

The Missing Poor

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Population censuses essential for the functioning of the state

- ▶ The history of census taking goes back more than 2,000 years
- ▶ Today censuses are legally mandated by the constitution in many countries
- ▶ Censuses inform a wide range of fundamental state functions, such as:
 - ▶ Taxation
 - ▶ Military conscription
 - ▶ Public resource allocation
 - ▶ Legislative apportionment

The economics of population counting

- ▶ Population miscounting a politically explosive issue in many countries
 - ▶ Census implementation failures widely studied in political science, demography, history and sociology
 - ▶ But little work in economics to understand enumeration incentives and their implications for population counts
- **This paper: overlooked margin of failure in census data collection**

Sierra Leone 2015: Census enumeration form

SIERRA LEONE 2015 POPULATION AND HOUSING CENSUS

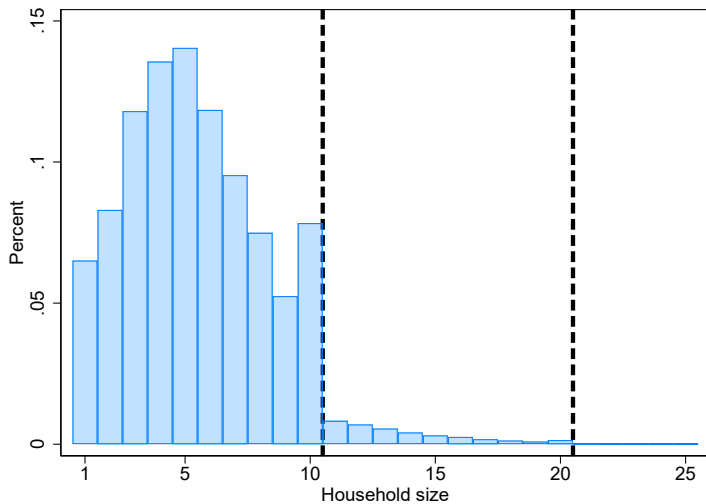
SECTION I: IDENTIFICATION

| | | | | | | | | | | | | | | | | | |
|---|--|----------------------------------|--|---------------------------------------|--|---|--|---|--|--|--|-------------------------------------|--|---|--|----------------------------------|--|
| 1. HOUSE NO. <input type="text"/> | | 2. DISTRICT <input type="text"/> | | 3. CHIEFTAINSHIP <input type="text"/> | | 4. SECTION <input type="text"/> | | 5. SA <input type="text"/> | | 6. LOCAL COUNCIL <input type="text"/> | | 7. SUBDIVISION <input type="text"/> | | 8. QUARTER <input type="text"/> | | 9. LOCALITY <input type="text"/> | |
| 10. STREET ADDRESS <input type="text"/> | | | | | | 11. STRUCTURE TYPE <input type="text"/> | | 12. STRUCTURE NUMBER <input type="text"/> | | 13. HOUSEHOLD NUMBER WITHIN THE STRUCTURE <input type="text"/> | | | | 14. HOUSEHOLD NUMBER WITHIN THE SA <input type="text"/> | | | |
| 15. Type of Residence: 1. Coupled Housing Unit <input type="checkbox"/> 2. Standalone Unit <input type="checkbox"/> | | | | | | | | | | | | 16. 1. TO SECTION II | | | | | |

SECTION II: POPULATION CHARACTERISTICS

| SEX | ALL PERSONS | | | | | | | | | | | | | | 0-4 YEARS | 5-9 YEARS | 10 YEARS AND ABOVE | 15 YEARS AND ABOVE | 20 YEARS AND ABOVE | 25 YEARS AND ABOVE | 30 YEARS AND ABOVE | 35 YEARS AND ABOVE | 40 YEARS AND ABOVE | 45 YEARS AND ABOVE | 50 YEARS AND ABOVE | 55 YEARS AND ABOVE | 60 YEARS AND ABOVE | 65 YEARS AND ABOVE | 70 YEARS AND ABOVE | 75 YEARS AND ABOVE | 80 YEARS AND ABOVE | 85 YEARS AND ABOVE | 90 YEARS AND ABOVE | 95 YEARS AND ABOVE | 100 YEARS AND ABOVE | | | |
|-----|-------------|---|----------|---|-----------|---|----------|---|----------|----|-----------|----|----------|----|-----------|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|----|----------|--|
| | NAME | | RELIGION | | ETHNICITY | | LANGUAGE | | LITERACY | | EDUCATION | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | | MARRIAGE | |
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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | | |
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Sierra Leone 2015: Household size distribution



This paper

Causal evidence from 254 population censuses across 82 countries that:

- a Common census implementation practices generate incentives for enumerators to undercount household members in large households
- b This results in an undercounting of the total population in LMICS by 0.6%
- c Within countries, undercounting is 3 times more severe among poor households
- d This leads to unequal access to public services and political misrepresentation

Contribution to the literature

- (i) Differential undercounting in censuses
Price 1947; Gumbo 2016; Kumar 2024; Jacome et al. 2025; Neidert et al. 2025
→ Document how specific incentive leads to disproportionate undercounting of members of larger households and demonstrate policy implications
- (ii) Role of enumerators in data collection
West & Blom 2017; Di Maio & Fiala 2020; Figueiredo Walter & Moneke 2025
→ Show how census protocols create incentives for disproportionate undercounting in large households and demonstrate the relevance of the resulting distortions
- (iii) Missing people in low- and middle-income countries
Sen 1992; Foster & Rosenzweig 1999; Ray & Anderson 2010; Jayachandran 2017
→ Highlight previously overlooked mechanism through which subgroups go missing from official records

1. Introduction

2. Background & Data

3. Empirical Strategy

4. Results

5. Implications

6. Conclusion

Census enumeration

- ▶ Census enumeration typically implemented through face-to-face interviews
- ▶ For each household, enumerators complete a short enumeration form that includes a roster of all household members
- ▶ Rosters are pre-printed with a fixed number of slots
- ▶ If a household has more members than slots available on the form, enumerators are instructed to use a second form
 - ▶ Need to copy all household identifiers
 - ▶ May need to request additional enumeration form from supervisor

[▶ Instructions](#)

Enumerator incentives

- ▶ Data collection carried out by a large number of enumerators over a short time
- ▶ Enumerators typically work on short-term fixed-wage contracts
 - ▶ Some countries use civil servants and/or local volunteers for data collection
 - ▶ Some countries pay per completed household
- ▶ Limited monitoring of enumerators

▶ Example: Kenya 2019

Data

254 population censuses from 82 countries

▶ Sample selection

▶ Map

1. Microdata samples from population censuses (typically 10%)

- ▶ 246 censuses from IPUMS-International
- ▶ 8 recent censuses from National Statistical Offices
- ▶ Total of nearly 700 million individuals living in 178 million households

2. Enumeration forms and enumerator manuals

- ▶ Manually code the number of available slots for household members in the household enumeration form

▶ Distribution
- ▶ Record other implementation details of interest (e.g., paper vs tablet-based)

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Estimation approach

- ▶ Build on classic bunching estimators developed to exploit discontinuities in incentives to measure behavioral responses (Kleven, 2016)
- ▶ Standard assumption in the literature: no distortions to the distribution outside a given window around a policy threshold
- ▶ Here: households recorded at a size that coincides with the number of pre-printed slots can have any actual household size at or above this number

Assumption 1: Exponential decay

The true household size distribution exhibits exponential decay above the threshold:

$$H_s = H_{x-1} \alpha^{s-x+1} \quad \forall s \in [x, x+c]$$

where

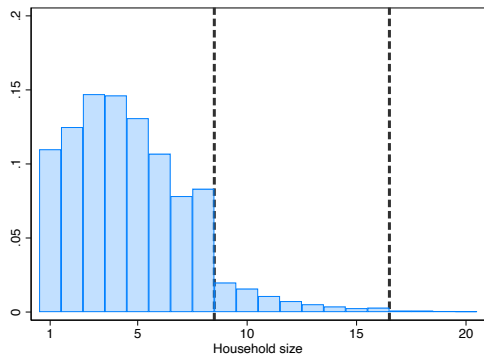
- ▶ H_s : share of households of size s
- ▶ x : number of pre-printed slots (threshold)
- ▶ α : rate of exponential decay
- ▶ c : strictly positive integer, set to $2x - 1$ in preferred specification

Supporting evidence from tablet-based censuses

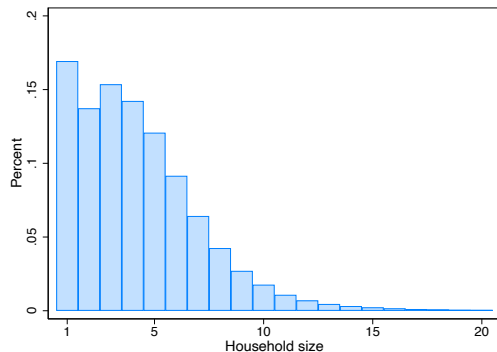
- ▶ Cost of adding household members constant across all household sizes
 - ▶ Simply click “Add member”
 - ▶ Allows for characterization of undistorted household size distributions
 - ▶ 17 tablet-based censuses in our sample
- What do undistorted household size distributions look like?

Tablet vs paper-based census: Tanzania

Paper-based census (2012)

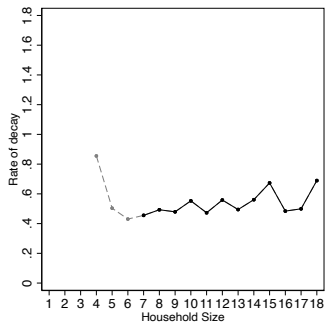


Tablet-based census (2022)

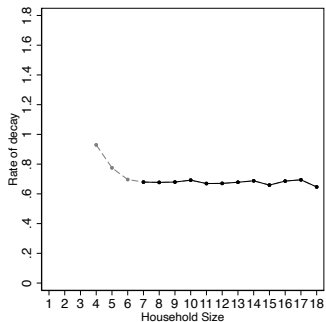


Constant decay after the peak

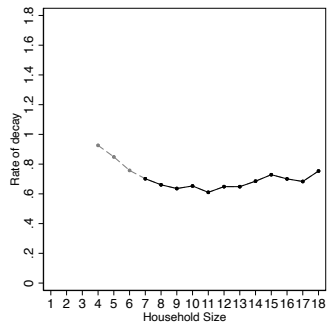
Brazil 2010



South Africa 2022



Tanzania 2022



Assumption 2: Displacement to the threshold from above

▶ Supporting evidence

Enumerators displace households with sizes above the threshold to the threshold:

1. Observed share of households at threshold: $\tilde{H}_x = H_x + \sum_{s=x+1}^{x+c} D_s + \epsilon_x$
2. Observed share of households of size $s \in [x+1, x+c]$: $\tilde{H}_s = H_s - D_s + \epsilon_s$
3. Observed share of households of size $x-1$: $\tilde{H}_{x-1} = H_{x-1} + \epsilon_{x-1}$

where

- ▶ \tilde{H}_s : observed share of households of size s
- ▶ D_s : share of households displaced away from true size s
- ▶ ϵ_s : sampling error

Definition of estimator

Assumptions yield two moment conditions:

1. In the interval $[x, x + c]$, the total observed mass is equal to the total true mass, up to sampling error.
2. At $x - 1$, the observed mass is equal to the true mass, up to sampling error.

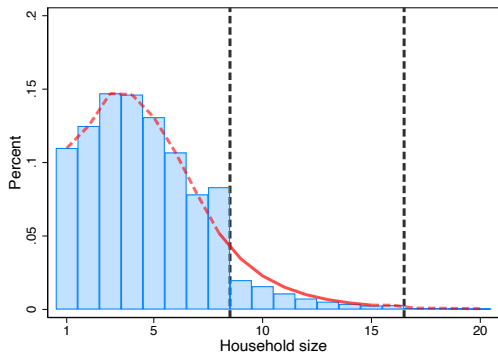
Estimate decay rate as the unique $\hat{\alpha}$ consistent with these two conditions:

$$\frac{\hat{\alpha}(1 - \hat{\alpha}^{(c+1)})}{1 - \hat{\alpha}} = \frac{1}{\tilde{H}_{x-1}} \sum_{s=x}^{x+c} \tilde{H}_s$$

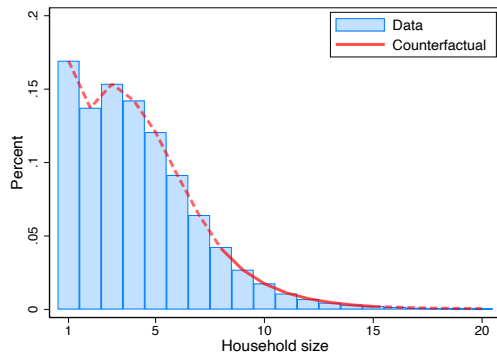
Counterfactual household size distribution: Tanzania

▶ Placebo

Paper-based census (2012)



Tablet-based census (2022)



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2. Background & Data

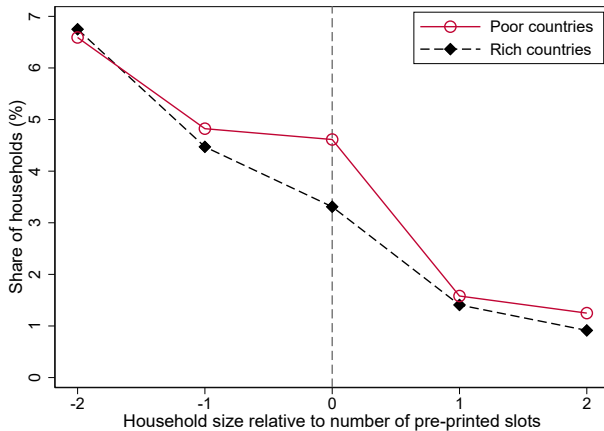
3. Empirical Strategy

4. Results

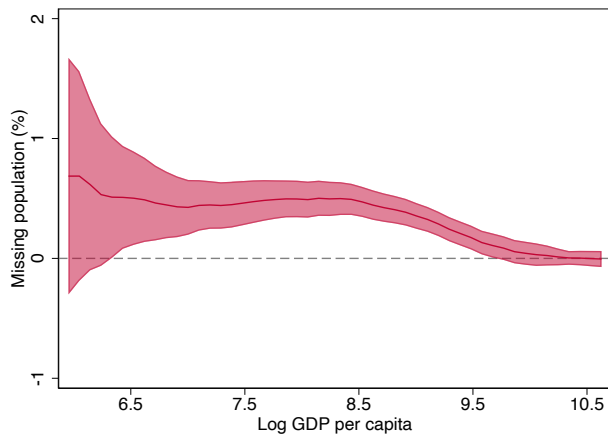
5. Implications

6. Conclusion

Bunching in poor vs. rich countries



More missing population in poorer countries



0.6% missing in low- and middle-income countries, none in high-income countries

Robustness to alternative assumptions

Results robust to alternative assumptions about displacement and distribution:

1. Do not limit redistribution of mass to window between threshold x and $2x - 1$
 - ▶ Set c to 90th percentile of observed household size distribution above $2x - 1$
2. Assume household size distribution follows power law:

$$H_s = H_{x-1} \left(\frac{s}{x-1} \right)^{-\beta}$$

▶ Results under alternative assumptions

▶ Placebo: Large c

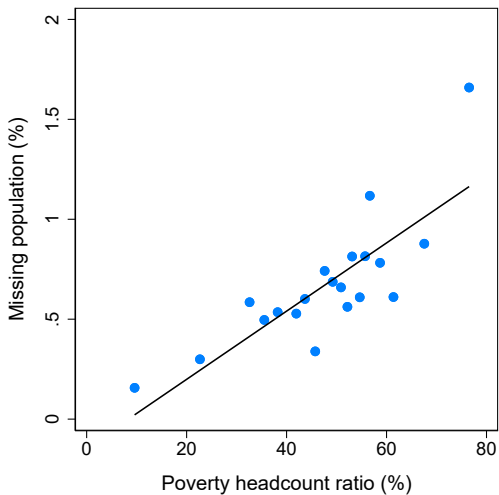
▶ Placebo: Power law

What role does the design of enumeration forms play?

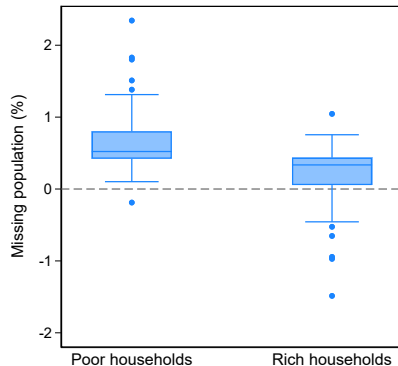
| | (1) | (2) | (3) | (4) |
|-----------------------------------|--------------------|-----------------------------------|-----------------------|-----------------------|
| | No. of slots | Share of HH below no. of slots | Missing population | Missing population |
| log GDP per capita | -0.270* (0.151) | 2.206*** (0.547) | -0.160** (0.065) | -0.071 (0.051) |
| Share of HH below no. of slots | | | | -0.041*** (0.012) |
| N | 186 | 186 | 186 | 186 |
| R2 | 0.018 | 0.065 | 0.050 | 0.275 |

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. *Standard errors in parentheses.*

Within-country variation: more missing in poorer subnational units



Within-country variation: more missing in poorer households



Members of poor households three times as likely to be missing

► Poverty measurement

► Example: Sierra Leone 2015

► Urban vs rural households

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Implications for equity

Present three examples that highlight implications for:

1. Allocation of public resources in Tanzania
2. Targeting of infrastructure in India
3. Political representation in Bolivia and Sierra Leone

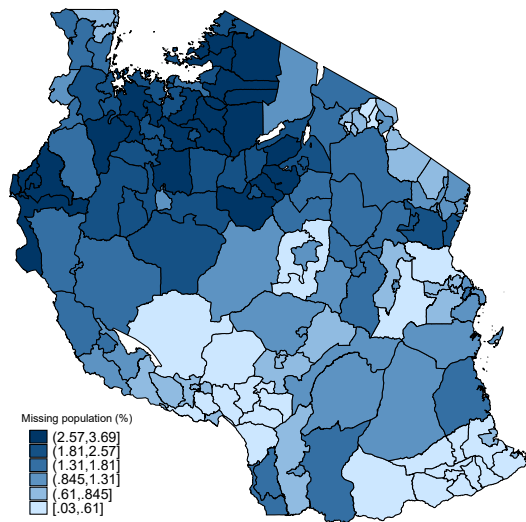
Example 1: Public resource allocation

- ▶ Spatial variation in household size within countries gives rise to spatial variation in undercounting
 - ▶ Public resources frequently allocated to subnational units based on population
 - ▶ Transfers from central government to local governments
 - ▶ Public service provision (e.g., health, education)
- Deprivation of areas with disproportionately many large and poor households

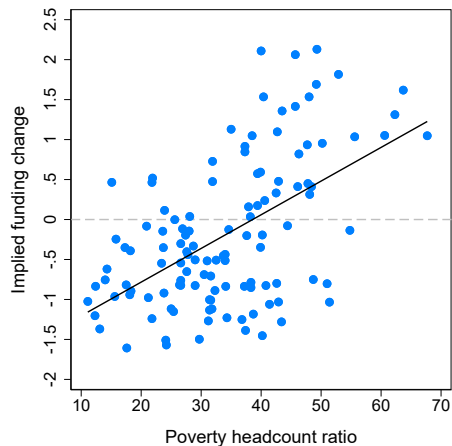
Local government funding in Tanzania

- ▶ Transfers from the central government account for more than 90% of local government revenues
 - ▶ Transfers are formula-based, with census population counts as a key input
 - ▶ 70% of public health funds allocated based on total population
 - ▶ 100% of primary education funds allocated based on school-aged population
 - ▶ 70% of the Water Sector Development allocated based on total population
 - ▶ 50% of General Purpose Grant allocated based on total population
- How does the systematic undercounting of members of large households affect local government budgets?

Spatial variation in undercounting in Tanzania 2012



Correcting the funding allocation for undercounting

[▶ Map](#)

Poorer districts more likely to be underfunded

Example 2: Targeting public infrastructure

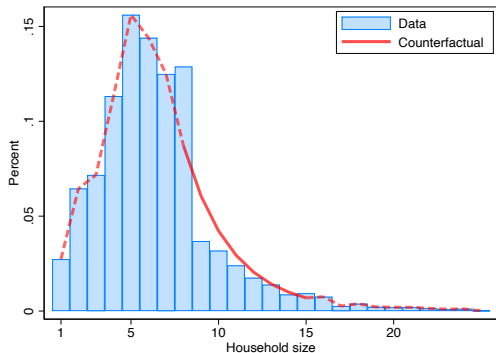
- ▶ Centrally designed public infrastructure projects frequently targeted based on census counts of local population
- ▶ In many Indian states, eligibility of villages for signature infrastructure programs subject to local population exceeding a minimum threshold [▶ Programs](#)
- Does the omission of household members from the census lead to the wrongful disqualification of villages from key infrastructure programs?

Wrongful disqualification from infrastructure programs in Bihar?

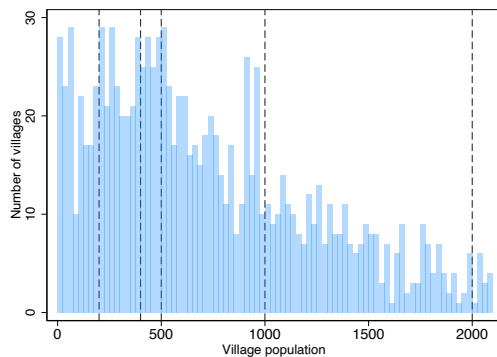
- ▶ Estimate missing population in each of Bihar's 38 district from 5% census sample
 - ▶ Individual-level census data not geo-identified at lower geographic levels
 - ▶ Average missing population of 0.45%
 - ▶ Variation across districts between 0% and 1.33%
- ▶ Assume that missing people at the village-level are uncorrelated with village size
 - ▶ Likely conservative since more missing from rural, poor households and most program cutoffs at small population sizes
- ▶ Compute number of villages that missed out on key infrastructure programs due to omission of members from large households

Example: Kaimur-Bhabua district

Household size distribution



Village size distribution



Total of 35 (270) villages missed out on key infrastructure in district (state)

Example 3: Political representation

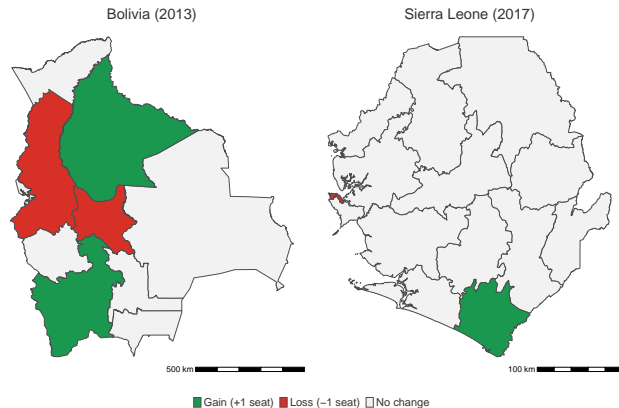
- ▶ In many countries, census counts are the basis for distributing political power
 - ▶ Almost every democracy uses some form of population-based apportionment to divide seats for their national legislature across subnational geographic units
 - ▶ In other settings, the establishment of political institutions is a function of local population (e.g., village councils in India)
- Undercounting can lead to disenfranchisement of large households

Delimitation of parliamentary seats in Sierra Leone and Bolivia

- ▶ Sierra Leone
 - ▶ Total of 146 parliamentary seats
 - ▶ 132 seats allocated across 16 districts proportional to population
 - ▶ Remaining 14 seats allocated to paramount chiefs

- ▶ Bolivia
 - ▶ Total of 130 parliamentary seats (Chamber of Deputies)
 - ▶ Seats allocated across 9 departments based on population and development
 - ▶ Extra seats for small and poor departments

Correcting the seat allocation for undercounting

[▶ Details](#)

Reallocation of seats from rich to poor regions

Further implications

(a) Bias in cross-country comparisons of aggregate statistics

- ▶ Aggregate per capita statistics more upward biased in poorer countries
- Cross-country income inequality underestimated

(b) Under-representation of large households in household surveys

- ▶ Large households underweighted because census used as sampling frame
- Interests of large households may not be adequately considered in policy

Incomplete listings beyond population censuses

1. Household surveys ▶ Nigeria GHSP
 - ▶ Pre-printed forms used to list all household members
 - ▶ Potential bias in per capita statistics (e.g., per capita consumption)
 - ▶ But earlier adoption of tablets than for censuses
2. Firm censuses
 - ▶ Pre-printed forms used to record all firms in an enumeration area
3. Price surveys
 - ▶ Pre-printed forms used to record the prices of all goods in a market

Conclusion

- ▶ Limited length of census enumeration forms generates incentive for enumerators to omit household members from large households
- ▶ This leads to an underestimation of total population by 0.6% on average in poor countries, but barely affects population counts in high-income countries
- ▶ Within affected countries, the poor are three times as likely to be missing as the rich
- ▶ This has dramatic consequences for them, including deprivation from public services and political disenfranchisement

Appendix

Exemplary instructions:

- ▶ Bolivia 2012: “If the number of census forms is not sufficient for all the dwellings in the enumeration area, inform your supervisor as soon as possible.”
- ▶ Zambia 2000: “Should you run out of questionnaires, quickly inform your supervisor who should immediately supply you with more.”

Enumerator contracting in Kenya, 2019

▶ Back

- ▶ Kenyan National Bureau of Statistics advertised 135,000 enumerator positions
- ▶ Fixed term contract for a period of 16 days, including 7 days of training, 2 days of household listing and 7 days of enumeration
- ▶ Gross remuneration of 1,500 KES per day, yielding a total of 23,000 KES
- ▶ Payment upon completion of enumeration

Sample selection

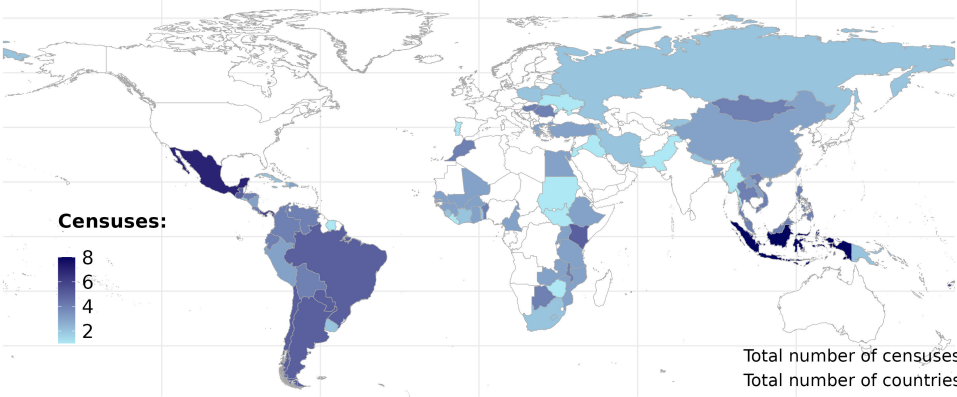
▶ Back

Sample restricted to censuses meeting the following criteria:

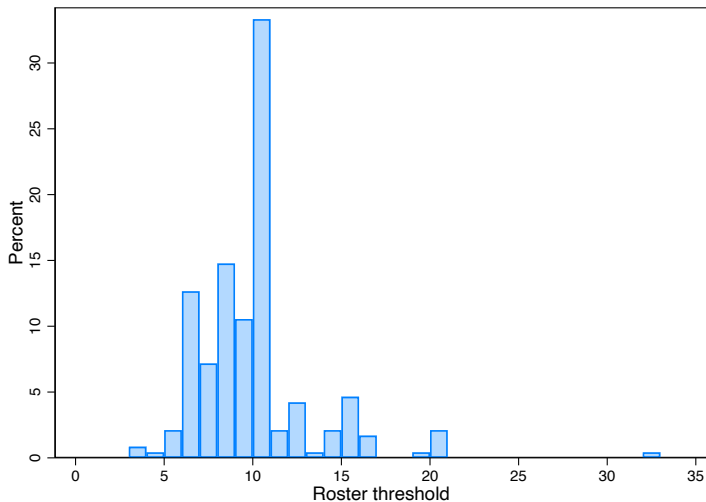
1. Direct enumeration (as opposed to self-enumeration)
2. Individuals organized into households
3. Complete enumeration form available

Geographic coverage

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Design of the enumeration form [▶ Back](#)

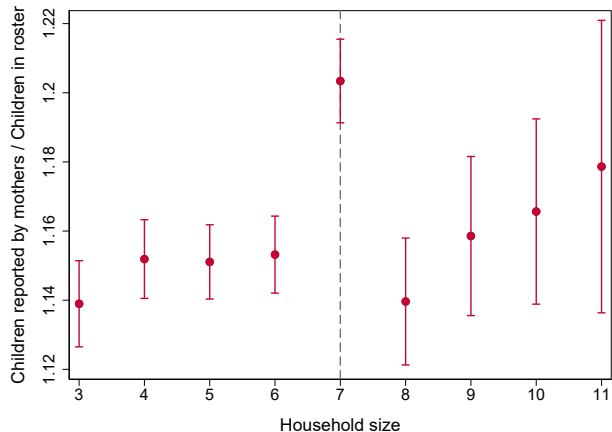


Supporting evidence from Papua New Guinea, 2000

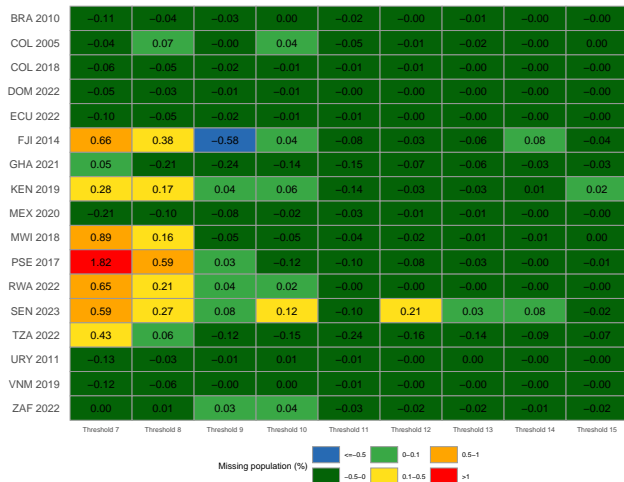
- ▶ Build on two census questions:
 1. Census records for each individual whether or not their mother is in the same household (if alive)
 2. Census asks each woman above the age of 14 to report the number of their biological children living with them in their household
- Compare number of children reported by mothers in the household to number of children in the roster whose mother is indicated to reside in the same household

Mothers' children and children's mothers

▶ Back

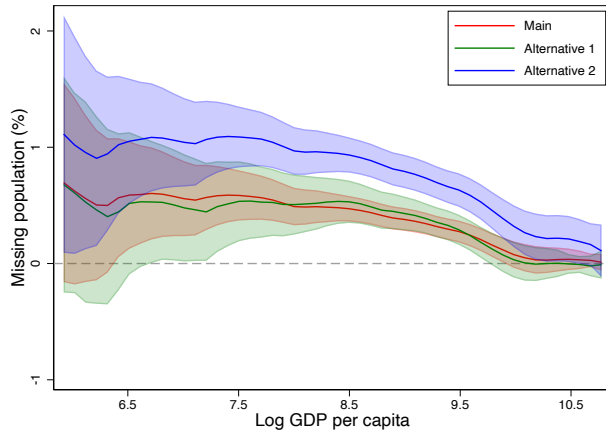


Placebo: tablet-based censuses [▶ Back](#)



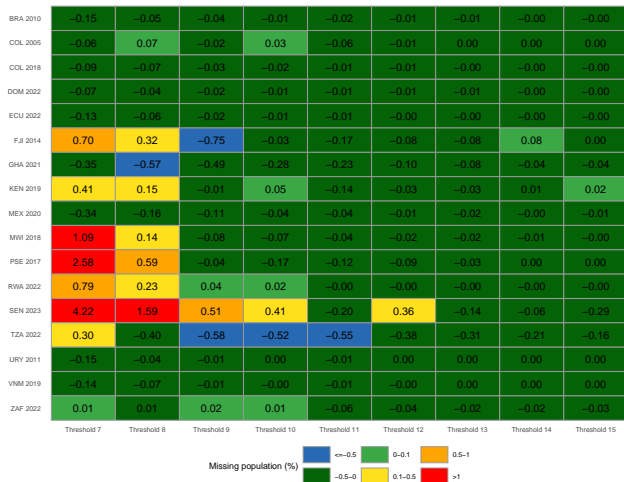
Robustness of results

▶ Back



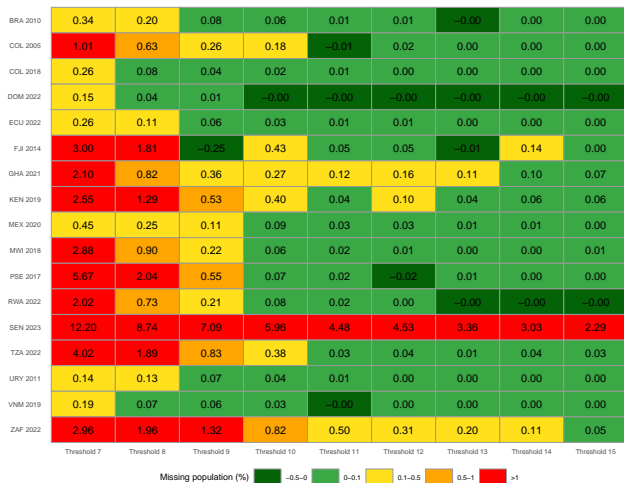
Placebo for alternative 1: Large c

▶ Back



Placebo for alternative 2: Power law

▶ Back



Poverty measurement

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Heterogeneity in undercounting by:

1. First-tier administrative unit

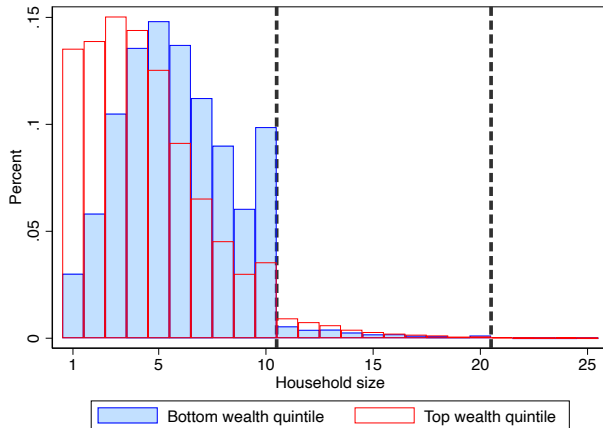
- ▶ Merge regional poverty headcount data from Global Multidimensional Poverty Index
- ▶ Data built from household surveys (DHS/MICS)

2. Household wealth

- ▶ Use principal component analysis to generate wealth score for each household
- ▶ Restrict sample to censuses reporting ownership of least 4 household assets
- ▶ Assign households to wealth quintiles based on wealth score
- ▶ Refer to top quintile as “rich” and bottom quintile as “poor”

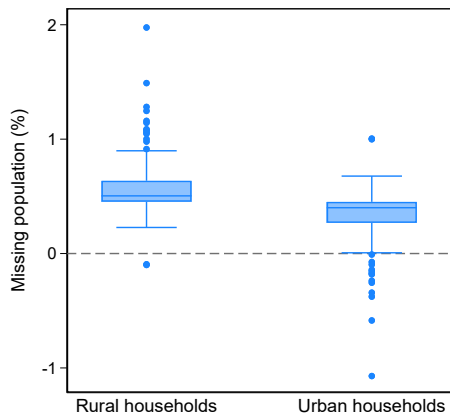
Missing in poor vs rich households in Sierra Leone 2015

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More missing in rural households

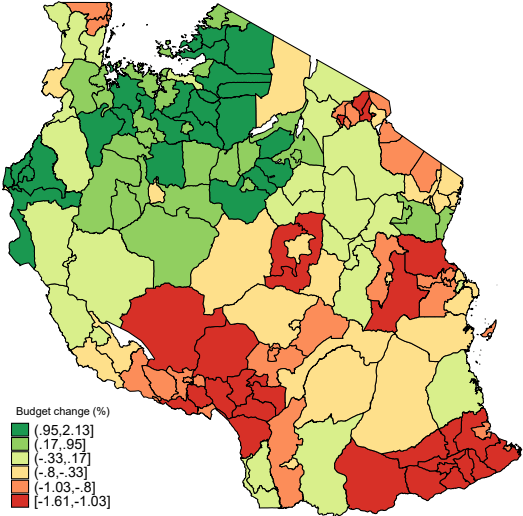
▶ Back



Members of rural households twice as likely to be missing

Implied funding changes across districts

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Eligibility for public infrastructure programs in Bihar, India

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- ▶ Rural roads (Asher & Novosad 2020): minimum population of 500 or 1,000
- ▶ Rural electrification (Burlig & Preonas 2024): minimum population of 300
- ▶ Primary school construction: minimum population of 300
- ▶ Health center construction: minimum population of 400
- ▶ Subsidies for local drinking water supplies: minimum population of 2,000
- ▶ Subsidies for grey waste water management: minimum population of 5,000

Counterfactual parliamentary seat allocation

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Derive counterfactual seat allocation as follows:

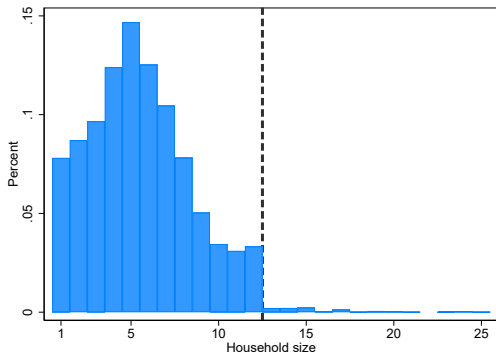
1. Estimate counterfactual population in each region
2. Replicate algorithm used for seat allocation by electoral commission
 - ▶ Compute representational quotient (total population over seats)
 - ▶ Allocate seats using the 'highest remainder method'
 - ▶ Algorithm in Bolivia slightly more complex

Missing household member in household surveys

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Nigeria General Household Survey Panel

Paper-based survey (2012)



Tablet-based survey (2023)

