

AGRODEP Training Session

Vulnerability

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Vulnerability and Poverty

- ▶ Vulnerability to poverty: probability that income/ consumption falls below a given threshold
- ▶ Relation b/w vulnerability and poverty.
 - ▶ "Ex-ante" poverty: measure the exposure to poverty rather than the outcome (forward looking concepts)
 - ▶ Poverty indexes gives an incomplete picture
 - ▶ Vulnerability as one dimension of poverty
 - ▶ Vulnerability as a cause of poverty (risk poverty traps)

Quantifying vulnerability

- ▶ Vulnerability = $\text{risque} * \text{resilience}$
- ▶ To measure poverty, you would need
 - ▶ the distribution of risks in the future
 - ▶ the risk-management and risk-coping strategies of households
- ▶ These data are rarely available
⇒ others methods

Quantifying vulnerability

- ▶ Vulnerability: propensity to suffer a significant welfare shock that bring the household below a socially defined minimum level of welfare (Alwang et al., 2001)
- ▶ More formally,

$$Vi = v(z, y, p)$$

- ▶ Three approaches to measure poverty (Hoddinott, 2003)
 - ▶ vulnerability as expected poverty (VEP)
 - ▶ vulnerability as low expected utility (VEU)
 - ▶ vulnerability as uninsured exposure to risk (VER)

A normative framework

$$Vi = v(z, y, p)$$

What properties should v have ?

Symmetry, focus, Probability dependent outcomes, probability transfer, risk sensitivity, scale invariance (Calvo and Dercon, 2005)

$$Vi = \sum_i p_i v(x_i)$$

with

$$x_i = \frac{\min(y_i, z)}{z}$$

this is the probability weighted average of some convex function of outcomes, so that the worst states get no lower weight than good states.

Quantifying vulnerability: VEP

(Chaudhuri et al, 2001)

- ▶ Use a model to predict future mean and variability of income/consumption

$$v_{ht} = P(c_{ht+1} < z)$$

- ▶ *notations*: household h , time t , poverty line z
- ▶ Consumption model

$$c_{ht} = c(x_{ht}, i_h, \beta_t, \alpha_h, \varepsilon_{ht})$$

- ▶ Vulnerability:

$$v_{ht} = P(c(x_h, i_h, \beta_{t+1}, \alpha_h, \varepsilon_{ht+1}) < z))$$

Quantifying vulnerability: VEP

(Chaudhuri et al, 2001)

Practically, with cross-sectional data:

1. Estimate a consumption model:

$$\ln c_h = x_h \beta + \varepsilon_h$$

with

$$\varepsilon_h \sim N(0, x_h \theta)$$

2. Retrieve the $\hat{\beta}$ estimated parameters
3. Regress squared residuals on x_h to obtain $\hat{\theta}$
4. Calculate idiosyncratic variance $\text{var}(c_h) = \text{var}(\varepsilon_h) = x_h \hat{\theta}$

Quantifying vulnerability: VEP

(Chaudhuri et al, 2001)

- Calculate the probability that consumption falls below the poverty line base on the estimated consumption model:

$$v_{ht} = P(\ln c_h < \ln z) = \Phi\left(\frac{\ln(z) - x_h \hat{\beta}}{\text{sqroot}(x_h \hat{\theta})}\right)$$

- Define thresholds:
 - highly vulnerable if $\hat{v}_{ht} > 0.5$
 - relatively vulnerable from 0.22 to 0.5
 - not vulnerable above 0.5

Quantifying vulnerability: VEP

Table 8 Poverty and Vulnerability in Indonesia December 1998 (percentages)

	poor	non-poor	total
high vulnerability	0.05	0.03	0.08
low vulnerability	0.12	0.25	0.37
no vulnerability	0.05	0.50	0.55
Total	0.22	0.78	1.00

Source: Chaudhuri et al. (2001).

High vulnerability is 50+ percent probability to be below the poverty line.

Low vulnerability is 23-50 percent probability to be below the poverty line.

No vulnerability is 0-22 percent probability to be below the poverty line.

Quantifying vulnerability: VEP

Extension to panel data, measurement error

$$\ln c_{ht} = x_{ht}\beta + D_{v,h \in v,t} + u_h + s_{ht}\alpha + e_{ht}$$

$$\text{Var}(c_h) = \sum_t (\alpha s_{ht} + e_{ht})^2$$

or

$$\text{Var}(c_h) = \sum_t (\alpha s_{ht})^2$$

Quantifying vulnerability: VEP

Extension to the depth of expected poverty

- Expected poverty

$$Vi = \sum_{y < z} p_i \left(\frac{z - y^i}{z} \right)^\alpha$$

Quantifying vulnerability: VEU

- Low expected utility (Ligon and Schechter, 2003, Elbers and Gunning 2003, Chaudhuri, 2002):

$$V_i = u_i(z_{CE}) - E(u_i(c_h))$$

$$V_i = [u_i(z_{CE}) - u_i(E(c_h))] - [u_i(E(c_h)) - E(u_i(c_h))]$$

$$V_i = [u_i(z_{CE}) - u_i(E(c_h))] - [u_i(E(c_h)) - E(u_i(c_h/D_t))] \\ - [E(u_i(c_h/D_t)) - E(u_i(c_h))]$$

violates scale invariance and the focus axiom

Quantifying Vulnerability : Dercon, 2005

If we choose to normalize the vulnerability measure $[0,1]$ and impose constant relative risk sensitivity

$$V_{\alpha} = 1 - E[\min(y_i, z)^{\alpha}]$$

The second term is the probability weighted value of the normalized outcomes.

Understanding Vulnerability VEP and VEU

- Vulnerability profile $V_i = f(x_i)$

Table 5: Correlates of vulnerability (based on total consumption) in Bulgaria in 1994. Based on table 2, Ligon and Schechter (2003).

Variable	Coefficient	Standard error
Primary Education	-0.0717	(0.0321)
Secondary Education	-0.2356	(0.0354)
Post-Sec. Education	-0.3350	(0.0377)
Male headed?	-0.0300	(0.0256)
Age	0.0083	(0.0047)
Age Squared	-0.0000	(0.0000)
Owens Animals?	-0.1001	(0.0259)
Land Cultivated in ha	-0.0011	(0.0025)
Urban?	0.0758	(0.0262)
# of Pensioners in hh.	-0.1183	(0.0212)
# of Employed in hh.	-0.3095	(0.0237)
Family Size	0.2426	(0.0137)

Note: These regressions also include province dummies. Details on variables and method in Ligon and Schechter (2003).

Understanding Vulnerability

- ▶ Vulnerability = $\text{risque} * \text{resilience}$
- ▶ To understand the sources of vulnerability:
 - ▶ you have to identify the most important shocks
 - ▶ the available risk management strategies

Understanding Vulnerability: VER

► Dercon (2001) framework

Table 3 Types of risks (alternative examples)			
Type of risk	Risks affecting individual or household	Risks affecting groups of household or communities	Risks affecting regions or nations
Natural		Rainfall Landslide Volcanic eruption	Earthquake Flood Drought High winds
Health	Illness Injury Disability Old age Death	Epidemic	
Social	Crime Domestic Violence	Terrorism Gang activity	Civil strife War Social upheaval
Economic		Unemployment Resettlement Harvest failure	Changes in food prices Growth collapse Hyperinflation Balance of payments, financial or currency crisis Technology shock Terms of trade shock Transition costs of economic costs
Political		Riots	Political default on social programs Coup d'état
Environmental		Pollution Deforestation Nuclear disaster	

Source: World Development Report 2000/01, p.136.

Understanding Vulnerability: VER

► Dercon (2001) framework

Table 4 Mechanisms for managing risk

Objective	Informal mechanisms		Formal mechanisms	
	Individual and household	Group-based	Market based	Publicly provided
Reducing risk	<ul style="list-style-type: none"> Preventive health practices Migration More secure income sources 	<ul style="list-style-type: none"> Collective action for infrastructure, dikes, terraces Common property resource management 		<ul style="list-style-type: none"> Sound macroeconomic policy Environmental policy Education and training policy Public health policy Infrastructure (dams, roads) Active labour market policies
Mitigating risk <i>Diversification</i>	<ul style="list-style-type: none"> Crop and plot diversification Income source diversification Investment in physical and human capital 	<ul style="list-style-type: none"> Occupational associations Rotating savings and credit associations 	<ul style="list-style-type: none"> Savings accounts in financial institutions Microfinance 	<ul style="list-style-type: none"> Agricultural extension Liberalised trade Protection of property rights
<i>Insurance</i>	<ul style="list-style-type: none"> Investment in physical and human capital Marriage and extended family Sharecropper tenancy Buffer stocks 	<ul style="list-style-type: none"> Investment in social capital (networks, associations, rituals, reciprocal gift giving) 	<ul style="list-style-type: none"> Old age annuities Accident, disability, and other insurance 	<ul style="list-style-type: none"> Pension systems Mandated insurance for unemployment, illness, disability, and other risks
Coping with shocks	<ul style="list-style-type: none"> Sale of assets Loans from moneylenders Child labour Reduced food consumption Seasonal or temporary migration 	<ul style="list-style-type: none"> Transfers from networks of mutual support 	<ul style="list-style-type: none"> Sale of financial assets Loans from financial institutions 	<ul style="list-style-type: none"> Social assistance Workfare Subsidies Social funds Cash transfers

Source: World Development Report 2000/01, p.141.

Understanding Vulnerability: VER

- ▶ Dercon (2001) framework
- ▶ An essential part of the life of the poor is trying to cope and survive in the face recurring misfortune – such as illness, loss of employment, harvest failure (Voices of the poor reports)

Table 1: The incidence of serious shocks 1999-2004 in rural Ethiopia

Type of shocks households reported to be affected by, leading to serious loss of assets, income or consumption, of those affected by a shock (note: 95 percent of households reporting such a shock)	Percentage
Drought	46.8
Death of head, spouse or another person	42.7
Illness of head, spouse or another person	28.1
Inability to sell outputs or decreases in output prices	14.5
Pests or diseases that affected crops	13.8
Crime	12.7
Difficulty in obtaining inputs or increases in input prices	11.3
Policy/political shocks (land redistribution, state confiscation of assets, resettlement, forced contributions or arbitrary taxation)	7.4
Pests or diseases that affected livestock	7.0

Source: Ethiopian Rural Household Survey, 2004, and Dercon, Hoddinott and Woldehanna (2005). Based on recorded three worst shocks per household, leading to serious loss of income, consumption or assets. 95 percent of households report at least one serious shock.

Vulnerability as cause of poverty: VER

- ▶ There is increasing evidence that the lack of means to cope with risk and vulnerability is in itself a cause of persistent poverty and poverty traps (Dercon, various work)
- ▶ Some recent work that has tried to highlight the crucial role played by risk and vulnerability in determining people's living conditions and opportunities to escape poverty

$$\ln(c_{ht}) = f(x_{ht}, s_{ht}) = \beta x_{ht} + \theta s_{ht} + ei + u_{it}$$

$$\Delta \ln(c_{ht}) = f(x_{ht}, s_{ht}) = \beta \Delta x_{ht} + \theta \Delta s_{ht} + ei + u_{it}$$

- ▶ Different measures of shocks (s_{ht})
- ▶ Interact shocks with households characteristics to have different "vulnerability level" by group

Vulnerability as cause of poverty: VER

The impact of uninsured risk is closely linked to vulnerability since it may drift households under some socially acceptable level.

Table 2: Impact of shocks on (log) consumption per capita, 2004

	Estimated coefficient	t statistic (absolute value)
Drought, 2002-04	-0.163	2.46**
Drought, 1999-2001	-0.137	2.72**
Pests or diseases that affected crops, 2002-04	-0.006	0.07
Pests or diseases that affected crops, 1999-2001	-0.052	1.05
Pests or diseases that affected livestock, 2002-04	-0.002	0.18
Pests or diseases that affected livestock, 1999-2001	0.022	0.24
Difficulty in obtaining inputs or increases in input prices, 2002-04	0.055	0.63
Difficulty in obtaining inputs or increases in input prices, 1999-2001	0.001	0.02
Inability to sell outputs or decreases in output prices, 2002-04	-0.187	2.23**
Inability to sell outputs or decreases in output prices, 1999-2001	-0.026	0.36
Lack of demand for non-agricultural products, 2002-04	-0.037	0.19
Lack of demand for non-agricultural products, 1999-2001	-0.195	2.28**
Crime shocks, 2002-04	-0.018	0.36
Crime shocks, 1999-2001	0.083	0.99
Death of head, spouse or another person, 2002-04	0.043	0.69
Death of head, spouse or another person, 1999-2001	-0.001	0.02
Illness of head, spouse or another person, 2002-04	-0.019	0.32
Illness of head, spouse or another person, 1999-2001	-0.151	2.33**
R ²	0.34	

Vulnerability as cause of poverty: VER

Table 4 Testing for persistent effects of shocks on food consumption growth.
Dependent variable: change in ln food consumption per adult between survey waves
(1989-94 and 1994-97). Hausman-Taylor and Jalan and Ravallion estimators.

	$\Delta \ln$ food cons (1) (HT)		$\Delta \ln$ food cons (2) (JR)	
	Coeff	p-value	Coeff	p-value
\ln food consumption _{t-1}	-0.318	0.000	-0.204	0.000
village mean \ln food cons _{t-1}	0.211	0.000	0.135	0.004
rainfall shocks _t	0.622	0.000	0.614	0.002
rainfall shocks _{t-1}	0.069	0.016	0.195	0.013
adult serious illness	-0.043	0.076	-0.053	0.064
crop shock (-1 is worst)	-0.014	0.757	-0.217	0.041
livestock shock (-1 is worst)	-0.018	0.704	-0.009	0.910
severity of famine impact	-0.116	0.079	-0.397	0.068
Constant	0.519	0.000	0.920	0.071
Number of observations	636		319	

Source: Dercon (2004), table 6. Regression (1) use the Hausman-Taylor model, and assume rainfall shocks, livestock shocks and crop shocks as time-varying, exogenous variables, and demographic changes, illness shocks and lagged consumption at household and village level as time-varying endogenous variables. The index of the severity of the crisis experienced (coping index) was treated as time-invariant exogenous, as was (if applicable) whether there was a road available. As time-invariant exogenous variables and instruments, the presence of harvest failure during the famine period, the estimated percentage of households suffering in each village and the ln of livestock before the famine were used. Regression (2) uses the Jalan-Ravallion estimator (Jalan and Ravallion (2002)).

Vulnerability as cause of poverty: VER

Vulnerability can easily be linked to the concept of transient poverty of the Jalan and Ravallion component approach

Transient poverty can be calculated directly using the shock measure

- Chronic poverty= estimated consumption without shock:

$$\ln c_{ht} = \hat{\beta} x_{ht}$$

$$P_c = \frac{1}{N} \sum_n \left(\frac{z - \hat{\bar{c}}_{ht}}{z} \right)$$

- Transient poverty/ vulnerability-estimated consumption with shocks

$$\ln c_{ht} = \hat{\beta} x_{ht} + \hat{\theta} s_{ht}$$

$$P_T = \frac{1}{N} \sum_n \left(\frac{z - \hat{\bar{c}}_{ht}}{z} \right) - P_c$$

Vulnerability as cause of poverty

Table 3 The impact of shocks in 1999-2004 on poverty in 2004

	Head count
Actual poverty	47.3
Predicted poverty (based on table 2)	43.8
Predicted poverty without drought shocks	33.1
Predicted poverty without illness shocks	40.4
Predicted poverty without input/output markets shocks	41.2
Predicted poverty without shocks	29.4
Transient as share of total (predicted) poverty	32.8

Source: Ethiopian Rural Household Survey 2004. The poverty line is a revalued poverty line based on the 1994 round of the same survey, valued at 61.48 birr in 2004 prices. Based on 1370 complete observations. Note that the transient poverty share is calculated relative to the predicted poverty level. As an estimate of 'national' poverty, it is deficient in terms of offering a comparison with national and other figures, since methods differ.

Vulnerability as cause of poverty

Vulnerability is likely to lead to poverty traps: testing the impacts of past shocks

$$\ln c_{ht} = \beta x_{ht} + \theta_0 s_{ht} + \theta_1 s_{ht-1} + i_h + \varepsilon_{ht}$$

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Vulnerability applied to multidimensional poverty measurement

- ▶ Multidimensional poverty is receiving more and more attention
- ▶ Consistently, vulnerability can be assessed in a multidimensional way
- ▶ Vulnerability can be assessed for each dimension of poverty

Conclusion

"Although some of the analytical methods described are in their infancy and the data requirement are high and currently not met, it is important to bring some of these issues higher on the policy agenda, including when assisting and contributing to the design of poverty reduction strategies, such as in the context of PRSPs and other key policy declarations. One important reason is that vulnerability and risk is increasingly shown not to be just another dimension of poverty; it is also a cause of poverty and destitution." (Dercon, 2011)