From Individual Vulnerability to Aggregate Vulnerability

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Outline

Introduction

Vulnerability to Individual Poverty

Vulnerability to Aggregate Poverty

Empirical illustration

Concluding remarks

Vulnerability *to Poverty*

- Joint work with Stefan Dercon (Oxford University)
- Osberg (2010): The main substantive difference appears to be that the vulnerability discourse focuses on the risk of *poverty* or destitution, while the insecurity perspective concerns the hazards faced by all citizens

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Vulnerability *to Poverty*

- Risk as a burden on wellbeing and a source of inefficiencies
  - Risk as part of the predicament of the poor (WB Voices of the Poor)
  - Empirical evidence on risk-induced poverty traps
  - Empirical evidence on long-lasting consequences of poverty episodes
- The stress caused by the threat of poverty
  - How likely poverty is, and how bad it would be if it strikes
  - Some form of aversion to uncertainty

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The differences

- Focus on *future* outcomes – not so much about the past or the present
  - *Ex-ante* concept
  - Empirically, the index will feed on some model to predict future consumption
  - Data requirements will be a challenge
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Notation

- $\mathbf{p} = \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_k \end{bmatrix}$
- $\mathbf{Y} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ y_{k1} & y_{k2} & \cdots & y_{kn} \end{bmatrix} = \begin{bmatrix} \mathbf{y}_1 & \mathbf{y}_2 & \cdots & \mathbf{y}_n \end{bmatrix}$
  - $[y_{si}]$ include all efforts to smooth consumption across states and across individuals
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- Individual vulnerability

$$v_i = f(z, \mathbf{p}, \mathbf{y}_i)$$

- Aggregate vulnerability

$$V = F(z, \mathbf{p}, \mathbf{Y})$$

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Related work

- Individual vulnerability
  - Ligon and Schechter (2003):

$$v_i^{EU} = u(z) - \mathrm{E}[u(y_i)]$$

  - Expected poverty:

$$v_i^{EP} = \mathrm{E}\left[d(z, y_i)\right], \text{ where e.g. } d(z, y_{si}) = \left[\frac{z - \mathrm{Min}(y_{si}, z)}{z}\right]^{\alpha}$$

  - Calvo and Dercon (2008):

$$v_i^{CD} = 1 - \mathrm{E}\left[\left(\frac{\mathrm{Min}\left[z, y_i\right]}{z}\right)^{\theta}\right], \text{ with } 0 < \theta < 1$$

- Aggregate vulnerability: v_i averages

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  - For any $k \times k$ permutation matrix $\mathbf{B}$, $f(z, \mathbf{p}, \mathbf{y}_i) = f(z, \mathbf{Bp}, \mathbf{By}_i)$
- Differentiability [D]
  - $f(z, \mathbf{p}, \mathbf{y}_i)$ is twice-differentiable in $\mathbf{y}_i$
- Scale Invariance [SI]
  - $f(z, \mathbf{p}, \mathbf{y}_i) = f(\lambda z, \mathbf{p}, \lambda \mathbf{y}_i)$ for any $\lambda > 0$
- State-Dependent Effect of Outcomes [SDEO]
  - For $y_{si} = y'_{si} > -c$ and $p_s p'_s \neq 0$, $f(z, \mathbf{p}, \mathbf{y}_i) - f(z, \mathbf{p}, \mathbf{y}_i + c\mathbf{e}_s^k) = f(z, \mathbf{p}', \mathbf{y}'_i) - f(z, \mathbf{p}', \mathbf{y}'_i + c\mathbf{e}_s^k)$ if and only if $p_s = p'_s$

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Axioms II

- Normalisation [N]
  - For $y_{si} = z$ for all s, $f(z, \mathbf{p}, \mathbf{y}_i) = 0$
- Probability Transfer [PT]
  - For $p_t \geq d > 0$, $f\left(z, \mathbf{p} + d\left(\mathbf{e}_s^k - \mathbf{e}_t^k\right), \mathbf{y}_i\right) \left\{ \begin{array}{c} \leq \\ \geq \end{array} \right\} f(z, \mathbf{p}, \mathbf{y}_i)$

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No-Compensation Axiom

- A farmer faces two scenarios: rain (no poverty: $y_{Ri} > z$) or drought (poverty: $y_{Di} < z$). Does she become less vulnerable to poverty if the harvest in the rainy state (y_{Ri}) improves, with no change in y_{Di}?
- $\tilde{y}_{si} \equiv \beta y_{si} + (1-\beta)\text{Min}(y_{si}, z) = \text{Min}(y_{si}, z) + \beta\text{Max}(0, y_{si} - z)$ with $0 \leq \beta \leq 1$
- Our view: $\beta = 0$, since poverty is as *likely* as before, as *bad* as before.
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- CONSTANT RELATIVE RISK SENSITIVITY [CRRS]
  - For $\lambda > 0$ and y_i^c such that $f(z, \mathbf{p}, \mathbf{y}_i) = f\left(z, \mathbf{p}, y_i^c \mathbf{1}^k\right)$, $f(z, \mathbf{p}, \lambda \mathbf{y}_i) = f\left(z, \mathbf{p}, \lambda y_i^c \mathbf{1}^k\right)$
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A family of measures

- Let $\tilde{x}_{si} = \text{Min}\left[1, \frac{y_{si}}{z}\right]$
- If f satisfies SOS, D, SI, SDEO, PT, RS, N, NC and CRRS, then

$$f(z, \mathbf{p}, \mathbf{y}) = \frac{1}{\theta}\left(1 - \text{E}\left[\tilde{x}^{\theta}\right]\right), \text{ with } \theta < 1^{*}$$

- or a positive multiple thereof.

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Outline

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Vulnerability to Individual Poverty

Vulnerability to Aggregate Poverty

Empirical illustration

Concluding remarks

‘Ex-ante’ and ‘ex-post’ revisited

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- This leaves no role for correlations in outcomes
- ‘Ex-ante’ and ‘ex-post’ stances (e.g. Fleurbaey 2010)

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A positive correlation increases *ex-ante*, ‘ex-post’ poverty

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Related intuitions

- Widespread poverty episodes may be harder to recover from
  - Asset depletion (Sen 1981)
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- SOS, D, SI, N, NC
- Symmetry over Individuals [SIS]
  - For any $n \times n$ permutation matrix $\mathbf{B}$, $F(z, \mathbf{p}, \mathbf{Y}) = F(z, \mathbf{p}, \mathbf{YB})$.
- Replication Invariance [RI]
  - For any integer $r > 1$, $F(z, \mathbf{p}, \mathbf{Y}) = F\left(z, \mathbf{p}, \mathbf{Y}^{(r)}\right)$, where $\mathbf{Y}^{(r)} \equiv [\mathbf{Y}, \mathbf{Y}, \ldots, \mathbf{Y}]_{k \times rn}$

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- SENSITIVITY TO CORRELATIONS IN OUTCOMES [SCO]
  - For $p_s = p_t$, $y_{si} > y_{ti}$, $y'_{tj} = y_{sj} < y_{tj} = y'_{sj}$, $F(z, \mathbf{p}, \mathbf{Y}) < F(z, \mathbf{p}, \mathbf{Y}')$
- Note RISK SENSITIVITY UNDER EQUALITY [RS^e] is not invoked.

A family of measures

- If F satisfies SOS, D, SI, SDEO, PT^e, N, NC, CRRS^e, SIS, RI and SCO, then

$$F\left(z,\mathbf{p},\mathbf{Y}\right)=\frac{1}{\Theta}\left(1-\mathrm{E}\left[\left(\prod_{i=1}^{n}x_i^{\frac{1}{n}}\right)^{\Theta}\right]\right), \text{ with } \Theta<0$$

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- Ethiopia 1994, 1999, 2004
- 1400 households from 15 villages
- Droughts and climatic vagaries shape life in rural Ethiopia
- Historical rainfall data will predict consumption (along with other observables)
  - Rainfall is exogenous – never a voluntary drop in consumption
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Consumption regression

	Coefficient	Standard error
Lagged consumption	0,537***	0,06
Rainfall		
Decile 2	−0,175	0,15
Decile 3	1,075***	0,15
Decile 4	−0,797***	0,16
Decile 5	−0,312**	0,14
Decile 6	0,646***	0,11
Decile 7	0,304***	0,08
Decile 8	−0,600***	0,12
Idiosyncratic risks	Yes	
Village fixed-effects	Yes	
Household composition	Yes	

A profile of the vulnerable

	FGT(2)	$v_{(\frac{1}{3})}$
Females [0-15]	8,709***	3,762**
	3,15	1,58
Females [16 and older]	11,602**	6,693***
	4,57	2,30
Males [0-15]	4,690	1,368
	2,99	1,52
Males [16 and older]	1,898	−1,060
	3,62	1,83
Males/Female ratio	2,396	1,509
	2,22	1,12

A profile of the vulnerable

	FGT(2)	$v_{(\frac{1}{3})}$
Permanent cropping villages	$-3{,}802$	$-10{,}311^{***}$
	4,35	2,25
Northern highland villages	$-19{,}234^{***}$	$-22{,}867^{***}$
	4,77	2,47
High-potential highland villages	$-24{,}973^{***}$	$-18{,}090^{***}$
	4,52	2,18
Resettlement villages	$-8{,}131^{*}$	$-17{,}511^{***}$
	4,92	2,60

A profile of the vulnerable

	FGT(2)	$v_{(\frac{1}{3})}$
Livestock	$-4{,}196^{***}$	$-1{,}254^{***}$
	0,59	0,30
Road access	$-1{,}444^{**}$	$-0{,}649^{*}$
	0,70	0,35
Distance to town	0,481	$2{,}434^{**}$
	1,90	1,00
Constant term	$-5{,}814$	2,420
	9,31	4,79
Observations	1138	1138
LR $\chi^2_{(12)}$	$209{,}8^{***}$	$199{,}6^{***}$

The aggregate picture

	1994	**1999**	**2004**
y_t	0.219	0.500	0.501
$\mathrm{E}[y_{t+1}]$	0.499	0.502	0.632
$\mathrm{E}[\mathrm{FGT}(0)]$	0.220	0.266	0.223
$\bar{v}_{(\frac{1}{3})}$	0.039	0.049	0.039
V	0.125	0.217	0.182

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From Individual Vulnerability to Aggregate Vulnerability

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