# **Drawing Statistical Inferences from International Census Data**

### **OBJECTIVE**

Using full count census data from 4 countries, we evaluate the impact of sample design on standard error estimates of microdata samples from the IPUMS International.

### BACKGROUND

Although census microdata used by social scientists derive from complex samples, researchers commonly apply methods designed for simple random samples. Standard error estimates from clustered and stratified data can differ dramatically from those derived from simple random samples of the same size.

To the extent that the characteristics of individuals are homogeneous within households, household clustering yields standard errors that are greater than would be obtained from a simple random sample of the same size. (Graubard and Korn 1996; Mansen, Hurwitz, and Madow 1953; Kish 1992; Korn and Graubard 1995, 1999). Variables such as race and poverty status tend to be comparatively homogeneous within household, and therefore pose a risk for underestimated standard errors if clustering is ignored.

Stratification in census microdata samples has the opposite effect from clustering: in general, failure to control for the effects of stratification leads to overestimated standard errors. To the extent that the characteristics of individuals or households are homogeneous within strata, the variance within the stratum is decreased and estimates that account for the additional information about the sample have lower standard errors. Household characteristics that reflect local or regional economic status as well as characteristics of individuals like literacy or ethnicity can be homogeneous within geographic strata.

We use data from the Integrated Public Use Microdata Series-International (IPUMS International) which consists of the world's largest collection of census microdata. Since some data samples in IPUMS International were drawn from full count census data, we were able to compare nearly perfect estimates of means and standard errors from the full count data to sample estimates from a test set of 4 countries for which we had access to full count data: Bolivia 2001, Ghana 2000, Mongolia 2000, and

Most IPUMS International samples are systematic random samples, typically drawn by selecting every tenth household in the source file after designating a random starting point. Due to the way that census data are collected, we assumed the existence of low-level geographic sorting. We replicated an approach used by Davern et al. (2009) for 4 IPUMS International census samples and created pseudostrata of 10 households, ensuring that each stratum fell entirely within an administrative unit of the country. Using a replicate method of variance estimation, we drew 100 10% replicates from the full count data using a sampling procedure that mimics the procedure used to draw the 10% public use sample and estimated the standard error of the mean around several household and person-level variables. We compared these estimates to estimates using three methods of variance estimation for the 10% public use sample:

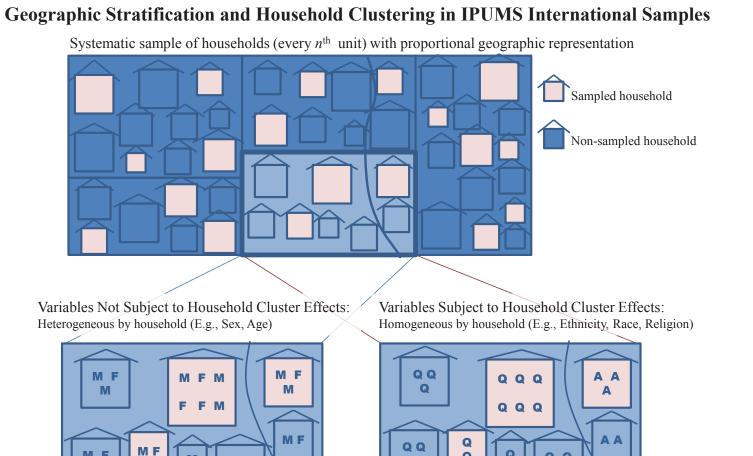
subsample replicate approach,

Rwanda 2002.

- specifications, and
- standard estimation relying on simple random sample assumptions.

simple random sample.

presented in Tables 1 through 4.



M=Male F=Female

Q=Quechua A=Aymara

Table 5. Comparison of Cluster IPUMS International 10% Bolir (Full ( Person Mean Repli Age (mean) 49.8 Sex (%) 0.00 Ethnicit Quechua (%) 30.7 0.0 Avmara (%) Married (%) 75.0 0.00 Literate (%) Worked (%) 34.4 0.002 (Reporting Ratios of Standard I Count Census using the Subsan Characteristics Independently a

approximates the full count subsample replicate estimate.

## Lara L. Cleveland and Michael Davern

Minnesota Population Center, University of Minnesota

### DATA AND METHODOLOGY

- Taylor series, using pseudostrata and household cluster complex sample
- If data are clustered by household or geographically stratified, we would expect the standard errors from the subsample replicate and Taylor series estimates (adjusting for geographic stratification and household clustering) to better approximate the standard errors from the "gold standard" estimates than those derived assuming a
- Ratios of estimates from both household-level and person-level characteristics are

1 ( Iuli 2	2001 Census Sam	1		
	Taylor	Series Lineariz	ation	SRS
E Count icate)	Accounting for Clustering and Implicit Stratification	Effect of Clustering (Adjusting for Strata Only)	Effect of Stratification (Adjusting for Cluster Only)	Combined Effect of Clustering and Stratification
004	1.1	1.0	1.1	1.0
)24	0.9	1.1	0.9	1.1
)53	1.0	0.6	1.4	0.8
)47	0.9	0.5	1.4	0.8
023	1.0	1.0	1.0	1.0
025	0.9	0.9	1.0	0.9
)22	1.1	1.0	1.2	1.0

The decomposition of stratification and clustering effects are illustrated in the figure and reported in Table 5. For variables that are neither geographically stratified nor clustered by household (e.g., age and sex), the method of standard error estimation makes little difference. Ethnicity in Bolivia 2001, however, is both geographically stratified and clustered by household. Specifying both the household cluster as well as the geographic sorting using a pseudostrata variable yields a standard error estimate that best

### Standard Error Computations Comparing Replicate Estimates from Complete count Censuses with Estimates Derived from Sample Data Using **Alternative Methods\***

	a 2002: Standar ete Count Censu		erived From Sample	Data Using Alternati	ive Methods
	Parameter Estimate From	Replicate Standard Error Estimates		Using the Rwanda 2002 1 From the Entire Rwanda 20	
Selected Characteristics	the Entire Rwanda 2002 Census	Error Estimates Drawn From the Entire Rwanda 2002 Census		Taylor Series Linearization With Pseudo-Strata	Simple Random Sample
Household					
Size (mean)	4.71	0.005	0.8	0.9	0.9
ric Light (%)	4.18	0.034	0.9	0.9	1.3
(%)	0.38	0.013	0.9	0.9	1.0
<b>b</b> )	43.11	0.103	0.9	1.0	1.0
n Floor (%)	85.28	0.073	0.8	0.9	1.0
Ownership (%)	86.41	0.056	1.1	1.1	1.3
elatives (mean)	0.30	0.002	1.1	1.0	1.1
	0.50	0.002		Pseudostrata and	Simple Random
(mean)	20.77	0.015	Subsample Replicate 0.9	HH Cluster 1.0	Sample 1.1
%)	46.81	0.045	0.9	1.0	1.1
				••	
gion tholic (%)	46.69	0.100	1.0	1.0	0.5
estant (%)	26.16	0.077	1.1	1.1	0.6
rried (%)	17.64	0.039	0.9	1.0	1.0
(%)	39.75	0.060	0.9	0.9	0.8
(0/)	40.94	0.049	0.9	0.0	1.0
Bolivia 2001	: Standard Erro		mparing Replicate Es		1.0
Bolivia 2001	: Standard Erro tes Derived Fron	• Computations Co I Sample Data Usin Replicate Standard	omparing Replicate Es ng Alternative Method Ratio of (SE) Estimates	timates From the Co	o <b>mplete Count Cens</b> 3% Sample to Replicate
Bolivia 2001 With Estima	: Standard Erro	: Computations Co Sample Data Usir	omparing Replicate Es ng Alternative Method Ratio of (SE) Estimates	timates From the Co ls Using the Bolivia 2001 10	o <b>mplete Count Cens</b> 3% Sample to Replicate
Bolivia 2001 With Estima	: Standard Error tes Derived Fron Parameter Estimate From the Entire Bolivia 2001 Census	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census	mparing Replicate Es 19 Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method	timates From the Co s Using the Bolivia 2001 10 irom the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample
Bolivia 2001 With Estima Characteristics d mean)	E Standard Erroo tes Derived Fron Parameter Estimate From the Entire Bolivia 2001 Census 3.93	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046	omparing Replicate Es ag Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0	timates From the Co ls Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample 1.1
Bolivia 2001 With Estima aracteristics ean)	Estimate From the Entire Bolivia 2001 Census 3.93 60.51	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536	mparing Replicate Es 19 Alternative Method Ratio of (SE) Estimates I Estimates I Subsample Replicate Method 1.0 1.1	timates From the Co s Using the Bolivia 2001 10 from the Entre Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2	omplete Count Cens 1% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9
Bolivia 2001 With Estima aracteristics ean) ht (%)	E Standard Erroi tes Derived Fron Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649	omparing Replicate Es og Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0	timates From the Co ls Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6
Bolivia 2001 With Estima haracteristics I nean) ght (%) separate room (%)	Estimate From the Entire Bolivia 2001 Census 3.93 60.51	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536	mparing Replicate Es 19 Alternative Method Ratio of (SE) Estimates I Estimates I Subsample Replicate Method 1.0 1.1	timates From the Co is Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.1	omplete Count Cens 1% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9
Bolivia 2001 With Estima naracteristics nean) tht (%)	E Standard Erroo tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649	omparing Replicate Es og Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0	timates From the Co ls Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6
Bolivia 2001 With Estima Characteristics d mean) ight (%) s separate room (%)	E Standard Error tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62	Computations Co Sample Data Usir Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882	mparing Replicate Es 19 Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9	timates From the Co is Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.1	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1
Bolivia 2001 With Estima Characteristics Id mean) ight (%) ) s separate room (%) )	E Standard Erroo tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605	mparing Replicate Es ag Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3	timates From the Co ls Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.1	omplete Count Cens 9% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4
Bolivia 2001 With Estima Characteristics dd imean) ight (%) ) s separate room (%) ) ) pr (%)	E Standard Error tes Derived Fron Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17	Computations Constraints Const	mparing Replicate Es ag Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9	timates From the Co ls Using the Bolivia 2001 10 from the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.1 1.0	omplete Count Cens 0% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1
	E Standard Erron tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17 35.66	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519	Pmparing Replicate Es Ig Alternative Method Ratio of (SE) Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2	timates From the Co s Using the Bolivia 2001 10 from the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.3 1.0 1.0	omplete Count Cens % Sample to Replicate 01 Census Simple Random 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.1 1.1 1.1 1.1 1.1
Bolivia 2001 With Estima Characteristics bld (mean) Light (%) 6) as separate room (%) 6) 6) bor (%) wnership (%)	E Standard Error tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17 35.66 62.81 0.19	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519 0.0877	mparing Replicate Es ag Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0	timates From the Co ls Using the Bolivia 2001 10 from the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0	omplete Count Cens % Sample to Replicate % Sample Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.4 1.1 1.9 1.1
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Bolivia 2001 With Estima Characteristics d mean) ight (%) ) s separate room (%) ) ) or (%) mership (%) ives (mean)	E Standard Error tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17 35.66 62.81 0.19	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519 0.0877 0.0012	mparing Replicate Es ig Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0 1.0 1.0 Subsample Replicate	timates From the Co s Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.1 1.0 1.1 1.0 1.3 1.0 1.3 1.0 1.9 Pseudo-Strata and HH Cluster	omplete Count Cens % Sample to Replicate 101 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.1 1.9 1.1 1.1 1.9 1.1 1.1
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Bolivia 2001 With Estima aracteristics ean) ht (%) eparate room (%) (%) es (mean)	E Standard Error tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17 35.66 62.81 0.19 24.70 49.84 30.69 25.19	Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519 0.0877 0.0012 0.0004 0.0004 0.00024 0.00053 0.0047	mparing Replicate Es ig Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0 1.0 1.0 5ubsample Replicate 1.0 0.9 1.2 1.0 1.0 1.0 5ubsample Replicate	timates From the Co ls Using the Bolivia 2001 10 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.1 1.0 1.3 1.0 1.3 1.0 1.3 1.0 1.0 Pseudo-Strata and HH Cluster 1.1 0.9 1.0 9.9	omplete Count Cens 3% Sample to Replicate 101 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.1 1.9 1.1 1.1 1.9 1.1 1.1

	a 2002: Standar										
Compl			erived From Sample	Data Using Alternati Using the Rwanda 2002 1			Parameter			Using the Mongolia 2000 10%	
	Parameter Estimate From the Entire Rwanda 2002 Census	Replicate Standard Error Estimates Drawn From the Entire Rwanda 2002 Census	Estimates From the Entire Rwanda 20				Estimate From the Entire	Error Estimates Drawn From the	Estimates Fr	rom the Entire Mongolia 2000 Taylor Series	0 Census
Selected Characteristics			Subsample Replicate Method	Taylor Series Linearization With Pseudo-Strata	Simple Random Sample	Selected Characteristics Mo	Mongolia 2000 Census	Entire Mongolia 2000 Census	Subsample Replicate Method	Linearization With Pseudo-Strata	Simple Ra Sampl
Household HH Size (mean)	4.71	0.005	0.8	0.9	0.9	HH Size (mean)	4.45	0.008	0.9	0.9	1.0
						Electric Light (%)	67.53	0.098	1.1	1.0	1.8
Electric Light (%)	4.18	0.034	0.9	0.9	1.3	Toilet (%)	62.46	0.135	1.1	1.2	1.4
Toilet (%)	0.38	0.013	0.9	0.9	1.0	Kitchen as separate	39.08	0.145	1.0	1.0	1.1
Radio (%)	43.11	0.103	0.9	1.0	1.0	room (%)					
Earth Floor (%)	85.28	0.073	0.8	0.9	1.0	Bathroom (%)	21.74	0.096	1.0	1.1	1.:
Home Ownership (%)	86.41	0.056	1.1	1.1	1.3	Phone (%)	17.01	0.136	1.0	1.0	1.
Non-relatives (mean)	0.30	0.002	1.1	1.0	1.1	Non-relatives (mean)	0.11	0.002	0.9	1.0	1.0
Person			Subsample Replicate	Pseudostrata and HH Cluster	Simple Random Sample	Person			Subsample Replicate	Pseudo-Strata and HH Cluster	Simple R Samp
Age (mean)	20.77	0.015	0.9	1.0	1.1	Age (mean)	24.57	0.034	1.0	1.0	1.0
Sex (%)	46.81	0.045	0.9	1.0	1.1	Sex (%)	49.47	0.078	0.9	1.0	1.2
Religion Catholic (%)	46.69	0.100	1.0	1.0	0.5	Ethnicity Khalkh (%)	81.59	0.111	0.9	1.0	0.6
Protestant (%)	26.16	0.077	1.1	1.1	0.6	Kazak (%)	4.28	0.047	1.0	1.1	0.8
Married (%)	17.64	0.039	0.9	1.0	1.0	Married (%)	32.33	0.081	0.9	1.0	1.1
Literate (%)	39.75	0.060	0.9	0.9	0.8	Literate (%)	81.56	0.071	1.1	1.0	1.0
Employed (%)	40.94	0.048	0.9	0.9	1.0						
e 3. Bolivia 2001	Standard Error	r Computations Co	mparing Replicate Es	stimates From the Co		Employed (%)	32.47	0.095	0.9	0.9	
le 3. Bolivia 2001	Standard Error	r Computations Co 1 Sample Data Usin	mparing Replicate Es g Alternative Method	stimates From the Co	omplete Count Censu	Table 4. Ghana 2	2000: Standard I	Error Computation	s Comparing Replic e Data Using Altern	cate Estimates from the	e Comple
le 3. Bolivia 2001	Standard Erroi tes Derived From Parameter	r Computations Co 1 Sample Data Usin Replicate Standard Error Estimates _	mparing Replicate Es g Alternative Methoo Ratio of (SE) Estimates	stimates From the Co ls Using the Bolivia 2001 10 From the Entire Bolivia 20	omplete Count Censu	Table 4. Ghana 2	2000: Standard I	Error Computation Perived from Samp Replicate St	s Comparing Replic e Data Using Altern ndard Ratio of (S)	cate Estimates from the	e Complet a 2000 10%
e 3. Bolivia 2001 With Estima	Standard Error tes Derived From Parameter Estimate From the Entire Bolivia	r Computations Co 1 Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia	<b>mparing Replicate Es</b> <b>g Alternative Method</b> Ratio of (SE) Estimates 1 Estimates 1 Subsample Replicate	stimates From the Co Is Using the Bolivia 2001 10 From the Entire Bolivia 200 Taylor Series Linearization With	omplete Count Censu % Sample to Replicate 01 Census Simple Random	Table 4. Ghana 2 Census	2000: Standard I with Estimates D	Error Computation terived from Samp Replicate St Stimate Error Estir Entire Drawn Fro	s Comparing Replic e Data Using Altern Indard Ratio of (Sl inates Replicate n the	cate Estimates from the native Methods E) Estimates Using the Ghan te Estimates From the Entire ( Taylor Series	a 2000 10% Ghana 2000
e 3. Bolivia 2001 With Estima ted Characteristics	Standard Error tes Derived From Parameter Estimate From the	r Computations Co 1 Sample Data Usin Replicate Standard Error Estimates _ Drawn From the	<b>mparing Replicate Es</b> <b>g Alternative Methoo</b> Ratio of (SE) Estimates Estimates I	stimates From the Co Is Using the Bolivia 2001 10 Taylor Series	omplete Count Censu % Sample to Replicate 01 Census	Table 4. Ghana 2 Census Selected Characteristics	2000: Standard I with Estimates D Parameter E From the J	Error Computatior Verived from Samp Replicate St Estimate Error Estir Entire Drawn Fro 000 Entire Ghan	s Comparing Replic e Data Using Altern Indard Ratio of (Sl Replicat n the 2000 Subsample Rep	cate Estimates from the native Methods E) Estimates Using the Ghan te Estimates From the Entire G Taylor Series plicate Linearization Wi	<b>e Complet</b> a 2000 10% ( Ghana 2000 (
e 3. Bolivia 2001 With Estima ted Characteristics ehold	Standard Error tes Derived From Parameter Estimate From the Entire Bolivia	r Computations Co 1 Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia	<b>mparing Replicate Es</b> <b>g Alternative Method</b> Ratio of (SE) Estimates 1 Estimates 1 Subsample Replicate	stimates From the Co Is Using the Bolivia 2001 10 From the Entire Bolivia 200 Taylor Series Linearization With	omplete Count Censu % Sample to Replicate 01 Census Simple Random	Table 4. Ghana 2 Census	2000: Standard I with Estimates D Parameter E From the J Ghana 2	Error Computatior Verived from Samp Replicate St Estimate Error Estir Entire Drawn Fro 000 Entire Ghan	s Comparing Replic e Data Using Altern Indard Ratio of (Sl Replicat n the 2000 Subsample Rep Method	cate Estimates from the native Methods E) Estimates Using the Ghan te Estimates From the Entire G Taylor Series plicate Linearization Wi	e Complet a 2000 10% Ghana 2000 th Sim
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ted Characteristics sehold fize (mean) ric Light (%)	Standard Erron tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48	r Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649	mparing Replicate Es ig Alternative Method Ratio of (SE) Estimates Estimates I Subsample Replicate Method 1.0 1.1 1.0	stimates From the Co ls Using the Bolivia 2001 10 Trom the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1	Dimplete Count Censu 1% Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6	Table 4.       Ghana 2 Census         Selected Characteristics         Household         HH Size (mean)         Electric Light (%)	2000: Standard I with Estimates D Parameter E From the I Ghana 2 Censu 4.99 43.54 8.49	Error Computation lerived from Sampi Replicate Sti Stimate Error Estir Entire Drawn Fro 000 Entire Ghan Is Censu: 0.005 0.042	s Comparing Replic e Data Using Altern Indard 12000 Replicato 1.1 1.1 1.5 1.2	cate Estimates from the native Methods E) Estimates Using the Ghan te Estimates From the Entire ( Taylor Series plicate Linearization Wi 1 Pseudo-Strata 1.0 1.5	e Complet a 2000 10% Ghana 2000 th Sim
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e 3. Bolivia 2001 With Estima ted Characteristics rehold fize (mean) ric Light (%) t (%) en as separate room (%) e (%) b (%) Floor (%) e Ownership (%)	Standard Error tes Derived From Parameter Estimate From the Entire Bolivia 2001 Census 3.93 60.51 59.48 70.62 21.33 71.17 35.66 62.81	r Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519 0.0877	mparing Replicate Es g Alternative Method Ratio of (SE) Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0	stimates From the Co ls Using the Bolivia 2001 10 From the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.3 1.0 1.0	omplete Count Censu % Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.9 1.1 1.1 1.1 1.1	Table 4.       Ghana 2 Census         Selected Characteristics         Household         HH Size (mean)         Electric Light (%)         Toilet (%)         Kitchen as separate room         Bathroom (%)         Non-relatives (mean)         Person         Age (mean)         Sex (%)	2000: Standard I with Estimates D From the I Ghana 2 Censu 4.99 43.54 8.49 (%) 46.17 23.47 0.14	Error Computation lerived from Samp Replicate St Estimate Error Estir Entire Drawn Fro 000 Entire Ghan is Censu 0.005 0.042 0.026 0.046 0.041	s Comparing Replic e Data Using Altern indard Replication in the 2000 Subsample Rep Method 1.1 1.5 1.2 1.2 1.5 0.9 Subsample Rep 1.0	cate Estimates from the native Methods SE) Estimates Using the Ghan te Estimates From the Entire ( Taylor Series Linearization Wi Pseudo-Strata 1.0 1.5 1.5 1.5 1.2 1.4 1.0 Pseudo-Strata and plicate Cluster	e Complet a 2000 10% Ghana 2000 th Sim
ted Characteristics with Estima ted Characteristics schold fize (mean) ric Light (%) t (%) e (%) b (%) c Floor (%) e Ownership (%) relatives (mean) on	Standard Erron           Parameter           Estimate From the           Entire Bolivia           2001 Census           3.93           60.51           59.48           70.62           21.33           71.17           35.66           62.81           0.19	r Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0519 0.0877 0.0012	mparing Replicate Es ig Alternative Method Ratio of (SE) Estimates Estimates 1 Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0 1.0 1.0 Subsample Replicate	stimates From the Co ls Using the Bolivia 2001 10 rom the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.3 1.0 1.0 Pseudo-Strata and HH Cluster	Simple to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.4 1.1 1.9 1.1 1.1 1.9 1.1 1.1 1.9 1.1 1.1	Table 4.       Ghana 2 Census         Selected Characteristics         Household         HH Size (mean)         Electric Light (%)         Toilet (%)         Kitchen as separate room         Bathroom (%)         Non-relatives (mean)         Person         Age (mean)	2000: Standard I with Estimates D Parameter E From the I Ghana 2 Censu 4.99 43.54 8.49 (%) 46.17 23.47 0.14 23.90	Error Computation Replicate Sti Estimate Error Estim Entire Drawn Fro 000 Entire Ghan is Censu 0.005 0.042 0.026 0.046 0.046 0.046	s Comparing Replic e Data Using Altern Indard Replication intees 1,2000 Subsample Rep Method 1.1 1.5 1.2 1.2 1.5 0.9 Subsample Rep 1.0 1.0 1.0	Cate Estimates from the native Methods ED Estimates Using the Ghan- te Estimates From the Entire ( Taylor Series Linearization Wi Pseudo-Strata 1.0 1.5 1.5 1.5 1.2 1.4 1.0 Pseudo-Strata and Cluster 1.1	e Complet a 2000 10% Ghana 2000 th Sim
le 3. Bolivia 2001 With Estima ted Characteristics rehold fize (mean) ric Light (%) t (%) e (%) e (%) p (%) Floor (%) e Ownership (%) relatives (mean) on (mean) %) icity	Standard Error           Parameter           Estimate From the Entire Bolivia 2001 Census           3.93           60.51           59.48           70.62           21.33           71.17           35.66           62.81           0.19           24.70           49.84	r Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0819 0.0519 0.0877 0.0012 0.0004 0.0004 0.0024	mparing Replicate Es g Alternative Method Ratio of (SE) Estimates I Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0 1.0 1.0 5ubsample Replicate 1.0 0.9	stimates From the Co ls Using the Bolivia 2001 10 From the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.2 1.1 1.0 1.1 1.0 1.3 1.0 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.0 1.3 1.0 1.0 1.0 1.0 1.0 1.2 1.1 1.0 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.2 1.1 1.0 1.3 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	Simplete Count Censu % Sample to Replicate 01 Census Simple Random Sample 1.1 1.9 1.6 1.1 1.4 1.1 1.9 1.1 1.9 1.1 1.1 Simple Random Sample 1.0 1.1	Table 4.       Ghana 2 Census         Selected Characteristics         Household         HH Size (mean)         Electric Light (%)         Toilet (%)         Kitchen as separate room         Bathroom (%)         Non-relatives (mean)         Person         Age (mean)         Sex (%)         Ethnicity	2000: Standard I with Estimates D Parameter E From the I Ghana 2 Censu 4.99 43.54 8.49 (%) 46.17 23.47 0.14 23.90 49.48	Error Computation lerived from Sampi Replicate Sti Entire Drawn Fro 000 Entire Ghan Is Censu: 0.005 0.042 0.026 0.046 0.001 0.013 0.035	s Comparing Replic e Data Using Altern indard Replicat n the 2000 Subsample Rep Method 1.1 1.5 1.2 1.2 1.5 0.9 Subsample Rep 1.0 1.0 0.9	cate Estimates from the native Methods E) Estimates Using the Ghan te Estimates From the Entire ( Taylor Series Linearization Wi Pseudo-Strata 1.0 1.5 1.5 1.5 1.2 1.4 1.0 Pseudo-Strata and cluster 1.1 1.0	e Complet a 2000 10% Ghana 2000 th Sim
e 3. Bolivia 2001 With Estima ted Characteristics ehold ize (mean) ric Light (%) t (%) en as separate room (%) t (%) Floor (%) e Ownership (%) relatives (mean) mean) %) city chua (%)	Standard Error           Parameter           Estimate From the Entire Bolivia 2001 Census           3.93           60.51           59.48           70.62           21.33           71.17           35.66           62.81           0.19           24.70           49.84           30.69	r Computations Co Sample Data Usin Replicate Standard Error Estimates Drawn From the Entire Bolivia 2001 Census 0.0046 0.0536 0.0649 0.0882 0.0605 0.0819 0.0819 0.0519 0.0877 0.0012 0.0004 0.0004 0.0024 0.0053	mparing Replicate Es ig Alternative Method Ratio of (SE) Estimates Estimates 1 Subsample Replicate Method 1.0 1.1 1.0 0.9 1.3 0.9 1.2 1.0 1.0 1.0 Subsample Replicate 1.0 0.9 1.2	stimates From the Co ls Using the Bolivia 2001 10 Trom the Entire Bolivia 20 Taylor Series Linearization With Pseudo-Strata 1.0 1.2 1.1 1.0 1.1 1.0 1.3 1.0 1.3 1.0 1.0 Pseudo-Strata and HH Cluster 1.1 0.9 1.0	Sample to Replicate           01 Census           Simple Random           Sample           1.1           1.9           1.6           1.1           1.4           1.1           1.9           1.6           1.1           1.4           1.1           1.9           1.1           1.9           1.1           1.9           1.1           1.1           1.1           1.1           0.1           0.8	Table 4.       Ghana 2 Census         Selected Characteristics         Household         HH Size (mean)         Electric Light (%)         Toilet (%)         Kitchen as separate room         Bathroom (%)         Non-relatives (mean)         Person         Age (mean)         Sex (%)         Ethnicity Akan (%)         Mole-dagbani (%)	2000: Standard I with Estimates D Parameter E From the I Ghana 2 Censu 4.99 43.54 8.49 (%) 46.17 23.47 0.14 23.90 49.48 45.28 15.25	Error Computation terived from Sampi Replicate Sti Stimate Error Estir Entire Drawn Fro 000 Entire Ghan is Censu: 0.005 0.042 0.042 0.046 0.001 0.013 0.035 0.066 0.051	s Comparing Replic e Data Using Altern indard Ratio of (SI Replication in the 2000 Subsample Rep Method 1.1 1.5 1.2 1.2 1.5 0.9 Subsample Rep 1.0 1.0 1.0 1.0 1.0	cate Estimates from the native Methods EE) Estimates Using the Ghan te Estimates From the Entire ( Taylor Series Linearization Wi Pseudo-Strata 1.0 1.5 1.5 1.5 1.5 1.2 1.4 1.0 Pseudo-Strata and Cluster 1.1 1.0 1.0 1.0 1.0 1.1 1.0 1.0 1.0	e Complet a 2000 10% Ghana 2000 th Sim
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\* Due to the relatively large sample sizes (10%), all sample estimates have been corrected by the finite population correction factor (fpc).

- the method of standard error estimation does not matter much for these variables.
- adjustment

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### RESULTS

### CONCLUSIONS

For many variables in each country, the ratios for each of the methods of standard error estimation to full count estimate are close to 1.0 and similar to each other, suggesting that

• Use of pseudostrata improves precision in estimating standard errors for variables that are geographically stratified, especially those dependent upon public utilities or ethnic group membership. For large samples, this correction may not be necessary as failure to do so will yield conservative estimates of standard error and statistical significance. Specifying pseudostrata in Taylor series linearization procedure may be beneficial for analysis of smaller geographic areas. The strata specification is of limited use in Ghana, requiring further work to assess whether the difference in geographic scale of the full count and sample estimates is contributing to the limited utility of the pseudostrata

As expected, household clustering is evident in some person level characteristics. Taylor series adjustments provide a reasonable correction in standard error estimation for household clustering. Research often concentrates on sub-populations which require only one person or one unit (a mother, a school-aged child, a cohabiting couple) from each household. Analyses on such populations are not subject to the effects of household clustering and do not require this type of correction.

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