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Abstract

We model interhousehold transfers between nomadic livestock herders as the state-dependent consequence of individuals' strategic interdependence resulting from the existence of multiple, opposing externalities. A public good security externality among individuals sharing a social (e.g., ethnic) identity in a potentially hostile environment creates incentives to band together. Self-interested interhousehold wealth transfers from wealthier herders to poorer ones may emerge endogenously within a limited wealth space as a means to motivate accompanying migration by the recipient. The distributional reach and size of the transfer are limited, however, by a resource appropriation externality related to the use of common property grazing lands. When this effect dominates, it can induce transfers from households who want to relieve grazing pressures caused by others' herds. Our model augments the extant literature on transfers, and is perhaps more consistent with the limited available empirical evidence on heterogeneous and changing transfers' patterns among east African pastoralists. The core principles of our model possibly apply more broadly, for example to long-distance migrants or even among "foot soldiers" in street gangs.

Keywords: Interhousehold transfers, migration, externalities, poverty traps

JEL Classification Numbers: D62, O13, O15, O12, Q2

INTRODUCTION

Scholars' explanations of interhousehold transfers serve as allegories for our understanding of human nature and the social environment that conditions human behavior. This topic has consequently been a source of dispute within most disciplines in the humanities and the social sciences. Philosophers have long disagreed as to whether altruism is merely apparent, meaning that even states of mind that are directed towards the welfare of others ultimately aim at advancing one's own pleasure (Hobbes, 1650; Hobbes 1651; Butler 1726). Within anthropology, substantivists argue that transfers arise from a "moral economy" in which prevailing ethical values such as generosity and individuals' primordial right to subsistence assure support for the poor (Scott, 1976), while rationalists counter that what appears to be a moral economy can be wholly explained by self-interested, opportunistic individual behavior (Popkin, 1979).

Economists have engaged this debate as well. Some explain interhousehold transfers as the result of altruistic preferences or some sort of moral code that constrains individual choice out of a sense of fairness or *noblesse oblige,* perhaps complemented by the "warm glow" effects the giver enjoys from impure giving (Phelps, 1975; Andreoni, 1989; Samuelson, 1993; Coate, 1995; Smith et al., 1995; Kirchler et al., 1996; Barrett, 1999). Others explain transfers as an endogenously supportable insurance mechanism adopted by purely self-interested individuals to cope with an environment of imperfect information and missing financial markets in which individuals interact repeatedly (Kimball, 1988; Fafchamps, 1992; Coate and Ravallion, 1993; Townsend, 1994; Platteau, 2000). We accept that these two canonical models explain many interhousehold transfers. Surely some people provide insurance for one another and some can be gracious toward those who suffer in their midst. However, the limited empirical evidence among the east African pastoralists we have been studying intensely for the past decade seems inconsistent with either explanation.

This paper therefore develops an alternative model appropriate to the particular setting we seek to understand. But the core principles apply elsewhere as well, as we discuss in the concluding section. In our model, transfers are a self-interested, manipulative gesture motivated by the strategic interdependence of individuals sharing both access to a productive resource and a common social identity in a potentially hostile environment. In our model, giving is intrinsically costly but can be instrumentally valuable to the giver if it motivates the recipient to undertake a self-interested action that has a positive spillover benefit for the donor. Put differently, transfers can serve as costly but desirable coordinating mechanisms among interdependent actors.

This is explicitly not a model of pure altruism nor of impure altruism due to "warm glow effects" (Andreoni, 1989), because individuals value only their own welfare and not the act of giving. Nor is this a model that relies on a patron-client relationship, in which marked inequalities in wealth, status or power give rise to vertical insurance systems or exchange of nontraded services (e.g., protection) for tradable goods and services such as material tribute or labor (Scott, 1976; Fafchamps, 1992; Carter, 1997; Platteau, 1995). In our model, redistribution occurs only with limited inequality in wealth and can be either distributionally progressive or regressive. Finally, this is neither insurance nor investment in social capital, because ours is a static model in which transfers do not occur in response to idiosyncratic shocks to agents' wealth or income and there is no opportunity for reciprocal behavior.

In our model, a voluntary, self-interested wealth transfer is essentially a side payment for a migration decision the recipient only prefers *ex post*, after having received the 'gift'. While the transfer may well strengthen the recipient's inclination towards 'cooperative' behavior (Fehr et al., 1997; Akerlof, 1982) or elicit his penchant for reciprocity (Bowles et al.*;* 1997), the 'service' the recipient offers – through the migration choice he makes – is unambiguously in his own interest. Like in the Bernheim et al. (1985) model of strategic bequests, the wealth transfer is strategic in that it influences the recipient's choice of actions. Such transfers are manipulative in nature. But unlike the individually costly services – such as care, visits, attention (Cox, 1987; Bernheim et al., 1985), sense of worth and status (Offer, 1997), and remittances (Lucas and Stark, 1985)[1] – considered in prior investigations of exchange-based motives for private transfers, the service returned by the recipient to the giver in our model is not costly at all, as it merely originates in the externality effects generated by the recipient's self-interested, post-transfer choice.[2]

We motivate and situate our model in the context of east African pastoralists whose livelihoods depend on the extensive grazing of livestock. One novelty of the current study is that we identify how transfers can be risk reducing and/or productivity enhancing for the donor household. As noted by many observers of pastoral economies, the area that a given user group calls its grazing area frequently has ambiguous borders (Schlee, 1989; Oba, 1992; Goodhue and McCarthy, 2000; Haro et al., 2005). The flexible and contested nature of these boundaries creates an incentive for donor households to support recipient households. Donor households have an interest in ensuring that their own group maintains access to contested production areas and to repel attacks by other groups. Insufficient livestock not only threatens a household with a food security crisis, but also threatens neighboring households with the potential loss of an ally in a hostile environment due to the existence of wealth thresholds that determine a household's ability to migrate (Lybbert et al., 2004; Barrett et al., 2006; Santos and Barrett, 2006b). As a result, progressive transfers may occur from richer to poorer households.

The production externality commonly assumed to exist in common property models is consequently not the full story of strategic interdependence. This production externality must be balanced against a security externality that arises from a "safety in numbers" effect. As many common property resource areas are vast and only loosely controlled by a state exercising police authority, concerns about security in such areas may be important.

Yet common property resource externalities matter. Indeed, as long as some basic level of public goods are provided in particular locations, such appropriation externalities may even give rise to modest, distributionally regressive transfers from poorer to wealthier households. We further argue that declines in mobility and transfers in pastoral areas of east Africa can be at least partly explained by the exogenous provision of public goods. As the state expands its reach into pastoral areas, it brings both security in the form of police forces and some low-level safety net in the form of food aid and other transfers. These services are typically confined to areas around towns, leading subpopulations to depend more on exogenously supplied public goods and less on the endogenous private provision of public goods. A gradual reduction in transfers and mobility in pastoral societies could then be at least partially due to increased localized provision of public goods. Finally, our model offers insights into how the incomplete provision of public services can lead to non-convex production functions commonly associated with poverty traps.

I. Background on East African Pastoralists

We develop our model around our observations of livestock transfers between nomadic pastoralists in the arid and semi-arid lands (ASAL) of east Africa. Pastoralists' livelihoods depend almost entirely on extensive livestock production. Traditionally, ASAL herders migrated with their herds in search of pasture and water for their animals and survived mainly by consuming milk, meat, and livestock blood. Few permanent settlements existed in pastoral areas in the pre-colonial and colonial eras. The few settlements that existed were almost exclusively occupied by traders. Pastoral households would temporarily occupy areas near these trading points when conditions were favorable and move on as other areas become more favorable.

The boundaries within which households moved were flexible and contested. The process of groups pushing into new areas or being pushed out of old areas was a constant fact of life.[3] Areas that were accessible to members of a group at one point in time were not guaranteed to be accessible in the future. Groups commonly raided others' herds in order to augment their own wealth, particularly when there was ample grazing land and water available elsewhere to sustain larger herds. Defense of a given area and of a group's livestock was the responsibility of group members, as was the potential conquest of neighboring areas. Membership in a social group was thus critical for ensuring access to grazing lands and security of one's wealth.

Group membership also involved access to a set of livestock transfer arrangements that are designed to circulate animals within ethnic groups (Schneider, 1979; Perlov, 1987; McCabe, 1987; Ensminger, 1992; Little, 1992).[4] One motivation for this study is that recent empirical work yields some surprising conclusions with regard to transfer behavior that are difficult to reconcile with existing models of transfers. One interpretation, given by Maybury-Lewis (1992), describes transfers as redistributive and altruistic, albeit with shame replacing altruism. He quotes a pastoral elder stating that transfers occur since "we must give to those who need it, for a poor man shames us all" (p.85), thus transfers should flow to the less well off in society. However, Desta's (1999) data show that among Borana pastoralists in southern Ethiopia, the poorest quartile of herders was only one-sixth as likely to receive livestock gifts or loans as the central half of the wealth distribution, and Santos and Barrett (2006a) and McPeak (2006) report qualitatively similar results for east African pastoralists. Further, the sense of shame induced by having members of the society become poor is difficult to reconcile with the observable fact that the very poor are commonly abandoned, left to turn to begging, prostitution, and illicit drug and alcohol trade in grim rangeland towns (Little et al., 2001).

A different interpretation in the anthropological literature stresses risk sharing. Transfers among pastoralists are socially embedded behaviors that occur in a risky production system, leading many observers to interpret them as social insurance (Torry, 1973; Schlee, 1989; Oba, 1992). Unfortunately, the informal insurance argument –that transfers are indemnity payments for idiosyncratic shocks herders suffer - likewise seems inconsistent with the transfer patterns observed among contemporary pastoralists in east Africa. Recent econometric studies find transfers are very small relative to losses suffered. Lybbert et al. (2004) report that Boran pastoralists in southern Ethiopia receive, on average, a gift or loan of only one head of cattle for every thirty livestock deaths beyond the community mean loss. McPeak (2006) finds transfers tend to go to herders who have experienced positive rather than negative herd growth in the prior year. These compensation proportions and timing of transfers suggest that interhousehold stock transfers among pastoralists offer meager insurance against asset loss.[5] This calls into question the completeness of insurance motives as an explanation for transfers in this setting.

Furthermore, within pastoralist communities, one hears informal reports that transfers have declined in frequency, scope and size over time. There also exists some indirect, albeit imperfect, evidence consistent with such reports. For Gabra herders in northern Kenya, Torry (1973) reports cumulative transfers per household since they began managing their herd independently averaging 17.8 camels out of the herd (12.0 camels into the herd) and 8.0 cattle out of the herd (2.6 cattle into the herd). More than 20 years later in the same area, McPeak's (2006) data for the same composition of inventory measures for camels averages 1.3 (1.2) and for cattle 1.4 (2.0). Using Desta's (1999) data, we derive similar suggestive evidence from a simple univariate regression of average gross household livestock transfers (the sum of the absolute value of transfers in and out) on a time trend variable yields a coefficient estimate of -0.147 cattle per year, with a p-value of 0.012. Both bits of evidence suggest the need for a framework to understand what factors could explain such declines in interhousehold transfers over time.

Those who rely on altruism or mutual insurance models of transfers must therefore explain the apparent decline in interhousehold transfers as reflecting 'moral decay' or cultural decline. Of course, this begs the question of why such decay happened. Our model does not rely on vague notions of moral decay to explain declining transfers. Rather, we hypothesize that major changes in the bio-physical and socio-economic environment of pastoralists in ASAL have induced the apparent sharp decline in transfers. We argue transfers traditionally kept people who lost their animals as mobile members of a group, thus enabling recipients to continue to help provide for the common defense of herds and grazing areas. We identify three key changes that could have undermined this logic behind transfer behaviour.

First, since the droughts of the early 1970's, the provision of food aid to pastoral areas has become increasingly frequent and the growth of towns has been rapid. Small towns that sprang up around relief distribution sites in the ASAL have rapidly expanded. Food aid distribution is often not targeted at needy recipients (Lentz and Barrett, 2005); identical food aid packages are given to all residents. So there is basically a lump sum (food aid) payment made to those living near settlements, thus creating an incentive to be in or around towns.[6]

Another important change is the growing violence in the rangelands. Livestock raiding between ethnic groups has long been a feature of pastoral areas (Bollig, 1990; Markakis, 1993; Hendrickson et al., 1996).[7] However, over the past thirty years, the growth in ownership of small arms has made traditional conflicts over pasture, water, and livestock increasingly lethal as civil strife in the region has created an abundant supply of automatic weapons at low prices (Oba, 1992; Hussein et al., 1999; Osamba, 2000; Smith et al., 2001). Government security forces rarely are able to stop these conflicts. Whether due to lack of manpower, supplies, or interest, they more commonly concern themselves with security issues in and around the small towns where they are posted. Government provided security is largely a matter of protecting town dwellers, while nomadic households are left to defend themselves as best as they can.

The third key change is that pastoralist mobility is has deteriorated over the past generation or so due to loss of spatial refugia to expanding rangeland towns, to extension of rainfed crop cultivation into traditional grazing areas, to recently gazetted parks and protected areas, and to violently contested no-man's-lands (Coppock, 1994; Desta, 1999; Fleisher, 1999; Heald, 1999). This has led to increased pressure on resources in areas around town that are viewed as safe (McPeak, 2003), and also spurred conflict over rangeland and watering points that were previously governed by overlapping, "fuzzy" property rights (Goodhue and McCarthy, 1999).

In the following section, we develop a model that captures and explains many of the facts just reported. We illustrate the interconnectedness of herd mobility, herd size, and transfers and show how the localized provision of relief food and security can influence these relationships. This permits explanation of both the apparently striking change over time in transfer behavior among pastoralists and the current observed transfer patterns that appear consistent with neither prevailing economic theories of altruistic preferences nor of social insurance and reciprocity.

II. A MODEL OF INDIVIDUAL MIGRATION CHOICE

The analysis in this section focuses on a single agent's binary decision over whether or not to migrate his herd and aims at elucidating the differential and conditional impacts of migration determinants. This analysis helps explain some stylized facts about pastoralism and apparent changes in the rangelands. It is also foundational, for in section III we will generalize these behaviors to allow for the simultaneous, strategically interdependent behaviors of multiple agents and allow the propositions with respect to migration derived in this section to inform our understanding of the evolution of interhousehold transfers among east African pastoralists.

The essence of our model is that there exist two externalities, an appropriation externality associated with potential site-specific overgrazing – the classic "tragedy of the commons" effect – and a physical security externality reflecting "strength in numbers" effects vis-à-vis hostile common opponents. Which of these effects dominates depends on herd sizes across agents in different ethnic groups, the level of external transfers available, and prevailing ecological conditions on the range. As section III shows, when the public security externality dominates, some agents may make limited strategic asset transfers to somewhat poorer kinfolk in order to induce co-migration to an unsafe location. When the appropriation externality dominates, some households transfer wealth to kin in order to induce them to migrate away and thereby relieve pressure on the common property grazing area. These transfers might even be regressive, flowing from poorer to richer households, although this phenomenon appears rare in practice. Overall, this model predicts precisely the sorts of current transfer patterns reported in the previous section, and can explain the shift over time that seems to have taken place in pastoralists' interhousehold transfer behavior. This framework is likewise consistent with the common sociological observation that individuals sharing a common identity frequently appear as allies in one setting (e.g., when faced with a common adversary in distant locations) and as competitors in other domains (e.g., over scarce forage and water for their herds near their homelands).

We structure the model in such a way as to underscore that neither insurance nor altruism could motivate the transfers that endogenously result.[8] We use this structure not because we do not believe that altruism or insurance are factors in the complex reality of east African pastoralism, but rather to isolate this new mechanism we model, which seems to offer a conceptual reconciliation with the empirical evidence on east African pastoralists that extant models of transfers fail to provide.

a. The agents and locations

Consider a two-area setting (respectively, a base camp near an established settlement, B, and a more distant satellite area, S). Define the livestock carrying capacity of each area $a \in \{B, S\}$, denoted $L_a^{max}(RF_a)$, as the maximal number of animals that can be placed on that plot without causing a decline in per animal productivity. We assume that areas are large enough that no single herder could feasibly manage a herd size equal to or greater than the carrying capacity in a given area. Carrying capacity is thus only a potential constraint when there are multiple herds in a given area. Carrying capacity is increasing in the rainfall realizations on an area, RF_a. Because herders in this region make migration decisions typically only after observing realized rainfall, thanks to word of mouth and/or reports from scouts sent out to prospect alternative grazing areas (O'Leary, 1985; Oba, 1992; Luseno et al., 2003), we assume that rainfall, while variable, is known; the model results are robust to making rainfall stochastic. Area-specific per animal productivity,[9] $f_a(RF_a)\geq 0$, is assumed to be increasing and concave in realized rainfall. Satellite areas have higher intrinsic productivity than base areas, $f_S(RF)>f_B(RF)$ for identical rainfall. For the same ecological reasons that productivity is higher there, satellite area carrying capacity exceeds base area carrying capacity for identical rainfall realizations, $L_S^{max}(RF) > L_B^{max}(RF)$.

Let there be three different herders representing two different, mutually hostile ethnic groups. Herders *1* and *2* share a common ethnic identity and are thus allies in any inter-ethnic conflict; herder *3* hails from the rival group. The herd size distribution $\{L^1, L^2, L^3\}$ is common knowledge. Each herder makes a discrete decision whether or not to migrate from his base camp area to the satellite area (m=1 for migration, 0 otherwise).[10] Henceforth, we set m^3 exogenously equal to 1. Thus, at the satellite area, there always exists a positive risk of inter-ethnic conflict. For the remainder of this section, we study herder *1*'s migration choice, m^1, conditional on the migration choice of herder *2*, m^2, and a given herd size of a rival group at the satellite area so as to be able to focus on the determinants of pastoralist migration. In the next section we relax this exogeneity assumption and explore the strategically interdependent migration decisions of the two herders and the distribution-conditional transfer regime that results endogenously.

b. Appropriation and security externalities

When the number of animals occupying an area exceeds its variable carrying capacity, productivity-degrading overgrazing results. Hence, in the event of excessive resource competition, an appropriation externality arises, wherein one herder's migration choice affects the productivity of other herders' animals. The herders (sharing a common identity) in the base area thus become competitors. Let $\delta_a = (L^1_a + L^2_a + L^3_a)/L_a^{max}(RF_a)$ express the area-specific occupancy rate as a proportion of its rainfall-dependent carrying capacity.[11] Then, we can define the expected proportional per animal productivity loss due to the appropriation externality as $\eta_a(L^1_a, L^2_a, L^3_a, RF_a) = (\delta_a - 1)/\delta_a$ if $\delta_a \geq 1$ and $\eta_a = 0$ if $\delta_a < 1$. This implies that herder *1*'s expected productivity loss at the satellite area is weakly increasing in herder *2*'s migration decision, $\partial\eta_S / \partial m^2 \geq 0$. Conversely, herder *1*'s expected productivity loss at the base area is weakly decreasing in his kinsman's migration decision, $\partial\eta_B / \partial m^2 \leq 0$.

Production is increasing in area-specific growth potential and actual rainfall. The common property appropriation externality negatively affects the production function only when the area-specific carrying capacity is exceeded. In the absence of the common property externality,[12] the pastoralist's production is unambiguously increasing in individual herd size.

Other herders' migration decisions matter not only because of prospective resource competition but also due to possible security externalities. If herders *1* and *2* both migrate to the satellite area, then because of inter-ethnic violence and/or livestock raiding they both risk a loss of animals.[13] Denote this security risk, again expressed as an expected proportional per animal productivity loss, as $\theta \in [0,1]$. At the satellite area, this security risk θ is a *decreasing* function of the aggregate herd size L^1+L^2. Intuitively, since security critically depends on human labor rather than herd size and given that treks are typically made in roughly fixed herder/herd size proportions, the larger the aggregate herd size, the more herders around to fend off the common enemy. There is strength in numbers in the sense that the presence of another member of a herder's ethnic group reduces his expected losses due to raiding and violence through a security externality. Hence, a common identity in the satellite area makes pastoralists allies.[14] Without loss of generality, we assume that security risk $\theta = 0$ at the base camp since the pastoralists who belong to a *different* social group never try to occupy the common property lands of another group and pastoralists of a *same* social group never raid or act violently against each other. At the satellite area, the limiting case of $\theta = 0$ only arises in the absence of violent raiding or if the rival group does not likewise occupy the area with its herd ($m^3 = 0$).

An important trade-off now emerges. If herders *1* and *2* both migrate, then the presence of more pastoralists from *1*'s ethnic group may create a positive security externality against raiding. On the other hand, it may also generate a negative resource appropriation externality, if and only if the resulting occupancy rate exceeds the area's carrying capacity.

c. Exogenous transfers and movement costs

As mentioned in section I, food aid has become nearly ubiquitous in the rangeland towns of the East African ASAL. We therefore introduce an exogenous transfer from outside the system, τ, which pastoralists only receive if they are at base camp, where they have ready access to town-based distribution of relief food.[15] This geography of food aid distribution creates a cost to migration that, because, as mentioned earlier, treks are typically made in fixed herder/herd size proportions, is monotonically increasing in herd size.[16] So if herder *1* chooses to leave the base camp for higher expected productivity satellite areas, he faces an opportunity cost of $\tau(L^1)$, *with* $\tau' > 0$,. In addition to this cost of foregone food aid, the migrating pastoralist incurs variable movement costs, $mc(L^1)$, that are similarly monotonically increasing in herd size, with $mc(0) = 0$ *and* $mc' > 0$. This cost reflects the animal weight loss and risk of injury or loss to wild predators incurred on the migratory trek.

d. The pastoralist's migration choice

We assume pastoralists maximize expected income conditional on others' simultaneous choice (m^2) that affects their payoffs. Utility is assumed to be increasing in income and, at the time of deciding whether to migrate, the key environmental parameters that shape the appropriation and security externalities are known to all.[17] The choice problem faced by pastoralist *1* is thus:

(1)

$$\underset{m^1 \in \{0,1\}}{Max} E\left(Y^1 \mid m^2\right)$$

$$Y^1 \equiv m^1\left\{(1-\eta_S)\left(1-\theta\left(L^1+m^2L^2\right)\right)L^1 f_S(RF_S) - mc\left(L^1\right)\right\} + \left(1-m^1\right)\left\{(1-\eta_B)L^1 f_B(RF_B) + \tau\left(L^1\right)\right\}$$

The first term of our expression for Y^1 represents pastoralist *1*'s payoff if he migrates to the satellite area, whereas the second term captures his payoff when staying at the base area. Both terms include an expression for the pastoralist's effective herd productivity, defined as his *ex ante* herd size adjusted for the expected impacts of the appropriation and security externalities, multiplied by the site-specific per animal productivity.

Pastoralist *1* then rationally decides to move to the satellite camp ($m^1 = 1$) if and only if

(2) $$f_S(RF_S) - f_B(RF_B) \geq \Omega$$

where $\Omega \equiv f_S(RF_S)\{\eta_S + \theta(L^1 + m^2L^2)(1-\eta_S)\} - f_B(RF_B)\{\eta_B\} + \frac{\tau(L^1)}{L^1} + \frac{mc(L^1)}{L^1}$. The lefthand side of (2) reflects a measure of general migration appeal, common for all pastoralists facing the same migration choice. The value of Ω is individual-specific since it depends in part on agent *1*'s individual herd size, L^1. All else equal, this migration condition is more likely to be satisfied when $\tau(L^1)$ and $mc(L^1)$ are small. This underscores how point-based free food aid distribution discourages migration, leading to increased herd concentration in base camp areas, an observation borne out empirically in the region (McPeak 2003). So in the absence of site-specific food aid transfers and variable movement costs, all pastoralists would move. But those costs of moving induce pastoralists with smaller herds to choose to stay at base camp and suffer lower productivity. More generally, however, the returns to migration depend fundamentally on m^2, L^1, L^2, L^3 θ, $L_B^{\max}(RF_B)$ $L_S^{\max}(RF_S)$, $f_B(RF_B)$, $f_S(RF_S)$, $mc(.)$, *and* $\tau(.)$.

Let us define the individual-specific migration threshold, $L^{1*}(m^2, L^2, L^3\ \theta, L_B^{\max}(RF_B)\ L_S^{\max}(RF_S), f_B(RF_B), f_S(RF_S), mc(.), \tau(.))$ as the minimum herd size that makes migration to the satellite area preferable. In other words, L^{1*} is the value for pastoralist *1*'s herd size that makes his migration condition hold with equality: $f_S(RF_S) - f_B(RF_B) = \Omega(L^{1*})$. In what follows, we let $\Omega(L^{1*}) = f_S(RF_S) - f_B(RF_B) \equiv \Omega^*$. For any given combination of parameter values, production functions and migration strategies chosen by the other herders, this specification generates a monotone, piecewise concave income function that is globally convex in herd size, with a kink point at L^{1*}.[18] The resulting threshold effect implies that ceteris paribus pastoralists with a herd size below L^{1*} find themselves in a low-level equilibrium of the sort described for this region empirically by Lybbert et al. (2004), McPeak and Barrett (2001) and Barrett et al. (2006).

Now, wealthier pastoralists are more likely to migrate to the satellite area if and only if

$$\frac{\partial\Omega}{\partial L^1} \leq 0$$

(3) $\Leftrightarrow$

$$f_S\left(RF_S\right)\left\{\frac{\partial \eta_s}{\partial L^1}(1-\theta)+\frac{\partial\theta}{\partial L^1}(1-\eta_s)\right\}-f_B\left(RF_B\right)\frac{\partial\eta_B}{\partial L^1} \leq \frac{\tau\left(L^1\right)+mc\left(L^1\right)-L^1\left(mc'+\tau'\right)}{L^{1^2}}$$

The righthand side of inequality (3) is necessarily positive, equaling zero if marginal migration costs are constant. The two terms on the lefthand side of inequality (3) correspond with the change in expected productivity caused by an incremental change in individual herd size respectively at satellite and base area. In the absence of overstocking (i.e., $\partial\eta / \partial L^1 = 0$), the lefthand side of (3) is negative and hence the condition clearly holds. If the appropriation externality occurs in the base camp but not in the satellite area, as is often the case (McPeak 2003) then inequality (3) still unambiguously holds. In the more general setting where appropriation externalities exist in both places, no fully general result exists. An increase in herd size is more likely to trigger migration to the satellite area the larger (smaller) the induced change in the negative appropriation externality at the base (satellite) area, and the greater the corresponding change in the positive security externality at the satellite area. A key assumption is

Assumption 1: Differences in rangeland carrying capacity across satellite and base area are such that $\frac{\partial\eta_B}{\partial L^1} >> \frac{\partial\eta_S}{\partial L^1}\left[(1-\theta)+\frac{\partial\theta}{\partial L^1}(1-\eta_S)\right]$.

Given the apparent empirical regularity among east African pastoralists that herd size is positively related to the probability of migration,[19] we henceforth assume that the difference in rangeland carrying capacity between satellite and base areas is indeed great enough that wealthier pastoralists are *ceteris paribus* more likely to migrate than poorer pastoralists. This leads to the following proposition:

Proposition 1: Suppose that Assumption 1 holds. A marginal increase in individual herd size decreases the migration threshold.

Let us next evaluate how an increase in wealth of a (non)migrating ally influences one's incentive to migrate. Two cases are separately considered: $m^2 = 1$ and $m^2 = 0$. Making use of the Implicit Function Theorem, we can rewrite the marginal effect of the herd size owned by one's clansman on the individual's migration threshold as:

(4)
$$\frac{\partial L^{1*}}{\partial L^2} = -\frac{\partial \Omega^* / \partial L^2}{\partial \Omega^* / \partial L^{1*}}$$

In the case where $m^2 = 1$, the numerator of (4) takes the form

(5)
$$\frac{\partial \Omega^*}{\partial L^2} = f_S\left(RF_S\right)\left\{\frac{\partial \eta_S}{\partial L^2}\left(1-\theta\left(L^1+L^2\right)\right)+\frac{\partial \theta}{\partial L^2}\left(1-\eta_S\right)\right\}$$

while the denominator is

(6)
$$-\frac{\partial \Omega^*}{\partial L^{1*}}$$

Given Assumption 1, the denominator is strictly positive. If in response to a marginal increase in *2*'s herd size at the satellite area, pastoralist *1* is more likely to migrate to the satellite area, then the migration decisions of both pastoralists are defined as strategic complements. Mathematically, strategic complementarity requires that

(7)
$$\left\{\frac{\partial \eta_s}{\partial L^2}\left(1-\theta\left(L^1+L^2\right)\right)+\frac{\partial \theta}{\partial L^2}\left(1-\eta_s\right)\right\} < 0$$
$$\Leftrightarrow$$
$$\left|\frac{\partial \theta}{\partial L^2}\left(1-\eta_s\right)\right| > \frac{\partial \eta_s}{\partial L^2}\left(1-\theta\left(L^1+L^2\right)\right)$$

In words, the positive security externality effect generated by an increase in pastoralist *2*'s wealth ($|\partial\theta/\partial L^2|$) must outweigh the inextricable nonpositive appropriation externality effect. If the rangeland conditions in the satellite area are such that the new occupancy rate is still less than its carrying capacity, then the requirement for strategic complementarity unambiguously holds and a marginal rise in wealth of pastoralist *2* generates only a positive public goods security externality, enhancing pastoralist *1*'s expected benefits from migrating. Conversely, in the absence of the risk of livestock raiding ($\theta = 0$, and $|\partial\theta/\partial L^2| = 0$), the requirement for strategic complementarity will never be satisfied. The corollary conditions for when the migration choices of pastoralist *1* and *2* constitute strategic substitutes can be readily derived in an analogous fashion.

In the case where $m^2 = 0$, the numerator of (4) equals

$$\frac{\partial \Omega^*}{\partial L^2} = -f_B\left(RF_B\right)\frac{\partial \eta_B}{\partial L^2}\,. \tag{8}$$

Thus, a marginal increase in the herd size of the non-migrating pastoralist either leaves the migration decision of his fellow kin unaffected or lowers the latter's migration threshold. In sum, we establish that:

PROPOSITION 2: A marginal increase in the herd size of a migrating pastoralist 2 lowers pastoralist 1's migration threshold if and only if the induced positive security externality effect outweighs the parallel negative appropriation externality effect. A marginal increase in the herd size of a non-migrating pastoralist 2 never raises pastoralist 1's migration threshold.

Change in external food aid transfers likewise affects pastoralist *1*'s migration behavior. By similar use of the Implicit Function Theorem, one can readily establish that a rise in food aid transfers unambiguously increases pastoralist *1*'s migration threshold by increasing the cost of migration.[20] As a consequence, the required minimal herd size to make migration attractive increases in the level of freely available food transfers.

PROPOSITION 3: An increase in the total amount of freely available transfers raises pastoralist 1's migration threshold.

A marginal rise in pastoralist *3*'s herd size (weakly) increases pastoralist *1's* migration threshold because it increases the risk of livestock loss (see footnote 12) and may affect productivity in the satellite area due to an appropriation externality.

PROPOSITION 4: Pastoralist 1's migration threshold is weakly increasing in the hostile pastoralist's herd size at the satellite area.

Rainfall obviously influences pastoralist *1*'s equilibrium migration strategy. Increased rainfall in the satellite area lowers pastoralist *1*'s migration threshold because productivity away improves. A marginal increase in rainfall also increases the carrying capacity of the satellite area, possibly reducing η_S and thereby creating further productivity gains. Conversely, if rainfall increases in the base area, pastoralist *1*'s migration threshold increases because it stimulates base area livestock productivity both directly and indirectly by potentially mitigating local appropriation externalities by increasing the base area's carrying capacity.[21] In sum, microvariability in precipitation induces pastoralists to follow the rains, migrating if it falls in the satellite area, staying if it falls around the base camp.

If the marginal change in rainfall is uniformly distributed across both the satellite and base areas, as often happens in time of drought, then, since $f_S(RF) > f_B(RF)$, any incremental change in rainfall (Δ) increases $f_S(RF_S+\Delta) - f_B(RF_B+\Delta)$ at a decreasing rate. Rainfall also affects Ω.. In sum, a uniform marginal increase in rainfall at both satellite and base areas generates a downward shift in the pastoralist 1's migration threshold.

PROPOSITION 5: A marginal change in rainfall favoring the satellite (base) area induces a downward (upward) shift in pastoralist 1's migration threshold. Pastoralist 1's migration threshold falls in response to a spatially uniform change in rainfall.

The final relation we seek to establish in this section relates to change in the security risk parameter, θ. An increase in the exogenous risk of raiding, perhaps due to the spread of modern weaponry, or to increased interethnic tensions due to political disputes, diminishes pastoralist *1*'s expected payoff from migrating and thus dampens his propensity to migrate.

PROPOSITION 6: An increase in the exogenous risk of raiding generates an upward shift in pastoralist 1's migration threshold.

The insights summarized in these six propositions lay the foundation for the next section, which explores transfer choices as the rational outcome of pastoralists' strategic interdependence through both appropriation and security externalities. The tradeoffs between risk of violence and livestock raiding and stocking rate pressures on common property rangelands create a limited space in which livestock transfers occur. The pattern of these transfers reflects particular combinations of ecological conditions, *ex ante* herd distributions, external transfer volumes, and the exogenous probability of violence. This matches the empirical evidence on east African pastoralists that extant theories cannot readily explain.

III. TWO-PERSON NON-COOPERATIVE MIGRATION GAME

The preceding section treated the decision of pastoralist *1* in isolation from the simultaneous, interdependent choice of the other pastoralist so as to better understand the nature and determinants of the crucial migration choice. In this section, we treat the two pastoralists' decisions as a sequential, noncooperative game of transfer followed by migration choices in order to tease out the conditions under which transfers emerge in equilibrium in the absence of altruism or repeated interactions that might permit endogenously enforceable informal insurance contracts.

The intuition of the results we develop runs as follows. The larger an individual's herd, the greater the incentive to migrate to the satellite area, *ceteris paribus*. When stocking rate pressures on the open range are low or nonexistent and there is real risk of livestock raids, a relatively wealthy, migrating pastoralist may then benefit from manipulating a poorer ally's independent migration choice by transferring animals to him and thereby inducing him to move voluntarily, and thus to fight alongside the bigger herder against their common foe.[22] However, some pastoralists are so poor that the transfer necessary to induce them to migrate is excessive relative to the security externality benefits the wealthier herder would enjoy.[23]

As a consequence, the resulting egalitarian transfers are limited in two crucial senses. First, they are limited to the transfer level necessary just to bring one's ally to his migration threshold and thereby induce him to move – and fight – alongside the donor.[24] Thus transfer volumes are small.[25] Second, they are limited only to ally households that are below but reasonably near the migration threshold, so that the security externality benefits can justify the cost of the animals given away. One outcome is that the poorest members of the ethnic group do not receive internal transfers (just external transfers of food aid), have herd sizes too small to migrate, and are consequently trapped in a relatively low productivity equilibrium.

This gives rise to a second, distinct type of manipulative transfer. If overstocking pressures are significant around the base areas, some pastoralists may find it in their interest to transfer an animal to another herder whose ex ante herd size lies just below his migration threshold, so as to induce the recipient to move and thereby increasing the productivity of the remainder of the donor's herd. If the probability of migration is increasing in herd size, such transfers to induce others to vacate shared rangelands around a base camp will typically be regressive, from poorer herders to slightly wealthier ones, although in principle such transfers could be to anyone. Still, this gives us a candidate explanation for the (infrequent) observation of modest regressive livestock transfers among east African pastoralists.[26] There thus exist state-dependent interdependencies between migration choices undertaken by pastoralists sharing a common social identity, manipulative interhousehold transfer behaviors, and low-level productivity equilibria for pastoralists trapped in and around rangeland towns.

Without loss of generality, let *1* be the wealthier of the two herders in the same ethnic group ($L^1 \geq L^2$). Given the discrete, simultaneous migration decision by these two agents, in theory there exist four different combinations of migration strategies that can possibly emerge. However, Proposition 1 rules out one of these possibilities because if *1* does not choose to migrate, then neither will *2* move because migration incentives are increasing in herd size. Figure 1 depicts the feasible strategy space of three migration/no migration combinations.

The problem, from pastoralist *1*'s perspective, is now one of maximizing expected income subject to the independent choice of pastoralist *2*. Each of the two herders is simultaneously solving the migration choice problem in (1). The key now is to recognize that their common social identity can create an incentive for either *1* or *2* to offer his fellow group member a side payment in the form of an interhousehold livestock transfer, in order to induce the other to migrate. To be more precise, *1*'s migration choice now becomes

$$\max_{\beta_{12}, m^1 \in \{0,1\}} E(Y^1)$$

(9)
$$Y^1 \equiv m^1 \{(1-\eta_S)(1-\theta(L^1-\beta_{12}+m^2(L^2+\beta_{12})))(L^1-\beta_{12}) f_S(RF_S) - mc(L^1-\beta_{12})\} + (1-m^1)\{(1-\eta_B)L^1 f_B(RF_B) + \tau(L^1-\beta_{12})\}$$

where β_{12} is the transfer from *1* to *2*, chosen by *1* only if $m^1=1$.[27] Intuitively, $\beta_{12}>0$ only when the transfer is necessary and sufficient to induce *2* to migrate (that is, when herder 2's incentive compatibility constraint is satisfied), and when the security benefits to *1* of *2*'s migration outweigh the costs of both relinquishing wealth and potentially aggravating the resource appropriation externality in the satellite area (that is, when herder *1*'s rationality constraint is satisfied). The minimum transfer necessary to induce *2* to move will be $\beta_{12}^{min}=max(L^{*2}_{|m^1=1} - L^2, 0)$.[28] Clearly, if herder 2 already owns sufficient livestock so that he benefits from migrating to the satellite area irrespective of whether he is given additional animals, there is no need for *1* to make a transfer: $\beta_{12}^{min}=0$. If, however, L^2 is sufficiently small that without the transfer *1* believes that $m^{2*}=0$, then a stock transfer may be in *1*'s interests. Define β_{12}^{max} as the transfer level that would leave herder *1* indifferent between making a transfer and moving to the satellite area alone. Obviously $\beta_{12}^{max} > 0$

if and only if strategic complementarity exists, i.e., if *2*'s presence in the satellite area confers more security benefits than it costs in resource competition.

Put these two conditions together and equilibrium positive transfers must fall in the interval [β_{12}^{min}, β_{12}^{max}]. No transfers result if $\beta_{12}^{max} < \beta_{12}^{min}$ or $\beta_{12}^{min}=0$. This is the sense in which transfers are limited in volume and can exclude both the poorest and richest pastoralists under contemporary conditions. If the migration threshold is reasonably high, perhaps because food aid distribution is significant, carrying capacity is low and security risks are great, then the necessary transfer to induce *2'*s migration may well exceed *1*'s reservation transfer level. We conjecture that over time, the changes in the east African ASAL have caused [β_{12}^{min}, β_{12}^{max}] to shrink, thereby explaining why significant past interhousehold transfers have fallen markedly.

Although transfers will only occur among pastoralists of the same social identity, they need not always be distributionally progressive. If either herder is willing to migrate based on his *ex ante* herd size, then $\beta_{12}>0$ is a possible transfer in equilibrium. This result obtains because *1* will always be willing to migrate when *2* is willing to migrate, since the only difference in their choice problem is their *ex ante* herd size and, by proposition 1, the migration threshold is decreasing in herd size. However, if neither *1* nor *2* have ex ante herd sizes sufficient to justify migration, the possibility of regressive equilibrium transfers arises. The logic depends on the notion of strategic substitutes, as defined in the previous section. If herd sizes in the base camp area are sufficient to induce significant appropriation externalities and pastoralist *1*'s herd size falls just below his migration threshold, then a livestock transfer from the poorer household, *2*, to the richer-but-still-poor household, *1*, may be mutually beneficial.[29] Somewhat more formally, the minimum transfer necessary to induce *1* to move would be $\beta_{21}^{min}= max(L^{*1}{}_{|m^2=0} - L^1, 0)$. Now define β_{21}^{max} as the transfer level that would leave herder *2* indifferent between making a transfer intended to induce *1* to exit the base camp common property and sharing those grazing areas in spite of the overstocking pressures. Strategic substitutability is necessary but not sufficient for $\beta_{21}^{max} > 0$, just as strategic complementarity is necessary but not sufficient for $\beta_{12}^{max} > 0$. If the transfer necessary to induce *1*'s migration is no greater than the maximum transfer *2* is willing to make to have the base camp grazing area to himself, then a regressive transfer in the interval [β_{21}^{min}, β_{21}^{max}] can take place in equilibrium.

Furthermore, if both 1 and 2 have ex ante herd sizes sufficient to justify migration provided they migrate together, then the possibility of regressive equilibrium transfers arises. The transfer then serves as a way of eliminating the possibility of a coordination failure: pastoralist *2* offers *1* just enough cattle to ensure that the latter migrates irrespective of *2*'s decision. Formally, the minimum transfer to induce *1* to move regardless of *2*'s actions would be $\beta_{21}^{min'} = max(L^{*1}{}_{|m^2=0} - L^{*1}{}_{|m^2=1},\ 0)$. Now define $\beta_{21}^{max'}$ as the transfer level that would leave herder *2* indifferent between making a transfer intended to induce *1* to exit the base camp common property whether she migrates or not, and staying on the base camp. If then the interval $[\beta_{21}^{min'}, \beta_{21}^{max'}]$ is nonempty, then a regressive transfer will take place in equilibrium.

Let us now summarize the feasible options in strategy space. First, we briefly consider one other situation, namely when $\theta = 0$, wherein the only manipulative transfers that could exist in equilibrium would be regressive transfers meant to relieve the resource appropriation externality in the base area. These will necessarily only be offered if *2*'s gift induces *1* to migrate while *2* remains at the base camp ($m^1 = 1$, $m^2 = 0$). In this setting, transfers represent a Coasian mechanism to resolve the resource appropriation externality. Such regressive transfers could, in theory, occur regardless of the size of the security risk in the satellite area. However, because $L^{*1}{}_{|\theta>0} \geq L^{*1}{}_{|\theta=0}$ following Proposition 4, $\beta_{21}^{min}{}_{|\theta>0} \geq \beta_{21}^{min}{}_{|\theta=0}$. In words, the transfer necessary to induce *1* to vacate the base area is necessarily larger when *1* expects to then incur a greater livestock loss at the satellite area. This necessarily implies that regressive transfers to a pastoralist who then has to fight for his grazing land are both less likely and, when they occur, larger than regressive transfers to those who do not ultimately have to fight.

The more likely possibility for limited progressive manipulative transfers arises when $L^1 \geq L^{*1}$. Strategic transfers within a social group may be mutually advantageous to *1* and *2*. Progressive interhousehold transfers intended by *1* to induce *2* to migrate and fight alongside him necessarily occur only if both parties ultimately move to the satellite area, fostering ethnic conflict over scarce resources ($m^1 = m^2 = 1$), as shown in Figure 2. Note, however, that in principle one could see regressive transfers because the security externality creates a coordination game best resolved by a small transfer from the poorer herder to the wealthier one so as to ensure that *1* migrates regardless of *2*'s choice.

Figure 3 depicts the relevant β_{12}^{min} and β_{12}^{max} curves for a given set of parameters $\{L^1, L^2, L^3, RF_a, f_a(.), \theta, \tau\}$. The shaded area reflects the set of feasible progressive transfers in equilibrium, which depends on how *1* and *2* interact. For ease of exposition, we hereafter assume *1* chooses β_{12} unilaterally, subject to satisfying *2*'s incentive compatibility constraint to migrate, implying that $\beta_{12}= \beta_{12}^{min}$.[30] As defined earlier, β_{12}^{min} is a linear, decreasing function of L^2 with unit slope in absolute value that is positive only below L^{*2}.[31] The willingness-to-transfer function, β_{12}^{max}, can never be positive below L^{*1}, and is concave in L^1 thereafter, increasing so long as the marginal change in the appropriation externality is dominated by the marginal change in the security externality, thus increasing expected per animal productivity for *1*:

$$(10)\quad \frac{\partial \eta_s}{\partial L^2}\left(1-\theta\right)+\frac{\partial mc(L^1)}{\partial L^1}<\frac{\partial \theta}{\partial L^2}\left(1-\eta_s\right)$$

The result is that not only are transfers limited to within the social group, but the fact that β_{12}^{max} is decreasing in L^1 beyond some threshold point and that β_{12}^{min} is decreasing in L^2 limits the wealth space within which progressive interhousehold transfers occur. The poorest pastoralists (those in the neighborhood of $L^2=0$ in Figure 2) receive no wealth transfers and the biggest herders make no transfers. This is a limited rational egalitarianism in which distributionally progressive transfers flow from an "upper middle class" to a "lower middle class" as a result of agents' identity-dependent strategic interdependence. This model thus yields predictions that contrast with both the insurance model, where net transfers covary positively with asset shocks but are unrelated to wealth, and with the canonical altruism model, where net transfers are monotonically increasing in wealth. We leave for future work empirical investigation to try to identify what proportion of observed transfers is best explained by each model.

The set $[\beta_{12}^{min}, \beta_{12}^{max}]$ may be empty. Figure 3 depicts how a decrease in L_s^{max}, the satellite area carrying capacity, might extinguish transfers in equilibrium. Because security risks increase in the satellite area, L^{*1} and L^{*2} both increase, per proposition 3, and the resource appropriation externality effect becomes more pronounced, diminishing the prospective benefits to *1* of a migration by *2*. Relative to the base case depicted in Figure 3, this increases β_{12}^{min} and decreases β_{12}^{max} for any $\{L^1, L^2\}$, potentially extinguishing herder *1*'s incentive to manipulate *2*'s migration choice through a stock transfer.

A situation where no equilibrium transfers occur is more likely to arise as the exogenous risk of raiding parameter increases, the carrying capacity at the satellite area decreases (leaving no scope for cases where the induced positive security externality surpasses the negative competition externality), the base-satellite productivity differences are low and the level of food transfers is high. Such parameter value shifts reflect the stylized changes over the past generation in conditions on the east African rangelands described in section I and may help explain the apparent reduction in interhousehold transfers observed among pastoralists there.

IV. Conclusion

Although models of interhousehold transfers have long fascinated social scientists, the extant models based on altruism or mutual insurance appear insufficient to explain some patterns of transfers and change in those behaviors. We illustrate this with reference to east African pastoralists and use that case to motivate an alternative, complementary model of transfers. Our model predicts that transfers are limited in frequency, scope, size and distributional reach, and occasionally flow from poorer to richer households. The model explains the observed decline in transfers as a byproduct of changing environmental conditions –increased town-based provision of food aid, diffusion of weapons leading to more inter-group violence, and reduced rangeland carrying capacity – that exogenously affect transfer incentives. Although the hypotheses our model generates are the only ones consistent with the mass of ethnographic, range science and economic evidence on which we draw, they are unfortunately not directly testable with available data. Nor would we expect new data to shed much light on this phenomenon since we are trying to explain an important phenomenon that seems to have largely vanished.

The theoretical model nonetheless provides an alternative, integrated understanding of pastoralists' migration and interhousehold transfer behavior, with significant policy implications. Notably, interventions that change the biophysical and socioeconomic environment in which pastoralists make migration and transfer choices can induce progressive interhousehold transfers or (unintentionally) further discourage such acts. For instance, while welfare may be increased due to the provision of public services and external transfers, the incentives to undertake manipulative private transfers decline. These incentives could be reversed through other public investments not yet taken. In particular, interventions to reduce inter-group violence – e.g., through serious conflict resolution intermediation efforts or geographically expanded police protection – and to increase rangeland carrying capacity through improved water and range management could stimulate herd mobility, which remains key to pastoralist welfare and wealth accumulation, and thereby encourage renewal of progressive interhousehold transfers.

Furthermore, the core principle of our model – that transfers may be state-conditional, rational responses to identity-dependent strategic complementarities between agents affected by one or more externalities – and the issue of endogenous provision of security when people identify themselves with distinct social groups both apply more widely than just to the very specific context of east African pastoralism. We briefly propose two concrete, alternative settings where variants of the mechanism modeled here may well apply and merit further exploration.

First, consider two different cases of joint human migration across long distances. One involves skilled workers moving from developing countries to foreign lands who often provide a self-serving transfer (e.g., a plane ticket) to a poorer clanswoman so as to induce her to migrate with them and subsequently provide domestic (e.g., child care) services. A prime motivation is the desire to preserve the child's natal culture and language, i.e., security against cultural erosion, as reflected in the fact that such behaviors appear more likely the fewer countrymen the skilled migrant expects to find in the destination and the more alien the host culture. Further, such transfers appear less likely the greater the crowding that would result from co-residence with the poorer co-migrant. Similarly, migrants from rural villages often use transfers to induce a neighbor or kinsman to join them in a distant city where a friend and ally can be valuable in an otherwise-insecure setting where one does not have reliable prior contacts, but can also create competition for living space, employment, etc. In both cases, trade-offs between security and a common resource externality help explain the emergence, under specific environmental parameters, of strategic complementarities that induce transfers that are neither altruistic nor mutual insurance.

The other example we offer, is that of "foot soldiers" in a street gang engaged in illegal activities such as drug sales or prostitution. Gang members have an incentive to band together so as to protect their turf against rival gangs. But because they are also competitors for a limited resource (e.g., prospective customers, social standing), this creates (at least pecuniary) externalities. So long as the former externality dominates, there is an incentive to give costly gifts – drugs, weapons, money, a uniform, etc. – to induce a prospective member to join the gang, but not for altruistic or mutual insurance reasons.

These examples illustrate how tradeoffs between a negative common property externality and a positive security externality may affect behaviors of widespread interest and be more widespread than is currently appreciated. When weak states are unable or unwilling to provide security services, individuals must resolve that state failure through non-market coordination mechanisms that rely heavily on group identity. The need to endogenously provide security influences economic behavior. Such insights may help resolve some behavioral puzzles, including but not only the case of interhousehold transfers among east African pastoralists.

Figure 1: Equilibrium Transfers Conditional on Optimal Ex Post Migration Choices

(cell entries are the value of the transfer)

	$m^1 = 0$	$m^1 = 1$
$m^2 = 0$	0	**<u>Regressive transfers</u>** 0 if $\beta_{21}^{min} = 0$ or if $[\beta_{21}^{min} > 0, \beta_{21}^{max}] = \emptyset$ $[\beta_{21}^{min}, \beta_{21}^{max}]$ otherwise
$m^2 = 1$	.	**<u>Regressive transfers</u>** 0 if $\beta_{21}^{min'} = 0$ or if $[\beta_{21}^{min'} > 0, \beta_{21}^{max'}] = \emptyset$ $[\beta_{21}^{min'}, \beta_{21}^{max'}]$ otherwise **<u>Progressive transfers</u>** 0 if $\beta_{12}^{min}=0$ $[\beta_{12}^{min}, \beta_{12}^{max}]$otherwise

Note: Without loss of generality, let *1* be the wealthier of the two herders in the same ethnic group ($L^1 \geq L^2$). Also, let Assumption 1 hold.

Figure 2: Limited Progressive Transfers in Equilibrium

(conditional on $m^1 = 1$, and $\theta>0$)

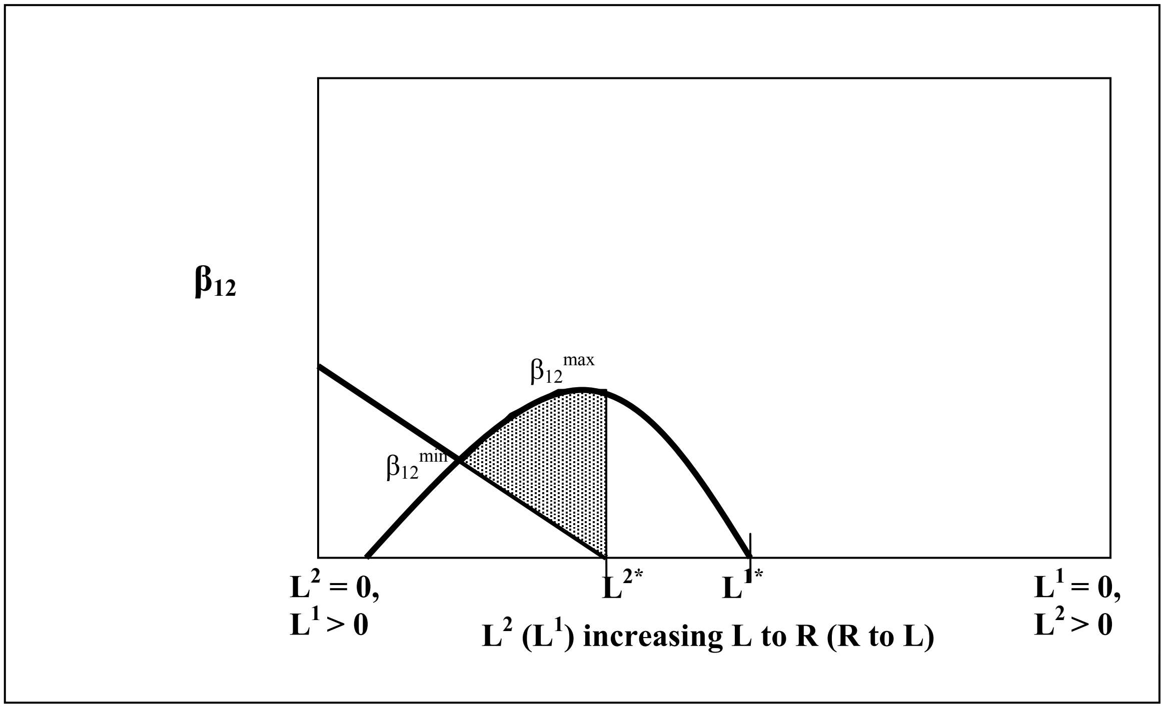
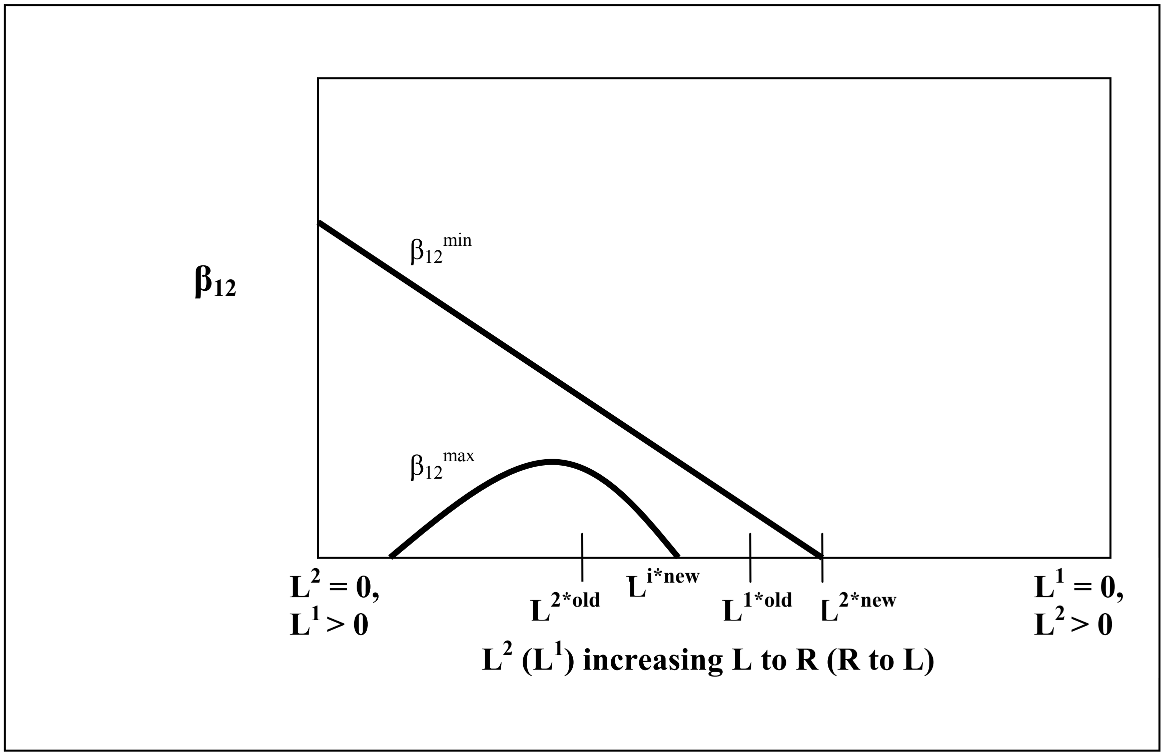


Figure 3: No Equilibrium Transfers

(conditional on m^1 1, and $\theta>0$)



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NOTES

[1] Like Lucas and Stark's (1985) theory of remittance behavior, we view transfers as a mechanism for redistributing the gains from some jointly agreeable action. As a result, the transfers can endogenously vanish when the contract is no longer mutually beneficial.

[2] Our 'service' does share with some of the previous models the important feature of having no close market substitutes.

[3] See Sobania (1979) and Robinson (1984) for northern Kenya examples.

[4] McPeak (2006) reports that 93% of transfers recorded among Gabra pastoralists in northern Kenya from 1993-97 occur between individuals with a mother's side, father's side, or in-law relation. Perlov (1987) describes exchange as a function of the social distance between the two parties. As the rules governing transfer arrangements follow those of a given ethnic group, almost no exchange across ethnic frontiers occurs as there are no cultural institutions to allow such exchange. Relatedly, marriage occurs within ethnic groups. Marriage patterns can potentially foster strategic alliances across clans, but only within groups that are already natural allies, not enemies.

[5] Nor does it seem that transfers have merely changed form, from livestock to money, food or other forms. Among northern Kenyan and southern Ethiopian pastoralists, interhousehold transfers of any kind are very modest and not strongly related to the experience of shocks (Lentz and Barrett, 2005).

[6] Food aid flows in response to covariate rainfall shocks have also increased over this period. If these were well-targeted based on household-specific shocks, this could salvage the insurance explanation of declining transfers, due to the crowding out of private transfers by public ones. But since household-level food aid receipts in this region are commonly lump sum transfers across households and uncorrelated with household wealth, income or idiosyncratic income or wealth shocks (Lentz and Barrett, 2005), these do not seem to affect private transfers in response to idiosyncratic shocks. Thus the puzzle remains.

[7] Cattle raiding and its attendant violence are occasionally inter-clan within some ethnic groups. We simplify in assuming violence is solely between ethnic groups.

[8] Agents in our model are purely materially self-interested, so altruism plays no role. And the model is static, so insurance contracts cannot exist because there is no opportunity for future reciprocation.

[9] Productivity here reflects the production of consumption goods: milk, blood and meat.

[10] We assume that no herder can be prohibited from moving by other members of his clan. If multiple herders each choose to move from one site to another, they necessarily do so together.

[11] Note that by construction, L^3_B equals zero.

[12] Both Lybbert et al. (2004) and McPeak (2005) find empirical evidence that mortality and productivity, respectively, do not necessarily fall with increased livestock in an area, underscoring that appropriation externalities are not ubiquitous and may frequently be dominated by security externalities.

[13] Today, violence and raiding risk almost entirely exist in the satellite areas of the hinterland. The town-based provision of public security services in the form of police protection provides reasonable assurance against raiding losses around towns. We simplify this to perfect assurance in the model. Prior to the introduction of town-based public services a few generations ago, however, there was no practical distinction between base and satellite areas, so raiding threats were nearly omnipresent.

[14] The value of the security risk also increases with the herd size of the rival group, L^3. Furthermore, it reflects the availability and trafficking of weapons in the region, political tensions between groups, and other factors that are unrelated to stocking rate pressures in the satellite areas of the rangelands. We thus assume the two externalities are not directly linked, as it appears that little contemporary violence and livestock raiding in this setting is in fact linked to competition for grazing area (Yirbecho et al., 2004).

[15] Since food aid distribution in the region is typically independent of a pastoralists' wealth, we treat this as a lump sum that is identical for all pastoralists. Our assumption that food aid is available only in the base camp is an obvious oversimplification. The key feature is that leaving the satellite area to come to town to receive food aid entails a nontrivial fixed cost. For simplicity's sake, we model this cost as prohibitive.

[16] There are other prospective benefits to being near town: access to markets and thus a wider variety of consumer goods, more timely information from the outside world, etc. These other location-specific amenities merely reinforce the basic logic of our model, namely that the rise of localized provision of public services changes migration and transfer patterns.

[17] For expositional purposes, we present our model for the case of risk-neutral agents only. Risk aversion merely complicates the analysis without adding substantially different insights.

[18] The area-specific gross total products, P_S and P_B, and are indeed concave functions of L^1 given that θ is a convex function of L^1 and that aggregate herd size, L^1+L^2, exceeds 2 under any realistic scenario.

[19] The simple bivariate correlation coefficient of L^1 and m^1 equals 0.352 using the 1560 observations of quarterly household-level data from Lentz and Barrett (2005). See as well Little et al. (2001), McPeak and Barrett (2001), McPeak (2003), and Kaburo-Mariara (2003). It thus seems in data from the region that herd size and migration probability are indeed positively correlated. Using a game-theoretic model of migration and conservation Ruttan and Borgerhoff Mulder (1999) also lend theoretical support to the idea that richer herders are more likely to migrate to satellite grazing reserves.

[20] A formal proof of this and other omitted (but we believe straightforward) claims to follow, all using the same Implicit Function Theorem technique that led to Proposition 2, are available on request from the authors.

[21] Higher rainfall in the base area diminishes $[f_S(RF_S) - f_B(RF_B)]$ by a factor which is greater than the induced reduction in the value of Ω. Accordingly, *ceteris paribus*, increased rainfall in the base area makes it less likely that the migration condition is fulfilled.

[22] While one herder may try to induce another herder to accompany him in his trek to the satellite area, it is assumed that nobody has the capacity to exclude any group member from moving with him. We thus rule out the possibility that a poor herder must pay a richer ally for 'protection' during his move.

[23] This is why herders do not induce poorer herders to trek with them using non-livestock transfers. The transfer required to induce migration is too expensive, whether paid in animals or other assets (e.g., cash).

[24] Note that if the herder refuses to accept the transfer offered by the donor, then his outside option is to stay in the base area. Hence his threat point is defined by his expected utility from staying when the other, richer group member nevertheless prefers to move out.

[25] Santos and Barrett (2006a) report that 91% of livestock transfers in this region were of just one animal and less than 2% were of more than two animals.

[26] One likely reason for the infrequency of such transfers is the coordination problem that exists when one generalizes beyond the two person game setting. Since inducing those nearest their migration threshold to move so as to relieve pressure on the commons is a public good, there exist incentives to free ride.

[27] We will shortly consider the possibility of $\beta_{21} = -\beta_{12}$, but abstract from this for the moment.

[28] Note that pastoralist *2*'s migration threshold $(L^{*2}{}_{|m^1=1})$ is, like before, defined by inequality (2), but now takes into account pastoralist *1*'s reduction of his herd size following the minimal transfer.

[29] In theory, variable returns to scale could also give rise to the coexistence of progressive and regressive transfers. Regressive transfers would occur at the low end of the wealth distribution, as poor herders seek to transfer their herd to bigger herders, and the progressive at the upper tail as wealthy herders reduce their herds through transfers to smaller neighbors. We know of no empirical evidence to support the variable returns hypothesis in this setting, however, and each of the several animal scientists we asked discounted this explanation as highly unlikely. Among other reasons, there would exist serious agency problems (the transferee could sell or slaughter the extra animals and simply claim they were eaten by wildlife predators), as similarly reflected in the lack of any significant hiring of herders (unlike in West Africa).

[30] Given a finite set of fellow community members, however, *2* may enjoy some bargaining power and be able to extract a greater transfer, although never beyond the β_{12}^{max} individual rationality constraint imposed by *1*'s choice problem. We leave this bargaining game refinement to future work.

[31] Recall from section II that the exogenous factors, including the ex ante herd distribution, determine L^{*2} by establishing the differential range productivity, fixed and variable movement costs, and the range appropriation and physical security externality values. So β_{12}^{min} changes with those parameters too.