



Sustaining poverty gains: A vulnerability map to guide social policy in Senegal

Poverty and Equity Global Practice

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What is a poverty map good for?

Geographical targeting of social programs

The consensus: Targeting maximizes programs' impacts in a context of limited resources.

The challenge: Targeting is expensive in monetary, administrative, and political terms.

One solution: Geographical targeting uses variations in poverty rates to channel resources.

Poverty maps: Small area poverty rates to focalize social programs

- Allow for a spatial resolution at administrative levels not covered by most (all?) household surveys
- Works best when poverty is concentrated

In Senegal: Determine commune-level quotas in the social registry

- Poverty: Cover the poor.
- Vulnerability: Insure past poverty gains.

We combine the poverty mapping and vulnerability literature

What is vulnerability?

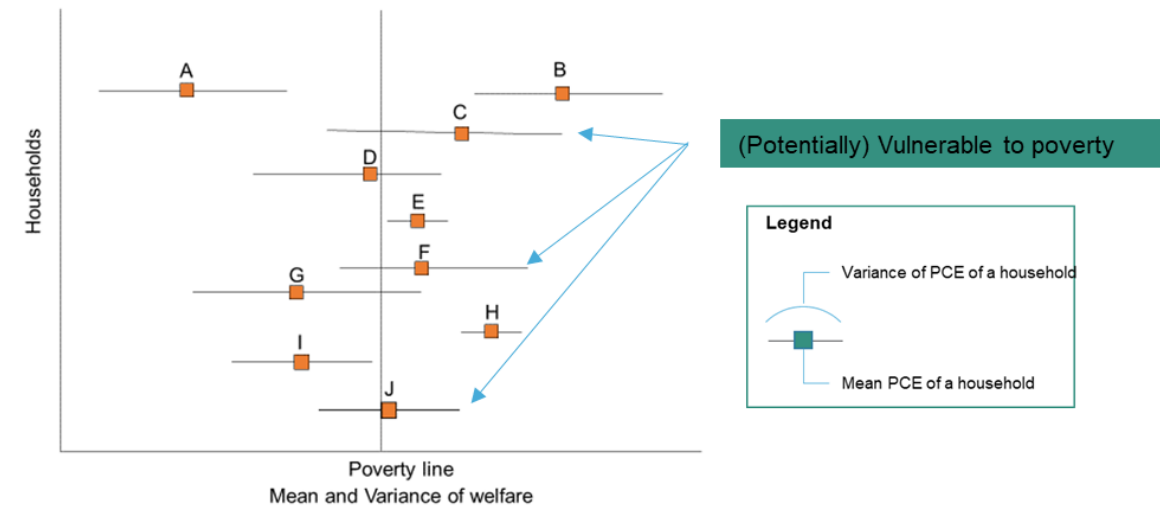
“.. risk of households falling into or remaining in poverty because of idiosyncratic or covariate aggregate hazards ..” Dercon (2005)

Challenging to measure

- Need mean and variance of consumption under different realizations of the potential shocks
- Most applications identify vulnerability by increasing the poverty line: *Different from income variability!*

One approach: Günther and Harttgen (2009)

- Recover mean consumption and its variance from cross-sectional data
- It was developed for household survey data. We translated it into the poverty mapping literature



Our application creates commune-level vulnerability rates

Data

Household survey data (EHCVM survey 2018/19):

- Representative nationally and 14 regions.

National Census 2013:

- Covers every household in the country

Two sources of vulnerability

i. Poverty-induced (conventional poverty mapping):

- Share of households currently poor

ii. Risk-induced (innovation):

- Share of nonpoor households highly likely to fall into poverty



**Bring resources where they are needed
the most**



**Sustaining past poverty gains by
moving from transfers to insurance**

Calculating vulnerability

In the household survey

1. Estimate income-generating function using a multilevel model (nested-error models)
2. Probability of falling into poverty for every household

$$\ln(y_{ch}) = \beta_{0c} + \beta_1 x_{ch} + \eta_c + \varepsilon_{ch} \text{ with } h = 1, \dots, N_c ; c = 1, \dots, C \quad (1)$$

$$\widehat{v}_{ic} = P(\ln y_{ch} < \ln z \mid X, Z) = \phi \left(\frac{(\ln(z) - (\widehat{\beta}_{0c} + \widehat{\beta}_1 x_{ch} + \widehat{\eta}_c))}{\sqrt{\widehat{\sigma}_{\eta_c}^2 + \widehat{\sigma}_{\varepsilon_{ch}}^2}} \right)$$

Imputing into the census (EB approach)

Uses model parameters, including community-level random effects $\eta_c \sim N(0, \sigma_\eta^2)$ and idiosyncratic errors within communes $\varepsilon_{ch} \sim N(0, \sigma_\varepsilon^2)$.

- Poverty-induced vulnerability: *Structurally poor*
- Risk-induced vulnerability: *Probability of falling into poverty above 29 percent in one year*

Vulnerability map for Senegal



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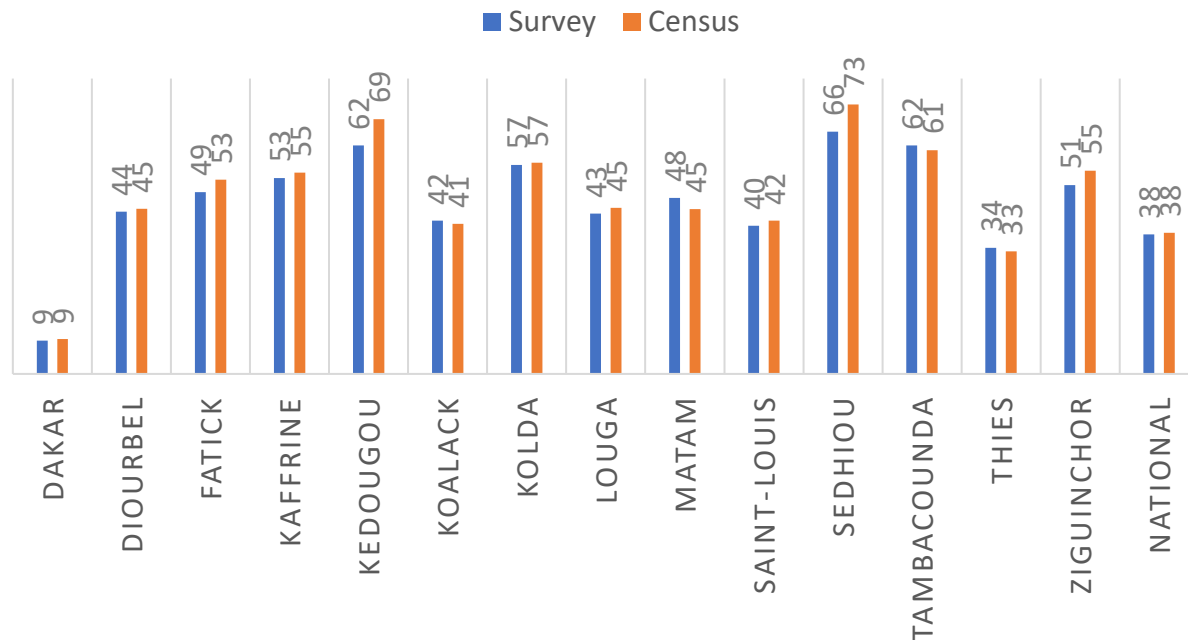
Validation of estimates

Several steps to calibrate models in line with latest poverty guidelines

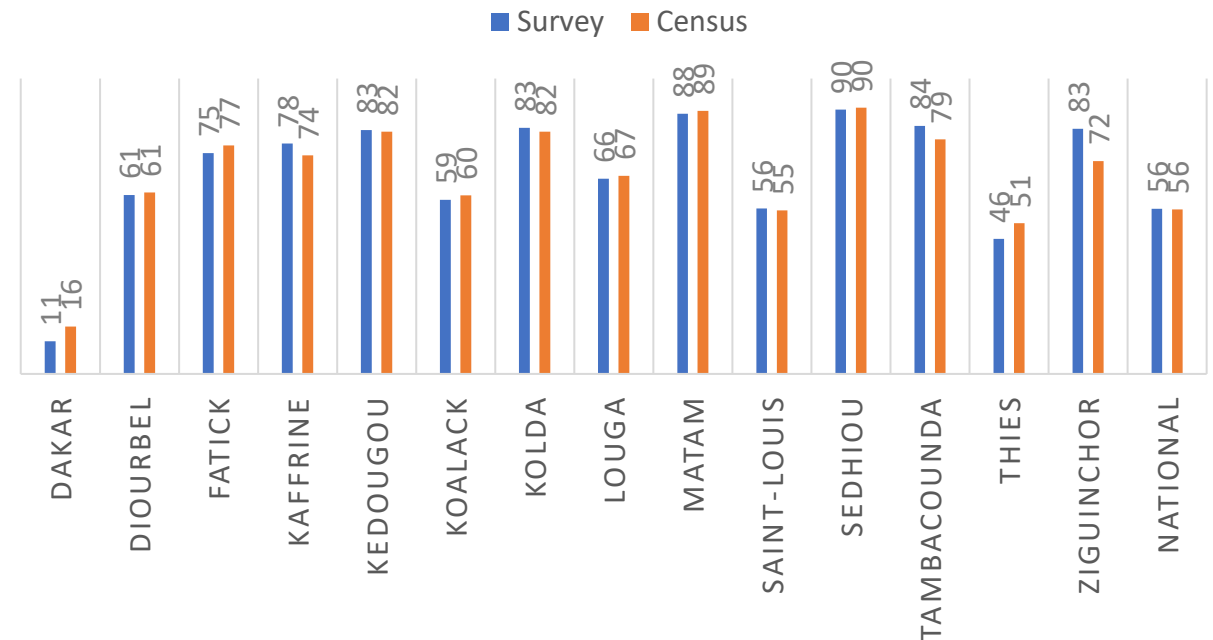
Among validation tests:

1. Consistent regression estimates across regions (see appendix)
2. Regional poverty and vulnerability estimates in the census are close to the survey data

Poverty estimates



Total vulnerability

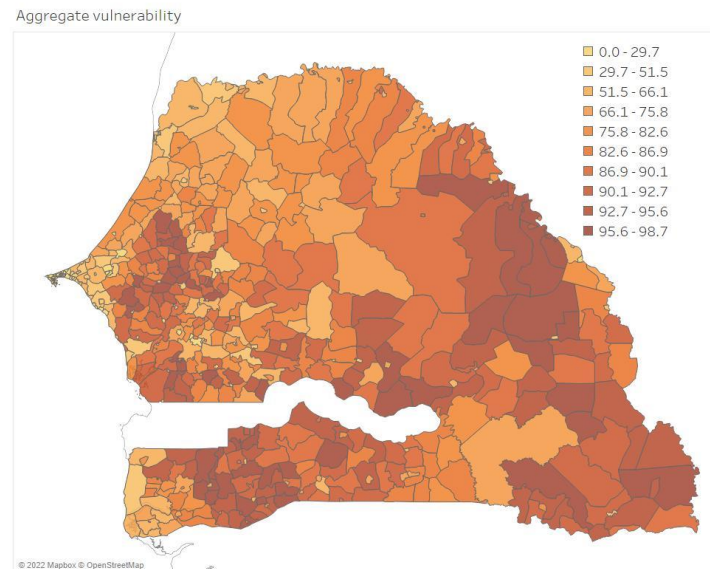


Small area estimation identify areas where people are more likely to fall into poverty when facing a shock

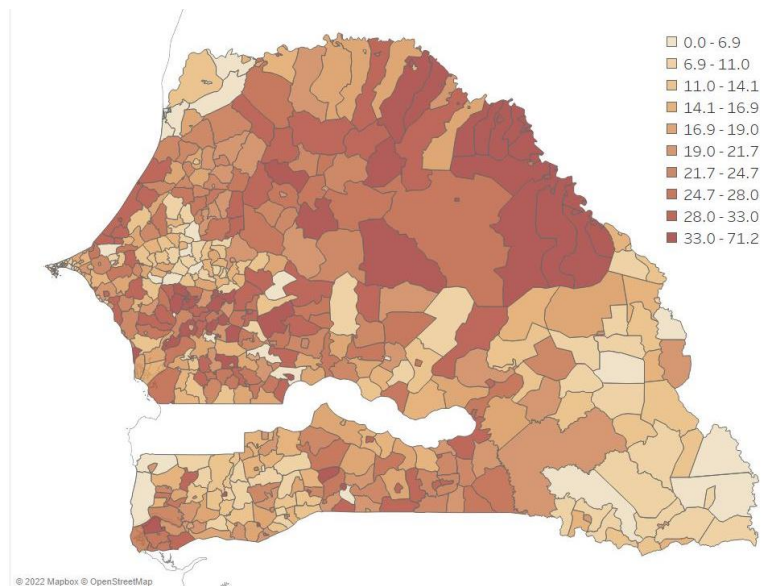
Understand the distribution of poverty and risk induced vulnerability across Senegal

What social protection should prioritize given poverty and vulnerability rates?

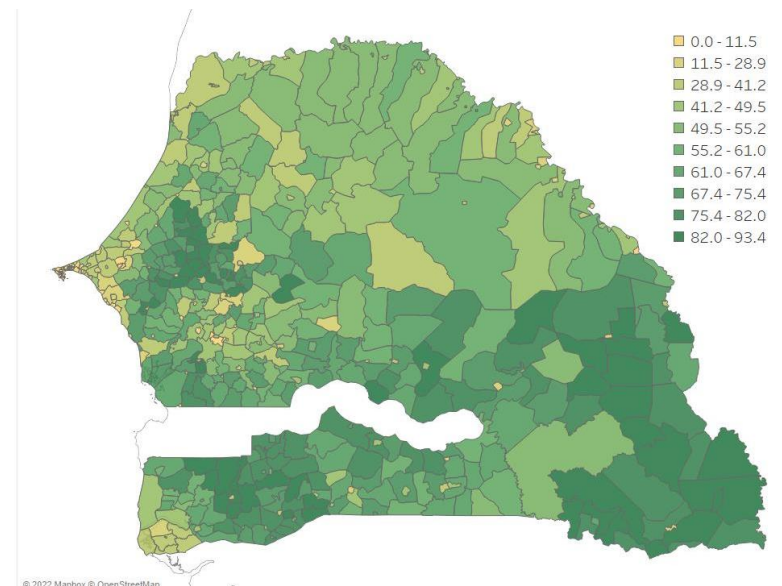
Vulnerability rate by commune



Risk induced vulnerability by commune



Poverty-induced vulnerability by commune

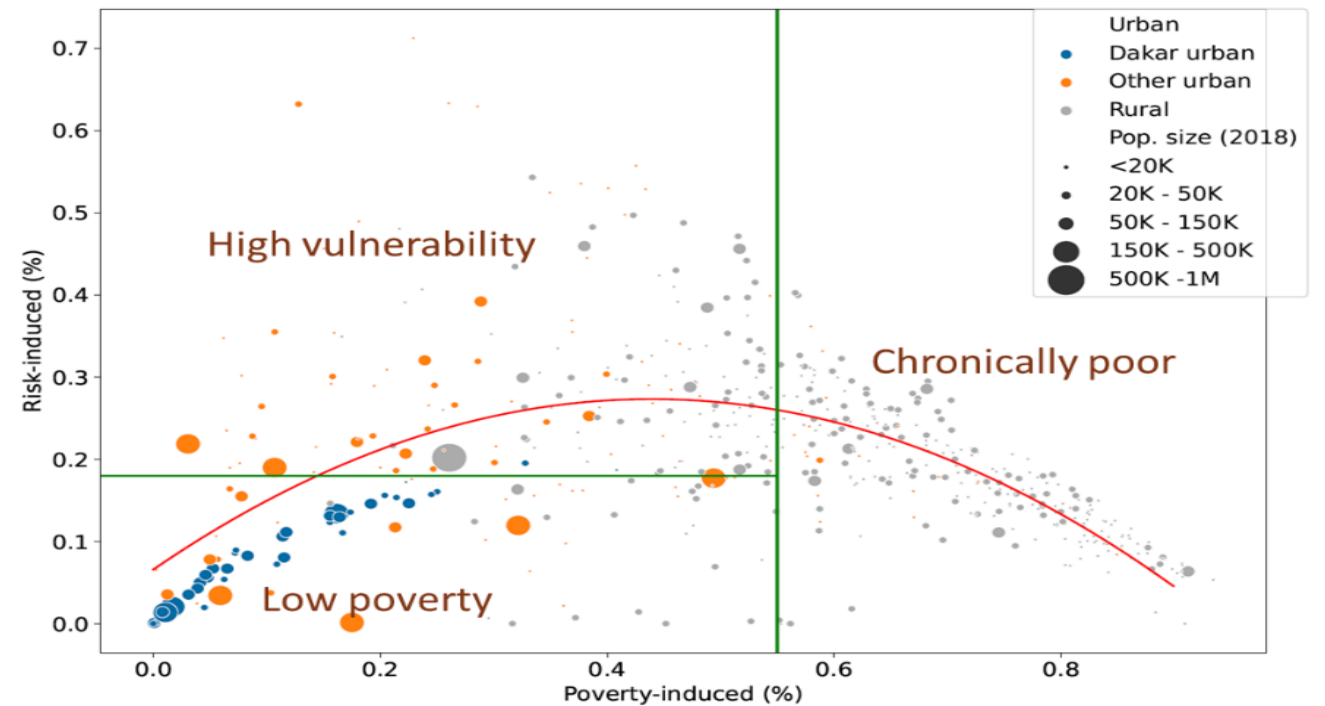


Communes can have low poverty but high vulnerability

Low-poverty communes more likely to have high populations and being urban

Small rural communes account for almost all the communes in the chronically poor group.

Relation between poverty and risk-induced vulnerability, distribution by commune



Effect of using vulnerability map to update the RNU quotas



Defining quotas using vulnerability boosts eligibility in urban and peri-urban areas

	Poverty-induced	Risk-induced	Vulnerability	Risk/poverty ratio
Dakar	8.2	6.9	15.1	83.9
Other urban	22.5	18.8	41.3	83.2
Rural	56.8	21.5	78.3	37.9
National	38.2	17.5	55.7	45.8

Increase in eligibility when accounting for vulnerability

Eligibility quotas if only current poverty is considered

Eligibility quotas accounting for vulnerability

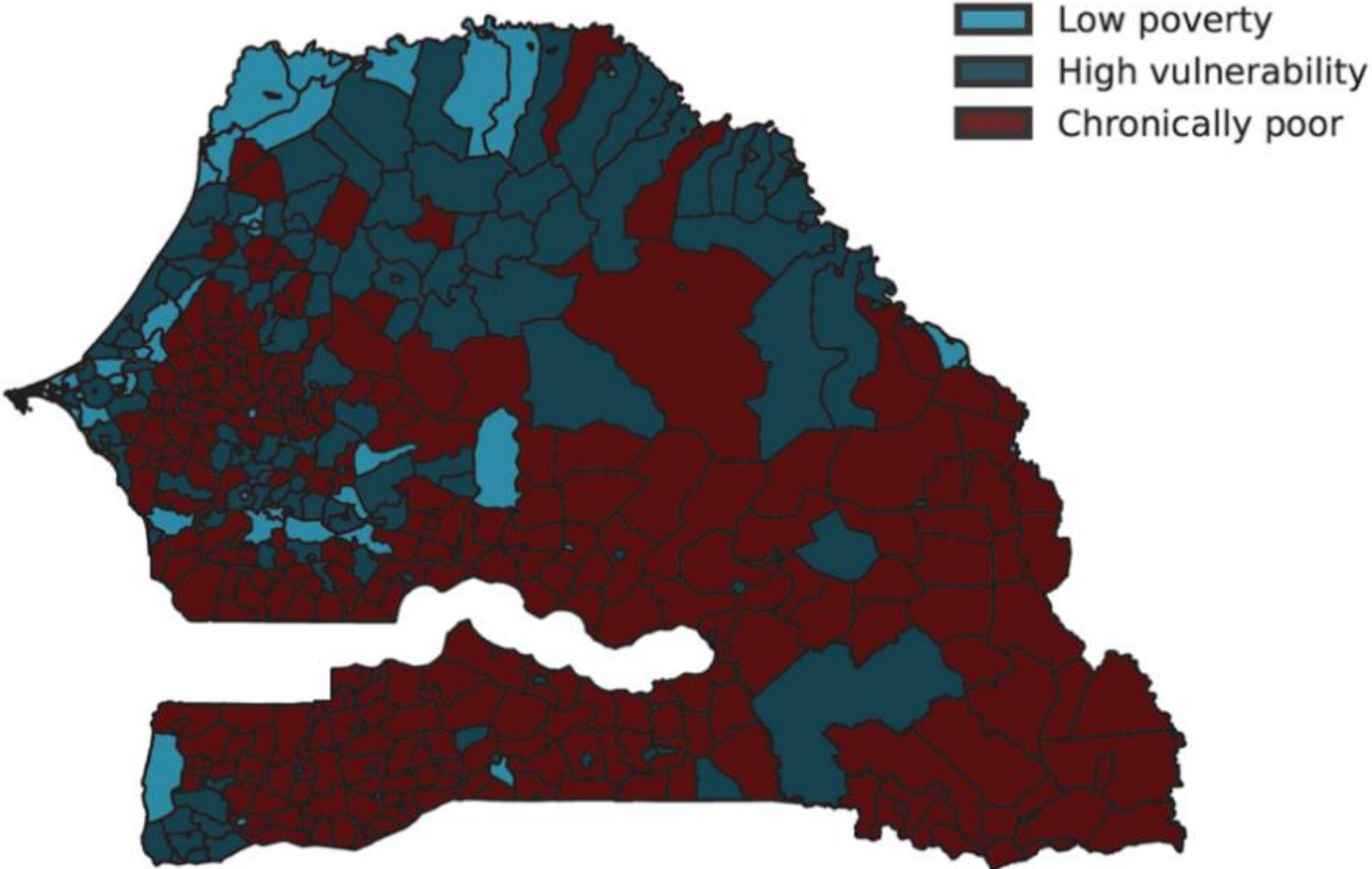
Conclusions

1. Poverty maps focus on *current* poverty, ignoring the dynamic nature of welfare.
2. Our method expands on well-known poverty mapping methodologies to account for vulnerability -*probability of households to fall into poverty*
3. We find:
 - High-poverty areas are more likely to be rural
 - Low poverty areas can have low vulnerability (Dakar) or high vulnerability (periurban).
These present systematic differences (service access, shock exposure)
4. For targeting purposes vulnerability :
 - Gives more relevance to areas with past poverty gains
 - Has implications on the type of benefits, balancing focus on social insurance versus social protection

Appendix



The spatial distribution of communes, by vulnerability classification

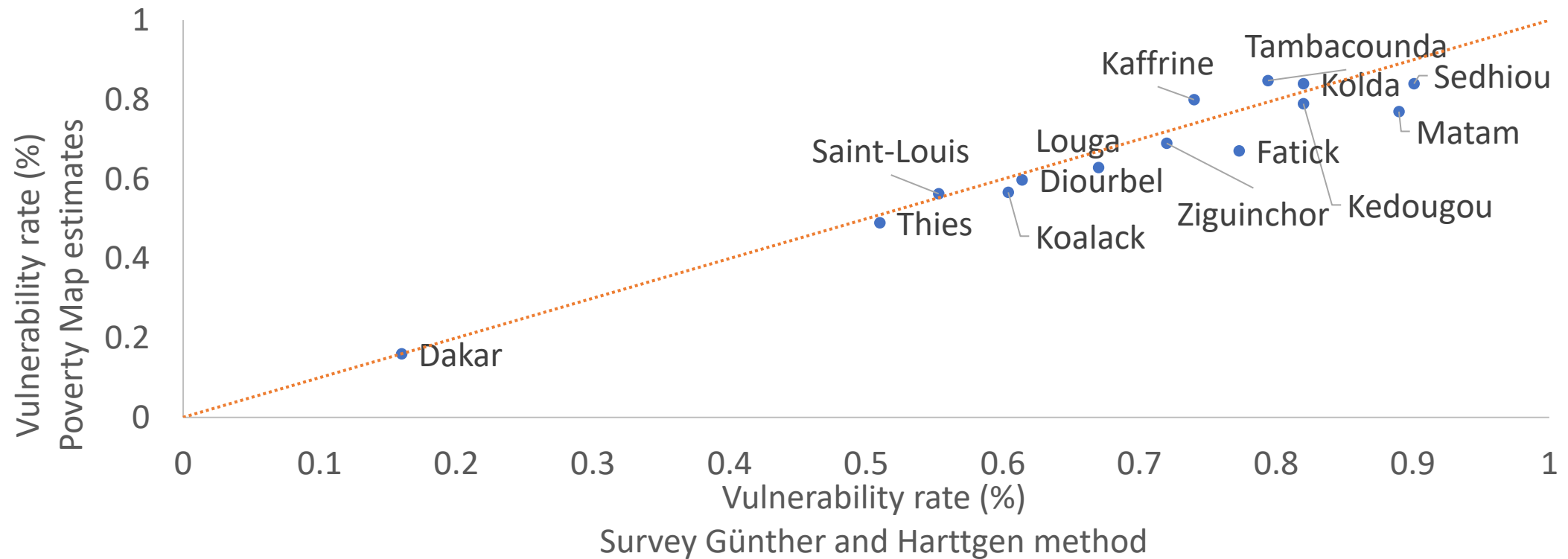


Comparison: commune-level characteristics

Indicator	Risk-induced vulnerability (poverty-induced vulnerability = low)		Chronically poor
	Low	High	
Household characteristics			
No formal education, household head	0.50	0.77	0.85
More than secondary education, head	0.19	0.06	0.02
Dependency ratio	0.40	0.50	0.55
Rural	0.12	0.62	0.96
Employment, head			
Employed	0.22	0.10	0.04
Self-employed	0.36	0.46	0.56
Unemployed	0.31	0.34	0.35
Assets			
Wealth index	0.92	-0.36	-1.30
Mobile phone	0.87	0.78	0.75
Computer	0.21	0.07	0.02
Car	0.13	0.07	0.02
Fridge	0.38	0.16	0.03
TV	0.79	0.47	0.16
Dwelling characteristics (improved)			
Walls	0.93	0.73	0.40
Floor	0.86	0.73	0.54
Roof	0.80	0.45	0.54
Electricity	0.86	0.50	0.14
Sewer	0.54	0.14	0.03
Flush toilet	0.31	0.04	0.16
Running water	0.56	0.29	0.12
Administrative data measures			
Coverage 3G mobile network (pop. shares)	0.98	0.92	0.78
Average nighttime light luminosity (2018)	15.00	1.30	0.03
Exposed to fluvial flood risks (pop. shares)	0.02	0.05	0.03
Exposed to pluvial flood risks (pop. shares)	0.02	0.03	0.52

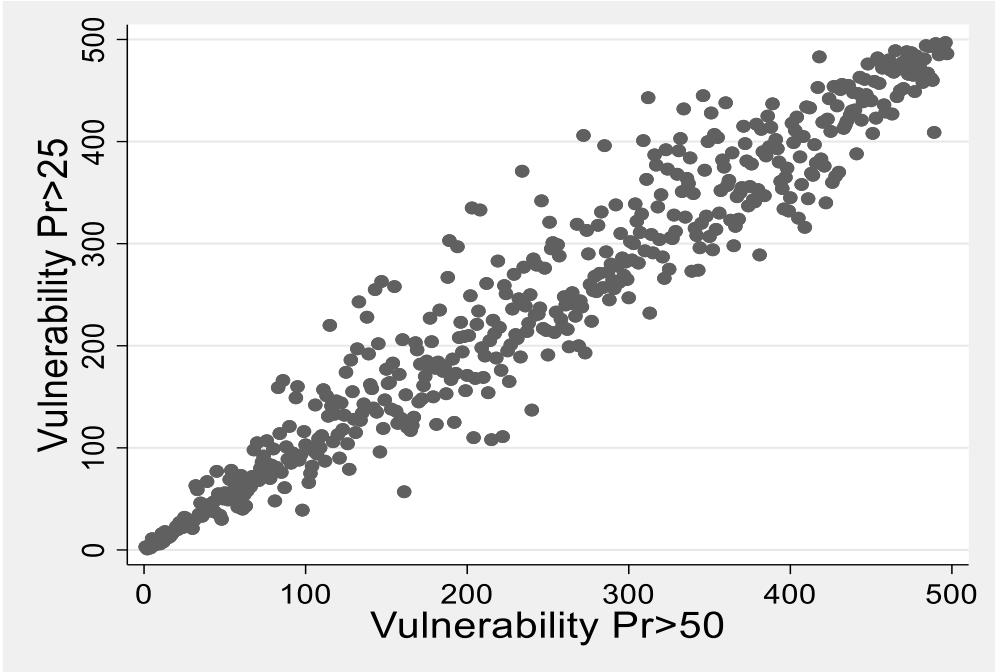
- Low- and high-vulnerability communes differ in access to services, exposure to flood risk, and asset ownership.
- Households in high-vulnerability communes:
 - Face a high risk of income loss, present lower educational attainment, access to services, and asset ownership.
 - Importance of disaster risk management in a strategy for poverty reduction: They present lower asset ownership, reflecting constrained to generate income and insure against shocks.

Vulnerability estimates of survey implementation using two methods, by department

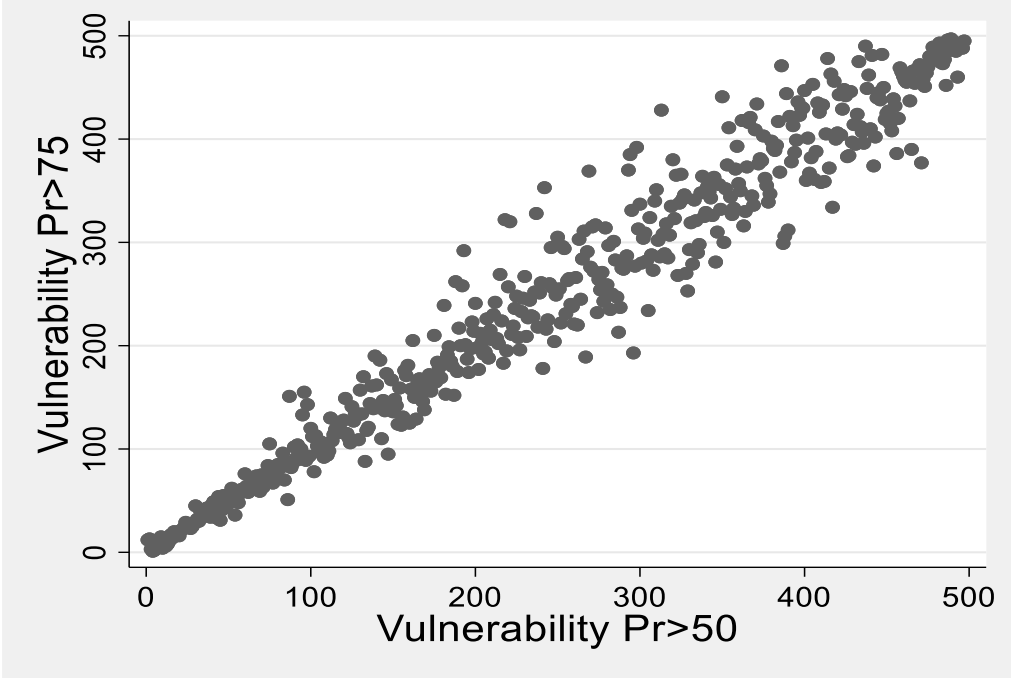


Robustness checks: Testing commune reranking under different probability cut-offs

Probability of falling into poverty > 25 percent



Probability of falling into poverty > 75 percent



Commune vulnerability rates, by urban or rural location

	<i>Dakar urban</i>	<i>Other urban</i>	<i>Rural</i>	<i>National</i>
<i>Communes, by vulnerability rate, number</i>				
Low poverty	47	35	28	110
High vulnerability	1	63	101	165
Chronically poor	0	20	256	276
<i>Census predictions: population averages, %</i>				
Poverty-induced	8.2	22.5	56.8	38.2
Risk -induced	6.9	18.8	21.5	17.5
Risk/poverty ratio	83.9	83.2	37.9	45.8
<i>Census predictions: commune average, %</i>				
Poverty-induced	9.5	32.6	63.0	51.8
Risk -induced	7.3	24.4	20.5	20.2
Risk/poverty ratio	77.6	75.0	32.5	39.0
<i>Estimated population, 2018</i>				
Total, million	3.3	3.6	8.7	15.5
Share of total, %	21.3	23.2	56.1	100

Thank you!

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