

POVERTY MAPPING IN BHUTAN

SMALL AREA ESTIMATION:
DISTRICT AND TOWN LEVEL RESULTS

2023



NATIONAL STATISTICS BUREAU

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National Statistics Bureau, Bhutan
Poverty and Equity Global Practice, The World Bank
December 2023

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Printed in Bhutan.
ISBN 978-99980-786-6-6

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FOREWORD

The commitment to poverty reduction is central to the national development agenda of the Kingdom of Bhutan, as reflected in the 12th Five-Year Plan (FYP) (2018–2023). The 13th FYP (2023–2028), under preparation, also highlights this commitment. The National Statistics Bureau (NSB) of Bhutan published a poverty profile based on the Bhutan Living Standards Survey (BLSS) conducted in 2022. The 2022 Poverty Analysis Report presented poverty estimates at the national, rural/urban, and *Dzongkhag* (district) levels. It showed major spatial disparities in poverty between rural and urban areas and across districts. The report also showed a shift in the geography of poverty in 2022 compared to the previous five years.

The changing geography of poverty emphasizes the need for updating and improving knowledge of poverty at lower administrative levels (that is, *Gewog*/town). This information is essential for the poverty eradication strategy and pro-poor policy making. This knowledge can be used to prioritize the poorest districts and increase the targeting efficiency of projects and programs aiming to reduce poverty. To this end, NSB and the World Bank have conducted a study to assess the poverty incidence at the *Gewog* (town) level based on a method called ‘small area estimation’

(SAE) using data from BLSS 2022 and the 2017 Population and Housing Census of Bhutan (PHCB). This report presents poverty estimates and maps at the *Gewog*/town level.

NSB greatly appreciates the technical support received from the World Bank and the close collaboration that ensued, resulting in the production of this report. I express my hope for continued fruitful collaboration to expand our statistical products and dissemination that serve the needs of policymakers and other users of statistics.

I believe the results presented in this report will provide useful insights to policymakers, inform planning, and serve as a benchmark for monitoring progress in poverty reduction during the implementation of the 13th FYP, especially in poverty eradication and equity promotion. Finally, I would like to thank in advance all those who will make use of this report. We welcome suggestions to assist NSB in improving our analysis and reporting in the future.

Mr. Phub Sangay
Officiating Director
National Statistics Bureau

ACKNOWLEDGMENTS

This small area estimation report is an outcome of the collaborative effort of the National Statistics Bureau (NSB) and the World Bank. The World Bank team was led by Mr. Alvin Etang Ndip (Senior Economist) and Mr. Minh Cong Nguyen (Senior Economist) and comprised Ms. Ando Rahasimbelonirina (Consultant). The NSB team comprised Mr. Tashi Dorjee (Chief Statistical Officer), Mr. Dorji Lethro (Chief Statistical Officer), and Mr. Bikash Subba (Statistical Officer).

Ms. Ximena Del Carpio (Practice Manager, World Bank) and Mr. Phub Sangay (Officiating Director, NSB) provided overall guidance to the team. Helpful comments were received from Mr. Alexandru Cojocaru (Senior Economist, World Bank), Mr. Paul Corral (Senior Economist, World Bank) and Ms. Ella Humphry (Education Specialist) who served as peer reviewers of the report and are gratefully acknowledged.

ABBREVIATIONS

ACC	Autoclaved Aerated Concrete
BIC	Bayesian Information Criterion
BLSS	Bhutan Living Standards Survey
CA	Consumption aggregate
CBN	Cost-of-Basic-Needs
CI	Confidence Interval
CPI	Consumer Price Index
CSS	Circular Systematic Sampling
CV	Coefficient of Variation
EA	Enumeration Area
EB	Empirical Best
ELL	Elbers, Lanjouw, and Lanjouw
FYP	Five-Year Plan
GLS	Generalized Least Square
MSE	Mean Squared Error
NSB	National Statistics Bureau
OLS	Ordinary Least Square
PHCB	Population and Housing Census of Bhutan
PPS	Probability Proportional to Size
PSU	Primary Sampling Unit
SAE	Small Area Estimation
SD	Standard Deviation
SE	Standard Error
VIF	Variance Inflation Factor

ABSTRACT

The availability of poverty statistics at local levels of administration is critical for effective poverty reduction policy planning. The Bhutan Living Standards Survey (BLSS), a national representative survey, is a primary source of poverty data in Bhutan. Based on the BLSS sampling methodology, poverty rates can be estimated at the national and *Dzongkhags* (district) levels. This report presents *Gewog*/town-level poverty maps for Bhutan using the small area estimation (SAE) technique and the most recent BLSS(2022) and the 2017 Population and Housing Census of Bhutan (PHCB). On the one hand, BLSS collects detailed information on household expenditures required for estimating monetary poverty but limits poverty estimation below the district level. On the other hand, the PHCB collects data from every household

but does not include household expenditures as this information is generally too costly and time-consuming to include. The SAE technique combines two sources of data and produces monetary poverty indicators at the *Gewog*/town level. This report presents the SAE results as well as poverty estimates and maps at the *Gewog*/town level. Three key findings of the report are as follows: (a) poverty is high in districts in mountainous areas bordering India and low in districts in the central part of the country and those bordering China; (b) there is a large variation in poverty rates across *Gewogs*/towns within the same district; and (c) *Gewogs*/towns with the highest number of the poor are mainly in Thimphu, Chhukha, Zhemgang, and Samtse districts.

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Chapter 1

Introduction

The Bhutan Living Standards Survey (BLSS), a national representative survey, has been conducted at five-year intervals since 2003 and is a primary source of poverty data. In total, five rounds of BLSS have been implemented: 2003, 2007, 2012, 2017, and 2022. Information from BLSS is used for estimating official poverty statistics, identifying poor and vulnerable groups, and monitoring progress in poverty reduction. Based on the BLSS sampling methodology, poverty estimates are reported at the national and district/*Thromde* levels.

A lack of poverty data at local administrative levels hinders effective poverty reduction policy planning. According to the Poverty Analysis Report 2022 (NSB and World Bank 2022), disparities exist across rural/urban areas and between *Dzongkhags*/districts. Using districts' poverty estimates likely masks the existence of poverty pockets in relatively well-off districts and the existence of well-off areas in relatively poor districts, leading to poorly targeted programs. Information at lower administrative levels could help minimize leaks and permit more cost-effective and efficient poverty reduction programs.

To improve our knowledge of poverty at lower administrative levels, a method called small area estimation (SAE) can be applied using data from

BLSS and the Population and Housing Census of Bhutan (PHCB). On the one hand, BLSS collects detailed information on household expenditures required for estimating monetary poverty, but it limits poverty estimation below the districts level. This poses important challenges to understanding poverty conditions and designing policies to tackle poverty at a grassroots level because variations in poverty might exist even within the same *Dzongkhag*. On the other hand, PHCB collects data from every household but does not include household expenditures as collecting expenditure data is generally too costly and time-consuming. The SAE combines the two sources of data and produces monetary poverty indicators at a lower administrative level, namely *Gewog*/town.

Updated information on spatially disaggregated indicators can inform policymakers to prioritize the poorest districts and improve the targeting efficiency of projects and programs aimed at reducing poverty. In Bhutan, a SAE technique using the traditional ELL approach (Elbers, Lanjouw and Lanjouw 2003) was used to produce poverty maps based on PHCB 2005 and BLSS 2007 (NSB and World Bank 2010). The maps were updated in 2017 using PHCB 2017 and BLSS 2017 using the same ELL approach (NSB and World Bank 2017). The 2017 map, however,

most likely no longer reflects Bhutan's current poverty conditions. Since the last poverty map was produced in 2017, living standards as well as the spatial distribution of poverty are likely to have changed because of economic growth and urbanization. It is therefore critical to update the map to capture a more contemporary picture of the extent and geographical concentration of poverty in Bhutan. In addition, in the recent year, there is a significant change in the SAE methodology that can improve the estimate points and the noise of the estimates.

This report updates the poverty maps using data from BLSS 2022 and PHCB 2017 using the new SAE approach. The SAE method adopted here increases the precision and reduces the bias of

small area estimates. The method was developed by Corral, Molina, and Nguyen (2021) and builds on the pioneer method developed by Elbers, Lanjouw, and Lanjouw (2003). The updated map complements the *Dzongkhag*-level results of the 2022 Poverty Analysis Report and could be a useful input for Bhutan's 13th Five-Year Plan (FYP) by helping to direct more resources toward *Gewogs* with a higher concentration of poverty.

Section II of this report provides an overview of poverty in Bhutan. The SAE methodology and data sources are described in Section III. Section IV explains model selection and diagnostics. Section V presents poverty mapping results. Section VI concludes with policy implications.

Chapter 2

Overview of Poverty in Bhutan

2.1 Poverty Methodology

The poverty methodology in Bhutan was first established in 2007 and revised in 2022 to better reflect changes in living standards and spending patterns. The revised poverty methodology updated the consumption aggregate to include all health expenditures (rather than medicine and dentist only) and consumption flow for a wider variety of durable goods to reflect the growing importance and availability of household appliances and assets. The new national poverty line was estimated based on the 'cost of basic needs' approach at Nu 6,204 per person per month at 2022 prices.

2.2 Poverty Incidence

It is important to note that because of changes in the poverty measurement methodology, the poverty numbers from BLSS 2022 are not directly comparable to those from the previous BLSS rounds. This SAE report focuses on the poverty patterns in 2022, while a more comprehensive poverty and equity assessment establishes comparability between 2017 and 2022 (in a separate report). The food poverty line and the upper-bound poverty line are used to compute the incidence of poverty and food poverty (that is, the percentage of poor persons), respectively. In 2022, the poverty rate for Bhutan was 12.4 percent, implying that 12 out of 100 individuals

belong to households whose monthly per capita real expenditure is below the upper-bound poverty line of Nu 6,204 per person per month. As FIGURE 2.1 shows, poverty is not evenly distributed across areas: while the poverty rate reaches 17.5 percent in rural areas, it plummets to 4.2 percent in urban areas. Food poverty is low: only 0.4 percent of the population belongs to households where monthly per capita real expenditure is below the food poverty line of Nu 2,852 per person per month. In this case too, poverty incidence is larger in rural areas, accounting for 0.7 percent.

Results suggest that poverty and food poverty are mainly concentrated in rural areas: 87



Figure 2.1 Poverty incidence, by area (percentage)
Source: NSB and World Bank 2022.

percent of all poor individuals in Bhutan reside in rural areas when poverty is defined by the upper-bound poverty line. Poverty rates vary across *Dzongkhags* and are higher in Zhemgang, Samdrup Jongkhar, Samtse, and Trongsa, while the lowest poverty rates are found in Thimphu and Punakha. The four *Thromdes* show poverty rates that are consistently below 10 percent. Samtse shows the largest share of poor individuals, out of the total in the country, accounting for 15.1 percent, followed by Trashigang (9.5 percent) and Monggar (7.7 percent). The rural poor are also much further below the poverty line (poverty depth) than the urban poor, indicating that they will require much more resources and support to help them escape poverty.

Chapter 3

Small Area Estimation Methodology and Data Sources

3.1 Small Area Estimation

There are numerous methods for implementing poverty mapping (Bigman and Deichmann 2000). Selecting a specific poverty mapping methodology is a critical first step in deriving poverty maps. When sufficient data are available, the SAE method developed by Elbers, Lanjouw, and Lanjouw (2003), hereafter ELL, has gained wide popularity among development practitioners. Improvements have also been made to the ELL method to increase precision and reduce the bias of small area estimates. Most recently, Corral, Molina, and Nguyen (2021) built on the ELL model and introduced a new method by employing a Monte Carlo simulation for the point estimates and bootstrapping for the mean squared error (MSE). This method is referred to as the Census-Empirical Best (EB) method. In this section, we briefly describe the small area estimation methodology. For a full explanation and discussion on the methodology and application, see Corral, Molina, and Nguyen (2021) and Corral et al. (2022).

The Census-EB method can be modeled as the log of per capita household consumption.

$$y_{ch} = X'_{ch}\beta + u_{ch}, \text{ (Eq. 1)}$$

where y_{ch} is the log of the per capita consumption of household h residing in area c ; X_{ch} includes

household and area characteristics; and $u_{ch} = \mu_c + \varepsilon_{ch}$ represents the residual, which is composed of the area or location error μ_c and the household-specific idiosyncratic error ε_{ch} . These two residual error components have expected values of zero and unknown variances σ_μ^2 and σ_ε^2 , and they are assumed to be independent of each other. It is assumed that the errors are normally distributed and $E(u_c^2) = \sigma_\mu^2 + \sigma_\varepsilon^2$.

To estimate variance parameters, Henderson's Method III (H3) is adopted. This is a commonly used estimator for the variance parameters of a nested error model (Henderson 1953; Searle, Casella, and McCulloch 1992). The idea of EB estimation is that the residuals for households sampled in area c , $e_{ch} = y_{ch} - X'_{ch}\beta$, are informative of the latent area error μ_c . This means that conditioning on the residuals observed for sampled households should enable us to tighten the distributions from which to simulate μ_c . It should be noted that EB only concerns the drawing of the area errors, and only areas that have been sampled in the 2022 BLSS benefit from the improvement offered by EB. For areas not sampled in the survey, errors are still drawn from the unconditional distribution as described in the Corral, Molina, and Nguyen (2021). In fact, more than 95 percent of 269 towns (the

area level used in modelling) in the census are available in the 2022 BLSS survey.

Small area point estimates are obtained through Monte Carlo simulations while noise estimates are obtained from the parametric bootstrap simulation, where under each bootstrap replicate, we obtain a 'true' rate and an estimated poverty rate from a new Monte Carlo simulation. The mean square error is obtained as the mean squared difference between the true and estimated values.

For a large number of Monte Carlo simulations, the Census-EB estimate takes the form:

$$\hat{\tau}_c^{CEB} = \frac{1}{M} \sum_{m=1}^M \tau_c^{*(m)}, \quad \text{Eq. 2}$$

where $\tau_c^{*(m)}$ is an indicator function of a simulated welfare vector $y_c^{*(m)}$ under the model where we fix the beta estimates and draw location effects and a household-specific residual from their distributions.

$$y_c^{*(m)} = X' \hat{\beta} + \tilde{\mu}_c^m + \tilde{\varepsilon}_{ch}^m \quad \text{Eq. 3}$$

To measure the noise of this Census-EB estimator, we apply a parametric bootstrap. Under this bootstrap method, the initial parameter estimates from the main model are fixed. For each bootstrap, one can simulate a vector of welfare in the census to obtain a 'true' estimate $\hat{\tau}_{c,b}^*$. The same parameter estimates are used to obtain a new simulated survey sample on the same covariates X . Then, we can run a new model on this simulated survey and apply a Monte Carlo simulation to obtain a new Census-EB estimator ($\hat{\tau}_{c,b}^{CEB*}$). This new estimation is then compared with the true estimate under a simulated census vector to get a bias and bootstrap estimator of the MSE. Corral, Molina, and Nguyen (2021) and Corral et al. (2022) provide greater detail on this method.

$$mse_B(\hat{\tau}_c^{CEB}) = \frac{1}{B} \sum_{b=1}^B (\hat{\tau}_{c,b}^{CEB*} - \hat{\tau}_{c,b}^*)^2 \quad \text{Eq. 4}$$

For this report, estimates from the poverty maps were produced based on the *sae* Stata package developed by Nguyen et al. (2018) using the Census-EB estimation with an H3 variance decomposition under a GLS model allowing for survey weights and heteroskedasticity with one-fold nested error models, with the assumption that errors are normally distributed. The modeling relies on detailed consumption information from the household survey to estimate a welfare model, given a set of observable household characteristics which are both available in the survey and the census. The Census-EB estimation method is employed with 100 Monte Carlo replications and 200 bootstraps. Finally, the point estimates are obtained from the Monte Carlo simulation and their corresponding standard errors are obtained from the bootstrapped MSEs.

3.2 Data Sources

Bhutan Living Standard Survey 2022

The National Statistics Bureau (NSB) has been conducting BLSS at five-year intervals since 2003. The fifth and most recent round was implemented between April and June 2022 with full funding support from the Royal Government of Bhutan. BLSS is the main source of data for poverty statistics in Bhutan. It provides critical information for monitoring progress on poverty reduction as well as for targeted intervention. The earlier four rounds of BLSS were conducted in 2003, 2007, 2012, and 2017. Only post 2003 surveys should be used for comparable poverty estimates. The 2022 BLSS used an improved methodology for estimating poverty including constructing a new poverty line, making the 2022 poverty estimates not directly comparable to the previous surveys. Bhutan's national poverty line is an absolute poverty line based on the 'Cost of

Basic Needs' approach. This approach estimates the cost of a food bundle that provides a basic minimum level of food energy. The total poverty line is obtained by adding to the food component the cost of the basic nonfood allowance. National poverty estimates are important inputs to FYPs by the Royal Government of Bhutan.

The data collection for 2022 BLSS was conducted between April and June 2022, and the survey was representative at the national and district levels. The sampling frame was developed from the 2017 PHCB and revised in 2022 with the preparation of enumeration areas (EAs) and listing of households in the rural areas. A total of 13,416 households were selected from 20 *Dzongkhags* and four *Thromdes*, out of which about 33 percent (4,368 households) were in urban areas and 67 percent (9,048 households) were in rural areas. The selected sample represents 164,331 households. The survey provides valuable information on the socioeconomic characteristics of households at the national and *Dzongkhag* levels.

There are 24 domains and 44 sampling strata from 20 *Dzongkhags* and four *Thromdes*. A stratified two-stage sampling design was adopted. In the first stage, the 'probability proportional to size' (PPS) sampling method was used to select Primary Sampling Units (PSUs) in both urban and rural areas with the number of households as size of variable. The EAs in both urban and rural areas are defined as PSU. In the rural areas, the smaller Chiwogs are considered as one EA and the bigger Chiwogs were divided into several EAs. In the second stage, all the regular households in the selected PSUs were listed and the required number of households in each PSUs were selected based on the circular systematic sampling (CSS) method. A total sample size for 2022 BLSS is estimated at 13,416 households at the national level. The sample size in each *Dzongkhag* was then allocated to

urban and rural areas. The allocation of sample size is in proportion to the size of urban and rural areas in the *Dzongkhag*. At the national level, 33 percent is allocated to urban areas and 67 percent to rural. The sample was allocated across 20 *Dzongkhags* by urban and rural areas and four major *Thromdes*. Estimates from the survey are reported at the national, *Dzongkhag*, and urban/rural levels.

For comparability, the questionnaire contents were carried over from the past BLSSs with a few modifications to cater to the needs of the country. The household questionnaire, which is the main data set used for SAE, comprises 11 blocks/modules: (a) information on household members (demographics, education, health, fertility); (b) housing; (c) assets ownership; (d) access and distance to facilities; (e) remittances sent outside Bhutan; (f) priorities, credits, and opinions; (g) sources of income; (h) food consumption; (i) nonfood expenditure; (j) home produced nonfood items; and (k) general perception and mortality. Data related to household consumption expenditure made it possible to assess the level of poverty and well-being in Bhutan.

Population and Housing Census of Bhutan 2017

The PHCB conducted in 2017 revealed that as on May 31, 2017, Bhutan had a population of 735,553 including 727,145 resident population and 8,408 non-Bhutanese tourists. Following the release of the census report, NSB has projected the population of Bhutan for a period of 30 years, that is, up to 2047. These projections are made based on the PHCB results, other available data on demographic parameters, its recent trends, and in consultations with experts on expected developments in the country. Various sources of data were examined for quality and demographic trends both at the national and

global levels to arrive at the baseline parameters and projected changes. Social and economic development might change the relationships between consumption and the explanatory variables over time. Thus, when the two data sources are several years apart, it is likely that the relationships estimated from the household survey, as represented by the estimation models, are not applicable to the census. The further apart the two data sources, or the more drastic social and economic conditions change during the period that the two data sets are collected, the higher the risk.

The Welfare/Consumption Aggregate

The welfare indicator that was used for poverty and inequality analysis is the *real* consumption aggregate, obtained by adjusting the *nominal* consumption aggregate for household demographic characteristics and differences in the cost of living. The *nominal* consumption aggregate includes four components: (a) food consumption expenditures, (b) non-food non-durable expenditures, (c) consumption flow of durable goods, and (d) housing expenditures. The food component includes the value of food items consumed, whether purchased, self-produced, or received for free. It also includes food consumed away from home. Expenditure in nonfood nondurable items is obtained by aggregating most of the expenditures recorded by the 2022 BLSS, with a few exceptions, following the guidelines provided in Mancini and Vecchi (2022). Most notably, all health expenditures are included, while some 'lumpy' expenditures are excluded (for example, purchase of durable goods, major maintenance, and repairs), together with expenditures that do not represent consumption (for example, taxes). The consumption flow from durable goods is estimated following the 'straight line depreciation model' (Amendola and Vecchi 2022). This approach allows for the

estimation of the use value of durable goods owned by households at the time of the interview. The housing expenditure component of the consumption aggregate is based on the actual rent for tenants and self-reported imputed rent for owners and nonmarket tenants (that is, the answer to the question "How much do you think your household would pay per month if you had to rent this dwelling?").

A real consumption aggregate is obtained by adjusting for the differences in purchasing power between households interviewed at different times during the survey period and in different areas of the country. The temporal price adjustment was carried out by deflating the nominal consumption aggregate with the official Consumer Price Index (CPI) produced by NSB. For the spatial price adjustment, a district/area-level food Paasche index was computed, based on information available from the survey. Finally, no adjustments for economies of scale and different household needs are implemented. Instead, the welfare indicator is computed as a per capita amount.

National Poverty Lines

The national poverty line used in Bhutan before 2022 was originally estimated in 2007 and has been updated through the CPI ever since. Based on the new BLSS data, new national poverty lines were estimated. Following the cost-of-basic-needs (CBN) method (Ravallion 1994, 2016), a national poverty line was estimated by summing up a *food poverty line* and a *nonfood allowance*. The food poverty line represents the minimum cost of achieving a minimum energy requirement (for the average person in the country), set at 2,200 kilocalories per person per day. The minimum cost of one calorie was estimated as the average unit calorie cost for households belonging to the poorest decile of real per capita expenditure. TABLE 3.1 shows that the resulting

Table 3.1 CBN national poverty lines (current ngultrum per person per month)

Food poverty line	2,852
Nonfood allowance, lower bound	1,247
Nonfood allowance, upper bound	3,352
Lower-bound poverty line	4,099
Upper-bound poverty line	6,204

Source: NSB and World Bank 2022.

food poverty line equals Nu 2,852 per person per month.

The nonfood component of the poverty line, also known as the *nonfood allowance*, was estimated in two ways: producing a lower-bound poverty line and an upper-bound poverty line. The difference depends on the reference group that is the basis for the estimation of the nonfood component. The lower-bound nonfood allowance represents the median nonfood expenditure of households for which *total* expenditures are 'near' the food poverty line. The upper-bound nonfood allowance, on the other hand, is the median nonfood expenditure of households for which *food* expenditures are 'near' the food poverty line. In practice, 'near' means a two-sided interval around the food poverty line (Chen and Ravallion 1996).¹ TABLE 3.1 summarizes the national poverty lines for 2022 Bhutan.

Merging of Towns into Larger Town Areas (>300 households)

In Bhutan, *Gewogs*/towns are numerous, and some have a small number of households. In some towns, the number of households is less than 300. To have statistical significance of the estimate points and standard errors, especially when comparing estimate points between towns, Ahmed et al. (2014) recommend that the sample size should be no smaller than 300 (households) for each reporting areas. Thus, for this report we combined small *Gewogs*/towns based on the number of households in the census and their spatial locations with each other to create a new town-level map. The new town-level map has 197 *Gewogs*/towns, reduced from the original 269 *Gewogs*/towns. TABLE 3.2 presents some examples of the merged towns. FIGURE 3.1 shows the towns merged with their new town ID. TABLE A 1.1 shows the merge from the original town (town1) to the new town (town2) used in the report.

¹ In the case of Bhutan, an additional condition related to individual caloric consumption has been imposed to identify the upper-bound nonfood component of the poverty line. The nonfood component estimate relies on households for which total expenditures are 'near' the food poverty line and per capita caloric consumption is 'near' 2,200 kilocalories per day.

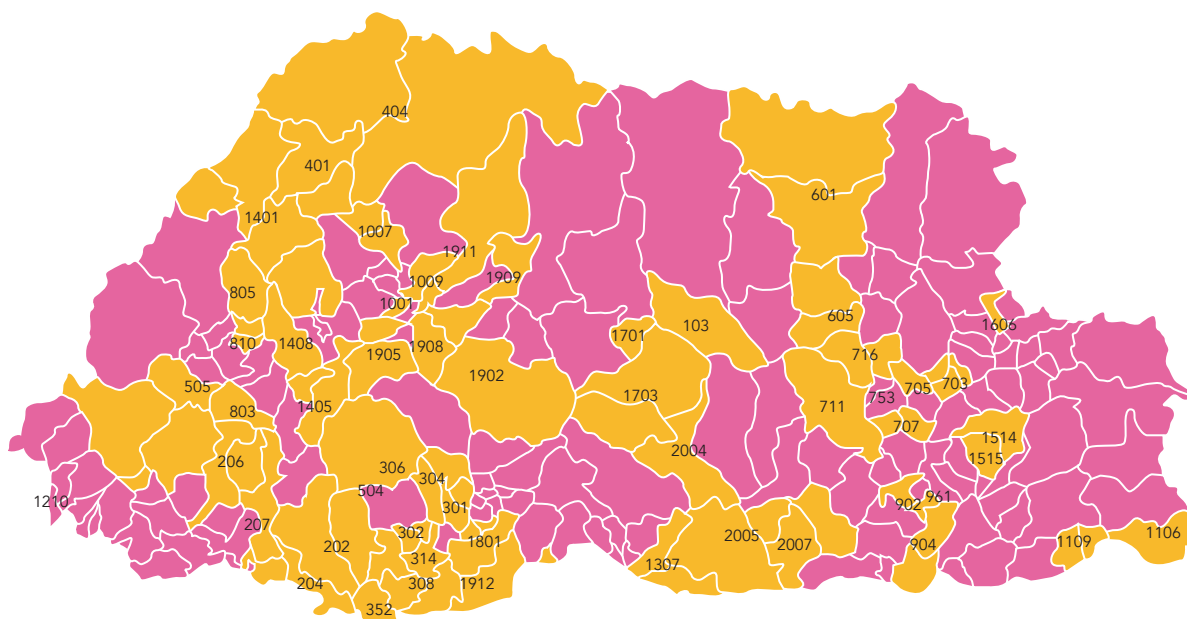


Figure 3.1 Town-level map before and after grouping areas

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Yellow indicates the merged town with the new town code in the middle.

Table 3.2 Examples of the aggregation of towns with less than 300 households

District code	District name	Original town code	Original town name	No. of households (town1)	No. of individuals (town1)	New town2 code	New town2 name
1	Bumthang	103	Chhumig	637	2,514	103	Chhumig+Chhumig town
1	Bumthang	152	Chhumig Town	72	259		
2	Chhukha	202	Bongo	786	3,439	202	Bongo+Getana
2	Chhukha	205	Getana	157	820		
2	Chhukha	204	Darla	1,749	7,256	204	Darla+Darla Town
2	Chhukha	262	Darla Town	266	1,034		
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
20	Zhemgang	2004	Trong	584	2,158	2004	Trong+Tingtibi Town
20	Zhemgang	2053	Tingtibi Town	137	486		
20	Zhemgang	2005	Bjoka	194	764	2007	Ngangla+Panbang Town+Bjoka
20	Zhemgang	2007	Ngangla	445	1,768		
20	Zhemgang	2052	Panbang Town	178	705		
20	Zhemgang	2008	Phangkhar	287	1,053	2006	Phangkhar+Goshing
20	Zhemgang	2006	Goshing	336	1,272		

Source: Based on 2022 BLSS and 2017 PHCB.

Chapter 4

Modeling Procedure

4.1 Variable Selection

The SAE modeling setup relies on estimating a consumption model based on the household survey data (2022 BLSS) and applying it to the census data (2017 PHCB) for prediction of welfare for all households in the census. Therefore, one of the key parts of the model setup is the similarity between the variables in the 2022 BLSS and 2017 PHCB. As part of building a welfare model, a two-stage process was undertaken:

- **Step 1:** Comparison of the 2022 BLSS and 2017 PHCB questionnaires to identify candidate variables present in both the survey and the census and which are generated from identical or similar questions.
- **Step 2:** Comparison of the distributions of the candidate variables identified in Step 1 to examine whether they appear to capture the same underlying phenomena, or despite similar questions, their empirical distributions differ in any important ways.

While the goal of model construction is to build a descriptive statistical model that explains the variation in per capita household consumption based on set of characteristics, the choice of candidate variables is based on a heuristic model of per capita household consumption.

The per capita household consumption is often assumed to be a function of demographic characteristics of the household (for example, if it contains young children, working-age adults, or elderly people) and characteristics of members of the household (such as, the maximum level of education in the household, the education level and employment status of household members, and the type of employment for those who are employed).

In addition, the household dwelling type and condition, access to basic services, and asset ownership are assumed to describe or reflect the income level of the household and thus its consumption. Furthermore, household consumption may also vary based on the household location and its characteristics, for example, if it is rural or urban, its proximity to urban or capital areas such as *Thromdes*, and if it is in an area with low or high employment rates. This list is neither unique nor exhaustive, but the choice of characteristics is typically constrained by the overlap between the survey and census questionnaires. Based on the information available in the survey and census, they share common variables:

- **Demographic characteristics:** Gender, age, marital status, household size, number of children, adults, and the elderly in the household, dependency ratio

- **Education:** Education level of the household head, highest level of education by any household member
- **Housing characteristics:** Type of housing unit, main construction material of walls, total area of land and dwelling, ownership and occupancy status of dwelling, source of drinking water and electricity, type of sewage and toilet, internet (mobile and fixed)
- **Productive and durable assets:** Ownership of television/video, smart mobile phone, simple mobile phone, personal computer or laptop, fridge or refrigerator, washing machine, sofa, sewing machine, vacuum cleaner, rice cooker, jewelry, bicycle, motorcycle or scooter, seshu gho/kira, livestock, and agriculture land.

The level at which regression models are run must be chosen carefully. If a single model is specified for the entire country, the implicit assumption is that the parameter estimates on the regressors are the same for all regions of the country. In other words, a national model assumes that the relationship between household expenditure and household characteristics is uniform throughout the country. This may not be a tenable assumption in a country like Bhutan, which has wide spatial heterogeneity in incidence of poverty, endowment of natural resources, and robustness of factor markets. For example, returns on education are likely higher in capital areas where the formal job market is more robust than in the poorest regions with thin labor markets.

For Bhutan, fitting separated models by districts or *Dzongkhags* allows the relationship between expenditure and the explanatory variables to vary, and therefore this reduces the standard error of poverty prediction due to modeling errors. An alternative way to allow the coefficients to vary by zone is to interact the variables with

zone dummy variables in the regression. This approach is flexible enough to allow differential relationships across districts and minimizes the chances of over fitting. One concern with running multiple models is the loss in degrees of freedom and the risk of over fitting (that is, the models are forced to explain the noise in the data in a small sample). To avoid the problem of over fitting, researchers recommended that the sample size be no smaller than 300 (households) for each regression (Ahmed et al. 2014).

Assignment of candidate variables for matching was done using both automatic procedures (based on percentage point differences less than 5, 10, or 15) and manual selection by comparing representative means at the *Dzongkhags* in the two data sources. Those variables deemed acceptable were included in the model selection process. For those that were shown to differ too greatly from one another—due, for instance, to slight differences in the wording of the question or the choice of respondent—the variable was excluded and not used in the model development process. As the gap between the survey and census is 5 years, there could be changes in characteristics of individuals and dwelling, thus to consider as “compatible” data we relax the condition allowing for maximum 15 percentage point differences. One might consider that the 15 percentage point differences could be large, however both covariates and their estimated coefficients are important in the linear combination. We show later that the mean of “xb” are similar across the percentile distribution at the *Dzongkhag* level. A summary of selected variables is presented in Annexure 2 for each *Dzongkhag*, and tables with survey and census means for each district can be found in Annexure 3.

4.2 Model Selection and Diagnostics

From the pool of variables that were not excluded for comparability concerns, a variety of model selection techniques were

used to determine the best performing model and evaluate performance based on several alternative criteria. The poverty map for Bhutan uses a stepwise and variable selection model, to minimize over fitting by incorporating degrees of freedom into the evaluation.²

Stepwise regression uses a threshold value to determine which variables are included in the model. There are three main approaches to stepwise regression for model selection: forward, backward, and bidirectional. In this case, backward stepwise was used (the default option in the Stata software). The process begins with all variables included in the model and removes those with p-values greater than the threshold value of 0.2. Similarly, variable selection with subset variable selection (*vselect*) is used with Akaike's information criterion in stepwise selection. As stepwise is particularly sensitive to collinearity, an additional preprocessing step was taken to remove these variables from the model. The variance inflation factor (VIF) is a measure of multicollinearity between variables in an ordinary least squares (OLS) regression. Although a VIF of 10 or higher indicates the presence of collinearity, here a more conservative threshold of 5 is used to exclude variables.³

The modeling procedure for Bhutan's small area estimation can be summarized as follows:⁴

- a. Variable selection process starts with a step-by-step VIF (using a threshold of 5) check and stepwise based on the list of comparable variables. This step produces a list of variables.
- b. OLS fitting is applied with this variable list above, followed by a stepwise regression for the alpha model, and finally combined

it with the GLS from the *sae* Stata package. Here, we use Census EB estimation with H3 variance decomposition under GLS model allowing for survey weights and heteroskedasticity with one-fold nested error models.

- c. The most insignificant variable in the GLS estimates is removed, and the process restarts from step (a).
- d. This process stops when all the variables in the final GLS model are all significant at the 5 percent level.

The SAE methodology often assumes normality in error distributions. In simulation studies that seek to validate SAE methods based on actual data, data-driven transformations may reduce bias and noise due to departures from normality (see Corral et al. 2021 and Tzavidis et al. 2018, among others). Thus, as part of model diagnostics, FIGURES 4.1, 4.2 and 4.3 show the linearity and normality of the residuals in each district before any transformation. In each *Dzongkhag's* graph, the normality assumptions hold although some distributions are skewed to the right, suggesting transformation is needed. We also performed the Residual's Shapiro-Wilk at the district or model level to test this assumption.

For *Dzongkhags* with more than one good selected variable set, we performed additional diagnostics by looking at the comparison of estimates from the ventile distribution, the value of MSE and CV in order to decide the final model.

² We use both stepwise (backward, forward) and *vselect* with different information criterion such as p-value, Akaike's information criterion (AIC) and Bayesian information criterion (BIC).

³ See Thompson (1995) for more information about the potential drawbacks to stepwise procedures for modeling.

⁴ The steps are implemented in *sae_auto_model* procedure (from the *sae* Stata ado).



Figure 4.1 Kernel density plot for residuals with a normal density overlaid

Source: Based on 2022 BLSS and 2017 PHCB.

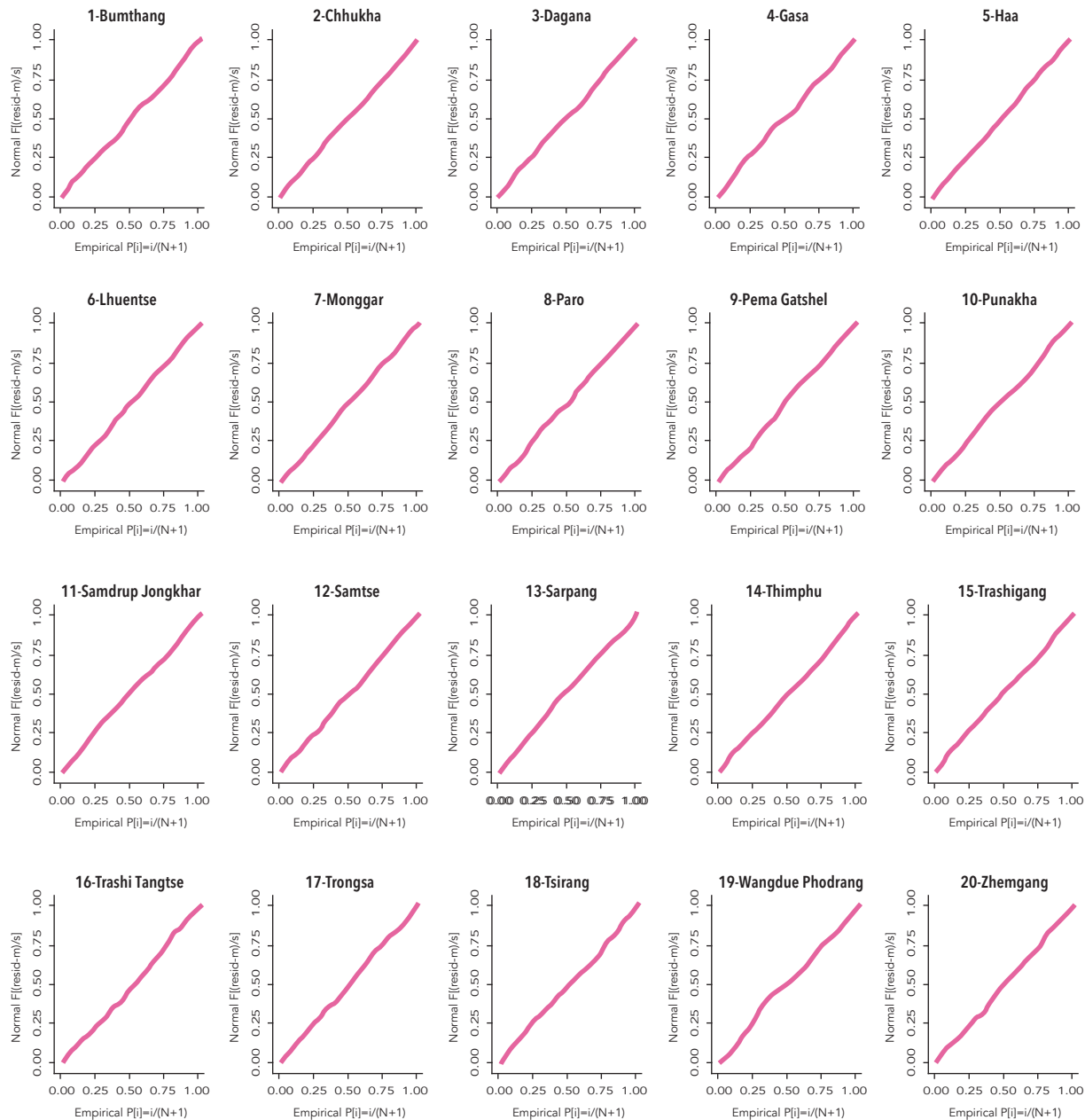


Figure 4.2 Standardized normal probability

Source: Based on 2022 BLSS and 2017 PHCB.

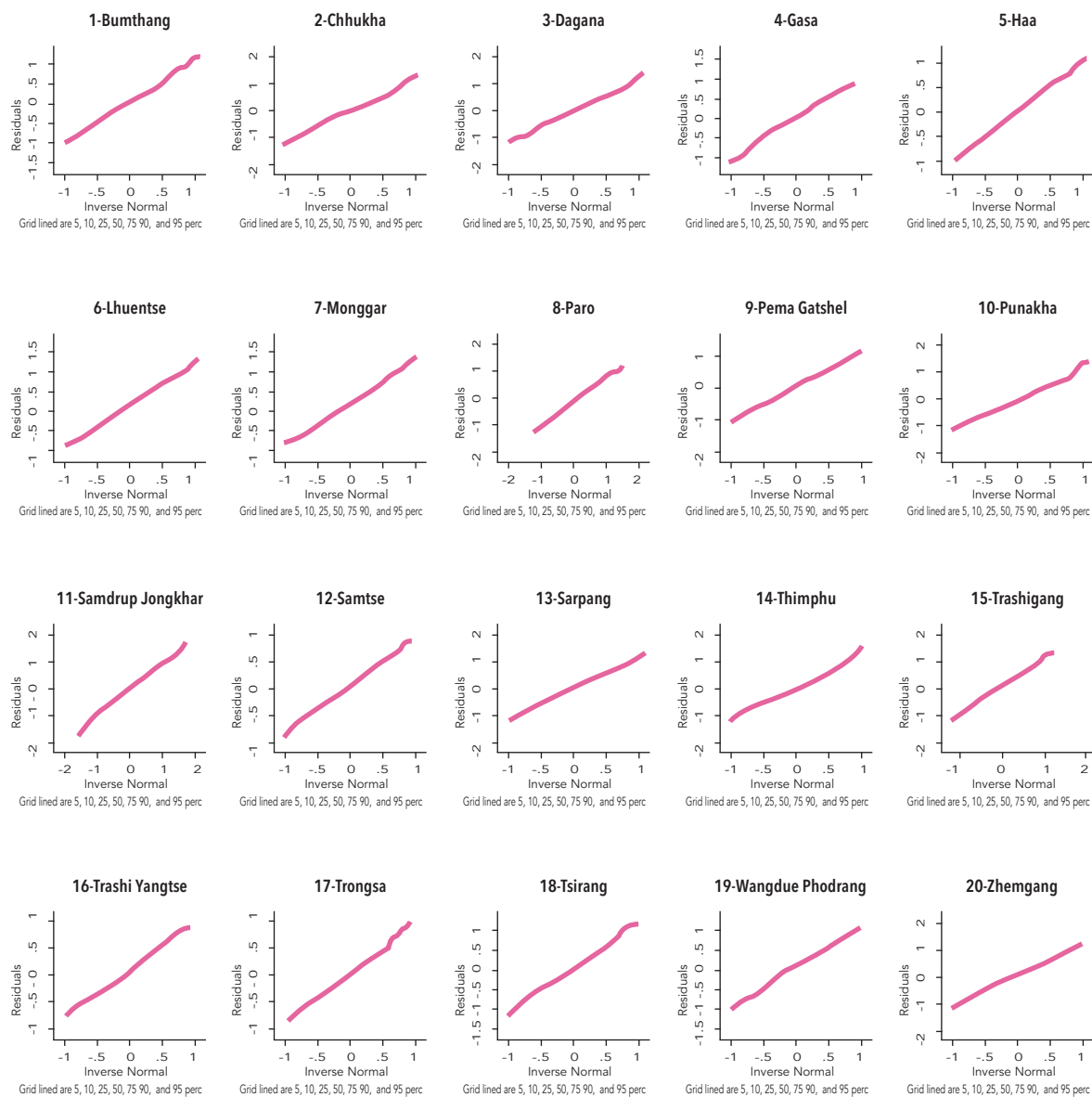


Figure 4.3 Quantiles of a variable against the quantiles of a normal distribution
Source:Based on 2022 BLSS and 2017 PHCB.

In the validation exercises conducted in this report, bias and MSEs are reduced for some *Dzongkhags* when using a Box-Cox (bcox) or log-shift transformations with and without survey weights (lnskew or lnskew_w). TABLE 4.1 reports the final variable selections across *Dzongkhags* resulting from applying backward stepwise and iterative GLS procedures to the list of comparable variables with 5, 10, and 15 percentage point differences between survey and census, together with options for transformations (Box-Cox, log-shift transformations, and no transformation). The final selection is based on the comparison of poverty estimates

at the *Dzongkhags'* level from the survey, MSE, standard error, and coefficient of variation (CV) across all four result sets while also taking into account the distributional assumption of residuals or errors. TABLE 4.2 is an extract of the variables included in the final model selected for each *Dzongkhag*. The full list is reported in TABLE A2.1(Annexure 2). Estimation results of the final *Dzongkhag*-level models are shown in Annexure 4. The beta model specification and estimates are reported in the Annexure but not the alpha model although it was used in the GLS model.

Table 4.1 Comparison of census-based poverty estimates at the district level, MSE, standard error, CV across models and transformations

	Survey estimate	Final selected models				Residual's Shapiro-Wilk W Prob>z
		bcox	lnskew	lnskew_w	no	
District (Dzongkhags)						
1-Bumthang						0.030
Poverty rate	9.78	9.07	9.41	9.62	10.14	
MSE*10,000		3.01	3.30	2.95	3.35	
Standard error	2.04	1.73	1.82	1.72	1.83	
CV		19.12	19.31	17.85	18.06	
2-Chhukha						0.007
Poverty rate	14.14	14.23	14.32	14.28	14.23	
MSE*10,000		1.25	1.45	1.46	1.59	
Standard error	1.98	1.12	1.20	1.21	1.26	
CV		7.86	8.41	8.45	8.86	
3-Dagana						0.527
Poverty rate	9.86	10.03	10.00	10.01	10.04	
MSE*10,000		1.39	1.41	1.41	1.37	
Standard error	1.50	1.18	1.19	1.19	1.17	
CV		11.74	11.90	11.85	11.64	
4-Gasa						0.049
Poverty rate	8.18	8.15	8.20	8.15	8.36	
MSE*10,000		2.63	2.80	2.50	2.76	
Standard error	2.13	1.62	1.67	1.58	1.66	
CV		19.90	20.43	19.38	19.89	
5-Haa						0.936
Poverty rate	9.73	9.03	8.88	8.80	10.30	
MSE*10,000		1.50	1.44	1.47	1.93	
Standard error	2.45	1.22	1.20	1.21	1.39	
CV		13.55	13.50	13.77	13.48	

Table 4.1 Comparison of census-based poverty estimates at the district level, MSE, standard error, CV across models and transformations

	Survey estimate	Final selected models				Residual's Shapiro-Wilk W Prob>z
		bcox	lnskew	lnskew_w	no	
6-Lhuentse						0.732
Poverty rate	15.67	15.38	16.33	16.35	15.42	
MSE*10,000		3.52	3.90	4.04	3.37	
Standard error	2.43	1.88	1.98	2.01	1.84	
CV		12.20	12.09	12.30	11.91	
7-Monggar						0.334
Poverty rate	17.79	16.83	17.29	17.29	17.44	
MSE*10,000		1.59	1.46	1.46	1.78	
Standard error		1.26	1.21	1.21	1.33	
CV		7.50	6.99	7.00	7.65	
8-Paro						0.172
Poverty rate	5.99	7.02	7.37	7.29	8.00	
MSE*10,000		0.97	0.98	0.97	1.04	
Standard error	1.37	0.98	0.99	0.99	1.02	
CV		14.02	13.43	13.52	12.75	
9-Pema Gatshel						0.791
Poverty rate	17.88	17.91	18.27	18.51	17.99	
MSE*10,000		2.48	2.45	2.50	2.49	
Standard error	2.44	1.57	1.56	1.58	1.58	
CV		8.79	8.56	8.54	8.78	
10-Punakha						0.336
Poverty rate	2.85	2.95	2.65	2.65	3.84	
MSE*10,000		0.64	0.79	0.78	0.82	
Standard error	0.97	0.80	0.89	0.88	0.90	
CV		27.23	33.49	33.33	23.51	
11-Samdrup Jongkhar						0.054
Poverty rate	20.09	20.07	20.04	20.19	19.94	
MSE*10,000		2.45	2.71	2.46	2.65	
Standard error	2.37	1.57	1.65	1.57	1.63	
CV		7.80	8.22	7.77	8.16	
12-Samtse						0.900
Poverty rate	21.89	20.79	22.17	22.33	22.09	
MSE*10,000		2.15	2.52	2.55	2.71	
Standard error	2.26	1.47	1.59	1.60	1.65	
CV		7.06	7.16	7.16	7.45	
13-Sarpang						0.001
Poverty rate	5.64	5.94	5.86	6.20	6.09	
MSE*10,000		0.76	0.86	0.73	0.74	
Standard error	1.16	0.87	0.93	0.86	0.86	
CV		14.69	15.84	13.79	14.09	

Table 4.1 Comparison of census-based poverty estimates at the district level, MSE, standard error, CV across models and transformations

	Survey estimate	Final selected models				Residual's Shapiro-Wilk W Prob>z
		bcox	lnskew	lnskew_w	no	
14-Thimphu						0.000
Poverty rate	2.10	2.05	2.04	2.00	2.59	
MSE*10,000		0.25	0.25	0.22	0.37	
Standard error	0.79	0.50	0.50	0.47	0.60	
CV		24.49	24.51	23.62	23.33	
15-Trashigang						0.185
Poverty rate	20.57	21.28	21.58	21.59	21.36	
MSE*10,000		2.01	1.91	1.92	2.40	
Standard error	2.27	1.42	1.38	1.39	1.55	
CV		6.67	6.41	6.42	7.25	
16-Trashi Yangtse						0.014
Poverty rate	16.48	14.80	16.08	16.10	15.89	
MSE*10,000		2.32	2.43	2.46	2.07	
Standard error	1.93	1.52	1.56	1.57	1.44	
CV		10.31	9.69	9.74	9.06	
17-Trongsa						0.357
Poverty rate	21.71	22.65	23.43	23.42	23.27	
MSE*10,000		2.34	2.46	2.55	2.28	
Standard error	2.99	1.53	1.57	1.60	1.51	
CV		6.75	6.69	6.82	6.48	
18-Tsirang						0.018
Poverty rate	19.54	18.75	19.48	19.47	19.48	
MSE*10,000		3.98	3.34	3.46	1.99	
Standard error	2.42	1.99	1.83	1.86	1.41	
CV		10.63	9.38	9.56	7.25	
19-Wangdue Phodrang						0.014
Poverty rate	15.85	15.60	15.55	15.53	15.90	
MSE*10,000		0.84	0.86	0.86	0.86	
Standard error	2.82	0.92	0.93	0.93	0.93	
CV		5.88	5.98	5.96	5.82	
20-Zhemgang						0.574
Poverty rate	41.38	35.26	35.90	36.04	34.37	
MSE*10,000		3.55	3.55	3.64	3.38	
Standard error	3.38	1.88	1.88	1.91	1.84	
CV		5.34	5.25	5.29	5.35	

Source:Based on 2022 BLSSand 2017 PHCB.

Table 4.2 Extract of the variable selection for each district

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Demographics																					
age_head	Age of household head												x								
age_mn	Mean of age at the household level					x			x		x	x				x			x		
age_yn	Maximum age of household members	x	x	x										x		x	x			x	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Education																					
educyrs_head	Number of years of education of the household head	x																			
everattd_head	Household head has ever attended school		x										x			x					x
everattd_mn	Share of household members who has ever attended school								x						x						
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Dwelling and access to services																					
ene_elec	Household mainly using electricity for cooking					x		x		x								x	x		
ene_gas	Household mainly using gas for cooking		x												x						
ene_wood	Household mainly using firewood for cooking																	x			
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Asset ownership																					
bicycle	Household with bicycle																	x			
computerlaptop	Household with computer or laptop		x	x									x		x			x			x
fridge	Household with fridge																	x			
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
District and town level																					
adult1564_c_t_s	Number of household members ages 15–64, at the town level			x		x															
hysize_m_t_s	Household size, town average	x										x									
seperated_m_t_s	Separated household members, town average																			x	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Source: Based on 2022BLSS and 2017 PHCB.

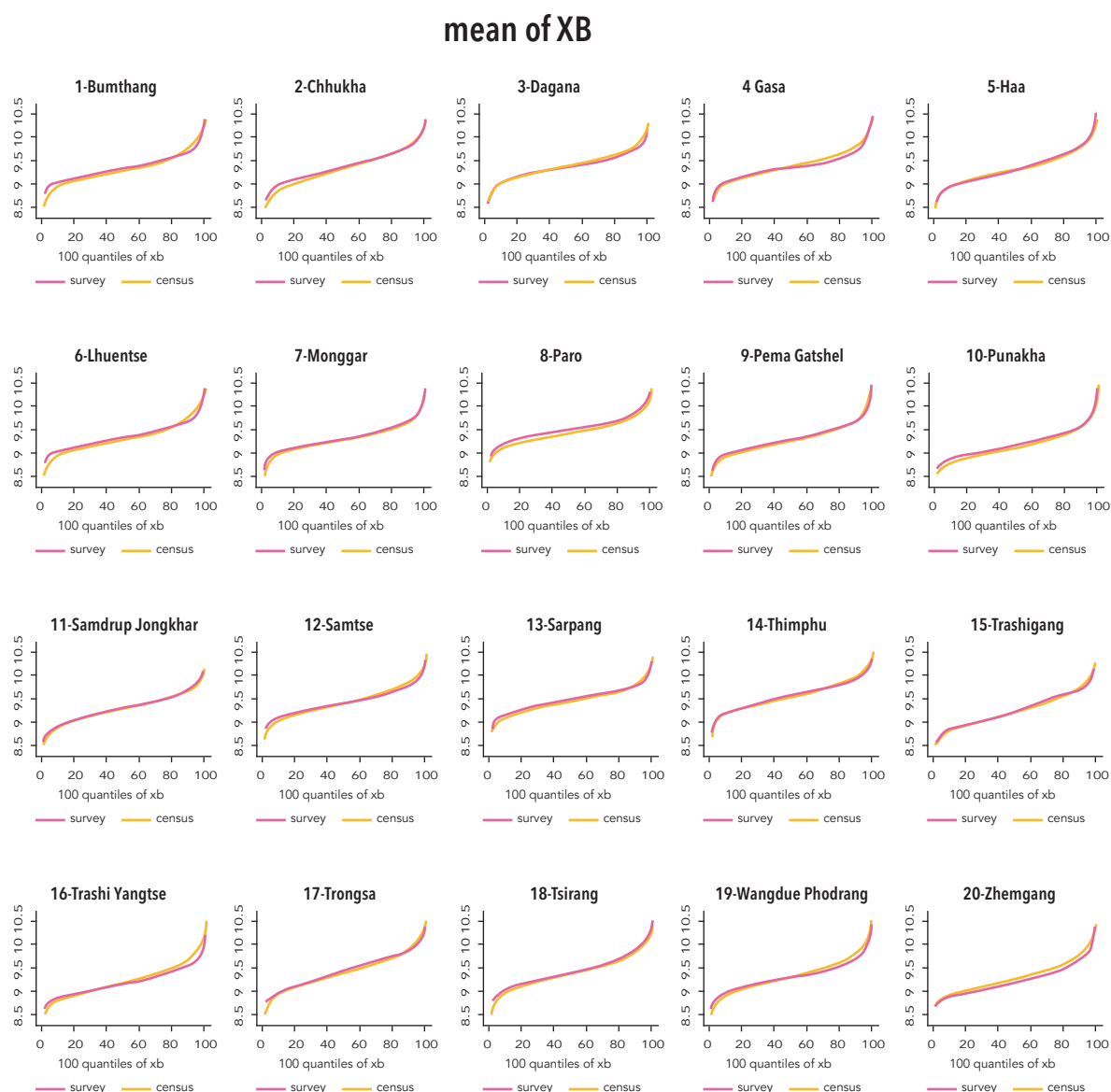
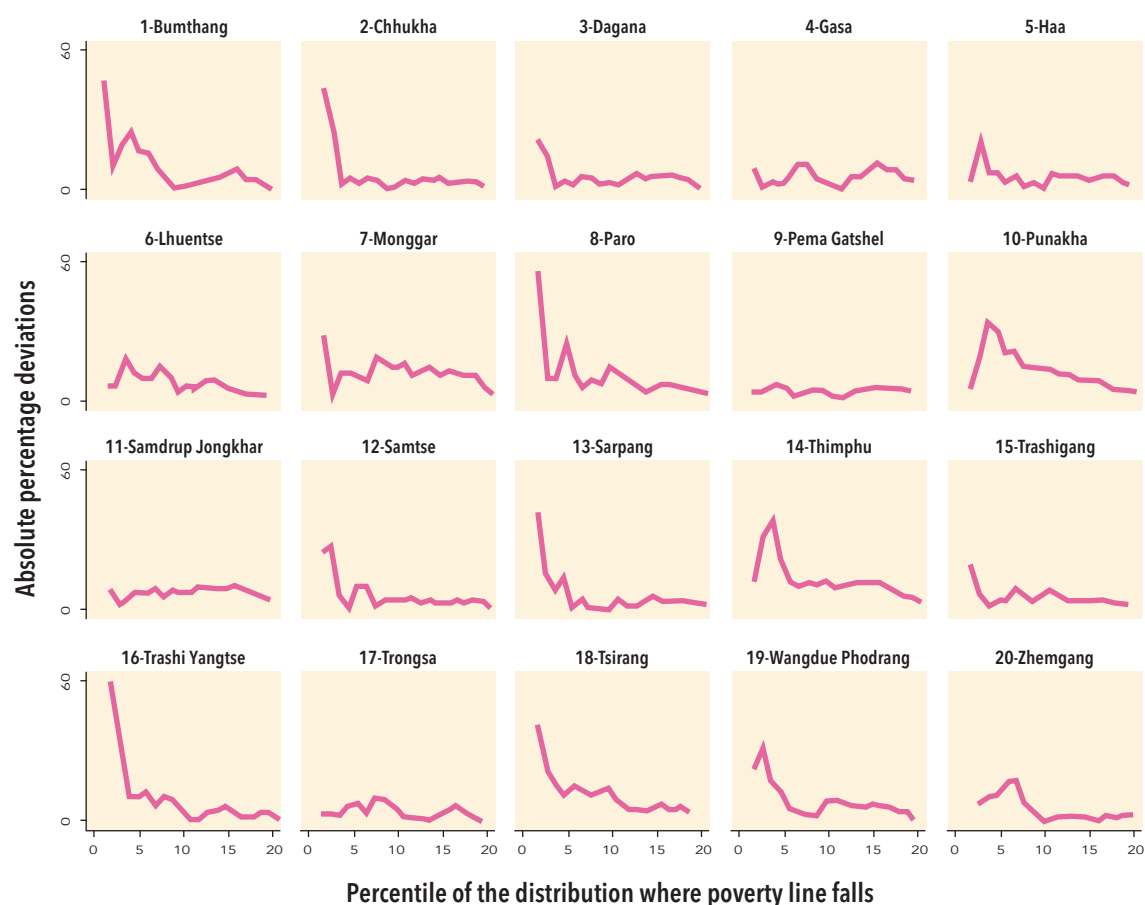


Figure 4.4 Percentile distribution of means of log predicted consumption

Source: Based on 2022BLSS and 2017 PHCB.

Given the final model selections at the district level, FIGURE 4.4 shows the level of covariate comparability between the survey and census data from all parts of the distributions. The figure shows means of the log of predicted consumption across 100 percentiles simply based on the set of coefficients from the district

OLS models and the covariates in the survey and the census. It shows that the *Dzongkhag*-level data are comparable at all parts of the distributions without controlling for the heteroskedasticity of households and different locations and areas.



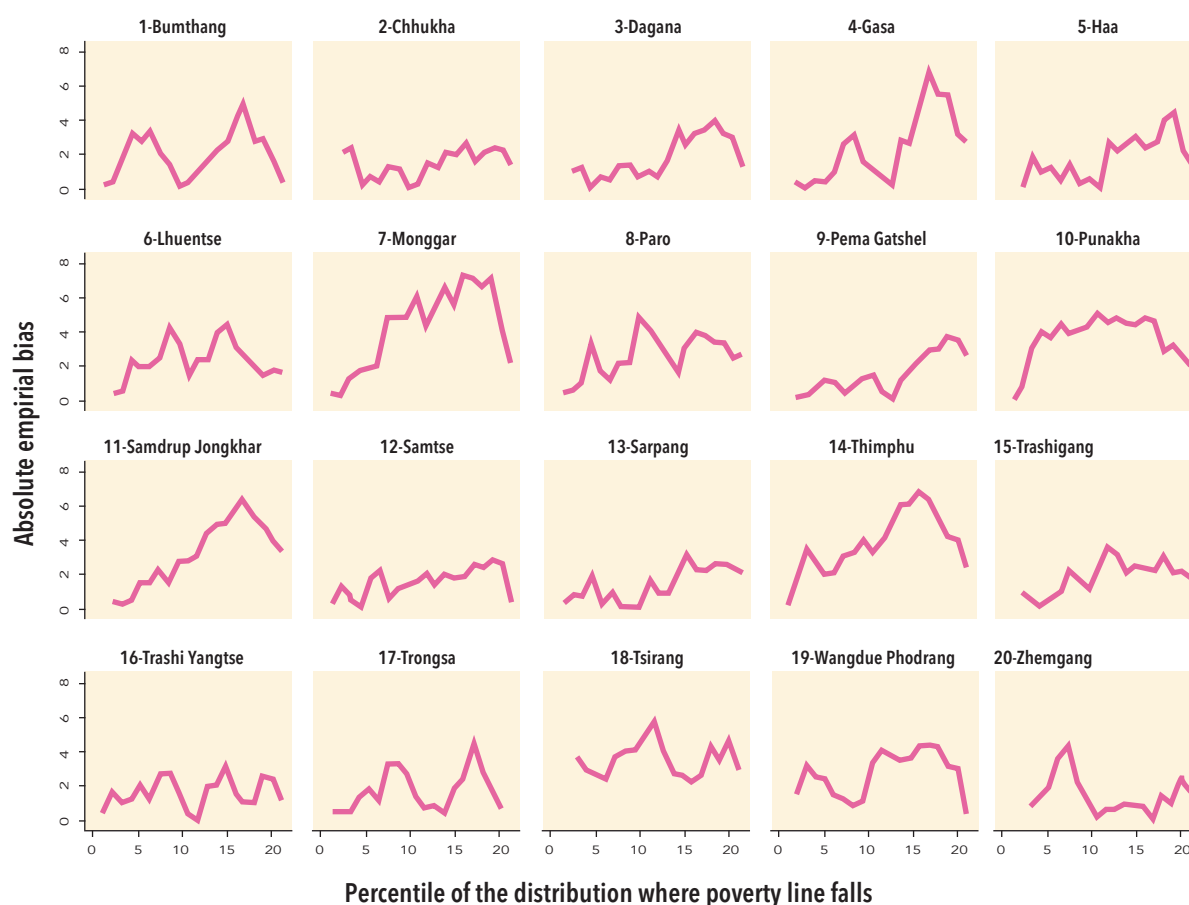
Graphs by reg

Figure 4.5 Absolute percentage deviations at each ventilewhere poverty line falls

Source:Based on 2022BLSS and 2017 PHCB.

To measure how good a model is within the SAE setting, we ran the models and imputed into the same survey data at all parts of the ventiles(20) in each *Dzongkhag* welfare distribution. For each ventile in a district, we use the threshold that define the ventile as the poverty line (i.e., the first ventile corresponds to the lowest part of the 20-ventile (part) of distributions). FIGURE 4.5 shows how large the absolute percentage deviations are from the survey estimates for each *Dzongkhag* calculated at all ventile-equivalent poverty lines. FIGURE 4.6 shows the

empirical bias from the survey estimates for each *Dzongkhag* calculated at all ventile-equivalent poverty lines. In a theoretical setting, one would see small absolute percentage deviations or small biases across all parts of the distribution, however in a real-world data setting, this is hard to achieve. In some districts, in the lower part of the distributions, the absolute percentage deviations are large suggesting that it is difficult to predict welfare and poverty rates when the poverty lines are defined at the lower tails or the poverty headcounts are very small.



Graphs by reg

Figure 4.6 Absolute empirical bias at each percentile where poverty line falls using survey

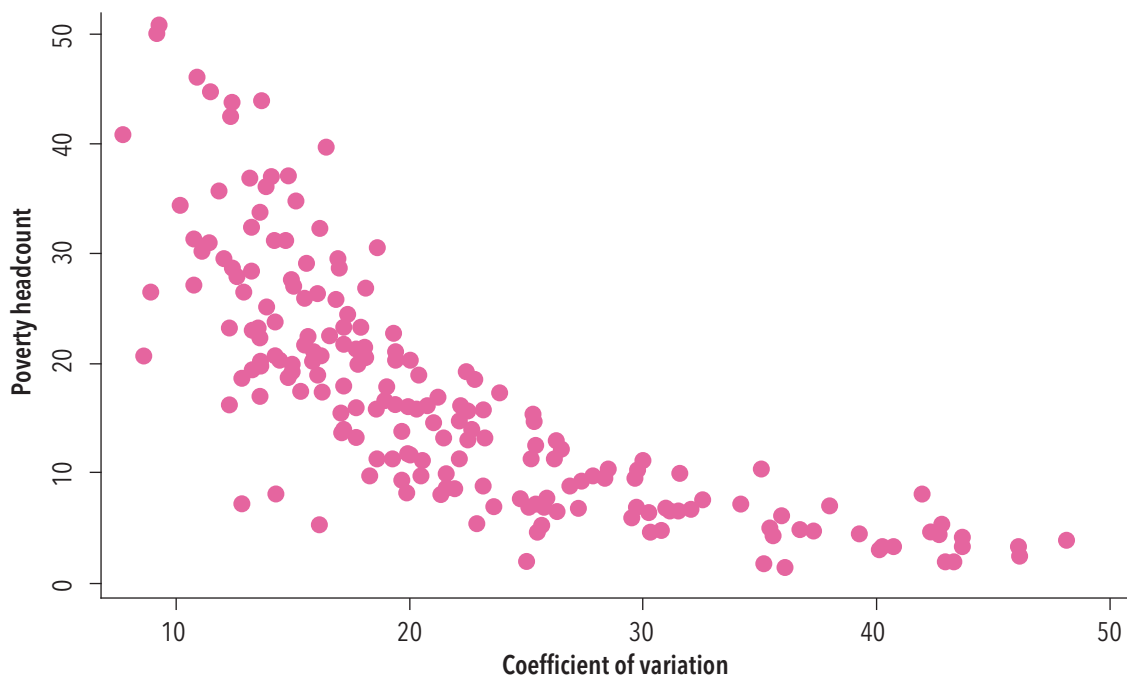
Source: Based on 2022BLSS and 2017 PHCB.

FIGURE 4.7 summarizes the poverty headcount estimates and noises across towns. Given the small size of towns and data availability of towns in the survey data, there are several towns with less than 5% poverty rate and high coefficients of variations. However, majority of towns are with coefficients of variation less than 30 (FIGURE 4.7, panel a).

At the town level the heterogeneity of poverty across the country is even more apparent. FIGURE 4.7 (panel b) presents the poverty rates for all towns in Bhutan with their respective confidence interval. Towns have been sorted from least poor to most poor. The confidence

intervals for the estimates are wider for some towns. To shrink the confidence interval as much as possible, the models for Bhutan makes use of Empirical Bayes (EB) methods (see section on modelling approach). The use of EB, however, will only affect towns included in the survey, since the added information for the location comes from the model run on the survey data. Even though the confidence intervals may be wide, there is not much re-ranking between municipalities when comparing the mean to either the lower or upper bound estimates.

a. Scatter plot of poverty headcount estimates and coefficients of variation



b. Poverty headcount estimates and 95% confidence interval

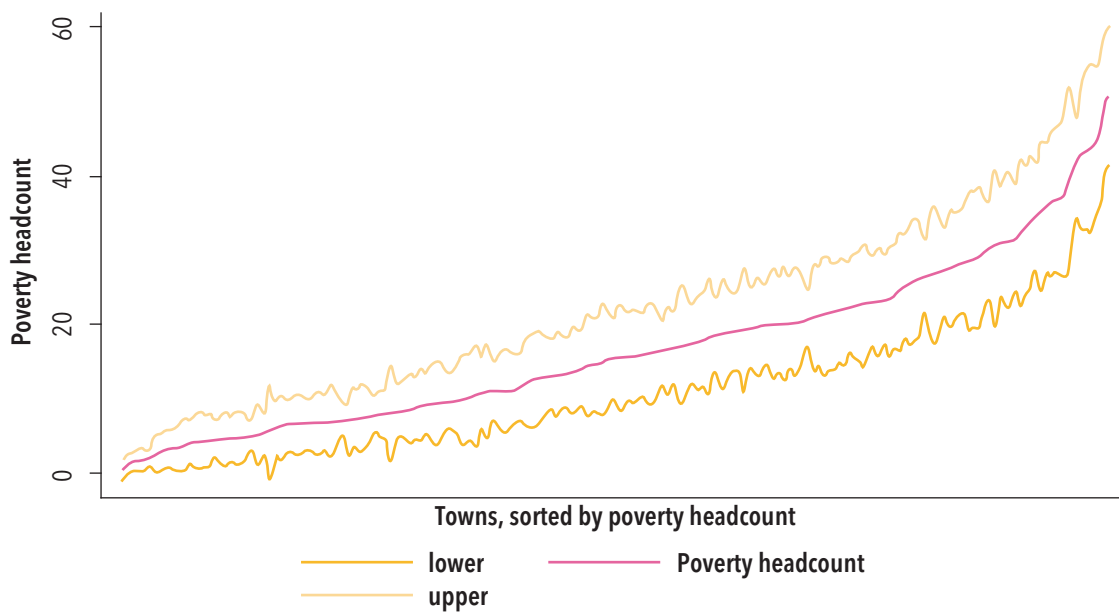


Figure 4.7 Poverty headcount estimates, coefficients of variation, and confidence interval

Chapter 5

Poverty Mapping Results

5.1 Poverty Headcount Rate by District and Town

FIGURE 5.1 and FIGURE 5.2 show the poverty headcount rate by *Dzongkhag*/district and *Gewog*/town. The poverty incidence is highest in Zhemgang, Trongsa, Samtse, Trashigang, and Samdrup Jongkhar districts. Thimphu shows the lowest poverty headcount rate. At a more disaggregated level, poverty is highest in *Gewogs* in Chhukha, Monggar, and Samdrup Jongkhar. The five *Gewogs* with the highest poverty headcount are Bardo, Phangkhar+Goshing, Kengkhar, Shingkar, and Silambi. In contrast, poverty is lowest in Punakha Town followed by Chang, Maedwang+Khasadrapchu Town, Barp+Lobaysa Town, Darkarla+Ge-nyen, and Thimphu Thromde with poverty headcount rates lower than 2 percent. These *Gewogs* are in the districts of Punakha and Thimphu.

Monggar, Zhemgang, and Chhukha exhibit substantial variations in poverty within the district. In Monggar Dzongkhag, the poverty headcount rate ranges from 2.9 percent in Monggar Gewog/town and Kilikhar Gewog to 46.1 percent in Kengkhar Gewog. In Zhemgang Dzongkhag, the poverty headcount rate ranges from 9.6 percent in Zhemgang Gewog to 50.8 percent in Bardo Gewog. As for Chhukha district, the poverty headcount rate ranges from

4.5 percent in Gedu Gewog to 43.7 percent in Doongna and Maedtabkha Gewogs combined. Annexure 3 reports the town-level poverty headcount rates with their standard errors.

5.2 Poverty Gap Index by District and Town

FIGURE 12 and FIGURE 13 show the poverty gap index by district and town. The poverty gap is highest in Zhemgang, Trongsa, and Samdrup Jongkhar and lowest in Thimphu and Punakha. Both Thimphu and Punakha show the lowest poverty headcount rate and gap. However, results at a town level show that the highest poverty gap town does not necessarily belong to Zhemgang district. In fact, the highest poverty gap at the town level is observed in Samdrup Jongkhar (Wangphu Gewog) while Bardo, Phangkhar+Goshing, from Zhemgang district are second and third rank, respectively. High poverty gap spreads across Monggar, Chhukha, Trashigang and Trongsa districts. In particular, Monggar districts has two of its towns (Kengkhar and Silambi) among the five towns that are much further from the poverty line.

Disparity within Monggar, Zhemgang and Chhukha districts is also confirmed in terms of poverty gap. In Monggar districts, poverty gap ranges from 0.4 percent in Monggar Gewog/

town and Kilikhar Gewog to 13.5 in Kengkhar Gewog. In Zhemgang Dzongkhag, poverty gap ranges from 1.8 percent in Zhemgang Gewog to 14.3 percent in Bardo. In Chhukha Dzongkhag, poverty ranges from 0.7 percent in Gedu Gewog to 10.6 percent in Doongna and Maedtabkha Gewogs combined.

5.3 Poverty Severity Index by District and Town

FIGURE 5.5 and FIGURE 5.6 show the poverty severity index by district and town. Similar to the poverty gap index, the poverty severity index is highest in Zhemgang, Trongsa, and Samdrup Jongkhar. Moreover, towns with relatively high poverty gaps tend to have relatively high poverty severity.

5.4 Distribution of the Poor across Districts and Towns

FIGURE 5.7 and FIGURE 5.8 show that the poor are concentrated in Samtse and Chhukha. Both districts exhibit large populations but not necessarily higher poverty headcount rates. The Samtse district has high poverty headcount rate, but Chhukha has a moderate poverty headcount rate. Towns with the highest number of the poor are spread across Thimphu district (Thimphu Thromde), Chhukha district (Phuentshogling, Darla and Darla Town, Phuentshogling Thromde, Bongo+Getana, Geling+Samphelling, Zhemgang district (Ngangla+PanbangTown +Bjoka, Phangkhar+Goshing, Bardo, Nangkor Gewogs), Samtse district (Dophuchen, Namgyalchhoeling, Norgaygang, Tendruk, Tading, Sang-Ngag-Chhoelin, Phuentshogpelri,, Pemaling,Norboogang, Samtse, Samtse Town), Trongsa (Langthil+Korphu) and Samdrup Jongkhar (Gomdar). Each of these towns host between 1 to 2.6 percent of the total number of poor in Bhutan.

There are also from Pema Gatshel, Samdrup Jongkhar, Trashigang, Trongsa and Wangdue Phodrang districts with 0.8 to 1 percent.

Gewogs with the lowest number of poor are mainly located in Paro district (Wangchang+Hoongrel), Punakha district (Chhubu+Goenshari, Guma, Dzomi, Lingmukha+Shelnga-Bjemii, Toedwang, Toedpaissa, Talog, Punakha Town), Samdrup Jongkhar district (Samdrupcholing Town), Sarpang district (Gakiling, Sarpang Town) but there are also those from Chhukha district(Gedu Town) and Thimphu district (Chang, Darkarla+Ge-nyen). Each of these towns host fewer than 0.1 percent of the total number of poor in Bhutan.

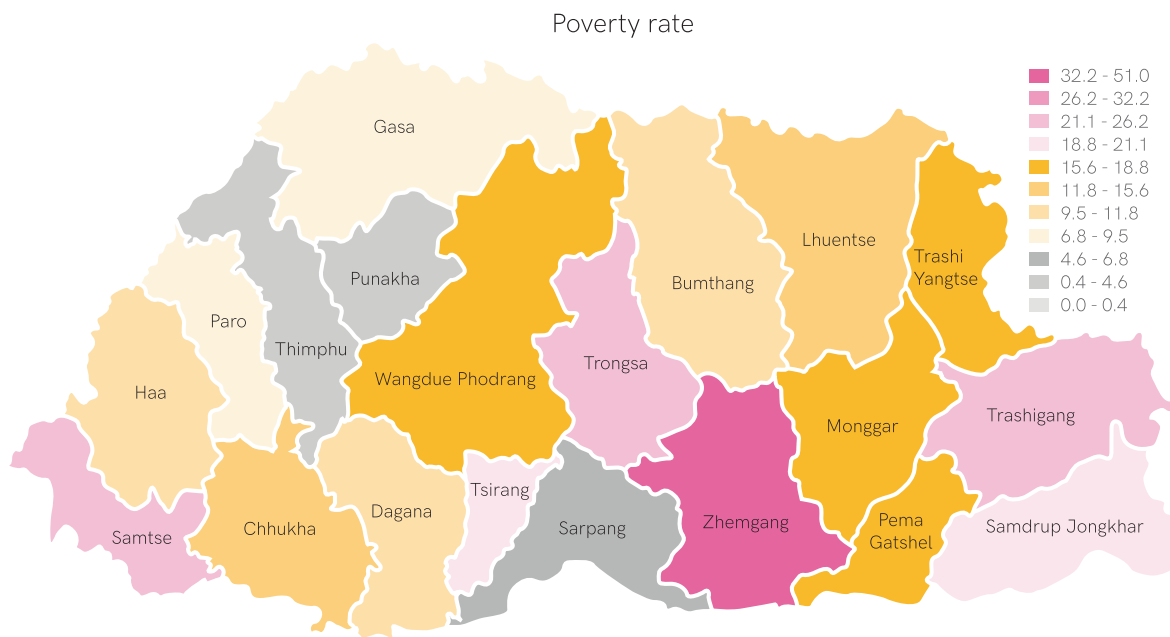


Figure 5.1 Poverty headcount rate by district

Source: Based on 2022 BLSS and 2017 PHCB.

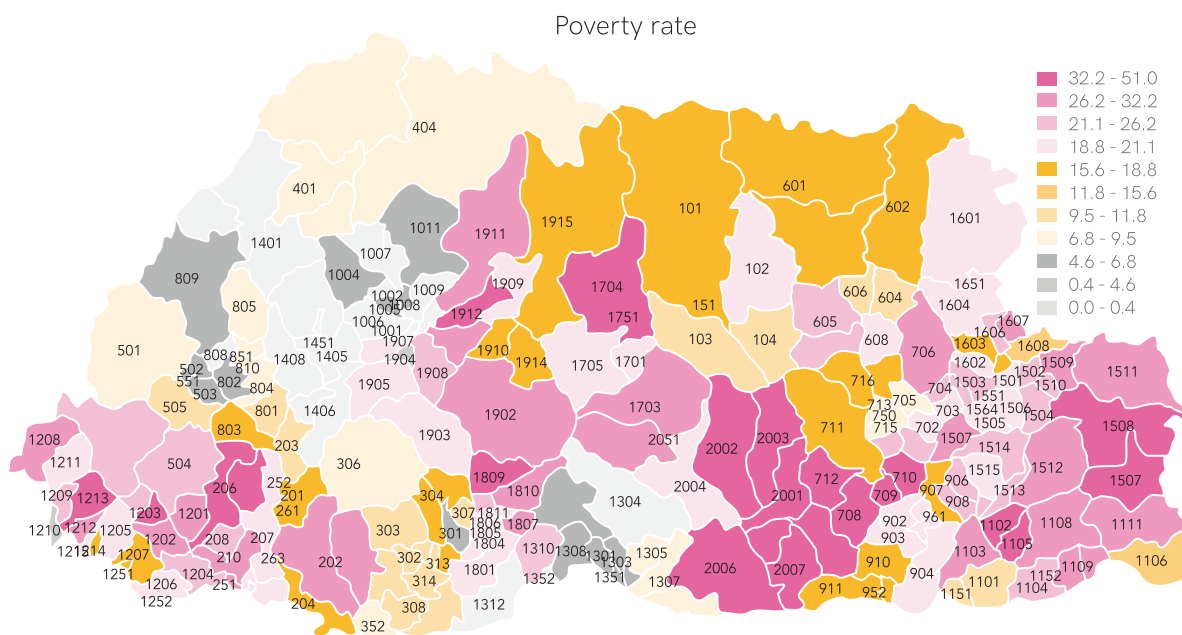


Figure 5.2 Poverty headcount rate by town

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Numbers within the town-level map are town IDs listed in the Annexure.

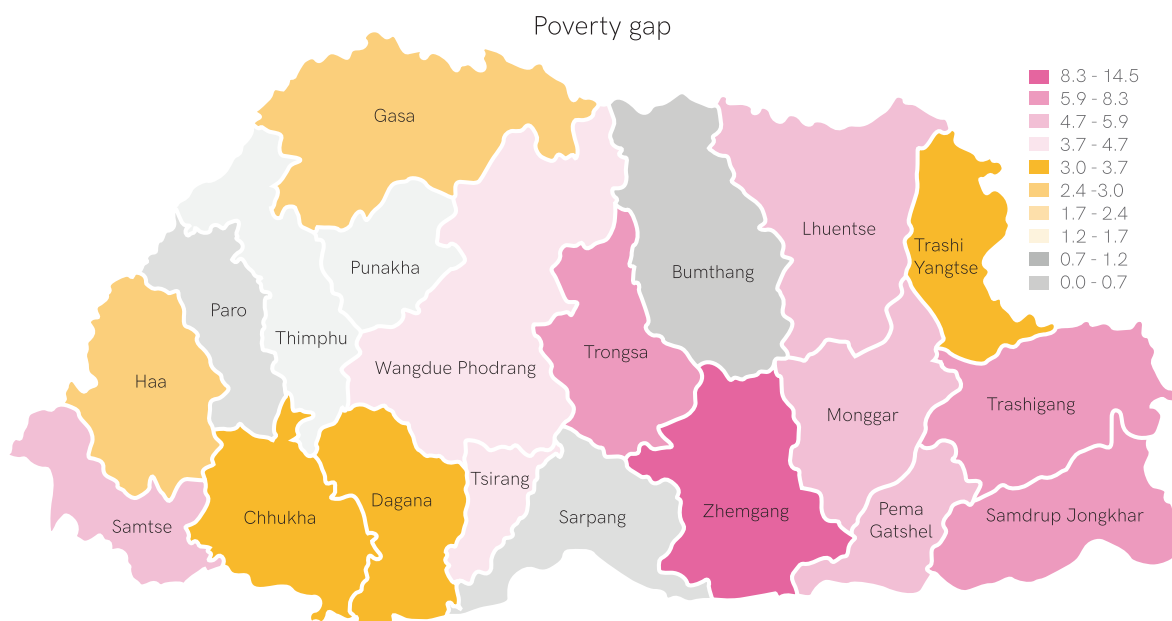


Figure 5.3 Poverty gap index by district

Source: Based on 2022 BLSS and 2017 PHCB.

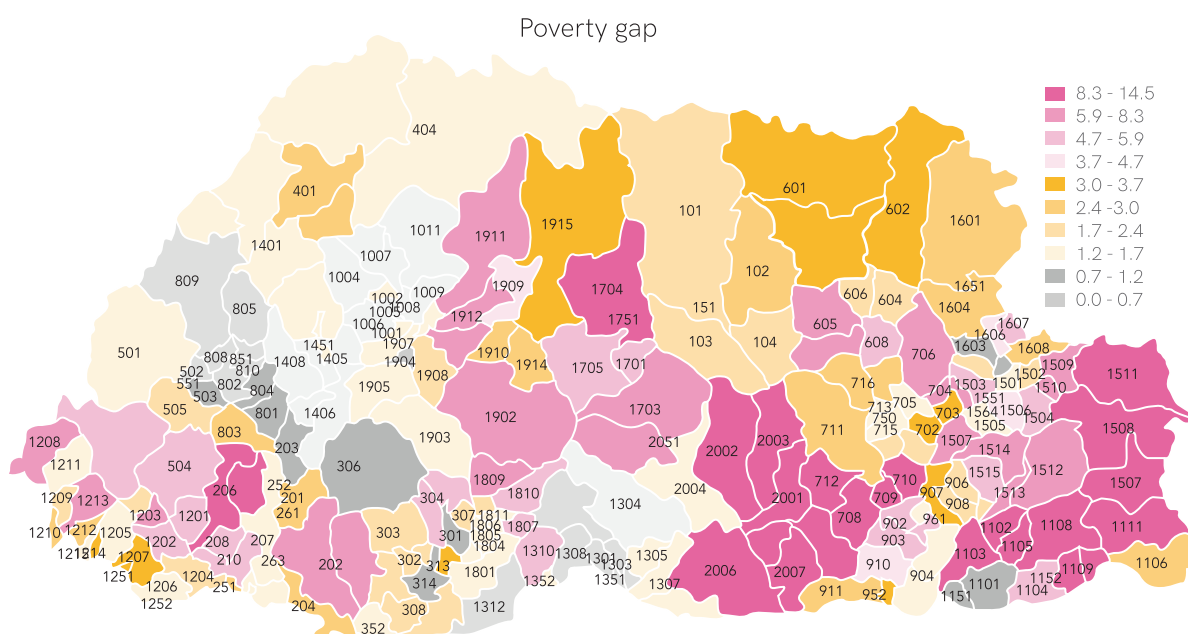


Figure 5.4 Poverty gap index by town

Source: Based on 2022 BLSS and 2017 PHCB.

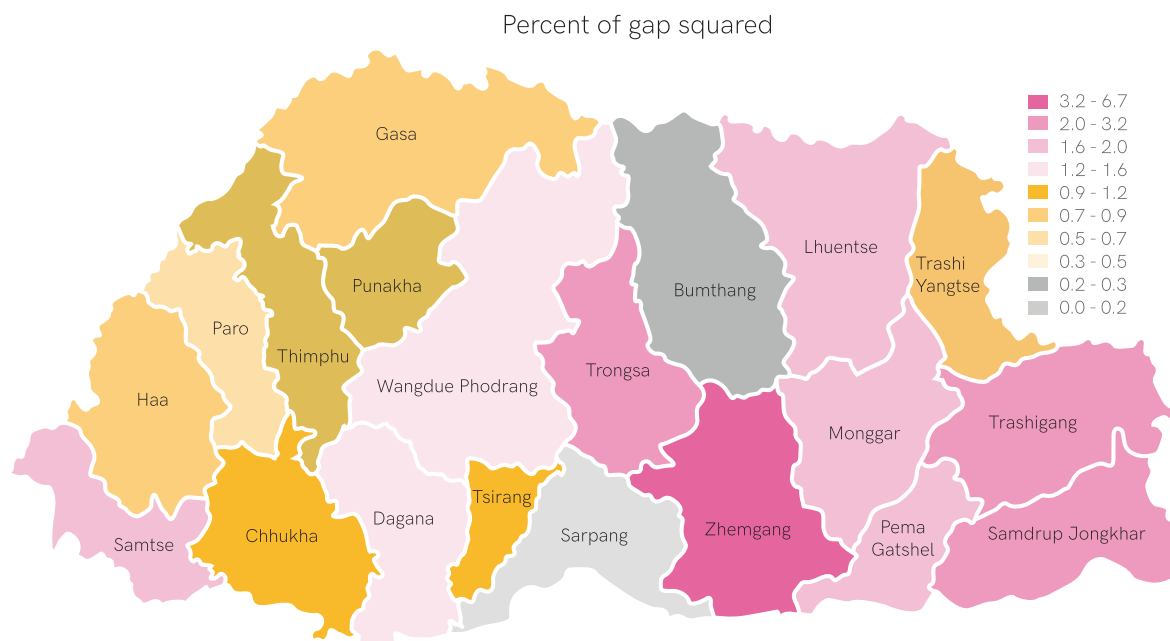


Figure 5.5 Poverty severity index by district

Source: Based on 2022 BLSS and 2017 PHCB.

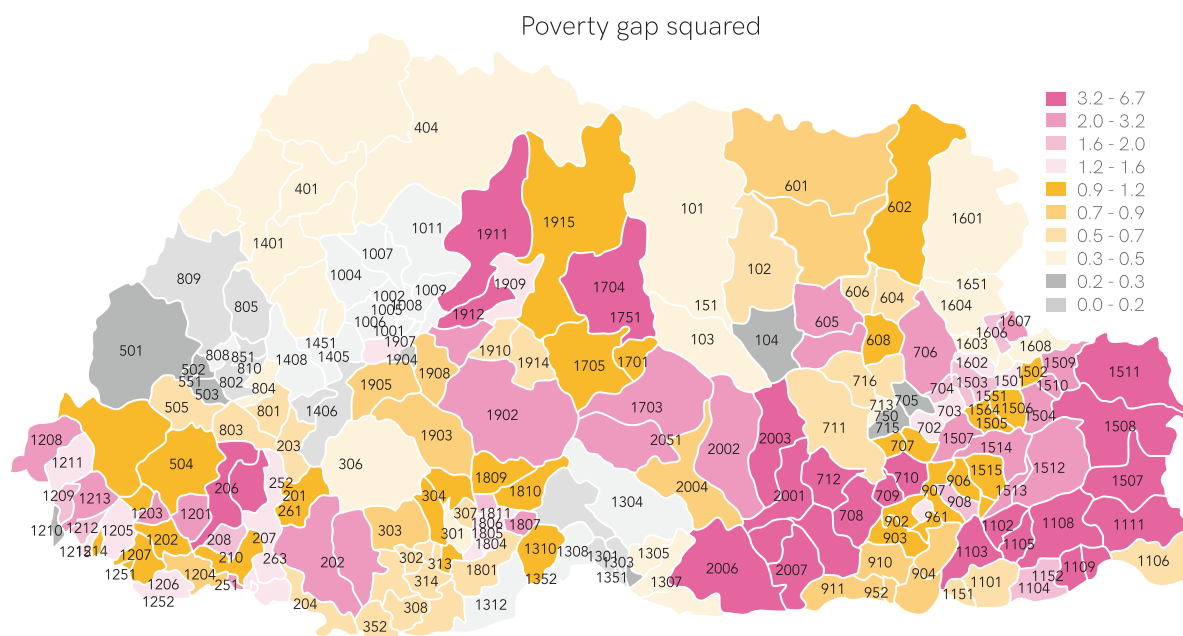


Figure 5.6 Poverty severity index by town

Source: Based on 2022 BLSS and 2017 PHCB.

Distribution of the poor

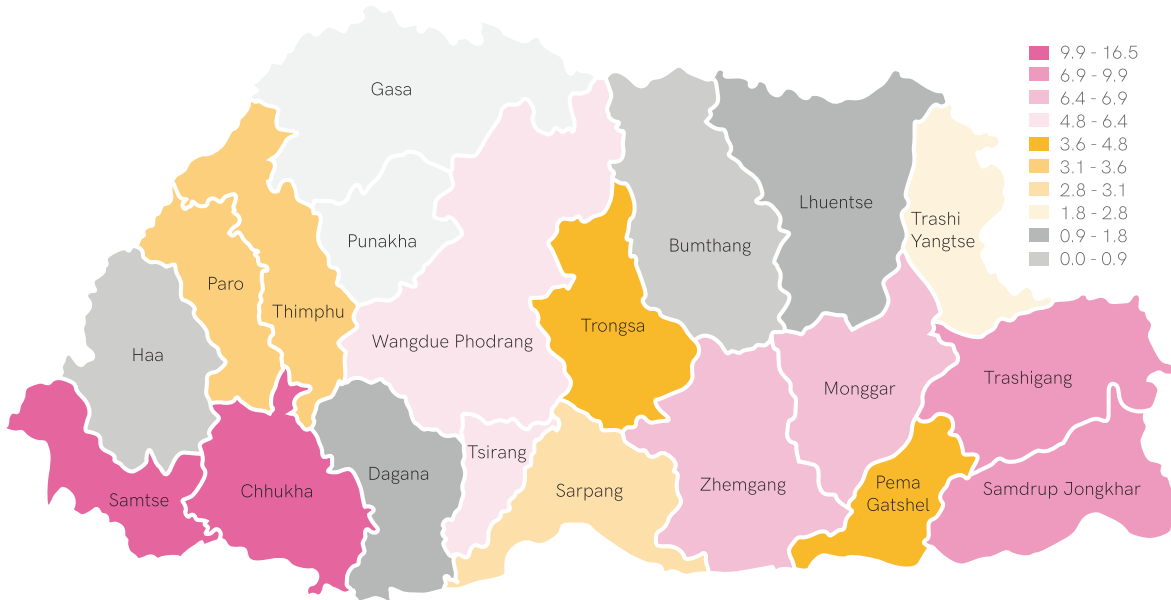


Figure 5.7 Distribution of the poor across district

Source:Based on 2022 BLSS and 2017 PHCB.

Distribution of the poor

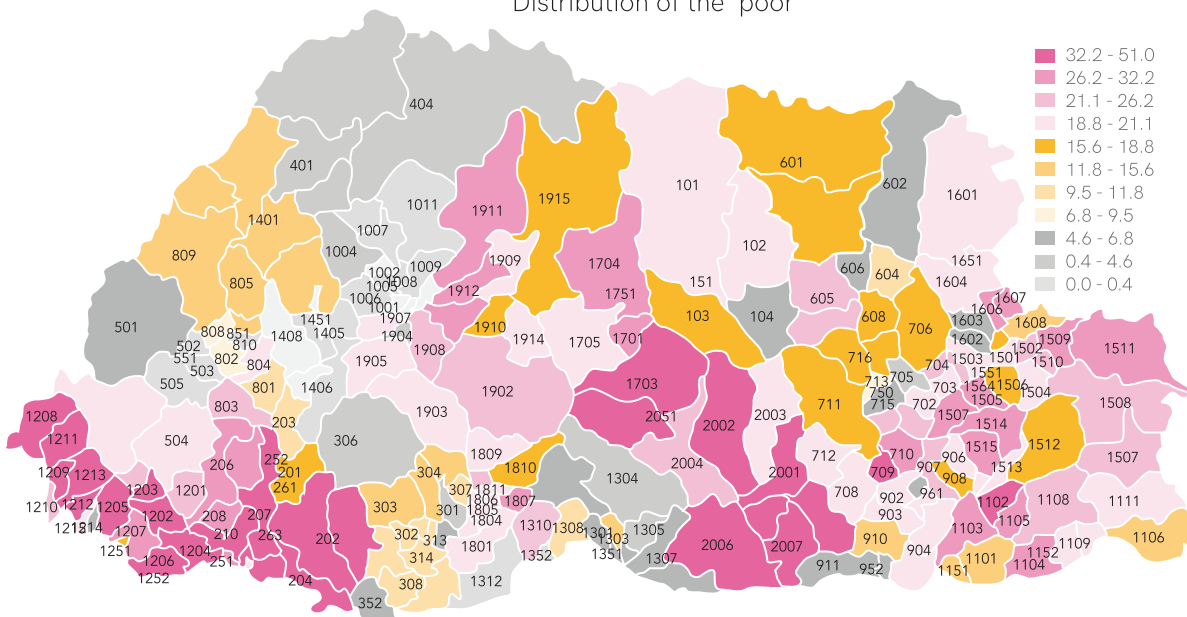


Figure 5.8 Distribution of the poor across town

Source: Based on 2022 BLSS and 2017 PHCB.

Chapter 6

Conclusion and Recommendations

This report updates the district- and town-level poverty maps for Bhutan using the SAE technique and the most recent Bhutan Living Standard Survey (BLSS 2022) and PHCB 2017. Three key findings of the report are as follows: (a) poverty is high in districts in mountainous areas bordering India and low in districts in the central part of the country and those bordering China; (b) there is a large variation in poverty rates across towns within the same district; and (c) towns with the highest number of the poor are primarily in Thimphu, Chhukha, Zhemgang, and Samtse.

These results can be used to design budget allocations to maximize the impact of poverty reduction programs by allocating more budget to districts and *Gewogs*/towns with higher poverty headcount rates, poverty gap index, poverty severity index, and number of poor. The wide disparity across *Gewogs*/towns within the same *Dzongkhag*/ district reinforces the need to target poverty reduction, service delivery and social protection interventions at

the *Gewog*/town level. The estimated poverty rate and number of poor Bhutanese can be used to locate the poor and inform policy decisions that aim to reduce poverty and spatial inequality in the country. The prominent geographical disparity at the *Gewog* level suggests the need for policies to boost economic growth in poor areas and narrow the income gap. Moreover, by integrating poverty maps with other spatial information, these results can be used to analyze the relationships between poverty and other development indicators such as infrastructure access, market access, public service delivery, exposure to natural hazards, climate change vulnerability, and agricultural production. In other words, a potential extension to this poverty mapping exercise that might help pinpoint the reasons pockets of poverty remain economically stagnant and potential solutions to improve their living standards is overlaying the poverty map with geographical information on social services, infrastructure, and social conditions.

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ANNEXURE I: AGGREGATION OF TOWNS WITH SMALLER THAN 300 HOUSEHOLDS

Table A1.1 Aggregation of towns with smaller than 300 households

District code	District name	Original Gewog/town code	Original Gewog/town name	Number of households (Gewog/town 1)	Number of individuals (Gewog/town 1)	New Gewog/town2 code	New Gewog/town2 name
1	Bumthang	103	Chhumig	637	2,514	103	Chhumig+Chhumig Town
1	Bumthang	152	Chhumig Town	72	259		
2	Chhukha	202	Bongo	786	3,439	202	Bongo+Getana
2	Chhukha	205	Getana	157	820		
2	Chhukha	204	Darla	1,749	7,256	204	Darla+Darla Town
2	Chhukha	262	Darla Town	266	1,034		
2	Chhukha	206	Doongna	223	1,064	206	Doongna+Maedtabkha
2	Chhukha	209	Maedtabkha	125	657		
2	Chhukha	207	Geling	295	1,182	207	Geling+Samphelling
2	Chhukha	211	Samphelling	964	4,029		
3	Dagana	301	Drukjeygang	517	1,790	301	Drukjeygang+Drukjeygang Town
3	Dagana	362	Drukjeygang Town	55	158		
3	Dagana	302	Gozhi	595	2,417	302	Gozhi+Gesarling
3	Dagana	310	Gesarling	276	976		
3	Dagana	304	Khebisa	302	1,198	304	Khebisa+Largyab
3	Dagana	305	Largyab	185	657		
3	Dagana	306	Tseza	272	1,038	306	Tseza+Dagana Town
3	Dagana	351	Dagana Town	229	869		
3	Dagana	307	Tsangkha	371	1,435	307	Tsangkha+Sankosh Town
3	Dagana	363	Sankosh Town	19	52		
3	Dagana	308	Karmaling	309	1,109	308	Karmaling+Dorona+Nichula
3	Dagana	309	Dorona	194	731		
3	Dagana	312	Nichula	134	425		
3	Dagana	314	Tsenda-Gang	466	1,782	314	Tsenda-Gang+Dagapela Town
3	Dagana	361	Dagapela Town	132	503		
3	Dagana	311	Lhamoi Dzingkha	194	769	352	Lhamoi Dzingkha Town+LhamoiDzingkha
3	Dagana	352	Lhamoi Dzingkha Town	416	1,576		
4	Gasa	401	Khamaed	142	467	401	Khamed+Damji+Gasa Town+Khatoed
4	Gasa	452	Damji Town	51	184		
4	Gasa	403	Khatoed	69	245		
4	Gasa	451	Gasa Town	229	707		
4	Gasa	402	Lunana	177	676	404	Laya+Lunana
4	Gasa	404	Laya	241	994		
5	Haa	504	Gakiling	288	1,086	504	Gakiling+Sangbay
5	Haa	506	Sangbay	255	836		
5	Haa	505	Samar	217	925	505	Samar+Jyenkana Town
5	Haa	552	Jyenkana Town	91	331		
6	Lhuentse	601	Gangzur	500	2,089	601	Gangzur+Kurtoed+Lhuentse Town
6	Lhuentse	603	Kurtoed	175	635		
6	Lhuentse	651	Lhuentse Town	248	896		
6	Lhuentse	605	Jarey	228	845	605	Jarey+Autsho Town+Maedtsho
6	Lhuentse	652	Autsho Town	112	429		
6	Lhuentse	607	Maedtsho	237	925		

District code	District name	Original Gewog/town code	Original Gewog/town name	Number of households (Gewog/town 1)	Number of individuals (Gewog/town 1)	New Gewog/town2 code	New Gewog/town2 name
7	Monggar	701	Balam	254	834	704	Na-Rang+Balam
7	Monggar	704	Na-Rang	323	1,116		
7	Monggar	703	Dramedtse	436	1,791	703	Dramedtse+Dramedtse Town
7	Monggar	761	Dramedtse Town	89	300		
7	Monggar	705	Ngatshang	420	1,595	705	Ngatshang+Yadi Town
7	Monggar	754	Yadi Town	70	237		
7	Monggar	707	Thang-Rong	402	1,441	707	Thang-Rong+Drepoong
7	Monggar	714	Drepoong	265	862		
7	Monggar	711	Saling	480	1,810	711	Saling+Lingmethang Town
7	Monggar	762	Lingmethang Town	233	823		
7	Monggar	716	Tsakaling	337	974	716	Tsakaling+Tsamang
7	Monggar	717	Tsamang	239	816		
7	Monggar	752	Kilikhar Town	90	372	753	Monggar Town+Kilikhar Town
7	Monggar	753	Monggar Town	934	3,629		
8	Paro	803	Nagya	735	3,143	803	Nagya+Betykha Town
8	Paro	852	Betykha Town	59	200		
8	Paro	805	Dopshar-ri	776	3,213	805	Dopshar-ri+Doteng
8	Paro	806	Doteng	290	1,221		
8	Paro	807	Hoongrel	45	134	810	Wangchang+Hoongrel
8	Paro	810	Wangchang	322	1,119		
9	Pema Gatshel	901	Chhimoong	152	515	902	Chongshing+Chhimoong
9	Pema Gatshel	902	Chongshing	219	771		
9	Pema Gatshel	904	Khar	386	1,460	904	Khar+Chhoeckhorling
9	Pema Gatshel	909	Chhoeckhorling	250	678		
9	Pema Gatshel	951	Denchi Town	71	255	961	Denchi Town+Kherigonpa Town+Yalang Town+Mongling Town +Khothakpa Town +Nangkhor Town+Olde Pema Gatshel Town
9	Pema Gatshel	962	Kherigonpa Town	20	61		
9	Pema Gatshel	963	Yalang Town	17	62		
9	Pema Gatshel	964	Mongling Town	11	37		
9	Pema Gatshel	965	Khothakpa Town	38	142		
9	Pema Gatshel	966	Nangkhor Town	108	434		
9	Pema Gatshel	961	Olde Pema Gatshel Town	231	823		
10	Punakha	1001	Barp	1,172	4,060	1001	Barp+Lobaysa Gewog/Town
10	Punakha	1052	Lobaysa Town	197	689		
10	Punakha	1003	Goenshari	145	525	1007	Chhubu+Goenshari
10	Punakha	1007	Chhubu	313	1,353		
10	Punakha	1009	Lingmukha	260	966	1009	Lingmukha+Shelnga-Bjemi
10	Punakha	1010	Shelnga-Bjemi	239	895		
11	Samdrup Jongkhar	1106	Langchenphu	243	920	1106	Langchenphu+Jomotsangkha Gewog/Town
11	Samdrup Jongkhar	1161	Jomotsangkha Town	287	1,057		
11	Samdrup Jongkhar	1109	Pemathang	380	1,441	1109	Pemathang+Samrang
11	Samdrup Jongkhar	1110	Samrang	55	191		
12	Samtse	1210	Tashichhoeling	980	3,834	1210	Tashichhoeling+Sipsu Town
12	Samtse	1261	Sipsu Town	169	597		

District code	District name	Original Gewog/town code	Original Gewog/town name	Number of households (Gewog/town1)	Number of individuals (Gewog/town1)	New Gewog/town2 code	New Gewog/town2 name
13	Sarpang	1306	Tareythang	82	279	1307	Umling+Tareythang
13	Sarpang	1307	Umling	411	1,527		
13	Sarpang	1311	Senggey	255	1,004	1312	Shompangkha+Senggey
13	Sarpang	1312	Shompangkha	357	1,455		
14	Thimphu	1401	Kawang	1,316	4,756	1401	Kawang+Lingzhi+Naro+Soe
14	Thimphu	1402	Lingzhi	92	468		
14	Thimphu	1403	Naro	44	221		
14	Thimphu	1404	Soe	37	182		
14	Thimphu	1406	Darkarla	344	1,380	1406	Darkarla+Ge-nyen
14	Thimphu	1407	Ge-nyen	237	1,052		
14	Thimphu	1408	Maedwang	1,505	6,241	1408	Maedwang+Khasadrapchu Town
14	Thimphu	1452	Khasadrapchu Town	236	966		
15	Trashigang	1514	Khaling	644	2167	1514	Khaling+Khaling Town
15	Trashigang	1562	Khaling Town	184	680		
15	Trashigang	1515	Lumang	883	2939	1515	Lumang+Resarbu Town+Wangrong Town
15	Trashigang	1563	Resarbu Town	57	186		
15	Trashigang	1564	Wangrong Town	92	340		
16	Trashi Yangtse	1652	Duksum Town	89	278	1606	Duksum Town+Khamdang
16	Trashi Yangtse	1606	Khamdang	719	2,800		
17	Trongsa	1701	Draagteng	994	3,280	1701	Draagteng+Kuengarabten Town
17	Trongsa	1752	Kuengarabten Town	112	395		
17	Trongsa	1702	Korphu	202	735	1703	Langthil+Korphu
17	Trongsa	1703	Langthil	748	2,642		
18	Tsirang	1801	Barshong	224	842	1801	Barshong+Patshaling
18	Tsirang	1802	Patshaling	296	1,147		
18	Tsirang	1804	Mendrelgang	434	1,629	1804	Mendrelgang+Mendrelgang Town
18	Tsirang	1852	Mendrelgang Town	16	59		
19	Wangdue Phodrang	1901	Athang	181	690	1902	Bjenag+Athang
19	Wangdue Phodrang	1902	Bjenag	437	1,495		
19	Wangdue Phodrang	1905	Gase Tshowogm	188	701	1905	GaseTshowogm+Nahi
19	Wangdue Phodrang	1906	Nahi	148	552		
19	Wangdue Phodrang	1908	Ruebisa	447	1,735	1908	Ruebisa+Rurichu Town
19	Wangdue Phodrang	1961	Rurichu Town	64	213		
19	Wangdue Phodrang	1909	Dangchhu	217	984	1909	Dangchhu+Nobding Town
19	Wangdue Phodrang	1952	Nobding Town	115	442		
19	Wangdue Phodrang	1911	Kazhi	334	1,229	1911	Kazhi+Phangyuel
19	Wangdue Phodrang	1913	Phangyuel	225	820		
20	Zhemgang	2004	Trong	584	2,158	2004	Trong+Tingtibi Town
20	Zhemgang	2053	Tingtibi Town	137	486		
20	Zhemgang	2005	Bjoka	194	764	2007	Ngangla+Panbang Town+Bjoka
20	Zhemgang	2007	Ngangla	445	1,768		
20	Zhemgang	2052	Panbang Town	178	705		
20	Zhemgang	2008	Phangkhar	287	1,053	2006	Phangkhar+Goshing
20	Zhemgang	2006	Goshing	336	1,272		

Source:Based on 2022 BLSS and 2017 PHCB.

ANNEXURE II: VARIABLE SELECTION FOR EACH DZONGKHAG

Table A2.1 Variable selection for each *Dzongkhag* (district)

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Demographics																					
age_head	Age of household head												x								
age_mn	Mean of age at the household level					x			x		x	x				x			x		
age_yn	Maximum age of household members	x	x	x										x		x	x			x	
age15t24_mn	Share of household members ages 15-24					x							x								
age15t24_yn	Household with at least one individual ages 15-24		x						x					x	x			x			
age1t14_mn	Household with at least one child ages 0-14	x																			
age1t14_yn	Household with at least one individual ages 0-14													x							
age25t64_head	Household head ages 25-64			x				x				x									
age25t64_mn	Share of householdmembers ages 25-64	x		x	x				x	x					x		x			x	x
age25t64_sm	Number of householdmembers ages 25-64																	x			
age25t64_yn	Household with at leastone individual ages 25-64	x						x		x			x			x			x	x	x
age65pl_head	Household head ages 65 and older																	x			
age65pl_mn	Share of householdmembers ages 65 and older																			x	
age65pl_yn	Household with at leastone individual ages 65 and older						x														
child_1	Household with onemember ages 1 to 14												x					x			
child_2	Household with twomembers ages 1 to 14												x	x				x			
child_3	Household with threemembers ages 1 to 14												x								
child_4p	Household with four or moremembers ages 1 to 14												x								
depratio	Dependency ratio		x														x	x			
female_mn	Share of female householdmembers					x	x												x		
female_yn	Household with at leastone female member	x	x					x		x			x	x		x	x	x		x	x
hhsz_4	Household with fourmembers																x				
hhsz_6	Household with six or moremembers													x							
ln_hdage	Log of household head age				x	x			x		x	x							x		x
male_head	Household head is male		x		x															x	

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
male_mn	Share of male householdmembers			x	x																
male_yn	Household with at leastone male member			x	x	x	x	x					x	x	x	x	x		x	x	x
married_head	Household head is married			x					x	x	x	x	x			x				x	
married_mn	Share of householdmembers who are married		x			x	x						x	x			x			x	x
married_sm	Number of householdmembers who are married			x	x					x											
married_yn	Household with at leastone married member		x			x		x										x			
widowed_head	Household head is awidower																				x
widowed_mn	Share of household members who are widowers							x													
widowed_yn	Household with at least one widowed member																x	x			
seperated_head	Household head is separated			x			x							x						x	x
seperated_mn	Share of householdmembers who are separated															x					
seperated_sm	Number of householdmembers who are separated			x	x									x			x	x			
urb_loghsize	Urban x Log of household size									x								x			
Education																					
educyrs_head	Number of years of education of the household head	x																			
everattd_head	Household head has everattended school		x										x			x					x
everattd_mn	Share of householdmembers who has ever attended school								x						x						
everattd_yn	Household with atleast one member who has ever attended school														x						
evereduc_share	Share of ever educatedamong adults ages 15-64				x								x					x			
linschool_share	Share of enrollmentamong children ages 6-18																	x			
literacy_head	Household head is literate					x	x										x			x	
literacy_mn	Share of literate householdmembers						x												x		
literacy_share	Share of literate amongadults ages 15-64		x											x						x	
literacy_yn	Household with at leastone literate member	x	x			x	x							x			x			x	x
lsec_abv_head	Household head withcompleted lowersecondary education andabove									x				x						x	x
lsec_abv_mn	Share of household members with completed lower secondary education and above	x									x				x						
lsec_com_head	Household head with completed lower secondary education																	x			

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
lsec_com_mn	Share of household members with completed lower secondary education		x																		
lsec_com_yn	Household with at least one member with completed lower secondary education														x						
pri_com_mn	Share of household members with completed primary education		x																		
unihi_com_head	Household head with completed university or higher education													x							
usec_abv_head	Household head with completed upper secondary education and above		x				x						x						x	x	
usec_abv_mn	Share of household members with completed upper secondary education and above					x		x			x						x				
usec_com_head	Household head with completed upper secondary education and above																	x			
usec_com_mn	Share of household members with completed upper secondary education							x													
usec_com_sm	Number of household members with completed upper secondary		x																		
Dwelling and access to services																					
ene_elec	Household mainly using electricity for cooking					x		x		x									x	x	
ene_gas	Household mainly using gas for cooking		x												x						
ene_wood	Household mainly using firewood for cooking																	x			
floor	Household main material of the floor																x			x	
floor_mat2	Floor made of tiles/marbles							x													
floor_mat3	Floor made of cement/concrete/terrazzo		x															x		x	x
floor_mat4	Floor made of plank/shingles				x																
fuel	Household main cooking fuel is electricity or gas												x							x	
grid_elec	Household with access to grid electricity				x								x								
nrooms	Number of rooms																x	x		x	
nrooms_2	Number of rooms = 2											x									
nrooms_4	Number of rooms = 4						x			x						x					
nrooms_5	Number of rooms = 5									x						x					
nrooms_6	Number of rooms = 6		x																		
nrooms_7	Number of rooms = 7						x														x
own_house	Household own the house														x	x					
pipd_water	Household with access to piped water (inside or outside)													x	x						

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
rent_house	Household rent the house from private individuals									x		x			x		x	x			
roof_mat1	Roof made of metal sheets	x	x																		
wall	Main materials of the external wall																			x	
wall_mat2	Wall made of bricks/cement blocks/AAC		x															x			
watersrc	Main source of drinking water																x			x	
Asset ownership																					
bicycle	Household with bicycle																	x			
computerlaptop	Household with computer or laptop		x	x									x		x			x			x
fridge	Household with fridge																	x			
jewelry	Household with jewelry		x																		
livestock	Household with livestock						x														
motorbikescooter	Household with motorbike or scooter																			x	
ricecooker	Household with rice cooker						x														
seshu_gho_kira	Household with seshu_gho_kira					x		x		x					x		x	x		x	x
sewing	Household with sewing machine												x								
sofaset	Household with sofa set																	x			
tv	Household with TV		x			x				x				x					x	x	
vacuum	Household with vacuum														x						
District and town level																					
adult1564_c_t_s	Number of household members ages 15–64, at the town level			x		x															
hsize_m_t_s	Household size, town average	x										x									
seperated_m_t_s	Separated household members, town average																			x	
linschool_sh_m_t_s	Share of enrollment among children ages 6–18, town average											x									
pri_com_sh_m_t_s	Share of completed primary education among adults ages 15–64, town average																			x	
ene_wood_m_g_s	Household mainly using firewood for cooking, town2 average							x													
floor_mat4_m_t_s	Household with floor made of clay/earthen floor/other, town average											x									
floor_mat5_m_t_s	Household with floor made of plank/shingles, town average												x								
grid_elec_m_t_s	Household with access to grid electricity, town average														x						
internet_m_g_s	Household with access to internet, town2 average																				x
nrooms_3_m_t_s	Household with number of rooms equal to three, town average												x								

Variables	Description	Dzongkhags																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
nrooms_7_m_t_s	Household with number of rooms equal to seven, town average																			x	
toilet_flush_m_d_s	Household with flush toilet, district average																			x	
toilet_flush_m_t_s	Household with flush toilet, town average												x	x					x		
toilet_pitnoslab_m_t_s	Household with pit toilet with no slab, town average																			x	
toiletshare_m_t_s	Household using shared toilet, town average																			x	
urban_m_t_s	Urban household, town average									x					x						
wall_mat1_m_g_s	Wall made of mud-bonded bricks/stones, town2 average							x													
wall_mat1_m_t_s	Wall made of mud-bonded bricks/stones, town average															x					
wall_mat2_m_t_s	Wall made of Bricks/Cement blocks/Autoclaved, town average													x							
watermins_m_d_s	Distance from nearest source of drinking water, district average (in minutes)																			x	
jewelry_m_t_s	Household with jewelry, town average		x																		
livestock_m_t_s	Household with livestock, town average											x									

Source: Based on BLSS 2022 and PHCB 2017.

Note: 1- Bumthang; 2- Chhukha; 3- Dagana; 4- Gasa; 5- Haa; 6- Lhuentse; 7- Monggar; 8- Paro; 9- Pema Gatsel; 10- Punakha; 11- Samdrup Jongkhar; 12- Samtse; 13- Sarpang; 14- Thimphu; 15- Trashigang; 16- Trashiyangtse; 17- Trongsa; 18- Tsirang; 19- Wangdue Phodrang; 20- Zhemgang

Literacy is the ability to read and write

Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p < .1 ** p < .05 *** p < .01

ANNEXURE III: SURVEY AND CENSUS MEAN COMPARISON

Table A3.1 Bumthang

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age1t14_mn	Household with at least one child aged 0–14	0.2479	0.2751	10.9976
age25t64_mn	Share of household members aged 25-64	0.5279	0.4695	11.0669
age25t64_yn	Household with at least one individual aged 25-64	0.9183	0.9811	6.8421
age_yn	Maximum age of household member	50.4186	56.0480	11.1654
educyrs_head	Number of years of education of the household head	4.1500	3.6528	11.9799
female_yn	Household with at least one female member	0.8873	0.9814	10.6067
literacy_yn	Household with at least one literate member	1.3008	1.4281	9.7878
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.2223	0.2483	11.6966
roof_mat1	Roof made of metal sheets	0.9111	0.9907	8.7306

Source: Based on 2022 BLSS and 2017 PHCB.

Table A3.2 Chhukha

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_yn	Household with at least one individual aged 15–24	0.4660	0.4863	4.3497
age_yn	Maximum age of household member	46.3336	50.7231	9.4736
computerlaptop	Household with computer or laptop	0.2265	0.2280	0.6466
depratio	Dependency ratio	0.5098	0.5845	14.6506
ene_gas	Household mainly using gas for cooking	0.6969	0.7970	14.3612
everattd_head	Household head has ever attended school	0.5691	0.5615	1.3324
female_yn	Household with at least one female member	0.8733	0.9631	10.2755
floor_mat3	Floor made of Cement/concrete/Terrazzo	0.6205	0.6044	2.6015
jewelry	Household with jewelry	0.3052	0.3502	14.7225
literacy_share	Share of literate among adults aged 15-64	0.7021	0.6843	2.5448
literacy_yn	Household with at least one literate member	1.2595	1.3640	8.2949
lsec_com_mn	Share of household members with completed lower secondary education	0.0972	0.1073	10.4138
male_head	Household head is male	0.7204	0.7728	7.2861
married_mn	Share of household members who are married	0.4956	0.4932	0.4894
married_yn	Household with at least one married member	0.8530	0.9246	8.3923
nrooms_6	Number of rooms =6	0.0261	0.0276	5.9906
pri_com_mn	Share of household members with completed primary education	0.0997	0.1100	10.2987
roof_mat1	Roof made of metal sheets	0.8280	0.9331	12.6902
tv	Household with tv	0.7342	0.7356	0.1917
usec_abv_head	Household head with completed upper secondary education and above	0.2001	0.1763	11.9047
usec_com_sm	Number of household members with completed upper secondary	0.4187	0.4519	7.9212
wall_mat2	Wall made of Bricks/Cement blocks/Autoclaved Aerated Concrete(AAC)	0.6287	0.6433	2.3244

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.3 Dagana

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_head	Household head aged 25–64	0.8357	0.8316	0.4814
age25t64_mn	Share of household members aged 25-64	0.5622	0.4980	11.4164
age_yn	Maximum age of household member	51.0795	56.2238	10.0711
male_mn	Share of male household members	0.4969	0.5071	2.0434
male_yn	Household with at least one male member	0.9210	0.9812	6.5364
married_head	Household head is married	0.8588	0.8783	2.2786

Source: Based on 2022 BLSS and 2017 PHCB.

Table A3.4 Gasa

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_mn	Share of household members aged 25-64	0.5740	0.5200	9.3950
evereduc_share	Share of ever educated among adults aged 15-64	0.4696	0.5049	7.5212
floor_mat4	Floor made of Plank/ Shingles	0.8548	0.8393	1.8087
grid_elec	Household with access to grid electricity	0.7525	0.7950	5.6513
ln_hdage	Log of household head age	3.7139	3.7985	2.2782
male_head	Household head is male	0.6513	0.5940	8.7970
male_mn	Share of male household members	0.5275	0.4934	6.4686
male_yn	Household with at least one male member	0.9120	0.9775	7.1858
married_sm	Number of household members who are married	1.9824	2.1684	9.3843
eparated_sm	Number of household members who are separated	0.1144	0.1223	6.8994

Source: Based on 2022 BLSS and 2017 PHCB.

Table A3.5 Haa

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_mn	Share of household members aged 15-24	0.1399	0.1395	0.2942
age_mn	Mean of age at household level	32.3999	32.6419	0.7468
ene_elec	Household mainly using electricity for cooking	0.9275	0.9287	0.1294
female_mn	Share of female household members	0.5002	0.5132	2.6018
literacy_yn	Household with at least one literate member	1.2199	1.3249	8.6132
ln_hdage	Log of household head age	3.7346	3.8362	2.7201
male_yn	Household with at least one male member	0.8970	0.9523	6.1611
married_mn	Share of household members who are married	0.5173	0.4831	6.6266
married_yn	Household with at least one married member	0.8659	0.9150	5.6725
seshu_gho_kira	Household with seshu gho kira	0.2857	0.2768	3.1197
tv	Household with tv	0.7774	0.8439	8.5570
usec_abv_mn	Share of household members with completed upper secondary education and above	0.1349	0.1460	8.2023

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.6 Lhuentse

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age65pl_yn	Household with at least one individual aged 65 and older	0.2925	0.3195	9.2176
female_mn	Share of female household members	0.5281	0.5254	0.5135
literacy_head	Household head is literate	0.4259	0.3746	12.0433
literacy_yn	Household with at least one literate member	1.2244	1.4018	14.4887
male_yn	Household with at least one male member	0.8917	0.9737	9.1944
married_mn	Share of household members who are married	0.5436	0.4628	14.8753
nrooms_4	Number of rooms =4	0.2170	0.2300	5.9954
nrooms_7	Number of rooms =7	0.0196	0.0182	7.1333
ricecooker	Household with rice cooker	0.8705	0.9885	13.5550
seperated_head	Household head is separated	0.0450	0.0405	9.8984
usec_abv_head	Household head with completed upper secondary education and above	0.1109	0.1190	7.3455

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.7 Monggar

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_head	Household head aged 25–64	0.8209	0.8504	3.5835
age25t64_yn	Household with at least one individual aged 25-64	0.9183	0.9718	5.8297
ene_elec	Household mainly using electricity for cooking	0.9465	0.9835	3.9054
female_yn	Household with at least one female member	0.9149	0.9905	8.2585
floor_mat2	Floor made of Tiles/marbles	0.0152	0.0153	0.8349
literacy_head	Household head is literate	0.4556	0.4220	7.3733
literacy_mn	Share of literate household members	0.7005	0.7411	5.7955
male_yn	Household with at least one male member	0.8815	0.9660	9.5922
married_yn	Household with at least one married member	0.8791	0.9290	5.6871
seshu_gho_kira	Household with seshu_gho_kira	0.1728	0.1556	9.9519
usec_abv_mn	Share of household members with completed upper secondary education and above	0.0980	0.1049	6.9732
usec_com_mn	Share of household members with completed upper secondary education	0.0710	0.0696	1.9896
widowed_mn	Share of household members who are widowers	0.0405	0.0426	5.1851

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.8 Paro

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_yn	Household with at least one individual aged 15–24	0.4561	0.4736	3.8327
age25t64_mn	Share of household members aged 25-64	0.5192	0.5135	1.0958
age_mn	Mean of age at household level	31.2521	30.1825	3.4223
everattd_mn	Share of household members who has ever attended school	0.6125	0.6408	4.6135
ln_hdage	Log of household head age	3.7099	3.7502	1.0851
married_head	Household head is married	0.7648	0.7974	4.2594

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.9 Pema Gatshel

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_mn	Share of household members aged 25-64	0.5142	0.4810	6.4658
age25t64_yn	Household with at least one individual aged 25-64	0.8736	0.9480	8.5218
ene_elec	Household mainly using electricity for cooking	0.9511	0.9543	0.3311
female_yn	Household with at least one female member	0.9085	0.9707	6.8489
lsec_abv_head	Household head with completed lower secondary education and above	0.1768	0.1944	9.9654
married_head	Household head is married	0.8319	0.8380	0.7333
married_sm	Number of household members who are married	1.8099	1.9504	7.7636
nrooms_4	Number of rooms =4	0.1648	0.1746	5.9561
nrooms_5	Number of rooms =5	0.0650	0.0684	5.1798
rent_house	Household rent the house from private individuals	0.1465	0.1411	3.7072
seshu_gho_kira	Household with seshu_gho_kira	0.1370	0.1480	8.0294
tv	Household with tv	0.5993	0.5583	6.8316
urb_loghhsz	Urban x Log of household size	0.3261	0.3329	2.0962

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.10 Punakha

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age_mn	Mean of age at household level	33.4368	32.7770	1.9731
ln_hdage	Log of household head age	3.7514	3.8311	2.1240
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.2087	0.2165	3.6982
married_head	Household head is married	0.7722	0.7911	2.4468
usec_abv_mn	Share of household members with completed upper secondary education and above	0.1416	0.1379	2.6093

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.11 Samdrup Jongkhar

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_head	Household head aged 25–64	0.8245	0.7971	3.3311
age_mn	Mean of age at household level	33.7905	32.3873	4.1525
ln_hdage	Log of household head age	3.7659	3.8175	1.3692
married_head	Household head is married	0.8558	0.8670	1.3005
nrooms_2	Number of rooms =2	0.3265	0.3224	1.2530
rent_house	Household rent the house from private individuals	0.1946	0.1913	1.6658

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.12 Samtse

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_mn	Share of household members aged 15-24	0.1483	0.1432	3.4212
age25t64_yn	Household with at least one individual aged 25-64	0.9469	0.9794	3.4292
age_head	Age of household head	46.9465	51.3616	9.4046
child_1	Household with one member aged 1 to 14	0.2529	0.2779	9.8799
child_2	Household with two members aged 1 to 14	0.2177	0.2382	9.3848
child_3	Household with three members aged 1 to 14	0.0915	0.0968	5.7518
child_4p	Household with four or more members aged 1 to 14	0.0323	0.0350	8.4893
computerlaptop	Household with computer or laptop	0.1218	0.1162	4.6478
everattd_head	Household head has ever attended school	0.4178	0.3850	7.8456
evereduc_share	Share of ever educated among adults aged 15-64	0.4790	0.4829	0.8094
female_yn	Household with at least one female member	0.9179	0.9814	6.9186
fuel	Household main cooking Fuel is electricity or gas	0.9232	0.9123	1.1827
grid_elec	Household with access to grid electricity	0.9496	0.9909	4.3479
male_yn	Household with at least one male member	0.9408	0.9808	4.2441
married_head	Household head is married	0.8579	0.8528	0.5940
married_mn	Share of household members who are married	0.5346	0.5251	1.7779
sewing	Household with sewing machine	0.0285	0.0257	9.6854
usec_abv_head	Household head with completed upper secondary education and above	0.0880	0.0803	8.7128

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.13 Sarpang

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_yn	Household with at least one individual aged 15–24	0.4617	0.5204	12.7152
age1t14_yn	Household with at least one individual aged 1–14	0.5912	0.6472	9.4781
age_yn	Maximum age of household member	49.3699	54.9682	11.3394
child_2	Household with two members aged 1 to 14	0.2191	0.2331	6.3982
female_yn	Household with at least one female member	0.9097	0.9894	8.7523
hhsiz_6	Household with six or more members	0.0935	0.1074	14.7649
literacy_share	Share of literate among adults aged 15-64	0.6684	0.7172	7.3096
literacy_yn	Household with at least one literate member	1.2491	1.3028	4.3016
lsec_abv_head	Household head with completed lower secondary education and above	0.2195	0.2158	1.6850
male_yn	Household with at least one male member	0.9235	0.9743	5.4982
married_mn	Share of household members who are married	0.5179	0.5301	2.3563
pipd_water	Household with access to piped water (inside or outside)	0.9872	0.9864	0.0817
seperated_head	Household head is separated	0.0393	0.0338	14.0129
seperated_sm	Number of household members who are sepatated	0.0785	0.0864	10.0526
tv	Household with tv	0.7408	0.7634	3.0500
unihi_com_head	Household head with completed university or higher education	0.0411	0.0358	12.9817

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.14 Thimphu

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age15t24_yn	Household with at least one individual aged 15–24	0.5308	0.5556	4.6597
age25t64_mn	Share of household members aged 25-64	0.5432	0.5259	3.1813
computerlaptop	Household with computer or laptop	0.4500	0.4498	0.0523
ene_gas	Household mainly using gas for cooking	0.9137	0.9413	3.0220
everattd_mn	Share of household members who has ever attended school	0.7303	0.7248	0.7549
everattd_yn	Household with at least one member who has ever attended school	0.9411	0.9840	4.5644
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.4010	0.4062	1.2771
lsec_com_yn	Household with at least one member with completed lower secondary education education	0.3818	0.3989	4.4990
male_yn	Household with at least one male member	0.9224	0.9653	4.6568
own_house	Household own the house	0.1462	0.1427	2.4048
piped_water	Household with access to piped water (inside or outside)	0.9917	0.9972	0.5604
rent_house	Household rent the house from private individuals	0.6166	0.6012	2.5002
seshu_gho_kira	Household with seshu_gho_kira	0.3503	0.3387	3.3035
vacuum	Household with vacuum	0.1364	0.1408	3.2512

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.15 Trashigang

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_yn	Household with at least one individual aged 25-64	0.8993	0.9544	6.1243
age_mn	Mean of age at household level	35.5676	32.8371	7.6769
age_yn	Maximum age of household member	50.9138	53.9451	5.9538
everattd_head	Household head has ever attended school	0.3565	0.3719	4.3198
female_yn	Household with at least one female member	0.8842	0.9653	9.1681
male_yn	Household with at least one male member	0.8989	0.9577	6.5387
married_head	Household head is married	0.8265	0.8169	1.1595
nrooms_4	Number of rooms =4	0.1797	0.1746	2.8438
nrooms_5	Number of rooms =5	0.0580	0.0524	9.7742
own_house	Household own the house	0.7155	0.7010	2.0279
seperated_mn	Share of household members who are separated	0.0310	0.0327	5.3154

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.16 Trashy Yangtse

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_mn	Share of household members aged 25-64	0.5290	0.4667	11.7810
age_yn	Maximum age of household member	51.0967	52.9916	3.7084
depratio	Dependency ratio	0.6943	0.7681	10.6239
female_yn	Household with at least one female member	0.9126	0.9932	8.8357
hhsz_4	Household with four members	0.1868	0.1838	1.6194
literacy_head	Household head is literate	0.4636	0.4605	0.6637
literacy_yn	Household with at least one literate member	1.2007	1.3690	14.0207
male_yn	Household with at least one male member	0.8847	0.9781	10.5483
married_mn	Share of household members who are married	0.5287	0.4757	10.0281
nrooms	Number of rooms	2.6999	3.0433	12.7186
rent_house	Household rent the house from private individuals	0.1690	0.1634	3.3200
seperated_sm	Number of household members who are sepatated	0.0902	0.0803	10.8878
seshu_gho_kira	Household with seshu_gho_kira	0.1502	0.1557	3.6665
usec_abv_mn	Share of household members with completed upper secondary education and above	0.0971	0.1014	4.4775
widowed_yn	Household with at least one widowed member	0.1311	0.1321	0.7519

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.17 Trongsa

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age65pl_head	Household head aged 65 and older	0.0992	0.0999	0.6633
computerlaptop	Household with computer or laptop	0.2337	0.2504	7.1256
ene_elec	Household mainly using electricity for cooking	0.9667	0.9323	3.5524
evereduc_share	Share of ever educated among adults aged 15-64	0.5855	0.6020	2.8187
female_yn	Household with at least one female member	0.8509	0.9768	14.7966
married_yn	Household with at least one married member	0.8235	0.9160	11.2306
nrooms	Number of rooms	3.4603	3.9674	14.6548
urb_loghsize	Urban x Log of household size	0.2419	0.2200	9.0667
wall_mat2	Wall made of Bricks/Cement blocks/Autoclaved Aerated Concrete(AAC)	0.2814	0.2574	8.5085

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.18 Tsirang

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_yn	Household with at least one individual aged 25-64	0.9380	0.9761	4.0616
age_mn	Mean of age at household level	35.2001	34.3962	2.2839
ene_elec	Household mainly using electricity for cooking	0.9585	0.9896	3.2461
female_mn	Share of female household members	0.4990	0.5081	1.8231
literacy_mn	Share of literate household members	0.7282	0.7631	4.7985
male_yn	Household with at least one male member	0.9311	0.9705	4.2354
tv	Household with tv	0.6769	0.6731	0.5694
usec_abv_head	Household head with completed upper secondary education and above	0.1019	0.1022	0.3115

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.19 TABLE A3. 19: Wangdue Phodrang (National)

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_mn	Share of household members aged 25-64	0.5432	0.5057	6.8983
age25t64_yn	Household with at least one individual aged 25-64	0.9267	0.9785	5.5999
age65pl_mn	Share of household members aged 65 and older	0.0792	0.0790	0.1700
age_yn	Maximum age of household member	48.9648	53.2377	8.7265
female_yn	Household with at least one female member	0.8943	0.9757	9.1043
floor_mat3	Floor made of Cement/concrete/Terrazzo	0.3919	0.3921	0.0314
fuel	Household main cooking Fuel is electricity or gas	0.9645	0.9859	2.2236
literacy_head	Household head is literate	0.6004	0.5941	1.0446
literacy_share	Share of literate among adults aged 15-64	0.6340	0.6887	8.6265
literacy_yn	Household with at least one literate member	1.2408	1.3522	8.9779
lsec_abv_head	Household head with completed lower secondary education and above	0.2550	0.2649	3.8523
male_head	Household head is male	0.6405	0.6802	6.1975
male_yn	Household with at least one male member	0.9100	0.9695	6.5300
married_head	Household head is married	0.8116	0.8509	4.8425
married_mn	Share of household members who are married	0.5088	0.4788	5.8961
motorbikescooter	Household with motorbike or scooter	0.0268	0.0267	0.3068
nrooms	Number of rooms	3.1879	3.4714	8.8959
seperated_head	Household head is separated	0.0487	0.0462	5.0943
seshu_gho_kira	Household with seshu_gho_kira	0.2193	0.2292	4.5097
tv	Household with tv	0.7151	0.7635	6.7594
usec_abv_head	Household head with completed upper secondary education and above	0.1863	0.1821	2.2870

Source:Based on 2022 BLSS and 2017 PHCB.

Table A3.20 Zhemgang

Variable	Variable description	Mean		Difference in percentage
		Census	Survey	
age25t64_mn	Share of household members aged 25-64	0.5463	0.4941	9.5571
age25t64_yn	Household with at least one individual aged 25-64	0.9281	0.9839	6.0064
everattd_head	Household head has ever attended school	0.4522	0.4662	3.1030
female_yn	Household with at least one female member	0.8832	0.9788	10.8233
floor_mat3	Floor made of Cement/concrete/Terrazzo	0.3354	0.3782	12.7498
literacy_yn	Household with at least one literate member	1.2501	1.3967	11.7262
ln_hdage	Log of household head age	3.7190	3.7615	1.1414
lsec_abv_head	Household head with completed lower secondary education and above	0.2151	0.2420	12.5101
male_yn	Household with at least one male member	0.9044	0.9772	8.0540
married_mn	Share of household members who are married	0.5016	0.4546	9.3657
nrooms_7	Number of rooms =7	0.0228	0.0230	0.8273
seperated_head	Household head is separated	0.0646	0.0688	6.4145
seshu_gho_kira	Household with seshu_gho_kira	0.2631	0.2503	4.8737

Source:Based on 2022 BLSS and 2017 PHCB.

ANNEXURE IV: SMALL AREA ESTIMATION MODEL

Table A4.1 Model Estimates - Bumthang (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age1t14_mn	Share of household members aged 1-14	-0.488**	0.202	-0.472***	0.163
age25t64_mn	Share of household members aged 25-64	0.611***	0.125	0.595***	0.116
age25t64_yn	Household with at least one individual aged 25-64	-0.695***	0.138	-0.647***	0.148
age_yn	Maximum age of household members	-0.003	0.002	-0.003**	0.001
educyrs_head	Number of years of education of the household head	0.010*	0.005	0.010**	0.005
female_yn	Household with at least one female member	-0.353***	0.130	-0.270**	0.120
hhsz_m_t_s	Household size, town average	-0.175***	0.039	-0.130***	0.048
literacy_yn	Household with at least one literate member	-0.138**	0.054	-0.153***	0.045
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.380***	0.131	0.439***	0.100
roof_mat1	Roof made of metal sheets	1.011***	0.122	0.926***	0.228
_cons		10.270***	0.301	10.000***	0.406
Number of observations		525	Empirical best methods		Yes
Adjusted R-squared		0.429	Transformation (lhs)		lnskew_w
Sigma eta sq.		0.005	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.023			
Variance of epsilon		0.216			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p < .1 ** p < .05 *** p < .01.

Table A4.2 Model Estimates -Chhukha(Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_yn	Household with at least one individual aged 15–24	-0.017***	0.003	-0.014***	0.004
age_yn	Maximum age of household members	-0.001***	0.000	-0.001***	0.000
computerlaptop	Household with computer or laptop	0.021***	0.004	0.022***	0.004
depratio	Dependency ratio	-0.016***	0.003	-0.013***	0.003
ene_gas	Household mainly using gas for cooking	0.014***	0.004	0.016***	0.004
everattd_head	Household head has ever attended school	0.010**	0.004	0.009**	0.004
female_yn	Household with at least one female member	-0.010	0.006	-0.014**	0.006
floor_mat3	Floor made of Cement/concrete/ Terrazzo	-0.013***	0.003	-0.014***	0.003
jewelry	Household with jewelry	0.015***	0.003	0.016***	0.003
jewelry_m_t_s	Household with jewelry, town average	0.048***	0.017	0.056***	0.017
literacy_share	Share of literate among adults aged 15-64	0.013**	0.006	0.011*	0.006
literacy_yn	Household with at least one literate member	-0.013***	0.003	-0.012***	0.003
lsec_com_mn	Share of household members with completed lower secondary education	-0.021**	0.010	-0.015*	0.009
male_head	Household head is male	-0.014***	0.003	-0.015***	0.004
married_mn	Share of household members who are married	0.063***	0.009	0.064***	0.008
married_yn	Household with at least one married member	-0.057***	0.008	-0.060***	0.008
nrooms_6	Number of rooms =6	0.029***	0.009	0.025***	0.008
pri_com_mn	Share of household members with completed primary education	-0.026**	0.010	-0.027***	0.009
roof_mat1	Roof made of metal sheets	0.006	0.005	0.005	0.005
tv	Household with tv	0.015***	0.004	0.016***	0.004
usec_abv_head	Household head with completed upper secondary education and above	0.013***	0.005	0.014***	0.004
usec_com_sm	Number of household members with completed upper secondary	-0.008***	0.002	-0.009***	0.002
wall_mat2	Wall made of Bricks/Cement blocks/ Autoclaved Aerated Concrete(AAC)	0.012***	0.003	0.013***	0.003
_cons		2.395***	0.011	2.393***	0.011
Number of observations		1184	Empirical best methods		Yes
Adjusted R-squared		0.499	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.008			
Variance of epsilon		0.002			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.3 Model Estimates - Dagana (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
adult1564_c_t_s	Number of household members aged 15-64, at town level	-9.549E-06	5.129E-05	1.243E-06	5.075E-05
age25t64_head	Household head aged 25-64	-0.218***	0.056	-0.224***	0.053
age25t64_mn	Share of household members aged 25-64	0.734***	0.082	0.754***	0.077
age_yn	Maximum age of household members	-0.005***	0.001	-0.005***	0.001
computerlaptop	Household with computer or laptop	0.245***	0.048	0.239***	0.047
male_mn	Share of male household members	0.030	0.112	0.096	0.105
male_yn	Household with at least one male member	-0.163	0.101	-0.141	0.099
married_head	Household head is married	0.174***	0.065	0.159**	0.072
married_sm	Number of household members who are married	-0.166***	0.022	-0.160***	0.021
seperated_head	Household head is separated	0.241*	0.125	0.331***	0.129
seperated_sm	Number of household members who are sepatated	-0.303***	0.059	-0.312***	0.064
_cons		9.887***	0.135	9.799***	0.134
Number of observations		563	Empirical best methods		Yes
Adjusted R-squared		0.322	Transformation (lhs)		No
Sigma eta sq.		0.002	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.010			
Variance of epsilon		0.163			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.4 Model Estimates - Gasa (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_mn	Share of household members aged 25-64	1.002***	0.137	1.063***	0.084
evereduc_share	Share of ever educated among adults aged 15-64	0.116	0.079	0.195***	0.052
floor_mat4	Floor made of Plank/ Shingles	-0.216***	0.084	-0.199***	0.064
grid_elec	Household with access to grid electricity	-0.125**	0.049	-0.102**	0.043
ln_hdage	Log of household head age	-0.124	0.088	-0.180***	0.059
male_head	Household head is male	0.209***	0.054	0.155***	0.036
male_mn	Share of male household members	0.386***	0.144	0.250**	0.097
male_yn	Household with at least one male member	-0.701***	0.110	-0.680***	0.073
married_sm	Number of household members who are married	-0.135***	0.026	-0.117***	0.017
seperated_sm	Number of household members who are separated	-0.288***	0.072	-0.254***	0.038
_cons		10.135***	0.335	10.273***	0.243
Number of observations		353	Empirical best methods		Yes
Adjusted R-squared		0.444	Transformation (lhs)		lnskew_w
Sigma eta sq.		0.001	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.004			
Variance of epsilon		0.197			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * $p < .1$ ** $p < .05$ *** $p < .01$

Table A4.5 Model Estimates - Haa (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
adult1564_c_t_s	Number of household members aged 15-64, at town level	1.10E-04***	4.41E-05	1.14E-04	7.17E-05
age15t24_mn	Share of household members aged 15-24	-0.363***	0.098	-0.413***	0.095
age_mn	Mean of age at household level	0.007***	0.002	0.009***	0.002
ene_elec	Household mainly using electricity for cooking	0.219***	0.063	0.247***	0.060
female_mn	Share of female household members	-0.369***	0.104	-0.366***	0.091
literacy_yn	Household with at least one literate member	-0.141***	0.039	-0.138***	0.034
ln_hdage	Log of household head age	-0.313***	0.081	-0.346***	0.073
male_yn	Household with at least one male member	-0.667***	0.079	-0.660***	0.075
married_mn	Share of household members who are married	0.797***	0.104	0.778***	0.092
married_yn	Household with at least one married member	-0.637***	0.082	-0.627***	0.076
seshu_gho_kira	Household with seshu_gho_kira	0.180***	0.039	0.144***	0.034
tv	Household with tv	0.230***	0.050	0.237***	0.044
usec_abv_mn	Share of household members with completed upper secondary education and above	0.526***	0.074	0.501***	0.055
_cons		10.944***	0.270	10.996***	0.253
Number of observations		514	Empirical best methods		Yes
Adjusted R-squared		0.579	Transformation (lhs)		No
Sigma eta sq.		0.002	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.015			
Variance of epsilon		0.131			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p < .1 ** p < .05 *** p < .01

Table A4.6 Model Estimates - Lhuentse (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age65pl_yn	Household with at least one individual aged 65 and older	-0.146***	0.039	-0.147***	0.039
female_mn	Share of female household members	-0.248*	0.130	-0.304***	0.108
literacy_head	Household head is literate	0.181***	0.046	0.171***	0.042
literacy_yn	Household with at least one literate member	-0.130***	0.032	-0.133***	0.029
livestock	Household with livestock	-0.148***	0.047	-0.159***	0.046
male_yn	Household with at least one male member	-0.395***	0.098	-0.407***	0.077
married_mn	Share of household members who are married	0.576***	0.075	0.565***	0.067
nrooms_4	Number of rooms =4	0.134***	0.039	0.155***	0.036
nrooms_7	Number of rooms =7	0.683***	0.056	0.684***	0.101
ricecooker	Household with ricecooker	0.306**	0.141	0.329*	0.173
seperated_head	Household head is separated	0.206**	0.081	0.212**	0.088
usec_abv_head	Household head with completed upper secondary education and above	0.380***	0.076	0.436***	0.060
_cons		9.412***	0.202	9.456***	0.212
Number of observations		515	Empirical best methods		Yes
Adjusted R-squared		0.418	Transformation (lhs)		No
Sigma eta sq.		0.011	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.065			
Variance of epsilon		0.159			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.7 Model Estimates - Monggar (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_head	Household head aged 25–64	0.092*	0.055	0.084*	0.050
age25t64_yn	Household with at least one individual aged 25-64	-0.143*	0.081	-0.157**	0.079
ene_elec	Household mainly using electricity for cooking	0.470***	0.077	0.487***	0.094
ene_wood_m_g_s	Household mainly using firewood for cooking, town2 average	-0.564***	0.090	-0.571***	0.145
female_yn	Household with at least one female member	-0.243**	0.121	-0.188	0.131
floor_mat2	Floor made of Tiles/marbles	0.080	0.057	0.078	0.067
literacy_head	Household head is literate	0.209***	0.040	0.201***	0.041
literacy_mn	Share of literate household members	-0.303***	0.059	-0.296***	0.058
male_yn	Household with at least one male member	-0.271***	0.085	-0.276***	0.084
married_yn	Household with at least one married member	-0.316***	0.059	-0.341***	0.044
seshu_gho_kira	Household with seshu_gho_kira	0.117***	0.042	0.149***	0.043
usec_abv_mn	Share of household members with completed upper secondary education and above	1.031***	0.092	0.990***	0.093
usec_com_mn	Share of household members with completed upper secondary education	-0.491***	0.116	-0.499***	0.113
wall_mat1_m_g_s	Wall made of Mud-bonded bricks/stones, town2 average	-0.207**	0.088	-0.187	0.152
widowed_mn	Share of household members who are widowers	-0.375**	0.147	-0.452***	0.125
_cons		10.003***	0.161	9.973***	0.192
Number of observations		624	Empirical best methods		Yes
Adjusted R-squared		0.477	Transformation (lhs)		No
Sigma eta sq.		0.006	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.037			
Variance of epsilon		0.157			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.8 Model Estimates - Paro (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_yn	Household with at least one individual aged 15–24	-0.008**	0.003	-0.008***	0.003
age25t64_mn	Share of household members aged 25–64	0.027***	0.006	0.025***	0.006
age_mn	Mean of age at household level	0.001***	0.000	0.001***	0.000
everattd_mn	Share of household members who has ever attended school	0.032***	0.005	0.033***	0.005
ln_hdage	Log of household head age	-0.039***	0.006	-0.040***	0.005
married_head	Household head is married	-0.011***	0.003	-0.012***	0.003
_cons		1.915***	0.020	1.918***	0.019
Number of observations		617	Empirical best methods		Yes
Adjusted R-squared		0.290	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.024			
Variance of epsilon		0.001			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * $p < .1$ ** $p < .05$ *** $p < .01$

Table A4.9 Model Estimates - Pema Gatshel (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_mn	Share of household members aged 25-64	0.017***	0.002	0.017***	0.002
age25t64_yn	Household with at least one individual aged 25-64	-0.013***	0.002	-0.013***	0.002
ene_elec	Household mainly using electricity for cooking	0.007***	0.002	0.007***	0.002
female_yn	Household with at least one female member	-0.003**	0.001	-0.003**	0.002
lsec_abv_head	Household head with completed lower secondary education and above	0.004***	0.001	0.004***	0.001
married_head	Household head is married	0.002	0.002	0.002	0.002
married_sm	Number of household members who are married	-0.003***	0.001	-0.003***	0.001
nrooms_4	Number of rooms =4	0.003**	0.001	0.003**	0.001
nrooms_5	Number of rooms =5	0.006***	0.002	0.006***	0.002
rent_house	Household rent the house from private individuals	0.006***	0.001	0.005***	0.001
seshu_gho_kira	Household with seshu_gho_kira	0.006***	0.001	0.006***	0.001
tv	Household with tv	0.003***	0.001	0.003***	0.001
urb_loghhsz	Urban x Log of household size	-0.003***	0.001	-0.003***	0.001
_cons		1.095***	0.003	1.095***	0.002
Number of observations		550	Empirical best methods		Yes
Adjusted R-squared		0.411	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.015			
Variance of epsilon		0.000			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.10 Model Estimates - Punakha (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age_mn	Mean of age at household level	0.000***	0.000	0.000***	0.000
ln_hdage	Log of household head age	-0.003***	0.000	-0.003***	0.000
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.001	0.001	0.002***	0.001
married_head	Household head is married	-0.000	0.000	-0.000*	0.000
urban_m_t_s	Urban household, town average	0.000	0.000	0.000	0.000
usec_abv_mn	Share of household members with completed upper secondary education and above	0.004***	0.001	0.003***	0.001
_cons		0.766***	0.001	0.765***	0.001
Number of observations		559	Empirical best methods		Yes
Adjusted R-squared		0.295	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.007			
Variance of epsilon		0.000			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * $p < .1$ ** $p < .05$ *** $p < .01$

Table A4.11 Model Estimates - Samdrup Jongkhar (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_head	Household head aged 25–64	0.059**	0.030	0.058**	0.027
age_mn	Mean of age at household level	0.008***	0.001	0.008***	0.001
floor_mat4_m_t_s	Household with floor made of Clay/ Earthen floor/Other, town average	-0.264***	0.049	-0.280***	0.060
hhsz_m_t_s	Household size, town average	0.111***	0.035	0.100**	0.040
linschool_sh_m_t_s	Share of enrollment among children aged 6-18, town average	-0.393**	0.174	-0.439***	0.157
livestock_m_t_s	Household with livestock, town average	-0.066	0.056	-0.122	0.075
ln_hdage	Log of household head age	-0.304***	0.048	-0.304***	0.044
married_head	Household head is married	-0.093***	0.027	-0.084***	0.023
nrooms_2	Number of rooms =2	-0.085***	0.022	-0.083***	0.019
rent_house	Household rent the house from private individuals	0.191***	0.029	0.159***	0.025
_cons		6.280***	0.229	6.396***	0.243
Number of observations		1041	Empirical best methods		Yes
Adjusted R-squared		0.282	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.004	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.053			
Variance of epsilon		0.075			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * $p < .1$ ** $p < .05$ *** $p < .01$

Table A4.12 Model Estimates - Samtse (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_mn	Share of household members aged 15-24	-0.876***	0.140	-0.857***	0.121
age25t64_yn	Household with at least one individual aged 25-64	-0.273***	0.105	-0.244**	0.097
age_head	Age of household head	-0.008***	0.002	-0.008***	0.001
child_1	Household with one member aged 1 to 14	-0.299***	0.053	-0.293***	0.046
child_2	Household with two members aged 1 to 14	-0.433***	0.070	-0.438***	0.057
child_3	Household with three members aged 1 to 14	-0.532***	0.089	-0.508***	0.080
child_4p	Household with four or more members aged 1 to 14	-0.636***	0.123	-0.665***	0.122
computerlaptop	Household with computer or laptop	0.167***	0.055	0.183***	0.051
everattd_head	Household head has ever attended school	0.178***	0.054	0.200***	0.051
evereduc_share	Share of ever educated among adults aged 15-64	0.353***	0.082	0.327***	0.071
female_yn	Household with at least one female member	-0.443***	0.106	-0.431***	0.083
floor_mat5_m_t_s	Household with floor made of Plank/ Shingles, town average	-0.604***	0.133	-0.578***	0.154
fuel	Household main cooking Fuel is electricity or gas	0.532***	0.081	0.527***	0.088
grid_elec	Household with access to grid electricity	0.332	0.215	0.307	0.201
male_yn	Household with at least one male member	-0.350***	0.124	-0.344***	0.127
married_head	Household head is married	-0.261***	0.078	-0.260***	0.069
married_mn	Share of household members who are married	0.236*	0.131	0.293***	0.105
nrooms_3_m_t_s	Household with number of rooms equal to three, town average	-0.830***	0.298	-0.651*	0.357
sewing	Household with sewing machine	0.314***	0.088	0.268***	0.099
toilet_flush_m_t_s	Household with flush toilet, town average	-0.765***	0.220	-0.823***	0.260
usec_abv_head	Household head with completed upper secondary education and above	0.194***	0.063	0.186***	0.060
_cons		10.748***	0.378	10.717***	0.371
Number of observations		624	Empirical best methods		Yes
Adjusted R-squared		0.500	Transformation (lhs)		Ins skew
Sigma eta sq.		0.002	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.007			
Variance of epsilon		0.214			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.13 Model Estimates –Sarpang (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_yn	Household with at least one individual aged 15–24	-0.279***	0.032	-0.268***	0.030
age1t14_yn	Household with at least one individual aged 1–14	-0.155***	0.037	-0.154***	0.036
age_yn	Maximum age of household members	-0.004***	0.001	-0.004***	0.001
child_2	Household with two members aged 1 to 14	-0.212***	0.039	-0.221***	0.039
female_yn	Household with at least one female member	-0.154	0.109	-0.273***	0.072
hsize_6	Household with six or more members	-0.286***	0.056	-0.254***	0.056
literacy_share	Share of literate among adults aged 15-64	0.189***	0.053	0.166***	0.051
literacy_yn	Household with at least one literate member	-0.096***	0.036	-0.091***	0.034
lsec_abv_head	Household head with completed lower secondary education and above	0.127***	0.035	0.143***	0.036
male_yn	Household with at least one male member	-0.542***	0.083	-0.530***	0.061
married_mn	Share of household members who are married	0.063	0.071	0.106*	0.063
pipd_water	Household with access to piped water (inside or outside)	0.441***	0.169	0.249**	0.121
seperated_head	Household head is separated	0.298***	0.106	0.319***	0.099
seperated_sm	Number of household members who are sepatated	-0.260***	0.067	-0.232***	0.071
toilet_flush_m_t_s	Household with flush toilet, town average	0.856***	0.201	0.837***	0.248
tv	Household with tv	0.146***	0.035	0.166***	0.033
unihi_com_head	Household head with completed university or higher education	0.188***	0.059	0.200***	0.055
wall_mat2_m_t_s	Wall made of Bricks/Cement blocks/ Autoclaved, town average	-0.394***	0.106	-0.394***	0.128
_cons		9.532***	0.267	9.825***	0.234
Number of observations		1114	Empirical best methods		Yes
Adjusted R-squared		0.364	Transformation (lhs)		Ins skew
Sigma eta sq.		0.006	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.033			
Variance of epsilon		0.169			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * $p < .1$ ** $p < .05$ *** $p < .01$

Table A4.14 Model Estimates - Thimphu (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_yn	Household with at least one individual aged 15–24	-0.227***	0.039	-0.200***	0.038
age25t64_mn	Share of household members aged 25–64	0.539***	0.091	0.560***	0.088
computerlaptop	Household with computer or laptop	0.049	0.039	0.065*	0.038
ene_gas	Household mainly using gas for cooking	0.142*	0.082	0.163**	0.075
everattd_mn	Share of household members who has ever attended school	0.367***	0.089	0.372***	0.091
everattd_yn	Household with at least one member who has ever attended school	-0.401***	0.118	-0.344***	0.110
grid_elec_m_t_s	Household with access to grid electricity, town average	0.315***	0.111	0.316***	0.107
lsec_abv_mn	Share of household members with completed lower secondary education and above	0.422***	0.076	0.423***	0.081
lsec_com_yn	Household with at least one member with completed lower secondary education education	-0.098**	0.038	-0.109***	0.036
male_yn	Household with at least one male member	-0.427***	0.113	-0.443***	0.139
own_house	Household own the house	0.258***	0.061	0.272***	0.055
piped_water	Household with access to piped water (inside or outside)	1.501***	0.217	1.352***	0.392
rent_house	Household rent the house from private individuals	0.109***	0.041	0.106***	0.040
seshu_gho_kira	Household with seshu_gho_kira	0.193***	0.038	0.175***	0.036
urban_m_t_s	Urban household, town average	-0.263***	0.035	-0.267***	0.065
vacuum	Household with vacuum	0.229***	0.057	0.233***	0.053
_cons		7.658***	0.292	7.729***	0.442
Number of observations		1175	Empirical best methods		Yes
Adjusted R-squared		0.446	Transformation (lhs)		lnskew_w
Sigma eta sq.		0.006	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.029			
Variance of epsilon		0.216			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p < .1 ** p < .05 *** p < .01

Table A4.15 Model Estimates - Trashigang (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_yn	Household with at least one individual aged 25-64	0.001	0.002	0.002	0.002
age_mn	Mean of age at household level	0.001***	0.000	0.001***	0.000
age_yn	Maximum age of household members	-0.001***	0.000	-0.001***	0.000
everattd_head	Household head has ever attended school	0.011***	0.002	0.010***	0.002
female_yn	Household with at least one female member	-0.007***	0.003	-0.007***	0.002
male_yn	Household with at least one male member	-0.009***	0.002	-0.009***	0.002
married_head	Household head is married	-0.006***	0.002	-0.005***	0.002
nrooms_4	Number of rooms =4	0.004**	0.002	0.005***	0.002
nrooms_5	Number of rooms =5	0.013***	0.003	0.013***	0.002
own_house	Household own the house	-0.008***	0.002	-0.007***	0.002
seperated_mn	Share of household members who are separated	-0.018***	0.005	-0.019***	0.004
wall_mat1_m_t_s	Wall made of Mud-bonded bricks/ stones, town average	-0.002	0.003	-0.007**	0.004
_cons		1.377***	0.005	1.378***	0.004
Number of observations		624	Empirical best methods		Yes
Adjusted R-squared		0.409	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.021			
Variance of epsilon		0.000			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.16 Model Estimates - Trashy Yangtse (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_mn	Share of household members aged 25-64	0.342***	0.099	0.321***	0.076
age_yn	Maximum age of household members	-0.008***	0.002	-0.010***	0.002
depratio	Dependency ratio	-0.075**	0.036	-0.024	0.035
female_yn	Household with at least one female member	-0.695***	0.148	-0.734***	0.139
floor	Household main material of the floor	-0.202***	0.053	-0.157***	0.047
hysize_4	Household with four members	0.090	0.059	0.098	0.060
literacy_head	Household head is literate	0.049	0.050	0.008	0.046
literacy_yn	Household with at least one literate member	-0.060	0.041	-0.058	0.037
male_yn	Household with at least one male member	-0.767***	0.103	-0.732***	0.072
married_mn	Share of household members who are married	0.705***	0.123	0.727***	0.093
nrooms	Number of rooms	0.074***	0.015	0.088***	0.013
rent_house	Household rent the house from private individuals	0.174**	0.074	0.026	0.059
seperated_sm	Number of household members who are sepatated	0.208**	0.082	0.145**	0.067
seshu_gho_kira	Household with seshu_gho_kira	0.258***	0.061	0.203***	0.052
usec_abv_mn	Share of household members with completed upper secondary education and above	0.507***	0.125	0.705***	0.095
watersrc	Main source of drinking water	-0.064	0.049	-0.044	0.047
widowed_yn	Household with at least one widowed member	0.169**	0.080	0.207***	0.068
_cons		10.796***	0.304	10.634***	0.265
Number of observations		539	Empirical best methods		Yes
Adjusted R-squared		0.469	Transformation (lhs)		lnskew
Sigma eta sq.		0.003	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.014			
Variance of epsilon		0.208			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.17 Model Estimates - Trongsa (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age15t24_yn	Household with at least one individual aged 15–24	-0.004***	0.000	-0.005***	0.000
age25t64_sm	Number of household members aged 25-64	-0.003***	0.000	-0.003***	0.000
age65pl_head	Household head aged 65 and older	-0.003***	0.001	-0.003***	0.001
bicycle	Household with bicycle	0.001	0.001	0.001	0.001
child_1	Household with one member aged 1 to 14	-0.001*	0.000	-0.001**	0.000
child_2	Household with two members aged 1 to 14	-0.001*	0.001	-0.001*	0.001
computerlaptop	Household with computer or laptop	0.001***	0.000	0.002***	0.000
depratio	Dependency ratio	-0.004***	0.000	-0.004***	0.000
ene_elec	Household mainly using electricity for cooking	-0.002***	0.001	-0.002***	0.001
ene_wood	Household mainly using firewood for cooking	-0.002**	0.001	-0.003***	0.001
evereduc_share	Share of ever educated among adults aged 15-64	0.002***	0.001	0.002***	0.001
female_yn	Household with at least one female member	-0.002*	0.001	-0.001*	0.001
floor_mat3	Floor made of Cement/concrete/Terrazzo	0.002***	0.000	0.001***	0.000
fridge	Household with fridge	0.001***	0.001	0.001***	0.000
linschool_share	Share of enrollment among children aged 6-18	-0.001**	0.000	-0.001***	0.000
lsec_com_head	Household head with completed lower secondary education	0.001	0.001	0.001	0.001
married_yn	Household with at least one married member	-0.004***	0.001	-0.003***	0.001
nrooms	Number of rooms	0.001***	0.000	0.001***	0.000
rent_house	Household rent the house from private individuals	0.002***	0.000	0.002***	0.000
seperated_sm	Number of household members who are sepatated	-0.002***	0.001	-0.002***	0.000
seshu_gho_kira	Household with seshu_gho_kira	0.002***	0.000	0.002***	0.000
sofaset	Household with sofaset	0.002***	0.000	0.002***	0.000
urb_loghhsz	Urban x Log of household size	-0.002***	0.000	-0.001**	0.000
usec_com_head	Household head with completed upper secondary education and above	0.002***	0.001	0.002***	0.000
wall_mat2	Wall made of Bricks/Cement blocks/Autoclaved Aerated Concrete(AAC)	0.001***	0.000	0.001***	0.000
widowed_yn	Household with at least one widowed member	-0.001**	0.001	-0.001**	0.001
_cons		0.976***	0.001	0.976***	0.001
Number of observations		527	Empirical best methods		Yes
Adjusted R-squared		0.721	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.004			
Variance of epsilon		0.000			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.18 Model Estimates - Tsirang (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_yn	Household with at least one individual aged 25-64	0.442***	0.140	0.389***	0.128
age_mn	Mean of age at household level	0.027***	0.003	0.027***	0.003
ene_elec	Household mainly using electricity for cooking	0.324	0.245	0.417*	0.222
female_mn	Share of female household members	-0.336**	0.136	-0.343***	0.123
literacy_mn	Share of literate household members	0.401***	0.109	0.406***	0.096
ln_hdage	Log of household head age	-0.549***	0.110	-0.590***	0.097
male_yn	Household with at least one male member	-0.733***	0.125	-0.648***	0.111
toilet_flush_m_t_s	Household with flush toilet, town average	-0.077	0.187	0.003	0.296
tv	Household with tv	0.228***	0.049	0.232***	0.047
usec_abv_head	Household head with completed upper secondary education and above	0.413***	0.077	0.403***	0.072
_cons		9.822***	0.498	9.803***	0.498
Number of observations		549	Empirical best methods		Yes
Adjusted R-squared		0.308	Transformation (lhs)		lnskew
Sigma eta sq.		0.006	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.022			
Variance of epsilon		0.262			
Error decomposition		H3			

Source: Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.19 Model Estimates – Wangdue Phodrang(Beta Model) National

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_mn	Share of household members aged 25-64	0.079***	0.004	0.079***	0.004
age25t64_yn	Household with at least one individual aged 25-64	-0.032***	0.004	-0.030***	0.004
age65pl_mn	Share of household members aged 65 and older	0.058***	0.005	0.060***	0.005
age_yn	Maximum age of household members	-0.001***	0.000	-0.001***	0.000
female_yn	Household with at least one female member	-0.056***	0.003	-0.056***	0.003
floor	Household main material of the floor	-0.009***	0.001	-0.008***	0.001
floor_mat3	Floor made of Cement/concrete/Terrazzo	-0.003**	0.001	-0.003*	0.001
fuel	Household main cooking Fuel is electricity or gas	0.023***	0.004	0.025***	0.004
literacy_head	Household head is literate	0.005***	0.002	0.006***	0.002
literacy_share	Share of literate among adults aged 15-64	0.021***	0.002	0.021***	0.002
literacy_yn	Household with at least one literate member	-0.015***	0.001	-0.016***	0.001
lsec_abv_head	Household head with completed lower secondary education and above	0.014***	0.002	0.014***	0.002
male_head	Household head is male	-0.008***	0.001	-0.008***	0.001
male_yn	Household with at least one male member	-0.040***	0.003	-0.038***	0.003
married_head	Household head is married	-0.021***	0.002	-0.020***	0.003
married_mn	Share of household members who are married	0.038***	0.004	0.037***	0.004
motorbikescooter	Household with motorbike or scooter	0.006**	0.003	0.004	0.003
nrooms	Number of rooms	0.006***	0.000	0.007***	0.000
nrooms_7_m_t_s	Household with number of rooms equal to seven, town average	0.076**	0.031	0.167***	0.056
pri_com_sh_t_s	Share of completed primary education among adults aged 15-64, town average	0.080***	0.015	0.079***	0.027
seperated_head	Household head is separated	0.001	0.003	0.004	0.003
seperated_m_t_s	Separated household members, town average	-0.115*	0.062	-0.194*	0.104
seshu_gho_kira	Household with seshu_gho_kira	0.021***	0.001	0.022***	0.001
toilet_flush_m_d_s	Household with flush toilet, district average	0.009*	0.005	0.027**	0.013
toilet_pitnoslab_m_t_s	Household with pit toilet with no slab, town average	0.007	0.007	0.016	0.012
toiletshare_m_t_s	Household using shared toilet, town average	0.066***	0.009	0.045***	0.015
tv	Household with tv	0.016***	0.001	0.016***	0.001
usec_abv_head	Household head with completed upper secondary education and above	0.006**	0.002	0.007***	0.002

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
wall	Main materials of the external wall	-0.002***	0.001	-0.002***	0.001
watermins_m_d_s	Distance from nearest source of drinking water, district average (in minutes)	-0.002***	0.001	-0.001	0.002
watersrc	Main source of drinking water	-0.012***	0.001	-0.012***	0.001
_cons		2.557***	0.009	2.535***	0.016
Number of observations		13340	Empirical best methods		Yes
Adjusted R-squared		0.504	Transformation (lhs)		Box-Cox
Sigma eta sq.		0.000	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.089			
Variance of epsilon		0.002			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

Table A4.20 Model Estimates - Zhemgang (Beta Model)

Variable	Variable description	bOLS		bGLS	
		coef	se	coef	se
age25t64_mn	Share of household members aged 25-64	0.738***	0.130	0.691***	0.119
age25t64_yn	Household with at least one individual aged 25-64	-0.597***	0.140	-0.498***	0.131
computerlaptop	Household with computer or laptop	0.191***	0.062	0.198***	0.064
everattd_head	Household head has ever attended school	0.272***	0.073	0.286***	0.063
female_yn	Household with at least one female member	-0.430***	0.118	-0.489***	0.116
floor_mat3	Floor made of Cement/concrete/Terrazzo	0.094**	0.045	0.126***	0.045
internet_m_g_s	Household with access to internet, town2 average	0.557***	0.113	0.512**	0.234
literacy_yn	Household with at least one literate member	-0.176***	0.039	-0.185***	0.039
ln_hdage	Log of household head age	-0.247***	0.094	-0.251***	0.090
lsec_abv_head	Household head with completed lower secondary education and above	0.186**	0.080	0.136*	0.075
male_yn	Household with at least one male member	-0.506***	0.124	-0.510***	0.113
married_mn	Share of household members who are married	0.355***	0.109	0.402***	0.102
nrooms_7	Number of rooms =7	0.325**	0.130	0.351**	0.162
seperated_head	Household head is separated	0.382***	0.125	0.444***	0.146
seshu_gho_kira	Household with seshu_gho_kira	0.131***	0.050	0.108*	0.055
widowed_head	Household head is a widower	0.271***	0.104	0.276**	0.115
_cons		10.496***	0.405	10.503***	0.391
Number of observations		538	Empirical best methods		Yes
Adjusted R-squared		0.545	Transformation (lhs)		lnskew
Sigma eta sq.		0.017	Alpha model		Yes
Ratio of Sigma eta sq. over MSE		0.070			
Variance of epsilon		0.230			
Error decomposition		H3			

Source:Based on 2022 BLSS and 2017 PHCB.

Note: Model settings: alpha model; error decomposition: H3; 100 simulations and 200 bootstraps with normal distribution; empirical best methods. * p <.1 ** p <.05 *** p <.01

ANNEXURE V: POVERTY RATE AND POOR POPULATION BY DISTRICT AND TOWN

Table A5.1 Estimates of poverty headcount rate and number of poor population by district and town

District code	District name	Town2 code	Town2 name	Poverty rate (%)	Standard error	Population in 2022	Number of poor
1	Bumthang			9.62	1.72	14,819	1,425
		101	Chhoekhor	13.31	3.00	3,460	461
		102	Tang	15.64	3.62	1,779	278
		103	Chhumig + Chhumig town	11.28	2.84	2,773	313
		104	Ura	10.17	3.02	1,467	149
2	Chhukha	151	Bumthang Town	4.20	1.49	5,340	224
				14.23	1.12	62,777	8,935
		201	Bjagchhog	15.99	2.83	2,735	437
		202	Bongo + Getana	30.84	3.53	4,258	1,313
		203	Chapchha	9.87	2.12	2,425	239
		204	Darla + Darla Town	16.27	2.00	8,290	1,348
		206	Doongna + Maedtabkha	43.67	5.42	1,721	752
		207	Geling + Samphelling	20.22	2.92	5,210	1,054
		208	Loggchina	25.87	4.02	2,521	652
		210	Phuentshogling	27.09	2.92	5,615	1,521
		251	Phuentshogling Thromde	5.20	0.84	24,624	1,280
		252	Tsimasham Town	6.56	1.73	1,853	122
		261	Chhukha Town	7.75	1.92	1,803	140
		263	Gedu Town	4.48	1.76	1,722	77
3	Dagana			10.04	1.17	21,600	2,169
		301	Drukjeygang + Drukjeygang town	6.70	1.82	1,948	131
		302	Gozhi + Gesarling	9.66	1.77	3,393	328
		303	Karna	11.37	2.52	2,473	281
		304	Khebisa + Largyab	13.83	2.73	1,855	256
		306	Tseza + Dagana Town	7.03	2.10	1,907	134
		307	Tsangkha + Sankosh Town	11.47	2.30	1,487	171
		308	Karmaling + Dorona + Nichula	11.24	2.16	2,260	254
		313	Tashiding	11.84	2.36	1,647	195
		314	Tsenda-Gang + Dagapela Town	9.51	1.87	2,285	217
		352	LhamoiDzingkha Town + LhamoiDzingkha	8.62	1.86	2,345	202
4	Gasa			8.15	1.58	3,273	267
		401	Khamed + Damji + Gasa Town + Khatoed	8.90	2.06	1,603	143
		404	Laya + Lunana	7.43	1.89	1,670	124

District code	District name	Town2 code	Town2 name	Poverty rate (%)	Standard error	Population in 2022	Number of poor
9	Pema Gatshel			17.91	1.57	21,300	3,815
		902	Chongshing + Chhimoong	20.38	3.69	1,286	262
		903	Dungmaed	20.98	3.77	1,169	245
		904	Khar + Chhoekhorling	19.73	2.96	2,138	422
		905	Yurung	17.30	4.12	1,091	189
		906	Nanong	21.52	3.89	1,984	427
		907	Shumar	16.20	3.14	3,040	492
		908	Zobel	21.31	3.77	1,496	319
		910	Dechhenling	17.40	2.65	1,502	261
		911	Norboogang	15.62	3.54	1,306	204
		952	Nganglam Town	16.92	2.31	4,474	757
10	Punakha	961	Denchi Town + Kherigonpa Town + Yalang Town + Mongling Town + Khotakpa Town + Nangkhori Town + Olde Pema Gatshel Town	13.05	3.04	1,814	237
				2.95	0.80	23,145	683
		1001	Barp + Lobaysa Town	1.84	0.79	4,749	87
		1002	Guma	3.38	1.37	2,243	76
		1004	Kabisa	4.91	1.74	2,334	115
		1005	Talog	4.83	1.77	1,123	54
		1006	Toedpaissa	3.19	1.47	1,769	56
		1007	Chhubu + Goenshari	4.27	1.86	1,878	80
		1008	Dzomi	4.47	1.91	1,677	75
		1009	Lingmukha + Shelnga-Bjemi	3.34	1.34	1,861	62
		1011	Toedwang	4.65	1.97	1,265	59
11	Samdrup Jongkhar	1051	Punakha Town	0.43	0.74	4,246	(*)
				20.07	1.57	29,541	5,929
		1101	Dewathang	10.37	3.63	2,586	268
		1102	Gomdar	33.67	4.59	2,474	833
		1103	Orong	31.13	4.42	2,358	734
		1104	Phuentshogthang	22.45	3.73	2,946	662
		1105	Wangphu	42.44	5.24	1,733	736
		1106	Langchenphu + Jomotsangkha Town	12.94	3.40	1,977	256
		1107	Lauri	36.96	5.21	1,493	552
		1108	Martshala	28.96	4.51	1,932	560
		1109	Pemathang + Samrang	28.62	4.86	1,632	467
		1111	Serthig	30.52	5.67	1,393	425
		1151	Samdrup Jongkhar Thromde	4.74	1.77	7,692	365
		1152	Samdrupcholing Town	5.49	3.26	1,325	73

District code	District name	Town2 code	Town2 name	Poverty rate (%)	Standard error	Population in 2022	Number of poor
12	Samtse			22.17	1.59	59,451	13,180
		1201	Duenchhukha	27.01	4.07	1,987	537
		1202	Dophuchen	27.89	3.52	4,634	1,293
		1203	Doomtoed	36.15	5.01	1,410	510
		1204	Tading	22.90	3.03	4,714	1,080
		1205	Norboogang	20.20	2.74	4,057	819
		1206	Phuentshogpelri	20.69	2.96	4,072	843
		1207	Samtse	18.61	2.75	3,571	665
		1208	Norgaygang	31.25	3.37	3,550	1,109
		1209	Pemaling	25.16	3.49	3,260	820
		1210	Tashichhoeling + Sipsu Town	11.22	2.10	4,431	497
		1211	Tendruk	19.99	2.70	5,545	1,109
		1212	Sang-Ngag-Chhoelin	29.52	3.57	2,994	884
		1213	Namgyalchhoeling	36.81	4.85	3,014	1,110
		1214	Ugyentse	17.91	3.07	1,330	238
		1215	Yoeseltse	20.61	3.32	2,577	531
		1251	Samtse Town	13.29	2.35	4,676	621
		1252	Gomtu Town	14.19	2.45	3,629	515
				5.86	0.93	41,408	2,426
		1301	Samtenling	6.73	1.73	2,670	180
13	Sarpang	1302	Chhuzanggang	9.80	2.01	2,459	241
		1303	Gelegphu	5.24	1.34	5,747	301
		1304	Jigme Chhoeling	3.92	1.89	3,091	121
		1305	Serzhong	6.95	2.64	1,973	137
		1307	Umling + Tareythang	9.33	2.55	1,806	169
		1308	Dekiling	4.74	1.46	5,262	249
		1309	Chhudzom	6.15	2.21	2,589	159
		1310	Gakiling1	3.41	1.49	2,085	71
		1312	Shompangkha + Senggey	4.53	1.93	2,459	111
		1351	Gelegphu Thromde	7.13	0.91	8,779	626
		1352	Sarpang Town	2.43	1.12	2,488	60
14	Thimphu			2.00	0.47	129,344	2,585
		1401	Kawang + Lingzhi + Naro + Soe	4.59	1.17	5,627	258
		1405	Chang	1.42	0.51	5,553	79
		1406	Darkarla + Ge-nyen	1.90	0.82	2,432	(*)
		1408	Maedwang + Khasadrapchu Town	1.56	0.55	7,207	113
		1451	Thimphu Thromde	1.92	0.48	108,525	2,089

District code	District name	Town2 code	Town2 name	Poverty rate (%)	Standard error	Population in 2022	Number of poor
15	Trashigang			21.28	1.42	37,179	7,911
		1501	Bartsham	15.81	3.23	1,431	226
		1502	Bidoong	20.20	3.93	1,265	255
		1503	Yangnyer	21.70	3.73	2,084	452
		1504	Shongphu	22.49	3.52	1,882	423
		1505	Kanglung	19.55	2.66	3,570	698
		1506	Samkhar	18.93	3.03	1,738	329
		1507	Udzorong	28.39	3.76	2,335	663
		1508	Merag	34.78	5.26	1,519	528
		1509	Phongmed	28.61	3.55	2,154	616
		1510	Radhi	23.15	3.97	2,152	498
		1511	Sagteng	31.19	4.57	1,985	619
		1512	Kangpar	26.23	4.21	1,420	372
		1513	Thrimshing	23.71	3.39	2,045	485
		1514	Khaling + Khaling Town	23.17	2.86	2,847	660
		1515	Lumang + Resarbu Town + Wangrong Town	18.96	2.83	3,465	657
		1551	Trashigang Town	6.84	2.19	2,616	179
16	Trashi Yangtse			16.08	1.56	14,554	2,340
		1601	Boomdeling	16.50	3.13	1,796	296
		1602	Jamkhar	15.79	2.93	986	156
		1603	Tongmajangsa	14.53	3.06	1,284	187
		1604	Yangtse	17.78	3.38	1,261	224
		1605	Ramjar	13.73	3.12	950	130
		1606	Duksum Town + Khamdang	19.16	2.54	3,078	590
		1607	Toedtsho	21.61	3.35	1,490	322
		1608	Yalang	17.35	2.81	1,271	220
		1651	Trashi Yangtse Town	8.81	1.93	2,438	215
17	Trongsa			22.65	1.53	13,128	2,974
		1701	Draagteng + Kuengarabten Town	20.73	1.79	3,675	762
		1703	Langthil + Korphu	26.49	2.35	3,377	895
		1704	Nubi	34.36	3.52	1,996	686
		1705	Tangsibji	18.49	2.36	1,625	300
		1751	Trongsa Town	13.48	2.36	2,455	331
				19.48	1.83	20,052	3,905
		1801	Barshong + Patshaling	18.86	3.85	1,989	375
		1803	Kilkhorthang	15.40	3.43	2,114	325
		1804	Mendrelgang + Mendrelgang Town	11.15	3.34	1,688	188
18	Tsirang	1805	Rangthangling	20.22	4.05	1,555	314
		1806	Tsholingkhr	22.77	4.41	1,716	391
		1807	Doonglagang	27.61	4.14	1,521	420
		1808	Gosarling	16.08	3.57	1,808	291
		1809	Sergithang	32.22	5.20	1,287	415
		1810	Pungtenchhu	29.37	4.98	1,325	389
		1811	Semjong	24.46	4.25	1,242	304
		1812	Tsirang Toed	23.24	4.16	1,373	319
		1851	Tsirang Town	7.14	2.44	2,434	174

District code	District name	Town2 code	Town2 name	Poverty rate (%)	Standard error	Population in 2022	Number of poor
19	Wangdue Phodrang			15.60	0.92	32,377	5,052
		1902	Bjenag + Athang	26.50	3.42	2,185	579
		1903	Darkar	15.96	3.20	2,092	334
		1904	Gase Tshogongm	8.00	1.72	3,004	240
		1905	Gase Tshowogm + Nahi	18.42	4.20	1,253	231
		1907	Thedtsho	11.07	2.28	2,949	326
		1908	Ruebisa + Rurichu Town	21.11	3.35	1,948	411
		1909	Dangchhu + Nobding Town	19.25	4.33	1,426	274
		1910	Gangteng	13.15	2.82	1,908	251
		1911	Kazhi + Phangyuel	30.21	3.36	2,040	616
		1912	Nyishog	32.41	4.29	1,909	619
		1914	Phobji	14.48	3.67	1,967	285
		1915	Saephu	15.30	3.87	1,563	239
		1951	Wangdue Phodrang Town	7.94	1.13	8,133	646
20	Zhemgang			35.90	1.88	14,269	5,122
		2001	Bardo	50.78	4.75	1,583	804
		2002	Nangkor	35.64	4.23	1,888	673
		2003	Shingkhar	44.70	5.13	1,079	482
		2004	Trong + Tingtibi Town	20.21	3.19	2,644	534
		2006	Phangkhar + Goshing	49.95	4.60	2,325	1,161
		2007	Ngangla + Panbang Town + Bjoka	40.84	3.12	3,237	1,322
		2051	Zhemgang Town	9.64	2.69	1,513	146
Bhutan				12.64		632,491	79,953

Source: Based on BLSS 2022 and PHCB 2017. Notes: [*] indicates that the number of poor are small.



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