The Environmental Impacts of Scaling a Microfinancial Product: Index-Based Livestock Insurance and East African Rangelands

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Abstract

Expanded access to financial products has ambiguous effects on natural resources use, especially in environments lacking clear private property rights. Index-based livestock insurance (IBLI) is a micro-insurance product originally developed to help pastoralists in East Africa manage catastrophic drought risk. Rigorous impact evaluations have clearly established welfare and productivity gains from IBLI. Open questions remain, however, regarding IBLI's potential environmental impacts. Might IBLI encourage overstocking or change grazing behaviors that harm the rangeland systems on which pastoralists rely, ultimately undermining the product's effectiveness in reducing livestock mortality risk? Or does IBLI reduce precautionary savings in-kind, thereby reducing overstocking and improving rangeland health? We address this question empirically by combining administrative data on the roll-out of IBLI with remotely-sensed rangeland condition measures spanning approximately 643,000 km^2 over the period 2000-2020. Using a staggered differences-in-differences estimator we find evidence for neutral to positive impacts of IBLI on East African rangelands.

Keywords: microfinance, drought, rangelands, pastoralism, remote sensing

JEL classification: O16, O13, Q24, C23

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1 Introduction

Recent decades have witnessed a microfinance revolution aimed at empowering the poor to save, borrow, and insure so that they can invest in sustainable improvements in living standards and weather the shocks that buffet them (Besley 1995; Robinson 2001). A sizeable literature documents generally favorable impacts of microfinance interventions on incomes, investment and other indicators of human well-being (for reviews, see Van Rooyen et al. 2012 and Cull and Morduch 2018). Index insurance against crop and livestock loss is one promising element of the broader microfinance movement (Carter et al. 2017).

Far less attention has been paid to whether improved access to financial products, including insurance, might generate unintended negative impacts on the natural systems that disproportionately support the livelihoods of the rural poor. By increasing the risk-adjusted returns, improved access to financial services could boost investments that expand or intensify extractive operations, with plausibly adverse impacts on forest, land, water and/or wildlife resources, especially in settings where property rights are insecure or open access tenure prevails (Assunção et al. 2020; Noack and Costello 2024). Conversely, newfound access to financial services could facilitate environmentally favorable changes, for example by enabling sustainable agricultural intensification that reduces extensification into fragile ecosystems, per the Borlaug hypothesis (Stevenson et al. 2013; Villoria 2019a,b), supporting transitions out of natural resource extraction industries, or reducing risk management behaviors that degrade nature (Barrett 1999; Gollin et al. 2021; Wilcox et al. 2025). Indeed, Noack and Costello (2024) show that in global fisheries, credit market development increases resource extraction under insecure property rights but reduces resource extraction under secure property rights. Such findings illustrate that the environmental impacts of microfinance are analytically ambiguous, sensitive to local conditions, and can be globally important.

The scant evidence on this topic originates partly from the paucity of data that reliably link microfinance interventions and environmental outcomes, and partly due to the small spatial scale and short duration of most microfinance interventions. While two recent studies (Assunção et al. 2020; Noack and Costello 2024) have overcome these barriers in regards to credit markets in the context of fisheries and forests, we know of no evidence with respect to rangelands, the dominant land type on Earth, nor on microinsurance or other traditional micro-financial products.

Index-based insurance, a form of microfinance, has been widely promoted in low-income, rural settings where adverse selection, moral hazard and high transaction costs limit access to conventional indemnity insurance (Carter et al. 2017; Jensen and Barrett 2017). Many

index insurance products have generated favorable outcomes for policyholders, including increased incomes, productivity, subjective well-being or children's education, as well as reduced con ict, distress sales and meal skipping (Karlan et al. 2014; Jensen et al. 2017; Janzen and Carter 2019; Tafere et al. 2019; Janzen and Carter 2019; Stoe er et al. 2022; Barrett et al. 2025; Gehring and Schaudt 2024; Jensen et al. 2025; Sakketa et al. 2025).

Given rural livelihoods' heavy reliance on natural resources, however, the sustainability of any observed gains from index insurance { or any micro nance product { depends in part on avoidance of unintended, negative environmental externalities. Multiple candidate mechanisms might cause environmental spillovers from index insurance uptake. For example, by increasing risk-adjusted returns, an index insurance product might encourage expansion of the cultivated frontier or grazing lands into fragile areas, resulting in loss of natural habitats, e.g. forests, protected areas, wetlands. Index insurance might also encourage more intensive production on existing working lands, perhaps via reduced mobility and intensi ed local grazing, or general overstocking and overgrazing of rangelands, leading to rangeland degradation, erosion, or soil nutrient loss, etc. These possibilities mimic the Jevons Paradox of agricultural productivity growth, wherein higher returns induce extensi cation into previously uncultivated lands. Conversely, the provision of formal, nancial insurance could reduce environmentally-damaging self-insurance behaviors, such as precautionary savings `on the hoof' that result in overgrazing (Jensen et al. 2017; Cissé and Barrett 2018; Bulte and Haagsma 2021) or overuse of natural resources as a means of self-insuring against producer price risk (Barrett 1999; Wilcox et al. 2025). Or insurance access might induce investments in boosting livestock productivity with less intensive rangelands use, per the Borlaug hypothesis (Jensen et al. 2017). The net environmental impacts of index insurance are therefore analytically ambiguous and an open empirical question.[1] A vibrant literature on agricultural development and land use has explored the tension between the Borlaug hypothesis and Jevons Paradox relating crop agriculture to deforestation (Stevenson et al. 2013; Villoria 2019a; Pelletier et al. 2020; Jayachandran 2022; Balboni et al. 2023), but there has been little work on analogous issues concerning livestock husbandry and rangelands.

This paper examines the environmental impacts of long-term access to index insurance at scale. It does so by exploiting a new, high spatial resolution data set from 2000-2020

[1] Bhattacharya and Osgood (2014) develop an analytical model to study the impact of weather index insurance on the commons in low income settings and demonstrate the ambiguity of the direction of environmental impacts. Prior empirical research on agricultural insurance and environmental impacts includes Walters et al. (2012) and Smith and Goodwin (2013) on the impacts of crop insurance programs in the United States, and Feng et al. (2021) on reductions in pesticide use in China. Empirical work on credit access has shown bene cial impacts in global sheries conditional on secure property rights (Noack and Costello 2024), and in reducing deforestation in Brazil conditional on land titling and environmental regulation compliance (Assunc-ao et al. 2020).

that covers 745,840 km^2 of East African rangelands that span the gradual roll-out of a successful micro-insurance product, index-based livestock insurance (IBLI) (Soto et al. 2024). IBLI has now insured more than 3.2 million livestock herders in Ethiopia and Kenya against catastrophic drought losses, including through the Kenyan government's national Kenya Livestock Insurance Program (Jensen et al. 2024) and the World Bank-led De-risking, Inclusion, and Value Enhancement of Pastoral Economies in the Horn of Africa (DRIVE) project (https://zep-re.com/drive-project/about-drive/). The spatial and temporal scale of IBLI's di usion across southern Ethiopia and northern Kenya, combined with high spatial resolution data on rangeland conditions spanning IBLI's pre- and post-introduction periods, enable rigorous causal identi cation of micro nance's impacts at scale on a key natural resource. As best as we can tell, no comparable empirical assessment exists for the environmental impact of a micro nancial product.

IBLI o ers an uncommon opportunity to test for micro nance's impacts on the natural environment. IBLI introduced drought insurance to low-income pastoralists who graze livestock on East Africa's rangelands, where drought-related herd mortality is the primary source of wealth loss (Lybbert et al. 2004; Barrett et al. 2006; Santos and Barrett 2011; Chantarat et al. 2013; Toth 2015; Santos and Barrett 2019). Initially piloted in northern Kenya in 2010, IBLI expanded into southern Ethiopia in 2012, and subsequently across northern, eastern and central Kenya (Jensen et al. 2024). Several impact evaluations have demonstrated IBLI's bene ts, including improved livestock productivity, children's nutritional status and educational attainment, household income and subjective well-being, and reduced con ict and adverse coping strategies, among others (Jensen et al. 2017, Janzen and Carter 2019, Tafere et al. 2019; Barrett et al. 2025; Gehring and Schaudt 2024; Jensen et al. 2025; Sakketa et al. 2025). But if IBLI adversely a ects rangelands, it might ultimately cause the very herd losses against which it ostensibly insures.

Theory- and simulation-based studies have predicted that IBLI and rangeland-oriented index insurance might have negative impacts on rangelands, though these studies have relied on strong, untested assumptions (Müller et al. 2011; John et al. 2019; Bulte and Haagsma 2021). Empirical ndings suggest that IBLI has reduced in-kind precautionary savings in the form of livestock and reduced trekking distances, either of which could have positive or negative environmental impacts (Jensen and Barrett 2017; Toth et al. 2020). So the question remains unsettled.

We use a new data set of remotely-sensed rangeland quality indicators from 2000-2020 (Soto et al. 2024) and administrative data on the staggered roll-out of IBLI across Kenya and southern Ethiopia from 2010-2020 to estimate IBLI's environmental impacts across approx-

imately 643,000 km^2. We tap recent advances in di erences-in-di erences (DiD) estimation in settings with e ectively-random, staggered roll-out and potentially-heterogeneous treatment e ects while controlling for pre- and post-treatment variation in exogenous covariates (Roth et al. 2023; Gardner et al. 2025[2]). In our setting, it is crucial to control for pre- and post-treatment seasonal weather variation to credibly isolate the e ect of IBLI from other processes that may drive much of the observed variation in rangeland conditions (Purevjav et al. 2025). We estimate models at multiple spatial scales and account for herder movement by inverse distance weighting IBLI exposure within a neighborhood de ned by GPS-tracking of livestock migration in the study area (Liao et al. 2018b).

Across a series of rangeland health indicators (described in Section 3.3), we nd no evidence of negative rangeland quality impacts from IBLI. On the contrary, IBLI's environmental impacts range from neutral to statistically signi cantly positive. At the extensive margin, we nd mostly precisely-estimated null results with the exception of small but statistically signi cant increases in rangeland biological productivity indicators (e.g., re ectance-based vegetation indices). At the intensive margin, not only do vegetation indices increase signi cantly with increased IBLI exposure but so does the fraction of land cover in photosynthetic vegetation, while we still get generally precise null e ects on both bare ground and non-photosynthetic vegetation cover. These ndings are encouraging and allay concerns regarding IBLI's potential to induce negative impacts on rangeland systems.

2 East African Pastoralism and IBLI

The arid and semi-arid lands (ASALs) of East Africa are characterized by limited physical and institutional infrastructure and low human population densities. Combined with poor soils and low and variable rainfall, the main livelihood is pastoralism, the extensive grazing of livestock on communal lands with complex, contested property rights (McCarthy et al. 1999; McPeak et al. 2011). Livestock are pastoralists' main store of wealth and generate most of their income, social status, and nutrient intake[3]. Livestock productivity depends fundamentally on rangeland conditions, which is adversely a ected by overgrazing, leading Garrett Hardin to famously reference extensive livestock grazing to motivate his `tragedy of the commons' hypothesis[4]. Pastoralists in the region have historically used mobility to manage drought risk exposure by adjusting seasonal and daily movements in response

[2]The Borusyak et al. (2024) estimator generates estimated treatment e ects numerically equivalent to those of Gardner et al. (2025).

[3]See McPeak et al. (2011) or Jensen et al. (2024) for rich descriptions of this area.

[4]Hardin (1968), p.1244 wrote \The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons."