1 Index-Based Livestock Insurance to Address Risk-Based Poverty Traps

Revisiting the Challenge of Persistent Poverty

When people's living standards fall below a minimum absolute or relative threshold that societies deem necessary to safeguard the dignity of human persons, they are typically labeled as "poor." Most cultures have sought to explain and reduce poverty, investing in the intrinsically normative topic with considerable moral authority (Iliffe 1987; Lipton & Ravallion 1995). Generations of scholars have sought to explain patterns of poverty and to identify interventions that might help reduce its tragic hold on humankind (Ravallion 2016).

A key empirical regularity throughout modern history is that poverty status varies more between places than within them, generating a large social science literature that documents and tries to explain spatially concentrated poverty (Lipton & Ravallion 1995; Jalan & Ravallion 2002; Bloom *et al.* 2003; Ravallion 2016). Dating back at least to Adam Smith (1776), economists have typically seen poverty as the natural consequence of insufficient accumulation of productive capital, and/or insufficiently advanced technologies to generate a stream of income from that capital sufficient to sustain adequate consumption of essential goods and services. Most poverty analysis starts from that conceptualization, pointing to spatial patterns of low capital accumulation and anemic rates of adoption of modern technologies – both often arising due to market failures, especially in finance – to explain widespread, deep poverty. Others take a more radical view of poverty, which they see as the natural result of surplus extraction from the weak by the powerful (Watts 1983; Iliffe 1987).

The poorest places on Earth are defined not only by the prevalence and depth of the poverty residents experience but also by the persistence of that poverty (Barrett & Swallow 2006). Poverty analysis has advanced considerably as longitudinal data on the same households and individuals have become more widespread (Carter & Barrett 2006; Barrett *et al.* 2016). The evolving poverty dynamics literature consistently finds that an identifiable subpopulation disproportionally suffers sustained deprivation that others never experience.

Normative concerns about persistent poverty have long motivated research on "poverty traps," which are defined as an absorbing state of persistent poverty. A large body of literature on poverty traps has focused on why low levels of capital accumulation and failure to adopt advanced technologies might be self-reinforcing equilibria (Azariadis & Stachurski 2005; Barrett & Swallow 2006; Bowles *et al.* 2006; Kraay & McKenzie 2014; Barrett *et al.* 2016). Poverty traps have typically been modeled as low-level equilibria that arise from coordination

(including market) failures with a focus on deterministic systems (Dasgupta 1997; Mookherjee & Ray 2002; Azariadis & Stachurski 2005; Ghatak 2015). Many poverty trap narratives and models have a Sisyphean character to them, in which people placed in impossible situations are doomed because desirable outcomes are simply unattainable. Rags-to-riches stories excite the popular imagination in part because they offer hope of escape from poverty traps, even if one's odds of success are slim.

The more recent literature on poverty traps dispenses with old, deterministic assumptions and focuses instead on the central role that risk plays in persistent poverty (Barrett *et al.* 2019). A deep, and influential literature documents the poor's considerable exposure to risk and the limited market- or technology-based tools they have available to mitigate risk (Stiglitz 1974; Fafchamps 2003; Dercon 2004)

The newer framing of risk-based poverty traps follows from the observation that another defining feature of places with high rates of deep, persistent poverty is disproportionate exposure to uninsured, catastrophic risk, often from multiple sources such as weather, markets, disease, and conflict. For example, across a range of societies at different stages of development, uninsured health shocks are consistently the single greatest cause of descent into persistent poverty (Krishna 2010), consistent with the literature that highlights how infectious disease risk exposure can trap individuals, or even entire communities, in long-term poverty (Bonds *et al.* 2010; Ngonghala *et al.* 2014; Ngonghala *et al.* 2017). This newer literature elevates the value of effective risk management to a status comparable to that of capital accumulation and improved technology adoption as central to enabling sustained improvements in living conditions (Barrett *et al.* 2019). In this view, deep, persistent poverty is not solely the consequence of bad initial conditions but rather of the combination of poor circumstances and excessive exposure to adverse shocks.

Some poverty traps feature multiple equilibria wherein any individual[1] may either escape poverty or collapse to an absorbing state of persistent poverty, depending only on their initial wealth and the sequence of shocks that they experience. Such a system generates what Ikegami *et al.* (2019) call "unnecessary deprivation," which occurs when individuals who have the capacity and means to be nonpoor are rendered poor by risk and shocks. Providing such individuals with better risk management tools should in principle reduce unnecessary deprivation and create substantial social and economic gains. Even for individuals who can in principle eventually escape poverty, risks and

[1] Individual here can mean a single person, but also a single or even more complex family unit.

shocks lower their expected long-term well-being, slow their advance to improved living conditions, and generate costly transitory poverty. Better risk management tools can offer substantial social and economic gains for such people as well.

Persistent Poverty in East Africa's Arid and Semiarid Lands

Index-based livestock insurance (IBLI) was conceived, launched, studied, and adapted within the context of the longstanding struggle to understand and reduce persistent poverty in a specific place: the arid and semiarid lands (ASALs) of East Africa.[2] In many ways, this is an archetypal region, characterized by widespread, deep, persistent poverty among populations routinely buffeted by a range of potentially catastrophic shocks. ASALs are the largest globally by area, covering roughly one-third of the Earth's land surface, and host over one billion people, who commonly are pastoralists whose livelihoods predominantly rely on livestock production, often involving extensive grazing on communal lands, whereby seasonal movement in search of forage and water is important (de Leeuw *et al.* 2019). In relatively more humid ASAL areas, agropastoralists combine livestock with rainfed crop production (Nidumolu *et al.* 2022).

Livestock are pastoralists' main store of wealth; a productive asset that generates a plurality of community income and consumption goods, offers social status, and underpins many cultural rituals. Livestock are pastoralists' main nonhuman productive asset and the production technologies involved in extensive grazing are few. In many ways, this makes pastoralist populations ideal for the study of stochastic poverty dynamics and the search to explain and unlock risk-based poverty traps.

The decade-long, multidisciplinary Pastoral Risk Management (PARIMA) project set out to study such populations in the ASALs of northern Kenya and neighboring southern Ethiopia.[3] The project identified the strong influence of drought risk on more salient food security and human health risks, which households perceive and attempt to manage (Smith *et al.* 2000; Barrett *et al.* 2001; Little *et al.* 2001; McPeak & Barrett 2001; Doss *et al.* 2008). A series of papers found that drought shocks led to considerable, avoidable human suffering and that existing policy responses – mainly relief food shipped from distant countries – were slow to arrive and ineffective in mitigating the most serious

[2] IBLI provides insurance against unusually low remote sensing (satellite) measures of forage availability that are strongly correlated with livestock productivity and mortality. Section 3 explains index insurance in greater depth. Sections 4 and beyond explain the particulars of IBLI in detail.

[3] McPeak *et al.* (2011) summarize many findings of that research project.

human consequences that emerged from droughts (Mude *et al.* 2009; Nikulkov *et al.* 2016).

Among the important findings from the PARIMA project, multiple data sets clearly established the existence of poverty traps in these communities (McPeak & Barrett 2001; Lybbert *et al.* 2004; Barrett *et al.* 2006; Santos & Barrett 2011). Multiple data sets consistently identified a threshold of 6–12 Tropical Livestock Units (TLUs),[4] above which pastoralists could viably maintain large herds through transhumant or rotational grazing, and below which herd size collapsed to a low-level equilibrium of roughly one cow as it became infeasible to sustain the mobility required to sustain a larger herd (Lybbert *et al.* 2004; Barrett *et al.* 2006; Santos & Barrett 2011; Barrett & Santos 2014; Toth 2015). Moreover, the work established that uninsured catastrophic drought risk exposure is the primary cause of those poverty traps (Santos & Barrett 2019) and increases in the frequency of catastrophic drought due to climate change threaten to close off the high-level equilibrium options that remain, leading to system collapse (Barrett & Santos 2014).

The drought risk-based poverty traps framing of the persistent poverty suffered by so many of the region's pastoralists also helped explain why standard interventions often failed in the long-term. Post-drought restocking, for example, rarely restored herd sizes to the point where households regained the ability to migrate seasonally, and the frequency of drought meant that herds could rarely grow to a viable size before the next drought struck (Toth 2015; Santos & Barrett 2019). Meanwhile, emergency food aid and other transfers commonly failed to equip poor households to build assets, nor did they prevent collapse into destitution for formerly nonpoor pastoralists who had lost much of their herd due to a catastrophic drought, swelling the involuntarily sedentarized subpopulations in ASAL towns that increasingly overwhelmed underfunded social protection programs (Ikegami *et al.* 2019). New tools were clearly needed to help pastoralists manage catastrophic drought risk. IBLI was initially developed as a microinsurance scheme for pastoralists in an ASAL system characterized by multiple equilibrium poverty traps. However, its effectiveness as a drought risk management tool drew broader interest as a scalable risk management instrument applicable to individuals and households at the micro level, among governments at the macro scale, as well as a range of meso-scale organizations in between.

[4] TLUs allow aggregation across livestock species based on body mass and nutrient intake requirements. For East Africa, ILRI deems one adult cow weighing 250 kg equivalent to 1.0 TLU, a camel equivalent to 1.4 TLUs, and sheep and goats each equivalent to 0.1 TLU.

Financial Innovation to Unlock Risk-Based Poverty Traps

Conventional forms of social assistance, whether emergency food aid or cash transfers, are reactive as they respond only to the needs of those who have already collapsed into unnecessary deprivation. They do not address the underlying structural causes that generate that collapse, nor necessarily help individuals maintain resilience to withstand and recover from shocks, or even advance economically in their wake.

We set out to identify alternative interventions that might work better than those conventional mechanisms. Index-based risk transfer products were seen as a potential instrument for unlocking poverty traps, both by preventing descents into poverty and by inducing productivity-increasing investment and lending to facilitate such investment (Chantarat *et al.* 2007; Barnett *et al.* 2008; Chantarat *et al.* 2011; Chantarat *et al.* 2013; Chantarat *et al.* 2017). We designed an IBLI product with the intention to reduce negative impacts from drought risk and thereby to facilitate escapes from the poverty traps among the region's residents. Similar objectives motivated parallel efforts elsewhere, as a range of agricultural index insurance products were designed in various settings to try to reduce risks associated with extreme weather events (as explained in greater detail in Section 3). A similarly named IBLI product emerged at roughly the same time in Mongolia, albeit with a different design and aimed at extreme weather events rather than droughts (Mahul & Skees 2007; Bertram-Huemmer & Kraehnert 2018). For a range of reasons explained in the coming sections, the East African IBLI product has generated greater – or at least better documented – impacts and diffused more broadly than most other agricultural index insurance products, which have largely remained pilots or small-scale projects (Carter *et al.* 2017).

Although social gains from financial risk management tools that disrupt poverty traps can be high (see Section 3), financial innovation needs to satisfy three key requirements. First, it must be high quality, so it reliably delivers payments when needed. Second, it must deliver assistance speedily during or near the onset of a shock to prevent individuals from losing or depleting their assets (e.g., through distress sales or abandonment with migration). Third, it must be trusted such that individuals will shift their behavior in advance of indemnity payments.

These triple requirements of quality, speed, and trust informed our approach to developing IBLI. We hypothesized that these goals could be more easily attained with a pre-financed commercial contract than through a politically mediated transfer process that would always be subject to the vagaries of public sector budgets and politicians' short-run interests. These challenges of quality,

speed, and trust required both excellent product design, aided by the emergence of new remote sensing techniques and technologies (see Section 5), as well as strong partnerships between researchers and operational agencies, both commercial and public, to continuously adapt the product and its outreach (see Sections 4, 6, and 8).

As an experiment, IBLI had two distinctive characteristics. Firstly, launching IBLI required collaboration with commercial reinsurers, underwriters, retail agents, and a wide range of social and environmental scientists, as well as international donors, national and local governments, communities, and non-profit partners. The resulting partnerships brought together organizations and individuals with markedly different motivations to develop, adapt, and diffuse IBLI. This posed major management challenges but also broadened insights and ultimately buy-in to IBLI as the original design proved successful (Banerjee *et al.* 2019; Johnson *et al.* 2019).

Secondly, IBLI needed rigorous impact evaluation. Did it really obviate the adverse, especially the catastrophic, impacts of drought? Did IBLI induce behavioral responses by pastoralist households and communities emboldened to risk scarce investible resources into economic advancement? Did it reduce descents into poverty, facilitate escapes from poverty traps, and generally boost welfare? And was it cost-effective in doing so, especially as compared to popular alternative investments, such as cash transfer programs? What programmatic and design lessons could be learned to inform the scaling of risk management tools more broadly, beyond just the original IBLI product and the specific place where it originated?

These are among the many questions that this Element will address. Before doing that, it is essential to understand the social and environmental setting of IBLI's place-specific origins in tackling the challenge of risk-based poverty traps.

2 East African Pastoralism: Change and Variability

The 300 million or so Africans who inhabit ASALs face serious challenges. The compounding effects of natural and environmental factors – such as unpredictable weather and spatially variable soil quality – policy and politics, and infrastructure make pastoralism in East Africa a risky endeavor. Droughts, the most common severe shock that hits ASALs, are often correlated with other shocks (e.g., conflict, disease, macroeconomic) and commonly cause catastrophic loss of wealth and income for many people within affected communities, frequently leading to humanitarian disasters. IBLI was designed to insure against drought, a "covariate shock" that affects large areas (distinct from

"idiosyncratic shocks" that strike just one or a few families at a time), and specifically for pastoralists in an area straddling the Ethiopia-Kenya border in East Africa.

Climate is a key determinant of rangeland productivity, as vegetation growth follows rainfall amount, frequency, and duration (Coppock 1994; Coppock *et al.* 2017). Forage and water availability drive variability in ASAL livestock production. Pastoralism has evolved over centuries to manage the spatial and temporal variability of water and pasture.

A key defining feature of East Africa's ASALs is low and highly variable rainfall, with a bimodal seasonal pattern in most cases. These areas typically receive as little as 200 to 300 mm of rainfall annually, and rarely more than 600 mm (Williams & Funk 2011). Unpredictable rainfall patterns, combined with calcareous soils of low carbon and mineral content (Homewood 2008), result in low crop yield potential and render crop agriculture unreliable. Livelihoods therefore depend heavily on extensive grazing of cattle, camels, goats, and sheep. Livestock enable sporadic crop cultivation – mainly of maize – as the animals import essential soil nutrients and water by grazing elsewhere and then concentrating manure and urine within overnight enclosures that people can subsequently farm. During periods of good rains and availability of inputs, pastoralists often diversify into crop cultivation as a temporary relief and a means of supporting livestock, at least on stover (Catley *et al.* 2013). Even so, crop yields remain low and crop failures are commonplace.

Because they are central to pastoralist livelihoods, livestock is equally central to pastoralists' individual and community identities. Livestock ownership is not just a store of wealth but is equally a centerpiece of sociocultural activities and a leading source of social status. Livestock and their products are embedded in a variety of rituals and ceremonies, beginning with a person's birth, and continuing through their circumcision, marriage, childbirth, and passing.

Complex usufruct rules and agreements traditionally allowed pastoralists the flexibility they needed to ensure access to precious dry season reserves. However, this same flexibility also makes pastoralists vulnerable to land loss and exclusion from customary ranges (Homewood 2008). In recent decades, spatial expansion of towns and cultivated farmlands, as well as the gazetting of protected areas, have increased land fragmentation and increased exclusive uses for purposes other than grazing, reducing pastoralists' ability to access crucial grazing and water reserves (Galvin *et al.* 2002; Munyao & Barrett 2007). Heavy grazing from restricted mobility can also degrade rangelands (Galvin *et al.* 2002) and threaten their sustainability. In addition, woody shrubs are expanding across rangelands because of both management practices and increases in carbon and nitrogen emissions (Galvin *et al.* 2002). Proliferation of woody

cover (or "bush encroachment") has been compounded by governments' (including Ethiopia's) misunderstanding of the role of fire in mesic savanna ecosystems, resulting in ill-advised, strict fire bans that enable woody species to expand, degrading rangeland productivity and biodiversity (Johansson *et al.* 2021). The introduction of the fast-growing, non-native woody species *Prosopis juliflora* in ASAL environmental rehabilitation programs has likewise caused considerable damage in many rangelands, generating conflict between conservationists and pastoralists and lawsuits for damages caused by the *Prosopis* (Maundu *et al.* 2009).

On top of increasingly restricted land and water access, droughts seem to have grown more frequent and severe in recent decades. Rainfall variability increases with aridity and climate change in this region (Overpeck & Udall 2020). The bimodal pattern in most of the Horn of Africa brings "short rains" from October to December and "long rains" from March to May. The "short" rains exhibit more interannual variability and are especially affected by El Niño Southern Oscillation (ENSO) events (Mutai & Ward 2000), with El Niño years bringing more precipitation and La Niña bringing less. Unfortunately, La Niña events are growing more frequent with global warming (Cai *et al.* 2015). Indian Ocean temperature anomalies can also influence precipitation in the absence of an ENSO event (Zhao & Cook 2021; Doi *et al.* 2022).

Analysis of decadal rainfall trends in East Africa showed significant declines in long rains precipitation and increased unpredictability in the region between 1960 and 2009 (Williams & Funk 2011). Liebmann *et al.* (2014) found that the short rainy season has become wetter while the long rains are drier, but the significant increase in the short rains is compromised by strong year-to-year fluctuations. Ayugi *et al.* (2022) projected more frequent, longer, and stronger intensity droughts in this ASAL region in the future. These patterns – and the associated potential for system collapse (Barrett & Santos 2014) – underpin the need for regular revisiting of IBLI product design and pricing (see Section 5).

In severe or prolonged droughts, livestock mortality rates increase sharply. Livestock population dynamics are determined by short-term losses during drought and longer-term trends in resource conditions, thus it can take several years for a herd to recover after a major drought and longer if several rainy seasons fail (as has been the case recently) and herd mobility is constrained. Significant droughts struck the region in 2011, 2014, 2016–2017, 2019, and 2021–2022, and the popular perception is droughts are becoming more severe in their impacts (Funk *et al.* 2015; Ayugi, Eresanya *et al.* 2022).

Pastoral communities have long been marginalized by colonial and postcolonial central governments. Pastoral systems are socioculturally alien to the foreign and highland populations that have long dominated Ethiopia, Kenya,

and other countries in the region. Few colonists or postcolonial leaders wanted to live in the harsher ASAL regions. Therefore, the infrastructure and institutions created to serve leaders' (and their core constituencies') own needs were concentrated outside the ASALs. Governments have often supported, explicitly or implicitly, the privatization of communal pastoralists grazing areas, gazetting protected areas or mining concessions, and even enclosures of rangelands previously held in common property with overlapping access rights among groups. Meanwhile, the central state has been notably absent in offering police protection, which contributes to a widespread sense of lawlessness in these ASALs (Catley & Iyasu 2010; Wild *et al.* 2019; Lind *et al.* 2020).[5] Even when trying to help pastoralists, insufficient understanding of the rationale for and logic of pastoralism has often led to misguided development interventions, especially with respect to market development, rangeland rehabilitation, and early warning.

Perhaps the most tangible material manifestation of pastoralists' marginalization is their relative lack of infrastructure. They have fewer schools, fewer health facilities, limited electricity or telecommunications connectivity, insufficient water, and sanitation facilities, and fewer maintained or all-season roads (McPeak *et al.* 2011). Indeed, the last stretch of the pan-African highway – which stretches from Egypt to South Africa – to get hard surface paving (e.g., asphalt or concrete) was in northern Kenya. The lack of roads, electricity, and so on, makes manufacturing and services difficult and hampers private investments in the livestock sector, such as in slaughterhouses, canneries, dairy processing plants, and other value addition services.

As ASAL populations live far from the major cities, this marginalization has been easy to ignore. This is changing in Kenya and Ethiopia, albeit slowly. Moreover, change is not always driven by communities' best interests, as with improvements made in northern Kenya connected to (largely foreign-financed) hydrocarbons exploration and trade infrastructure (e.g., the Lamu Port, South Sudan, Ethiopia Transport) LAPSSET corridor through Isiolo and oil discovery in Turkana).

Beginning in the late 2000s, however, mobile telephone service began in parts of southern Ethiopia and northern Kenya. Inexpensive phones and services offered unprecedented connectivity to distant markets and financial services such as mobile banking and digital payments. Communication is now much easier, and households can send and receive money, reducing two major impediments faced by these populations in prior years (McPeak *et al.* 2011).

[5] As Wild *et al.* (2019) explain, pastoralists' underrepresentation in national and global health statistics is another form of marginalization, especially because those statistics are used to direct public funds.