Mapping MPI and Monetary Poverty: The Case of Uganda

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Dynamic Comparison between the
Multidimensional Poverty Index (MPI)
and Monetary Poverty Workshop

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Introduction

- Poverty maps show poverty estimates for highly disaggregated geographic (and other) populations – i.e. towns, villages, urban neighborhoods (see Elbers, Lanjouw and Lanjouw 2002, 2004)
- Poverty maps are widely used to design and implement geographically-targeted interventions (e.g. community development funds)
- Monetary poverty maps require combining census (full spatial coverage, no consumption) and household survey data (limited spatial coverage, detailed consumption) → consumption is imputed into the census using a regression model calibrated on the survey and common explanatory variables (small-area estimation)

Introduction

- This paper discusses how to compute MPI-based poverty maps and compares MPI and monetary poverty maps:
  1. Census review and country selection for MPI-based maps
     - Is it possible to rely on variables available in the census?
     - Or do we need an imputation approach (as it is typically the case for monetary poverty maps)?
     - Based on a detailed review of census questionnaires available from the Integrated Public Use Microdata Series (IPUMS), we selected Uganda for the case study
  2. What is the correspondence between monetary and MPI-based poverty maps in Uganda?
  3. Which MPI variables are the best predictors of monetary poverty? Can we learn something about a potential weighting scheme for MPI indicators and dimensions?

Preview of Main Findings

- Around half of the censuses reviewed capture a sufficiently large number of MPI variables to allow computing a slightly 'reduced' variant of the MPI without further imputations
  - Most problematic indicator is nutrition, which is never captured by the censuses → leaves child mortality as the only available indicator for the health dimension
- High correlation between county rankings based on MPI poverty maps and monetary poverty in Uganda
  - But still substantial deviations for some counties
- Most MPI indicators are positively related to consumption, but some variables turn out insignificant or with a negative coefficient (bicycle ownership, sanitation, adult education)
  - Questions the 'instrumental' role of these indicators

Census review for computation of MPI poverty maps

- Review of census questionnaires from the Integrated Public Use Microdata Series (IPUMS) database for 18 countries
- Around half of the most recent censuses reviewed capture a sufficiently large number of MPI variables to allow computing a 'reduced' variant of the MPI without further imputations
  - Good news! Imputations are less likely to capture well the intra-household correlation between poverty indicators
  - This also means we could go "as low as we want"
    → significant advantage compared to traditional poverty maps
- Census very suitable for MPI mapping: Bolivia 2001, Cambodia 2008, Malawi 2008, Nepal 2001, Senegal 2002, Sierra Leone 2004, Thailand 2000, Uganda 2002
  - Only lack nutrition and max. one asset / living standard variable each

Census review for computation of MPI poverty maps

Dataset (census)	Education		Health		Standard of Living											
	Yrs Sch	Chd Att	Mort	Nutr	Elec	San	Wat	Floor	Cfuel	Radio	TV	Tel	Bike	Mbike	Refr	Car
Bolivia 2001	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Botswana 2001	X	X	X		X	X	X	X	X	X	X	X	X			X
Cambodia 2008	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Malawi 2008	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Mali 1998	X	X			X	X	X	X	X							
Mongolia 2000	X	X			X	X	X					X				
Nepal 2001	X	X	X		X	X	X		X	X	X	X	X	X	X	X
Pakistan 1998	X	X			X	X	X		X							
Paraguay 2002	X	X	X		X	(X)	X	X	X		X	X		X	X	X
Peru 2007	X	X	X		X	X	X		X	X	X	X			X	
Philippines 2000	X		X		X	X	X		X	X	X	X			X	(X)
Senegal 2002	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Sierra Leone 2004	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
South Africa 2001	X	X	X		(X)	X	X		X	X	X	X	(X)	(X)	X	(X)
Tanzania 2002	X	X	X		X	X	X	X	X	X		X	X			
Thailand 2000	X	X	X		X	X	X		X	X	X	X	X	X	X	X
Uganda 2002	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Vietnam 2009	X	X	X		X	X	X		X	X		X		X	X	X

Census review for computation of MPI poverty maps

- Uganda has been chosen for the case study, because:
  - The 2002 Uganda census captures all MPI variables except for nutrition and ownership of a refrigerator
  - The 2002 Uganda census was conducted shortly before the 2002/03 Uganda National Household Survey (UNHS)
    → facilitates traditional poverty mapping
  - Access to the 2002 census through the IPUMS database and the 2002/03 UNHS through the Uganda National Bureau of Statistics
- Disadvantages of using the IPUMS subsample:
  - 10% subsample only (approx. 530,000 households)
  - Location information anonymized below the county-level (hence cannot fully exploit the disaggregation advantage of MPI mapping)

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- Computation of MPI poverty maps based on the 2002 Uganda census:
  - Census does not capture information on nutrition
    → scale up weight for the mortality indicator (1/3 instead of 1/6)
    → the three dimensions remain equally weighted
  - One asset (refrigerator) is missing
    → rely on the remaining 5 assets
  - Use distance (instead of time) to water source (< 1 km)
- Exclude 'institutional' households (group quarters)
  → to improve comparability with household survey
- Compute MPI headcounts at the county-level (lowest level of disaggregation in the IPUMS database)

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- Computation of monetary poverty maps based on the 2002 Uganda census and the 2002/03 UNHS:
  - Identify common variables in the 2002 census and 2002/03 survey: household demographics; age, education and employment of household head; housing conditions; assets; welfare indicators (categorical variables recoded to series of dummy variables)
  - Compare census and survey means for the 8 Ugandan regions (Central/Eastern/Northern/Western rural and urban)
  - If the survey and census means do not differ significantly (p=0.05) the variable is considered a 'candidate variable' for the prediction (basic household demographics are always 'candidate variables')

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- Computation of monetary poverty maps based on the 2002 Uganda census and the 2002/03 UNHS (cont'd):
  - Run a stepwise regression model of log consumption per adult equivalent on all 'candidate' variables (including district fixed effects and interactions between district fixed effects and the 'candidate' variables) in each region using the survey data (backward selection)
  - Use the regional regression parameters to impute consumption into the census dataset
  - Compute monetary poverty estimate at the county-level based on the consumption expenditures imputed into the census dataset
  - These county-level poverty estimates are significantly more disaggregated than what could be computed directly from the survey (the UNHS is only representative for the eight regions)

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- To gauge the reliability of the imputations we compare the (imputed) census poverty headcounts to the survey estimates

P0	Central		Eastern		Northern		Western	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Survey	28.2%	7.7%	48.5%	17.7%	64.8%	38.7%	34.4%	18.7%
Census	20.8%	6.9%	51.0%	16.0%	71.9%	49.8%	35.0%	19.8%

- Imputations compare well in Central urban, Eastern and Western regions, but not so well in Central rural and Northern
- Potential explanations:
  - Survey could not visit some Northern districts due to insecurity
  - De jure (survey) vs. de facto (census) household concept
  - Sampling frame? Weights? Seasonality?

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- We next compare the (imputed) monetary poverty headcount estimates to the MPI headcount estimates (both based on census)
- To abstract from level differences (MPI headcounts are higher than monetary poverty headcounts) we also compare the MPI to a 're-calibrated' version of monetary poverty, where the poverty line has been increased by the factor 1.8 → gives roughly the same national headcount as the MPI

	Poverty Headcount, National
MPI	73.7%
Monetary Poverty (Census)	41.1%
Monetary Poverty (Census, Recalibrated)	74.2%

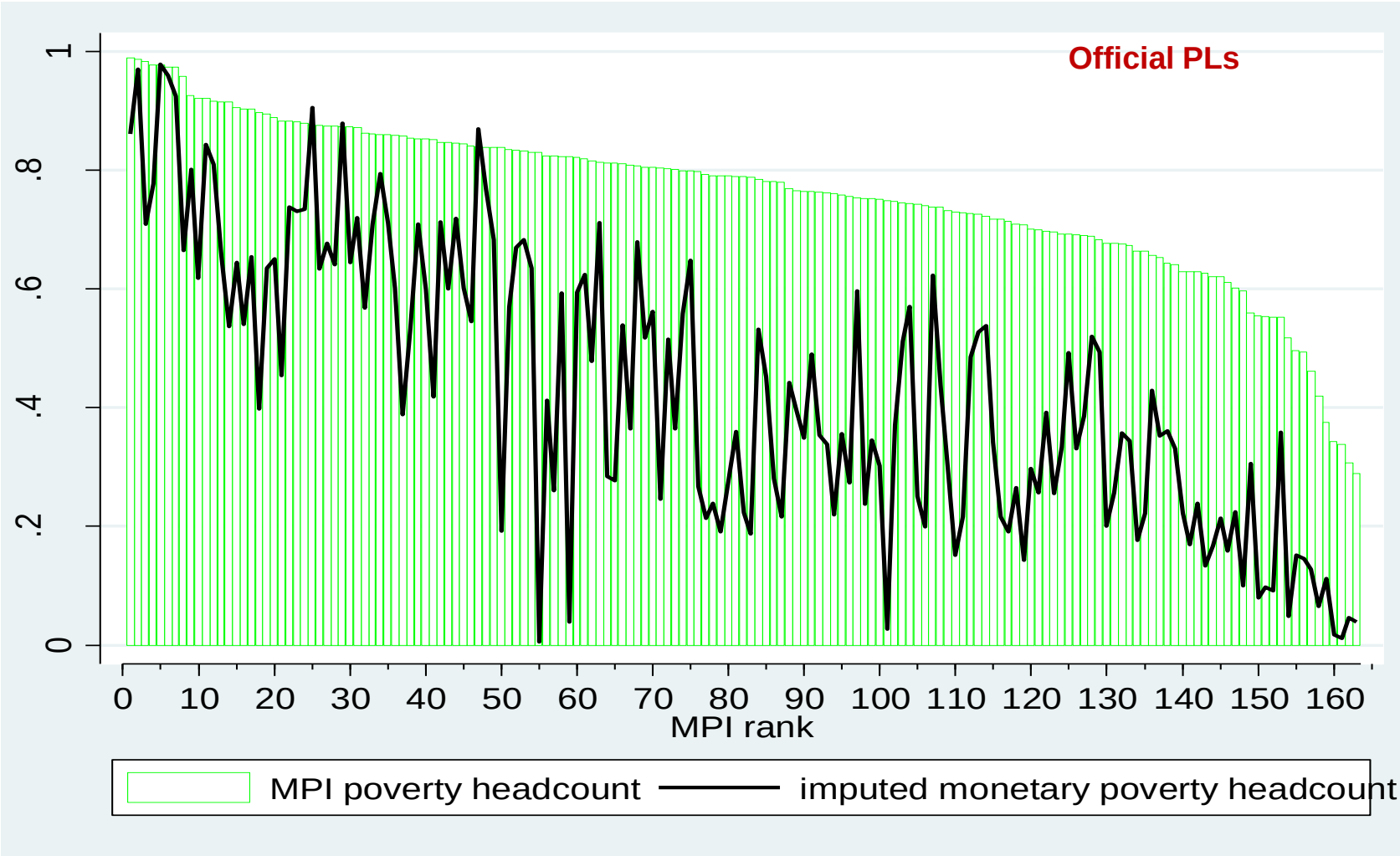
Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

Correlation of MPI and monetary poverty headcount (county-level)

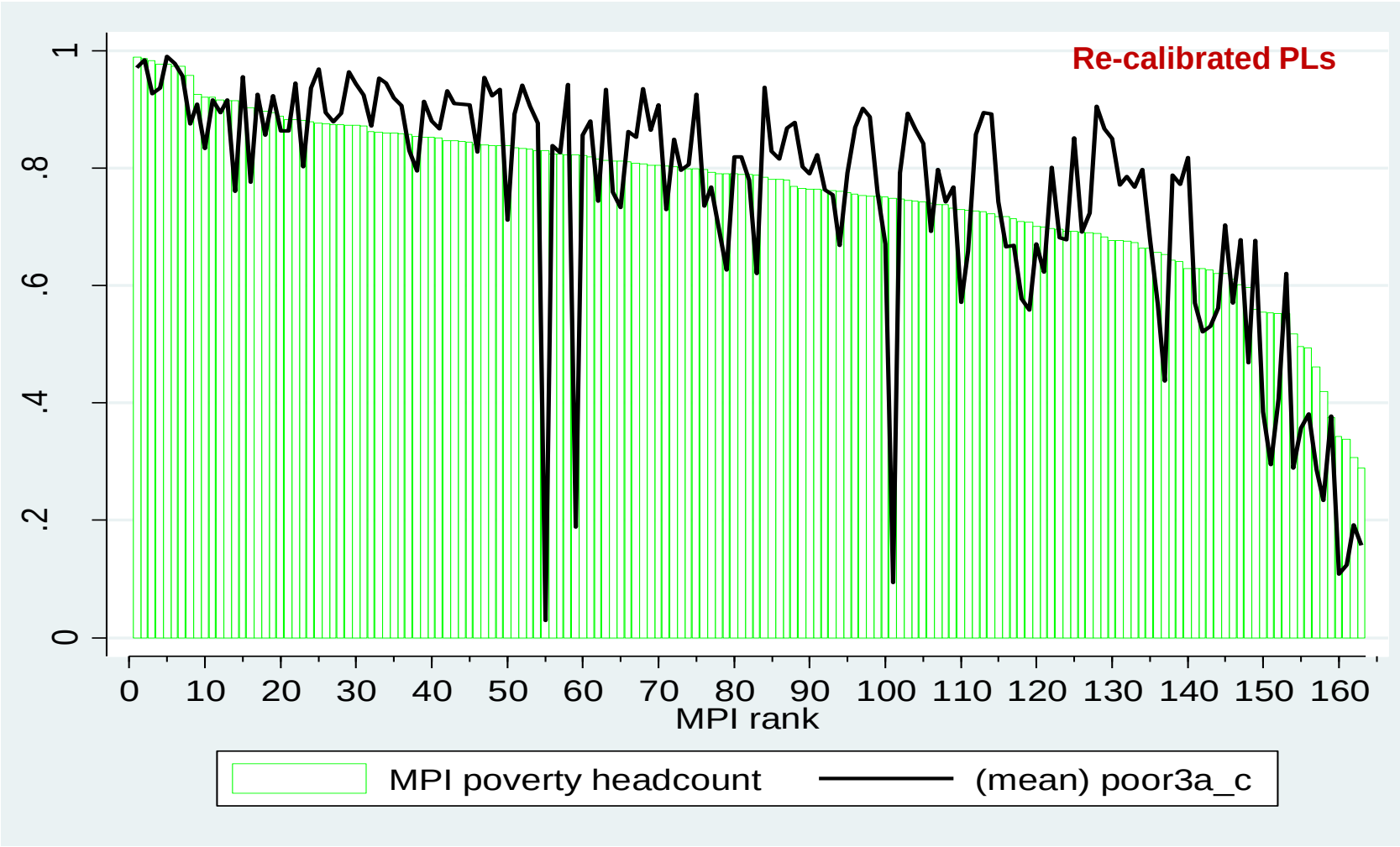
	Official Poverty Lines	Re-calibrated Poverty Lines (Official PLs*1.8)
All counties:	0.750	0.763
Rural:	0.729	0.584
Urban:	0.778	0.695

Note: for urban and rural, mixed urban-rural counties are dropped.

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda



Comparison of MPI and Monetary Poverty Maps for the Case of Uganda



Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

Comparison of quintile rankings based on poverty headcount (county level)

Official Poverty Lines:

		Monetary poverty headcount, quintile					
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Total**
MPI headcount, quintile	**Q1**	20	8	5	0	0	33
	Q2	7	12	9	5	0	33
	Q3	3	10	12	6	1	32
	Q4	3	3	4	11	12	33
	Q5	0	0	2	11	19	32
	Total	33	33	32	33	32	163

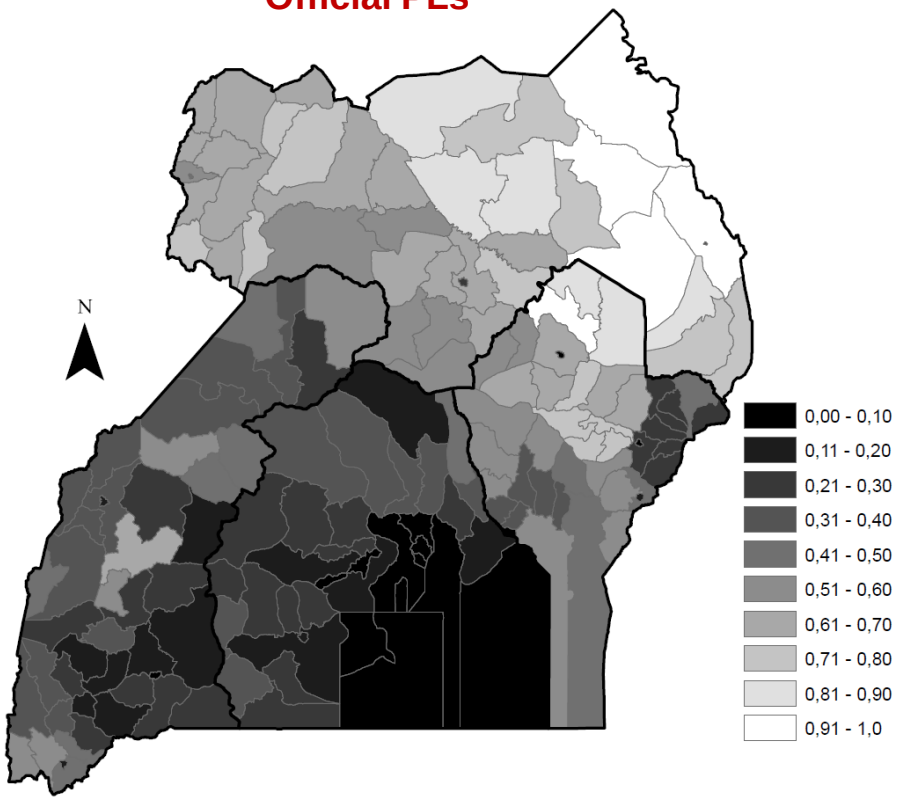
Re-calibrated Poverty Lines:

		Monetary poverty headcount, quintile					
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Total**
MPI headcount, quintile	**Q1**	22	7	4	0	0	33
	Q2	7	12	7	7	0	33
	Q3	2	8	12	7	3	32
	Q4	2	4	6	10	11	33
	Q5	0	2	3	9	18	32
	Total	33	33	32	33	32	163

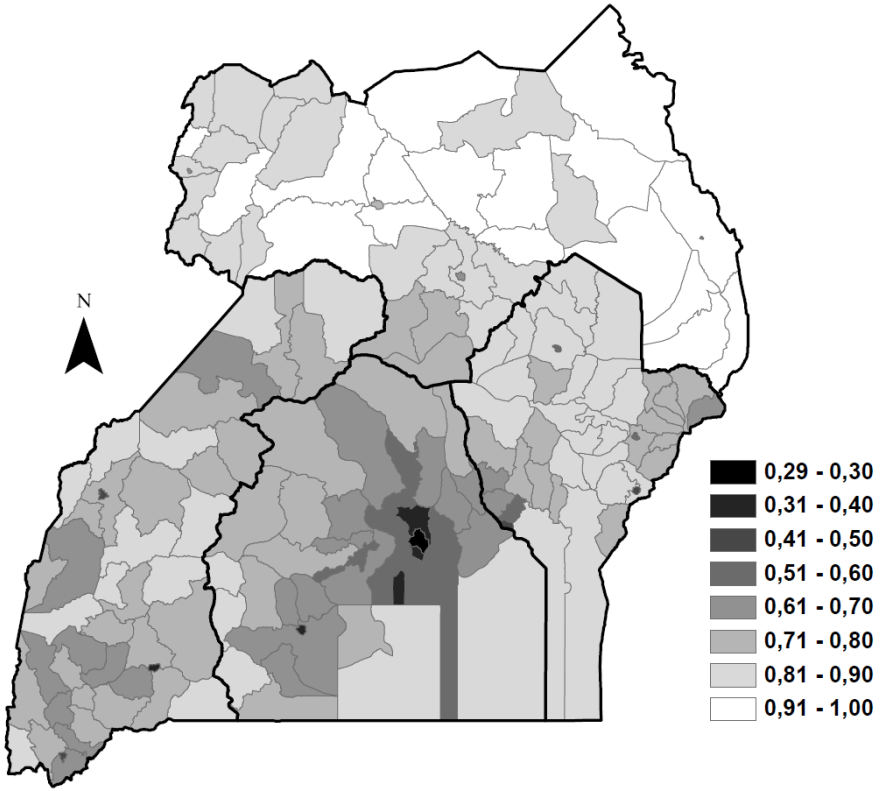
Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

Monetary Poverty (Predicted) in Uganda
Based on 2002 Census and 2002/03 Survey

Official PLs



MPI Poverty in Uganda
Based on 2002 Census

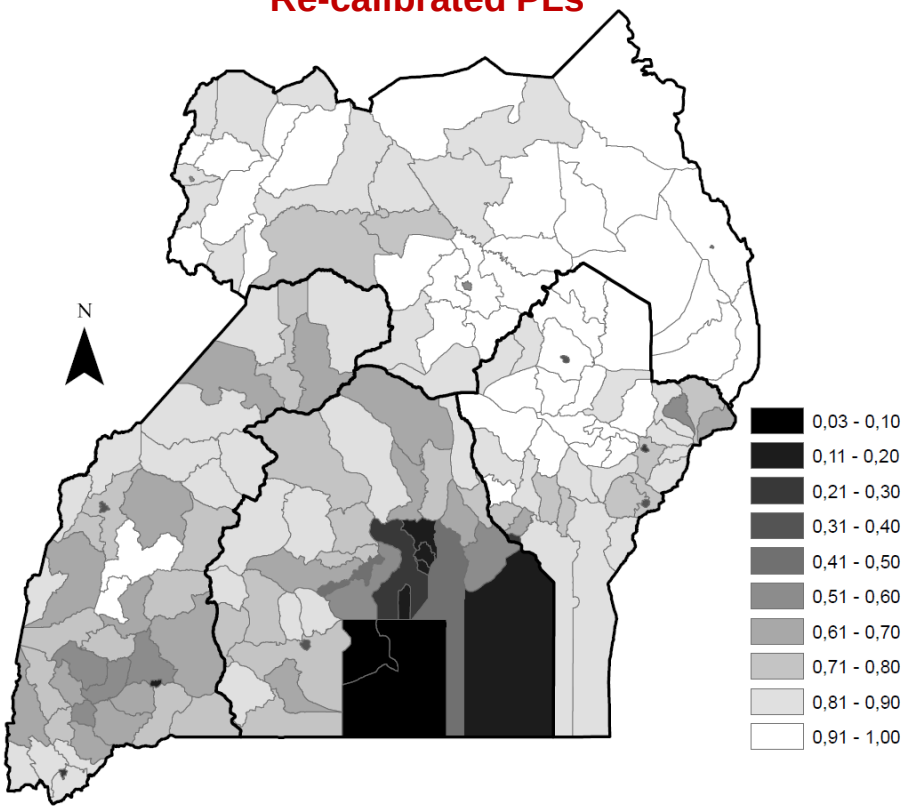


Note that legends/scales differ!

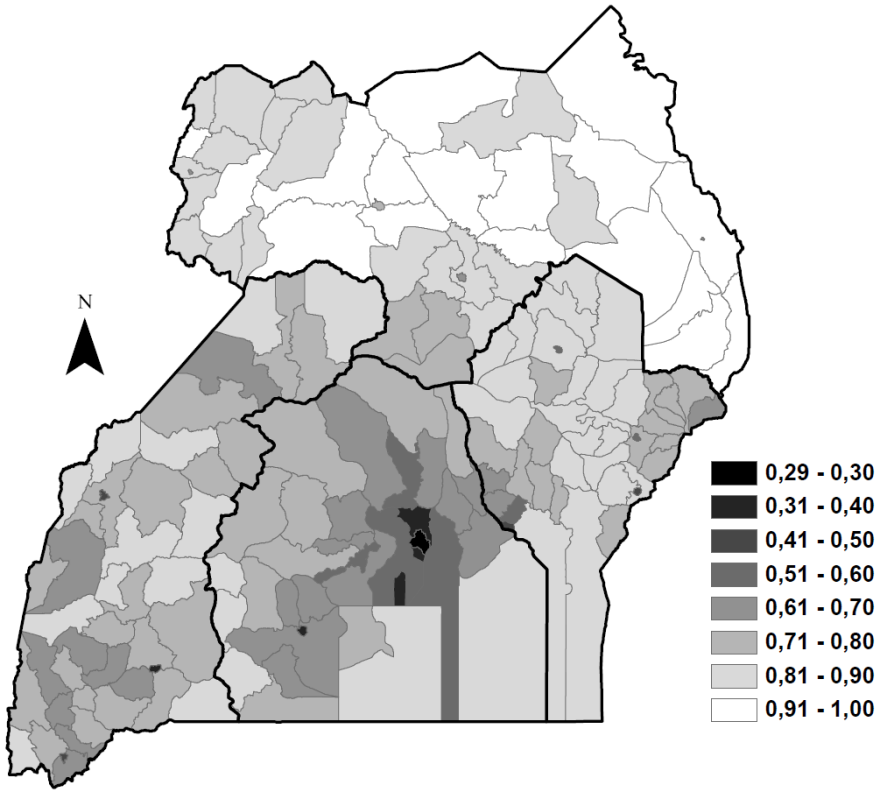
Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

Monetary Poverty (Predicted) in Uganda
Based on 2002 Census and 2002/03 Survey

Re-calibrated PLs



MPI Poverty in Uganda
Based on 2002 Census



Note that legends/scales differ!

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

Summary:

- Level differences: MPI poverty is much higher than monetary poverty (can be addressed re-calibrating the monetary poverty line)
- Monetary poverty shows greater spatial variation – ranging between 0.1% and 97.8% (2.9% - 99.1% for the re-calibrated version)
- MPI poverty varies less, between 28.9 and 98.9 %
- High overall correlation of poverty headcounts and county rankings
- But substantial differences for individual counties:
  - For example, two counties in the Lake Victoria region (Buvuma, Kyamuswa) appear to have very little monetary poverty (quintile 1), but substantial MPI poverty (quintile 4)

Which MPI variables are the best predictors of monetary poverty?

- Idea is to generate a monetary poverty map using only MPI variables as predictors
- Can we learn something about a potential weighting scheme for the MPI?
- How does the prediction compare to a more flexible poverty mapping approach?
- Run different versions (always on log consumption per adult)
  - National vs. regional regression models
  - Using detailed asset variables or just an overall asset indicator variable (1=asset non-deprived according to MPI definitions)
- Cannot include health variables, because the 2002/03 UNHS doesn't contain information on child mortality / nutrition

Regressions of ln cons on MPI variables - detailed assets, without district FE

	National	Rural				Urban			
		Central	Eastern	Northern	Western	Central	Eastern	Northern	Western
all children in school	0.335***	0.337***	0.231***	0.384***	0.194***	0.301***	0.332***	0.267***	0.347***
at least one adult with 5 years of schooling	0.083***	0.093***	0.029	0.092**	0.062*	-0.001	0.080	0.103*	0.028
hh owns radio	0.270***	0.158***	0.207***	0.260***	0.220***	0.106**	0.229***	0.394***	0.209***
hh owns TV	0.216***	0.181***	0.187		0.267*	0.244***	0.222***	-0.011	0.253***
hh owns phone	0.541***	0.418***	0.578***	0.244	0.432***	0.563***	0.560***	0.471***	0.532***
hh owns bike	-0.059***	-0.132***	-0.057**	0.152***	0.107***	-0.101***	-0.128***	-0.064	0.024
hh owns motor cycle	0.191***	0.137**	0.350***	0.799***	0.266***	0.115	0.044	0.354**	0.336***
hh owns motor vehicle	0.502***	0.554***	0.530***	1.292**	0.891***	0.646***	0.371***	0.521**	0.263***
hh has access to electricity	0.151*	0.183			-0.274	0.263**	0.004	0.064	-0.166
hh uses an improved sanitation facility	-0.013	-0.032	0.057**	0.045	-0.143***	-0.047	0.055	0.047	-0.079**
hh uses an improved water source	0.112***	0.001	0.163***	0.026	-0.011	0.103***	0.097**	0.151***	0.046
hh has improved floor material	0.423***	0.298***	0.351***	0.333***	0.291***	0.289***	0.315***	0.447***	0.429***
hh uses improved cooking fuel	0.589***	0.549***	0.301*	0.597***	0.114	0.589***	0.604***	0.484***	0.649***
N	9,282	1,444	1,542	1,047	1,426	1,191	1,028	642	962
R2	0.443	0.251	0.214	0.278	0.221	0.485	0.440	0.420	0.453

note: *** p<0.01, ** p<0.05, * p<0.1; Constant not reported.

Regressions of ln cons on MPI variables - collapsed assets, without district FE

	National	Rural				Urban			
		Central	Eastern	Northern	Western	Central	Eastern	Northern	Western
all children in school	0.352***	0.337***	0.245***	0.403***	0.172***	0.345***	0.329***	0.289***	0.354***
at least one adult with 5 years of schooling	0.134***	0.107***	0.079**	0.209***	0.128***	0.016	0.105**	0.211***	0.062
hh is non-deprived in assets	0.631***	0.339***	0.723***	0.669***	0.577***	0.646***	0.637***	0.652***	0.706***
hh has access to electricity	0.246***	0.166			-0.115	0.433***	0.061	0.384	-0.206
hh uses an improved sanitation facility	0.031**	-0.055*	0.086***	0.138***	-0.120***	0.028	0.110**	0.089	-0.040
hh uses an improved water source	0.136***	0.025	0.168***	0.017	-0.008	0.152***	0.118**	0.179***	0.052
hh has improved floor material	0.484***	0.328***	0.382***	0.409***	0.359***	0.320***	0.371***	0.492***	0.470***
hh uses improved cooking fuel	0.624***	0.574***	0.303*	0.597***	0.142	0.653***	0.587***	0.531***	0.657***
N	9,282	1,444	1,542	1,047	1,426	1,191	1,028	642	962
R2	0.402	0.217	0.192	0.217	0.167	0.408	0.383	0.364	0.427

note: *** p<0.01, ** p<0.05, * p<0.1; Constant not reported.

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- Most MPI variables are positively correlated with consumption
- But the following variables merit attention:
  - Adult education: often insignificant, esp. in urban areas (one adult with 5 years of schooling does not seem to be enough to reap significant labor market gains)
  - Bicycle ownership: typically negatively associated to consumption (seems to be rather an indicator of poverty)
  - Electricity: often insignificant/drops out → probably reflects the fact that access is extremely low in Uganda
  - Sanitation: often negative coefficient or insignificant (why?)
  - Water: Positively related to consumption in urban areas, but often insignificant in rural areas

Comparison of MPI and Monetary Poverty Maps for the Case of Uganda

- Flexible predictions (using all available variables) are much closer to the survey estimates than the predictions based on MPI variables

			MPI predictions (regional models)	
Region	**survey estimates**	**flexible predictions**	**detailed assets**	**collapsed assets**
Central rural	0.282	0.208	0.074	0.077
Central urban	0.077	0.069	0.010	0.015
Eastern rural	0.485	0.510	0.498	0.271
Eastern urban	0.177	0.160	0.031	0.043
Northern rural	0.648	0.719	0.723	0.514
Northern urban	0.387	0.498	0.335	0.216
Western rural	0.344	0.350	0.138	0.042
Western urban	0.187	0.198	0.052	0.064
Total	0.391	0.411	0.319	0.199

- This holds even if we include district fixed effects

Some tentative conclusions

- In principle, substantial advantages to ‚MPI mapping' versus income poverty mapping:
  - Measured rather than predicted;
  - Information readily available and easy to use (can be done at even more disaggregated level);
  - All prediction problems much less severe;
- Empirically, MPI poverty much less varied spatially than income poverty;
- Education, sanitation, electricity, bicycles correlate poorly with income poverty;
- MPI variables not very suitable for income poverty mapping;
- Further work: Consider depth of poverty and correlation across dimensions (Rippin, 2012);