Milk Money and Intra-Household Bargaining:
Evidence on Pastoral Migration and Milk Sales from Northern Kenya[1]

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Many agricultural development projects include components to strengthen marketing channels for communities where large proportions of output are consumed at home. Opening these communities to markets is generally seen as improving the prospects for growth. But as market institutions develop, new social norms and rules must be mediated with existing cultural institutions.

In this study, we investigate the impact of new market opportunities on Gabra nomadic pastoralists living in an arid climate in northern Kenya. The Gabra have recently experienced growth of milk marketing opportunities, and this change has caused a renegotiation of intrahousehold arrangements that affect households' location and migration decisions.

Among the Gabra, husbands traditionally decide where to locate the household. Households migrate frequently, as high rainfall variability requires moving livestock in search of pasture. Wives traditionally manage milk production and marketing. To sell milk, women walk to the small market towns of the study area.

These traditional roles give husbands and wives competing interests as to household locations. Wives can sell milk more easily if they are located near the towns. Husbands may have interests in keeping the household farther away. We explore this decision in the pages that follow.

We treat the household's location decision as a bargaining game. Tradition essentially confers upon the husband "first mover" status, as he gets to choose the location. The wife then chooses how much milk to market in town. Households may react to new milk marketing opportunities in three ways. First, in the cooperative approach, the husband and wife make joint decisions on migration and milk marketing to maximize household welfare. Second, in the traditional solution, the husband continues to make migration decisions without considering the impact on milk marketing. Finally, in the contested solution, the husband views his wife's use of milk markets with trepidation, as milk marketing allows a wife to expand her individual opportunities and potentially to expand her private consumption at the expense of household consumption. In this case, a husband may exploit his first mover status to limit his wife's ability to market milk. We formally model these outcomes below and then empirically investigate the pattern of household decision-making, using panel data from Gabra pastoral households.

Description of the Data

This study uses longitudinal data gathered in two areas of Marsabit District, Kenya (Chalbi and Dukana). The sampling methodology used in this study was similar to a transect. Enumerators moved between the main towns of the study area, interviewing herders at nomadic camps along the way. The retrospective questionnaire recorded information for each three-month season of the years 1993-1997. (See Table 1.)

For each period, households reported the walking time from their base camp to the nearest market town. 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. Full income was the equivalent of $0.61 per person per day in Chalbi and $0.38 in Dukana. Milk sales accounted for 11% of household cash income on average in Chalbi and 14% in Dukana. The majority of households (Chalbi 67%; Dukana 86%), sold milk during one or more seasons examined.

Models of Household Decision Making

We develop three models of intra-household decision making that correspond to different decision making scenarios. In each model, household members must decide how much milk to sell and where to locate the household. The location decision is made at the start of a period, along with a milk marketing plan. Milk marketing occurs through multiple round trips to the nearest town throughout the period. The temporal nature of the decisions allows the husband "first mover" status.

Cooperative Decision Making

In this model, the household decides on location and milk sales in a cooperative manner. The outcome maximizes the joint (and separable) household utility function. Individual 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 weights α and $1-\alpha$. Thus, the husband's utility is $U_h(c)=\ln(\alpha\cdot c)$ and the wife's utility is $U_w(c)=\ln((1-\alpha)\cdot c)$. Total household utility is defined as:

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

Total household consumption (c) includes milk consumed by household members and goods purchased with the income from milk sold. 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. Total milk production is m, and the quantity of milk sold is represented by s. Total consumption available to the household is represented as $c=(m-s)+\theta\cdot s$.

Milk markets are located in towns, and the distance to them is *d*. The labor to market 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 $-\omega_1 \cdot s \cdot d$.

Towns also are the centers of amenities, such as health centers, schools, bars and restaurants, public security, and markets. Settling farther from town provides disutility by reducing access to these amenities. Assume the household shares the amenities and household members agree on the weight to the benefits provided by town-based amenities, ω_2 . However, other herders also desire proximity to town. This reduces the quality of rangeland close to town and thus increases the labor necessary for herding, at a disutility weight of ω_3. We specify this disutility component as an inverse function of distance to reflect the gradient of grazing pressure around a fixed point of the town. We represent these two countervailing influences that bring disutility by $-\omega_2 \cdot d - \left(\frac{\omega_3}{d}\right)$.

The household solves the following problem.

$$(2)\ \underset{s,d}{Max}\ \ \ln\left(\alpha \cdot (m - s + \theta \cdot s)\right) + \ln\left((1-\alpha) \cdot (m - s + \theta \cdot s)\right) - \omega_1 \cdot s \cdot d - \omega_2 \cdot d - \frac{\omega_3}{d}$$

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

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

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

Thus, in the cooperative model, the two decisions are made simultaneously. 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 locate the household. The husband and wife each maximize their own utility. The husband decides where to locate. Taking this decision as given, the wife decides how much milk to sell. Husbands choose the household location based on the tradeoff between town-based amenities and increased labor for herding near town:

(5) $$\underset{d}{Max}\ \ln\left(\alpha\cdot(m-s+\theta\cdot s)\right)-\omega_2\cdot d-\omega_3\cdot\left(\frac{1}{d}\right)$$

while wives takes the distance as given and solve:

(6) $$\underset{s}{Max}\ \ln\left((1-\alpha)\cdot(m-s+\theta\cdot s)\right)-\omega_1\cdot s\cdot d$$

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:

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

and

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

This model indicates that distance is determined independently of milk sales and milk sales are a decreasing function of distance. Assuming sales are non-zero, contrasting equation (3) to equation (7) indicates that distance from town will be higher under the traditional model than the cooperative model. By contrast, equations (4) and (8) respectively imply a lower level of milk sales in the traditional model compared to the cooperative model.

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 moving to a cooperative outcome as described above, he views this new opportunity as a threat: Milk marketing allows his wife to convert milk into income that she controls. The husband realizes that his power as first mover allows him 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-η) is under the wife's control for her private consumption. The husband's consumption is $\alpha \cdot \left(m - s + \theta \cdot s \cdot \eta\right)$ while the wife's is $(1-\alpha)\cdot\left(m - s + \theta \cdot s\right)$; she receives both the value of the milk for household consumption and that which enters her private consumption. As the milk sales lead to less milk in shared consumption and more available for the wife's exclusive consumption, the husband may have an interest in reducing her incentive to sell milk. The husband's first mover status is reflected in this problem by replacing s with s^* which represents 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).

The husband solves:

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

while the wife solves:

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

We solve this problem recursively. We begin with the wife's maximization problem in equation (10).

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

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

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

The first order necessary condition is:

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

As always, 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 so $\eta\cdot\theta\neq 1$, distance increases as s^* increases. The comparison of the three models is summarized in table 2.

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

Empirical Analysis

In this section, we use observed values for the distance from town and the total amount of milk sold 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, $\boldsymbol{X}$ as matrices of exogenous variables, and *u* as bivariate normally distributed disturbance terms, the following two-equation system is defined:

$$(14)\quad \begin{aligned} d &= \gamma_s \cdot s + \boldsymbol{\beta_d X_d} + u_d \\ s &= \gamma_d \cdot d + \boldsymbol{\beta_s X_s} + u_s \\ u_d, u_s &\sim BVN(\sigma_d^2, \sigma_s^2, \rho) \end{aligned}$$

The parameter of interest is γ_s in the distance equation. A negative and significant result is consistent with the cooperative model. A result not significantly different from zero is consistent with the traditional model. Finally, a positive and significant result 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.

A series of issues emerge when attempting to estimate this system of equations. Because both dependent variables are by construction non-negative and censored at zero, we use full information maximum likelihood estimation of a bivariate tobit system. Separate models are estimated for Chalbi and Dukana.

Due to the longitudinal nature of the panel data, there may be 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. Therefore, 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 and simulated full information maximum likelihood (SFIML) methods are used to control for a household specific random effect that is uncorrelated with the observed means. (Gourieroux and Monfort 1993).

We include lagged dependent variables in the regression. Distance remains the same in consecutive periods in the majority of cases and milk sales tend to occur in consecutive seasons. Including lagged dependent variables 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.

To resolve the identification problems, we include indicators of whether a raid occurred anywhere in the rangelands during the period and the number of pack camels owned by the household in the distance equation. All else equal, a raid should cause households to move closer to town for security, while increased access to pack camels allows 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 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, we expect this variable to be positively related to sales: all else equal, more sales will occur when there is greater likelihood of walking companions. In addition, we use exclusion restrictions based on the age of the female to identify milk sales levels. 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 is more strenuous.

The results for the endogenous parameters satisfy the coherency condition in all results presented. 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. 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 from Dukana (34 minutes further) and a 1% increase from Chalbi (3 minutes further). A one 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. However, as seen by the results for the elasticities of the milk sales equation, it does not take a large change in distance to have a relatively large impact on milk sales. The fact remains that husbands are moving, albeit not far, in the opposite direction from what a cooperative model would predict.

One alternative explanation is that the positive coefficient for milk sales in the distance equation could reflect cooperative behavior, if a move further from town increases milk production, thus increasing the availability of milk to sell. We estimate milk production using fixed effects and find no significant relationship to distance in Chalbi. In Dukana, milk production decreases as distance to town increases up to fourteen hours away from town. In short, the data do not support the idea that husbands are trying to maximize milk production by locating so far from towns.

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 into the market domain. While there may be benefits to increased milk marketing, men seem reluctant to facilitate this increase, possibly because they do not gain the benefits. A related explanation is that men may choose to limit milk marketing simply 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 .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. The literature on pastoral sedentarization finds a clear link between child malnutrition and lack of access to milk. Thus, the impact on children is ambiguous.

What we can say is that husbands and wives are responding to the new opportunities for milk marketing in a way that appears non-cooperative. 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 appear to be using their traditional control over migration patterns to reduce wives sales. Apparently, they do not view the benefits they are getting from milk marketing as large enough to move towards a more cooperative model of decision making. Wives are asserting that their traditiona 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.

This study provides an intuitive and straightforward way of understanding how households react to new market opportunities when there is a gendered division of labor. As development strategy increasingly relies on using markets to accelerate development (USAID 2004; World Bank 2001), we suggest that policy makers should recognize the potential for intra-household 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, this study suggests that intrahousehold renegotiations may be difficult.

References:

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Table 1. Descriptive Statistics

	Chalbi Mean	Chalbi Std. Dev	Dukana Mean	Dukana Std. Dev.
Distance to town (hours walk)	5.12	4.78	8.27	8.22
Value of Milk Sales	420.11	856.39	29.27	70.05
Milk Production (liters per day)	5.21	4.41	3.71	2.19
Herd size (TLU)	42.67	31.13	18.66	6.84
Household size (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 over past six months (mm)	58.39	42.09	65.53	47.57
Long Rains	0.27	0.45	0.25	0.43
Short Rains	0.24	0.43	0.25	0.43
Food aid deliveries (tons)	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	

Table 2. Summary of Model Predictions

	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

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

	Dukana		Chalbi	
	Distance	Milk Sales ($x10^{-2}$)	Distance	Milk Sales ($x10^{-3}$)
Milk sales	3.16611 *** (1.02678)		3.70025 *** (0.25908)	
Distance		-0.658005 (0.597104)		-0.686938 *** (0.250100)
No. pack camels	-0.597525 (0.700377)		-0.148756 (0.341006)	
Raid dummy	-0.00467 (0.080205)		-0.157237 (0.678321)	
Age Male	-1.60016 *** (0.405667)		-0.114330 (0.0903741)	
Age Male^2 ($x10^{-2}$)	0.0481240 * (0.0279672)		-0.327497 *** (0.120488)	
Average community milk sales ($x10^{-3}$)		1.21607 (1.31930)		1.05392 (0.66353)
Age Female		0.759154 (1.11347)		0.057281 (0.07209)
Age Female^2 ($x10^{-2}$)		-0.0459006 (0.0288405)		-0.029279 (0.072929)
Constant	12.2803 (10.7371)	-17.8559 ** (8.16485)	-8.05165 ** (3.45926)	-2.20547 (1.93031)
Distance last period	0.458494 *** (0.0357006)	0.200812 (0.158266)	0.458468 *** (0.0553490)	-0.117103 ** (0.058656)
Sales last period	0.951257 ** (0.435340)	0.196624 (1.18545)	-1.36179 *** (0.311567)	0.740558 *** (0.166458)
Herd size (TLU) ($x10^{-1}$)	-0.9902040 (0.822048)	1.45691 (1.23312)	0.0976145 (0.235259)	0.004418 (0.169209)
Household size (adult equivalents)	1.97146 ** (0.879839)	3.18593 (2.47187)	-1.27893 (1.01103)	0.346612 ** (0.162650)
Food aid ($x10^{-2}$)	-1.14117 *** (0.414120)	1.08195 (1.06367)	-6.26452 *** (1.63783)	-1.95668 (1.53858)
Rainfall (mm past six months) ($x10^{-2}$)	-0.099194 (0.546279)	0.704351 (2.33609)	2.10473 *** (0.692972)	-0.00158 (0.18819)
Long rains	-2.64453 *** (0.985721)	7.33979 * (3.97177)	-0.967397 * (0.526434)	0.774157 ** (0.400687)
Short rains	-1.43078 (0.955378)	7.22790 * (4.25104)	1.91526 ** (0.888379)	-0.035171 (0.957286)
Random Effect scaling term	-2.85106 *** (0.453921)	1.63210 ** (0.782943)	2.00160 *** (0.400190)	1.80756 ** (0.774466)
Sigma	7.54423 *** (0.270483)	4.95976 (3.30215)	4.92100 *** (0.181131)	2.24230 *** (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	3646.91		2093.81	
No. observations	931		632	

Significance: *.10, **.05, ***.01