Labor Response to Climate Variation in Eastern Africa

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- Africa is likely to experience warming in excess of 2 standard deviations (IPCC 2013; Niang et al., 2014)
- Heat stress affects productivity in agriculture (Schlenker et al., 2006; Seo et al., 2009; Lobell et al., 2011, 2012) and perhaps other sectors (Hsiang, 2010; Dell et al., 2012; Burke et al., 2015)
- Adaptation is a key component of the UN Framework Convention on Climate Change agreements and development assistance
- Worker response to temperature is poorly understood, especially in Africa

What do we do?

- Take individual panel Living Standards Measurement Study microdata (55,277 person-years, ages 15–65) on participation in 7 activities over previous 12 months

Agriculture		Non-agriculture				
Wage	Self-employed	Wage	Self-employed	Migrate*	School	Not employed

*Temporary: away for at least 1 of previous 12 months

- for four East African countries: Malawi (2010, 2012), Uganda (2009, 2010, 2011), Tanzania (2008, 2010, 2012), Ethiopia (2011, 2013);

- merge with temperature and rainfall taken from NASA's Modern-Era Retrospective Analysis for Research and Applications (MERRA);
    1. Take the mean of the monthly values over a 24-month period leading to the interview month t
    2. 24-month period allows for lagged effects on employment outcomes
    3. Derive z-scores to characterize deviations in climate relative to all other consecutive 24-month periods between 2000 and 2014
- to see how temperature affects worker responses.

To anticipate where needs for climate adaptation resources will likely be highest.

Do increasing temperatures lead to productivity shocks that

- provoke rural out-migration?(Barrios et al., 2006; Dillon et al., 2011; Poelhekke, 2011; Marchiori et al., 2012; Henderson et al., 2017; Gray and Mueller, 2012a,b; Gray and Bilsborrow, 2013; Hunter et al., 2013; Mueller et al, 2014; Gray and Wise, 2016)
- cause a shift from agricultural to nonagricultural activity? (Kochar, 1999; Mathenge and Tschirley, 2015; Colmer, 2016)
- cause a shift from self to wage employment? (Rose, 2001)
- cause rural unemployment?

- Workers allocate time h across K activities with income y_k to maximize utility from consumption c and leisure s.
- Return from each activity except leisure depends on individual characteristics d and local climate z.

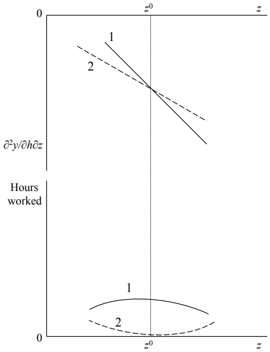
$$\max_{c,s} \left\{ U(c,s) : c = \pi(\mathbf{h}; \mathbf{d}, \mathbf{z}); s = \bar{h} - \sum_{k=1}^{K} h_k \right\},$$

where π denotes total income,

$$\pi(\mathbf{h}; \mathbf{d}, \mathbf{z}) = \sum_{k=1}^{K} y_k(h_k; \mathbf{d}, \mathbf{z}).$$

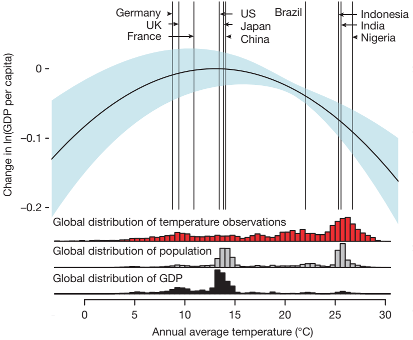
marginal return to each activity equals marginal rate of substitution of leisure for consumption.

Result: Relative, not absolute, climate productivity impacts determine time allocated to each activity.



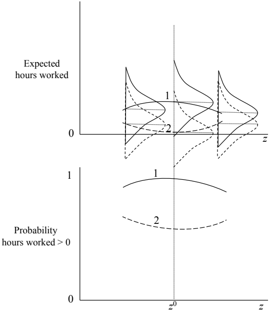
Result: Only changes in overall non-employment rates indicate a productivity impact.

Several reasons why monotonic productivity impact can produce non-monotonic time response, even for warm countries



Source: Burke et al. (2015)

Result: Changes in continuous hours can be transmitted to discrete participation decisions (our data)



Data: Descriptive Statistics

	Urban	Rural	Total
Occupational participation rates			
Agriculture			
Wage labor	0.03	0.09	0.07
Self-employed	0.51	0.84	0.78
Non-agriculture			
Wage labor	0.18	0.07	0.09
Self-employed	0.23	0.15	0.16
Migrate	0.12	0.11	0.11
School	0.18	0.13	0.14
Non-participant	0.14	0.06	0.07
Climate			
Temperature z-score	0.52	0.35	0.39
	(0.97)	(0.99)	(0.99)
Rainfall z-score	-0.07	-0.15	-0.13
	(0.88)	(0.84)	(0.85)
Other			
Female	0.52	0.51	0.52
Large landowner	0.40	0.55	0.52
Observations	15,241	40,036	55,277

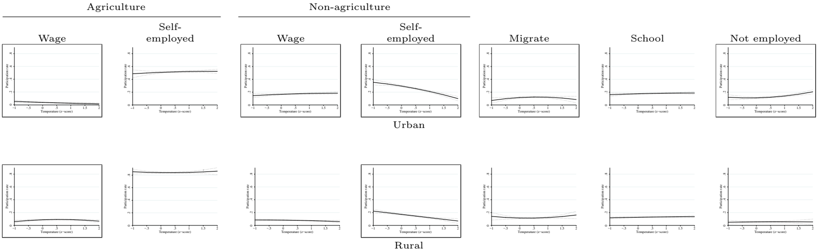
Linear probability model for seven activities

$$L_{ikt} = \sum_{\ell=1}^{2} d_\ell \left[\sum_{m=1}^{2} \left[\beta_{k\ell m} z_{imt} + \beta_{k\ell mm} \left[z_{imt} \right]^2 \right] + \beta_{k\ell 12} z_{i1t} z_{i2t} \right]$$
$$+ \gamma_{ik} + \tau_k(t) + \epsilon_{ikt},$$

for $\ell = \{\text{rural, urban}\}$, $\qquad m = \{\text{temperature, rain}\}$.

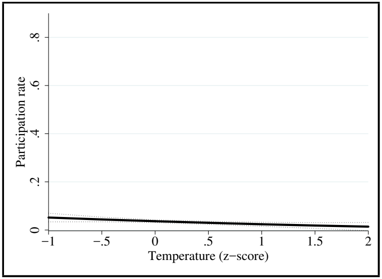
- individual fixed effect
- quadratic time trend–robust to linear, linear country, linear rural and urban, linear country rural and urban time trends
- standard errors clustered by baseline enumeration area
- use sampling and inverse probability weights accounting for attrition–robust to exclusion of ipw (Fitzgerald et al., 1998)
- q-values for false discovery rates (Anderson, 2008)

Main Results

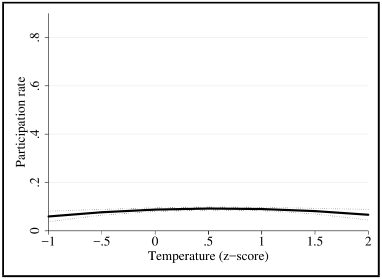


High temperature decline in agricultural wage labor

Agricultural wage employment



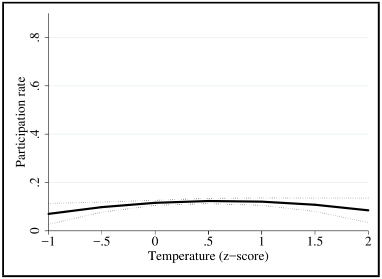
Urban



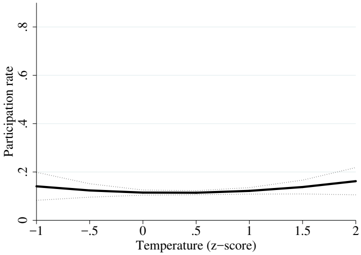
Rural

High temperature decline in *urban* outmigration

Migration

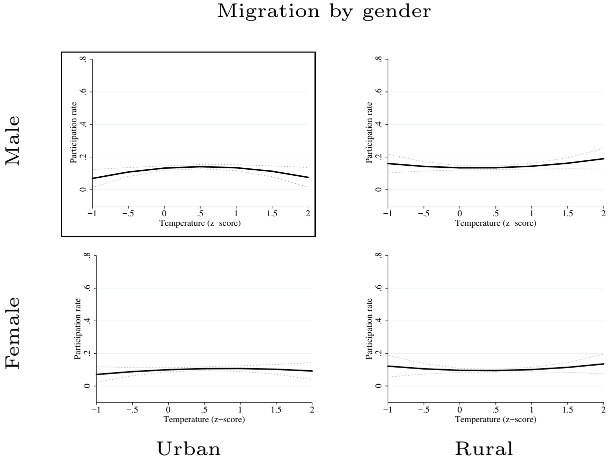


Urban

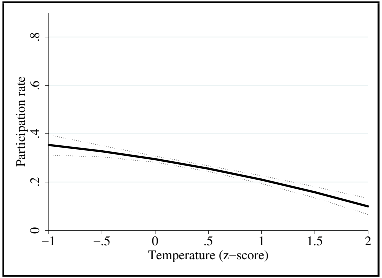


Rural

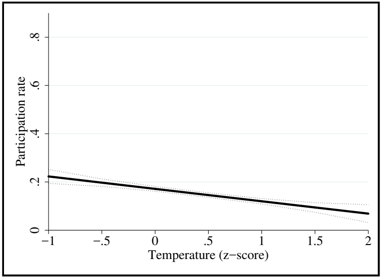
High temperature decline in *male* urban outmigration



Non-agriculture self-employed

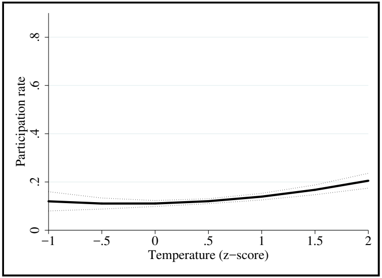


Urban

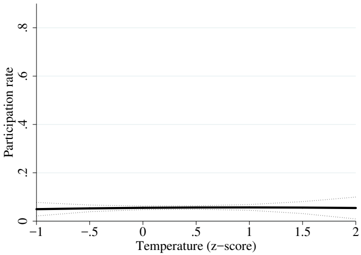


Rural

Not Employed



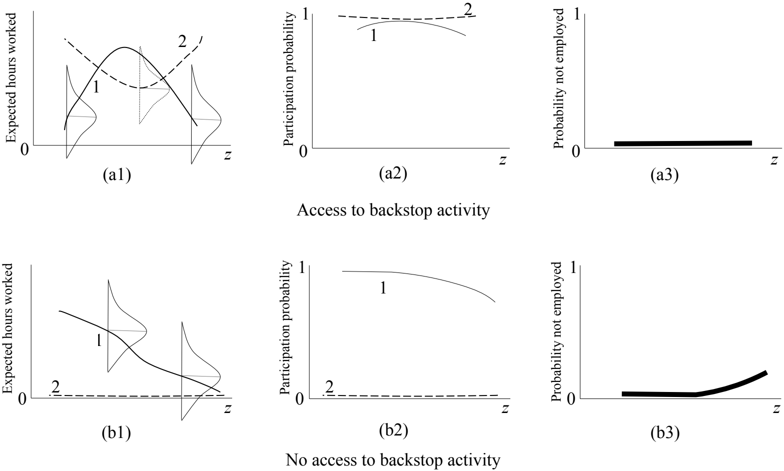
Urban



Rural

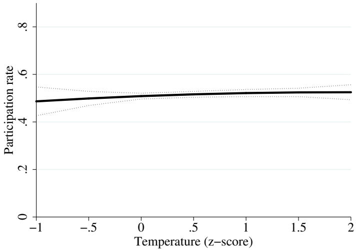
Why Urban Areas?

Agricultural self-employment as a "backstop" activity (Theoretical Extension)

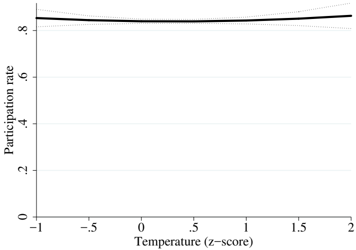


Lower probability of engaging in agricultural self employment backstop

Agricultural self employment



Urban



Rural

Is there a barrier to entry to agricultural self-employment?

Cannot observe directly

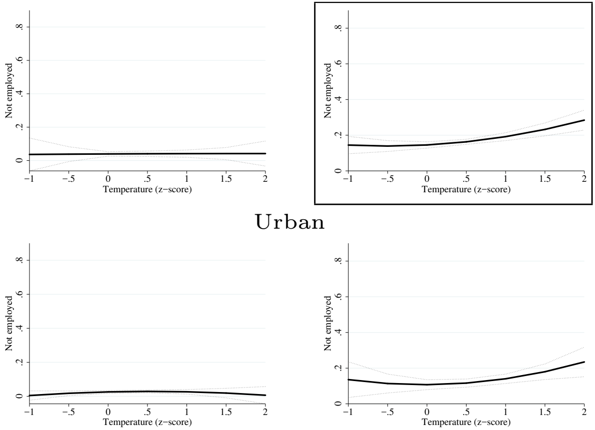
Instead, divide sample engaging in an activity besides agricultural self-employment into two groups:

- Have engaged in the other activity *and* ag self employment in the same year ("access")
- Have engaged in the other activity *but not* ag self employment in the same year ("no access")

If no barrier, probability of not employed should be same across groups.

Probability not employed

Access | No Access

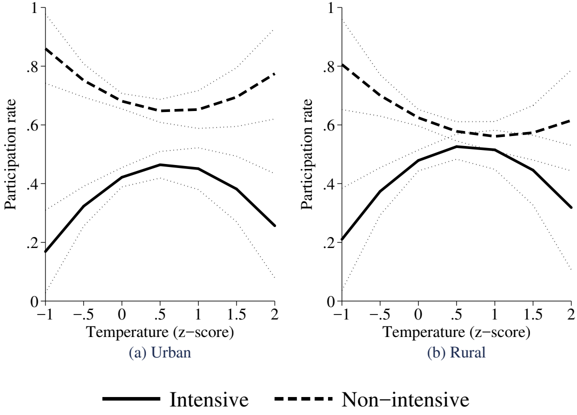


Urban

Rural

Only non-agricultural self employment reliant on agricultural inputs sees participation decline with high temperatures

Participation in non-agricultural self employment, conditional on agricultural input intensity



(a) Urban

(b) Rural

At high temperatures:

- Urban unemployment increases
  - reduced migration
  - nonagricultural self employment reliant on agricultural inputs
- Rural unemployment unaffected
  - nonagricultural self employment reliant on agricultural inputs falls
  - high levels of agricultural self-employment independent of temperature

Empirical results consistent with following narrative.

Agricultural self-employment is a backstop occupation. People always work a little on family plot, regardless of temperature. At high temperatures, however, agricultural productivity declines, causing:

- reduced demand for agricultural wage labor and temporary urban migrants (Potts 1995, 2013; Tacoli 2001)
- reduced demand for labor in sectors for which it is a complement to agricultural inputs (e.g., food vendors)
- reduced employment in urban areas since relatively little access to agricultural self-employment

As temperatures in East Africa increase with global climate change, we may

- not see migration from rural to urban areas, but reduced migration from urban to rural
- not see a shift from agricultural to non-agricultural employment (i.e., complements)
- see increased unemployment and attendant social disruption primarily in urban areas

May be greater need for adaptation in urban areas due to agricultural linkages.