Measuring vulnerability to poverty allowing for agricultural and non-agricultural risks: Evidence from Tanzanian household data

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Introduction

- Many studies have attempted to measure households' vulnerability to poverty: future probability of falling into poverty
- A household's vulnerability is usually calculated using its probability distribution for welfare indicators such as income and consumption
- However, it is sometimes difficult to obtain country-wide long-term panel data, particularly in developing countries
- Chaudhuri, Jalan and Suryahadi (CJS: 2002) proposed a method to estimate welfare distribution for each household using cross-sectional data
- The CJS method has widely been utilized owing to its less stringent data requirement
- The CJS method has been criticized, however, for its assumption that inter-temporal welfare variation of a household can be approximated by cross-sectional variation of household welfare

Objectives

- We propose a new method to measure vulnerability that can be implemented with cross-sectional data and capture the risk faced by each household more accurately
- Our goal is to obtain household-specific welfare distribution that allows for agricultural and non-agricultural risks, then calculate the vulnerability
- To show the validity of our method, we predict poverty status using both our method and the CJS method and compare accuracies of the predictions

Model

- Farmers choose the labor allocation between agriculture and non-agriculture to maximize the expected utility
- Both agricultural and non-agricultural incomes contain risk factors: climate risk and unemployment risk, respectively

$$\max_{L_{Ai},L_{Ni}} \quad \ln Y_i\left(L_{Ai}\left(L_{Ni}\right), X_i, S_i, r_i\right),$$

$$s.t. \quad L_{Ai} + L_{Ni} = \overline{L}_i$$

Y: household income, *L*: working hours, *X*: exogenous factors that affect income, *S*: asset holding, *r*: risk factors; *A*: agriculture, *N*: non agriculture

- This setting is consistent with Ito and Kurosaki (2009) who showed that households in India with a higher agricultural climate risk are more likely to allocate their labor to non-agricultural activities

- Specification of the income variables:

$$Y_i = Y_{Ai}\left(L_{Ai}, X_{Ai}, r_{Ai}\right) + Y_{Ni}\left(L_{Ni}, X_{Ni}, r_{Ni}\right) + S_i,$$

$$Y_{Ai} = \alpha + \beta L_{Ai} + X_{Ai}\gamma + \delta r_{Ai}, \quad r_{Ai} \sim \text{precipitation of recent 100 years},$$

$$Y_{Ni} = w\left(X_{Ni}\right) L_{Ni} r_{Ni}, \quad r_{Ni} \sim \text{Beta}\left(a, b\right)$$

w: wage function (determined outside of this model), Greek letters: parameters

Numerical analysis

- Because the above optimization problem cannot be solved analytically, we solve it numerically using the Monte Carlo approach
- We propose the following procedure to derive the income distribution of each household using cross-sectional data and then calculate its vulnerability

Procedure for deriving income distribution and vulnerability

Estimate by OLS parameters in Y_{Ai} and w(X_{Ni}) using observed L_{Ai} and r_{Ai}

↓

Generate income distribution of each household using the distributions of r_{Ai} and r_{Ni}

Procedure for obtaining the parameters *a* and *b* to specify the distribution of r_{Ni}

Assume that the mode of the distribution is the observed value of r_{Ni} ($\overline{r}_{Ni}$)

↓

Given a value of *a*, find the value of L_{Ai} that produces the largest $\ln Y_i$

↓

Change the value of *a*, and find the optimal value of L_{Ai} for each *a*

↓

Find a value of *a* (*a**) with which the derived and actual values of L_{Ai} match

↓

Calculate *b* using *a** and $\overline{r}_{Ni}$ to specify the beta distribution

↓

Using the generated incomes, calculate each household's vulnerability

Application to Tanzanian household data

- We applied both our method and the CJS method to the Tanzanian LSMS data
- We calculated vulnerability of each household using the 2008-09 data and predicted its poverty status in 2010-11 based on this value
- We then compared the accuracies of prediction based on the realized income included in the 2010-11 data

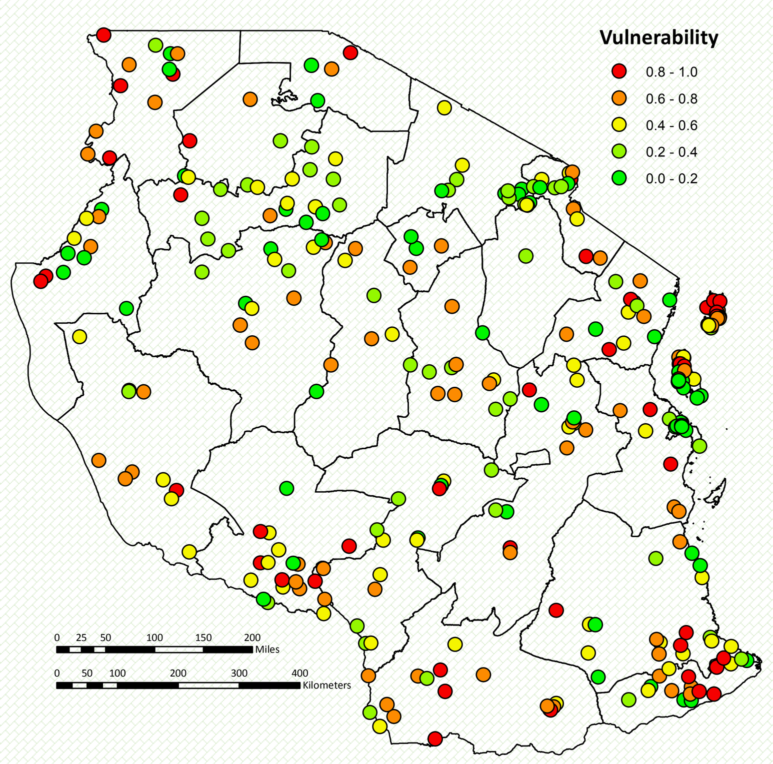
Results

- Our method produced a vulnerability index with higher accuracy and fewer false-positive cases than that obtained by the CJS method
- Compared to the CJS method that assumes normally distributed vulnerability, our method gave more "deterministic" evaluations, i.e. index values close to zero and one
- The results were robust to the specification of the utility function and the location of the poverty line

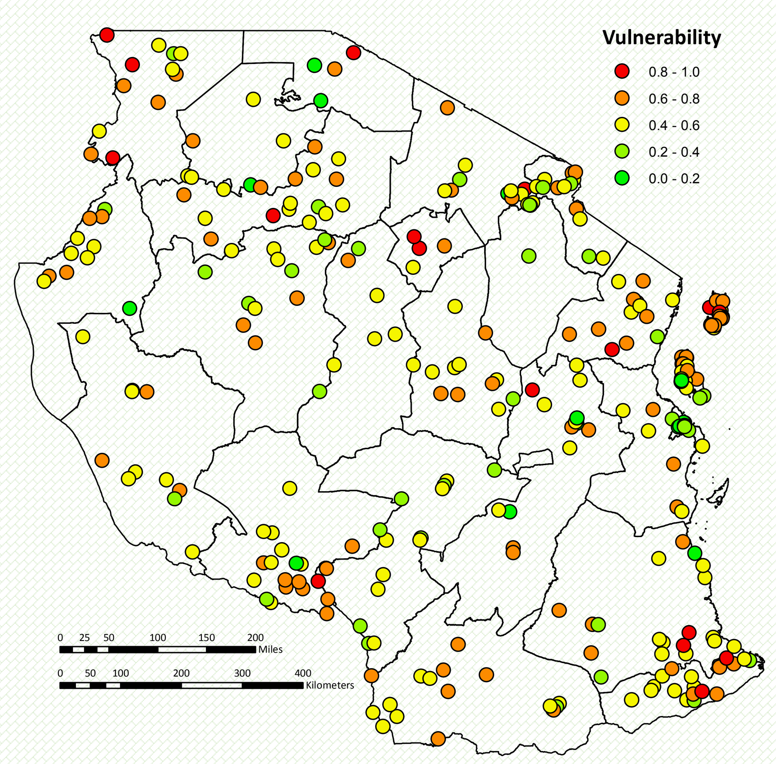
		Our method			The CJS method		
		Vul (vul >.5)	Non-vul (vul <.5)	Total	Vul (vul >.5)	Non-vul (vul <.5)	Total
Actual	Poor	520	239	759	564	195	759
	Non-poor	257	486	743	355	385	740
	Total	777	725	1,502	919	580	1,499
Accuracy				0.670			0.633
Score (pov)				0.691			0.635
Score (non-pov)				0.645			0.522
Score (total)				0.668			0.580

Note: Score (pov) $= (1/I)\sum_i^I \mathit{vulnerability}_{ki}$, $i \in$ poverty, $k \in \{$Our method, The CJS method$\}$,
Score (non-pov) $= (1/J)\sum_j^J \left(1 - \mathit{vulnerability}_{kj}\right)$, $j \in$ non-poverty,
Score (total) $= \left(1/(I+J)\right)\left(\sum_i^I \mathit{vulnerability}_{ki} + \sum_j^J \left(1 - \mathit{vulnerability}_{kj}\right)\right)$

Our method



The CJS method



Note: A vulnerability at a point indicates the mean vulnerability of households in the enumeration area

Conclusion

- Considering both agricultural and non-agricultural risks in an explicit manner can improve the accuracy of vulnerability index, even when only cross-sectional data are available

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