Are Household Production Decisions Cooperative? Evidence on Migration and Milk Sales from Northern Kenya

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Abstract:

Among the Gabra of Northern Kenya, men decide where to migrate with the household herds while women decide whether to sell milk. We test three models of household decision-making. The results suggest that household decisions are contested. Husbands appear to use migration decisions to resist their wives' access to income.

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Introduction

When new opportunities are introduced into societies, the benefits are often contested. In particular, men and women frequently renegotiate their traditional roles and responsibilities with the advent of new opportunities. Some evidence, much of it descriptive and anecdotal, suggests that it may not be appropriate to model household decisions regarding the use of these new opportunities as cooperative decisions. Cooperative models may overlook the contested nature of intra-household decision making. Understanding the nature of such contestation is critical for those who seek to introduce new opportunities to a given society in the name of development. What appears to be a beneficial intervention under the assumption that households act cooperatively may instead lead to unforeseen, potentially adverse, outcomes if decisions are contested.

One frequent source of new opportunities arises when market opportunities develop for goods that have been traditionally produced and consumed within the household. In most economic analyses, market institutions are treated as a fixed set of rules that guide economic behavior. It is, however, important to recognize that as markets develop, new rules associated with the market must be reconciled with existing cultural rules. Observed economic behavior may be the result of a negotiation process over which rules, those of the market or those prevailing in the culture, are applicable.

In this paper, we investigate intra-household patterns of decision making for the Gabra who are nomadic pastoralists in northern Kenya. Over the past thirty years, herders in northern Kenya have seen a rapid growth of milk marketing opportunities. What makes this situation intriguing is that among the Gabra, traditional cultural rules allocate the responsibility to decide where to locate the household to the husband, while the management of milk is the wife's domain. As livestock-raising in the Gabra area requires frequent migration and milk marketing only takes place in the small market towns of the study area, the analysis of these two decisions allows unique insight into intra-household negotiation over new market opportunities. Simply put, we investigate how men use their decision-making power on migration to influence their wife's milk marketing.

As we will elaborate below, people in the area describe four possible reactions by households to the new opportunities presented by the development of milk markets. The first possibility is that husbands and wives recognize the market opportunities and make joint decisions on location and milk marketing to maximize household welfare. We call this the cooperative solution. A second possibility is that husbands take over the milk marketing and decide individually regarding location and milk marketing. This is a specific case of a cooperative solution.[1] A third possibility is that husbands continue to make location decisions without considering the impact on milk marketing. We call this the traditional solution. The final possibility is that husbands view wives' use of milk markets with trepidation, as milk marketing allows wives to expand their control over household milk to control over cash income. In this case, men may make location decisions to limit their wife's ability to market milk. We call this the contested solution. We formally model these outcomes below and then empirically investigate the pattern of household decision-making using panel data from Gabra pastoral households.

The outline of this study is as follows. Section two presents a brief review of the literature on intra-household decision-making. Section three describes the nature of pastoral production in the study area. Section four presents information on the data used in this study. Section five formalizes the three models of decision-making described above: the cooperative model, the traditional model, and the contested model. In section six, results of empirical analysis of household decisions are presented. A concluding section discusses the implications of these findings.

Empirical Literature on Cooperative and Noncooperative Outcomes

Most of the literature on household decision-making assumes that households act cooperatively. Although the literature on noncooperative models is expanding, there are still relatively few empirical examples where the outcome is noncooperative. Many empirical studies that have examined the issue of whether some measure of bargaining power affects household decisions simply assume that the outcome is cooperative.

Much of the intrahousehold literature focuses on whether or not the household can appropriately be modeled as a single decision maker or whether the bargaining power of individuals within the household affects outcomes. For example, using data from Brazil, Thomas (1993) tests whether the distribution of nonlabor income among household members affects expenditures and finds that nonlabor income controlled by women is associated with a larger share of expenditure on human capital and leisure. Thomas and Chen (1993) find similar results for Taiwan. In Ghana, Doss (1999) finds that the share of assets owned by women is significant in explaining household expenditure patterns. Quisumbing and Maluccio (2000) test whether assets brought to marriage by each spouse have differential effects on household-level and individual-level outcomes in Bangladesh, Ethiopia, Indonesia, and South Africa. The most consistent result that they find is that when women control relatively higher shares of resources, a greater share of the household budget is spent on education. Other outcomes that have been explored are health and education outcomes for children. All of these examine which cooperative model of the household is appropriate.

None of these results rejects the notion that the outcome is a cooperative one. Thomas and Chen (1993) explicitly test for Pareto Efficiency in consumption and do not reject it. Similarly, Bourguinon, *et al.* (1993), use data on households in which both adults work full time and in which there is at most once child and claim that the behavior that they observe is consistent with a Pareto efficient outcome. Thus, individual preferences and power may affect the outcomes of household decisions, but the decisions appear to be cooperative outcomes.

Two examples of noncooperative outcomes come from studies that examine production decisions within the household. Udry (1996) uses detailed agronomic data from Burkina Faso and finds that crop yields are different on plots controlled by men from those controlled by women within the same household in a given year. He also finds that households could achieve higher total output by reallocating labor and fertilizer from men's plots to women's plots. Pareto efficiency would require that marginal productivity for an additional unit of labor or fertilizer be the same across all plots owned by the household. Thus, he rejects a cooperative outcome.

Similarly, Jones (1983) rejected a cooperative outcome in her study of labor allocation following the introduction of irrigated rice production in Northern Cameroon. Both men and women continued to grow sorghum after irrigated rice was introduced, even though the returns to labor from rice production were higher. Men and women jointly cultivated the rice fields, whereas sorghum plots were individually cultivated. Women received some compensation for working on rice plots, but the amount of compensation was contested. Reallocating labor from sorghum to rice would again have increased total household production.

This example from Cameroon highlights a theme that is found frequently in the literature – the introduction of new technologies or opportunities often results in the gains being contested. Descriptions of these contestations are widespread in the literature on women in development, but relatively few instances are explicitly modeled and tested. Similar to the example of the introduction of irrigated rice in Cameroon is that of the Gambia. Von Braun and Webb (1989) found that with the introduction of irrigated rice in Cameroon, men took over rice cultivation, displacing the women who had traditionally grown rice. In addition, women began growing cotton and groundnuts, which were traditionally men's crops. The introduction of a mechanical maize sheller into a Nigerian village shifted the control of the shelling process from men to women (Lapido 1991). The men responded by contesting the women's right to charge for shelling and eventually some of the men seized the machine.

Another way that researchers have examined intrahousehold decision making is by examining risk sharing within households. Two studies suggest that household members do not fully pool their risk with each other. Dercon and Krishnan (2000) find that poor southern households in Ethiopia do not engage in complete risk sharing; women in these households bear the brunt of adverse shocks. They reject the collective model of the household which imposes Pareto efficiency on allocations. Doss (2001) finds that in Ghana shocks to men's and women's incomes have different affects on household expenditure patterns. These studies provide support for the idea that individual household members may be concerned about their own long-term access to resources and that membership in a household is one way, but not the only way, that they seek to ensure this access.

Most of the models look at these issues in a static framework. In a static framework, it is challenging to think about why households would not reach cooperative outcomes. However, in the longer term, changing the relative positions of individuals within the household will affect the distribution of resources. Although, at this stage, our model is static in the sense that it does not cover more than one time period, the story for why we see noncooperative outcomes is due to concern over the potential long-term changes within households that could result from women gaining control over income.

Gabra Pastoral Production

Gabra are nomadic pastoralists living in northern Kenya and southern Ethiopia. Gabra inhabit an extremely arid and variable environment. Mean rainfall is below 300mm for most of the Gabra rangelands. Rainfall is also highly variable, with a coefficient of annual variation of 58 in Chalbi. Gabra households share access to their grazing area, and migrate throughout this area in reaction to changing pasture conditions. Gabra households migrate with their herds of camels, cattle, goats and sheep and rely almost entirely on these animals to meet their household needs.

In Gabra culture, the husband is given the right to decide when and where to move the household and the household herd. Such moves can be over extremely long distances. Traditionally, upon the husband's decision to migrate, the housing materials and all the household belongings are loaded onto camels and moved to the new location he has selected. It is the woman's responsibility to reconstruct the house when they reach the new location and the husband's responsibility to build new night enclosures for the animals from thorny bushes. They will remain at this site until the husband decides the time has come to move again.

All things inside the hut are under control of the wife. Gabra symbolism is rich with contrasts between that which is inside the hut (female) with what is outside the hut (male). This is played out each evening in the ritual surrounding the milking of the herd. After the animals return from grazing, they are placed in their night enclosures and milked by a designated milker (women are not allowed to milk camels, nor are sexually active men). The containers full of milk are then taken to where the husband sits outside the door of the hut. He inspects the milk, takes a ritual sip, and then passes it through the door into the hut where his wife receives it. When it passes into the hut, it becomes the wife's and it is her responsibility to manage it.

Traditionally, the management responsibility meant that the wife decided how much to use for each meal, how much to conserve as fermented milk or ghee, and how much to give away to other households. Increasingly, it means she decides how much of the milk will be marketed and how much will be consumed by the household. The marketing option has introduced a change in the nature of the management decision. Marketing allows the transformation of milk produced from the herd into cash. As she will usually spend this money on goods before returning to the family in the evening, she is now presented with a new set of decisions over how to spend this income. We use evidence on how men use migration decisions to influence their wife's milk sales to investigate the nature of the intra-household negotiation over granting the wife this decision-making power.

Description of the Data

This study uses longitudinal data gathered in two areas of Marsabit District, Kenya. Gabra pastoralists occupy the two areas studied: the Chalbi area and the Dukana area. The Chalbi area is drier than the Dukana area, but has more water points as it lies along the lowland Chalbi basin. Marketing is more developed in Chalbi than in Dukana, since Dukana is more remote and less served by transport; vehicles traveling to Dukana must first past through Chalbi.

The data was gathered using a sampling methodology similar to a transect. Enumerators walked between the main towns of the study area and interviewed nomadic households they met along the way. This approach was chosen as there is no population list of exclusively nomadic herders to sample from in the study area.

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.

Respondents were asked to report the following variables for each time period: ages of household members; household size; starting period household herd size and species composition; average milk production from the herd per day[2] and total milk sales per period; and other sources of household income. Household size was converted into an adult equivalent scale following the method outlined by Martin (1985).[3] Variables recording herd size are converted to total livestock units (TLU), following the method of Schwartz et al (1991).[4] The results appear to be reliable, both in terms of respondents ability to provide answers and in terms of the internal coherence of the results.

Variables exogenous to the household are also recorded in the data set. Four variables are used to record rainfall characteristics of a given time period; one measures total rainfall in the current three-month period plus the last three-month period, a second measures the percent of this total that fell in the current three month period, and the final two are dummy variables that record whether the period in question is a rainy season. A variable records the tons of food aid delivered to the towns of the study area in a given time period.[5] Table 1 presents summary statistics of variables used in later regressions.

Milk marketing is relatively new in the Gabra area. It began to appear in the late 1960's, as towns began to grow in the Gabra area. Now, milk marketing is widespread. In the Chalbi sample, 67% of the 39 surveyed households sold milk at some time between 1993 and 1997. In Dukana, 86% of the 49 surveyed households were involved in milk marketing over the same period. Milk sales accounted for 11% of household cash income on average in Chalbi and 14% in Dukana. In contrast, livestock sales provide the majority of household cash income; 73% in Chalbi and 67% in Dukana.

Models of Household Decision Making

Three different models of household decision making are presented. In each, the household decides where to locate and how much milk to sell.[6]

A) Cooperative Decision Making

In this model, the household decides on the distance to settle from town and the milk sales level in a cooperative manner. Here, we model it as a joint decision by the husband and wife. If instead, the husband took over the milk marketing and made both distance and sales decisions himself, the outcome would still be a cooperative one[7]. The outcome maximizes the joint household utility function. For both the husband and wife, define a logarithmic utility function. Utility is an increasing and concave function of consumption. Total household utility is obtained by summing the utility of the husband and the wife. Therefore total household utility is defined by

$$U(c) = \alpha \ln(c^h) + (1-\alpha)\ln(c^w) \qquad (1)$$

where *h* represents the husband, *w* represents the wife, and α represents the weights for the individual consumption in the utility function. Consumption (*c*) includes milk consumed by the household members, goods purchased with the income from milk sold, and goods purchased from the sale of livestock. Assume that decisions over the sale of livestock occur prior to decisions over household location and milk sales, so that the herd contribution to consumption is fixed at *hc* when the location and milk sales decisions are made.[8] Total milk production is *m*, milk sales occur at price *p*,[9] and milk sales are represented by *s*. Consumption can be represented

$$c = hc + (m - s) + s \cdot p \tag{2}$$

The distance from town to the household location is represented by *d*. Milk markets are located in towns. Therefore, the labor effort involved with marketing milk is an increasing function of milk sales and distance from town. Assume the labor cost of milk marketing can be represented by a multiplicative specification $\omega_1 \cdot s \cdot d$, where ω_1 represents a parametric weight on milk marketing labor.

Towns also are the centers of amenities, such as health centers, schools, news and communication centers, public security, and markets for consumption goods. Therefore, settling further from town provides disutility by reducing household members' ability to access these amenities. However, as other herders also desire to be near town to take advantage of these amenities, labor effort for herding increases the closer one settles to town. Represent these two countervailing influences by

$$-\omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{3}$$

where ω_2 and ω_3 again represent parametric weights on distance.

The household thus solves the following problem.

$$\underset{s,d}{Max} \quad \ln(hc + (m - s) + s \cdot p)^h + \ln(hc + (m - s) + s \cdot p)^w - \omega_1 sd - \omega_2 d - \omega_3 \cdot \left(\frac{1}{d}\right) \quad (4)$$

The solution of this problem provides the following conditions:

$$d = \left(\frac{\omega_3}{\omega_2 + \omega_1 \cdot s}\right)^{\frac{1}{2}} \quad (5)$$

$$s = \left(\frac{2}{\omega_1 \cdot d}\right) - \left(\frac{m}{p-1}\right) - \left(\frac{hc}{p-1}\right) \quad (6)$$

Thus, in the cooperative model, the two decisions are made simultaneously and each depends on the other. Households choose the distance from town as a decreasing function of milk sales. Households choose milk sales as a decreasing function of distance.

B) The Traditional Model.

In this model, we assume that the husband makes the location decision without considering how this influences milk sales. In this case, a husband acts and the wife reacts. The husband is still operating under the traditional cultural rules, and has not yet introduced milk marketing as a strategic consideration in his decision. Assume he views the proceeds of milk marketing as his wife's concern and does not consume the products purchased from milk sales. He decides where to locate the herd based on his own considerations and leaves it to his wife to adjust her milk marketing accordingly. The husband decides the distance from town variable by solving the problem

$$\underset{d}{Max} \quad \ln \ (hc + (m - s))^h - \omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \quad (7)$$

while his wife takes the distance as given and solves:

$$\underset{s}{Max} \quad \ln \ (hc + (m - s) + s \cdot p)^w - \omega_1 \cdot s \cdot d - \omega_2 d \quad (8)$$

The solutions to this problem are

$$d = \left(\frac{\omega_3}{\omega_2}\right)^{\frac{1}{2}} \tag{9}$$

and

$$s = \left(\frac{1}{\omega_1 \cdot d}\right) - \left(\frac{m}{p-1}\right) - \left(\frac{hc}{p-1}\right) \tag{10}$$

In this case, distance is determined independently of milk sales and the milk sales decision is a decreasing function of distance.

C) The Contested Model.

In this model as in model (B) we assume that women control the income from milk sales and that the proceeds from milk sales do not enter the husband's consumption. In contrast to model (B), the husband has now understood that the introduction of milk marketing has created a new decision-making context. In this situation, the husband has realized that his power as first mover allows him some leverage to manipulate his wife's milk sales. [10] As the milk sales lead to less milk for him to consume, it is in his interest to reduce the wife's incentive to sell.

Men thus again solve the following problem:

$$\underset{d}{Max} \quad \ln \quad (hc + (m - s))^{h} - w_2 \cdot d - w_3 \cdot \left(\frac{1}{d}\right) \tag{11}$$

while the wife is faced with the problem:

$$\underset{s}{Max} \quad \ln \quad (hc + (m - s) + s \cdot p)^{w} - w_1 \cdot s \cdot d - w_2 \, d \tag{12}$$

Solving recursively, we arrive at the first order condition for the wife from (12) above. Substituting this into the husband's decision problem and maximizing gives us the following.

$$\underset{d}{\text{Max}} \quad ln^{h}\left(hc + m - \left(\frac{1}{\omega_1 \cdot d}\right) + \left(\frac{m}{p-1}\right) + \left(\frac{hc}{p-1}\right)\right) - \omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right) \tag{13}$$

Solving this problem gives us the following condition:

$$d = \left(\omega_3 + \left(\omega_1 \cdot \omega_2 \cdot \left(hc + m - s^*\right)\right)^{-1}\right)^{\frac{1}{2}} \tag{14}$$

where, as in (10):

$$s^* = \left(\frac{1}{\omega_1 \cdot d}\right) - \left(\frac{m}{p-1}\right) - \left(\frac{hc}{p-1}\right) \tag{15}$$

In this case, distance is an increase function of milk sales, and the milk sales decision is a decreasing function of distance.

The comparison of the three models is summarized as follows:

	Cooperative	Traditional	Contested
Distance Variable	Decreasing in s	Not a function of s	Increasing in s
Milk Sales Variable	Decreasing in d	Decreasing in d	Decreasing in d

We expect the milk sales variable to be always decreasing in distance. The distinction between the three models depends on the sign and the significance of the milk sales parameter in the equation for distance. These results provide the foundation for the empirical estimations that follow.

Empirical Analysis

In this section, we use observed values for the distance a household settles from town in a given period and the total amount of milk sold in the period to investigate the relationship between these decisions. Denoting the distance from town decision by *d*, the milk sales decision by *s*, γ and 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:

$$
\begin{aligned}
d &= \gamma_s \cdot s + \beta_d X_d + u_d \\
s &= \gamma_d \cdot d + \beta_s X_s + u_s \qquad (16) \\
u_d, u_s &\sim BVN(\sigma_d^2, \sigma_s^2, \rho)
\end{aligned}
$$

Given our analysis above, the parameter of interest is the sign and significance of γ_s in the distance equation. If estimation reveals it to be negative and significant, this result is consistent with the cooperative model. If it is not significant, the result is consistent with the traditional model. Finally, if we find it to be positive and significant, this provides a result consistent with the contested model.

Three issues emerge when attempting to estimate this system of equations. First, both dependent variables are by construction non-negative and censored at zero. Distance from town equals zero for 7% of observations in Chalbi and 3% in Dukana. In addition, no milk was sold for 72% of observations in Chalbi and 82% in Dukana.[11] Failure to take account of the censored nature of dependent variables results in inconsistent parameter estimates. As the equations are specified as a system, the methodology used is full information maximum likelihood estimation of a bivariate tobit system (Maddala 1983).

A second issue arises due to the longitudinal nature of the data. It is possible that there are underlying household specific characteristics that influence livestock transfer behavior. If not controlled for, the presence of such characteristics will lead parameter estimates to be inconsistent (Hsiao 1986). The response used to address this issue was to include a time invariant household specific effect by creating a matrix recording the means of household specific variables for all time periods observed. The unobserved household specific effect is assumed to be a function of these household specific means.

A third issue is the possibility that milk production is endogenously determined. In other words, if milk production is a function of distance, and milk production increases the further one is from town, we could misinterpret a husband's decision to move away from town in order to increase milk production as evidence supporting the contested model. We take two steps to address this issue. First, we present the results of a fixed effects estimation of milk production. These results (see Table 2) indicate that the distance a household settles from town has no significant impact on milk production. Second, we present results of estimations of equation (16) with and without milk production included as a regressor.

Estimations are conducted separately for the Chalbi and the Dukana data. As both the land and the market associated with these two towns differ, there may be parametric differences in the decision processes. Table 3 presents results of simultaneous tobit estimation of milk sales and distance from town decisions for the Chalbi sample and the Dukana sample.

The results show clearly that the coefficient on milk sales in the distance estimation is positive and significant, thereby supporting the contested model of the household. As expected, the coefficient on distance in the milk sales estimations are negative and significant. As distance increases, milk sales decrease. There is almost no difference between the two specifications for each sample; the model is robust to the inclusion or exclusion of milk production. In Dukana, milk production affects milk sales, but this is not the case in Chalbi. In neither sample does milk production affect distance. The herd size variables are not statistically significant in the estimation of either location or milk sales decisions. Age of the oldest members of the household does affect these decisions. There is some evidence of seasonality in both distance from town and milk sales based on the seasonal dummies. In Dukana, food aid deliveries decrease the distance from town and increase milk sales. Food aid is usually delivered to the towns and thus they provide an incentive for people to locate closer to town.

Conclusion

The results are consistent with a contested model of household decision-making. Men appear to be making decisions about the distance from town in order to limit women's ability to market milk. This result is consistent with the notion that men resist the ability of their wives to obtain independent sources of income. While women gain the benefits of milk marketing, men are reluctant to facilitate this.

Is this contestation a good thing or a bad thing for overall household welfare? We do not have the data to adequately address this issue in this context. Since most studies indicate that income in women's control is more likely than men's income to be spent on goods for children[12], it may be that children's welfare would increase if women earned income from milk sales. On the other hand, by selling milk, women are also reducing the amount of milk available to the household. Thus, the impact on children is ambiguous. We leave as a topic for further study who is "right" in this case; husbands who argue milk marketing has a negative impact on household utility or wives who argue it has a positive impact on household utility.

What we can say is that husbands and wives are in a process of adjusting to the new opportunity brought about by milk marketing in this area. Our evidence suggests the most appropriate way to understand the process is one of contestation. Husbands are using their traditional right to decide migration patterns to influence wives sales' decisions. Wives are asserting that their traditional right over milk management extends to this new setting. This finding suggests that the introduction of market opportunities for goods that are traditionally home consumed may meet with resistance within the household.

Table 1. Descriptive Statistics

Variable	Chalbi Mean	Chalbi Standard Deviation	Dukana Mean	Dukana Standard Deviation
Distance --base camp to town (hours walk)	5.13	4.78	8.27	8.22
Milk Sales (liters per period * 20 shillings per liter)[a]	408.47	843.57	29.27	70.05
Milk Production (liters per day)	5.33	4.67	3.71	2.19
Herd size in TLU	43.27	32.70	18.66	6.84
Herd size in TLU / Adult Equivalent	9.07	5.14	4.68	1.77
Household Size in Adult Equivalents	5.09	2.12	4.14	0.99
Percent at satellite camp (of labor force for Chalbi, of herd for Dukana)	33.88	31.89	24.15	30.56
Rainfall in mm over past six months	58.39	42.09	65.53	47.57
Long Rains Dummy	0.27	0.45	0.25	0.43
Short Rains Dummy	0.24	0.43	0.25	0.43
Food aid deliveries in tons per period	72.37	88.97	65.22	85.74
Age of oldest male in household	47.12	14.33	53.12	12.09
Age of oldest female in household	37.19	13.48	36.50	10.04
Number of Observations	707		980	
Number of Households	39		49	

[a] Note that the price of milk was constant at 20 shillings per liter over the entire period.

Table 2. Fixed Effects Estimation of Milk Production Function

	Chalbi Fixed Effects	Dukana Fixed Effects
Herd Size in TLU	0.0767 ***	0.1653 ***
	(0.0137)	(0.0403)
Herd Size in TLU^2 (x 10^{-2})	-0.0052	0.0549
	(0.0044)	(0.0820)
Distance in hours from town	0.0102	-0.0462
	(0.0440)	(0.0289)
Distance in hours from $town^2$	-0.0001	0.0016 *
	(0.0013)	(0.0008)
Percent of herd at satellite camp	0.2092	-0.1102
	(0.7295)	(0.3081)
Rainfall in past six months	0.0169 ***	0.0042
	(0.0059)	(0.0036)
Rainfall in past six $months^2$ (x 10^{-2})	-0.0059	0.0010
	(0.0036)	(0.0019)
Long rains dummy	1.3419 ***	2.3547 ***
	(0.2272)	(0.1412)
Short rains dummy	0.5048 **	1.3754 ***
	(0.2024)	(0.1309)
Time trend (1993 long rains =1, … 1997 2^{nd} dry season =20)	0.2366 ***	0.1603 ***
	(0.0893)	(0.0503)
$Period^2$	-0.0149 ***	-0.0086 ***
	(0.0045)	(0.0025)
Constant	-1.6380 ***	-1.6233 ***
	(0.3907)	(0.2540)
Herd significance $\chi^2_{(2)}$	176.0 ***	103.5 ***
Distance significance $\chi^2_{(2)}$	4.3	0.1
R^2	.38	.28
Number of observations	687	980

* indicates significance at the .10 level, ** at the .05 level, *** at the .01 level

Table 3. FIML Simultaneous Tobit Results for Distance from Town and Milk Sales

	Chalbi				Dukana			
	Distance from Town	Milk Sales	Distance from Town	Milk Sales	Distance from Town	Milk Sales	Distance from Town	Milk Sales
Milk Sales	3.2671 ***		3.2635 ***		3.4664 ***		2.9925 ***	
	(0.2451)	-	(0.2486)	-	(0.6004)	-	(0.7039)	-
Distance from Town		-1.4153 ***		-1.4169 ***		-0.1200 ***		-0.1107 ***
	-	(0.3518)	-	(0.3644)	-	(0.0334)	-	(0.0310)
Constant	-4.8563 *	-12.9083 ***	-4.7578 **	-12.856 ***	11.9521 **	-12.0676 ***	11.4082 *	-9.5236 **
	(2.7869)	(4.3405)	(1.9430)	(4.0122)	(5.5419)	(2.1667)	(6.3416)	(4.3670)
Last period distance	0.6090 ***		0.6157 ***		0.6327 ***		0.6284 ***	
	(0.0443)	-	(0.0448)	-	(0.0284)	-	(0.0280)	-
Herd size per adult equivalent	0.2846	0.4224	0.4894	0.1457	1.7354	5.9065	3.1908	2.9725
	(1.9809)	(2.1897)	(1.0582)	(0.6821)	(13.1165)	(4.2797)	(10.6818)	(3.4564)
Herd size per adult equivalent^2	0.2971	-3.1441	-0.4768	-2.4536	-5.4087	-2.6967	-6.1436	-2.2034
	(2.6590)	(7.9263)	(3.5015)	(3.4069)	(9.4313)	(3.4248)	(8.4033)	(3.0587)
Food aid deliveries	-0.9060	-2.6834	-0.9854	-2.4377	-1.3279 ***	0.7942 ***	-1.2674 **	0.7894 ***
	(6.3676)	(3.3505)	(2.2560)	(3.0283)	(0.4693)	(0.2994)	(0.5639)	(0.3026)
Rainfall in past six months	0.3634	-0.3040	0.3954	-0.3027	0.7467	0.1939	0.7005	0.2806
	(0.8211)	(0.7820)	(0.5985)	(0.7377)	(0.6770)	(0.3731)	(1.1648)	(0.3562)
Long rain dummy	-0.8170	1.0904 *	-0.7481	0.9431	-3.5538 ***	3.9179 ***	-3.0437 ***	2.8221 ***
	(0.5435)	(0.6351)	(0.5523)	(0.6726)	(0.7452)	(0.5082)	(1.0810)	(0.4479)
Short rains dummy	1.2845 **	0.2580	1.3254 ***	0.2162	-1.7961 ***	3.6504 ***	-1.4757 **	3.0060 ***
	(0.5789)	(0.6855)	(0.5130)	(0.6474)	(0.6837)	(0.5056)	(0.6976)	(0.4494)
Age of oldest male	2.1030		1.9742		-1.5270 ***		-1.4576 ***	
	(5.7519)	-	(1.2497)	-	(0.3865)	-	(0.4932)	-
Age of oldest male^2	-2.0669 ***		-2.0049 **		3.1793 *		3.0999 *	
	(0.7791)	-	(0.8004)	-	(1.7527)	-	(1.8445)	-
Age of oldest female		4.0646 **		4.1662 **		0.7507 ***		0.6170 ***
	-	(1.6562)	-	(1.6582)	-	(0.1903)	-	(0.2207)
Age of oldest female^2		-3.6750 **		-3.7324 **		-2.8428 ***		-2.2026 *
	-	(1.4843)	-	(1.4736)	-	(0.9086)	-	(1.2005)
Milk production in period			-0.6617	1.0750			-0.9700	4.0863 ***
	-	-	(0.6220)	(1.4206)	-	-	(2.2421)	(0.7476)
σ	5.2123 ***	4.4045 ***	5.2085 ***	4.3643 ***	7.8964 ***	2.4949 ***	7.7928 ***	2.2913 ***
	(0.1881)	(0.7715)	(0.1891)	(0.7934)	(0.2284)	(0.2462)	(0.2313)	(0.2196)
σ12	-11.2715 ***		-10.8340 ***		-6.7540 ***		-5.0950 ***	
	(2.0918)		(2.1315)		(1.8373)		(1.9797)	
Herd size joint sig. $\chi^2_{(2)}$	0.44	0.35	0.33	0.52	3.32	4.68 *	1.58	0.78
Age joint sig. $\chi^2_{(2)}$	7.10 **	6.34 **	6.29 **	6.61 **	15.70 ***	18.33 ***	8.75 **	7.82 **
Fixed effect joint sig. $\chi^2_{(4)}$	15.24 ***	13.71 ***	16.25 ***	13.73 ***	17.27 ***	11.11 **	14.27 ***	9.52 **
Beta sig. χ^2	553.15 ***	17.51	561.58 ***	19.43	1553.75 ***	78.37 ***	1589.17 ***	82.47 ***
Equation Joint sig. χ^2	561.39 ***		569.16 ***		1637.32***		1680.82 ***	

* indicates significance at the .10 level, ** at the .05 level, *** at the .01 levR

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Notes

[1] In this paper, we do not try to distinguish among the different types of cooperative outcomes. Much of the intrahousehold literature has focused on determining which cooperative outcome results, based on bargaining power or other factors. Here we are interested in whether or not the outcome is a cooperative one.

[2] This is the milk produced for human consumption. Traditionally, half the udder of a milking animal is taken for human consumption and the other half is left for young stock to suckle.

[3] The adult equivalent weighting scheme used in this study assigns a value of one to individuals of both sexes older than 15, a value of .6 to individuals 6-14 years old, a value of .3 to children ages 2-5, a value of .1 for children under 2.

[4] One livestock unit = 10 sheep or goats = 1 head of cattle = 0.7 camels. This differs slightly from the scheme in Schwartz et al. as they weigh 11 goats equal to one TLU. As the total number of sheep and goats is the variable recorded in the data set, the composite measure of smallstock is assigned a weight of 1 animal = 0.1 TLU.

[5] The rainfall and food aid records were provided by the Catholic mission in North Horr and the AIC mission in Kalacha.

[6] While the focus of this paper is the dynamic process of cultural adaptation to market development, we develop our argument through models of different states of this process as separate static models rather than through use of a unified dynamic model. This keeps the model as simple as possible while illuminating our main points. We leave as a future extention the connection of these different phases in a unified dynamic model.

[7] Within the cooperative models, the outcomes would differ depending on the weights assigned to each person's utility. But changing the weights would not affect the sign on the distance variable, which is our concern in this paper.

[8] This allows us to focus attention on the static aspect of the distance and milk sales decision. Livestock sales introduce a dynamic element to the model that we chose to ignore at this stage in the interest of simplicity.

[9] The price of milk was constant over the study period at a price of 20 shillings per liter.

[10] Wives advance the story that milk sales will enhance household welfare overall, as they provide food and clothing for themselves and the children with this income, leaving the husband to consume the milk-based diet that he expects. In this case, assume the children's welfare is subsumed under the wife's utility. Milk sales in this case expand the household's budget constraint due to the advantageous caloric terms of trade, thus expanding overall household welfare, while not detracting from the husband's utility. Husbands, alternatively, argue that

when women gain control over income they will adversely impact the household budget as they will spend the proceeds of milk sales on town based boyfriends thus depriving the household of both milk and income from milk sales. In this case, assume the children's welfare is subsumed under the husband's utility. While the former story is perhaps more credible than the latter, it remains an area for further research.

[11] Note that although most of the households sold milk during at least one of the periods of the survey, most of these households also had periods where they sold no milk.

[12] See for example, Hoddinott and Haddad (1995), Doss (1999), Thomas (1993).