Risk Sharing and Asset Transfers: The Role of Livestock Transfers in Northern Kenya

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Abstract
In many low-income, high-risk environments households participate in informal risk sharing institutions involving inter-household transfers. This study focuses on: asset transfers and asset risk; the influence of past behavior on access to transfers; and wealth-differentiated transfer behavior. Panel data on livestock transfers in northern Kenya are analyzed. Three explanations of livestock transfers are investigated: *ex post* insurance; *ex ante* precautionary savings; and redistribution. Findings indicate that livestock transfers are best viewed as a form of *ex ante* precautionary savings. The findings have implications for both research on the persistence of poverty and the design of formal insurance mechanisms.

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1. INTRODUCTION

This study investigates the role of livestock transfers in addressing asset risk in a pastoral production system. It contributes to a literature that increasingly recognizes low income and expenditure are only part of what defines household-level poverty. Vulnerability to adverse shocks is now recognized as an additional defining characteristic of being poor (World Bank, 2000). Vulnerability relates not just to exposure to risk, but also access to institutions that ameliorate the impact of unforeseen events.

In many low-income, high-risk environments, formal risk management institutions are unavailable. Instead, households rely on a combination of self-insurance and informal risk sharing arrangements. The self insurance aspect of livestock accumulation in the study area is addressed in McPeak (2004) and will not be the focus of the current study. The current study investigates the practice of livestock transfers between households. We assess alternative theories in the anthropological literature on the role and functioning of livestock transfers. These theories have predominantly described such transfers as an informal risk sharing mechanism.

The economic literature on informal risk sharing has largely focused on how transfers between households reduce *ex post* consumption variability in the presence of transitory income shocks (Kimball, 1988; Rosenzweig, 1988; Townswend, 1988; Fafchamps, 1992; Coate and Ravallion, 1993). When facing stochastic income shocks over time, risk averse households can benefit by pooling risk through informal institutions. These institutions transfer resources from households with better than average realizations to households with lower than average realizations in a given period.

One major theme of recent research on informal risk sharing arrangements focuses on the role commitment problems play in preventing informal mechanisms from providing a socially optimal level of risk sharing. (Kocherlakota, 1996; Platteau, 1997; Fafchamps, 1999; Ligon et al., 2000; Ligon et al., 2002). A variety of studies have illustrated that conditioning current period transfers on past transfer behavior allows informal risk sharing mechanisms to at least partially address commitment problems and move closer to Pareto optimality. The importance of the role played by past behavior has been confirmed by empirical studies that include a record of past transfer behavior. These studies find past behavior does indeed play a conditioning role in determining current period transfers (Foster and Rosenzweig, 2000; Foster and Rosenzweig, 2001; Lybbert et al. forthcoming).

While conditioning access to transfers on past behavior does help address commitment problems, we draw attention with this study to the *ex ante* incentive structure such conditioning adds to informal risk sharing mechanisms. Recent studies have begun to investigate *ex ante* incentives in informal risk sharing mechanisms. Ligon et al. (2000) note “it is the possibility of benefiting from future insurance which acts as an incentive for the current providers of insurance…” (p. 217). Fafchamps and Lund (2003) arrive at a similar assessment, suggesting “obtaining gifts and credit in the future may thus be a motivation for extending gifts and loans today” (p. 273). Udry (1994) identifies risk management benefits for lenders in flexible credit arrangements, as credit repayment terms respond to changing conditions for not just the recipient, but also the lender. Fafchamps (1999) and Platteau and Abraham (1987) recognize this *ex ante* aspect of risk sharing mechanisms by describing them as quasi credit institutions involving implicit obligations to reciprocate. In this study, we elaborate on these earlier contributions to arrive at new insights into the functioning and effectiveness of informal risk sharing mechanisms.

Recent developments in the literature indicate that an enhanced understanding of *ex ante* incentives in risk sharing mechanisms is critical. First, there is a growing awareness that risk sharing groups operate at the sub-village level, and that individuals have some ability to select the risk sharing group they will participate in. Both Murgai et al. (2002) and Fafchamps and Lund argue that risk sharing takes place not at the village level, but within sub-village level networks of relatives and friends. Murgai et al. describe how transaction costs can be used to explain the formation of risk sharing networks at a sub-village level. Fafchamps and Lund suggest the reason for their result is that monitoring and enforcement are more effective within such sub-groups. An endogenous aspect of risk sharing group formation has been noted in previous studies. Rosenzweig and Stark (1989) identify marriage and associated migration in India as a process by which households can form risk sharing alliances with other households. Platteau (1997) describes how members of a risk sharing mechanism in Senegal opt out of a particular network to join another due to frustration over being a net donor over time. As risk sharing takes place within sub-community groupings and individuals make choices about the group within which they participate, better understanding of the incentive structure facing the individual when considering alternative risk sharing partners is critical.

In addition, recent literature on poverty traps and asset dynamics suggests that *ex ante* incentives to select a particular recipient will not only be influenced by the expected commitment of the recipient to reciprocate, but also his or her expected capacity to reciprocate. Fafchamps (1999) notes "…quasi-credit loans are unlikely to be made to someone whose expected future contribution to, or gain from, risk sharing is low." (p. 268). As noted by a set of recent studies (Dercon, 1998; Carter and Zimmerman, 2000; McPeak and Barrett, 2001; Carter and Barrett, 2001; Zimmerman and Carter 2003) current period asset holdings can have a critical influence on a household's future income and asset trajectory. These studies indicate that not only are returns to assets potentially conditioned on the size of the asset holding, but also that if asset levels fall below a critical threshold there is a potential for a household to be caught in a poverty trap – a low income, low asset equilibrium from which escape is difficult if not impossible. As most models of informal risk sharing mechanisms in the literature are based on the premise of stationary income streams over time, the future capacity of the recipient to return the favor in the future is not an issue and commitment has been the major concern. However, introducing the possibility that the income generation process is non-stationary due to asset accumulation, and that there may be multiple dynamic equilibria in asset space, requires explicit attention be given to expected capacity to repay. The issue of expected capacity to repay is likely to be particularly important in the pastoral setting of this paper, as recent studies of pastoral herd dynamics suggest there are bifurcating herd asset dynamics over time, leading to distinct low herd size and high herd size stable equilibria (Lybbert et al., forthcoming; Barrett and McPeak, forthcoming). Households who show signs of being drawn toward the lower asset equilibrium could be excluded from the transfer mechanism due to concerns about the future capacity to reciprocate.

However, we should note that this study does not explicitly investigate the process of risk-sharing group formation. We also do not identify bifurcating asset dynamics explicitly in this study. Rather, we will consider how household specific and time period specific variables influence household level transfer behavior. We will draw on the insights of previous studies that explicitly focus on endogenous risk sharing group formation and asset dynamics to help interpret results. We use these interpretations to differentiate between three theories proposed in the anthropological literature concerning livestock transfers between households.

The following section provides a discussion of theories about livestock transfers proposed in the anthropological literature, and presents models corresponding to these theories. This is followed by a section describing the data used in this study. The fourth section presents information on the nature of pastoral production in this area that explains the broader context within which livestock transfers take place. In section five, empirical analysis of transfer behavior is presented and discussed. Section six contains the conclusions of the study.

2. Modeling Livestock Transfers

There are three main interpretations of livestock transfers in the anthropological literature. One interpretation stresses the *ex post* risk coping benefits livestock transfers provide to recipients. From this perspective, livestock transfers serve as an emergency insurance mechanism that helps households replace animals that are lost due to asset shocks. Torry (1973) writes of the Gabra in northern Kenya "[i]f every family had to rely entirely upon the products of its own herds for food, only a small fraction of the Gabra population would be able to sustain itself for very long. It is imperative then that in order to cope with temporary economic emergencies, each household be able to borrow stock from a wide range of others" (p.349-50). Schlee (1989) provides a similar assessment, as he describes camel transfers in northern Kenya as "insurance against loss from drought, epidemics and human and animal predators…"(p.56), and Oba (1992) describes livestock transfers in northern Kenya as "an indigenous social security system of coping with drought" (p.

66). These views suggest livestock transfers operate primarily as an *ex post* insurance mechanism to help households cope with unexpected herd loss.

A second interpretation in the anthropological literature describes an *ex ante* risk management aspect of livestock transfers. From this perspective, livestock are transferred to other herders as a form of precautionary savings in anticipation of future shocks. From this perspective, donors provide livestock to others in the knowledge that they may one day find themselves in need of assistance. Lane (1996) describes this role for Barabig households in a pastoral area of Tanzania. He notes herders have an incentive to transfer livestock to other households in order to ensure that they themselves will be helped if they find themselves in need sometime in the future. Torry in his discussion of transfers among the Gabra also notes an *ex ante* risk management aspect of livestock transfers. He writes "…the more animals a man has in the herds of other stockowners, the greater his ability will be to avert local disasters by pressing pre-established claims for support from his stock associates." (p. 350). Broch-Due (1999) reports that Turkana herders in Kenya describe falling into poverty as a result of not managing livestock in a way that establishes social relations to provide a web of support when sudden herd losses occur. They do not believe that poverty originates in the loss of animals, but the loss of animals combined with a failure to manage social relations well prior to a loss. Perlov (1987) notes that Samburu herders in Kenya use livestock exchanges to invest in social relationships that will be critical to the individual's future success.[1] Households are viewed as using livestock to develop and reinforce social ties that can be called upon in the case of need.[2]

A third interpretation of informal livestock transfer institutions in pastoral societies focuses on their redistributive aspect. This view of livestock transfers identifies the practice not as an explicit risk sharing mechanism, but as an informal taxation system. Maybury-Lewis (1992) discusses livestock transfers among the Gabra as a means to redistribute wealth. He cites a Gabra elder who states that transfers occur because "we must give to those who need it, for a poor man shames us all" (p.85). Lane (1996) also notes livestock transfers serve a redistributive function, as transfers occur as a response to social pressure on wealthy herders to share their livestock with poorer herders.

Each interpretation is now presented in a formal model to illustrate similarities and differences across interpretations. The objectives of this modeling section are to provide a formal statement of each theory and generate predictions that will help interpret the observed patterns of livestock transfers among herders in northern Kenya presented in section five.

We begin by defining a baseline autarkic model in which no transfer mechanism is present. We define one decision making individual as representative of each household. Define individual i's capital stock at time t by k_t^i. Capital grows according to a growth function $g(k_t^i, \theta_t^i)$. θ_t^i is an individual and time period specific shock that increases growth for high realizations of θ_t^i and decreases growth for low realizations of θ_t^i. The growth function is bounded below by total herd loss, $g(k_t^i, \theta_t^i) = -k_t^i$, and bounded above by natural limits on livestock reproduction. [3] Individual i selects an offtake level from the capital stock at time t for consumption. The offtake level is defined as ot_t^i. The state equation for capital evolution is thus defined as $k_{t+1}^i = k_t^i + g(k_t^i, \theta_t^i) - ot_t^i$. The offtake choice for time t is made prior to observing the outcome of the growth process at time t.

Consumption is defined as the sum of the offtake level plus the consumable products generated by the capital stock. In this pastoral setting, we can think of the offtake as consumption of animals, and the consumable product that is generated from a herd as milk. The consumable product is defined by the function $f(k_t^i)$, which is concave and non-decreasing in k_t^i and equal to zero when $k_t^i = 0$.[4] Consumption by individual i at time t is written $c_t^i = ot_t^i + f(k_t^i)$. The individual obtains utility from this consumption according to the utility function $U(c_t^i)$, which obeys the Inada conditions.

Denoting the discount factor as β and the expectation operator by E, the following Bellman's equation characterizes the problem facing the individual.

$$V[k_t^i] \equiv \max_{ot_t^i} U\left(ot_t^i + f(k_t^i)\right) + \beta \cdot E_t V\left[k_t^i + g(k_t^i, \theta_t^i) - ot_t^i\right]. \qquad (1)$$

The optimal decision rule corresponding to this problem obeys the condition $\frac{\partial U}{\partial c_t^i} = \beta \cdot E_t\left[\frac{\partial V}{\partial k_{t+1}^i}\right]$ and the shadow value of capital is

$\frac{\partial V}{\partial k_t^i} = \frac{\partial U}{\partial c_t^i} \cdot \left(\frac{\partial f}{\partial k_t^i}\right) + \beta \cdot E_t\left[\frac{\partial V}{\partial k_{t+1}^i}\right] \cdot \left(1 + \frac{\partial g}{\partial k_t^i}\right)$. This solution sets the marginal utility of consuming a unit of capital equal to the expected marginal value of retaining that capital for another period. The shadow value of capital reflects the contribution of an additional animal to consumption plus the discounted expected contribution of the animal to next period herd size.

We now modify this autarkic model to include transfer mechanisms corresponding to the discussion of transfer mechanisms presented above. We define a transfer rule as a social norm that defines an upper bound on the net transfer that the individual can select. Transfers are defined as the net transfer into the herd minus the net transfer out of the herd. The transfer rule is denoted by T_t^i and the net transfer selected is denoted by τ_t^i. The individual selects a net transfer level subject to the constraint imposed by the transfer rule, so that $\tau_t^i \leq T_t^i$.

We begin by specifying a transfer rule that is triggered by herd loss, corresponding to the description of livestock transfers serving an *ex post* risk coping mechanism. The livestock transfer rule is conditioned on the previous period's herd growth experience for a given herder. Define the maximum allowable net transfer into herder i's herd at time t as $T(g(k_{t-1}^i, \theta_{t-1}^i))$ under the assumption that $\frac{\partial T_t^i}{\partial g_{t-1}^i} < 0$ and

$\tau_t^i \in [-k_t^i, \sum_{j \neq i} k_t^j]$. An *ex post* transfer mechanism triggered by herd growth would increase net transfers into the herd due to herd loss. In this model, the first order condition for the transfer level selected will equate the expected marginal value of capital with the shadow value of the transfer rule constraint, $\beta \cdot E_t\left[\frac{\partial V}{\partial k_{t+1}^i}\right] = \lambda^T$.

In contrast, we specify a transfer mechanism that corresponds to an *ex ante* explanation of livestock transfers. In this setting, households seek to build up transfer records with each other in anticipation of expected future herd loss, and call upon those with whom they have credits when they experience herd loss.[5] Define for household i a transfer record with each of the other (N-1) households indexed by j

$tr_{t+1}^{ij} = tr_t^{ij} + \tau_t^{ij}$. In addition, define a transfer rule constraint $T(tr_t^{ij})$ that obeys $\frac{\partial T_t^{ij}}{\partial tr_t^{ij}} > 0$,

and decision τ_t^{ji}. This generates a (N-1) set of constraints $\tau_t^{ij} \in [-k_t^i, k_t^j]$, and (N-1) first order conditions $\beta \cdot E_t\left[\frac{\partial V}{\partial k_{t+1}^i}\right] = \beta \cdot E_t\left[\frac{\partial V}{\partial tr_{t+1}^{ij}}\right] + \lambda^{T^{ij}}$. This *ex ante* specification implies that the shadow value of livestock held in the household herd equals the shadow value of livestock placed in the herds of other households and recorded in the transfer record plus the shadow value of the transfer rule constraint if the rule is binding. One implication of this specification is that, assuming concavity of the value function in both arguments, households with larger herds will also have higher transfer records. This means that as a household herd grows, there will be a net transfer of livestock out of the household herd into other households' herds. As all herders realize this, an individual providing livestock to another herder in the current period with some expectation of future reciprocation must assess the expected prospects for herd growth from the recipient. Herders will face the prospect that a transfer will never be reciprocated if it is placed in a herd that is completely lost. Self interested individuals placing their animals in other households' herds will seek out the households that provide the highest probability of reciprocation rather than those who are in the greatest need. In fact, those who are in the greatest need may be avoided if herders decide these households offer little prospect of ever being capable of returning the favor.

A transfer mechanism that operates on a redistributive principle could be defined by conditioning the current period transfer rule on the size of the individual household's deviation from the average herd size of others in the community. Define this transfer rule as $T_t^i\left(k_t^i-(1/(N-1))\cdot\sum_{j\neq i}^{N-1}k_t^j\right)$ with $\frac{\partial T_t^i}{\partial(k_t^i-\bar{k}_t^{j\neq i})}<0$, denoting the average herd size of others by $\bar{k}_t^{j\neq i}$ and the community size by N. In recognition of the redistributive role of such a mechanism, we can define a constraint on such a transfer as $\tau_t^i\in[-\left(k_t^i-\bar{k}_t^{j\neq i}\right),\left(\bar{k}_t^{j\neq i}-k_t^i\right)]$. We can state the state equation for capital in this model as $\frac{\partial V}{\partial k_t^i}=\frac{\partial U}{\partial c_t^i}\cdot\left(\frac{\partial f}{\partial k_t^i}\right)+\beta\cdot E_t\left[\frac{\partial V}{\partial k_{t+1}^i}\right]\cdot\left(1+\frac{\partial g}{\partial k_t^i}\right)+\lambda^T\left(\frac{\partial T_t^i}{\partial(k_t^i-\bar{k}_t^{j\neq i})}\right)$. As the marginal utility of consumption is equal to the shadow value of capital, this model suggests there will be a higher level of consumption by the individual selected than in the autarkic model for a given herd size if the transfer rule constraint binds. This introduces an *ex ante* incentive problem, as the next period average herd size will be smaller in the presence of the transfer mechanism than if no such mechanism exists.[6]

Each model reveals practical flaws. In the first model, the well known commitment problem must be confronted, as there is an incentive for households that do not suffer negative shocks to withdraw from the mechanism *ex post* and adopt the autarkic strategy. In addition, the transfer rule is conditioned solely on previous period's asset change, regardless of the individual's wealth position. It is unlikely that a social insurance mechanism requiring transfers of livestock from poor herders to wealthier herders who suffered a loss yet remain relatively wealthy would be endogenously supportable for an extended period of time. The second model shares this flaw, as the transfer rule allows transfers to flow to individuals with higher transfer records, regardless of their wealth position. In addition, in this specification the transfer rule does not adjust based on asset loss. However, this second specification provides a mechanism commonly specified in the literature as a means to address the *ex post* commitment problem described above as it conditions current period access to transfers on past behavior. Finally, the redistributive model is limited as a risk sharing mechanism as it is not triggered by asset change but by relative wealth position and it provides a disincentive for individual households to work towards herd accumulation by encouraging *ex ante* offtake increases, thus reducing expected average herd size over time.

Given the incentive problems and relative flaws of each model taken in isolation, it is perhaps not surprising that the literature on livestock transfers fails to provide a clear statement of the role and functioning of transfer mechanisms. It is likely that actual livestock transfer mechanisms have evolved to combine aspects of each of these models that address the relative benefits and flaws revealed by considering each model in turn. Formally, we can combine the different specifications for the transfer rules to arrive at composite transfer rule $T_t^{ij}(g(k_{t-1}^i, \theta_{t-1}^i), tr_t^{ij}, k_t^i - \bar{k}_t^{j \neq i})$. Deriving closed form predictions to generate testable hypotheses from a model that uses the composite transfer rule was not found to be possible. However, we can briefly return to the main implication of each specification of the transfer mechanism to help in interpreting the empirical results presented later in this study. If transfers are triggered *ex post* due to an asset shock, herd loss should lead to higher transfers into the herd. If transfers reflect *ex ante* management of a herd in anticipation of shocks, net donors in the past should obtain higher current period transfers and transfers out of the herd should increase as herd size increases. Finally, if transfers are essentially redistributive, livestock should flow from larger than average household herds to smaller than average household herds in a given period.

3. DESCRIPTION OF THE DATA

This study uses a panel data set gathered in two areas of Marsabit District, Kenya, to investigate livestock transfers between pastoral households. The sample was drawn from two areas occupied by Gabra herders: Chalbi (39 households are in this sample) and Dukana (49 households are in this sample). The sampling method was based on the idea of a transect, as no list of pastoral households existed for this area. Enumerators moved between the main towns of the study area (Kalacha and

North Horr in Chalbi and Sabarei and Dukana in the Dukana area) interviewing herders they encountered at nomadic camps along the way.[7]

The questionnaire was retrospective in nature, recording information for four time periods per-year for each of the years 1993-1997. Within a year, the four time periods correspond to the bimodal rainfall pattern of the area: the long rains, the dry season following these rains, the short rains, and the dry season following these rains. Each period is roughly three months in length. This approach provided multiple data points for a given household (from 16 to 20 data points per household depending on when the household was interviewed).[8]

Respondents were asked to report the following variables for each time period[9]: ages of household members; household size[10]; household herd size and species composition; sales from the household herd, characteristics and price per animal sold; slaughters from the household herd, and characteristics of animals slaughtered; transfers into and out of the herd and characteristics of animals transferred; and sources of household income. Stock variables are recorded at opening period levels, flow variables recorded for within period levels. Variables relating to livestock are recorded in total livestock units (TLU), where 1 livestock unit = 10 sheep or goats = 1 head of cattle = 0.7 camels (Schwartz et al 1991).[11]

A record of household past transfer behavior is constructed from this data using as a starting point herders' responses to a question on the net TLU value of pre-1993 cattle and camel transfers starting from the time they took over as household herd manager. The TLU value of a household's reported first period net transfers is added to this starting value to determine the second period's transfer record. This procedure is then repeated for each ensuing time period, so that the variable records the extent to which a household has been a net giver or net receiver from the livestock exchange mechanism in previous periods. An offtake record is also constructed using the data set. This variable sums the TLU value of household sales and slaughters over the past four periods. Similarly, a variable recording herd growth is constructed summarizing the net TLU change in the household herd during a given period that can not be accounted for by sales, slaughters, or transfers. It thus is a composite reflecting the net impact of births, deaths, and unexpected losses due to factors such as raids.[12] A growth record is constructed for the past year by applying this method to herd information for the four periods of the year preceding a period.

Variables exogenous to the household are also represented in the data set. The average herd size of other herders in the sample is calculated as is the average growth record of all other herders in the sample. The average price received for all male goat sales in a given time period is calculated for use in the analysis.[13] Three variables are used to record rainfall characteristics of a given time period; one measures total rainfall over the past six months, and the other two are dummy variables that record whether the three month period in question is a rainy season. As a rainy season dry season pair last six months and is the relevant growing period for pasture, a six month interval is selected and the dummy variables capture seasonality within a six month interval. Finally, a variable recording the tons of food aid delivered to the towns of the study area in a given time period is included.[14] These exogenous variables are included to ensure that covariate influences on transfer behavior are controlled for. Table one presents summary statistics of variables used in later regressions for the total sample as well as two sub-samples that will be described in more detail in the following section.

[insert table 1]

4. PASTORAL PRODUCTION

Gabra rangelands are the most arid in all of East Africa (FAO 1971). Robinson (1985) describes the environment as "…one of rugged desolation; searing winds and unrelenting sun" (p.43). Mean annual rainfall is below 300 millimeters for the vast majority of the rangeland area, making rain-fed cultivation impossible (Schwartz *et al*., 1991). Gabra herders practice nomadic pastoralism with their herds of camels, cattle, goats and sheep in order to survive in this harsh environment.[15]

Gabra herders' almost total reliance on animals is reflected in the income sources of the sample households. If market values are assigned to home-consumed goods, the study data reveal that on average 72% of total income is obtained from milk produced by the household herd; 14% is obtained by the sale of animals; 13% is obtained by home consumption of slaughtered animals; and 1% is obtained from skin and hide sales, gifts and remittances. The low income level of Gabra herders is also revealed by this derived income measure. The average income level of 30.3 shillings per-person per-day corresponds to $0.54 at the average exchange rate 1993-1997.

The consequences of herd loss can be severe since households derive incomes almost entirely from their herds. To illustrate the impact of herd loss on income, consider the average herd size per-time period[16] reported in figure one, and note the rapid decrease in average herd size of 12.2 TLU that occurred in late 1996.[17] The average herd size decrease over this six month period corresponds to a 34% decrease in expected income per-person per-day using results generated from this data set reported in McPeak (forthcoming).

[insert figure 1]

Beyond the negative impact of herd loss on expected income for an already poor population, the prospect of total herd loss also confronts households as a possible outcome. Historical studies of this area (Sobania 1979; Robinson 1984) suggest total household herd loss is not unprecedented. A variety of studies have associated the rapid growth of towns populated by sedentarized former pastoralists over the past four decades in this study area with widespread herd losses (O'Leary, 1987; Legesse, 1989; Fratkin 2004). Although total herd loss was not a significant issue in the study area during the study period even following the crisis of 1996, pastoral households point to impoverished town dwellers as providing ample evidence of the potential crisis sudden herd loss causes, and from which recovery is difficult, if not impossible.

Covariate herd losses such as the one illustrated in figure one are frequent in northern Kenya. In the post-independence era, widespread herd losses are reported in this area in 1965, 1970-1, 1975-6, 1980, 1983, 1991-2 and 1996 (Robinson 1985; O'Leary, 1987; Tablino, 1999). As is well understood in the literature, informal risk sharing mechanisms are of limited effectiveness if shocks are largely covariate. While figure one suggests there are periods characterized by covariate loss, figures two and three illustrate that there is a significant idiosyncratic element to herd growth when household specific observations are compared. While there are clearly periods that are better than others as described by the solid line representing the average growth rate recorded per time period, there is a great deal of household level variation in growth rates reflected by the points around the average. In no period is it the case that all households experienced positive (or negative) herd growth rates. As such, an informal system of mutual assistance could confront stochastic herd growth, as there is a great deal of idiosyncratic variation in herd growth experience across households over time.

[insert figures 2 and 3]

Given this variation, one might wonder what influences household herd growth over time. Previously published work (McPeak 2004) investigates this question using this data set. Findings indicate that period specific herd growth is significantly influenced by rainfall levels and that there is a great deal of unexplained variation in herd growth, supporting the interpretation of shocks playing a role in herd growth. The results also indicate that expected herd growth is a decreasing function of herd size. This provides further insight into why households may increase transfers out of the herd as herd size increases. Beyond a herd size threshold of approximately 35 TLU, increased herd size leads to expected negative herd growth.[18]

The data set also allows us to consider herd size inequality across households and across time to focus on a potentially redistributive role of transfers. Herd ownership Gini coefficients constructed from the data set for the first period of each year are: 1993, 0.36; 1994, 0.37; 1995, 0.38; 1996, 0.38; 1997, 0.27.[19] To investigate whether the inequality revealed in these measures reflects persistent household level inequality across households across time or household level transitions over time around a relatively constant level of inequality, we appeal to an asset based poverty line suggested in the literature on pastoralism corresponding to a herd size of 4.5 total livestock units per-adult equivalent. This is the standard established by Pratt and Gwynne (1977) and adopted by Fratkin and Roth (1990) as the level above which herders can survive solely from the products of their household herd. Table two reports transition matrices for the sample, where asset poverty as defined by herd size per adult equivalent in 1993 is compared to herd size per adult equivalent in 1997. The majority of household (65%) began and ended the period in the same asset poverty category. This general pattern is reported in a variety of studies on east African pastoralism. Those who are initially relatively wealthy tend to stay relatively wealthy over time, and those who are poor tend to stay poor over time (Fratkin and Roth 1990; Herren 1991; Ensminger 1992). The overall impression of persistence in asset based wealth status is consistent with the finding of bifurcating asset dynamics in herd wealth among east African pastoralists presented by Lybbert et al. (forthcoming) and Barrett and McPeak (forthcoming). The motivation for splitting the sample by initial poverty status is to place explicit focus on the group that began the period in poverty to develop a better understanding of why asset transfers do not eliminate such persistent poverty.

[insert table 2]

Analyzing the transfer record information together with the herd size information suggests that herders who are wealthy in livestock also tend to have higher net transfer records – the correlation between the TLU and transfer record measures for the 1686 observations available in the total data set is 0.43. In addition, as noted in table one, the average transfer record for the sub sample of households who began the study period poor was -0.62 TLU as compared to 1.0 TLU for the non-poor sample. Households who are relatively poor in livestock also tend to have been net receivers of livestock over time. This is consistent with the *ex ante* model of livestock transfers developed above, as herders relatively wealthy in livestock also tend to be relatively wealthy in the transfer record.

4. Evidence on Transfer Behavior.

Among the Gabra, the two parties to a livestock transfer reach an agreement in face-to-face negotiations. The negotiation process leading to a transfer is often long and complex. When a transfer is eventually agreed upon, there is no outside authority to enforce the commitment. In addition, there is no formal record kept of livestock transfers between herders, nor is there a public announcement of the transfer.

There are different types of transfers, some involving the full transfer of rights to the recipient, while others retain partial rights for the donor. Almost all transfers in the data set involve the full transfer of rights to the recipient (92%).[20] The majority of transfers were of goats and sheep (87%), and the majority of all transfers involved female animals (57%). The majority of transfers recorded in the data set occurred between individuals who are in some sense related: 93% of transfers occurred between individuals who had a mother's side, father's side or an in-law relationship.[21] The data also indicate that the majority of livestock transfers occur as part of an ongoing relationship between individuals: 61% are to individuals from whom animals have been received in the past, and 72% are to individuals to whom animals have been given in the past. Transfers are described as being generally redistributive, as 66% were described as moving animals from a larger herd to a smaller herd. However, species specific redistribution may also be important, as 86% of transfers were described as moving animals from a herd with more of the species transferred to a herd with less of that species.

Data were not collected on the negotiation process leading to livestock transfers, and the data only focused in detail on one party to the transfer. Only the outcome of the negotiation process is observed for a given household in terms of a transfer of animals out of the herd or a transfer into the herd. Further research focused on the nature of the negotiation process and patterns of risk sharing networks will be required to provide a more nuanced understanding of the nature of the risk sharing mechanism in this area. However, estimation using the available data does provide information on the practice of livestock transfers in this area. We are able to investigate how livestock transfers function between the household and the rest of the community, and use measures on the rest of the community to reflect changing conditions of other households. As all households both transferred animals out and transferred animals in at some point in the period covered by the longitudinal data, we can utilize the panel nature of the data to identify what time period and household specific factors make a household more likely to receive a transfer into the herd and what factors make a household more likely to transfer out of the herd.

Discussions of the negotiation process leading to livestock transfers with herders suggest the influence of household or time period specific characteristics may not be symmetric between transfers from and transfers to a household herd. Parameters characterizing "persistence" required to receive transfers are not necessarily the mirror image of parameters characterizing "resistance" to giving animals.[22] We allow the transfer out decision rule to differ parametrically from the transfer in decision rule rather than estimating a net transfer decision rule. As the two decisions are clearly related, they are jointly estimated as a system to improve estimation efficiency.

Denoting transfers out by tro, transfers in by tri, β as parameters to be estimated, X as matrices of exogenous variables, and u as underlying disturbance terms, the following two equation system is defined.

$$\begin{aligned} tro &= \beta_{tro}X_{tro} + u_{tro} \\ tri &= \beta_{tri}X_{tri} + u_{tri} \\ u_{tro}, u_{tri} &\sim BVN(\sigma^2_{tro}, \sigma^2_{tri}, \rho) \end{aligned} \qquad (2)$$

A few econometric issues must be addressed when attempting to estimate this system of equations. First, both dependent variables are by construction non-negative and censored at zero. Transfers out of the herd equal zero for 75% of observations and transfers into the herd equal zero for 78% of observations. Failure to take account of the censored nature of dependent variables results in inconsistent parameter estimates. As the equations are specified as a system, estimation is conducted for a bivariate tobit system (Maddala 1983).

A second issue raised in the previous section is that the persistence of household poverty status over time and positive correlation between the transfer record and household wealth lead one to wonder whether poorer households utilize the transfer mechanism in the same way as wealthier households. In terms of the modeling exercise, it is possible that the transfer rule conditioned on the transfer record is binding for poorer households and not binding for richer households. To allow for this possibility, the data set is divided into two groups depending on household poverty status in 1993 as defined in table two. Estimation is conducted separately for the 43 households that began the study period poor and the 45 households that began the study period non-poor. A Wald test is used to evaluate the hypothesis of equality in the parameter vectors characterizing the poorer group with the overall sample.

A third issue arises due to the potential identification problems resulting from inclusion of the transfer record as an endogenous variable (Foster and Rosenzweig, 2001). To address this problem, we estimate the transfer rule in a separate (unreported) regression, and conduct Smith and Blundell tests of the endogeneity of the variable in the transfer estimation using the residuals from this first stage estimation.[23]

A final estimation issue arises due to the longitudinal nature of the data. It is possible that there are unobserved, time invariant, household specific characteristics such as family history, size of extended kinship network, or innate ability to “persist” or “resist” transfers, that may influence livestock transfer behavior. If not controlled for, the presence of such characteristics will lead parameter estimates to be inconsistent (Hsiao 1986). In this study, a time invariant household specific effect is controlled for by creating a matrix recording the means of household specific variables for all periods and using these to control for a time invariant household specific effect correlated with observed household characteristics.[24]

Variables selected for inclusion in the estimation record both household specific and covariate measures. Household specific information includes herd size, herd size change over the past year, difference in herd size from the average herd size of others, herd offtake over the past year, and demographic information on the household. Time period specific information includes rainfall levels, whether the time period in question is a rainy season, measures of livestock market prices and food aid delivery, and the average herd growth of other households to control for covariate shocks that could influence livestock transfer behavior. Estimation results are presented in table three.

[insert table 3]

The Smith Blundell test results indicate that the transfer record can be treated as an exogenous variable in the regression using the total data set ($\chi^2_{(2)}$=2.3) and in the regression of the sub-sample of poorer households ($\chi^2_{(2)}$=3.0). The hypothesis that the parameters characterizing transfer behavior for the poorer group does not differ from the total sample is rejected at a $p<0.01$ level with a $\chi^2_{(44)}$ statistic of 665.6. [25] Poorer herders differ significantly parametrically in their use of the livestock transfer mechanism from the overall pattern characterizing the total sample.

We simulate estimation results to illustrate the economic significance of particular variables of interest. [26] The estimation results for the total sample and the poorer sample are simulated one variable at a time over the range of one standard deviation above and below the average for a given variable as calculated for the total sample. Figures five and six present the results of these simulations. [27]

[Insert figures 5 and 6]

Overall, the simulations illustrate that livestock transfers are quantitatively small. Recalling that average herd size is close to 30 TLU and that the average herd lost 12.2 TLU in a six month period as reported in figure one, the range of net TLU transfers identified by the simulation results is an order of magnitude lower than these figures. The existing livestock transfer mechanism is not characterized by large transfers of assets between households.

Results do allow some insight into the operation of the transfer mechanism for the animals that are transferred. The results for herd growth are of interest, as it was posited that an *ex post* risk sharing mechanism would trigger livestock transfers in response to asset shocks. While herd growth is a statistically significant variable in estimation results for the total sample, the impact of this variable is the opposite of that predicted by an *ex post* model of risk sharing and relatively small as illustrated by the simulation results. Rather than transfers into the herd being triggered by asset loss, we find that net transfer into the herd decreases as herd growth increases, although by a small amount in TLU terms. While it would require further research to fully understand this result, we offer the hypothesis that it could be explained as a response to a signal of future capability. For a given herd size, a household that has experienced higher growth over the past year is seen as being more likely to be headed in the right direction than one with a lower, or negative, herd growth record.

Overall, livestock transfers do not appear to operate according to the logic of an *ex post* risk coping mechanism.

The livestock transfer record and herd size variables are also of interest, as the *ex ante* risk management interpretation of this mechanism implied that current period transfers would be conditioned on past transfer behavior. The *ex ante* risk management model also predicted that as a household's herd size increased, there would be higher levels of transfers out of the herd and lower levels of transfers into the herd, leading to increases in the livestock transfer record. The livestock transfer record performs as predicted by this model, with a higher record of net transfers leading to higher current period net transfers into the herd and net transfers into the herd decreasing as herd size increases. The quantitatively most important variable illustrated in the simulations is the transfer record for poorer herders. Though large, it is important to note that even at the upper range of the simulation exercise, this is implicitly a costly form of savings, as the ratio of the transfer record to the net transfer triggered by such a transfer record one standard deviation above the mean is roughly 4:1.

The redistributive specification posited that transfers are conditioned on the relationship between a household's herd size and the average herd size of other herders in the sample. The redistributive model specification only finds partial support from the estimation results. There is some evidence that households that have larger than average herd size in a given period make larger net transfers out of their herds, but there is no corresponding evidence that the transfers go to those who are farther below this average. In addition, the quantitative impact of such a mechanism is quite small, as illustrated by the simulation results.

A few of the other results merit discussion before moving to the conclusions of this study. The household's past offtake behavior has a negative impact on transfers into the herd, but this impact is not significant. The *ex ante* incentive problem is arguably not a major factor to confront in this setting, perhaps because low offtake levels are critical in this environment for self-insurance. Certainly the low offtake level reported in figure one suggests higher than optimal offtake from household herds is not a pronounced problem in the study area. Transfers positively respond to the quantity of rain in the past six months, and there is a clear seasonality to transfer behavior, with the long rains period being the key season for transfers to take place.[28] Food aid deliveries have a weakly significant negative impact on transfers among the poorer sample, but this impact is not significant for the total sample. It is not clear whether exogenously provided food aid does or does not crowd out indigenous social risk sharing mechanisms in this context. One final interesting result is that there is no significant impact of market prices on transfer behavior.

6. CONCLUSION AND POLICY IMPLICATIONS

Households in low-income, high-risk areas face the possibility that "bad luck" can cause them to face starvation. To minimize such a possibility, households engage in informal risk-sharing mechanisms. The nature and extent of these mechanisms has been of long standing interest to social scientists both due to the light they shed on the nature of rural societies and for their relevance to the design of formal insurance mechanisms.

This study contributes to the literature on how households confront risk by engaging in risk sharing mechanisms in two important ways. First, it extends analysis of informal risk sharing mechanisms to a topic previously unexplored in the literature:

asset risk. Second, it uses a longitudinal data set to provide empirical evidence to contrast interpretations of transfer behavior proposed in the anthropological literature as reflecting: an *ex post* risk sharing mechanism; an *ex ante* risk management mechanism; and a mechanism promoting asset redistribution from the wealthier to the poorer.

The particular transfer institution considered in this study involves the transfer of livestock between households in northern Kenya. Households in the study area confront the ever-present possibility that herd losses can lead to a food security crisis. This study focuses on transfers in a setting where asset accumulation introduces an important non-stationary element to income generation over time. While the pastoral setting of this study illustrates the issue of asset accumulation and loss in a particularly stark setting, there is a growing awareness in the development economics literature that asset endowments can be critical for future income trajectories in a variety of contexts. We suggest that as research on endogenous risk sharing group formation goes forward, explicit recognition of asset dynamics may help develop understanding of how persistent poverty and inequality can co-exist with risk sharing mechanisms.

This study indicates that conditioning access to a transfer mechanism on past behavior may play a broader role than previously realized. This type of conditioning has been discussed in the literature as a means to address the commitment problem in an *ex post* risk coping mechanism. Here, we find that although transfers are conditioned on past behavior, the *ex post* risk coping interpretation of livestock transfers is not well supported by results. In fact, herd growth influences net transfers in a way that makes households marginally less likely to receive a transfer rather than more likely following asset losses. Overall, the results indicate an *ex ante* interpretation of the livestock transfer mechanism is most consistent with the evidence.[29] Livestock transfers among herders create debts that can be called upon in the case a household finds itself in need of animals at some point in the future. Retention of animals in the herd beyond a threshold herd size leads to expected herd loss, making precautionary saving in the livestock transfer mechanism more attractive. Herders place transferred livestock in the herds of others who they expect will have the future capacity to help them. Those who suffer shocks or who are currently in poverty and have not been net donors in the past can expect little assistance in the form of livestock transfers. Those who have higher transfer records can expect at least partial recovery of these past transfers should the need arise. The role of the transfer record indicates that the ability to escape poverty is influenced by less immediately visible factors such as the history of past transfers. For this reason, research on informal risk-sharing mechanisms that does not incorporate information on household history may provide only a partial understanding of how the institution operates.

Finally, the evidence suggests that the existing informal institution does not obviate the need for better insurance at the household level against the risk of asset loss. Households are exposed to the risk of asset loss, and asset loss has a significantly negative impact on household income. The existing informal institution is not well suited to address asset shocks and is particularly limited in the help it provides households who are net debtors in the transfer institution and who are poor in livestock. If development efforts are designed to help herders confront asset risk and address poverty, there are two main alternatives. The first is to target asset transfers at households that are also targeted by the informal mechanism while designing alternative income generating opportunities for households facing little hope of obtaining assets from the informal mechanism. The second is to specifically target this latter group for restocking efforts while allowing the informal mechanism to address the needs of those more eligible for transfers due to their past history. Further research will be needed to identify which alternative offers the greatest potential for risk mitigation and poverty reduction.

Table One: Means of variables used in this study with standard deviations in parentheses. Flow variables are per three month season unless otherwise noted.

Variable Name (measure)	Full Sample	Poorer (<4.5 TLU/AE in 1993)	Wealthier (≥4.5 TLU/AE in 1993)
Transfer out (TLU)	0.14 (0.50)	0.10 (0.38)	0.20 (0.59)
Transfer in (TLU)	0.13 (0.51)	0.10 (0.31)	0.18 (0.67)
Herd Size (TLU)	29.43 (26.51)	20.52 (10.92)	40.18 (35.04)
Transfer Record (TLU)	0.18 (5.12)	-0.62 (4.10)	0.99 (6.05)
Offtake Record (TLU)	1.71 (1.72)	1.07 (0.92)	2.35 (2.06)
Growth Record (TLU)	2.17 (15.34)	2.66 (5.67)	1.69 (20.92)
Average Growth Record Others (TLU)	2.43 (8.16)	2.23 (6.22)	2.62 (9.71)
Household Herd Size – Average Others Herd Size (TLU)	1.10 24.36	-4.34 (10.93)	6.50 (31.74)
Age of Head (years)	50.82 (13.43)	52.89 (12.63)	49.80 (13.91)
Adults (adult equivalents)	4.57 (1.68)	4.68 (1.64)	4.46 (1.72)
Zone dummy (1= Dukana)	0.58 (0.49)	0.77 (0.42)	0.41 (0.49)
Rainfall past 6 months (mm)	62.30 (45.39)		
Long rains dummy	0.26 (0.44)		
Short rains dummy	0.25 (0.43)		
Food aid deliveries (metric tons)	67.55 (86.78)		
Male goat price (Kenya shillings)	876.58 (254.89)		
Number	1335	666	669

Table Two: Poverty transition matrix

	Not Poor 1997 n=49	**Poor 1997 n=39**
Not Poor 1993 N=45	36%	15%
Poor 1993 N=43	20%	29%

Table Three: Transfers, coefficients with standard errors in parentheses

Variable Name	All Transfer Out	All Transfer In	Poorer Transfer Out	Poorer Transfer In
Herd size x10^{-2} (TLU)	3.982 *** (0.553)	-0.081 (0.427)	4.686 * (2.836)	-1.074 (2.711)
Herd size^2 x10^{-4}	-0.759 *** (0.165)	-0.748 * (0.428)	2.854 (2.506)	0.157 (2.054)
Herd Growth in past year x10^{-1} (TLU)	-0.018 (0.052)	0.230 *** (0.073)	-0.217 (0.178)	0.162 (0.144)
Transfer Record (TLU)	-0.050 (0.041)	0.140 *** (0.050)	-0.381 *** (0.117)	0.328*** (0.071)
Herd size – others' average herd size x10^{-2} (TLU)	-0.124 * (0.071)	-0.204 * (0.112)	-0.359 (0.297)	-0.261 (0.235)
Offtake Record (TLU)		-0.055 (0.048)		-0.100 (0.068)
Age of head x10^{-1}	1.666 *** (0.209)	-0.129 (0.456)	-0.197 (1.268)	-0.288 (0.946)
Age of head^2 x10^{-1}	-0.411 ** (0.174)	-0.206 (0.214)	-0.681 (0.604)	-0.293 (0.234)
Household size (Adult equivalents)	-0.347 ** (0.171)	-0.241 (0.232)	-0.725 (0.956)	-0.286 (0.222)
Male goat price x10^{-3} (Kenyan Shillings)	-0.510 (0.317)	-0.832 (0.510)	0.725 (0.661)	0.182 (0.536)
Food aid delivery x10^{-2} (Tons)	0.060 (0.090)	-0.099 (0.098)	-0.235 * (0.126)	-0.205 (0.144)
Rainfall past 6 months x10^{-2} (mm)	0.042 (0.141)	0.347 ** (0.147)	0.158 (0.141)	0.267 (0.155)
Long rains dummy	1.092 *** (0.092)	1.263 *** (0.105)	0.908 *** (0.116)	0.685 *** (0.098)
Short rains dummy	0.025 (0.142)	-0.001 (0.057)	0.135 (0.134)	0.075 (0.127)
Growth others	-0.232 *** (0.079)	-0.292 *** (0.101)	-0.404 (0.306)	-0.311 (0.197)
Zone dummy	-0.012 (0.065)	-0.135 (0.395)	1.165 (0.941)	0.445 (0.730)
Constant	-1.587 *** (0.553)	-2.001 ** (1.958)	-5.438 * (3.106)	-2.611 * (1.571)
σ	1.009 *** (0.040)	1.175 *** (0.052)	0.812 *** (0.054)	0.721 *** (0.047)
σ_{12}	0.307 *** (0.058)		0.098 ** (0.045)	
Household means joint significance $\chi^2_{(4)}$	12.3 **	17.7 ***	110.6 ***	30.2 ***
Equation significance $\chi^2_{(19\text{ or }20)}$	333.0 ***	280.5 ***	235.9 ***	135.0 ***
LnL	1643.5		672.3	
Number of observations	1335		666	
Number of households	88		43	

*** indicates significant at 1% level, ** indicates significant at 5% level, * indicates significant at 10% level.

Figure One: Average herd size and offtake level over time

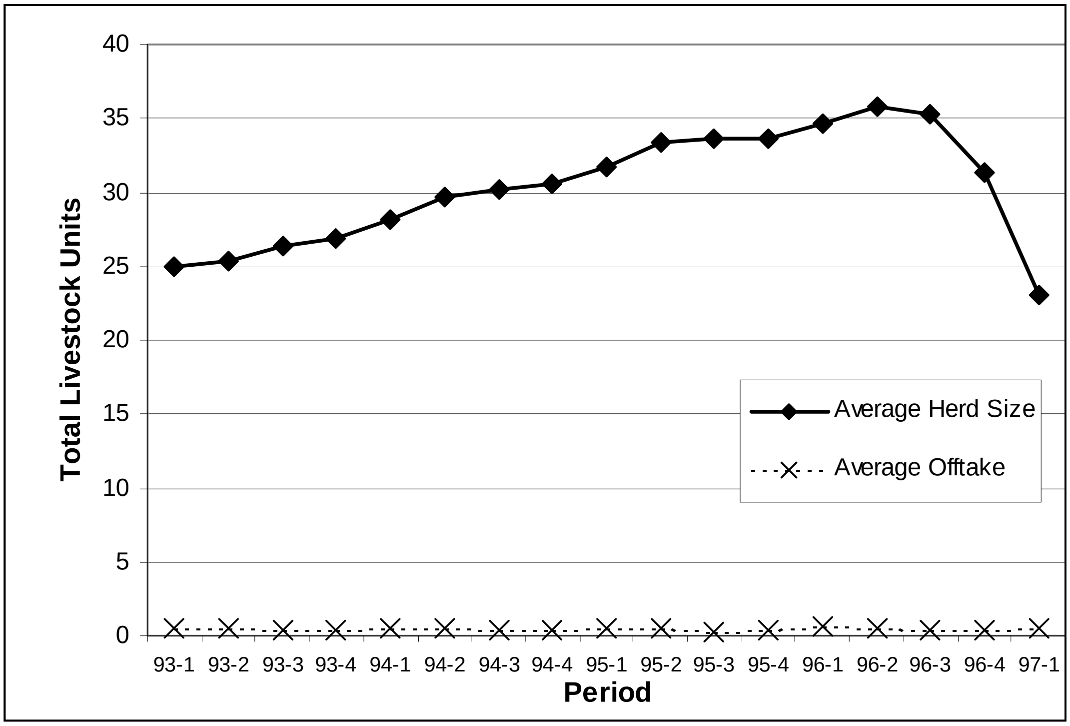
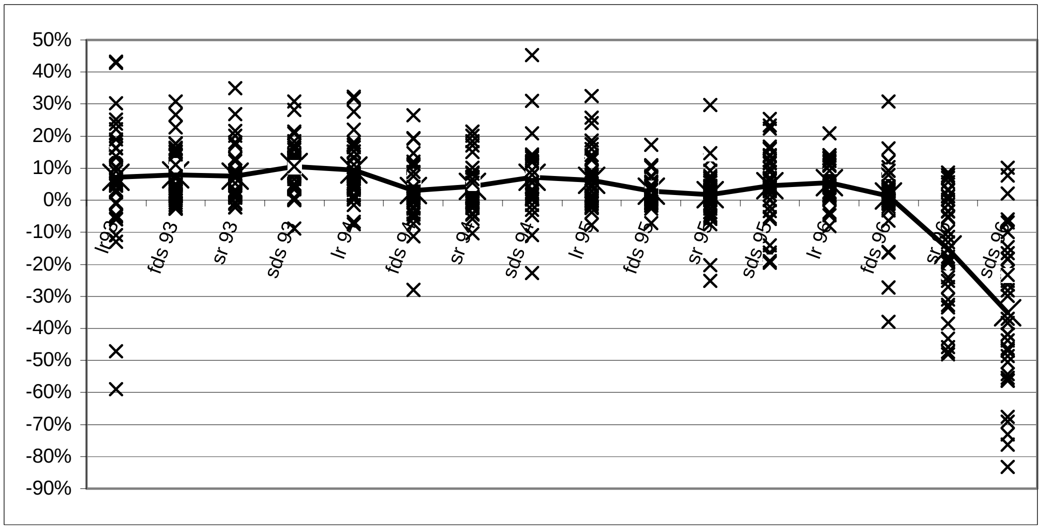
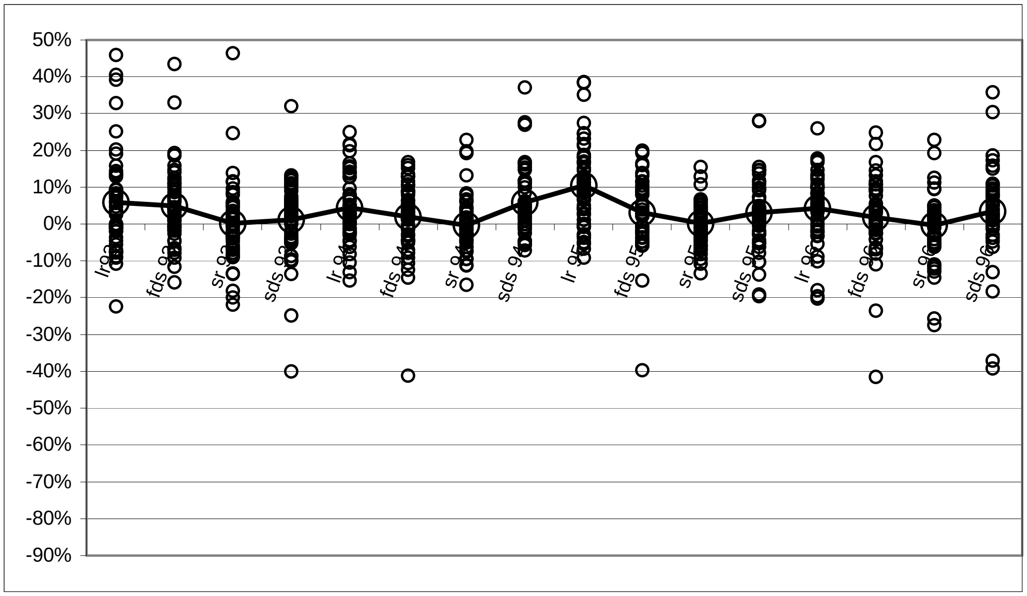


Figure Two: Household Specific and Time Period Average for Chalbi Herd Growth Rates, early 1993-early 1997



The solid line represents the average for all households. Household specific observations per time period are denoted by an x

Figure Three: Household Specific and Time Period Average for Dukana Herd Growth Rates, early 1993-early 1997



The solid line represents the average for all households. Household specific observations per time period are denoted by an o.

Figure Four: Simulation of results for total sample.

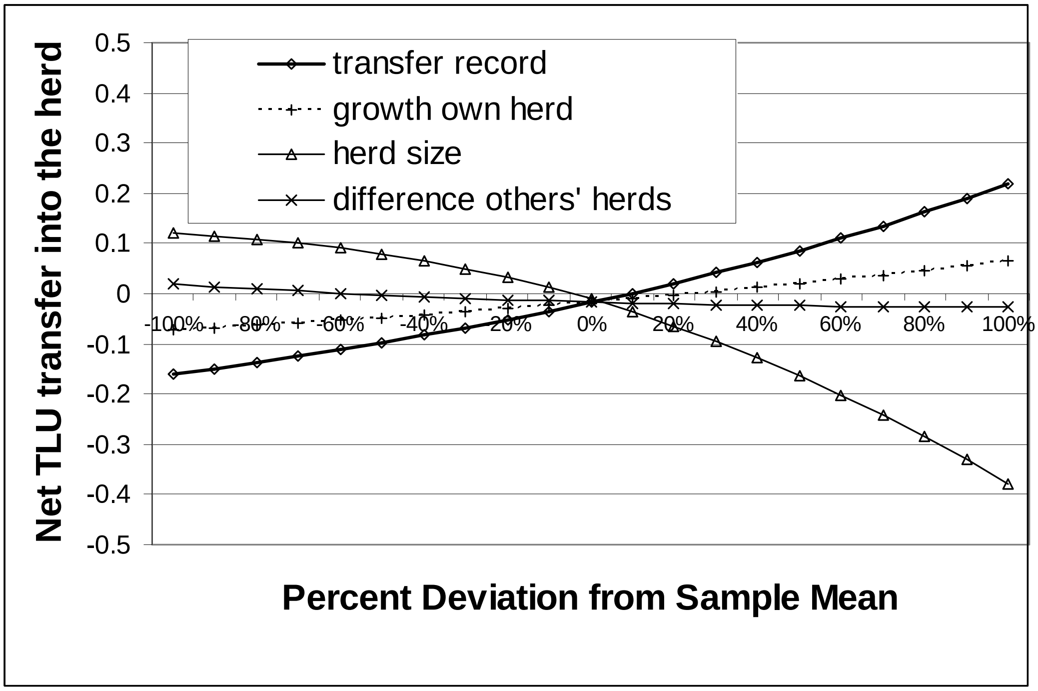
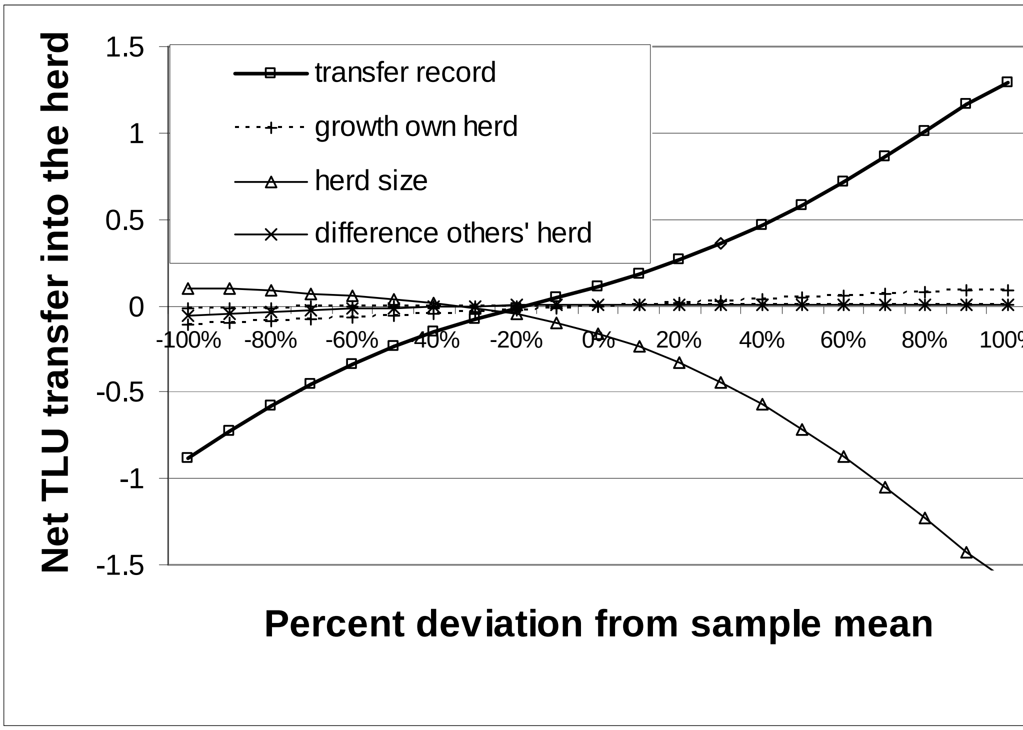


Figure Five: Simulation of results for sample that began relatively poorer.



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End Notes

[1] The anthropological literature does suggest that transfers can lead to assistance in domains other than livestock loans. It is sometimes noted that such relationships can be called upon during disputes with others, for ceremonial needs due to demographic transitions, or for non-livestock related emergencies. We place focus explicitly on reciprocal livestock transfers as that is the predominant interpretation in the literature.

[2] Perlov as well as Potkanski (1999) indicate there is a distinction between transfers among related individuals which obey properties of generalized reciprocity, and those that take place among more socially distant households that obey the properties of balanced reciprocity. We are unable given data limitations to directly test the difference between these two types of reciprocity. However indirect evidence on this issue is discussed in footnote 23.

[3] It is assumed for simplicity that all other inputs, such as land and labor, are fixed.

[4] We are assuming that the shock that impact herd growth does not impact herd production for simplicity.

[5] This presents livestock transfers as solely reflecting balanced reciprocity, and one's risk sharing group as composed of those with whom one has an established relationship. One could also specify a more generalized form where transfers to one member of a defined group are recognized and honored by all in a risk sharing group. We are not able to differentiate between these two with the data set, though as will be

noted below, the results are more consistent with a theory of balanced reciprocity than generalized reciprocity.

[6] Although not the focus of the current study, it merits noting that this result would lead to lower stocking levels over time than the autarkic model. To the extent that one considers pastoral areas overstocked, a redistributive mechanism could have the secondary effect of reducing overall stocking pressure over time.

[7] The definition of this sample did not include former herders who have moved to the small towns of the study area, either in search of economic opportunities or due to the loss of their herd. Issues of selection bias are possible if herders who lost their animals between 1992 and 1997 were systematically overlooked due to the sampling method based on the outcome of herders still residing in the grazing areas. However, discussion with both nomads and town residents indicated this was not likely to be a major issue, as there was not a significant population flow from the rangelands into the towns during this time period, and very few households were forced out of pastoralism due to the herd losses experienced in 1996.

[8] The data set is not longitudinal in the sense that there are repeated observations of a single household over time by an interviewer gathered during multiple visits, but it is longitudinal in the sense that the interviewer recorded repeated observations made by the household over time, but did so during a single interview.

[9] Respondents appeared to have little difficulty in recalling season-specific information over the four year time period covered in this study. This was likely aided by the fact that widespread herd losses in 1992 served as a notable starting period. In addition, herd genealogies were constructed for camels and cattle to record livestock production information, and served as the foundation for other questions (for a discussion of this methodology, see Grandin, 1984 and Turner, 2003). In a society where records are not written, information contained in herders' memories serves a critical function in herd management decisions. Knowledge of complicated genealogy structures and historical events is critical for both Gabra society and for herd management decisions (Torry, 1973; Robinson, 1985; Tablino, 1999). While repeated observations would be preferable for construction of a longitudinal data set, the recall data in this study is internally consistent, and is in our judgment reliable enough to analyze empirically.

[10] Household size is reported in adult equivalents using the scale reported in Martin (1985).

[11] Schwartz *et al.* use the formula 1 TLU = 10 sheep = 11 goats. As herders reported sheep and goats in a combined figure, they are accorded an equal weighting of 1 TLU = 10 smallstock.

[12] There could be unexpected positive gains to raids that could complicate analysis, but during the time period of the study Gabra were for the most part were being raided rather than raiding others.

[13] The average price is constructed from all male goat sales observed in a given time period and area, and is corrected for the age structure of animals sold. Male goat price is the critical price as this is the type of animal most often sold.

[14] Rainfall and food aid data were obtained from the Catholic mission in North Horr and the African Inland Mission in Kalacha. The author expresses his gratitude to these missions for making this data available.

[15] A more detailed overview of the Gabra pastoral economy is presented in McPeak (2004).

[16] Figure one also reports the time period's average offtake level to verify that observed changes in herd size are not explained by increased sales and slaughters.

[17] Herders report the main reason for these losses was the starvation of goats and sheep in the Chalbi area resulting from below average rains in three successive rainy seasons. Animals weakened by insufficient pasture were unable to survive the walk to better areas. That better areas were available is supported by the fact that herders in the Dukana rangelands did not experience a significant drop in herd size in late 1996.

[18] There is a positive impact on income production per person per day over the entire range of herd sizes in the data according the results presented in McPeak (forthcoming). This indicates households must balance retention of an animal leading

to increased current income against the negative impact this will have on expected herd growth.

[19] Results are similar whether using herd size per adult equivalent or total herd size.

[20] Transfers that imply a less than total transfer of rights (termed *dabare, kalassime,* and *darana)* and transfers that involve a total transfer of rights (termed *halal)* are treated identically in the analysis. In addition, transfers due to cultural practices such as payment of bridewealth are not treated separately. These should not lead to major problems in interpreting results since loaned animals are rarely if ever returned to the original donor and bridewealth animals are not frequently paid in full at the time of the wedding. Demanding return of a loaned animal and payment of bridewealth in full at the time of the wedding are frowned upon, as they are interpreted as a wish to sever the social relationship that accompanies the livestock transfer.

[21] The definition of what constitutes a family relation in this case is rather broad. Gabra will go back many generations to establish a family connection when pressing their case for a transfer if necessary.

[22] For 10% of periods, households both gave and received animals, suggesting estimation of net transfers would potentially lose important information. The fact that households are both donors and recipients in some periods does suggest that households have relationships with different herders and that risk sharing takes place in networks defined at the sub-community level.

[23] Regressors in this first stage estimation include species specific herd size measures per period, household demographics measures of the age of the husband and the wife and household size, time period specific factors such as rainfall measures, seasonal dummies, annual dummies, and a time trend, and the 1993 starting value of the transfer record. The adjusted R^2 for this estimation is 0.85.

[24] Estimation was also conducted using simulation methods to control for a household specific random effect that is uncorrelated with observed variables, but the results using these methods are not significantly different from the simpler method that does not use simulation methods. Tests indicate that results using simulation methods do not differ significantly for the combined sample ($\chi^2_{(2)} = 0.44$) for the non poor sample ($\chi^2_{(2)} = 3.1$), or for the poor sample ($\chi^2_{(2)} = 1.2$)

[25] A Wald test of parameter equality for the poorer group and the non-poor group leads to a test statistic $\chi^2_{(44)}$ =835.3. The estimation for the non-poor group used the predicted value of the transfer record calculated from the first stage regression described in footnote 23, as the hypothesis of endogeneity of this record could not be rejected for this subsample with a $\chi^2_{(2)}$ =13.8. Alternatively, a LR test of parameter stability rejects the hypothesis of parameter equality between the richer and poorer sample with a $\chi^2_{(44)}$ =121.3 using the variance-covariance matrix of the poorer sample estimation.

[26] The test statistics for the joint statistical significance of key variable for the estimation using the total sample are: own growth $\chi^2_{(2)}$ =10.8***, herd size

$\chi^2_{(4)}$ =41.5***, difference in household herd size and community average herd size $\chi^2_{(2)}$ =5.3 *, net transfer record $\chi^2_{(2)}$ =10.6 ***. For poorer herders they are: growth $\chi^2_{(2)}$ =2.6, herd size $\chi^2_{(4)}$ =8.4 *, difference in household herd size and community average herd size $\chi^2_{(2)}$ =2.8, net transfer record $\chi^2_{(2)}$ =34.3 ***. Significance level notation is as described in table three.

[27] Note the scale of the y-axis differs between figures five and six. The scale of the x-axis is based on one standard deviation from the pooled mean in both figures for ease of comparison. Note that one standard deviation above and below the poorer sub sample mean corresponds to the following ranges: transfer record, (-96%,64%); growth record, (-34%, 40%); herd size, (-75%, 8%); difference with others herd, (-62%,23%).

[28] Herders confirm this result, noting that the long rains are a period of relatively low labor demand and also that households are able to settle close together in such periods due to pasture growth, thus making transfers easier to implement. This annual focal point suggests that the year time horizon for the growth record is a reasonable approach.

[29] There are other alternative interpretations of livestock transfers possible that are not considered here. Non-risk interpretations of transfers include transfers for herd composition or breeding reasons, transfers demanded by ritual requirements, and transfers as a means of symbolizing social relations that are important for non risk sharing reasons. We leave as a topic for further research distinguishing between

livestock transfers as an *ex ante* risk management institution and these alternative interpretations.