*0.012*		*0.036*	*0.019*	*0.011*
703	Tanoso	123,084	0.393	0.132	0.062	53,078	0.287	0.087	0.039	70,006	0.472	0.166	0.079
			0.045	*0.021*	*0.012*		*0.049*	*0.020*	*0.011*		*0.042*	*0.022*	*0.013*
704	Sunyani	178,531	0.276	0.091	0.042	131,867	0.203	0.062	0.028	46,664	0.483	0.170	0.082
			0.038	*0.017*	*0.010*		*0.036*	*0.015*	*0.008*		*0.045*	*0.024*	*0.014*
705	Dormaa	150,050	0.426	0.147	0.070	46,785	0.280	0.092	0.044	103,265	0.492	0.172	0.082
			0.041	*0.020*	*0.012*		*0.043*	*0.020*	*0.011*		*0.040*	*0.021*	*0.012*
706	Jaman	147,686	0.629	0.273	0.152	46,725	0.617	0.253	0.133	100,961	0.635	0.283	0.161
			0.038	*0.030*	*0.023*		*0.051*	*0.045*	*0.033*		*0.032*	*0.023*	*0.018*
707	Berekum	93,978	0.332	0.112	0.052	51,723	0.202	0.061	0.027	42,255	0.492	0.174	0.083
			0.041	*0.019*	*0.011*		*0.033*	*0.014*	*0.007*		*0.051*	*0.026*	*0.015*
708	Wenchi	166,354	0.468	0.168	0.082	49,570	0.408	0.130	0.059	116,784	0.494	0.184	0.092
			0.043	*0.021*	*0.012*		*0.055*	*0.023*	*0.013*		*0.038*	*0.020*	*0.012*
709	Techiman	175,170	0.347	0.125	0.061	97,812	0.191	0.064	0.031	77,358	0.544	0.201	0.099
			0.036	*0.019*	*0.011*		*0.029*	*0.013*	*0.008*		*0.045*	*0.026*	*0.016*
710	Nkoranza	128,626	0.515	0.194	0.097	37,398	0.559	0.216	0.109	91,228	0.497	0.184	0.092
			0.043	*0.026*	*0.017*		*0.054*	*0.038*	*0.027*		*0.038*	*0.020*	*0.012*
711	Kintampo	146,206	0.491	0.180	0.089	39,019	0.475	0.171	0.084	107,187	0.497	0.184	0.091
			0.041	*0.022*	*0.014*		*0.046*	*0.027*	*0.018*		*0.039*	*0.021*	*0.012*
712	Atebubu	162,634	0.464	0.166	0.081	53,477	0.427	0.128	0.054	109,157	0.482	0.185	0.095
			0.046	*0.022*	*0.013*		*0.060*	*0.027*	*0.014*		*0.038*	*0.020*	*0.012*
713	Sene	82,078	0.442	0.156	0.075	7,040	0.397	0.116	0.048	75,038	0.446	0.160	0.078
			0.042	*0.019*	*0.011*		*0.081*	*0.031*	*0.015*		*0.038*	*0.018*	*0.010*
8	**Northern**	**1,807,615**	**0.695**	**0.325**	**0.190**	**476,041**	**0.570**	**0.212**	**0.104**	**1,331,574**	**0.740**	**0.366**	**0.220**
			0.034	***0.027***	***0.021***		***0.049***	***0.028***	***0.018***		***0.028***	***0.027***	***0.023***
801	Bole	127,188	0.648	0.285	0.159	15,604	0.440	0.132	0.055	111,584	0.677	0.306	0.174
			0.038	*0.025*	*0.018*		*0.072*	*0.031*	*0.016*		*0.033*	*0.024*	*0.018*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
802	West Gonja	138,701	0.572	0.234	0.125	19,898	0.496	0.157	0.068	118,803	0.584	0.247	0.135
			0.041	*0.023*	*0.015*		*0.074*	*0.035*	*0.019*		*0.036*	*0.021*	*0.015*
803	Wast Gonja	174,566	0.551	0.220	0.116	23,881	0.463	0.142	0.061	150,685	0.565	0.232	0.125
			0.040	*0.023*	*0.015*		*0.068*	*0.030*	*0.016*		*0.036*	*0.021*	*0.015*
804	Nanumba	143,866	0.712	0.323	0.184	28,308	0.691	0.277	0.142	115,558	0.717	0.335	0.194
			0.039	*0.030*	*0.023*		*0.056*	*0.040*	*0.028*		*0.035*	*0.028*	*0.021*
805	Sabsugu-Tatale	79,036	0.684	0.298	0.164	16,720	0.760	0.322	0.171	62,316	0.663	0.291	0.162
			0.046	*0.032*	*0.022*		*0.059*	*0.047*	*0.033*		*0.043*	*0.028*	*0.019*
806	Chereponi-Saboba	93,471	0.752	0.351	0.202	6,144	0.866	0.410	0.231	87,327	0.744	0.347	0.199
			0.036	*0.033*	*0.026*		*0.066*	*0.073*	*0.057*		*0.034*	*0.031*	*0.024*
807	Yendi	128,387	0.718	0.333	0.192	43,889	0.629	0.236	0.117	84,498	0.764	0.383	0.231
			0.038	*0.031*	*0.024*		*0.056*	*0.035*	*0.022*		*0.028*	*0.029*	*0.024*
808	Gushiegu-Karaga	121,117	0.857	0.459	0.287	23,545	0.926	0.492	0.297	97,572	0.840	0.452	0.285
			0.037	*0.044*	*0.038*		*0.047*	*0.071*	*0.061*		*0.034*	*0.038*	*0.033*
809	Savelugu-Nanton	90,202	0.672	0.293	0.163	32,574	0.544	0.178	0.078	57,628	0.745	0.357	0.211
			0.045	*0.032*	*0.022*		*0.072*	*0.038*	*0.022*		*0.030*	*0.028*	*0.023*
810	Tamale	292,151	0.565	0.226	0.120	196,126	0.461	0.148	0.065	96,025	0.777	0.385	0.231
			0.048	*0.029*	*0.019*		*0.056*	*0.027*	*0.015*		*0.031*	*0.033*	*0.027*
811	Tolon-Kumbungu	131,791	0.835	0.453	0.289	20,532	0.660	0.238	0.112	111,259	0.868	0.492	0.322
			0.036	*0.042*	*0.037*		*0.076*	*0.047*	*0.029*		*0.029*	*0.041*	*0.039*
812	West Mamprusi	114,220	0.800	0.405	0.246	18,038	0.683	0.290	0.156	96,182	0.822	0.426	0.262
			0.035	*0.037*	*0.031*		*0.053*	*0.041*	*0.030*		*0.032*	*0.037*	*0.032*
813	East Mamprusi	172,919	0.861	0.470	0.299	30,782	0.739	0.314	0.167	142,137	0.888	0.504	0.327
			0.031	*0.041*	*0.037*		*0.050*	*0.042*	*0.031*		*0.027*	*0.041*	*0.038*
9	**Upper East**	**914,016**	**0.715**	**0.337**	**0.197**	**141,885**	**0.511**	**0.182**	**0.088**	**772,131**	**0.752**	**0.365**	**0.217**
			0.035	***0.03***	***0.023***		***0.049***	***0.026***	***0.016***		***0.033***	***0.031***	***0.025***
901	Builsa	75,246	0.575	0.224	0.115	n/a	n/a	n/a	n/a	75,246	0.575	0.224	0.115
			0.039	*0.024*	*0.016*						*0.039*	*0.024*	*0.016*
902	Kassena-Nankani	148,719	0.611	0.246	0.128	23,245	0.532	0.194	0.095	125,474	0.626	0.255	0.134
			0.050	*0.032*	*0.021*		*0.059*	*0.035*	*0.023*		*0.049*	*0.032*	*0.021*
903	Bongo	77,768	0.706	0.299	0.160	n/a	n/a	n/a	n/a	77,768	0.706	0.299	0.160
			0.051	*0.036*	*0.025*						*0.051*	*0.036*	*0.025*

Annexe 3: Regional and District Level Poverty Estimates, by Urban/Rural (continued…)

District		Total				Urban				Rural			
ID	Name	Population	P0	P1	P2	Population	P0	P1	P2	Population	P0	P1	P2
904	Bolgatanga	227,725	0.647	0.276	0.150	48,472	0.395	0.115	0.047	179,253	0.716	0.319	0.178
			0.043	*0.030*	*0.021*		*0.066*	*0.028*	*0.014*		*0.037*	*0.031*	*0.022*
905	Bawku West	80,109	0.832	0.419	0.251	7,747	0.847	0.408	0.234	72,362	0.830	0.420	0.253
			0.038	*0.043*	*0.036*		*0.071*	*0.075*	*0.059*		*0.035*	*0.040*	*0.033*
906	Bawku East	304,449	0.821	0.443	0.282	62,421	0.552	0.201	0.098	242,028	0.891	0.506	0.329
			0.031	*0.037*	*0.033*		*0.051*	*0.028*	*0.017*		*0.026*	*0.039*	*0.037*
10	**Upper West**	**574,918**	**0.758**	**0.385**	**0.236**	**100,458**	**0.379**	**0.112**	**0.047**	**474,460**	**0.839**	**0.443**	**0.276**
			0.058	***0.044***	***0.033***		***0.123***	***0.049***	***0.024***		***0.044***	***0.043***	***0.035***
1001	Wa	223,424	0.677	0.319	0.187	66,364	0.361	0.104	0.043	157,060	0.811	0.410	0.248
			0.071	*0.045*	*0.030*		*0.124*	*0.047*	*0.023*		*0.048*	*0.043*	*0.034*
1002	Nadawili	83,013	0.855	0.452	0.280	n/a	n/a	n/a	n/a	83,013	0.855	0.452	0.280
			0.040	*0.043*	*0.035*						*0.040*	*0.043*	*0.035*
1003	Sissala	84,707	0.801	0.432	0.275	8,839	0.385	0.116	0.050	75,868	0.850	0.469	0.301
			0.054	*0.046*	*0.037*		*0.130*	*0.054*	*0.028*		*0.046*	*0.045*	*0.038*
1004	Jirapa-Lambussie	96,602	0.754	0.377	0.229	13,296	0.402	0.121	0.051	83,306	0.810	0.418	0.257
			0.069	*0.053*	*0.039*		*0.132*	*0.054*	*0.027*		*0.059*	*0.053*	*0.041*
1005	Lawra	87,172	0.836	0.454	0.287	11,959	0.449	0.141	0.061	75,213	0.898	0.504	0.323
			0.046	*0.044*	*0.036*		*0.139*	*0.061*	*0.032*		*0.032*	*0.041*	*0.037*

Sources: author's calculation based on GLSS4 and Census 2000