Estimating Multidimensional Development Resilience

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Overview

- This study develops multidimensional-resilience measures encompassing different dimensions of household well-being, incl. consumption, nutrition and assets.
- We use 5 rounds of household-level panel data in rural Ethiopia to investigate PSNP's association w/ household resilience.
- We find that (i) resilience measures built on single well-being indicators are weakly correlated, (i) multidimensional resilience measures are significantly different from those under univariate resilience, and (iii) PSNP positively associated with some dimensions, but not all.

Resilience in International Development

- Improving household and community resilience has become a key target of development and social protection programs in Africa.
- Since resilience is a latent variable without a consensus definition or measure, agencies conceptualize resilience differently.
  1. As the capacity to withstand exposure to negative stressors or shocks. (e.g., RIMA, TANGO)
  2. As return to equilibrium after shocks (e.g., Knippenberg et al., 2019)
  3. As an ability to achieve some normative condition (e.g., Cissé and Barrett 2018)
- Existing resilience measures all rely on a single well-being indicator, such as food expenditure or food consumption score (FCS).

Limitations to Existing Measures

- There is no single *best* well-being indicator.
- No indicator reliably captures other dimensions.
  - ex: Income/expenditure resilience measure may not capture nutritional resilience.
  - Households often trade off one sort of well-being for another to cope with shocks.
- It is unknown how sensitive evaluations of interventions are to different resilience measures.

Research Overview

- We first evaluate the implication of using alternative indicators of well-being for measuring resilience.
- We then introduce multidimensional measures of resilience by extending the moment-based approach.
  - We quantify households' resilience in three dimensions: consumption, nutrition and livestock holdings.
  - We propose a family of multidimensional resilience measures.
- We then study the association of these new multidimensional resilience measures with PSNP in Ethiopia.

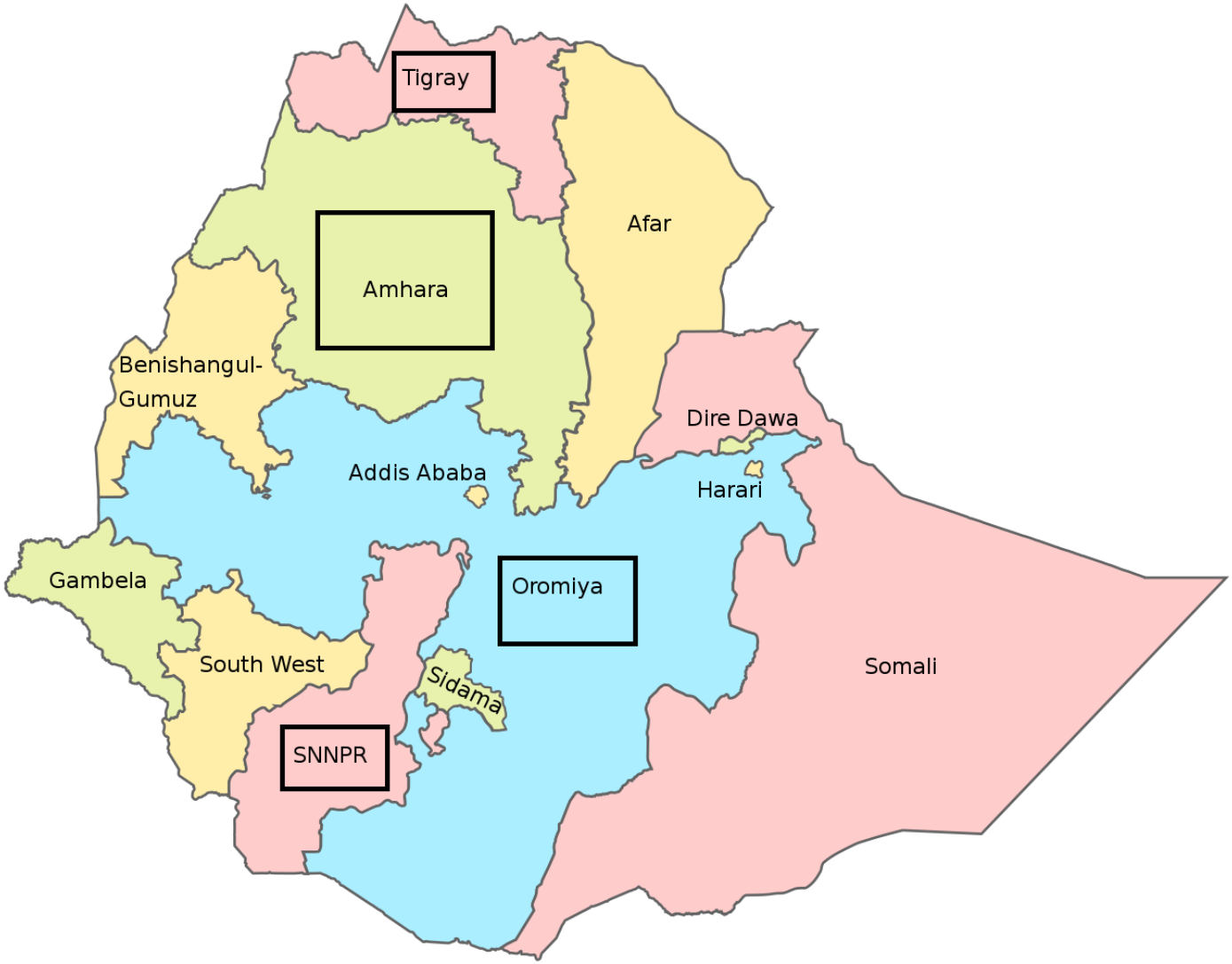
Data

- Household panel survey data in Ethiopia with five rounds;2006, 2008, 2010, 2012, 2014
- Sample size: 23,000 observations from 6,400 households.
- Study regions: Amhara, Oromiya, SNNP and Tigray
- Poor and/or food insecure rural households eligible for the Productive Safety Net Program (PSNP).
- Collected for the impact evaluation of the PSNP.

Productive Safety Net Program (PSNP)

- PSNP is a program to reduce household vulnerability and improve resilience to shocks of rural food insecure households.
  - Two components: public works (80%) and direct transfer (20%)
  - Eligibility determined by (1) chronic food insecurity (2) limited income from alternative sources (family support) (3) asset holdings
  - Two-stage random selection (district-level and household-level)
- Complemented by Household Asset Building Program (HABP), which facilitates access to credit services + technical support.

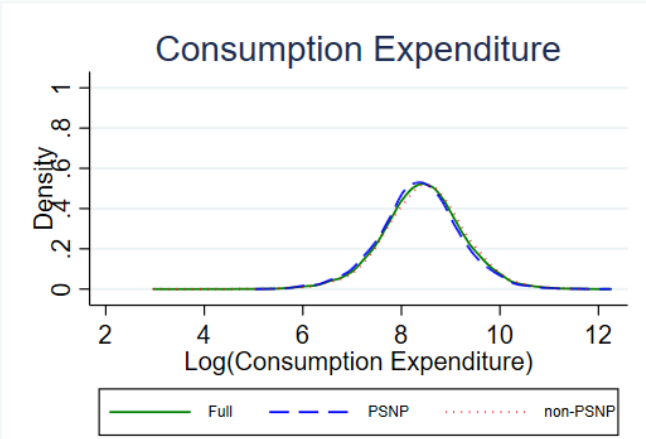
Study Area

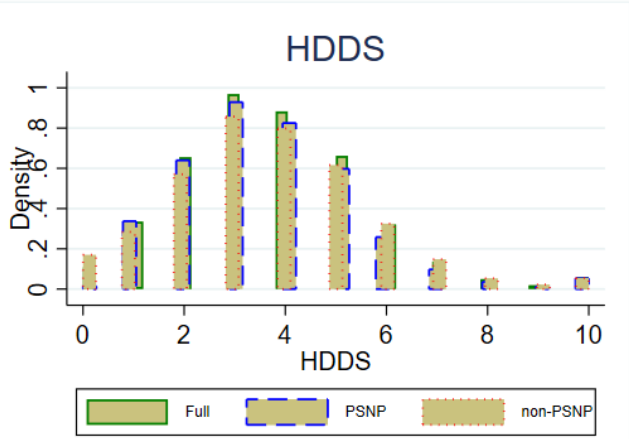

Tigray
Afar
Amhara
Benishangul-
Gumuz
Dire Dawa
Addis Ababa
Harari
Gambela
Oromiya
South West
Sidama
Somali
SNNPR

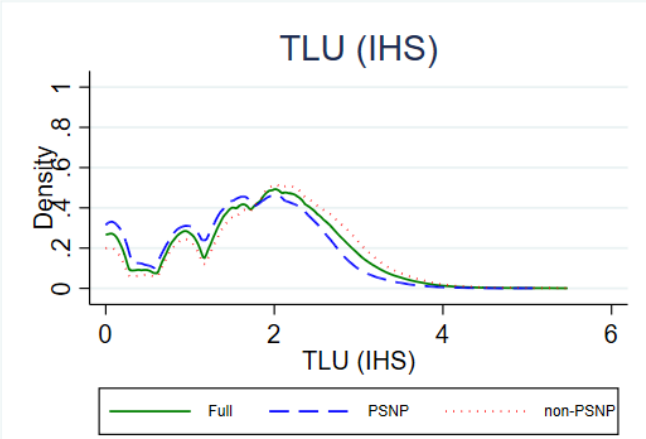
Well-being Indicators

- We conceptualize resilience as conditional probability to achieve some normative condition(s), defined by one or several well-being indicator(s).
- We use 3 indicators:
  - Annual consumption expenditure - **Poverty resilience**
  - Household Dietary Diversity Score (HDDS) - **Nutritional resilience**
  - Tropical Livestock Units (TLU) - **Asset resilience**
- Mostly normally distributed, at least after transformation.

Distribution of Well-being Indicators





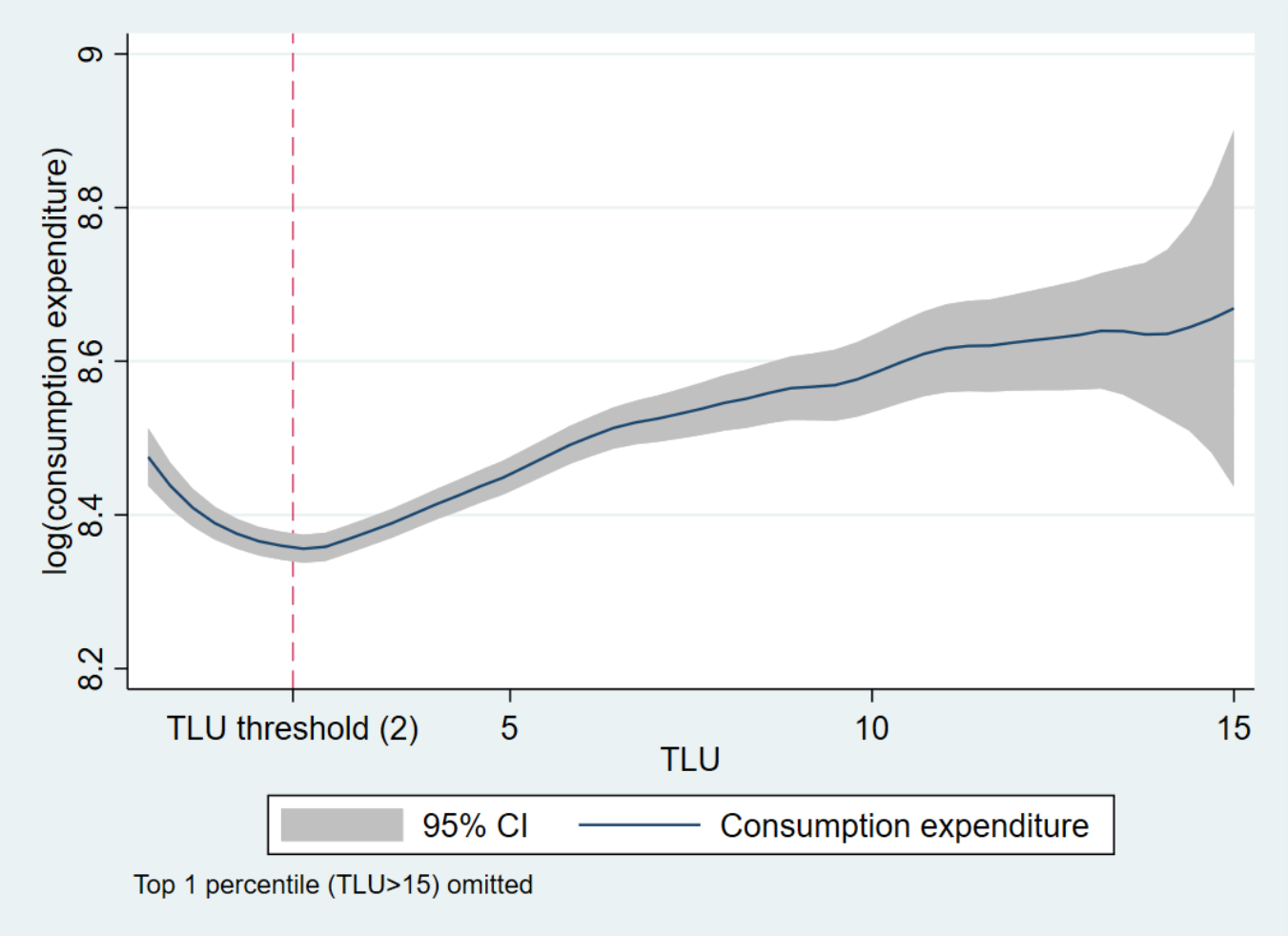


- PSNP and non-PSNP are nearly comparable.

Normative Thresholds

- For each well-being indicator, we need a well-defined threshold.
- For poverty resilience (consumption expenditure), we use the national poverty line of Ethiopia
- For nutritional resilience (HDDS), we use 5, the minimum threshold for women's diet quality per FAO and FHI360 (2016).
- For asset resilience, we use 2 TLU, based on two contextual/empirical patterns.
  - Two oxen/cows provide as a minimum threshold (Hoddinott 2006)
  - Consumption positively assoc w/ TLU only after 2 in our data.

Association between TLU and consumption



- Positively associated after TLU=2

Summary Stats

	count	mean	sd
Annual real consumption per aeu (USD)	16235	6464.26	7062.99
Household Dietary Diversity Score (HDDS)	16649	3.68	1.86
Tropical Livestock Unit (TLU)	15412	3.82	3.34
Male-headed household	16649	0.73	0.44
Age of household head	16301	47.76	15.37
Household head no education	16649	0.67	0.47
PSNP beneficiaries	16649	0.45	0.50
HABP beneficiaries	16649	0.42	0.49
PSNP benefit amount per capita*	7413	285.19	291.95

*Including only PSNP beneficiaries. Non-beneficiaries have zero-value.
All monetary variables are in 2014 constant price.

Well-Being Dynamics

	Consumption expenditure Below poverty line	HDDS Below 5	TLU Below 2
2006	0.80	0.81	0.26
2008	0.82	0.74	0.27
2010	0.62	0.70	0.25
2012	0.58	0.65	0.28
2014	0.45	0.59	0.32
Total	0.66	0.70	0.28

- Poverty and malnutrition rates have declined across rounds.

Measuring Resilience (1)

- We first construct univariate resilience measures using the 3-step moment-based approach (Cissé and Barrett *JDE* 2018).
  - Step 1: Regress well-being indicator on a set of variables.

$$W_{idt} = \alpha_0 + \alpha_1 W_{idt-1} + \alpha_2 W_{idt-1}^2 + \alpha_3 PSNP_{it} + \alpha_4 PSNPamt_{it} + \alpha_X X_{it} + \gamma_t + \mu_d + \mu_{idt} \quad (1)$$

    - W_{idt} : Well-being indicator of household i in district d in year t. (expenditure per AEU, HDDS, TLU)
    - $PSNP$ Binary indicator of program participation.
    - $PSNPamt$: PSNP benefit amount received.
    - X : Household characteristics
  - The predicted value $\hat{W}_{idt}$ is our estimated conditional mean.

Measuring Resilience (2)

- Step 2: Estmate conditional variance by squaring the residual from step 1 (ε_{it}^2) and regressing it on the same variables as in the step 1.
  - E $[\varepsilon_{it}^2] = \hat{\varepsilon}_{it}^2$ is estimated conditional variance.
- Step 3:Household resilience (τ_{idt}) = conditional probability that household welfare a normative threshold $\underline{W}$.

$$\begin{aligned} \tau_{idt} &= Pr(W_{it} \geq \underline{W} | X_{it}, W_{it-1}, PSNP_{it}) \\ &= 1 - F_{W_{it}}(\underline{W}; \hat{W}_{idt}, \hat{\sigma}_{idt}^2) \end{aligned} \tag{2}$$

- $F_{W_{it}}(\cdot)$: household-time-specific well-being CDF.

Measuring Resilience (3)

- Estimation of the CDF $F(\cdot)$ requires assuming that well-being indicators follow certain distribution.
- We observe outcomes are roughly normally distributed, so estimate the resilience as $\tau_{idt}(W_{it}) = 1 - \Phi(Z_{idt}|\cdot)$ where Z is the normalized Z-score $(Z_{idt} = \frac{W - \hat{W}_{idt}}{\sqrt{\hat{\sigma}^2_{idt}}})$

Measuring Multidimensional Resilience (1)

- We construct multidimensional resilience measures by aggregating multiple well-being indicators, by 2 approaches.
- We first construct the *weighted average resilience measures*, following Alkire and Foster (2011).

$$\tau_{ave,idt} = [\sum_{m=1}^{M} w_m {\tau_{idt}}^m]/M \tag{3}$$

  - M: the number of indicators aggregated
  - *w*: weight of indicator *m*

Measuring Multidimensional Resilience (2)

- Second, we construct bivariate and trivariate resilience measures, using union and intersection measures.
  - Union: At least one well-being indicator is above threshold.
  - Intersection: Multiple well-being indicators are above thresholds.

$$\begin{aligned}\tau_{uni,it} &= Pr(W_{1it} \geq \underline{W_1} \text{ or } W_{2it} \geq \underline{W_2}|\cdot) \\ &= 1 - F_{W_{1it},W_{2it}}(\underline{W_1}, \underline{W_2}; \hat{W}_{1idt}, \hat{\sigma}^2_{1idt}, \hat{W}_{2idt}, \hat{\sigma}^2_{2idt}, \hat{\rho}_{12})\end{aligned} \tag{4}$$

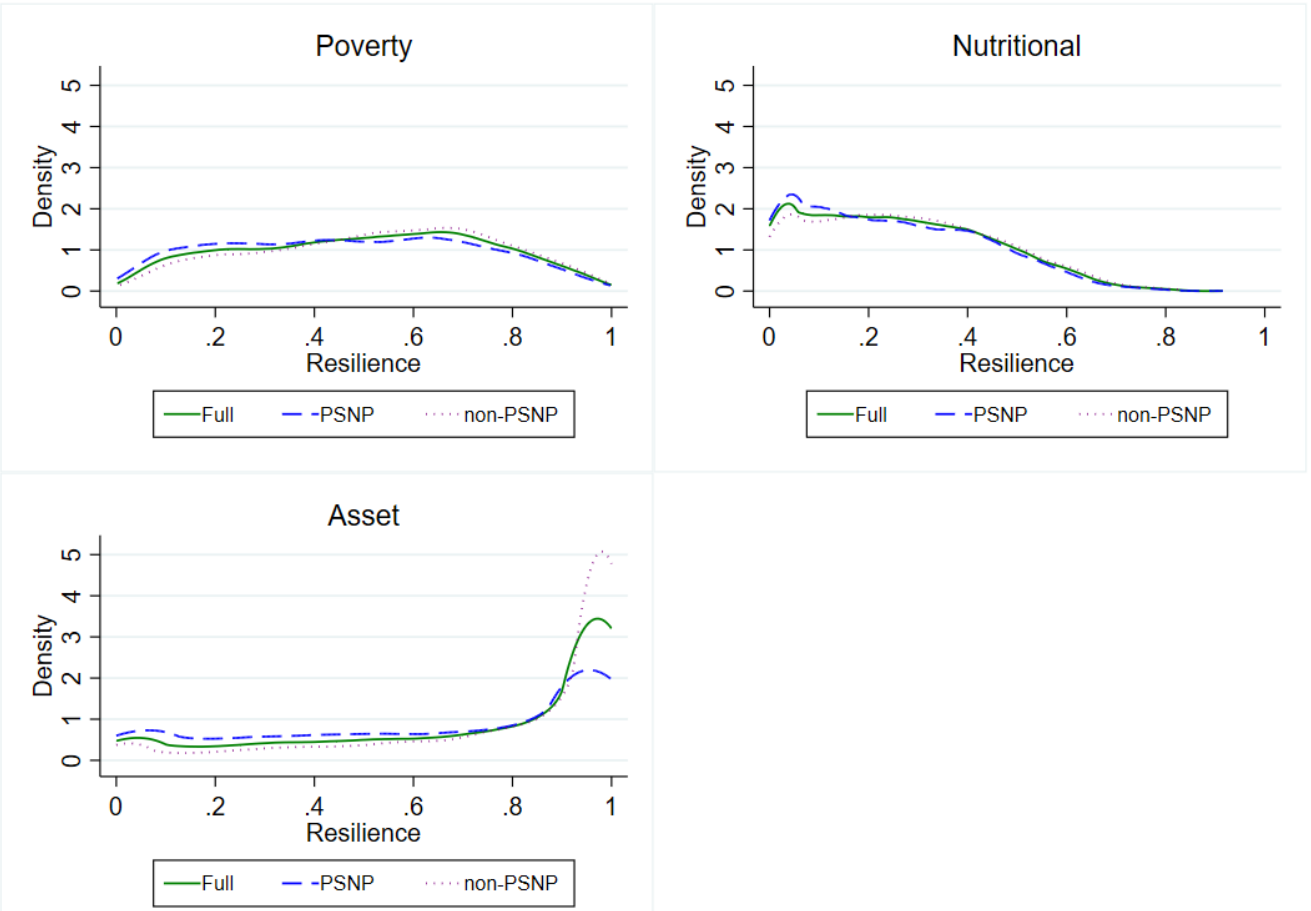
$$\begin{aligned}\tau_{int,it} &= Pr(W_{1it} \geq \underline{W_1}, W_{2it} \geq \underline{W_2}|\cdot) \\ &= 1 - F_{W_{1it}}(\underline{W_1}; \hat{W}_{1idt}, \hat{\sigma}^2_{1idt}) - F_{W_{2it}}(\underline{W_2}; \hat{W}_{2idt}, \hat{\sigma}^2_{2idt}) \\ &+ F_{W_{1it},W_{2it}}(\underline{W_1}, \underline{W_2}; \hat{W}_{1idt}, \hat{\sigma}^2_{1idt}, \hat{W}_{2idt}, \hat{\sigma}^2_{2idt}, \hat{\rho}_{12})\end{aligned} \tag{5}$$

Resilience Dynamics

	Poverty Resilience		Nutritional Resilience		Asset Resilience	
	(1) non-PSNP	(2) PSNP	(3) non-PSNP	(4) PSNP	(5) non-PSNP	(6) PSNP
2008	0.27	0.22	0.20	0.19	0.79	0.68
2010	0.54	0.49	0.24	0.24	0.81	0.66
2012	0.60	0.59	0.33	0.30	0.80	0.61
2014	0.67	0.66	0.32	0.28	0.80	0.59
Total	0.53	0.47	0.28	0.25	0.80	0.64

- Poverty and nutritional resilience have increased over time, but asset resilience has change little.

Distribution of Resilience Measures (1)



- Notable differences across measures.

Correlation among univariate resilience measures

Table: Correlation among univariate resilience measures

	Poverty	Nutritional	Asset
Poverty	1		
Nutritional	0.36	1	
Asset	0.11	0.16	1

Note: All singnificant at 95%

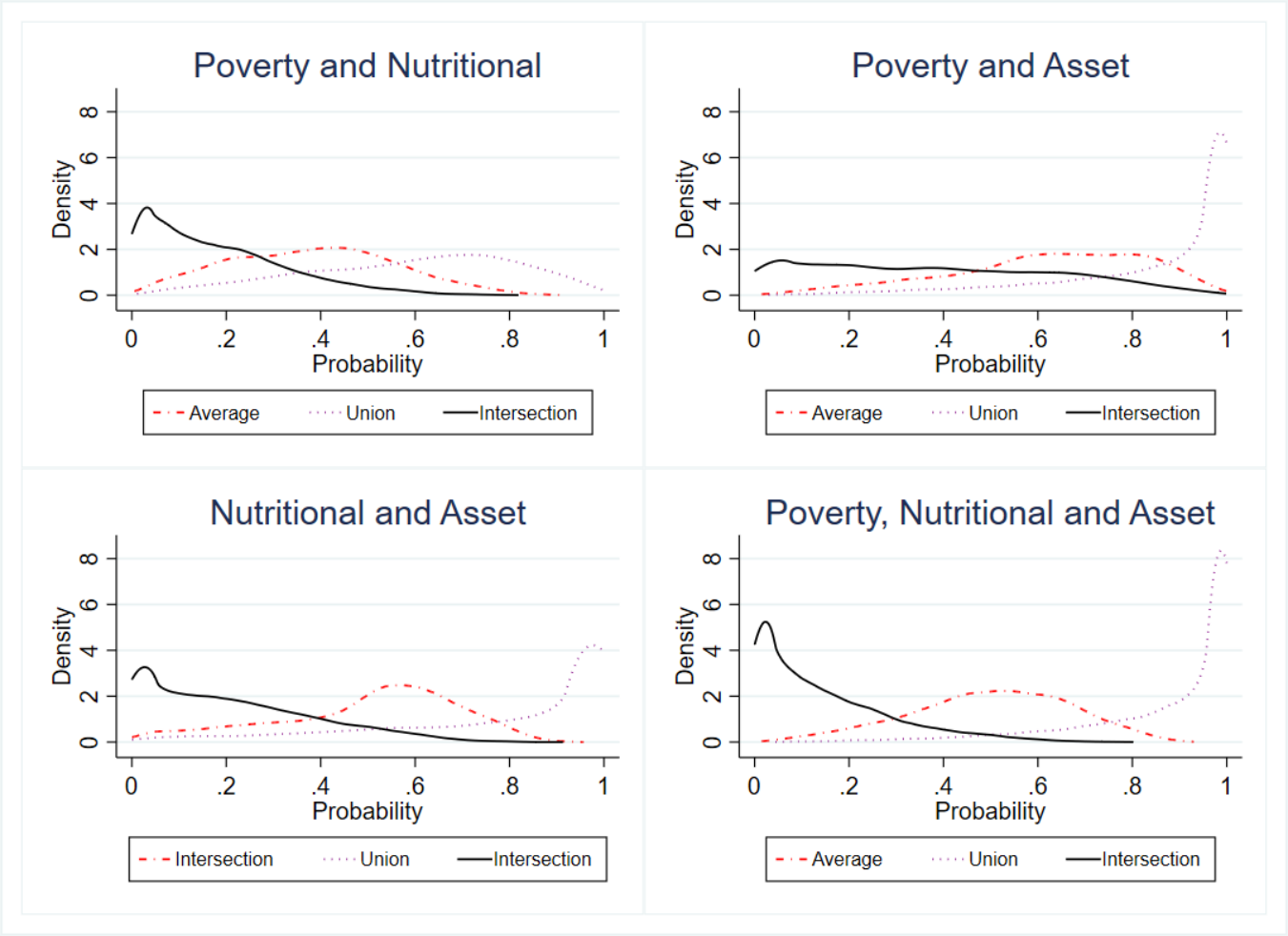
- Univariate resilience measures are weakly correlated one another
- A single measure of well-being might not sufficiently capture alternative dimensions of resilience

Univariate Resilience on Program Participation

	Poverty	Nutritional	Asset
Log(household head age)	-0.746***	-1.048***	0.745***
	(0.04)	(0.04)	(0.10)
Male headed household	-0.0267***	-0.0158***	0.0293***
	(0.00)	(0.00)	(0.01)
Household size	-0.0311***	0.0169***	0.0156***
	(0.00)	(0.00)	(0.00)
PSNP beneficiaries	-0.208***	0.0687***	0.00816
	(0.01)	(0.01)	(0.01)
IHS (PSNP transfer per capita)	0.0299***	-0.0148***	-0.0101***
	(0.00)	(0.00)	(0.00)
N	11410	11425	11035
R^2	0.964	0.943	0.850
Lagged outcome and controls	Y	Y	Y

- Resilience measures are differently associated with hh characteristics.
- Possible selection bias in PSNP

Distribution of Multivariate Resilience



- Distribution differs (a lot!) by the way aggregated.

Multivariate resilience association with PSNP (1)

	Poverty and Nutritional			Poverty and Asset		
	Avg	Uni	Int	Avg	Uni	Int
Log(household head age)	-0.897***	-0.982***	-0.812***	-0.00330	0.209**	-0.215**
	(0.029)	(0.041)	(0.038)	(0.056)	(0.084)	(0.096)
Male headed household	-0.0211***	-0.0242***	-0.0181***	0.00121	-0.00281	0.00524
	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)
Household size	-0.00717***	-0.0161***	0.00173***	-0.00785***	0.00282***	-0.0185***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
PSNP beneficiaries	-0.0694***	-0.139***	0.0000317	-0.100***	-0.0908***	-0.110***
	(0.007)	(0.011)	(0.014)	(0.007)	(0.014)	(0.014)
IHS (PSNP transfer per capita)	0.00751***	0.0181***	-0.00309	0.00994***	0.00866***	0.0112***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
N	11410	11410	11410	11027	11027	11027
r2	0.962	0.956	0.879	0.903	0.753	0.850
Other controls	Y	Y	Y	Y	Y	Y

- PSNP is differently associated with different resilience measures.
- Influencing a specific dimension may be easier than overall resilience.

Multivariate Resilience on Program (2)

	Nutritional and Asset			Poverty, Nutrition and Asset		
	(1) Avg	(2) Uni	(3) Int	(4) Avg	(5) Uni	(6) Int
Log(household head age)	-0.150***	0.292***	-0.592***	-0.350***	0.0924	-0.481***
	(0.056)	(0.104)	(0.076)	(0.041)	(0.081)	(0.060)
Male headed household	0.00664**	0.0197***	-0.00644*	-0.00450**	-0.00171	-0.00798***
	(0.003)	(0.006)	(0.003)	(0.002)	(0.004)	(0.002)
Household size	0.0162***	0.0165***	0.0159***	0.000350	0.00466***	0.00239***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
PSNP beneficiaries	0.0389***	0.0134	0.0645***	-0.0436***	-0.0699***	0.0153
	(0.008)	(0.011)	(0.011)	(0.006)	(0.012)	(0.011)
IHS (PSNP transfer per capita)	-0.0126***	-0.0113***	-0.0139***	0.00161	0.00531***	-0.00532***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
N	11035	11035	11035	11027	11027	11027
r2	0.890	0.821	0.833	0.925	0.737	0.798
Controls	Y	Y	Y	Y	Y	Y

Summary

- Univariate resilience indicators are weakly correlated w/one another, highlighting the importance of exploring multidimensional resilience.
- Multidimensional resilience indicators exhibit significantly different distributions and orderings compared to that of univariate indicators.
- Social protection programs aimed to build resilience are positively associated with resilience in some dimensions, while negligible or negatively associated on other dimensions.

Thank you

Questions and/or comments are highly appreciated.