Do crop income shocks widen disparities in smallholder agricultural investments? Panel survey evidence from Zambia

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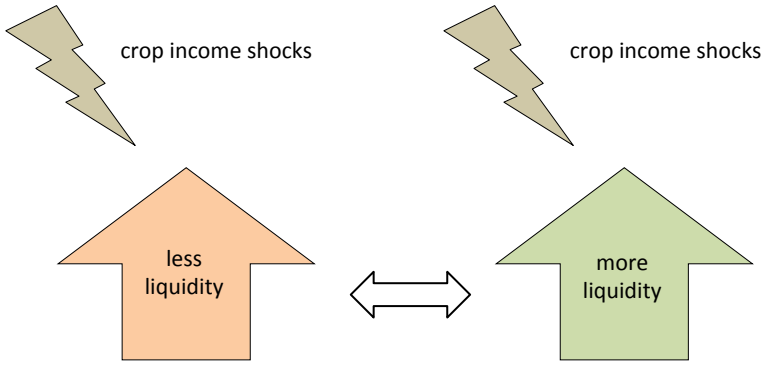
Outline

- Conceptual framework and setting
- Research question*: Does liquidity 'shield' input decisions from income shocks?*
- Related literature
- Empirical specification and data
- Results
- Conclusions

Kusunose and Lybbert's (2014) conceptual model



liquidity constraint BINDS
Households respond by
- reducing consumption
- "renting out" assets
- reducing crop inputs

liquidity constraint DOES NOT BIND
Households respond by
- maintaining consumption
- "renting in" assets
- maintaining/increasing crop inputs

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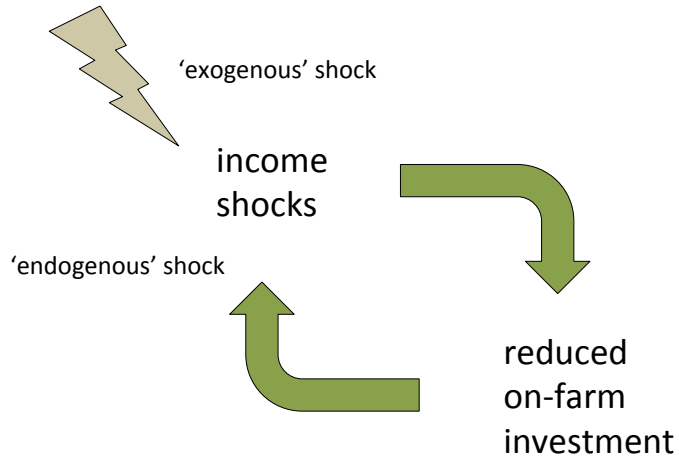
A *poverty trap* for liquidity-constrained households?



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Related empirical studies

- Income and farm inputs
  - Mathenge et al. (2015) *Kenya*
- Cash transfers and farm productivity
  - Boone et al. (2013) *Malawi*
- Subsidies and fertilizer use
  - Duflo et al. (2011) *Kenya*
- Shocks and off-farm work
  - Fink et al. (2014) Zambia
  - Mathenge and Tschirley (2015) *Kenya*

Zambian smallholders

- Chronically poor households earn the majority (66-74%) of their income from on-farm activities. (Chapoto et al. 2011)
- Maize is a major staple food crop; it is grown by the vast majority of households.
- Income shocks arise from illness, death, pests, and insufficient/ill-timed rains. (Chapoto et al. 2011, Mason et al. 2010)
- Reduced investment in maize production can lead to reductions in future income, consumption, and savings. (Smale and Mason 2014)
- Do income shocks cause farmers—particularly liquidity-constrained farmers--to reduce maize investments (area, fertilizer, hybrid seed, weeding effort)?

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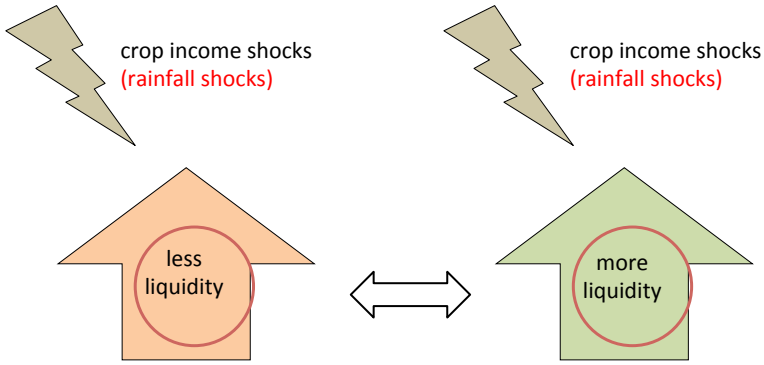

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Empirical specification

- *ΔI* change in input (area, fertilizer, seed, and weedings)
- *R* rainfall shock (proxy for income shock):
  number of 20-day periods with less than 40 mm of rainfall
- *L* liquidity variables
  - livestock
  - credit access
  - non-agricultural wage earners
  - Farmer Input Support Program (FISP) participation
- *X* covariates: AEZ, input prices, maize grain price

$$\Delta I_i = \beta_R R_v + \beta_{RL} R_v L_i + \beta_L L_i + \boldsymbol{\beta_{RX}}' R_v \boldsymbol{X_i} + \boldsymbol{\beta_x}' \boldsymbol{x_i} + \epsilon_i$$

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Instrumental Variables estimation

Liquidity variables (suspected endogenous)
- credit access
- livestock
- off-farm, non-farm wage earners
- Farmer Input Support Program (FISP) participation

Instrumental variables
- village mean of credit access (excluding household)
- village mean of landholdings (excluding household)
- distance variables (livestock marketing center, dip tank, school, electricity)
- educational attainment of household head
- district-level allocation of maize seed and fertilizer for FISP (Mason and Ricker-Gilbert 2013)
- constituency-level past presidential election outcomes (Mason and Ricker-Gilbert 2013)

Data

Tropical Applications of Meteorology using SATellite data (TAMSTAT)

- high-resolution, dekadal rainfall data for 2010/2011

Rural Agricultural Livelihoods Survey (RALS) by IAPRI/CSO/MAL (8839 households);

RALS largest maize field survey (1684 households)

- household maize input data for 2010/11 and 2011/12
  - area of main maize field
  - fertilizer
  - hybrid seed
  - weeding effort
- liquidity variables, control variables, instrumental variables as observed in 2010/011

		Zone 1: Western Semi-Arid Plains	Zone 2: Luangwa-Zambezi Rift Valleys	Zone 3: Central, Southern and Eastern Plains	Zone 4: Northern High Rainfall Zone
	obs.	120	140	733	690
area	*decreased*	0.267	0.371	0.572	0.336
	no change	0.492	0.364	0.144	0.343
	increased	0.242	0.264	0.284	0.302
fertilizer	*decreased*	0.033	0.143	0.288	0.271
	no change	0.850	0.693	0.471	0.422
	increased	0.117	0.164	0.241	0.307
hybrid maize seed	*decreased*	0.125	0.179	0.263	0.222
	no change	0.717	0.571	0.511	0.452
	increased	0.158	0.250	0.226	0.326
weedings	*decreased*	0.167	0.171	0.129	0.142
	no change	0.667	0.721	0.729	0.632
	increased	0.167	0.107	0.143	0.226
rainfall deficit periods	0	76.67	37.14	20.91	63.62
(number of 2-dekad	1	23.33	42.86	53.88	23.48
intervals with less	2	0	14.29	23.55	12.90
than 40mm of rainfall)	3	0	0	1.66	0
	4	0	5.71	0	0

	Zone 1: Western Semi-Arid Plains	Zone 2: Luangwa-Zambezi Rift Valleys	Zone 3: Central, Southern and Eastern Plains	Zone 4: Northern High Rainfall Zone
LIQUIDITY VARIABLES				
credit (binary)	0.115	0.401	0.487	0.250
access to at least one credit source	(0.320)	(0.492)	(0.500)	(0.433)
livestock (TLU)	0.049	0.641	0.767	0.309
pigs, goats, and sheep in April 2011	(0.236)	(1.285)	(1.337)	(0.794)
earners	0.042	0.129	0.148	0.207
no. of members with non-ag. wages	(0.201)	(0.357)	(0.423)	(0.443)
FISP (binary)	0.108	0.221	0.449	0.509
rec'd FISP maize seed and/or fertilizer in 2010/11	(0.312)	(0.417)	(0.498)	(0.500)

OLS, 2SLS, and 2SGMM results: area and fertilizer

	Change in area (ha)			Change in total nutrient nitrogen (kg)		
	OLS	**2SLS**	**GMM**	**OLS**	**2SLS**	**GMM**
rainfall shock	0.67	0.84	1.27	-52.89	-192.32	-187.97
liquidity variables						
shock X credit	-0.19***	-0.10	-0.22	-6.12	34.42	26.34
shock X TLUs	0.00	0.38*	0.36*	4.02	13.03	10.09
shock X earners	0.07	0.37	0.17	4.63	-1.65	-19.76
shock X FISP	-0.11*	-0.52	-0.30	-5.72	-0.58	18.13

OLS, 2SLS, and 2SGMM results: seed and weedings

	Change in total hybrid maize seed (kg)			Change in number of weedings		
	OLS	**2SLS**	**GMM**	**OLS**	**2SLS**	**GMM**
rainfall shock	19.09	39.07	-67.76	-0.13	1.43	1.17
liquidity variables						
shock X credit	-0.63	3.03	-12.94	0.02	-0.66**	-0.58*
shock X TLUs	0.34	15.25	-3.03	0.01	-0.07	-0.01
shock X earners	3.47	14.74	0.05	0.01	0.05	0.15
shock X FISP	-2.38	-28.66	-14.39	-0.00	0.45	0.27

First-stage regression results

	shock x credit	***shock x TLUs***	***shock x earners***	***shock x FISP***	***credit***	***TLUs***	***earners***	***FISP***
Partial R-sq	0.049	0.020	0.138	0.041	0.049	0.017	0.165	0.037
Angrist-Pischke R-sq	0.017	0.012	0.025	0.007	0.019	0.006	0.041	0.007
F test of excluded instruments								
F(22, 418)	3.029	2.139	5.333	1.768	3.932	1.925	8.828	2.662
p-value	0.000	0.002	0.000	0.018	0.000	0.008	0.000	0.000
Sanderson-Windmeijer multivariate F test of excluded instruments								
F(15, 418)	1.986	2.238	0.870	1.005	2.247	0.664	1.159	0.966
p-value	0.015	0.005	0.598	0.449	0.005	0.820	0.301	0.491
Angrist-Pischke multivariate F test of excluded instruments								
F(15,418)	3.912	3.351	6.334	0.949	1.786	0.723	4.407	0.709
p-value	0.000	0.000	0.000	0.509	0.034	0.762	0.000	0.776

Test of overidentifying restrictions

Hansen's J test of overidentifying restrictions

equation	Chi-squared (12)	p-value
area	13.50	0.48
fertilizer	7.98	0.89
hybrid maize seed	13.72	0.47
weedings	11.27	0.66

Summary and conclusions

- Livestock may buffer area cultivated from negative income shocks.
- Households with credit are more likely to reduce weeding effort in response to negative shocks.
- Results are inconclusive.
  - Weak instruments—low first-stage correlation, especially for *livestock* and *FISP* variables
  - Short panel precludes panel data methods, complicates interpretation of results
- FOR THESE REASONS, results do not necessarily refute model.

Interpreting the contemporaneous correlation matrix

	area	*fertilizer*	*hybrid seed*	*weedings*
area	1.20			
fertilizer	43.21	8022.90		
hybrid seed	17.37	319.45	2145.17	
weedings	-0.02	-7.37	-0.51	0.52