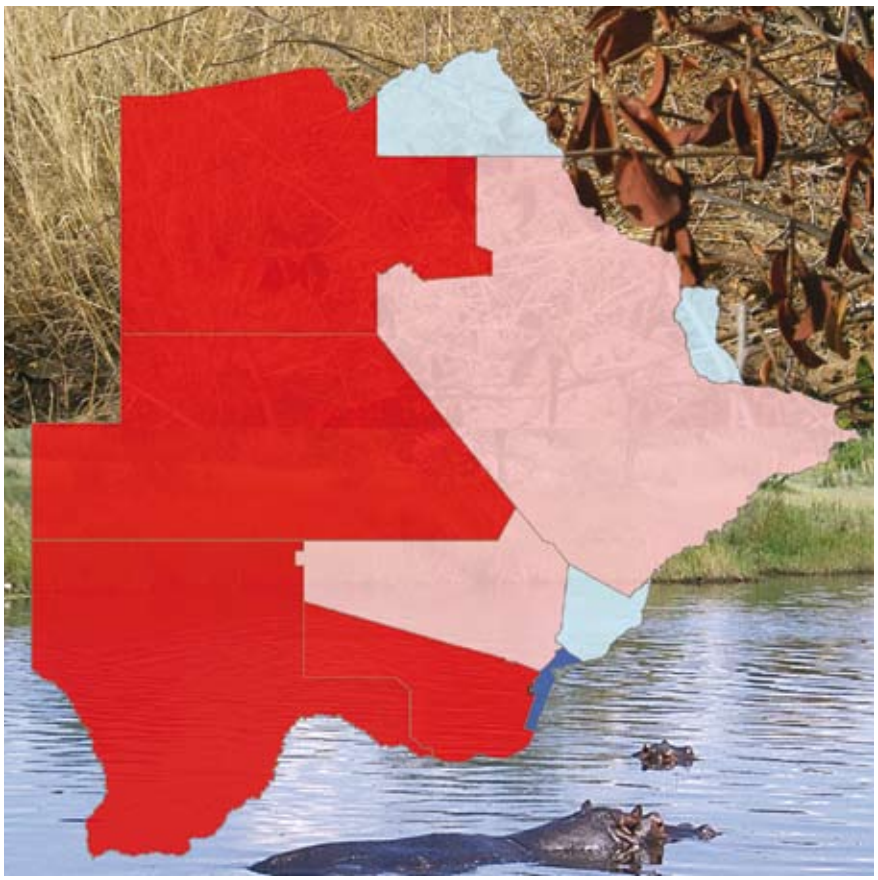
Republic of Botswana

BOTSWANA CENSUS-BASED

POVERTY MAP REPORT

District Level Results



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BOTSWANA CENSUS-BASED POVERTY MAP
District Level Results[1]

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Layout and Design: Kolobe Botswana
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Preface

This is the first Disaggregated Poverty Map report by the Central Statistics Office (CSO). The report details poverty rates at district and sub-district levels, making use of the detailed information from the 2001 Population and Housing Census and in-depth poverty analysis from the 2002/03 Household Income and Expenditure Survey (HIES) published in the Botswana Poverty Datum Line.

The work on the Disaggregated Poverty Map was undertaken through a consultancy funded by the United Nations Development Programme (UNDP). The consultancy was done in two parts. The first part involved preparation of the Census and HIES data, establishing linkages between the two data sets. The second part undertook to calculate small area estimates of poverty, making use of the PDL estimates, to come up with the district and sub-district poverty rates.

The CSO would like to thank the UNDP for assistance in funding the consultancy. It further extends appreciation to the consultants, Mr. Thomas Otter and Dr. Harold Coulombe for constructing the Poverty Map.

A. N. Majelantle
Government Statistician

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1 Introduction

1.1 This paper documents the construction and selected results of a Botswana Poverty Map, based on data from the 2002/03 Household Income and Expenditure Survey (HIES) and the Population and Housing Census 2001. The authors utilised a methodology developed by Elbers *et al* (2002, 2003).

Poverty indicators are calculated at low levels of aggregation, using the detailed information found in the HIES survey and the exhaustive coverage of the Census. Results at district-, sub-district- and locality- levels are presented. Village level indicators were also computed, but were not retained, as in most cases the precision of the estimates – as measured by the coefficient of variation – was too low. The very small population of most villages was the main reason behind these imprecise estimates.

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

While these household-based studies have greatly improved our knowledge of the welfare levels of households in general, and of the poorer ones in particular, the approach has a number of constraints. In particular, policy-makers and planners need finely disaggregated information in order to implement their anti-poverty schemes. Typically, they need information for small geographic units, such as city neighbourhoods, towns or villages.

Informing policy-makers in Botswana that the neediest people are in the rural areas would not be too impressive or useful, as that information is general and well known. However, informing them in which sub-districts, or even towns and villages, the poorest households are concentrated would be more useful and convincing!

Using district-level information often hides the existence of poverty pockets in otherwise relatively well-off districts, which would lead to poorly targeted schemes. Having better information at the local level would necessarily minimise information leakages and therefore permit more cost effective and efficient anti-poverty schemes. Poverty indicators are needed at the local level, as spatial inequalities can be important within a given region.

1.3 The methodology used has been developed by Elbers, Lanjouw and Lanjouw (2002, 2003) and should be seen as more sophisticated than other methods, as it incorporates information on household expenditure, is fully consistent with poverty profile figures, and permits the computation of standard errors of poverty indicators.

Since this type of poverty map is fully compatible with poverty profile results, it should be seen as a natural extension to the poverty profile, and a way to operationalise Poverty Profile results.

[2] *See CSO (2008) for the latest poverty profile in Botswana.*

This report documents the construction of the Poverty Map. It should be noted, however, that the map should reach its full potential once a series of applications under consideration are undertaken.

1.4 The remaining sections of this paper are structured as follows:

1/ A presentation of the methodology used, in layman terms;
2/ A description of the data used;
3/ A discussion of the results – including gender-specific data; and
4/ Further work to be undertaken.

A more technical presentation of the methodology can be found in Annex 1, along with more detailed results.

2 Methodology[3]

2.1 The basic idea behind the methodology is rather straightforward. Firstly, a regression model of adult equivalent expenditure is estimated using HIES survey data; it limits the set of explanatory variables to those which are common to both the survey and the latest Census. Secondly, the coefficients from that model are applied to the Census data set to predict the expenditure levels 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.

2.2 Although the idea behind the methodology is conceptually simple, its proper implementation requires complex computations. These complexities mainly arise from the need to take into account spatial auto-correlation (expenditure from households within the same cluster are correlated) and heteroskedasticity in the development of the predictive model.

Taking into account these econometric issues ensures unbiased predictions, as does our willingness to compute standard errors for each set of welfare statistics. These standard errors are important, since they tell us how low we can disaggregate the poverty indicators. As we disaggregate our results at lower and lower levels, the number of households upon which the estimates are based decreases, and therefore yields less and less precise estimates. At a certain point, the estimated poverty indicators would become too imprecise to be used with confidence. The computation of these standard errors will help us to decide where to stop the disaggregation process. The methodology used is further discussed in Annex 1.

3 Data

3.1 The construction of such a Poverty Map is very demanding in terms of data. The utmost requirement is a household survey having an expenditure module, as well as 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 profiles would be used.

[3] *The methodology has been applied to a myriad of developing countries, including those in Africa. For example, Coulombe and Wodon (2007) described the West and Central Africa Poverty Map Initiative in which 15 countries participated.*

Apart from household-level information, community level characteristics are also useful in the construction of a 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 standards of living, whether or not defined in monetary terms. In the case of Botswana, some of that information was available in compiling the data.

Census

3.2 The latest Population and Housing Census was conducted in August, 2001. Its questionnaire is relatively detailed, but does not contain any information on household incomes and expenditures. At the individual level, it covers demography, education and economic activities. At the household level, dwelling characteristics and ownership of durable goods are well covered. The Census database turns out close to 1.7 million individuals grouped into approximately 405 000 households. The Census fieldwork grouped households into approximately 4 150 Enumeration Areas (EAs) of about 97 households each, on average.

HIES Survey

3.3 The third round of the Household Income and Expenditure Survey (HIES, 2002/03) is the latest national survey having collected expenditure data at household level. Time-wise, it was the most appropriate survey to use in poverty mapping.

3.4 The Welfare Index (WI) 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 HIES (CSO, 2008). Using the same household-level Welfare Index and the associated poverty lines ensured full consistency between the Poverty Profile and the new Poverty Map. It also permitted us to test whether or not the predicted poverty indicators match those found in the Poverty Profile at strata level, the lowest statistically robust level achievable in HIES.

Administrative Layers

3.5 The administrative structure of Botswana is rather straightforward. The top tier is composed of ten districts, whilst the villages comprise the lower administrative level. In our study, we use the official definitions of the districts, as well as the unofficial definitions of sub-districts, a breakdown of districts used during the Census fieldwork.

Botswana is also divided into 485 'villages,' including cities and towns which are considered 'large' villages. However, some of the villages are too small to yield reliable poverty estimates. We therefore grouped them into 53 localities.

Table 1 presents some descriptive statistics on the size of these different administrative levels. The districts vary a lot in terms of population, from Chobe District, with only 16 547 people to the much larger Central District, with more than 557 000 individuals.

The ten districts can be further divided into 26 sub-districts, often called 'census districts.' They were originally territorial divisions designed to ease the Census fieldwork. However, they are also useful for planning purposes.

Table 1: Descriptive Statistics on the Botswana Administrative Structure

Territorial Unit	Number of Units	Number of Households			Number of Individuals		
		Median	Minimum	Maximum	Median	Minimum	Maximum
District	10	30,136	4,600	129,102	126,184	16,547	557,101
Sub-District	26	10,766	979	58,476	49,037	2,726	188,063
Locality	53	5,143	979	58,476	20,920	2,726	188,627
Village	485	242	1	58,476	1,132	6	188,627

Source: Authors' calculations based on the Census 2001.

Finally, the lower disaggregated level is the 'localities.' These include seven towns and cities, 27 large villages having urban characteristics, and the rural areas of 19 sub-districts. At a median of only 242 households, village level estimates would clearly be unreliable.

4 Results

4.1 In order to maximise the accuracy of the poverty estimates, we have created a model at the lowest geographical level for which the HIES is representative. This consists of sampling strata in the following categories: Gaborone, Other Towns & Cities, Urban Villages and Rural Villages. A household level expenditure model has been developed for each of these strata, using explanatory variables which are common to both the HIES and the Census.

Stage 1: Aligning the data

4.2 The first task was to make sure that the variables deemed common to both the Census and the HIES 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 (dichotomised) variables and tested whether or not they were equal, using a ninety five percent (95%) confidence interval.

Restricting ourselves to these variables ensured that the predicted welfare figures would be consistent with the survey-based Poverty Profile.[4] As noted, that comparison exercise was done at strata level. The two-stage sample design of the HIES was taken into account in the computation of the standard errors. The results are presented in Annex 2.

Stage 2: Survey-based regressions

4.3 Annex 3 presents the strata-specific regression (Ordinary Least Squares) results based on HIES. 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, these models are

[4] *We also deleted or redefined dichotomic variables less than 0.03 or larger than 0.97 to avoid serious multi-collinearity problems in our econometric models.*

not for discussion. They are exclusively prediction models, not determinant of poverty models that can be analysed in terms of causal relationships.

In the models used for the Poverty Map, we were only concerned with the predictive power of the regressors without regards, for example, for endogenous variables. At that stage, we attempted to control location effect by incorporating cluster averages of some of the variables. We also ran a series of regressions using the base model residuals as dependent variables. Those results – not shown here – will be used in the last stage of analysis in order to correct for heteroskedasticity.[5]

4.4 The R^2s of the different regressions vary from 0.44 to 0.57. 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 these coefficients look 'credible,' it is important to note that these models were purely predictive in the statistical sense and should not be viewed as determinants of welfare or poverty. The relatively lower R^2s for the Rural Villages are mainly due to four important factors:

1/ In many areas, households are rather homogeneous in terms of observable characteristics, even if their consumption habits vary. That necessarily yields low R2.

2/ A large number of potential correlates are simply not observable using standard closed-questionnaire data collection methods.

3/ Many good predictors had been discarded at the first stage, since their distributions did not appear to be identical.

4/ Many indicators do not take into account wide variations in the quality of the correlates, which makes many potential correlates useless in terms of predictive power.

Stage 3: Welfare Indicators[6]

4.5 Based on the results from the previous stage, we applied the estimated parameters[7] to the Census data to compute a series of poverty indicators: the headcount ratio (P0), the poverty gap index (P1) and the poverty severity index (P2). Table 2 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 indicator, the equality of HIES-based and Census-based indicators cannot be rejected (at 95%).[8] The census-based headcount

[5] *As described in the Methodology Section and Annex 1, two statistical problems are likely to violate Ordinary Least Squares assumptions. Spatial autocorrelation (expenditure from households within the same cluster are surely correlated, i.e. there are location effects) is minimised by incorporating in the regressions Enumeration Areas Means some key variables. The heteroskedasticity (error terms are not constant across observations) is corrected by modelising the error terms. Correcting for these two problems yields unbiased estimates. See also Elbers et al (2002, 2003).*

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

[7] *Apart from regression models explaining household welfare level, we 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 annex for further details.*

[8] *It is worth noting that the standard errors of the mean of the census-based figures are systematically lower than the ones calculated from HIES.*

Table 2: Poverty Rates based on HIES (actual) and Census 2001 (predicted), by Strata

	Headcount Incidence (P_0)		Poverty Gap Index (P_1)		Poverty Severity Index (P_2)	
	HIES (Actual)	Census (Predicted)	HIES (Actual)	Census (Predicted)	HIES (Actual)	Census (Predicted)
Gaborone	**0.063** *(0.008)*	**0.076** *(0.008)*	**0.018** *(0.003)*	**0.023** *(0.003)*	**0.009** *(0.002)*	**0.010** *(0.002)*
Other Towns & Cities	**0.135** *(0.018)*	**0.149** *(0.010)*	**0.043** *(0.006)*	**0.051** *(0.005)*	**0.019** *(0.003)*	**0.025** *(0.003)*
Urban Villages	**0.247** *(0.016)*	**0.258** *(0.012)*	0.085 *(0.007)*	**0.096** *(0.006)*	**0.040** *(0.004)*	**0.050** *(0.004)*
Rural Villages	**0.453** *(0.032)*	**0.455** *(0.020)*	**0.183** *(0.018)*	**0.197** *(0.013)*	**0.097** *(0.012)*	**0.112** *(0.009)*

Sources: Authors' calculations based on HIES 2002/03 and Census 2001.
Note: Robust standard errors are in parentheses.

ratio is at most 1.4 percent points different and often minute. Although census-based poverty figures can only be compared with the ones provided by the HIES survey at stratum level, the equality of these poverty figures provided an excellent reliability test of the methodology used here.

4.6 Once having established the reliability of the different predictive models, we estimated poverty figures for the first three disaggregated levels described in Table 1: district, sub-district and locality. Before presenting the actual results, we needed to determine whether or not they are precise enough to be useful.

As discussed in the Methodology section, the precision of the poverty estimates declines as the number of households in the different administrative units gets smaller. For example, while we expect the sub-district-level poverty estimates to be precise enough, it is legitimate to be interrogative for the locality-level estimates.

How low can we go?

4.7 In order to make an 'objective' judgment on the precision of our estimates, we computed coefficients of variation for all three levels (district, sub-district and locality), as well as for the headcount estimates from the HIES-based Poverty Profile.

Figure 1 presents the headcount incidence coefficients of variation of the district-, sub-district- and locality- level estimates and compares them to the ones computed from the HIES survey. Hence, we can use the precision of the HIES-based headcount incidence as a benchmark, which is represented by the step curve. These steps represent the different coefficients of variation associated with the different stratums.

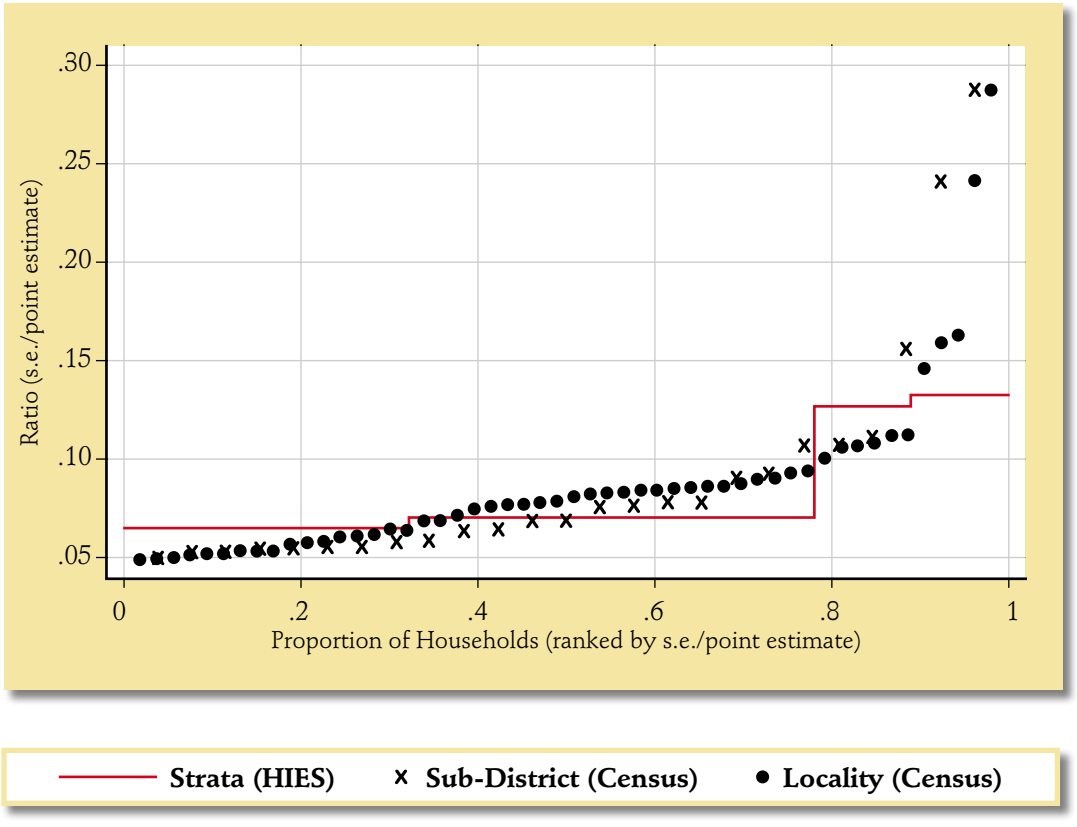
The curves in Figure 1 clearly show that our district-, sub-district- and locality-level headcount incidence estimates compare favourably to the HIES-based poverty estimates, since the district-level curve lies on or below the HIES

one. Amongst the three exceptions are two sub-districts/localities with very low levels of poverty (Orapa and Sowa Town). However, it is not clear why the North-East sub-district/locality has a significantly higher coefficient of variation.

How low can we go? If one takes the HIES benchmark as valid, it is clear that poverty estimates at all three disaggregated levels would be good guides for policy-makers. Village-level estimates (not shown here) would be clearly misleading to use, since most are not precise enough.

4.8 Table 3 presents poverty figures for each of the ten districts, 26 sub-districts and 53 localities. The standard errors are also presented and are – in most cases – relatively small, which make the predicted poverty figures quite reliable. These disaggregated estimates are the first ever monetary-based poverty figures available in Botswana. As might be expected, rural poverty is much more prevalent than urban poverty, and therefore the area of residence should clearly be taken into account in poverty alleviating policies and programmes.

Figure 1: Poverty Headcount Accuracy, by Disaggregation (administrative) Level



Sources: Authors' computations on HIES 2002/03 and Census 2001.

For each sub-district, the headcount poverty rate is much higher in rural areas than in urban areas. However, having residence in urban areas does not exclude being poor. Whilst Gaborone and the main mining towns enjoyed a very low level of poverty, some other localities (notably Moshupa in Southern Sub-District and Letlhakeng in Kweneng West) have an urban poverty headcount rate of approximately forty percent (40%) closer to the ones found in rural areas.

The heterogeneity of poverty headcounts across sub-districts and localities strongly argues for the usefulness of the Poverty Map. If we take the depth (P1) or the severity (P2) as measures of poverty, the poverty patterns remain similar.

4.9 Maps 1 to 3 reproduce Table 3 poverty headcount figures on a series of geographical maps at district-, sub-district- and locality- levels respectively. Using maps instead of tables permits the user to establish geographical patterns difficult to see from the tables. Comparing all three maps, it is striking how dissagregating the poverty figures provides a finer poverty pattern, hence a better targeting indicator.

Patterns from the locality-level map (Map 3) show that almost all rural areas have poverty headcount figures above forty percent (40%); four rural localities have more that fifty percent (50%). On the contrary, urban localities (represented by circles) have much lower poverty rates. While the capital and the mining towns enjoy the lowest rates of poverty, their neigbouring rural localities are quite poor.

How low should we go?

4.10 Although we have demonstrated that we can use the district, sub-district and locality poverty figures with some confidence, it may be that these disaggregated figures do not yield much more information. Within a rather homogenous sub-district, it might be possible that the different localities are not statistically different from each other in terms of monetary poverty.

To test whether or not additional information about poverty levels is an advantage when we disaggregate from district to sub-district to locality, Table 4 tells us which localities are statistically poorer or richer than their own sub-districts or districts, or when compared to the national level of poverty. If we look at headcount poverty, 41 out of 53 localities are either poorer (16 cases) or richer (25 cases) than their own districts. The figures are very similar if we take poverty depth or severity as our poverty indicators. This clearly shows the value added by using localities instead of sub-districts or districts as the appropriate levels to target poverty.

Gender

4.11 Although the methodology used to construct poverty maps is mainly geared towards geographically-based outcomes, it is possible to compute poverty indicators for any population group having a large enough size. At more than forty six percent (46%), Botswana has one of the highest percentages of female-headed households worldwide. On average, they are also poorer than their male counterparts, since thirty four percent (34%) lie below the poverty line, compared to only twenty seven percent (27%) of male-headed households.

Table 5 presents the usual poverty indicators by district and sub-district, but also broken down by the gender of the household head. The table shows that at sub-district level, the gender gap goes from nonexistent (Sowa Town and Orapa) to more than ten percent (10%) in Chobe District. Map 4 illustrates these gender gap figures at sub-district level. Even if this is not the case for all districts and sub-districts, the gender gap tends to be larger in urban areas than in rural areas.

5 Concluding Remarks

5.1 This paper has documented the construction of a district-, sub-district- and locality-level Poverty Map for Botswana. The methodology developed by Elbers *et al* (2003) has been used by the researchers/authors to obtain the first ever reliable poverty estimates. A gender breakdown is also presented. The finely disaggregated poverty figures are fully compatible with the latest Botswana Poverty Profile.

5.2 One of the main advantages of the methodology used here is the ability to compute standard errors for the different poverty estimates and therefore to have an idea of the reliability of these estimates. We observed that by using the precision level of the latest Poverty Profile as a benchmark, figures at district-, sub-district- and locality- levels are precise enough to be useful to planners, policy-makers and researchers. Due to the rather small population size of the different villages, the computations at village level were too unreliable to be used with confidence.

5.3 However interesting the results are, they should acquire their full potential according to the ways in which they are used. Amongst others, the results can be used to design budget allocation regulations to be applied by the different administrative offices towards their subdivisions, the central Government towards the districts, and the districts towards their sub-districts and localities.

The Botswana Poverty Map could become an important tool in support of the government administrative and decentralisation processes currently taking place in the country. Obviously, such monetary-based target indicators could be used in conjunction with alternative measures of poverty alleviation based on education, health or infrastructure indicators. In particular, merging the Poverty Map with education and health maps would yield powerful targeting tools. Other uses could include the evaluation of locally targeted anti-poverty schemes (i.e. social funds, town/village development schemes), impact analysis, etc. And finally, it can serve as a useful tool in the study of the relationships between poverty distribution and various socio-economic outcomes.

Table 3: Poverty Indices, by District, Sub-District and Locality

Disaggregated Levels	Population	Poverty Headcount (P0)	Poverty Gap Index (P1)	Poverty Severity Index (P2)	Number of Poor Individuals
SOUTHERN	**185,540**	**0.407** *(0.024)*	**0.176** *(0.015)*	**0.100** *(0.010)*	**75,515**
Jwaneng	**14,559**	**0.088** *(0.010)*	**0.031** *(0.004)*	**0.016** *(0.003)*	**1,281**
Jwaneng	14,559	0.088 *(0.010)*	0.031 *(0.004)*	0.016 *(0.003)*	1,281
Southern	**113,186**	**0.430** *(0.027)*	**0.187** *(0.017)*	**0.107** *(0.012)*	**48,670**
Rural	56,126	0.473 *(0.023)*	0.205 *(0.015)*	0.116 *(0.010)*	26,548
Kanye	40,138	0.369 *(0.030)*	0.161 *(0.018)*	0.093 *(0.013)*	14,811
Moshupa	16,922	0.432 *(0.037)*	0.191 *(0.023)*	0.111 *(0.016)*	7,310
Borolong	**47,324**	**0.434** *(0.025)*	**0.184** *(0.015)*	**0.103** *(0.011)*	**20,539**
Rural	47,324	0.434 *(0.025)*	0.184 *(0.015)*	0.103 *(0.011)*	20,539
Ngwaketse West	**10,471**	**0.481** *(0.037)*	**0.211** *(0.024)*	**0.120** *(0.017)*	**5,037**
Rural	10,471	0.481 *(0.037)*	0.211 *(0.024)*	0.120 *(0.017)*	5,037
SOUTH-EAST	**270,305**	**0.111** *(0.011)*	**0.037** *(0.005)*	**0.018** *(0.003)*	**30,004**
Gaborone	**181,627**	**0.076** *(0.008)*	**0.023** *(0.003)*	**0.010** *(0.002)*	**13,804**
Gaborone	181,627	0.076 *(0.008)*	0.023 *(0.003)*	0.010 *(0.002)*	13,804
Lobatse	**28,801**	**0.191** *(0.014)*	**0.070** *(0.007)*	**0.036** *(0.004)*	**5,501**
Lobatse	28,801	0.191 *(0.014)*	0.070 *(0.007)*	0.036 *(0.004)*	5,501
South East	**59,877**	**0.175** *(0.016)*	**0.063** *(0.008)*	**0.032** *(0.005)*	**10,478**
Rural	18,671	0.242 *(0.022)*	0.097 *(0.012)*	0.053 *(0.005)*	4,518
Ramotswa	20,286	0.199 *(0.021)*	0.065 *(0.008)*	0.031 *(0.005)*	4,037
Tlokweng	20,920	0.093 *(0.010)*	0.031 *(0.004)*	0.015 *(0.002)*	1,946
KWENENG	**227,986**	**0.332** *(0.017)*	**0.134** *(0.010)*	**0.073** *(0.007)*	**75,691**
Kweneng East	**188,063**	**0.300** *(0.017)*	**0.117** *(0.009)*	**0.063** *(0.006)*	**56,419**
Rural	67,441	0.416 *(0.022)*	0.178 *(0.014)*	0.100 *(0.010)*	28,055
Molepolole	53,727	0.287 *(0.017)*	0.104 *(0.009)*	0.053 *(0.006)*	15,420
Gabane	10,399	0.203 *(0.022)*	0.069 *(0.010)*	0.033 *(0.006)*	2,111
Kopong	5,571	0.336 *(0.029)*	0.121 *(0.015)*	0.061 *(0.009)*	1,872
Mogoditshane	32,829	0.117 *(0.011)*	0.039 *(0.004)*	0.019 *(0.002)*	3,841
Thamaga	18,096	0.281 *(0.023)*	0.099 *(0.011)*	0.048 *(0.006)*	5,085
Kweneng West	**39,923**	**0.485** *(0.026)*	**0.211** *(0.017)*	**0.120** *(0.012)*	**19,363**
Rural	33,941	0.496 *(0.024)*	0.219 *(0.017)*	0.126 *(0.012)*	16,835
Letlhakeng	5,982	0.419 *(0.035)*	0.164 *(0.021)*	0.086 *(0.014)*	2,506

Table 3: Poverty Indices, by District, Sub-District and Locality (continued...)

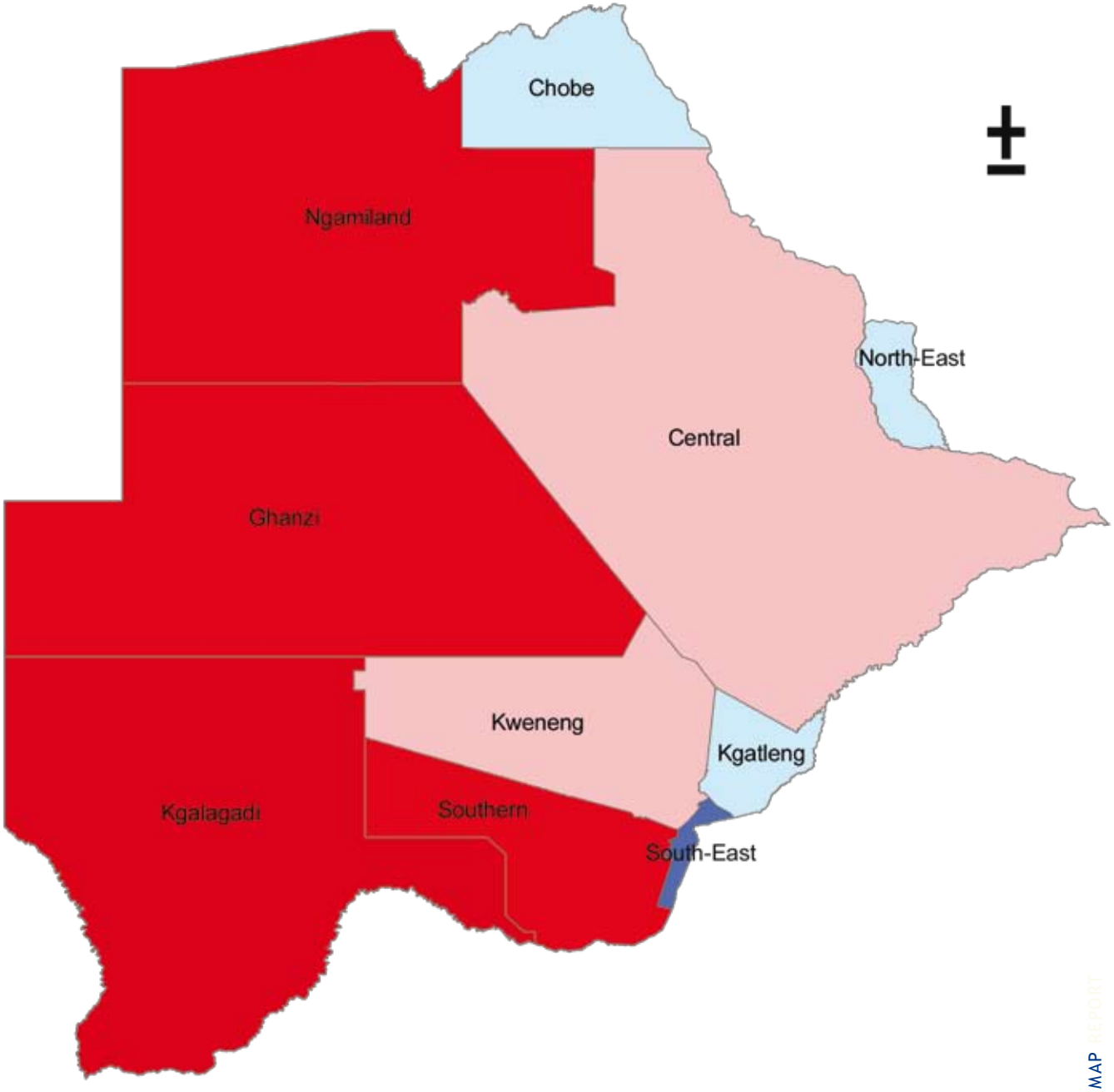
Disaggregated Levels	Population	Poverty Headcount (P0)	Poverty Gap Index (P1)	Poverty Severity Index (P2)	Number of Poor Individuals
KGATLENG	**73,199**	**0.272** *(0.019)*	**0.105** *(0.010)*	**0.055** *(0.006)*	**19,910**
Kgatleng	**73,199**	**0.272** *(0.019)*	**0.105** *(0.010)*	**0.055** *(0.006)*	**19,910**
Rural	36,525	0.334 *(0.020)*	0.137 *(0.012)*	0.076 *(0.008)*	12,199
Mochudi	36,674	0.211 *(0.017)*	0.072 *(0.007)*	0.035 *(0.004)*	7,738
CENTRAL	**557,101**	**0.370** *(0.018)*	**0.152** *(0.011)*	**0.083** *(0.008)*	**206,127**
Selebi-Phikwe	**48,825**	**0.157** *(0.012)*	**0.052** *(0.005)*	**0.025** *(0.003)*	**7,666**
Selebi-Phikwe	48,825	0.157 *(0.012)*	0.052 *(0.005)*	0.025 *(0.003)*	7,666
Orapa	**8,306**	**0.018** *(0.005)*	**0.005** *(0.002)*	**0.002** *(0.001)*	**150**
Orapa	8,306	0.018 *(0.005)*	0.005 *(0.002)*	0.002 *(0.001)*	150
Sowa Town	**2,726**	**0.034** *(0.010)*	**0.010** *(0.003)*	**0.004** *(0.002)*	**93**
Sowa Town	2,726	0.034 *(0.010)*	0.010 *(0.003)*	0.004 *(0.002)*	93
Central Serowe	**151,884**	**0.373** *(0.018)*	**0.154** *(0.012)*	**0.085** *(0.008)*	**56,653**
Rural	78,241	0.487 *(0.024)*	0.213 *(0.016)*	0.121 *(0.012)*	38,103
Serowe	41,811	0.258 *(0.013)*	0.094 *(0.007)*	0.047 *(0.005)*	10,787
Palapye	26,085	0.212 *(0.015)*	0.076 *(0.008)*	0.038 *(0.005)*	5,530
Lerala	5,747	0.397 *(0.034)*	0.149 *(0.018)*	0.076 *(0.012)*	2,282
Central Mahalapye	**108,324**	**0.389** *(0.021)*	**0.160** *(0.013)*	**0.088** *(0.009)*	**42,138**
Rural	62,439	0.483 *(0.026)*	0.210 *(0.017)*	0.119 *(0.012)*	30,158
Mahalapye	38,414	0.241 *(0.015)*	0.085 *(0.007)*	0.042 *(0.004)*	9,258
Shoshong	7,471	0.356 *(0.032)*	0.130 *(0.016)*	0.065 *(0.010)*	2,660
Central Bobonong	**66,602**	**0.414** *(0.023)*	**0.172** *(0.014)*	**0.094** *(0.010)*	27,573
Rural	41,216	0.479 *(0.025)*	0.207 *(0.016)*	0.117 *(0.012)*	19,742
Bobonong	14,529	0.308 *(0.020)*	0.115 *(0.011)*	0.059 *(0.007)*	4,475
Mmadinare	10,857	0.309 *(0.025)*	0.114 *(0.012)*	0.058 *(0.008)*	3,355
Central Boteti	**47,738**	**0.425** *(0.023)*	**0.182** *(0.015)*	**0.102** *(0.011)*	**20,289**
Rural	32,857	0.501 *(0.026)*	0.221 *(0.018)*	0.126 *(0.013)*	16,461
Letlhakane	14,881	0.255 *(0.017)*	0.095 *(0.009)*	0.049 *(0.006)*	3,795
Central Tutume	**122,696**	**0.419** *(0.022)*	**0.173** *(0.014)*	**0.095** *(0.009)*	**51,410**
Rural	88,200	0.454 *(0.023)*	0.193 *(0.015)*	0.108 *(0.010)*	40,043
Maitengwe	5,221	0.453 *(0.038)*	0.173 *(0.023)*	0.089 *(0.015)*	2,365
Tutume	13,671	0.345 *(0.026)*	0.127 *(0.014)*	0.064 *(0.009)*	4,716

Table 3: Poverty Indices, by District, Sub-District and Locality (continued...)

Disaggregated Levels (Central Tutume continued)	Population	Poverty Headcount (P0)	Poverty Gap Index (P1)	Poverty Severity Index (P2)	Number of Poor Individuals
Tonota	15,604	0.276 (0.021)	0.099 (0.010)	0.049 (0.006)	4,307
NORTH-EAST	**130,252**	**0.214** (0.035)	**0.078** (0.017)	**0.040** (0.010)	**27,874**
Francistown	**81,003**	**0.159** (0.012)	**0.054** (0.005)	**0.026** (0.003)	**12,879**
Francistown	81,003	0.159 (0.012)	0.054 (0.005)	0.026 (0.003)	12,879
North East	**49,249**	**0.304** (0.073)	**0.118** (0.037)	**0.063** (0.022)	**14,972**
Rural	49,249	0.304 (0.073)	0.118 (0.037)	0.063 (0.022)	14,972
CHOBE	**16,547**	**0.277** (0.030)	**0.112** (0.015)	**0.061** (0.009)	**4,584**
Chobe	**16,547**	**0.277** (0.030)	**0.112** (0.015)	**0.061** (0.009)	**4,584**
Rural	9,195	0.387 (0.036)	0.164 (0.020)	0.091 (0.013)	3,558
Kasane	7,352	0.139 (0.022)	0.046 (0.009)	0.022 (0.005)	1,022
NGAMILAND	**122,115**	**0.419** (0.027)	**0.181** (0.016)	**0.102** (0.011)	**51,166**
Ngamiland East	**71,369**	**0.339** (0.031)	**0.139** (0.016)	**0.077** (0.010)	**24,194**
Rural	27,977	0.532 (0.030)	0.240 (0.021)	0.139 (0.015)	14,884
Maun	43,392	0.214 (0.031)	0.074 (0.014)	0.036 (0.008)	9,286
Ngamiland West	**50,746**	**0.533** (0.031)	**0.239** (0.021)	**0.137** (0.015)	**27,048**
Rural	44,729	0.549 (0.031)	0.248 (0.021)	0.144 (0.016)	24,556
Gumare	6,017	0.418 (0.036)	0.168 (0.021)	0.090 (0.014)	2,515
GHANZI	**32,704**	**0.416** (0.027)	**0.181** (0.017)	**0.102** (0.012)	**13,605**
Ghanzi	**32,704**	**0.416** (0.027)	**0.181** (0.017)	**0.102** (0.012)	**13,605**
Rural	23,176	0.486 (0.031)	0.215 (0.021)	0.123 (0.015)	11,264
Ghanzi	9,528	0.247 (0.021)	0.097 (0.010)	0.051 (0.007)	2,353
KGALAGADI	**41,684**	**0.459** (0.051)	**0.212** (0.036)	**0.126** (0.027)	**19,133**
Kgalagadi South	**25,617**	**0.506** (0.079)	**0.243** (0.057)	**0.148** (0.042)	**12,962**
Rural	19,348	0.598 (0.097)	0.296 (0.072)	0.182 (0.054)	11,570
Tsabong	6,269	0.224 (0.022)	0.082 (0.011)	0.041 (0.007)	1,404
Kgalagadi North	**16,067**	**0.383** (0.026)	**0.163** (0.016)	**0.091** (0.011)	**6,154**
Rural	16,067	0.383 (0.026)	0.163 (0.016)	0.091 (0.011)	6,154

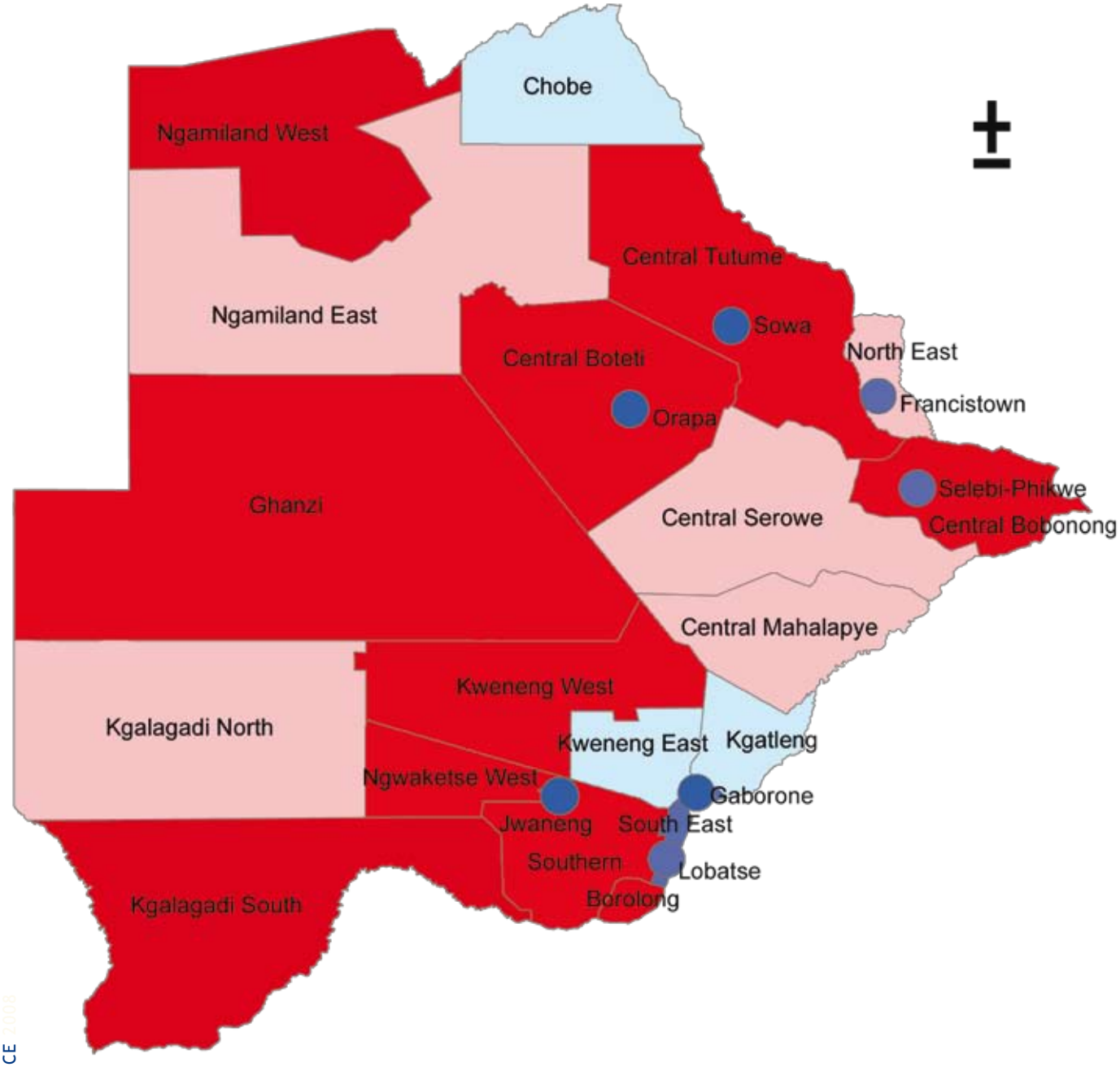
Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.
Note 1: Robust standard errors are in parentheses.
Note 2: The districts are shown in bold and upper case. The associated sub-districts are listed in bold and the localities are shown below their respective sub-districts.
Note 3: Because of the nature of Delta and CKGR sub-districts, they were aggregated with Ngamiland West and Ghanzi respectively.

Map 1: District Level Poverty Headcount



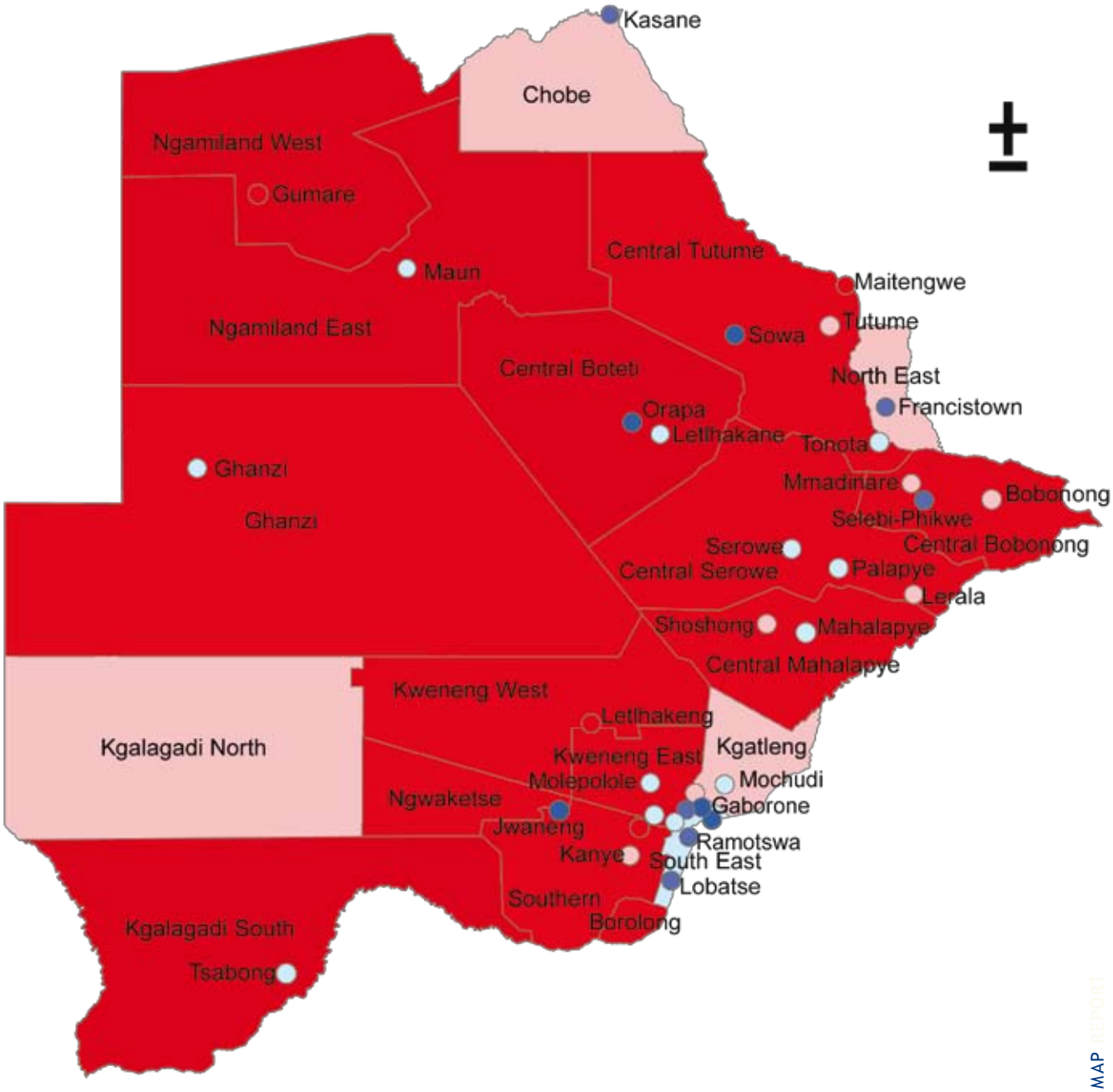
Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.

Map 2: Sub-District-Level Poverty Headcount



Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.

Map 3: Locality-Level Poverty Headcount



Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.

Table 4: Comparison of Poverty Indicators between Locality, Sub-District and District

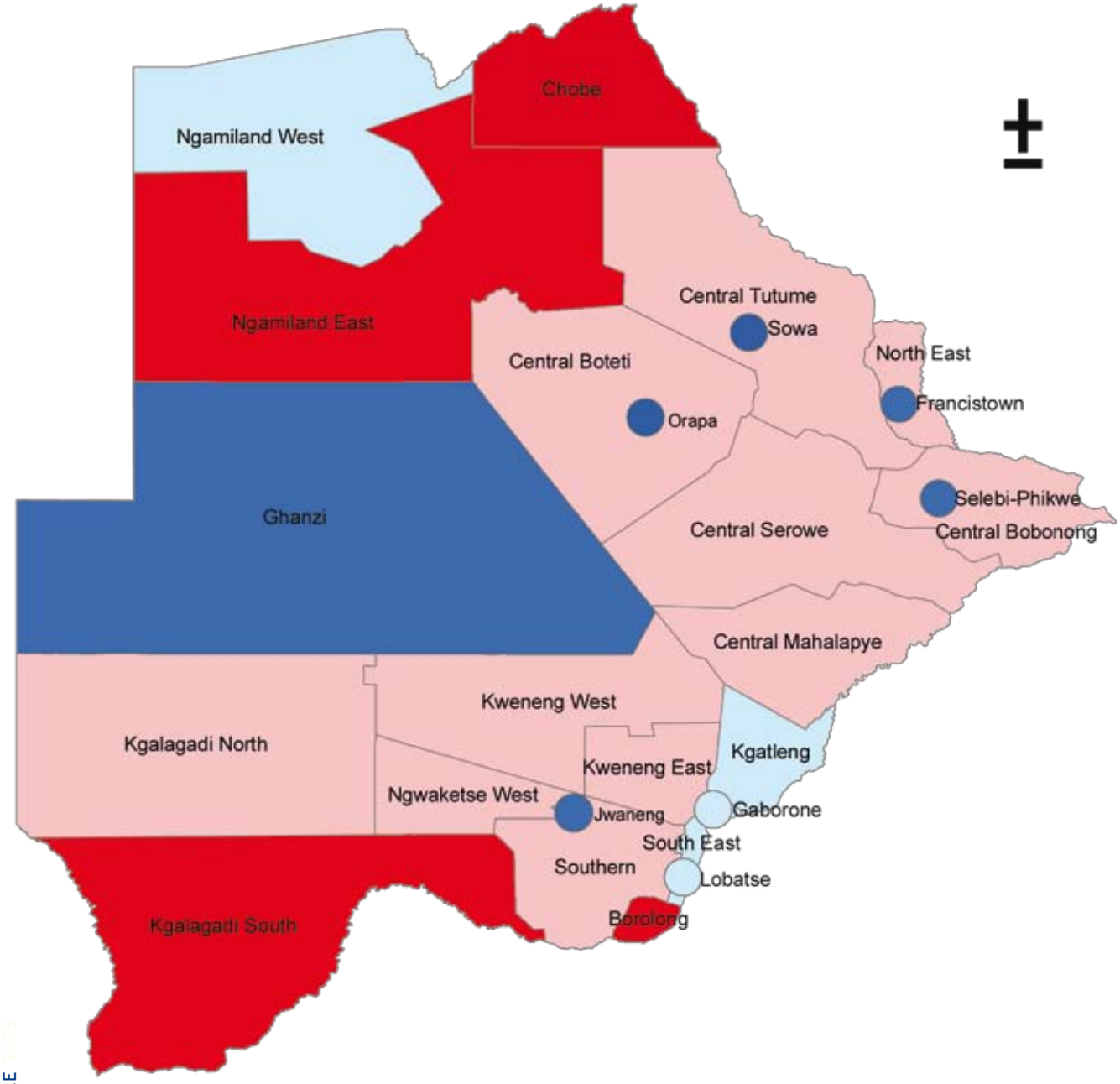
District	Sub-District	Locality	Poverty Headcount (P0)			Poverty Gap Index (P1)		
			Locality compared to ...			Locality compared to ...		
			National	District	Sub-District	National	District	Sub-District
Southern	Jwaneng	Jwaneng	Richer	Richer	Richer	Richer	Richer	Richer
Southern	Ngwaketse	Rural	Poorer	Poorer		Poorer		
Southern	Ngwaketse	Kanye	Poorer		Richer	Poorer		Richer
Southern	Ngwaketse	Moshupa	Poorer		Poorer	Poorer		Poorer
Southern	Borolong	Rural	Poorer		Poorer	Poorer		Poorer
Southern	Ngwaketse West	Rural	Poorer	Poorer	Poorer	Poorer		Poorer
South-East	Gaborone	Gaborone	Richer	Richer	Richer	Richer	Richer	Richer
South-East	Lobatse	Lobatse	Richer	Poorer		Richer	Poorer	
South-East	South East	Rural	Richer	Poorer	Poorer		Poorer	Poorer
South-East	South East	Ramotswa	Richer	Poorer	Poorer	Richer	Poorer	Poorer
South-East	South East	Tlokweng	Richer		Richer	Richer		Richer
Kweneng	Kweneng East	Rural	Poorer	Poorer	Richer	Poorer	Poorer	Richer
Kweneng	Kweneng East	Molepolole		Richer	Richer		Richer	Richer
Kweneng	Kweneng East	Gabane	Richer	Richer	Richer	Richer	Richer	Richer
Kweneng	Kweneng East	Kopong						
Kweneng	Kweneng East	Mogoditshane	Richer	Richer	Richer	Richer	Richer	Richer
Kweneng	Kweneng East	Thamaga		Richer	Richer		Richer	Richer
Kweneng	Kweneng West	Rural	Poorer	Poorer		Poorer	Poorer	
Kweneng	Kweneng West	Letlhakeng	Poorer	Poorer		Poorer		Richer
Kgatleng	Kgatleng	Rural		Poorer	Poorer		Poorer	Poorer
Kgatleng	Kgatleng	Mochudi	Richer	Richer	Richer	Richer	Richer	Richer
Central	Selebi-Phikwe	Selebi-Phikwe	Richer	Richer	Richer	Richer	Richer	Richer
Central	Orapa	Orapa	Richer	Richer	Richer	Richer	Richer	Richer
Central	Sowa Town	Sowa	Richer	Richer		Richer	Richer	
Central	Central Serowe/Palapye	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Central	Central Serowe/Palapye	Serowe	Richer	Richer	Richer	Richer	Richer	Richer
Central	Central Serowe/Palapye	Palapye	Richer	Richer	Richer	Richer	Richer	Richer
Central	Central Serowe/Palapye	Lerala	Poorer		Poorer			Poorer

Table 4: Comparison of Poverty Indicators between Locality, Sub-District and District (Continued...)

District	Sub-District	Locality	Poverty Headcount (P0)			Poverty Gap Index (P1)		
			Locality compared to ...			Locality compared to ...		
			National	District	Sub-District	National	District	Sub-District
Central	Central Mahalapye	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Central	Central Mahalapye	Mahalapye	Richer	Richer	Richer	Richer	Richer	Richer
Central	Central Mahalapye	Shoshong						Richer
Central	Central Bobonong	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Central	Central Bobonong	Bobonong		Richer	Richer		Richer	Richer
Central	Central Bobonong	Mmadinare		Richer	Richer		Richer	Richer
Central	Central Boteti	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Central	Central Boteti	Letlhakane	Richer	Richer	Richer	Richer	Richer	Richer
Central	Central Tutume	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Central	Central Tutume	Maitengwe	Poorer	Poorer		Poorer		
Central	Central Tutume	Tutume			Richer			Richer
Central	Central Tutume	Tonota		Richer	Richer		Richer	Richer
North-East	Francistown	Francistown	Richer	Richer		Richer	Richer	
North-East	North East	Rural						
Chobe	Chobe	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Chobe	Chobe	Kasane	Richer	Richer	Richer	Richer	Richer	Richer
Ngamiland	Ngamiland East	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Ngamiland	Ngamiland East	Maun	Richer	Richer	Richer	Richer	Richer	Richer
Ngamiland	Ngamiland West	Rural	Poorer	Poorer	Poorer	Poorer	Poorer	Poorer
Ngamiland	Ngamiland West	Gumare	Poorer		Richer	Poorer		Richer
Ghanzi	Ghanzi	Rural	Poorer	Poorer	Poorer	Poorer		
Ghanzi	Ghanzi	Ghanzi	Richer	Richer	Richer		Richer	Richer
Kgalagadi	Kgalagadi South	Rural	Poorer			Poorer		
Kgalagadi	Kgalagadi South	Tsabong	Richer	Richer	Richer	Richer	Richer	Richer
Kgalagadi	Kgalagadi North	Rural	Poorer	Richer		Poorer	Richer	

Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.
Note: A Locality is deemed poorer (richer) than its own Sub-District/District if its poverty indicator is more (less) than two standard errors than its Sub-District/District poverty indicator. A blank cell signifying the hypothesis that the poverty indicators are equal cannot be rejected. The same logic applies to the comparison between Locality and national poverty.

Map 4: Gender Gap in Poverty Headcount by Sub-District



Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.

Table 5: Poverty Indices, by Sex of Household Head, District, Sub-District and Area

District/ Sub-District	Sex of Head	Urban				Rural				Total			
		Pop.	P_0	P_1	P_2	Pop.	P_0	P_1	P_2	Pop.	P_0	P_1	P_2
Southern	**Male**	**35,029**	**0.270**	**0.116**	**0.066**	**57,415**	**0.421**	**0.178**	**0.100**	**92,444**	**0.364**	**0.155**	**0.087**
	Female	**36,617**	**0.379**	**0.167**	**0.097**	**56,479**	**0.495**	**0.217**	**0.123**	**93,096**	**0.450**	**0.197**	**0.113**
Jwaneng	Male	9,892	0.079	0.029	0.015	..	..	..	..	9,892	0.079	0.029	0.015
	Female	4,667	0.107	0.035	0.017	..	..	..	..	4,667	0.107	0.035	0.017
Ngwaketse	Male	25,137	0.346	0.150	0.086	29,455	0.442	0.190	0.107	54,592	0.398	0.171	0.097
	Female	31,950	0.419	0.186	0.108	26,644	0.506	0.222	0.127	58,594	0.459	0.202	0.117
Borolong	Male	..	..	..	..	23,109	0.391	0.161	0.089	23,109	0.391	0.161	0.089
	Female	..	..	..	..	24,215	0.477	0.207	0.117	24,215	0.477	0.207	0.117
Ngwaketse West	Male	..	..	..	..	4,851	0.442	0.192	0.109	4,851	0.442	0.192	0.109
	Female	..	..	..	..	5,620	0.520	0.233	0.134	5,620	0.520	0.233	0.134
South-East	**Male**	**147,945**	**0.077**	**0.025**	**0.011**	**10,434**	**0.214**	**0.085**	**0.046**	**158,379**	**0.086**	**0.028**	**0.014**
	Female	**103,911**	**0.135**	**0.043**	**0.020**	**8,015**	**0.287**	**0.116**	**0.063**	**111,926**	**0.146**	**0.049**	**0.023**
Gaborone	Male	111,294	0.057	0.016	0.007	..	..	..	..	111,294	0.057	0.016	0.007
	Female	70,333	0.107	0.033	0.014	..	..	..	..	70,333	0.107	0.033	0.014
Lobatse	Male	15,714	0.167	0.064	0.034	..	..	..	..	15,714	0.167	0.064	0.034
	Female	13,087	0.220	0.077	0.038	..	..	..	..	13,087	0.220	0.077	0.038
South East	Male	20,937	0.116	0.038	0.018	10,434	0.214	0.085	0.046	31,371	0.149	0.054	0.027
	Female	20,491	0.176	0.059	0.028	8,015	0.287	0.116	0.063	28,506	0.207	0.075	0.038
Kweneng	**Male**	**63,394**	**0.194**	**0.068**	**0.034**	**53,634**	**0.426**	**0.184**	**0.104**	**117,028**	**0.300**	**0.121**	**0.066**
	Female	**67,185**	**0.280**	**0.101**	**0.051**	**43,773**	**0.499**	**0.219**	**0.124**	**110,958**	**0.367**	**0.148**	**0.080**
Kweneng East	Male	61,310	0.189	0.066	0.033	35,220	0.408	0.174	0.098	96,530	0.269	0.106	0.056
	Female	63,229	0.269	0.096	0.048	28,304	0.473	0.205	0.116	91,533	0.332	0.130	0.069
Kweneng West	Male	2,084	0.344	0.131	0.067	18,414	0.460	0.203	0.116	20,498	0.448	0.195	0.111
	Female	3,956	0.458	0.182	0.096	15,469	0.546	0.244	0.141	19,425	0.528	0.231	0.131
Kgatleng	**Male**	**16,823**	**0.183**	**0.062**	**0.030**	**19,224**	**0.297**	**0.120**	**0.065**	**36,047**	**0.244**	**0.093**	**0.049**
	Female	**19,888**	**0.234**	**0.081**	**0.040**	**17,264**	**0.380**	**0.159**	**0.088**	**37,152**	**0.302**	**0.117**	**0.062**
Kgatleng	Male	16,823	0.183	0.062	0.030	19,224	0.297	0.120	0.065	36,047	0.244	0.093	0.049
	Female	19,888	0.234	0.081	0.040	17,264	0.380	0.159	0.088	37,152	0.302	0.117	0.062
Central	**Male**	**115,735**	**0.186**	**0.066**	**0.033**	**143,588**	**0.440**	**0.188**	**0.106**	**259,323**	**0.327**	**0.134**	**0.073**
	Female	**139,616**	**0.287**	**0.104**	**0.052**	**158,162**	**0.511**	**0.224**	**0.128**	**297,778**	**0.406**	**0.168**	**0.092**

Table 5: Poverty Indices, by Sex of Household Head, District, Sub-District and Area (continued...)

District/ Sub-District	Sex of Head	Urban				Rural				Total			
		Pop.	P_0	P_1	P_2	Pop.	P_0	P_1	P_2	Pop.	P_0	P_1	P_2
Selebi-Phikwe	Male	28,881	0.141	0.049	0.024	..	..	..	..	28,881	0.141	0.049	0.024
	Female	19,944	0.179	0.057	0.026	..	..	..	..	19,944	0.179	0.057	0.026
Orapa	Male	5,889	0.017	0.005	0.002	..	..	..	..	5,889	0.017	0.005	0.002
	Female	2,417	0.018	0.005	0.002	..	..	..	..	2,417	0.018	0.005	0.002
Sowa Town	Male	1,905	0.035	0.010	0.005	..	..	..	..	1,905	0.035	0.010	0.005
	Female	821	0.030	0.008	0.003	..	..	..	..	821	0.030	0.008	0.003
Central Serowe/Palapye	Male	29,065	0.192	0.068	0.034	37,441	0.451	0.194	0.110	66,506	0.338	0.139	0.076
	Female	44,778	0.290	0.107	0.054	40,600	0.523	0.232	0.133	85,378	0.401	0.166	0.092
Central Mahalapye	Male	18,146	0.201	0.071	0.035	29,572	0.440	0.188	0.105	47,718	0.349	0.143	0.078
	Female	27,742	0.297	0.107	0.054	32,864	0.520	0.229	0.131	60,606	0.418	0.174	0.096
Central Bobonong	Male	9,816	0.252	0.090	0.045	18,667	0.429	0.182	0.102	28,483	0.368	0.150	0.082
	Female	15,570	0.342	0.128	0.065	22,549	0.521	0.230	0.131	38,119	0.448	0.188	0.104
Central Boteti	Male	7,810	0.189	0.070	0.036	17,119	0.478	0.210	0.120	24,929	0.387	0.166	0.094
	Female	7,200	0.325	0.122	0.063	15,609	0.522	0.232	0.133	22,809	0.460	0.197	0.111
Central Tutume	Male	14,223	0.290	0.106	0.053	40,789	0.418	0.176	0.098	55,012	0.385	0.158	0.087
	Female	21,144	0.358	0.132	0.066	46,540	0.486	0.210	0.118	67,684	0.446	0.185	0.102
North-East	**Male**	**44,848**	**0.145**	**0.051**	**0.026**	**21,096**	**0.264**	**0.101**	**0.053**	**65,944**	**0.183**	**0.067**	**0.034**
	Female	**36,155**	**0.176**	**0.056**	**0.026**	**28,153**	**0.334**	**0.131**	**0.070**	**64,308**	**0.245**	**0.089**	**0.046**
Francistown	Male	44,848	0.145	0.051	0.026	..	..	..	..	44,848	0.145	0.051	0.026
	Female	36,155	0.176	0.056	0.026	..	..	..	..	36,155	0.176	0.056	0.026
North East	Male	..	..	..	..	21,096	0.264	0.101	0.053	21,096	0.264	0.101	0.053
	Female	..	..	..	..	28,153	0.334	0.131	0.070	28,153	0.334	0.131	0.070
Chobe	**Male**	**3,745**	**0.096**	**0.032**	**0.015**	**4,266**	**0.328**	**0.135**	**0.074**	**8,011**	**0.220**	**0.087**	**0.047**
	Female	**3,676**	**0.178**	**0.061**	**0.029**	**4,860**	**0.452**	**0.195**	**0.110**	**8,536**	**0.334**	**0.137**	**0.075**
Chobe	Male	3,745	0.096	0.032	0.015	4,266	0.328	0.135	0.074	8,011	0.220	0.087	0.047
	Female	3,676	0.178	0.061	0.029	4,860	0.452	0.195	0.110	8,536	0.334	0.137	0.075
Ngamiland	**Male**	**21,720**	**0.168**	**0.059**	**0.029**	**32,479**	**0.519**	**0.234**	**0.136**	**54,199**	**0.378**	**0.164**	**0.093**
	Female	**29,354**	**0.300**	**0.111**	**0.056**	**38,562**	**0.572**	**0.261**	**0.152**	**67,916**	**0.455**	**0.196**	**0.111**

Table 5: Poverty Indices, by Sex of Household Head, District, Sub-District and Area (continued...)

District/ Sub-District	Sex of Head	Urban					Rural					Total			
		Pop.	P_0	P_1	P_2		Pop.	P_0	P_1	P_2		Pop.	P_0	P_1	P_2
Ngamiland East	Male	18,501	0.140	0.046	0.022		13,991	0.498	0.222	0.128		32,492	0.294	0.122	0.068
	Female	24,999	0.268	0.096	0.047		13,878	0.576	0.264	0.154		38,877	0.378	0.156	0.085
Ngamiland West	Male	3,219	0.332	0.131	0.069		18,488	0.534	0.243	0.141		21,707	0.504	0.226	0.131
	Female	4,355	0.482	0.198	0.106		24,684	0.570	0.259	0.151		29,039	0.557	0.250	0.144
Ghanzi	**Male**	**5,319**	**0.238**	**0.098**	**0.053**		**14,105**	**0.471**	**0.208**	**0.119**		**19,424**	**0.407**	**0.178**	**0.101**
	Female	**5,067**	**0.316**	**0.125**	**0.066**		**8,213**	**0.508**	**0.226**	**0.130**		**13,280**	**0.435**	**0.188**	**0.106**
Ghanzi	Male	5,319	0.238	0.098	0.053		14,105	0.471	0.208	0.119		19,424	0.407	0.178	0.101
	Female	5,067	0.316	0.125	0.066		8,213	0.508	0.226	0.130		13,280	0.435	0.188	0.106
Kgalagadi	**Male**	**3,157**	**0.163**	**0.058**	**0.029**		**19,434**	**0.463**	**0.213**	**0.126**		**22,591**	**0.421**	**0.191**	**0.112**
	Female	**3,133**	**0.287**	**0.108**	**0.055**		**15,960**	**0.543**	**0.260**	**0.157**		**19,093**	**0.501**	**0.235**	**0.141**
Kgalagadi South	Male	3,157	0.163	0.058	0.029		10,870	0.552	0.266	0.161		14,027	0.465	0.219	0.131
	Female	3,133	0.287	0.108	0.055		8,457	0.650	0.330	0.206		11,590	0.552	0.270	0.165
Kgalagadi North	Male	..	..	..	..		8,564	0.350	0.145	0.081		8,564	0.350	0.145	0.081
	Female	..	..	..	..		7,503	0.422	0.182	0.103		7,503	0.422	0.182	0.103

Sources: Authors' calculations based on the HIES 2002/03 and Census 2001.
Note 1: Robust standard errors associated with these figures are available on request.
Note 2: The districts are shown in bold. The associated sub-districts are listed below each district.
Note 3: Because of the nature of Delta and CKGR sub-districts, they were aggregated with Ngamiland West and Ghanzi respectively.
Note 4: Population (Pop.) refers to the number of individuals having either a Male or a Female Household Head.

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Annex 1: Methodology

The basic idea behind the methodology developed by Elbers, Lanjouw and Lanjouw (2002, 2003) cannot be challenged for its accuracy. Firstly, a regression model of a log of per capita expenditure is estimated using survey data, employing a set of explanatory variables that are common to both the HIES survey and the 2001 Census. Secondly, parameters from the regression are used to predict expenditures for every household in the Census. And thirdly, a series of welfare indicators are constructed for different geographical subgroups.

The term 'welfare indicator' embraces an entire set of indicators based on household expenditures. This note puts 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 requires complex computations, if one wants to take into account spatial autocorrelation and heteroskedasticity in the regression model. Furthermore, proper calculation of the different welfare indicators and standard errors tremendously increases the methodology's complexities.

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

Stage 1

In the first instance, we needed 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 HIES.

We started by checking the wording of the different questions as well as the proposed answer options. From the set of selected questions, we then built a series of variables which would be tested for comparability. Although we might have wanted to test the comparability of the entire distribution of each variable, in practice we restrained 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 is not presented in this note, but can be obtained upon request.

Stage 2

We first modelled the per capita household expenditure[9] using the limited sample survey. In order to maximise accuracy, we estimated the model at the

[9] *In our study we used the Welfare Index constructed for the HIES Poverty Profile. Although this Welfare Index is defined in terms of equivalent adults, the demonstration remains unchanged.*

lowest geographical level for which the survey is representative. In the case of the HIES, that level is the sampling strata: Gaborone, Other Towns & Cities, Urban Villages and Rural Villages.

Let us 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:

$$(1) \qquad \ln y_{ch} = \mathrm{E}\left[\ln y_{ch} \mid \mathrm{x}_{ch} \right] + u_{ch}$$

The locations represent clusters as defined in the first stage of typical household sampling design. They usually also represent census enumeration areas, although not necessarily so. The explanatory variables need to be present in both the HIES and the Census, and need to be defined similarly.

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

$$(2) \qquad \ln y_{ch} = \mathrm{x}_{ch}\,\beta + u_{ch}$$

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

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

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

In practice we first estimated equation (2) by simple ⊙LS and used the residuals as an estimate of the overall disturbances, given by μ_{ch}. We then decomposed these residuals between uncorrelated household and location components:

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

The location term ($\hat{\eta}_c$) is estimated as the 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 regressing its squared (e^2_{ch}) on a long list of 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 then the sum of $\hat{\Sigma}$, the estimated variance-covariance matrix of the original model (2). The latest matrix allowed us to estimate the final set of coefficients of the main model (2).

Stage 3

To complete the Poverty Map, we associated 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 simulated for each household found in the census a value of welfare index ($\hat{y}^r_{ch}$) based on the predicted values and the disturbance terms:

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

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

Annex 2: Data Predictors & Means Testing

Annex 2a: Definition of the Different Predictors

hhsize	Household size
kid06	Number of children aged between 0 and 6
boy714	Number of boys aged between 7 and 14
girl714	Number of girls aged between 7 and 14
male	Number of adult males aged between 15 and 64
female	Number of adult females aged between 15 and 64
elderly	Number of elderly aged 65 or more
hedu	Household head years of schooling
sedu	Spouse years of schooling
headmale	=1 if household head is a male; 0 if not
literate	=1 if household head is literate; 0 if not
noneduc	=1 if household head has no formal education; 0 if not
primary	=1 if household head went to primary school (at most); 0 if not
secondary	=1 if household head went to secondary school (at most); 0 if not
tertiary	=1 if household head went to post secondary school; 0 if not
single	=1 if household head is single; 0 if not
couple	=1 if household head is in couple; 0 if not
primesec	=1 if household head works in the primary sector; 0 if not
secesec	=1 if household head works in the secondary sector; 0 if not
teresec	=1 if household head works in the tertiary sector; 0 if not
empl	=1 if household head works as an employee; 0 if not
selfempl	=1 if household head is self-employed; 0 if not
fathsurv	=1 if household head's father is still alive; 0 if not
mothsurv	=1 if household head's mother is still alive; 0 if not
agehd	Age of household head (in years)
no_spouse	=1 if there is no spouse in the household; 0 if not
noneducsp	=1 if spouse has no formal education; 0 if not
primarysp	=1 if spouse went to primary school (at most); 0 if not
secondarysp	=1 if spouse went to secondary school (at most); 0 if not
tertiarysp	=1 if spouse went to post secondary school; 0 if not
primesecsp	=1 if spouse works in the primary sector; 0 if not
secesecsp	=1 if spouse works in the secondary sector; 0 if not
teresecsp	=1 if spouse works in the tertiary sector; 0 if not
emplsp	=1 if spouse works as an employee; 0 if not
selfemplsp	=1 if spouse is self-employed; 0 if not
fathsurvsp	=1 if spouse's father is still alive; 0 if not
mothsurvsp	=1 if spouse's mother is still alive; 0 if not
agesp	Age of spouse (in years)
pocc	Proportion of household members being occupied (employed)
psch	Proportion of household members currently going to school
self_built	=1 if household built its own dwelling; 0 if not
other_house	=1 if household purchased its own dwelling; 0 if not
indiv_rent	=1 if household rents its dwelling from an individual; 0 if not
pubcomp_rent	=1 if household rents its dwelling from a public corporation; 0 if not
pip_in	=1 if household uses piped indoor as its main source water; 0 if not
pip_out	=1 if household uses piped outdoor as its main source of water; 0 if not

hhsize	Household size
com_tap	=1 if household uses communal tap as its main source of water; 0 if not
borehole	=1 if household uses borehole as its main source of water; 0 if not
flush_toi	=1 if household uses flush toilet; 0 if not
vip_toi	=1 if household uses ventilated improved pit latrine; 0 if not
lat_toi	=1 if household uses latrine; 0 if not
other_toi	=1 if household uses other types of toilet; 0 if not
elec_cook	=1 if household uses electricity for cooking; 0 if not
wood_cook	=1 if household uses wood for cooking; 0 if not
gas_cook	=1 if household uses gas for cooking; 0 if not
para_cook	=1 if household uses paraffin for cooking; 0 if not
elec_light	=1 if household uses electricity for lighting; 0 if not
elec_heat	=1 if household uses electricity for heating; 0 if not
wood_heat	=1 if household uses wood for heating; 0 if not
none_heat	=1 if household does not use any combustible for heating; 0 if not
other_heat	=1 if household uses other types of combustible for heating; 0 if not
room	Number of rooms in dwelling
van	=1 if household owns a van; 0 if not
car	=1 if household owns a car; 0 if not
tractor	=1 if household owns a tractor; 0 if not
bike	=1 if household owns a bicycle; 0 if not
cart	=1 if household owns a cart; 0 if not
barrow	=1 if household owns a barrow; 0 if not
phone	=1 if household owns a phone; 0 if not
pc	=1 if household owns a personal computer; 0 if not
radio	=1 if household owns a radio; 0 if not
tv	=1 if household owns a television; 0 if not
d1	=1 if household resides in Gaborone sub-district; 0 if not
d2	=1 if household resides in Francistown sub-district; 0 if not
d3	=1 if household resides in Lobatse sub-district; 0 if not
d4	=1 if household resides in Selebi-Phikwe sub-district; 0 if not
d5	=1 if household resides in Orapa sub-district; 0 if not
d6	=1 if household resides in Jwaneng sub-district; 0 if not
d7	=1 if household resides in Sowa Town sub-district; 0 if not
d10	=1 if household resides in Ngwaketse sub-district; 0 if not
d11	=1 if household resides in Borolong sub-district; 0 if not
d12	=1 if household resides in Ngwaketse West sub-district; 0 if not
d20	=1 if household resides in South East sub-district; 0 if not
d30	=1 if household resides in Kweneng East sub-district; 0 if not
d31	=1 if household resides in Kweneng West sub-district; 0 if not
d40	=1 if household resides in Kgatleng sub-district; 0 if not
d50	=1 if household resides in Central Serowe/Palapye sub-district; 0 if not
d51	=1 if household resides in Central Mahalapye sub-district; 0 if not
d52	=1 if household resides in Central Bobonong sub-district; 0 if not
d53	=1 if household resides in Central Boteti sub-district; 0 if not
d54	=1 if household resides in Central Tutume sub-district; 0 if not
d60	=1 if household resides in North East sub-district; 0 if not
d70	=1 if household resides in Ngamiland East sub-district; 0 if not
d71	=1 if household resides in Ngamiland West sub-district; 0 if not
d72	=1 if household resides in Chobe sub-district; 0 if not
d80	=1 if household resides in Ghanzi sub-district; 0 if not
d90	=1 if household resides in Kgalagadi South sub-district; 0 if not

Annex 2b: Aligning the Data, Test on Equality of Means

	Gaborone				Other Towns & Cities			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
Households	3.106	3.185	0.085	Not Rejected	3.341	3.556	0.093	Rejected
kid06	0.359	0.370	0.022	Not Rejected	0.473	0.487	0.029	Not Rejected
boy714	0.202	0.232	0.015	Rejected	0.257	0.336	0.023	Rejected
girl714	0.231	0.251	0.017	Not Rejected	0.294	0.357	0.020	Rejected
male	1.115	1.078	0.028	Not Rejected	1.085	1.065	0.034	Not Rejected
female	1.157	1.227	0.035	Rejected	1.174	1.245	0.035	Rejected
elderly	0.041	0.027	0.005	Rejected	0.059	0.066	0.009	Not Rejected
hedu	9.971	9.993	0.324	Not Rejected	8.729	8.526	0.286	Not Rejected
sedu	3.462	3.678	0.252	Not Rejected	2.850	2.880	0.220	Not Rejected
headmale	0.610	0.605	0.015	Not Rejected	0.598	0.594	0.020	Not Rejected
literate	0.880	0.883	0.012	Not Rejected	0.839	0.821	0.019	Not Rejected
noneduc	0.097	0.100	0.011	Not Rejected	0.123	0.139	0.015	Not Rejected
primary	0.249	0.252	0.017	Not Rejected	0.329	0.338	0.019	Not Rejected
secondary	0.519	0.483	0.017	Rejected	0.490	0.461	0.021	Not Rejected
tertiary	0.135	0.165	0.025	Not Rejected	0.058	0.062	0.014	Not Rejected
single	0.469	0.465	0.020	Not Rejected	0.415	0.416	0.022	Not Rejected
couple	0.509	0.502	0.020	Not Rejected	0.550	0.529	0.023	Not Rejected
primesec	0.006	0.005	0.002	Not Rejected	0.007	0.010	0.003	Not Rejected
secesec	0.203	0.237	0.014	Rejected	0.318	0.368	0.029	Not Rejected
teresec	0.643	0.641	0.018	Not Rejected	0.479	0.476	0.027	Not Rejected
empl	0.772	0.793	0.011	Not Rejected	0.718	0.742	0.022	Not Rejected
selfempl	0.085	0.091	0.008	Not Rejected	0.087	0.112	0.012	Rejected
fathsurv	0.498	0.470	0.014	Rejected	0.457	0.416	0.015	Rejected
mothsurv	0.773	0.737	0.011	Rejected	0.735	0.685	0.015	Rejected
agehd	35.8	37.6	0.48	Rejected	36.9	39.2	0.48	Rejected
no_spouse	0.661	0.644	0.018	Not Rejected	0.679	0.669	0.019	Not Rejected
noneducsp	0.020	0.023	0.004	Not Rejected	0.032	0.031	0.005	Not Rejected
primarysp	0.073	0.072	0.008	Not Rejected	0.103	0.116	0.011	Not Rejected
secondarysp	0.197	0.195	0.014	Not Rejected	0.170	0.170	0.014	Not Rejected
tertiarysp	0.048	0.066	0.012	Not Rejected	0.016	0.014	0.005	Not Rejected
primesecsp	0.002	0.003	0.002	Not Rejected	0.002	0.003	0.001	Not Rejected
secesecsp	0.041	0.054	0.006	Rejected	0.049	0.044	0.005	Not Rejected
teresecsp	0.169	0.176	0.014	Not Rejected	0.123	0.121	0.012	Not Rejected
emplsp	0.186	0.200	0.013	Not Rejected	0.140	0.126	0.012	Not Rejected
selfemplsp	0.028	0.032	0.006	Not Rejected	0.034	0.041	0.007	Not Rejected
fathsurvsp	0.179	0.190	0.013	Not Rejected	0.161	0.160	0.013	Not Rejected
mothsurvsp	0.268	0.276	0.015	Not Rejected	0.246	0.253	0.017	Not Rejected
agesp	11.7	12.6	0.78	Not Rejected	11.2	12.2	0.73	Not Rejected
pocc	0.609	0.591	0.012	Not Rejected	0.551	0.529	0.013	Not Rejected
psch	0.149	0.167	0.009	Rejected	0.171	0.213	0.009	Rejected
self_built	0.128	0.155	0.019	Not Rejected	0.199	0.216	0.022	Not Rejected
other_house	0.179	0.134	0.020	Rejected	0.141	0.124	0.020	Not Rejected
pip_in	0.492	0.460	0.051	Not Rejected	0.405	0.421	0.051	Not Rejected
pip_out	0.276	0.403	0.045	Rejected	0.306	0.337	0.041	Not Rejected
com_tap	0.230	0.108	0.032	Rejected	0.281	0.204	0.033	Rejected

Annex 2b: Aligning the Data, Test on Equality of Means (continued...)

	Gaborone				Other Towns & Cities			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
borehole	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
other_wate	0.002	0.028	0.007	Rejected	0.008	0.038	0.011	Rejected
flush_toi	0.511	0.457	0.051	Not Rejected	0.438	0.442	0.050	Not Rejected
vip_toi	0.224	0.303	0.039	Rejected	0.202	0.269	0.035	Not Rejected
lat_toi	0.258	0.234	0.036	Not Rejected	0.329	0.260	0.038	Not Rejected
other_toi	0.007	0.006	0.002	Not Rejected	0.031	0.028	0.008	Not Rejected
elec_cook	0.146	0.114	0.023	Not Rejected	0.107	0.123	0.026	Not Rejected
wood_cook	0.016	0.004	0.002	Rejected	0.121	0.101	0.016	Not Rejected
gas_cook	0.714	0.785	0.022	Rejected	0.613	0.637	0.027	Not Rejected
para_cook	0.125	0.098	0.015	Not Rejected	0.159	0.139	0.017	Not Rejected
elec_light	0.491	0.488	0.045	Not Rejected	0.438	0.473	0.045	Not Rejected
elec_heat	0.205	0.219	0.031	Not Rejected	0.156	0.156	0.024	Not Rejected
wood_heat	0.156	0.087	0.014	Rejected	0.276	0.218	0.025	Rejected
none_heat	0.561	0.664	0.031	Rejected	0.492	0.610	0.025	Rejected
other_heat	0.078	0.030	0.007	Rejected	0.076	0.016	0.005	Rejected
room	1.972	2.240	0.114	Rejected	2.164	2.313	0.087	Not Rejected
indiv_rent	0.480	0.512	0.039	Not Rejected	0.410	0.395	0.036	Not Rejected
ubcomp_rent	0.214	0.198	0.036	Not Rejected	0.250	0.265	0.048	Not Rejected
van	0.157	0.175	0.019	Not Rejected	0.142	0.157	0.021	Not Rejected
car	0.224	0.432	0.046	Rejected	0.149	0.386	0.052	Rejected
tractor	0.022	0.009	0.003	Rejected	0.023	0.008	0.003	Rejected
bike	0.125	0.119	0.012	Not Rejected	0.146	0.119	0.012	Rejected
cart	0.047	0.019	0.004	Rejected	0.064	0.032	0.005	Rejected
barrow	0.245	0.255	0.017	Not Rejected	0.300	0.306	0.018	Not Rejected
phone	0.584	0.613	0.036	Not Rejected	0.466	0.519	0.034	Not Rejected
pc	0.126	0.152	0.024	Not Rejected	0.055	0.071	0.015	Not Rejected
radio	0.762	0.752	0.017	Not Rejected	0.755	0.726	0.018	Not Rejected
tv	0.486	0.500	0.037	Not Rejected	0.391	0.423	0.033	Not Rejected
d1	1.000	1.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d2	0.000	0.000	0.000	Not Rejected	0.419	0.419	0.059	Not Rejected
d3	0.000	0.000	0.000	Not Rejected	0.155	0.158	0.043	Not Rejected
d4	0.000	0.000	0.000	Not Rejected	0.277	0.279	0.053	Not Rejected
d5	0.000	0.000	0.000	Not Rejected	0.047	0.044	0.024	Not Rejected
d6	0.000	0.000	0.000	Not Rejected	0.085	0.083	0.032	Not Rejected
d7	0.000	0.000	0.000	Not Rejected	0.018	0.016	0.016	Not Rejected
d10	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d11	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d12	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d20	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d30	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d31	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d40	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d50	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d51	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d52	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected

	Gaborone				Other Towns & Cities			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
d53	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d54	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d60	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d70	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d71	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d72	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d80	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d90	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected

	Urban Villages				Rural Villages			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
hhsize	4.356	4.489	0.131	Not Rejected	4.496	4.394	0.172	Not Rejected
kid06	0.717	0.683	0.036	Not Rejected	0.848	0.899	0.051	Not Rejected
boy714	0.388	0.448	0.024	Rejected	0.554	0.531	0.037	Not Rejected
girl714	0.444	0.499	0.027	Rejected	0.499	0.494	0.043	Not Rejected
male	1.138	1.106	0.032	Not Rejected	1.104	1.003	0.037	Rejected
female	1.428	1.493	0.041	Not Rejected	1.177	1.151	0.057	Not Rejected
elderly	0.241	0.259	0.021	Not Rejected	0.315	0.317	0.020	Not Rejected
hedu	6.631	6.670	0.311	Not Rejected	4.271	3.786	0.222	Rejected
sedu	1.901	1.982	0.136	Not Rejected	1.114	1.155	0.116	Not Rejected
headmale	0.479	0.477	0.016	Not Rejected	0.538	0.535	0.023	Not Rejected
literate	0.663	0.657	0.023	Not Rejected	0.464	0.424	0.022	Not Rejected
noneduc	0.271	0.279	0.019	Not Rejected	0.457	0.507	0.023	Rejected
primary	0.347	0.336	0.016	Not Rejected	0.338	0.327	0.017	Not Rejected
secondary	0.343	0.336	0.022	Not Rejected	0.193	0.158	0.015	Rejected
tertiary	0.039	0.049	0.009	Not Rejected	0.013	0.008	0.003	Not Rejected
single	0.380	0.388	0.017	Not Rejected	0.345	0.357	0.019	Not Rejected
couple	0.520	0.466	0.018	Rejected	0.546	0.480	0.018	Rejected
primesec	0.022	0.049	0.009	Rejected	0.156	0.307	0.041	Rejected
secesec	0.129	0.149	0.014	Not Rejected	0.079	0.080	0.016	Not Rejected
teresec	0.389	0.441	0.023	Rejected	0.214	0.215	0.024	Not Rejected
empl	0.450	0.498	0.027	Not Rejected	0.339	0.328	0.029	Not Rejected
selfempl	0.094	0.140	0.014	Rejected	0.122	0.273	0.032	Rejected
fathsurv	0.360	0.311	0.016	Rejected	0.319	0.270	0.013	Rejected
mothsurv	0.602	0.545	0.020	Rejected	0.536	0.489	0.015	Rejected
agehd	44.0	46.4	0.95	Rejected	47.0	49.3	0.73	Rejected
no_spouse	0.719	0.706	0.014	Not Rejected	0.712	0.692	0.015	Not Rejected
noneducsp	0.065	0.064	0.008	Not Rejected	0.138	0.147	0.015	Not Rejected
primarysp	0.110	0.119	0.009	Not Rejected	0.105	0.117	0.011	Not Rejected
secondarysp	0.096	0.097	0.010	Not Rejected	0.042	0.043	0.009	Not Rejected
tertiarysp	0.010	0.015	0.004	Not Rejected	0.003	0.002	0.001	Not Rejected
primesecsp	0.005	0.009	0.003	Not Rejected	0.021	0.055	0.008	Rejected
secesecsp	0.025	0.025	0.004	Not Rejected	0.016	0.016	0.004	Not Rejected

Annex 2b: Aligning the Data, Test on Equality of Means (continued...)

	Urban Villages				Rural Villages			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
teresecsp	0.091	0.095	0.008	Not Rejected	0.045	0.055	0.010	Not Rejected
emplsp	0.094	0.088	0.008	Not Rejected	0.058	0.056	0.009	Not Rejected
selfemplsp	0.028	0.041	0.005	Rejected	0.028	0.069	0.010	Rejected
fathsurvsp	0.111	0.103	0.010	Not Rejected	0.096	0.092	0.010	Not Rejected
mothsurvsp	0.184	0.172	0.014	Not Rejected	0.163	0.172	0.013	Not Rejected
agesp	11.8	12.8	0.65	Not Rejected	13.2	14.4	0.69	Not Rejected
pocc	0.370	0.383	0.017	Not Rejected	0.304	0.391	0.029	Rejected
psch	0.221	0.244	0.009	Rejected	0.237	0.196	0.015	Rejected
self_built	0.623	0.620	0.033	Not Rejected	0.773	0.762	0.027	Not Rejected
other_house	0.111	0.078	0.008	Rejected	0.139	0.150	0.024	Not Rejected
pip_in	0.195	0.196	0.029	Not Rejected	0.067	0.051	0.012	Not Rejected
pip_out	0.456	0.500	0.027	Not Rejected	0.160	0.162	0.032	Not Rejected
com_tap	0.316	0.253	0.025	Rejected	0.506	0.446	0.049	Not Rejected
borehole	0.001	0.000	0.000	Rejected	0.123	0.050	0.022	Rejected
other_wate	0.033	0.051	0.008	Rejected	0.144	0.291	0.046	Rejected
flush_toi	0.177	0.195	0.029	Not Rejected	0.068	0.073	0.021	Not Rejected
vip_toi	0.268	0.281	0.027	Not Rejected	0.141	0.136	0.024	Not Rejected
lat_toi	0.388	0.411	0.030	Not Rejected	0.241	0.221	0.032	Not Rejected
other_toi	0.167	0.113	0.014	Rejected	0.550	0.571	0.046	Not Rejected
elec_cook	0.034	0.035	0.007	Not Rejected	0.011	0.009	0.007	Not Rejected
wood_cook	0.386	0.354	0.028	Not Rejected	0.785	0.809	0.033	Not Rejected
gas_cook	0.510	0.556	0.024	Not Rejected	0.170	0.168	0.028	Not Rejected
para_cook	0.070	0.054	0.007	Rejected	0.035	0.014	0.006	Rejected
elec_light	0.286	0.355	0.027	Rejected	0.080	0.070	0.015	Not Rejected
elec_heat	0.077	0.074	0.009	Not Rejected	0.022	0.014	0.006	Not Rejected
wood_heat	0.575	0.489	0.033	Rejected	0.834	0.847	0.027	Not Rejected
none_heat	0.298	0.414	0.031	Rejected	0.113	0.126	0.025	Not Rejected
other_heat	0.051	0.022	0.004	Rejected	0.031	0.012	0.003	Rejected
room	2.548	2.777	0.071	Rejected	2.264	2.441	0.083	Rejected
indiv_rent	0.182	0.186	0.024	Not Rejected	0.033	0.033	0.011	Not Rejected
ubcomp_rent	0.084	0.116	0.026	Not Rejected	0.055	0.055	0.011	Not Rejected
van	0.136	0.129	0.012	Not Rejected	0.086	0.050	0.007	Rejected
car	0.118	0.241	0.039	Rejected	0.064	0.266	0.055	Rejected
tractor	0.035	0.017	0.003	Rejected	0.029	0.013	0.004	Rejected
bike	0.172	0.135	0.012	Rejected	0.174	0.156	0.020	Not Rejected
cart	0.132	0.112	0.011	Not Rejected	0.224	0.250	0.026	Not Rejected
barrow	0.485	0.500	0.023	Not Rejected	0.420	0.405	0.033	Not Rejected
phone	0.406	0.512	0.027	Rejected	0.153	0.153	0.024	Not Rejected
pc	0.030	0.029	0.005	Not Rejected	0.010	0.011	0.003	Not Rejected
radio	0.730	0.691	0.015	Rejected	0.579	0.504	0.019	Rejected
tv	0.272	0.312	0.023	Not Rejected	0.109	0.062	0.013	Rejected
d1	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d2	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d3	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d4	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected

Annex 2b: Aligning the Data, Test on Equality of Means (continued...)

	Urban Villages				Rural Villages			
	Census	Survey		Test on Equality of Means (95%)	Census	Survey		Test on Equality of Means (95%)
	Mean	Mean	s.d.		Mean	Mean	s.d.	
d5	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d6	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d7	0.000	0.000	0.000	Not Rejected	0.000	0.000	0.000	Not Rejected
d10	0.100	0.104	0.033	Not Rejected	0.073	0.079	0.035	Not Rejected
d11	0.000	0.000	0.000	Not Rejected	0.062	0.053	0.030	Not Rejected
d12	0.000	0.000	0.000	Not Rejected	0.014	0.014	0.014	Not Rejected
d20	0.080	0.091	0.033	Not Rejected	0.029	0.033	0.023	Not Rejected
d30	0.239	0.234	0.047	Not Rejected	0.085	0.082	0.036	Not Rejected
d31	0.011	0.000	0.000	Rejected	0.044	0.038	0.027	Not Rejected
d40	0.064	0.073	0.029	Not Rejected	0.055	0.062	0.030	Not Rejected
d50	0.135	0.130	0.037	Not Rejected	0.103	0.097	0.038	Not Rejected
d51	0.082	0.079	0.029	Not Rejected	0.081	0.085	0.036	Not Rejected
d52	0.047	0.050	0.024	Not Rejected	0.055	0.054	0.031	Not Rejected
d53	0.029	0.039	0.022	Not Rejected	0.040	0.050	0.028	Not Rejected
d54	0.063	0.059	0.026	Not Rejected	0.116	0.114	0.042	Not Rejected
d60	0.000	0.000	0.000	Not Rejected	0.065	0.048	0.028	Not Rejected
d70	0.080	0.079	0.029	Not Rejected	0.034	0.031	0.022	Not Rejected
d71	0.011	0.014	0.014	Not Rejected	0.052	0.070	0.034	Not Rejected
d72	0.018	0.012	0.012	Not Rejected	0.014	0.015	0.015	Not Rejected
d80	0.022	0.025	0.017	Not Rejected	0.030	0.018	0.018	Not Rejected
d90	0.014	0.011	0.011	Not Rejected	0.024	0.033	0.023	Not Rejected

Annex 3: Survey-Based Regression Models

Strata 1: Gaborone

OLS Result				
Number of observations				1416
R-square				0.473899
Adj. R-square				0.469399
Var	**Coef.**	**Std.Err.**	**t**	**Prob>|t|**
Intercept	0.2381769	0.098491	2.418	0.0157
LNHHSIZE	-0.1701538	0.0425679	-3.997	<.0001
HEDU	0.0435303	0.0052495	8.292	<.0001
HEADMALE	0.1214941	0.0440434	2.759	0.0059
POCC	0.404568	0.0813135	4.975	<.0001
LAT_TOI	-0.1790979	0.0531913	-3.367	0.0008
ELEC_COOK	0.3242945	0.0725188	4.472	<.0001
ELEC_LIGHT	0.3883621	0.0625414	6.21	<.0001
VAN	0.3201606	0.0616613	5.192	<.0001
PHONE	0.1233106	0.0490012	2.516	0.012
PC	0.3195958	0.0691948	4.619	<.0001
RADIO	0.1298748	0.0501286	2.591	0.0097
TV	0.3308698	0.0587581	5.631	<.0001

Strata 2: Other Towns & Cities

OLS Result				
Number of observations				1403
R-square				0.534677
Adj. R-square				0.526916
Var	**Coef.**	**Std.Err.**	**t**	**Prob>|t|**
Intercept	-0.8244724	0.2562724	-3.217	0.0013
KID06	-0.0625897	0.0275977	-2.268	0.0235
MALE	-0.0904476	0.024372	-3.711	0.0002
HEDU	0.030794	0.0055096	5.589	<.0001
SEDU	0.0267959	0.0103214	2.596	0.0095
HEADMALE	0.1285616	0.0523431	2.456	0.0142
TERTIARY	0.1214278	0.0913556	1.329	0.184
SINGLE	-0.2527069	0.092037	-2.746	0.0061
COUPLE	-0.2466743	0.0964106	-2.559	0.0106
NO_SPOUSE	0.4587054	0.1932194	2.374	0.0177
AGESP	0.0062617	0.003478	1.8	0.072
POCC	0.6006978	0.0663344	9.056	<.0001
PIP_IN	0.3071151	0.0682209	4.502	<.0001
GAS_COOK	0.0975748	0.0528421	1.847	0.065
PARA_COOK	-0.2278888	0.0729658	-3.123	0.0018
ELEC_LIGHT	0.3169513	0.0664221	4.772	<.0001
VAN	0.4713308	0.0617177	7.637	<.0001
PC	0.2092166	0.0844879	2.476	0.0134
RADIO	0.1275051	0.0455006	2.802	0.0051
TV	0.1843409	0.0550807	3.347	0.0008
MSECONDARY	-1.2176457	0.2593629	-4.695	<.0001
MELEC_COOK	-0.6346226	0.1228846	-5.164	<.0001
MEMPL	0.6556504	0.1835715	3.572	0.0004
MHEDU	0.1031643	0.0179735	5.74	<.0001

Strata 3: Urban Villages

OLS Result				
Number of observations				1758
R-square				0.578988
Adj. R-square				0.573895
Var	**Coef.**	**Std.Err.**	**t**	**Prob>|t|**
Intercept	0.1481195	0.1166024	1.27	0.2041
LNHHSIZE	-0.3625015	0.0333901	-10.857	<.0001
HEDU	0.0269838	0.0049296	5.474	<.0001
SEDU	0.02347	0.0079738	2.943	0.0033
HEADMALE	0.1739154	0.0476143	3.653	0.0003
SINGLE	-0.1701171	0.0461512	-3.686	0.0002
EMPL	0.154624	0.0477392	3.239	0.0012
NO_SPOUSE	0.2895495	0.0808339	3.582	0.0004
POCC	0.4861628	0.0772172	6.296	<.0001
PIP_IN	0.5912371	0.1460227	4.049	<.0001
PIP_OUT	0.2482076	0.0472407	5.254	<.0001
FLUSH_TOI	0.476567	0.1532707	3.109	0.0019
VIP_TOI	0.3142308	0.0694489	4.525	<.0001
LAT_TOI	0.2165864	0.0653801	3.313	0.0009
ELEC_COOK	0.3752	0.1127903	3.327	0.0009
GAS_COOK	0.2494052	0.0473082	5.272	<.0001
ELEC_HEAT	0.1504111	0.0757218	1.986	0.0471
VAN	0.3308518	0.0618234	5.352	<.0001
TV	0.2785336	0.0507411	5.489	<.0001
D10	-0.2971803	0.0630257	-4.715	<.0001
D70	0.2896169	0.0695317	4.165	<.0001
MELEC_LIGHT	-0.3766534	0.1051625	-3.582	0.0004

Strata 4: Rural Villages

OLS Result				
Number of observations				1403
R-square				0.534677
Adj. R-square				0.526916
Var	**Coef.**	**Std.Err.**	**t**	**Prob>|t|**
Intercept	0.6205013	0.0668019	9.289	<.0001
LNHHSIZE	-0.44441	0.0324199	-13.708	<.0001
HEADMALE	0.1975546	0.0505266	3.91	<.0001
LITERATE	0.1958288	0.0504958	3.878	0.0001
SINGLE	-0.1551154	0.0512671	-3.026	0.0025
EMPL	0.3594446	0.0543494	6.614	<.0001
NONEDUCSP	-0.2701309	0.0727789	-3.712	0.0002
FATHSURVSP	-0.2096494	0.0824586	-2.542	0.0111
FLUSH_TOI	0.4023625	0.1272069	3.163	0.0016
VIP_TOI	0.2592718	0.0660722	3.924	<.0001
GAS_COOK	0.3681034	0.0761244	4.836	<.0001
ELEC_LIGHT	0.4471726	0.1197241	3.735	0.0002
PHONE	0.3828551	0.0710522	5.388	<.0001
D60	0.2573657	0.1041893	2.47	0.0136
D90	-0.3780958	0.123747	-3.055	0.0023

Republic of Botswana

BOTSWANA CENSUS-BASED

POVERTY MAP REPORT

JULY 2008

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