



Cornell University

# Measuring/Estimating Resilience

Christopher B. Barrett

IFPRI/IPA/Mercy Corps workshop on  
Financial Inclusion And Resilience To Climate Variability  
Washington, DC  
May 29, 2018



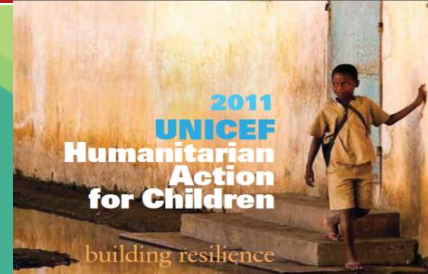
**DFID** International Development Finance Corporation  
**Defining Disaster Resilience:**  
A DFID Approach Paper



**The resilience renaissance?**

Unpacking of resilience for tackling climate change and disasters

Aditya V. Bahadur, Maggie Ibrahim and Thomas Tanner



**ENHANCING RESILIENCE IN THE HORN OF AFRICA**

WITHIN AN EVOLVING RISK PROFILE

13-14 DECEMBER 2011 | WASHINGTON, DC

**RESILIENT LIVELIHOODS**

DISASTER RISK REDUCTION FOR FOOD AND NUTRITION SECURITY

**“Resilience” has rapidly become a ubiquitous buzzword, but ill-defined concept within the development and humanitarian communities**



**Building the Resilience of Nations and Communities to Disasters**

THE WORLD BANK 2010-2015 SOCIAL PROTECTION AND LABOR STRATEGY



**Resilience, Equity, and Opportunity**



**TOWARDS HUMAN RESILIENCE: SUSTAINING MDG PROGRESS IN AN AGE OF ECONOMIC UNCERTAINTY**

**Resilience Initiative**

Partnership for resilient livelihoods in a changing climate



**Sahel food crisis- Commission scales up assistance and launches a Partnership for Resilience in Sahel**

The European Commission is increasing its humanitarian funding to the Sahel by €40 million, bringing its response to the food crisis to €337 million. This extra funding comes just weeks before the food crisis is set to peak across the region where 18 million people are in danger from hunger.

The funding increase comes just as the European Commission is hosting a high level gathering on the Sahel hunger crisis. International donors, representatives from Senegal, Gambia, Mauritania, Mali, Burkina Faso, Niger, Chad and Nigeria- as well as international and local organizations are attending. Among the delegates are Valerie Amos, the UN Under-Secretary-General for Humanitarian Affairs and人道 Lindberg, the Assistant Administrator for Democracy at USGID.

The meeting aims to launch a new partnership on strengthening the resilience of the Sahel to future crises. The initiative, called 4GR Sahel (Africa Globalize your Initiative Resilience), has one core aim to make sure that the people in the Sahel can better cope with future droughts.



## **At the same time, much ambivalence (even cynicism) about the ‘rise of resilience’**

- 1) Seen as too imprecise and malleable a concept/term
- 2) Not necessarily pro-poor as commonly formulated
- 3) Often ignores issues of agency/power/rights

If resilience is to prove a useful concept in international development/humanitarian programming, we need a theory-and-evidence-based understanding of what resilience is with respect to human well-being, how to measure/estimate it, and how to effectively promote it so as to sustainably improve living standards.



**To date, the gap b/n practitioner demand and academic supply has been filled w/atheoretical methods or relabeling of familiar variables ('old wine,new bottles').**

**Key questions. Is resilience:**

- A capacity (RHS) versus an outcome (LHS)? If we want to 'build resilience' then it must be an (intermediate?) outcome.
- Return to initial state, or persistence of a normative state? If pro-poor, then must anchor to a normative standard.
- Inverse of vulnerability? Rapid recovery from shock? If normative, then must encompass both stressors and shocks.
- One outcome (and its properties) or a suite of outcomes? Answer turns on question one wants to answer.
- Are all processes stationary? Must explicitly address dynamics.



## Toward a theory of resilience for international development applications

Christopher B. Barrett<sup>a,b,1</sup> and Mark A. Condas<sup>a</sup>

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Edited by Anthony J. Bebbington, Clark University, Worcester, MA, and approved August 28, 2014 (received for review November 7, 2013)

We advance a theory of resilience as it applies to the challenges of international development. The conceptualization we advance for change of a state variable, driving variables, and still persist? (1). Later, Holling distinguished between

Barrett&Condas (*PNAS* 2014) offers a theory of development resilience.

**Subject of interest:** quality of life, ~ Sen's 'capabilities'.

Focus on *minimizing individual human experience of ill-being*.

Implies:

- focus on individuals' (and groups') *well-being within* a system, not the *state of* a system itself.
- consider the *stochastic dynamics of well-being*
- do not focus on specific sources of risk b/c problem is uninsured exposure to many stressors (*ex ante* risk) and shocks (*ex post*, adverse realizations) to which resilience implies *adaptability while staying/becoming non-poor*.



## Stochastic Well-Being Dynamics

Consider the moment function for conditional well-being:

$$m^k(W_{t+s} | W_t, \varepsilon_t)$$

where  $m^k$  represents the  $k^{\text{th}}$  moment (e.g., mean ( $k=1$ ), variance ( $k=2$ ) or skewness ( $k=3$ ))

$W_t$  is well-being at time  $t$

$\varepsilon_t$  is an exogenous disturbance (scalar or vector) at time  $t$

These moment functions describe quite generally, albeit in reduced form, the stochastic conditional dynamics of well-being.

Much like 'poverty' measurement, 'resilience' holds when the time path of conditional probabilities of well-being are sufficiently high by some normative criteria (pov & prob lines).



If agencies program around resilience goals, then we need to be able to measure resilience & evaluate program/project performance. Should use theory to guide measurement.

**Core challenge:** resilience is unobservable, a **latent variable**.

This raises data challenges: need micro-scale panels, ideally high frequency from sentinel sites to capture seasonality and a range of shocks/stressors.



## Opinion: Measuring development resilience in the world's poorest countries

Derek Headey<sup>a,1</sup> and Christopher B. Barrett<sup>b,1</sup>

<sup>a</sup>Poverty, Health, and Nutrition Division, International Food Policy Research Institute (IFPRI), Washington, DC 20015; and <sup>b</sup>Charles H. Dyson School of Applied Economics and Management, Department of Economics, and Atkinson Center for a Sustainable Future, Cornell University, Ithaca, NY 14853

widespread interest in building “development resilience,” which has quickly become a centerpiece of many humanitarian and development organizations’ programming.

But whereas a social science theory



## Cissé & Barrett (*JDE* in press) Approach To Development Resilience Estimation

- Application of Barrett-Constas (*PNAS* 2014) probabilistic, cond moments-based estimation of well-being dynamics
- Like poverty estimation, a normative method. Assume:
  - (i) Level – Minimum acceptable standard of well-being (outcome) for individual or household.
  - (ii) Probability – Minimum acceptable likelihood of meeting level criterion

Development resilience is sufficient prob. of attaining an adequate standard of living (given shocks and stressors)

Aggregable/decomposable, like FGT poverty measures.





## **How to Estimate Resilience**

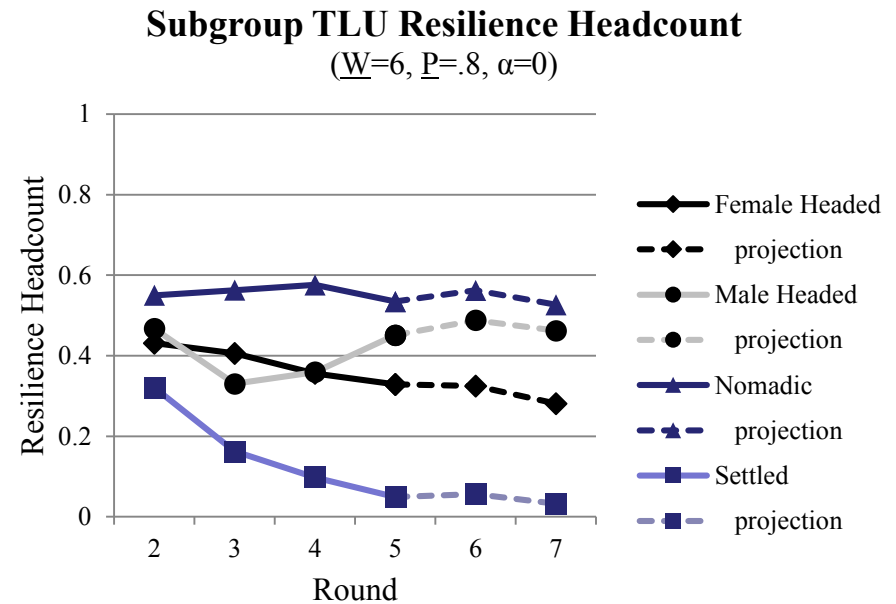
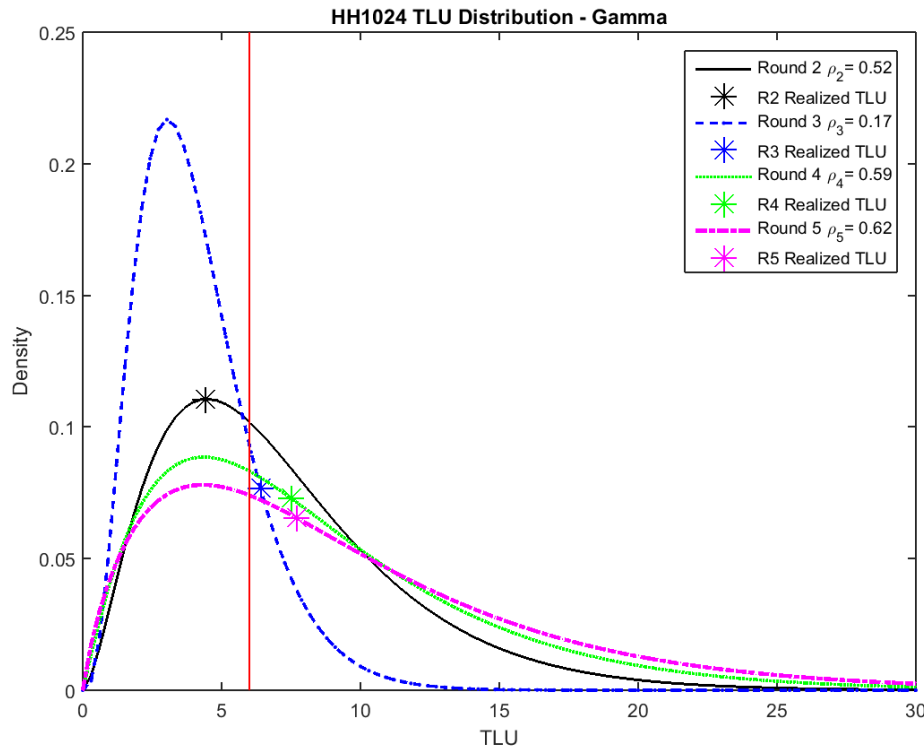
1. Estimate conditional moments of the well-being outcome variable of interest, as a function of variables reflecting
  - (i) Observable exogenous shocks (e.g., drought, cyclone)
  - (ii) conditioners of exposure, recovery (e.g., gender)
  - (iii) interventions (plausibly exog., if evaluating);  
Interact with shocks if targeted intervention.
  - (iv) polynomial lags of DV and shocks (i.e., nonlinear dynamics and cumulative, delayed response)
2. Use  $\hat{m}^k(\cdot)$  to estimate conditional probability of outcome in sequence of time periods, assuming a dist'n.
3. Based on a normative tolerable likelihood of a tolerable outcome over time, classify individuals as resilient or not where resilience is inverse conditional density.
4. Describe/predict resilience time path for indivs/aggregates



# Examples from northern Kenya pastoralists

HH-period-specific CPDs:

Population-level measures:





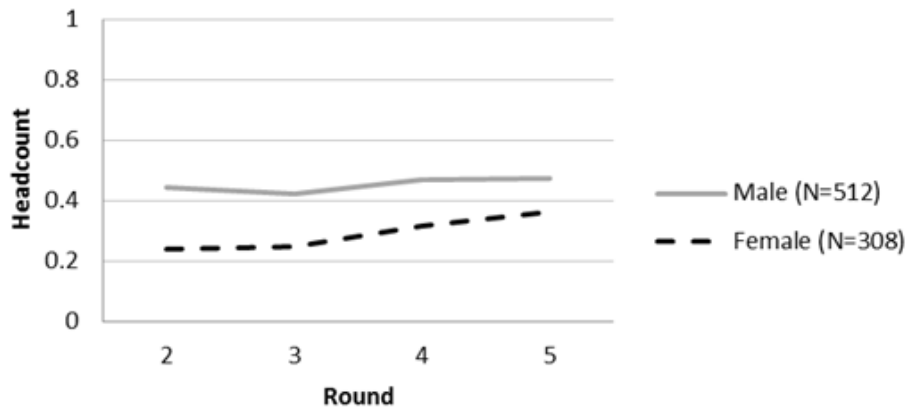
Can use same methods with food intake indicators as DVs. Satisfies axioms from 1996 World Food Summit definition of food security.

## Food security as resilience: reconciling definition and measurement

Joanna B. Upton, Jennifer Denno Cissé, Christopher B. Barrett\*

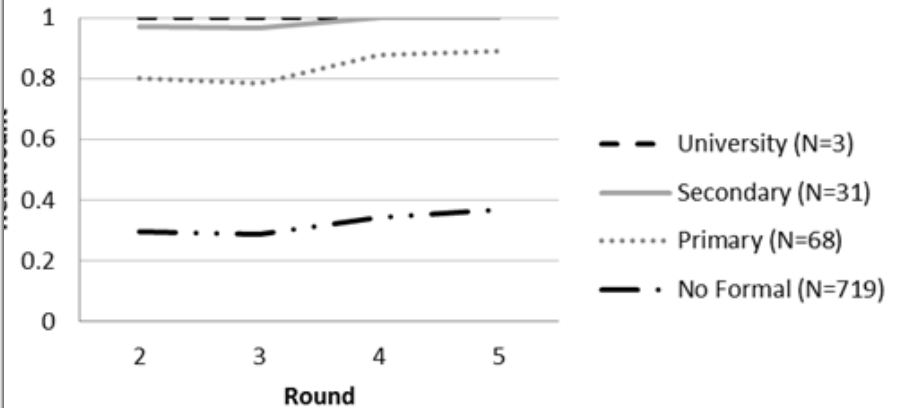
### Food Security by Gender of HH Head

HDDS:  $\underline{W}=7.91$ ;  $\underline{P}=0.25$ ;  $\alpha=0$



### Food Security by Education of Head

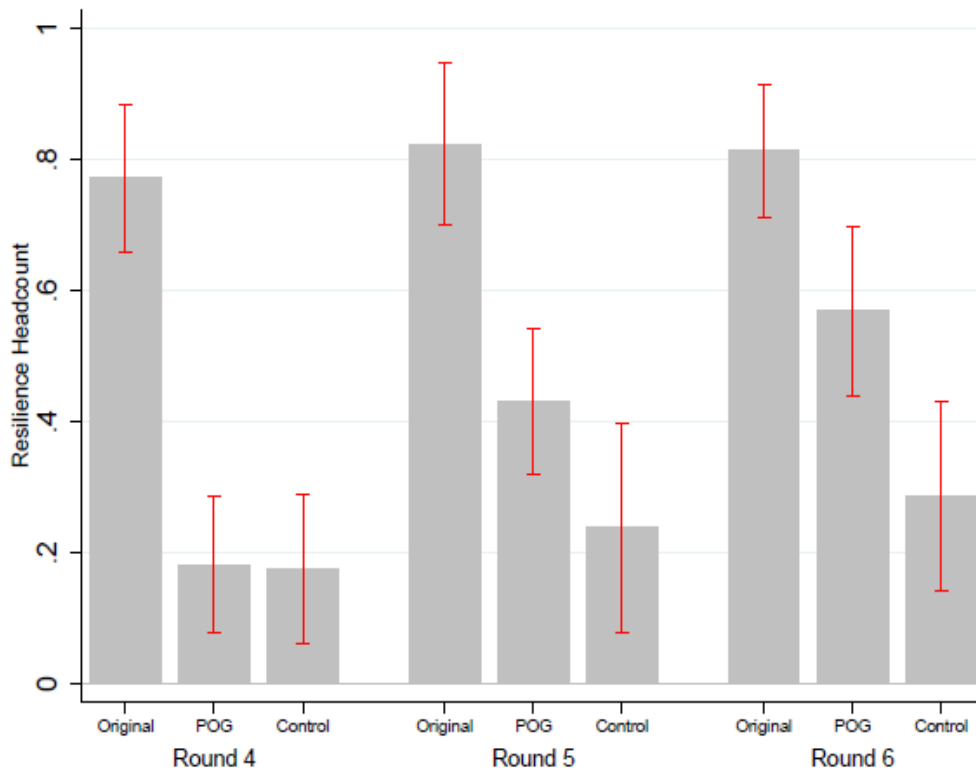
HDDS:  $\underline{W}=7.91$ ;  $\underline{P}=0.25$ ;  $\alpha=0$





## Example from Zambia project by Heifer Int'l

Figure 5: Headcount Resilient Rate (Gamma,  $\bar{A} = 308$ ,  $R = 0.5$  and  $k = 3$ )

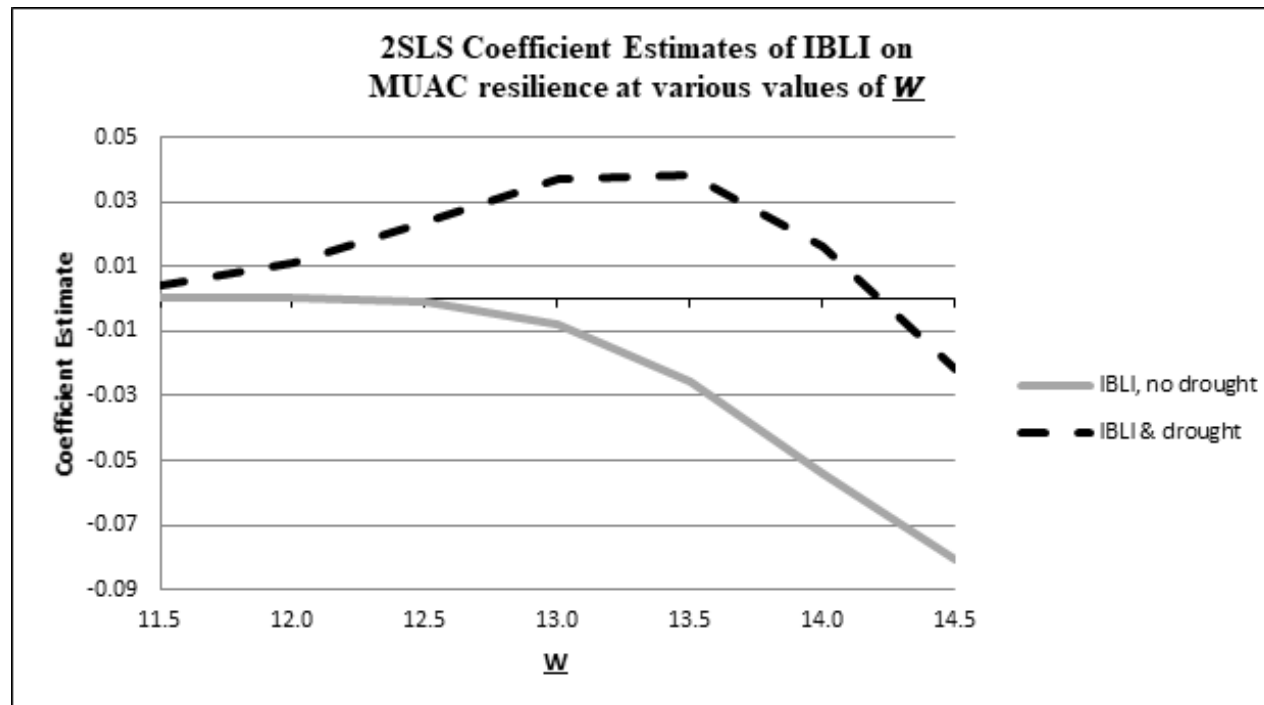


Training and asset transfers significantly increase conditional mean and reduce conditional variance of household wealth over time. Total B/C  $\sim 7$  [2.5,8.7] across hh wealth deciles

Source: Phadera, Michelson, Winter-Nelson & Goldsmith (2018)



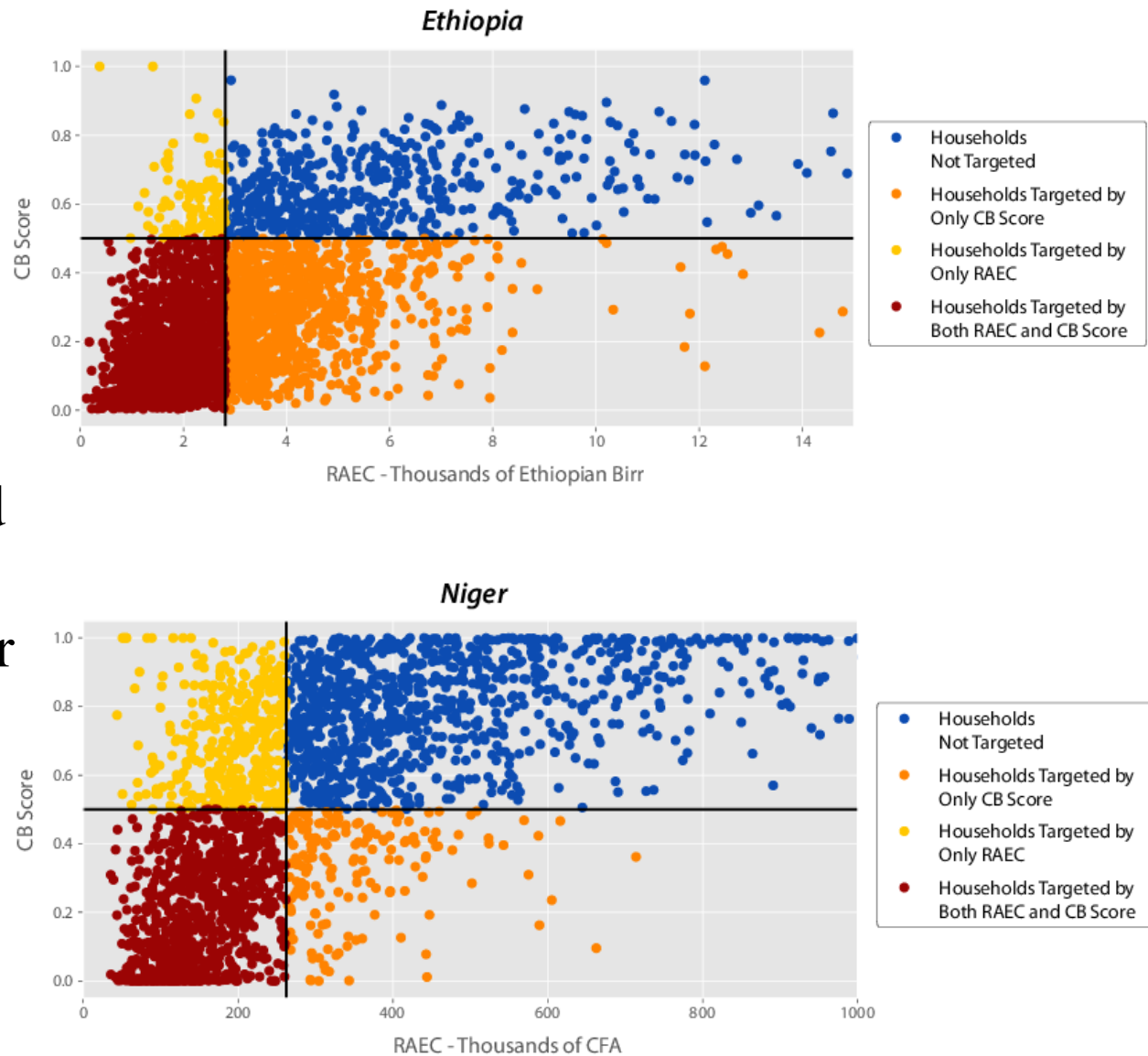
# Example from Kenya: Index-based livestock insurance increases resilience in child anthropometric terms over most values



Source: Cissé & Ikegami (2017)



Given stochasticity, most recent outcome is not strongly correlated with probability of a good outcome. So which measure works better for targeting interventions?



Source: Kimetrica (2017)



C-B method can be useful for targeting interventions. Relative to standard PMT/IT, can adjust  $Pr(\underline{W})$  to vary T1/2 errors based on one's strategy/resources.

Estimates of Targeting Accuracy: Livestock Holdings

$\underline{P}$	Correctly Not Targeted	Correctly Targeted	TI Error	TII Error	Sum of Errors
0.45	0.539	0.342	0.059	0.059	0.119
0.5	0.519	0.358	0.079	0.044	0.123
0.55	0.505	0.363	0.093	0.038	0.132
0.6	0.485	0.368	0.113	0.034	0.147
0.8	0.384	0.386	0.214	0.015	0.229
Standard	0.526	0.352	0.072	0.049	0.122

Source: Cissé & Barrett (*JDE* in press)

Estimates of Targeting Accuracy - HDDS

$\underline{P}$	Correctly Not Targeted	Correctly Targeted	TI Error	TII Error	Sum of Errors
0.15	0.266	0.503	0.088	0.143	0.231
0.20	0.198	0.566	0.156	0.080	0.236
0.25	0.122	0.609	0.231	0.037	0.268
0.30	0.056	0.644	0.298	0.002	0.300
Standard	0.209	0.536	0.145	0.110	0.255

Source: Upton, Cissé & Barrett (*Ag Econ* 2016)



Resilience is a popular buzzword now. But little precision in its use, theoretically or methodologically. Makes learning about 'building resilience' difficult-to-impossible.

Methods are now becoming available to enable rigorous, precise use of the concept to identify how best to avoid and escape chronic ill-being. Initial results promising for descriptive/predictive purposes as well as impact evaluation.

Much to do in all areas ... a massive research agenda, especially as agencies begin using resilience as a programming principle.

**But we must start with a firm theoretical foundation.**

**Thank you for your time and interest**