

The Environmental Impacts of Microfinance: Index-Based Livestock Insurance and East African Rangelands

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- Sparse empirical work, in large part due to data constraints.
- Downside especially worrisome for index-based livestock insurance (IBLI).
Upside would expand microfinance's enumerated benefits.

Index-Based Livestock Insurance (IBLI): purpose and impacts

- IBLI is a successful micro-insurance product that has scaled from an ILRI-run pilot to 4 countries and growing:
 - product addresses missing financial services access and catastrophic drought-related herd mortality associated with poverty traps in East African pastoralist communities.
 - contracts provide 12 months' coverage across 2 rainy/dry season sales and payout periods; NDVI-based index; pilots in 2010, 2012, w/broad expansion after.

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- *Big unknown: might IBLI induce the losses it seeks to insure against via negative impacts on rangelands?* rangeland defn.
 - theoretically ambiguous, w/ mixed evidence @ household level regarding sign of impacts on herd size and herding effort. (Matsuda et al. 2019, Jensen et al. 2017, Toth et al. 2017, Son 2021)
 - Models predict neg. effects (Bulte and Haagsma 2021; Jon et al. 2019)

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Data: aggregated to index insurance units (11K km²) and sub-watershed units, down to HUC-12 (125 km²).

* **IBLI:** admin data on all semi-annual IBLI sales in East Africa 2010-2020

* **Rangeland quality:** remotely sensed rangeland health (RH) measures, 2000-2020: 30m land cover and fractional cover (Soto et al. 2024); 250m MODIS data; 5km SIF data

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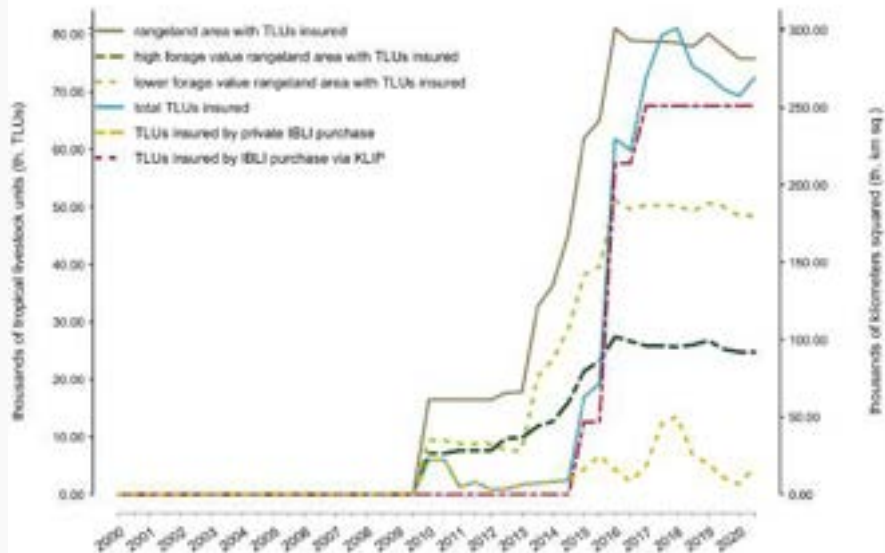
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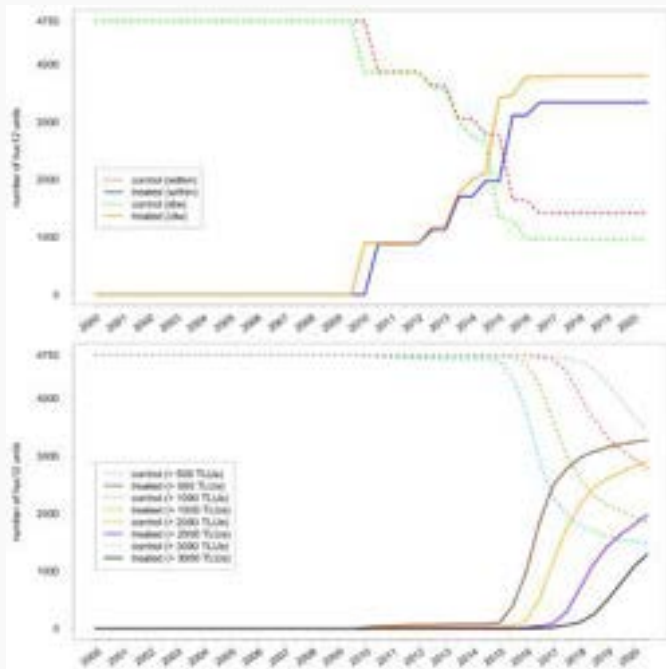
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Treatment: binary variables reflecting margins of IBLI exposure (*down-scaled to sub-watershed units & inverse-distance weighted to incorporate spill-over effects from herder movement*). exposure

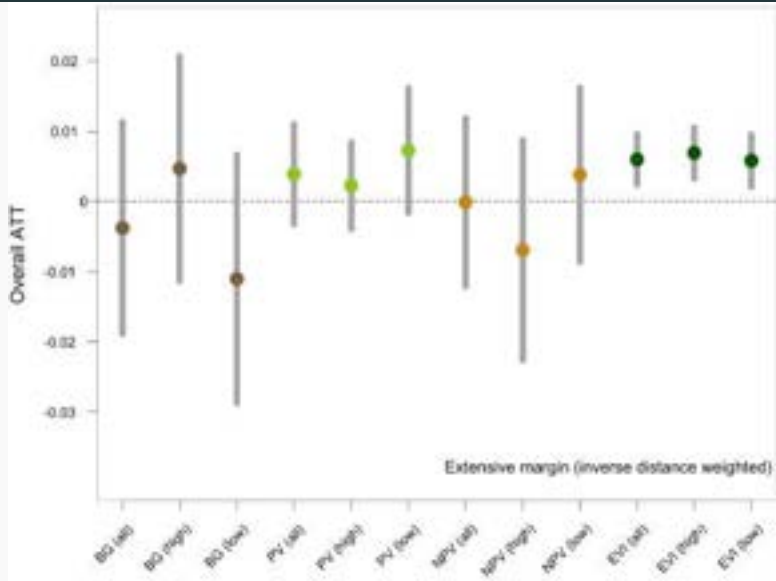




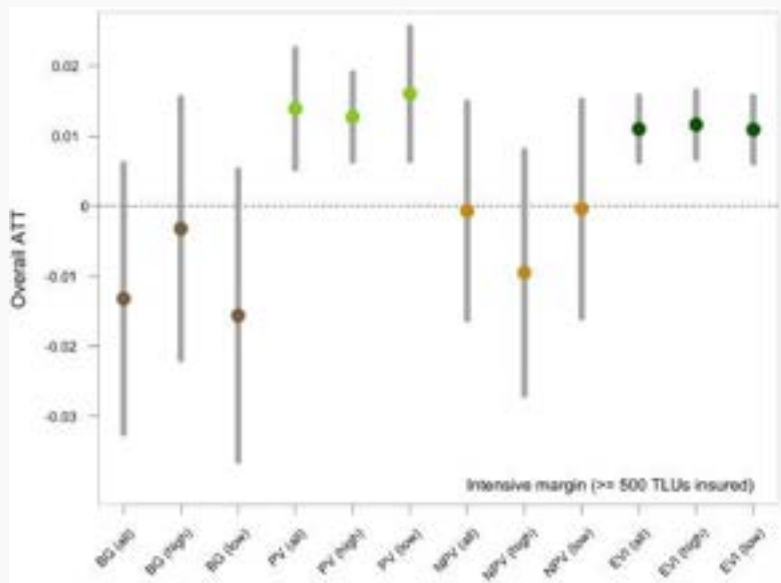
Rangeland quality trends

- Vector of fractional cover metrics, vegetation indices, summarized by 8 rangeland types, 4 different levels of aggregation.
 - fractional cover in SRSD only (21 years of variation); observe vegetation indices in LRLD and SRSD (42 periods; 250m MODIS).
- Unconditional trends:
 - Swings associated w/ weather apparent (esp. wet/dry periods); no obvious trend breaks; slow and slight increases in bare ground and photosynthetic vegetation. fc vi
- Conditional trends: Comparison of average trends before exposure to IBLI are very similar. conditional-fc conditional-vi

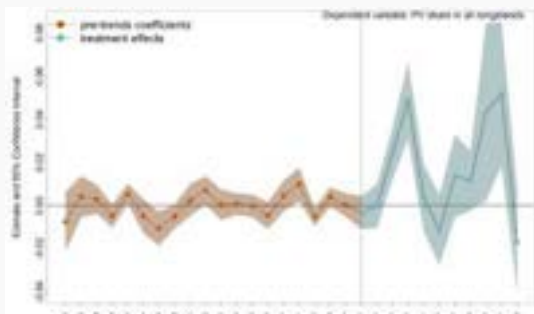
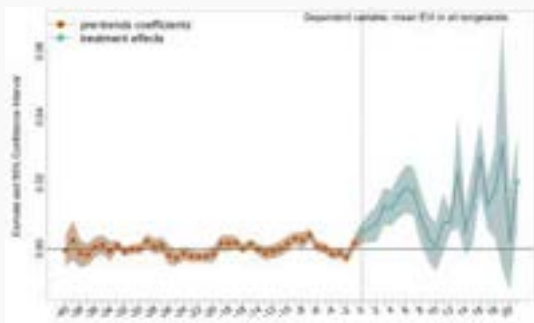
Results: extensive margin average impacts across all rangelands



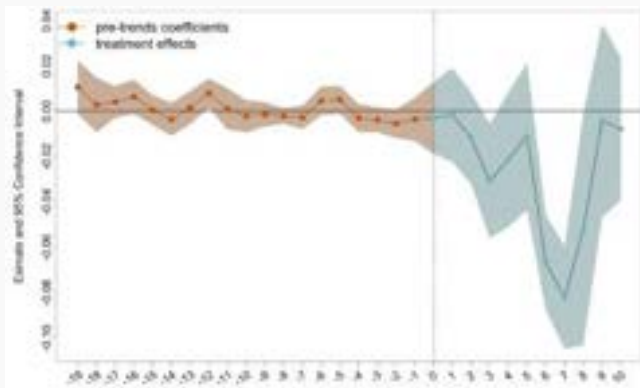
Results: intensive margin average impacts across all rangelands



Results: intensive margin event study view, EVI/PV (all)



Results: intensive margin event study view, bare ground (all)



- Our findings clearly do **not** support the hypothesis that IBLI has had negative impacts on rangeland quality. Indicators are all neutral to positive (e.g., increase greenness and photosynthetic vegetation cover).

Conclusion

- Our findings clearly do **not** support the hypothesis that IBLI has had negative impacts on rangeland quality. Indicators are all neutral to positive (e.g., increase greenness and photosynthetic vegetation cover).
- Implications: not only are the worst fears – that IBLI might induce overstocking, causing the losses it is trying insure against – not true, there may even be favorable rangelands impacts.



Thank you! Comments welcome: cbb2@cornell.edu

Appendix

TWFE and associated tests from Jakiela 2021:

$$Y_{i,s,t} = D_{ist}\delta + \mathbf{X}'_{i,s,t}\beta + \gamma_i + \sigma_t + \varepsilon_{i,s,t}$$

negative weights

Gardner et al. 2024 two-stage DiD:

Step 1: For treatment D_{ist} , subset to all untreated observations (i.e., such that $D_{ist} = 0$) and regress $Y_{i,r,s,t}$ on fixed effects and controls $\mathbf{X}_{i,s,t}$:

$$Y_{i,r,s,t} = \mathbf{X}'_{i,s,t}\theta + \gamma_i + \sigma_t + \mu_{i,r,s,t} \quad (1)$$

Step 2: Take the $\hat{\theta}$ estimates from step 1 and regress adjusted $Y_{i,r,s,t}$, defined as $\ddot{Y}_{i,r,s,t} = \tilde{Y}_{i,r,s,t} - \widetilde{\mathbf{X}}'_{i,s,t}\hat{\theta}$, on treatment dummy D_{ist} where \tilde{Y} and $\widetilde{\mathbf{X}}'$ are residualized from the fixed effects estimated in the first step.

$$\ddot{Y}_{i,r,s,t} = D_{ist}\beta + \ddot{\varepsilon}_{i,r,s,t} \quad (2)$$

Data: constructing IBLI exposure

Challenge: *How to account for herder movement and down-scale IBLI exposure to affected rangelands within each unit?*

Answer: *Use the all rangelands mask and define a “neighborhood” to inverse distance weight exposure from units j in unit i .*

$$WIBE_i = IBE_i + \sum_{j \sim i} \frac{(\mathbf{1}_j w_{ij} IBE_j)}{\sum_{j \sim i} \mathbf{1}_j w_{ij}}$$

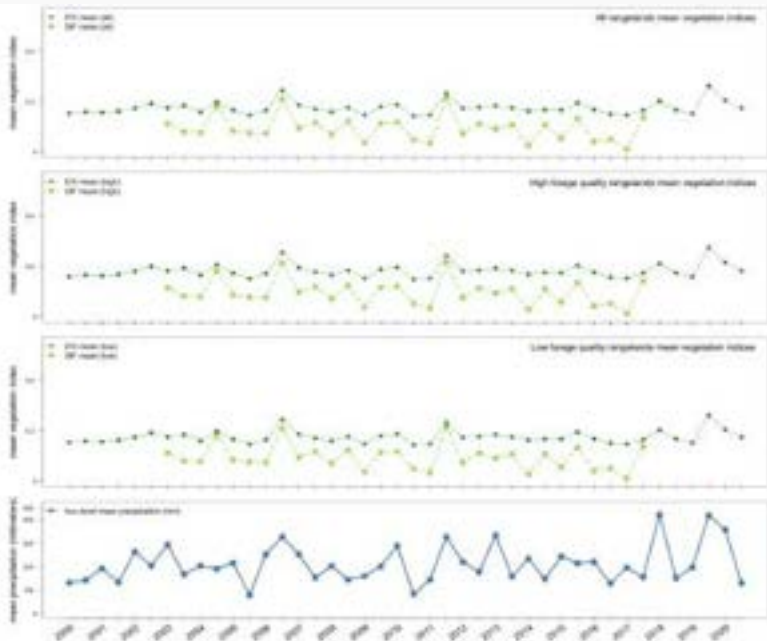
Define neighborhood, $\mathbf{1}_j$: SRSD grazing extent ≈ 63 km [grz fig](#)

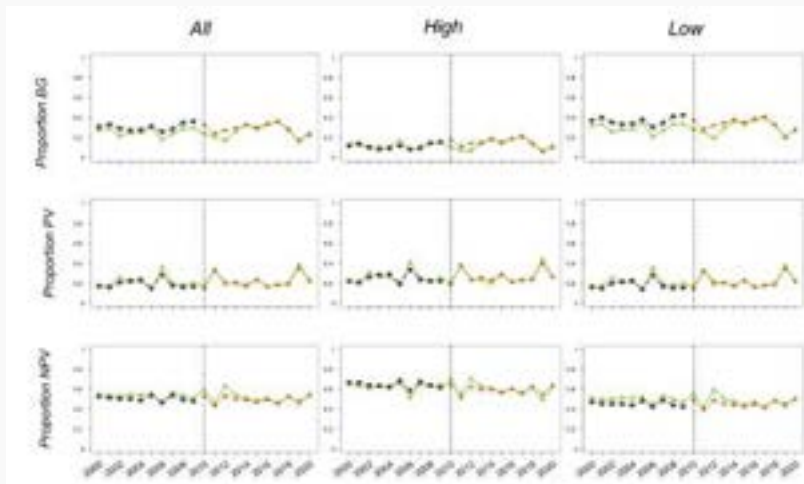
Divide the neighborhood: split neighborhoods into buffers b_n [buffer](#) ;
use distances to the boundary of unit i as building block for weights, w_{ij} .

Define exposure: *a unit becomes exposed to IBLI in the first period when ≥ 1 insured tropical livestock unit (TLU) is observed. At intensive margin, can discretize into bins using cumulative exposure.*

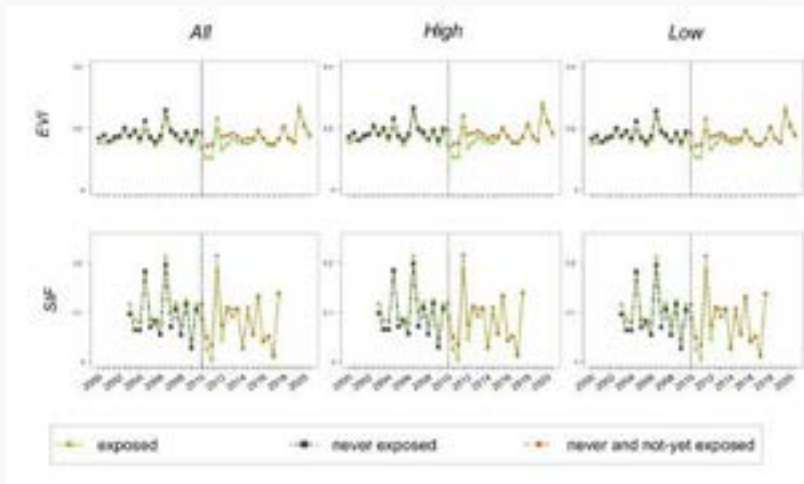
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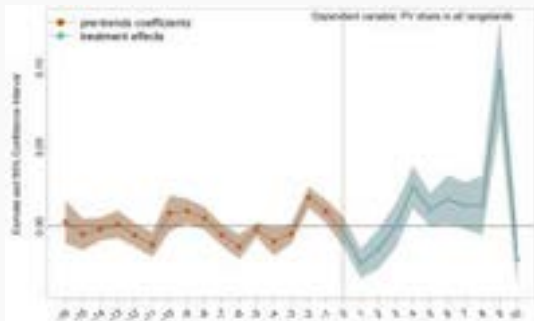
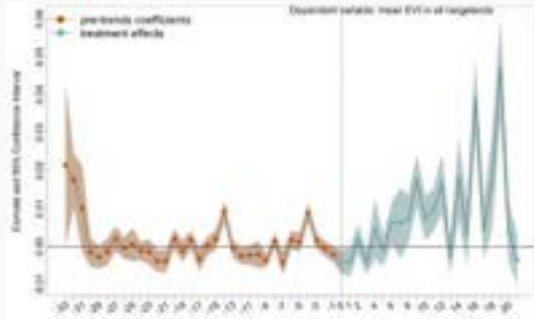




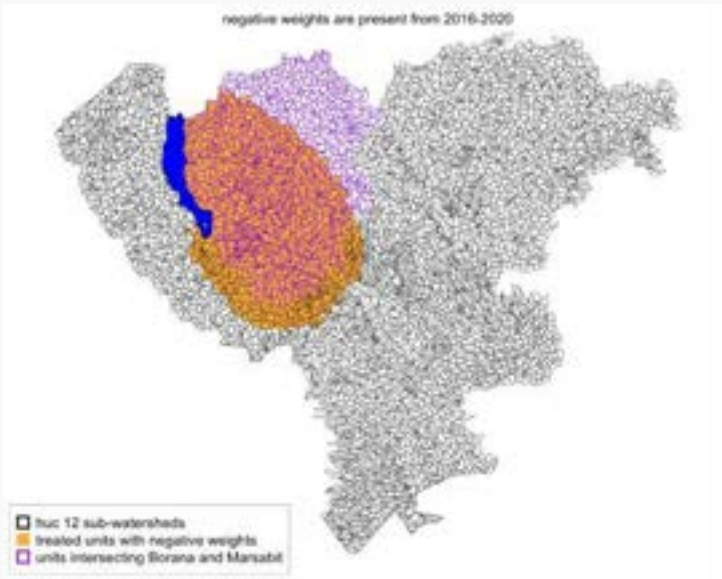
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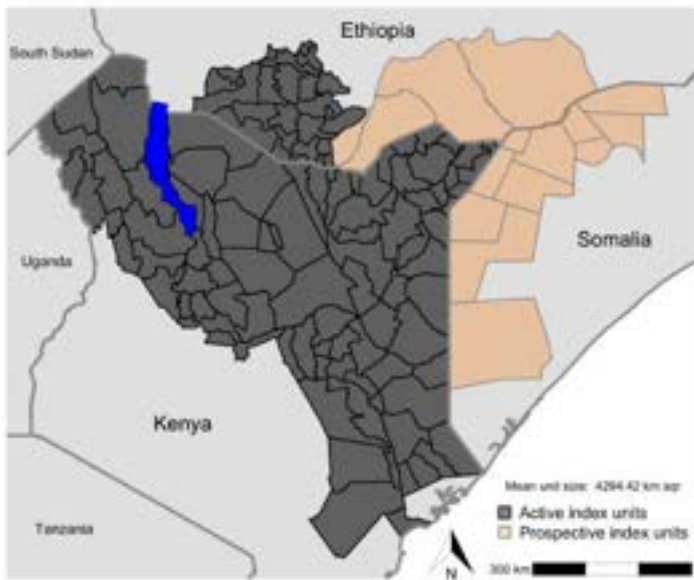


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Results: TWFE

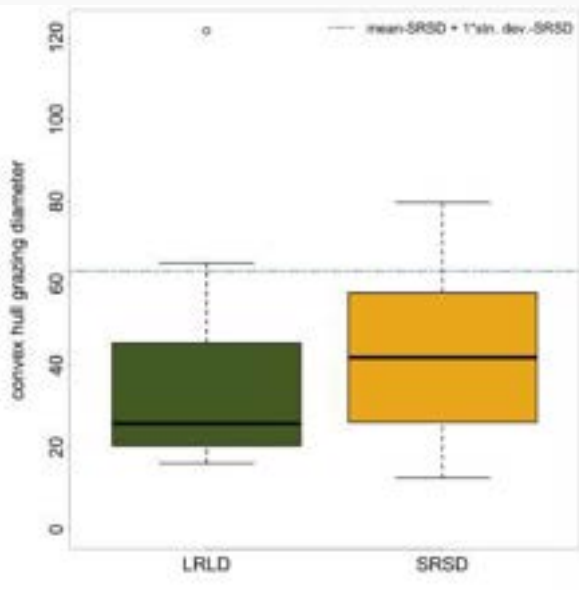






Rangelands are often cited as the dominant land type on Earth.


Definition (Pellant et al. 2020): “lands on which the indigenous vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed similarly” . [back](#)





figures/aoi_all_91322.png

(only masks out water and impervious cover) [back](#)



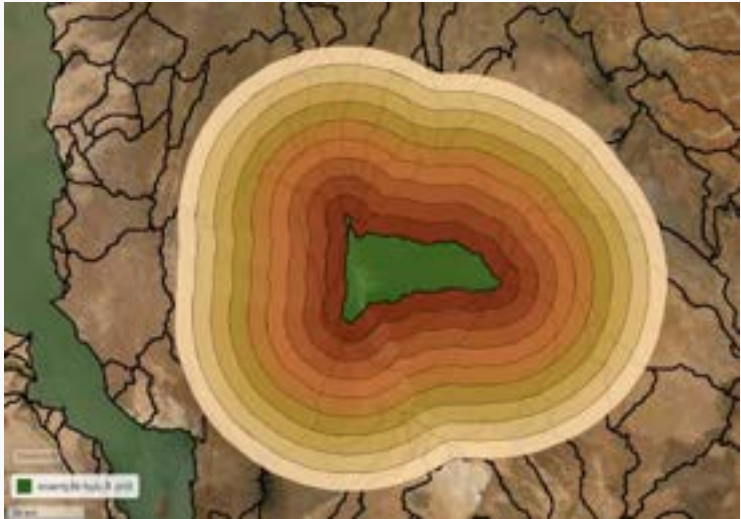
figures/aoi_high_91322.png

(includes grassland, open canopy woodland, sparse scrubland, and



figures/aoi_low_91322.png

(includes sparse vegetation, bushland, dense scrubland, close canopy



back