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

John G. McPeak and Cheryl R. Doss

Market-based development efforts frequently create opportunities to generate income from goods previously produced and consumed within the household. Production within the household is often characterized by a gender and age division of labor. Market development efforts to improve well-being may lead to unanticipated outcomes if household production decisions are noncooperative. We develop and test models of household decision making to investigate intrahousehold decision making in a nomadic pastoral setting from Kenya. Our results suggest that household decisions are contested, with husbands using migration decisions to resist wives' ability to market milk.

Key words: household production, intrahousehold, noncooperative models, pastoralism.

When new opportunities, such as improved market access or new production technologies, are introduced into societies, the nature of intrahousehold production decisions may affect the outcomes. Men and women frequently renegotiate their traditional roles and responsibilities with regard to production decisions in the advent of new opportunities. Some evidence, much of it descriptive and anecdotal, suggests that it may not be appropriate to model household decisions in response to new opportunities as cooperative decisions.[1] Cooperative models may overlook the contested nature of intrahousehold decision making. Understanding the nature of such contestation is critical for those who seek to introduce new opportunities in the name of development. What appears to be a beneficial intervention under the assumption that households act cooperatively in adopting the new opportunity and distributing the benefits may instead have little impact or even lead to unforeseen adverse outcomes if decisions are contested.

Development efforts often focus on bringing goods that have been traditionally produced and consumed within the household into the market domain. As market institutions develop, new rules associated with the market must be reconciled with existing cultural institutions. In this study, we investigate intrahousehold production decisions for Gabra nomadic pastoralists who live in an arid climate 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 the ability to market milk depends on one's proximity to town. Among the Gabra, traditional cultural rules allocate the responsibility to decide where to locate the household to the husband. Households migrate frequently, as high spatial and temporal variability in rainfall requires moving the herds of cattle, camels, sheep, and goats in search of pasture. In contrast to migration decisions, management of milk is traditionally the wife's domain. Milk marketing has been added relatively recently to milk management decisions. Marketing only takes place in the small market towns of the study area and requires trips on foot from the household location to the nearest market town. The nature of these decisions confers

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Financial support for this study was provided by an International Predissertation Fellowship from the Social Science Research Council and the American Council of Learned Societies with funds provided by the Ford Foundation, the Mellon Foundation, and the Graduate School of the University of Wisconsin-Madison. Work on the manuscript was conducted as a result of the authors' collaboration on the Pastoral Risk Management Project of the Global Livestock Collaborative Research Support Program, funded by the Office of Agriculture and Food Security, Global Bureau, USAID, under grants DAN-1328-G-00-0046-00 and PCE-G-98-00036-00. The opinions expressed do not necessarily reflect the views of the U.S. Agency for International Development.

[1] Examples of analyses that do not formally model these issues but suggest noncooperative outcomes include Kabeer (1997) and Dolan (2001).

Amer. J. Agr. Econ. 88(3) (August 2006): 525–541

upon the husband "first mover" status unless he decides to participate in a decision-making process where milk sales and migration decisions are made jointly. This allows analysis of these two decisions to provide unique insight into intrahousehold negotiation in the advent of a new market opportunity.

Households may react to the new opportunities presented by the development of milk markets in four different ways. The first possibility is that a husband and a wife recognize economic benefits provided by the new market opportunity and make joint decisions on migration and milk marketing to maximize household welfare. We call this the joint cooperative solution, and it is characterized by the husband sacrificing his first mover status and participating in a decision-making process that incorporates both the migration decision and a milk sales plan for the coming period. A second possibility is what we term the individual solution: in response to the new opportunity, the husband takes over milk marketing and decides on behalf of the household the migration decision and milk sales plan.[2] A third possibility we describe as the traditional solution, where a husband continues to make migration decisions without considering the impact on milk marketing. The final possibility is that a husband views his wife's use of milk markets with trepidation, as milk marketing allows a wife to expand her traditional control over household milk to control cash income potentially moving a component of household consumption to her private consumption. In this case, a husband may exploit his first mover status for the location decision to limit his 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.

Empirical Literature on Cooperative and Noncooperative Outcomes

Much of the literature on household decision making assumes that households act cooperatively and examines which cooperative model, a unitary model or a bargaining model, best fits the data.[3] The literature on intrahousehold consumption decisions is extensive. Studies that explicitly test for whether the assumptions of the cooperative model hold in consumption decisions tend to reach findings that reject the unitary model but do not reject Pareto efficiency as a characteristic of household decision making (Thomas, Contreras, and Frankenberg 2002; Thomas and Chen 1993). Many studies use this finding to offer models of cooperative household decision making that do not rely on the unitary model and allow for different preferences and different weights or bargaining power of individuals to affect the outcomes (Doss 2006, Quisumbing and Maluccio 2003; Attanasio and Lechene 2002; Hallman 2000; Lundberg, Pollack, and Wales 1997; Lundberg, Startz, and Stillman 1997).[4]

Studies examining risk sharing within households find less support for the assumption of cooperative decision making. Dercon and Krishnan (2000) find that poor households in southern Ethiopia do not engage in complete risk sharing; women in these households bear the brunt of adverse shocks. Doss (2001) finds that in Ghana, shocks to men's and women's incomes have different effects on household expenditure patterns, suggesting that household members may be concerned about their individual long-term access to resources and that membership in a household is one way, but not the only way, to ensure this access. Both of these findings implicitly reject a cooperative model of the household.

Investigations of intrahousehold production decisions also tend to find less support for the cooperative decision-making model. 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

[2] In this paper, we do not try to distinguish among different types of cooperative outcomes, such as the joint cooperative solution and the individual solution. Much of the intrahousehold literature has focused on determining which cooperative outcome results, based on bargaining power or other factors. We model the joint cooperative solution, and note that the individual solution is a special case of it.

[3] A unitary model assumes that the household acts as though there is one decision maker. Bargaining models explicitly note that there may be more than one decision maker and that the decision makers may have different preferences which may affect the outcomes.

[4] A separate theme in the literature is intrahousehold household decision making with regard to supplying labor. Two studies extend Chiappori's (1988) collective model of labor supply to examine censoring and nonparticipation in employment (Blundell et al. 2002) and marriage markets and divorce (Chiappori, Fortin, and Lacroix 2002). Again, studies on this theme tend to support the assumption that household decision making is cooperative.

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) rejects the hypothesis of 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. Reallocating labor from sorghum to rice would again have increased total household production. Von Braun and Webb (1989) and Dey (1981) present findings similar to Jones; the introduction of irrigated rice displaced women who had traditionally grown this crop in The Gambia as men took over rice cultivation. Women, in turn, began growing cotton and groundnuts, which were traditionally men's crops.

These examples highlight a common theme—the introduction of new production opportunities interacts with an existing gendered division of labor to lead to unforeseen outcomes. A variant of this theme considers the case of an existing product increasing in value when it enters the market domain. In this setting, production decisions may respond to new opportunities that may also challenge existing cultural definitions of the intrahousehold division of labor. A variety of studies in Africa consider the impact of increased milk marketing in pastoral areas, noting that the decisions about the management of milk, including milk marketing decisions, are made by women while herd management decisions, including migration, are made by men (Coppock 1994; Holden and Coppock 1992; Holden, Coppock, and Assefa 1991; Bekure et al. 1991; Sikana and Kerven 1991; Herren 1991; Ensminger 1987; Waters-Bayer 1985). The impact of the introduction of milk markets on household decision making varies across sites. Michael (1987) presents findings from Sudan consistent with a cooperative outcome: men recognize the growing importance of milk marketing and adjust their migration decisions to incorporate this new opportunity. Ndagala's findings (1982) from Tanzania are consistent with the individual solution. In this case, when a market opportunity was introduced, men took control of milk marketing and the cash it generated. Evidence consistent with the contested model is provided by Waters-Bayer (1985) in Nigeria. In this setting, women control income from milk production and men are responsible for purchasing animal health products and services. This limited the adoption of milk production improving technologies based on purchased inputs, since the benefits did not accrue to the household member who bore the costs. Indirect evidence consistent with the contested model is also presented by Nduma, Kristjanson, and McPeak (2001): pastoral women in northern Kenya are less likely to market milk when a husband is present in the household, all else equal.[5]

Given this wide range of outcomes, we seek in this study to formalize the nature of the different types of outcomes. We contribute to the literature on this topic both by developing a simple but intuitive methodology to investigate intrahousehold patterns of decision making and presenting empirical evidence to support our findings. Our model presents one explanation for why households may end up with a noncooperative outcome. We discuss other possible explanations.

Gabra Pastoral Production

Gabra are nomadic pastoralists living in northern Kenya and southern Ethiopia. Gabra inhabit an extremely arid and variable environment in which cultivation is not possible. Mean annual rainfall is below 300 mm for most of the Gabra rangelands. Rainfall is also highly variable, with a coefficient of annual variation of 0.55 at the center of the Gabra rangelands in North Horr. Gabra households share access to their grazing area and migrate throughout this area with their herds of camels, cattle, goats, and sheep, in reaction to changing pasture conditions. They rely almost exclusively on their herds to meet their subsistence and income needs.

Although Gabra culture is dynamic and subject to different perceptions by different people, the social norm is that the husband has the right to decide when and where to

[5] Two different themes in the literature on milk marketing merit note. First, it is frequently found that milk marketing is a function of wealth as represented by herd size (Nduma, Kristjanson, and McPeak 2001; Herren 1992; Holden, Coppock, and Assefa 1991) and that milk marketing is a function of household distance to market (Holden and Coppock 1992). Our study builds on the latter theme.

move the household and the household herd.[6] 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. It is the woman's traditional 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 remain at this site until the husband decides the time has come to move again. The husband also makes decisions about splitting the herd. Gabra households frequently establish a satellite camp that usually moves male and nonlactating animals away from the milk herd kept at the base camp.

All things inside the hut are traditionally under the control of the wife. Gabra symbolism is rich with contrasts between that which is inside the hut (female) with that 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. The containers full of milk are then taken to the husband who 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 that 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. Women generally walk to town without their husband to participate in milk marketing. Thus, they have the opportunity to make independent decisions on how to spend this income before returning to the household.[7] We investigate evidence on migration decisions and milk sales to investigate the outcome of intrahousehold negotiation over how to respond to this new market opportunity.

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. Dukana is more remote and less served by transport; vehicles traveling to Dukana must first pass through Chalbi. Markets are more active in Chalbi than in Dukana partially due to this difference in transport availability.

The sampling methodology used in this study is similar to 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.[8] The questionnaire was retrospective in nature, recording information for each three-month season per year for each of the years 1993–7.[9] Within

[6] Migration decisions are occasionally taken by a collection of households jointly residing at a camp, but each household has the right to break away and join another camp, settle on their own, or remain where they are and perhaps be joined by other households. As camp composition changes over time, the ultimate decision-making authority over migration decisions rests with the eldest male in the household. Households do not follow a set pattern of where to migrate.

[7] As noted by the reviewers for this journal and discussed further in footnote 23, it is possible that the issue is not so much control over income, but rather control over a wife's activities. We believe the income issue is the most important one and use this as the basis of our model, but recognize that the source of contestation could be broader than control over income.

[8] 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.

[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 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 (Tablino 1999; Robinson 1985; Torry 1973). While repeated observations would be preferable for construction of a longitudinal data set, the recall data in this study

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, depending on when the household was interviewed in 1997 or early 1998).[10]

For each period, households reported the distance from the base camp to the nearest market town in the number of hours it took to walk this distance. They also reported the number of people and animals sent to a satellite camp if one was established. The distance between the base camp and town averaged just over five hours' walk in the Chalbi and over eight hours in Dukana. In both areas, roughly half of the households reported migrating and changing the distance from town from one three-month period to the next.

Households also reported income sources, average daily milk production, and total milk sales per period. Almost all income is derived from livestock and livestock products. Assigning market values to home consumed goods reveals that the total value of marketed and home consumed income was the equivalent of \$0.61 per person per day in Chalbi and \$0.38 per person per day in Dukana.[11] In Chalbi, 55% of the household income is accounted for by home-consumed milk produced by the household herd; 21% is obtained by home consumption of slaughtered animals; 20% is obtained by sale of animals; 3% is obtained by milk sales; and 1% is obtained by hide sales, gifts, and remittances. In Dukana, 82% of the household income is accounted for by home-consumed milk produced by the household herd; 9% is obtained by sale of animals; 8% is obtained by home consumption of slaughtered animals; 1% is obtained by milk sales; and less than 1% is obtained by hide sales, gifts, and remittances. Milk sales accounted for 11% of household cash income on average in Chalbi and 14% in Dukana. The majority of households, 67% of households in Chalbi and 86% in Dukana, sold milk during one or more seasons between 1993 and 1997. In Chalbi, if a household sold milk in a given period, 62% of the time they also sold milk in the following period. In contrast, milk sales were more seasonal in Dukana where the corresponding figure is 10%. The price of milk was constant over the study period at a price of 20 shillings per liter in both sites. Median milk production per day[12] in the Chalbi area was 4.5 liters per household per day, 34% of which came from camels, 5% from cattle, and 61% from sheep and goats. In Dukana, the corresponding figure are 3.5 liters per household per day, 21% from camels, 26% from cattle, and 53% from sheep and goats.

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. Household size was converted into an adult equivalent scale following the method outlined by Martin (1985).[13] Variables recording herd size are converted to total livestock units (TLU), following the method of Schwartz, Shaabani, and Walther (1991).[14] The median Chalbi household had six residents (4.5 adult equivalents) while the median Dukana household had five residents (4.3 adult equivalents). The median herd size per species in Chalbi was: 9 camels, 2 cattle, and 193 sheep and goats. In Dukana, the corresponding figures are: 4 camels, 5 cattle, and 58 sheep and goats.

The data set also records variables exogenous to the household. Monthly rainfall data were gathered at the North Horr Catholic mission and the Kalacha African Inland Church mission. Both rainfall collection sites were in Chalbi; no rainfall data were available for

are internally consistent, and are in our judgment reliable enough to analyze empirically.

[10] Work began in Chalbi before Dukana, so the number of observations per household in Dukana tends to be greater than that for Chalbi. Not all observations are used directly in the estimations reported below, as some observations are used to construct lagged variables, and a few observations in Chalbi had to be omitted due to missing variables

[11] In caloric terms, this corresponds to an average potentially available caloric level per adult equivalent per day of 2,929 in Chalbi and 1,136 in Dukana. Note neither the income variable nor the calorie variable includes the value of food aid. Although we did not collect food aid receipt data per household, we can estimate the contribution by noting that food aid when distributed in this area often works with a target level of 10 kg of grain per person per month. This would generate roughly 1,200 more calories per person per day. Food aid was distributed in 70% of time periods observed.

[12] 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.

[13] The adult equivalent weighting scheme used in this study assigns a value of one to individuals of both sexes older than fifteen years a value of 0.6 to individuals six to fourteen years old, a value of 0.3 to children ages two to five, a value of 0.1 for children under age 2.

[14] One livestock unit = 10 sheep or goats = 1 head of cattle = 0.7 camels. This differs slightly from the scheme in Schwartz et al. (1991) as they weight eleven goats equal to one TLU. As the data set records the total number of sheep and goats combined, this composite measure of smallstock is assigned a weight of one animal = 0.1 TLU.

Table 1. Descriptive Statistics

Variable	Chalbi Mean	Chalbi Standard Deviation	Dukana Mean	Dukana Standard Deviation
Distance—base camp to town (hours walk)	5.12	4.78	8.27	8.22
Value of milk sales (liters per period * 20 shillings per liter)[a]	420.11	856.39	29.27	70.05
Milk production (liters per day)	5.21	4.41	3.71	2.19
Herd size in TLU	42.67	31.13	18.66	6.84
Household size in adult equivalents	5.04	2.17	4.68	1.77
Percent or periods satellite camp used	47.71	49.98	43.82	49.63
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	47.13	14.33	53.12	12.09
Age of oldest female in household	36.84	13.24	36.50	10.04
Number of observations	677		980	
Number of households	39		49	

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

Dukana; thus, we use Chalbi data as the best available measure of rainfall. The rainfall variable is constructed as the average of the two Chalbi sites for a given season. Three 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 as this corresponds to the effective growing season for pasture in this bimodal rainfall system, and two dummy variables 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 and is constructed from data gathered at the above-mentioned missions which are also food aid distribution points. Table 1 presents summary statistics of variables used in later regressions.

Models of Household Decision Making

We develop three static models of intrahousehold decision making in this section that correspond to different decision-making scenarios.[15] In each model, the household members are confronted with a decision about how much milk to sell and where to locate the household.[16] There is a clear difference in the nature of the timing associated with the actions that result from these decisions. The location decision is made at the start of a period and implemented over at most a few days, and characterizes the distance a household will reside from town for a three-month period. Milk marketing takes place as multiple round trips throughout the period between the household and the nearest town. We place these two decisions on the same time scale by viewing the observed milk marketing behavior as the implementation of a seasonal "milk marketing plan" that is chosen at the start of the period and implemented over the entire period. This plan specifies the amount of milk that the household will market during a given three-month period. In the cooperative model, this "milk marketing plan" is selected jointly with the distance decision. In the traditional model, the distance decision is made without consideration of this plan. In the contested model, this plan is conceived of as the wife's best response function. The specification of the traditional and the contested models rely on the fact that the temporal nature of the decisions allows the husband "first mover" status should he choose to make decisions noncooperatively.

Cooperative Decision Making

In this model, the household decides on the distance to settle from town and the milk sales

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

[16] For simplicity, we assume a household in our model is only composed of a husband and a wife.

level in a cooperative manner. Here, we model it as a joint decision by the husband and wife. This can be viewed as the outcome of a family meeting, where the husband and wife discuss the implications of various decisions prior to the opening of a period, and jointly choose a distance from town and the milk marketing plan for the coming period to maximize household utility. For our purposes, the results derived from this model and the individual model, where the husband takes over the milk marketing and makes both sales and distance decisions himself, are the same.[17] We are not concerned here with the process of household decision making, but rather with the outcomes, which are observable. In either case, the outcome maximizes the joint household separable utility function. The distribution of this utility may vary across the two models, but we are not able to examine this.

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. Consumption is defined as a household good that is shared proportionally by the husband and wife according to the parametrically defined weighting shares α and $1 - \alpha$.[18] Thus, the husband's utility is $U_{\mathrm{h}}(c) = \ln(\alpha \cdot c)$ and the wife's utility is $U_{\mathrm{w}}(c) = \ln((1 - \alpha) \cdot c)$. Therefore, total household utility is defined as

$$(1) \qquad U(c) = \ln(\alpha \cdot c) + \ln((1 - \alpha) \cdot c).$$

Total household consumption (c) includes milk consumed by the household members and goods purchased with the income from milk sold.[19] The value of milk in home consumption can be viewed as the *numéraire* good so that the relative value of goods purchased by milk sales to the value of milk in home consumption is defined by θ.[20] Total milk production is m, and the quantity of milk sold is represented by s which is assumed to be in the interval $[0, m]$. The total level of consumption available to the household can be represented as $c = (m - s) + \theta \cdot s$.

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 with a parameter ω_1 assigning a parametric weight on milk marketing labor. Thus, the disutility of milk marketing labor effort can be represented by $- \omega_1 \cdot s \cdot d$.[21]

Towns also are the centers of amenities, such as health centers, schools, news and communication centers, bars and restaurants, public security, and markets for consumption goods. Therefore, settling further from town provides disutility by reducing household members' ability to access these amenities. Assume the household shares the benefits and household members agree on the weight of the benefits provided by town based amenities, and assign them a weight equal to ω_2.[22] However, as other herders also desire to be near town to take advantage of these amenities, the labor effort necessary for herding increases the closer one settles to town, at a disutility weight of ω_3. As men are generally responsible for herding tasks, this can be seen as a reflection of the husband's labor—leisure trade-off. We specify this disutility component as an inverse function of distance to reflect the gradient of grazing pressure around a fixed point such as a town. We can represent these two countervailing influences that bring disutility by

$$-\omega_2 \cdot d - \left(\frac{\omega_3}{d}\right).$$

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[17] Within the models, outcomes would differ depending on the weights assigned to consumption in each person's utility. But changing the weights does not affect the sign on the response of distance to milk sales, which is our main concern in this paper.

[18] For simplicity we specify weights and values in our models as parameters to focus on outcomes. The model could be extended to view the weights and values themselves as an outcome of a negotiation process, but we leave that as a further refinement. Also note that these are not weights for the individual utility functions, but rather reflect the share of the household's consumption.

[19] In reality, there are other goods that are consumed, such as meat from the herd or goods purchased with the proceeds of livestock sales. Husbands do make decisions about livestock sales and slaughters that we abstract from here to focus on milk sales.

[20] There is a positive caloric terms of trade for milk and grains in this area, as the equivalent cash value of milk and grain provides around six times more caloric value when in the form of grain, so on way to interpret θ in that it equals six in caloric terms. This is a limited, but simple way of interpreting the relative "value" in consumption of home consumed milk and goods purchased with milk sales proceeds. Home consumed milk is assumed to have the same price as marketed milk.

[21] Key, Sadoulet, and de Janvry (2000) and Holloway, Barrett, and Ehui (2005) note that agricultural supply decisions may be influenced by both fixed and variable costs of market participation. Our model only includes a variable cost specification in the sense that we model the costs of market participation as the number of trips to town. Households in these areas have limited surpluses (and little storage capacity) and can only carry a small amount of milk per trip. Thus, milk marketing costs vary by the number of trips made.

[22] The model assumes away any problems arising from different valuation of proximity to town, but we recognize that it is also a potential source of contestation. For simplicity, we assume the husband's location decision is based on the value of town based amenities to the family as a whole.

The household thus solves the following problem.

$$\text{(2)}\qquad \operatorname*{Max}_{s,d} \ln(\alpha \cdot (m - s + \theta \cdot s)) + \ln((1-\alpha) \cdot (m - s + \theta \cdot s)) - \omega_1 \cdot s \cdot d - \omega_2 \cdot d - \frac{\omega_3}{d}.$$

The joint solution of this problem provides the following first-order necessary conditions:

$$\text{(3)}\qquad d = \left(\frac{\omega_3}{\omega_2 + \omega_1 \cdot s}\right)^{\frac{1}{2}}$$

$$\text{(4)}\qquad s = \left(\frac{2}{\omega_1 \cdot d}\right) - \left(\frac{m}{\theta - 1}\right).$$

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.

The Traditional Model

In this model, we assume that the husband makes the location decision without considering how this influences milk sales. His first mover status is granted by reference to cultural precedent that gives him exclusive right to base mobility decisions on what is in the best interest of the herd and family. There is no such cultural precedent for basing decisions on the implications for milk marketing. The husband and wife each maximize their own utility. The husband acts by making the location decision and the wife takes the location decision as given and then decides how much milk to sell. Although we did not find any discussion of such a model in the literature, it was a description of the decision-making process proposed by Gabra respondents during our fieldwork. It can perhaps best be thought of as an initial stage of reaction to the introduction of a new market, when households are sorting out what to make of this new opportunity while still operating under existing cultural rules.

Assume the husband views decisions about milk marketing as his wife's concern and does not pay attention to the implication of his distance decision for her ability to market milk. Husbands choose the household location based on considerations of the trade-off between town-based amenities and increased labor effort for herding near town:

$$\text{(5)}\qquad \operatorname*{Max}_{d} \ln(\alpha \cdot (m - s + \theta \cdot s)) - \omega_2 \cdot d - \omega_3 \cdot \left(\frac{1}{d}\right)$$

while wives takes the distance as given and solve

$$\text{(6)}\qquad \operatorname*{Max}_{s} \ln((1-\alpha) \cdot (m - s + \theta \cdot s)) - \omega_1 \cdot s \cdot d.$$

Note that equations (5) and (6) allocate the components included in equation (2) to either the husband or wife and the summation of (5) and (6) reproduces (2). The first-order necessary conditions resulting from this specification are

$$\text{(7)}\qquad d = \left(\frac{\omega_3}{\omega_2}\right)^{\frac{1}{2}}$$

and

$$\text{(8)}\qquad s = \left(\frac{1}{\omega_1 \cdot d}\right) - \left(\frac{m}{\theta - 1}\right).$$

This model indicates that distance is determined independently of milk sales and the milk sales decision is a decreasing function of distance. Assuming sales are nonzero, contrasting equation (3) to equation (7) indicates that distance from town will be higher under the traditional model than the cooperative model. This difference combined with the difference in the numerator in the first terms of equations (4) and (8), respectively, imply a lower level of milk sales in the traditional model compared to the cooperative model. This suggests that there are internal forces within the traditional model that would lead it to break down over time, as husbands begin to realize that higher consumption and utility are available by recognizing the role of women's milk marketing in overall household consumption and incorporating the potential for milk sales into the location decision.

The Contested Model

In this model, we allow for the husband to understand that the introduction of milk marketing has created a new decision-making context. However, rather than seeing the benefits and moving to a cooperative outcome as described in the paragraph above, the husband instead views this new opportunity as presenting a threat. He sees the marketing opportunity as a way for his wife to convert milk that was in joint household consumption into income that is under her sole control.[23] In this situation, the husband realizes that his power as first mover allows him some leverage to manipulate his wife's milk sales. Assume that some fraction of the milk sales income, η, is devoted to the household consumption bundle, while the remainder $(1 - \eta)$ is under the wife's control for her private consumption, so that the husband's consumption is $\alpha \cdot (m - s + \theta \cdot s \cdot \eta)$ while the wife's is $(1 - \alpha) \cdot (m - s + \theta \cdot s)$ since she receives both the benefits of the milk proceeds that are represented in shared household consumption as well as those that now enter as her private consumption. As the milk sales lead to less milk in shared consumption and more used for the wife's exclusive consumption, it may be in a husband's interest to reduce his wife's incentive to sell milk. The husbands first mover status is reflected in this problem by replacing s with s^* which represent the wife's best response function. Other than this difference in notation, the components of equation (1) are allocated to the respective decision makers as shown in equations (9) and (10).

Husbands solve the following problem:

$$(9)\qquad \underset{d}{\text{Max}}\ \ln(\alpha \cdot (m - s^* + \theta \cdot s^* \cdot \eta)) - \omega_2 \cdot d - \frac{\omega_3}{d}$$

while wives are faced with the problem

$$(10)\qquad \underset{s}{\text{Max}}\ \ln((1 - \alpha) \cdot (m - s + \theta \cdot s)) - \omega_1 \cdot s \cdot d.$$

We solve this problem recursively. We begin with the wife's maximization problem in equation (10). Note that it is identical to equation (6) above, so that the solution is as described in equation (8) above. Equation (11) replicates equation (8) with the addition of best response notation

$$(11)\qquad s^* = \left(\frac{1}{\omega_1 \cdot d}\right) - \left(\frac{m}{\theta - 1}\right).$$

Substituting the wife's best response function into the husband's decision problem gives us the following

$$(12)\qquad \underset{d}{\text{Max}}\ \ln\left(\alpha \cdot \left(m + \left[\frac{1}{\omega_1 \cdot d} - \frac{m}{\theta - 1}\right] \cdot (\eta \cdot \theta - 1)\right)\right) - \omega_2 \cdot d - \frac{\omega_3}{d}.$$

Solving this problem gives us the following first-order necessary condition

$$(13)\qquad d = \left[\frac{\omega_3}{\omega_2} - \frac{(\eta \cdot \theta - 1)}{\omega_1 \cdot \omega_2 \cdot (m + s^*(\eta \cdot \theta - 1))}\right]^{\frac{1}{2}}.$$

As in the other cases considered, milk sales are a decreasing function of distance. In this model, assuming the term in brackets in equation (13) is greater than zero so that a positive distance results and that $\eta \cdot \theta \neq 1$, distance increases as s^* increases. The comparison of the three models is summarized in table 2.

These findings suggest that we should expect the milk sales variable to be always decreasing in the 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. We estimate these two decision variables jointly. Denoting the distance from town decision by d, the milk sales decision by s, γ, and $\boldsymbol{\beta}$ as parameters to be estimated, $\mathbf{X}$ as matrices of exogenous variables, and u as bivariate normally distributed

[23] We model the disutility of milk sales arising in the reduced milk available for the husband's consumption. In our field work, we heard wives advance the story that milk sales enhance household welfare overall, as they provide food and clothing for themselves and the children with this income, while still leaving enough milk for the family. However, we also had husbands propose that when women gain control over income they will spend it on private goods thus depriving the household of both milk and income from milk sales. Interestingly, discussions with Gabra husbands suggested that there was also a fear that a wife would spend money on town-based boyfriends, echoed by Fratkin who quotes a woman from the neighboring Ariaal group reflecting on issues of women's control over income saying "…some men oppose their wives to work for money, maybe they think we will overlook them and become proud, or we might leave them and go away with another man. With some people, this will happen" (2004, p. 128). Here we model contestation arising over control of income, but it is important to note that contestation could arise from a husband's desire to control his wife's activities. Our data do not allow us to sort out these two explanations. Further research could help clarify the relative importance of these and perhaps other sources of contestation.

Table 2. Summary of Model Predictions

	Cooperative/ Individual	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

disturbance terms, the following two equation system is defined:

$$(14) \qquad d = \gamma_s \cdot s + \boldsymbol{\beta}_d \mathbf{X}_d + u_d$$
$$s = \gamma_d \cdot d + \boldsymbol{\beta}_s \mathbf{X}_s + u_s$$
$$u_d, u_s \sim \mathrm{BVN}\left(\sigma_d^2, \sigma_s^2, \rho\right).$$

The parameter of interest is the sign and significance of γ_s in the distance equation. If it is negative and significant, this indicates an outcome of a decision-making process that is consistent with the cooperative model. If it is not significantly different from zero, the outcome is consistent with the traditional model. Finally, if it is positive and significant, it is consistent with the contested model.

The simultaneous equation specification (14) nests the three models introduced above. We model the two decisions as taking place jointly within a given season. As discussed above, there are four distinct seasons per year. A location decision and a milk sales plan are made in response to the same set of information revealed at the start of the season. If the two decisions are made at the same moment within the period, as in the cooperative model where the husband and wife decide on a plan for the season, equation (14) holds as written under the assumption that the observed milk sales behavior is the implementation of the jointly defined seasonal milk marketing plan. If the traditional structure holds, the model is recursive so that $\gamma_s = 0$ meaning that husbands decide the distance without concern about the impact on milk sales, and the milk sales plan is defined in response to this distance decision. This specification corresponds to the special case of a simultaneous equations model that Greene terms triangular (1993, p. 582). Finally, if the contested model holds, equation (14) remains as written under the assumption that the observed behavior is the implementation of a wife's best response milk sales plan defined in reaction to a husband's distance decision.

A series of issues emerge when attempting to estimate this system of equations. First, both dependent variables are by construction nonnegative and censored at zero.[24] Distance from town equals zero for 7% of observations in Chalbi and 3% in Dukana. In addition, although the majority of households sold milk during at least one period, no milk was sold for 72% of total observations in Chalbi and 82% in Dukana.[25] 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 panel data. It is possible that there are underlying household specific characteristics that influence distance and milk sales decisions. If not controlled for, the presence of such characteristics will lead parameter estimates to be inconsistent (Hsiao 1986). To address this issue, a time-invariant household-specific fixed effect is controlled for by creating a matrix recording the means of household specific variables for all time periods observed[26] and using simulated full information maximum likelihood (SFIML) methods to control for a household specific random effect that is uncorrelated with the observed means (Gourieroux and Monfort 1993).

Third, as has been noted, there are significant differences between the two study areas in terms of production and market conditions. To allow for parametric differences between the sites, estimations are conducted separately for the Chalbi and the Dukana data.

Fourth, there are reasons to suspect that lagged dependent variables should be included

[24] Milk purchasers are generally town-based households who do not have significant livestock holdings. The milk sellers are pastoral nomads.

[25] Although as noted above most households sold milk during at least one of the periods of the survey, only one of the 88 households surveyed sold milk in each period recorded, suggesting this is an activity households enter and exit over time.

[26] Four variables are constructed to control for the household specific fixed effect: average household herd size, average household size in adult equivalents, average age of the oldest male, and average age of the oldest female.

in the regression. As noted above in the description of the data, distance remains the same in consecutive periods in the majority of cases and milk sales tend to occur in consecutive seasons in Chalbi and to a lesser extent also in Dukana. In response, we include both lagged dependent variables in each equation to be estimated. This allows us to hold constant the outcomes of past decisions and focus attention exclusively on any changes to the two variables of interest in the current period.

Fifth, to identify the endogenous variables in the system, we need at least one variable that affects location but not milk sales and at least one variable that affects milk sales but not distance. Included in the distance equation are variables recording whether a raid occurred anywhere in the rangelands during the period and the number of pack camels owned by the household, as it was suggested during our survey work that these factors influenced migration decisions. Since raids are events that move households closer to town to be nearer security forces and other herders for self-defense, and pack camels are used to load and move households, we expect that, all else equal, a raid causes households to move closer to town and increased access to pack camels allow a household to settle further from town. We also use the husband's age, but not the wife's age, in the estimation of the distance equation. Men are responsible for herding and we assume that their age influences the distance decision due to the impact on their labor effort.

To identify the milk sales equation, we constructed a variable that records the average value of milk sold by other households in the sample for a given study site in the period. As women generally walk the long distance to town and back after joining others from nearby base camps early in the morning, we expect this variable to be positively related to sales: all else equal, more sales will occur when there is more likelihood of company with whom to pass the time on the long walk to and from town. In addition, we use exclusion restrictions based on the age of the female to identify milk sales level. We expect that younger women will be less likely to sell milk as child care activities at home make daylong absences from the camp difficult and walking to town carrying young children more strenuous.

A possible criticism of the exclusion restrictions is that the relative age of men and women is often considered a measure of bargaining power (Lundberg and Ward-Batts 2000; Laferrere 2001; Lundberg and Ward-Batts 2000), which would argue for its inclusion in the estimation if decisions are made jointly though a bargaining process as could occur in the cooperative model. However, as we are controlling for household specific effects and are willing to assume relative bargaining power derived from relative ages of the husband and wife does not change significantly over the four-year period we believe this does not disqualify use of the age exclusion restrictions.[27] Results are presented in table 3.

The results for the endogenous parameters satisfy the coherency condition described by Maddala (1983) in all results presented. The results show that the coefficient on milk sales in the distance estimation is positive and significant in all versions of the model estimated, thereby providing results consistent with the contested model of the household. As expected, the coefficient on distance in the milk sales estimation is negative. As distance increases, milk sales decrease. The quantitative impact can be seen by conducting a numeric simulation of estimation results at sample means to generate elasticities. The elasticity of distance with respect to milk sales is 0.1 in Dukana and 0.2 in Chalbi. The elasticity of milk sales with respect to distance is −2.8 in Dukana and −3.7 in Chalbi. These results indicate that distance is relatively inelastic to milk sales, but milk sales are highly elastic in response to distance. Using these elasticities and information about the sample means, we can calculate that a one liter increase in milk sales corresponds to a 7% increase in predicted distance in Dukana (34 minutes further) and a 1% increase in Chalbi (3 minutes further). A 1 hour increase in distance corresponds to a 31% reduction in predicted milk sales in Dukana (9 shillings) and a 72% reduction in Chalbi (304 shillings). While the impact of milk sales on distance is statistically significant and positive, the elasticities indicate that the quantitative impact is not all that large, suggesting husbands may not move all that much further out in response to increased milk sales. This perhaps explains why what we have termed the traditional model was proposed as an explanation of behavior in our field work. However, as seen by the results for the elasticities of the milk sales equation, it does not take a large change

[27] Although potentially there could be additional explanatory power by including the age of the wife in the distance equation and the age of the husband in the milk sales equation, our results did not differ significantly when the model was specified in this way from the results presented in table 3 (see footnote 28).

Table 3. SFIML Simultaneous Tobit Estimation of Distance from Town and Milk Sales

	Dukana		Chalbi	
	Distance	Milk Sales ($\times10^{-2}$)	Distance	Milk Sales ($\times10^{-3}$)
Milk sales	3.16611***		3.70025***	
	(1.02678)		(0.25908)	
Distance		−0.658005		−0.686938***
		(0.597104)		(0.250100)
Number of pack camels	−0.597525		−0.148756	
	(0.700377)		(0.341006)	
Raid dummy	−0.00467		−0.157237	
	(0.080205)		(0.678321)	
Age male	−1.60016***		−0.114330	
	(0.405667)		(0.0903741)	
Age male squared ($\times10^{-2}$)	0.0481240*		−0.327497***	
	(0.0279672)		(0.120488)	
Average milk sales by others ($\times10^{-3}$)		1.21607		1.05392
		(1.31930)		(0.66353)
Age female		0.759154		0.057281
		(1.11347)		(0.07209)
Age female squared ($\times10^{-2}$)		−0.0459006		−0.029279
		(0.0288405)		(0.072929)
Constant	12.2803	−17.8559**	−8.05165**	−2.20547
	(10.7371)	(8.16485)	(3.45926)	(1.93031)
Distance last period	0.458494***	0.200812	0.458468***	−0.117103**
	(0.0357006)	(0.158266)	(0.0553490)	(0.058656)
Sales last period	0.951257**	0.196624	−1.36179***	0.740558***
	(0.435340)	(1.18545)	(0.311567)	(0.166458)
Herd size in TLU ($\times10^{-1}$)	−0.9902040	1.45691	0.0976145	0.004418
	(0.822048)	(1.23312)	(0.235259)	(0.169209)
Household size in adult equivalents	1.97146**	3.18593	−1.27893	0.346612**
	(0.879839)	(2.47187)	(1.01103)	(0.162650)
Food aid in tons ($\times10^{-2}$)	−1.14117***	1.08195	−6.26452***	−1.95668
	(0.414120)	(1.06367)	(1.63783)	(1.53858)
Rainfall in mm in past six months ($\times10^{-2}$)	−0.099194	0.704351	2.10473***	−0.00158
	(0.546279)	(2.33609)	(0.692972)	(0.18819)
Long rains dummy	−2.64453***	7.33979*	−0.967397*	0.774157**
	(0.985721)	(3.97177)	(0.526434)	(0.400687)
Short rains dummy	−1.43078	7.22790*	1.91526**	−0.035171
	(0.955378)	(4.25104)	(0.888379)	(0.957286)
Random effect scaling term	−2.85106***	1.63210**	2.00160***	1.80756**
	(0.453921)	(0.782943)	(0.400190)	(0.774466)
Sigma	7.54423***	4.95976	4.92100***	2.24230***
	(0.270483)	(3.30215)	(0.181131)	(0.376620)
Covariance	11.0787		−7.61454***	
	(25.2866)		(1.15797)	
Male age joint $\chi^2_{(2)}$	25.1***		12.3***	
Female age joint $\chi^2_{(2)}$		4.5		5.8*
Household fixed effect joint $\chi^2_{(4)}$	23.3***	7.2	15.5***	20.1***
Log likelihood	3,646.91		2,093.81	
Number of observations	931		632	

Note: Single (*), double (**), and triple asterisks (***) denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

in distance to have a relatively large impact on milk sales. The fact remains that husbands are moving, albeit not all that far, in the opposite direction from what a cooperative model would predict.

Some of the other estimation results merit discussion. All estimations indicate that distance from town is a decreasing function of male age and milk sales are an increasing function of female age. The variables for the husband's age are significant in the distance equation for all estimations. The female age variables are not statistically significant in the Dukana milk sales equation and are significant at the 10% level in the Chalbi estimation, suggesting identification could still be an issue in the milk sales estimation results. The pack camel, raid dummy variables, and milk sales by others variables are not individually or jointly significant in either estimation.[28]

The lagged dependent variables indicate that there is a positive association between the lagged value of the dependent variable and the current period value, and this impact is statistically significant with the exception of milk sales in Dukana. The sites present contrasting results for the impact of the signs of the lagged value of one dependent variable on the current period value of the other dependent variable. In Chalbi, both effects are negative and significant, while in Dukana lagged sales is positively and significantly associated with current period distance. One possible explanation for this difference is that there are very few nonzero observations for lagged sales in Dukana compared to Chalbi due to differences in seasonality of marketing.

Household size has a significant impact on distance from town in Dukana and on milk sales in Chalbi. Increased food aid deliveries decrease distance from town, but have no impact on milk sales. Food aid is usually delivered to the towns and thus food aid deliveries provide an incentive for people to locate closer to town. The food aid result presents an interesting contrast to the milk marketing result. As food aid enters joint household consumption, it appears that men are willing to adjust location decisions to ease their ability to access food aid. This contrasts with their behavior in response to milk sales that move milk out of home consumption and into income controlled by their wives. Rainfall only has a significant impact on distance from town in Chalbi, and the seasonal dummy variables, when significant, indicate that rainy seasons lead households to be closer to town and to sell more milk, with the exception of the second rainy season in Chalbi. As the rainfall variable reflects data collected in the Chalbi area (as noted above, Dukana data were not available), this could explain the lack of significance of the rainfall measure in Dukana. The herd size variables are not statistically significant in the estimation of either location or milk sales decisions in Chalbi. It appears that wealth in livestock is not a major determinant of household distance from town or milk sales.

Two alternative explanations to the contested decision-making hypothesis could explain the observed pattern of the endogenous coefficients and should be considered. First, it could be the case that the positive coefficient for milk sales in the distance equation reflects cooperative behavior as a move further from town increases milk production, thus increasing the availability of milk to sell. For this to be the explanation, milk production would have to be an increasing function of distance from town. We investigate this possibility by conducting fixed effects estimation of the milk production data presented in table 4. We find no significant impact on milk production attributable to the distance a household settles from town in Chalbi. In Dukana, milk production decreases as distance to town increases up to fourteen hours away from town. This latter result could reflect the fact that water points in the Dukana area are few and far between and located in towns, compared to the low-lying Chalbi basin that has multiple water sources away from towns, so that increased distance from town also leads to increased distance from water for animals (up to some point where one becomes closer to an alternative watering point).

A second alternative interpretation of our results recognizes that the distance a household settles from town and the use of a satellite camp are to some degree substitutes

[28] We first estimated the model with the variables of raid, pack camels, and sales of other women as identifying restrictions with the age of both husbands and wives included in the regression of distance and sales, but these three variables were not jointly significant. The parameters for the age and age squared of the oldest female are not jointly significant in the distance equation for Dukana or Chalbi. The parameters for the age and age squared of the oldest male are not jointly significant in the milk sales equation for Dukana but are jointly significant in Chalbi. We then reestimated the model excluding the age variables for the individual not making the respective decision. Likelihood ratio tests indicate there is not a statistically significant difference between these alternative model specifications in Dukana ($\chi^2_{(4)} = 1.0$) or Chalbi ($\chi^2_{(4)} = 2.7$), and the joint significance of the identifying restrictions is now statistically significant (Dukana ($\chi^2_{(7)} = 22.5^{***}$) and Chalbi ($\chi^2_{(7)} = 20.1^{***}$)).

Table 4. Fixed Effects Estimation of Milk Production in Liters Per Day

	Dukana	Chalbi
Constant	−1.62334***	−2.17184***
	(0.25398)	(0.36791)
Herd size in TLU	0.16528***	0.01831***
	(0.04032)	(0.00112)
Herd size in TLU^2 ($\times 10^{-2}$)	0.00055	0.00011***
	(0.00082)	(0.00002)
Distance in hours from town	−0.04618	0.01972
	(0.02890)	(0.04431)
Distance in hours from town^2	0.00156*	−0.00032
	(0.00081)	(0.00130)
Fraction at satellite camp	−0.11024	−0.43618**
	(0.30812)	(0.17863)
Rainfall in past six months	0.00424	0.00766***
	(0.00358)	(0.00264)
Rainfall in past six months^2 ($\times 10^{-3}$)	−0.01038	−0.000290***
	(0.01918)	(0.00011)
Long rains dummy	2.35465***	1.24280***
	(0.14122)	(0.22212)
Short rains dummy	1.37542***	0.47704**
	(0.13088)	(0.20147)
Time trend	0.16034***	0.46463***
	(0.05027)	(0.07266)
Time trend^2 ($\times 10^{-2}$)	−0.85621***	−2.65219***
	(0.25284)	(0.37309)
Herd joint significance $\chi^2_{(2)}$	176.0***	341.6***
Distance joint significance $\chi^2_{(2)}$	3.7*	0.3
R^2	0.38	0.68
Number of observations	980	687

Note: Single (*), double (**), triple (***) denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

(McPeak 2003). By moving further from town, a household is able to occupy less crowded pastures and allow for the satellite herd to rejoin the base camp herd. This could also explain the observed results in a way that is cooperative, rather than contested. This is not likely to be the explanation, as satellite animals tend to be composed of male and nonlactating animals in this area while milk herds are kept at the base camp with the family. However, we cannot reject this hypothesis empirically given data limitations.

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 wives' milk sales. This result is consistent with the notion that men resist the ability of their wives to move milk from current cultural institutions into the market domain. While there may be benefits to increased milk marketing in this area, our results suggest men are reluctant to facilitate this increase, possibly because they do not gain the benefits. A related explanation that is consistent with our findings is that men choose to limit milk marketing because they wish to control women's access to cash income and to town.

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. Some studies indicate that income in women's control is more likely than men's income to be spent on goods for children (Hoddinott and Haddad 1995; Thomas 1993). This would suggest that children's welfare will increase when women earn income from milk sales. On the other hand, by selling milk, women are also reducing the amount of milk available to the household, though potentially increasing caloric availability. As noted on the literature on pastoral sedentarization, there is a clear link between child malnutrition and lack of access to milk (Fratkin, Roth, and Nathan 1999).

Thus, the impact on children is ambiguous. We leave as a topic for further study who is "right" in this case; husbands who resist milk marketing or wives who wish to expand it.

What we can say is that husbands and wives are responding to the new opportunity brought about by milk marketing in this area in a way that appears noncooperative. While the verbal description most often encountered in our field work matches the traditional model, the empirical 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 reduce wives sales' and do not appear to view the benefits they are getting from this new marketing opportunity to be large enough to move towards a more cooperative model of decision making. 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.

The production context, model, and statistical approach outlined in this study provide an intuitive and straightforward way of understanding how households react to new market opportunities when there is a gendered division of labor in household production. Moving what has been a home produced and consumed good into the market domain may have unforeseen consequences if the presumption is that households will make cooperative decisions to benefit from the new market opportunity. As development strategy increasingly relies on using markets to accelerate development (USAID 2004; USAID 2002; World Bank 2001), we suggest that market development efforts can be improved by recognizing the potential for intrahousehold contestation over production decisions in the advent of new market opportunities. While much remains to be understood about the dynamics of response to new market opportunities, we present this study as a step towards developing a more profound understanding of how households will react the introduction of new market opportunities.

[Received February 2004; accepted October 2005.]

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