Willingness to Pay for Improved Milk Sensory Characteristics and Assurances in Northern Kenya Using Experimental Auctions

By

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Abstract

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Pastoralists in northern Kenya may be able to diversify income by selling milk in nearby towns and cities. However, milk sold in open-air markets in communities in northern Kenya is often of low quality in terms of its sensory characteristics. The milk is also often adulterated before sale. These markets are characterized by poor consumers who need to make choices about milk quality with virtually no information other than their own sensory perceptions. These conditions are similar in many parts of the world for many different commodities and products. An examination was undertaken using experimental auctions to determine if consumers in the border town of Moyale, Kenya are willing to pay for enhanced milk sensory characteristics and assurances. The results suggest that even poor consumers are willing to pay for enhanced sensory characteristics and assurances if these can be communicated in a trusted manner. Older, relatively well-informed women are the group most willing to pay the highest prices for milk quality.

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Introduction

Milk is a primary source of protein for people living in the semi-arid areas of southern Ethiopia and northern Kenya. In the rural areas of this part of Africa, fresh milk produced from cows is typically consumed by the pastoralist families who own the cows, but fresh milk in excess of what the family consumes is also shipped unrefrigerated by bus to nearby towns and cities to sell in open-air markets.[1] The space of time between when cows are milked and when the milk is actually sold at market can range from a few hours to over a day. There is an active market for fresh milk in these towns and cities, but bacterial growth causes the quality of the milk, in terms of its sensory characteristics and even perhaps its safety, to degrade rapidly when the milk is unrefrigerated. Milk is also often adulterated prior to sale at open-air markets in this part of Africa. Adulteration usually is done by adding water, fillers, or color in an attempt to hide the low quality of the milk (Wayua et al. (2007)).

The study area selected for the analysis described in this paper is Moyale, Kenya. Moyale straddles the border between Ethiopia and Kenya and has a population of over 40,000 residents. It is an important terminal market for pastoral dairy products from both southern Ethiopia and northern Kenya. This area is an arid or semi-arid where pastoralist production systems are the norm. Rainfall is low and variable with mean annual rainfall varying from 150-650 mm. The infrastructure is extremely weak, in terms of roads, schools, and health facilities.

Pastoralists in this part of Africa have traditionally held most of their financial asset portfolio in the form of livestock and have very limited options to obtain outside cash income. The study area is subject to frequent and severe droughts and livestock losses during drought

[1] A limited amount of milk is also processed through pasteurization at small local milk processing plants.

periods can be very high on a percentage basis. During drought periods, pastoralists are forced to sell livestock to try to raise money to buy grain or other sources of protein. As a result, local grain prices are often rising during times when local livestock prices are falling. These conditions place pastoralists in extremely precarious economic circumstances (Bailey et al. (1999)).

Because drought stress causes milk production to decline, pastoralists are left with little or no milk for their household to consume or sell during these periods. Increasing cash income during wet periods would provide the poorest pastoralists with cash that could be used to buy grain for human consumption given the historically favorable terms of trade between milk/butter and grain. Grain has more energy per unit volume than milk. Consequently, small-volume milk sales are often part of a survival strategy for food security given the overall volume of milk production can be seasonally insufficient on which the family can depend for food if only milk is consumed. Consequently, cash from milk sales during wet periods can be very important for grain purchases during dry periods. In saying this, one must realize that pastoralists make only a modest amount of income from milk and butter sale to urban consumers (Coppock et al. (2007)). However, even modest increases in cash income might have very consequential positive effects on an individual basis for the poorest pastoralists during drought periods. So, if the revenue from milk sales could be increased, it could be very meaningful for individual small producers, but could also justify small-scale technical or social (cooperative) interventions to yield a higher quality milk product and/or actions to market milk more effectively than is currently being done.

This study assumes that actions to enhance the price of milk are the “best” strategies for increasing pastoralists’ cash income from their livestock. While milk production might be increased by increasing the number of cows being milked, rangeland in the study area is already

overgrazed and adding cows would exacerbate this problem. Also, adding additional cows adds additional risk because of frequent droughts.

This study determines if pastoralists could receive higher prices for the milk they sell if they made efforts to improve the sensory characteristics and assurances about the milk. It is acknowledged that food safety concerns are closely connected to this research question. However, there is at best loose government oversight of these markets and a very limited to no ability for market participants to obtain scientific measures about milk safety. This makes the sensory characteristics of milk sold in these markets and any assurances made by sellers the principal sources of information available to buyers with which to value milk. Consequently, this study examines the connection between sensory characteristics, assurances, and price.

Pastoralists might be able to marginally enhance these characteristics (sensory characteristics and assurances) in the milk they sell through actions such as shipment in sisal-wrapped, water-soaked jerry cans to help reduce the temperature of the milk before and during shipment. Agents might also be established at the markets to ensure that the milk is not adulterated while at the market or the milk could be sold to local processors where it could be fumigated[2] and/or pasteurized. Pastoralists could also cooperate in establishing some type of basic branding or appellation strategies to signal quality to consumers. For example, certain villages could participate in assuring buyers that milk has been handled properly and has not been adulterated prior to sale.

Efforts to improve sensory characteristics and/or assurances for milk will increase production and/or transaction costs for pastoralists and these additional costs need to be covered

[2] Fumigation/smoking of vessels used for milking and milk storage is commonly practiced by pastoral communities in northern Kenya and the Greater Horn of Africa. Plant materials, including grass, shrubs and hardwoods, are used for smoking as well as cleaning the milk containers. Smoking flavors the product, disinfects (sterilizes) the container and is also thought to control fermentation by retarding bacterial growth (Ashenafi (1996); Coppock (1994)).

by higher prices paid by consumers who are buying milk. Consequently, the economic success of actions taken to improve milk characteristics depends on consumer willingness to pay (WTP) [3] for milk with better sensory characteristics and/or assurances compared to the milk that is currently being sold in local open-air markets. In other words, economic incentives need to exist for pastoralists to improve the quality of the milk they are selling. However, if fresh milk demand is constrained because consumers are unable or unwilling to pay for milk with better sensory qualities and assurances than the milk currently being sold in these markets, efforts to further develop these markets by enhancing these characteristics would not be currently possible.

The overarching objective and aim of this study is to provide recommendations to pastoralists in this part of Africa about whether or not higher milk prices can be achieved by improving the sensory characteristics or assurances related to their milk. The study reports, based on experimental auctions, whether or not milk consumers in Moyale are WTP more for milk with better sensory characteristics and/or assurances than for the milk that is typically sold in open-air markets in that city. The study (sampling, focus groups, and experimental auctions) was conducted during the period of August 16-28, 2007 at a community social hall outside of Moyale.[4] Transportation to and from the venue was provided to participants.

The demographics of participants in the experimental auctions are also used to determine the components of the market (niches) that might be willing to pay more for these enhanced characteristics. This type of information is essential for pastoralists if they pursue strategies to increase prices for the milk they sell.

[3] Willingness to pay or WTP is a term commonly used in the literature as a measure of the monetary value consumers are willing to pay for a good or service. This either be directly observed in the case of existing markets, unobserved in the case of a non-market market good, or can be estimated using experimental markets such as is the case here.

[4] Hellu Social Hall, about three km from town.

To our knowledge, no past work has examined WTP for improved sensory characteristics and/or assurances for milk using experimental auctions in the study area. The results indicate that informed older women are willing to pay more for better milk quality in this market when compared with other market participants. Participants in the experimental auction also indicated a general willingness to pay more for additional food safety assurances about milk. Consequently, there are segments of the Moyale milk market that could potentially be targeted with higher-quality (defined by improved sensory characteristics and assurances), higher-priced milk to increase pastoralists' incomes from milk sales. Improving these characteristics for a portion of the milk sold in these markets might also result in improving overall market quality for the milk sold in Moyale because these markets appear to be competitive and buyers would essentially be forced to improve these characteristics in the milk they sell if they wish to compete with milk being sold with improved sensory characteristics and/or assurances.

Defining Quality

The basis for evaluating quality as it relates to food products is defined and represented in a number of different ways in the literature. For example, some studies examine food quality in terms of food's nutritional value (e.g., You and Nayga, 2005, Kim, Nayga, and Capps, 2001; and Poole, Marshall, and Bhupal, 2002). Other studies define food quality as food's observable (intrinsic) characteristics (e.g., size and color) or non-observable (extrinsic) characteristics[5] (e.g., Kimenju and De Groote (2008); Charatsari and Tzimitra-Kalagianni, 2007; Chilton, Burgess, and Hutchinson, 2006; Travisi and Nijkamp, 2004; Tunçer, 2001; and Northen, 2000).[6] Many other

[5] Extrinsic food characteristics often are related to assurances about production processes used to produce a food product and food safety (e.g., organic, animal welfare, environmental responsibility, social responsibility, absence of genetically-modified organisms, traceability, country-of-origin, etc.).

[6] Many of these past studies examining food quality use a hedonic approach in an attempt to identify the marginal contribution to price of specific characteristics using either regression

studies have valued food characteristics using experimental auctions (e.g., Shogren et al. (1994); Hayes et al. (1995); Dickinson and Bailey (2002 and 2005); and Onyango, Nayga, and Govindasamy (2006); Goldberg, Roosen, and Nayga (2006)).[7]

In this study milk quality is defined solely by the sensory characteristics and assurances consumers can use in these markets to judge the value of milk prior to consumption (e.g., smell, taste, appearance and texture).[8] The reason for using this definition is that it mirrors the information consumers have for judging the utility of milk in the open-air markets in Moyale. We assume that milk sellers and buyers attempt to judge milk's quality in these markets through sight, smell, and other sensory methods or assurances and base WTP largely on these characteristics. This relies on the premise that obtaining higher prices for fresh milk in these markets is hampered by the general poor sensory characteristics of fresh milk sold at the open-air markets (Wayua et al. (2007)).

Estimating WTP

Establishing WTP for milk quality is an important, but only first step in this market development process because it doesn't consider how pastoralists and markets would need to organize to provide higher quality milk. If consumers are willing and able to pay for improved milk quality (as defined here) and, consequently improved food safety in these markets, overall milk quality should improve because the markets appear to be competitive.[9] However, the poverty that characterizes most of the population in southern Ethiopia and northern Kenya raises

techniques, experimental auctions, or conjoint analysis (e.g., Charatsai and Tzimitra-Kalogianni (2007).

[7] Lusk and Shogren (2007) provide over 50 citations for valuations made using experimental auctions, most of them for food products.

[8] These are also referred to in the literature as information or search characteristics (i.e., Josling, Roberts, and Orden (2004); Hobbs (1997)).

[9] No direct test for a competitive market was undertaken by this study. However, casual observation and communications with market participants suggest that buyers do compete in these markets rather than behaving cooperatively.

a question about consumers' WTP for improved quality, because some researchers in the U. S. have suggested the demand for higher quality is associated with higher incomes and other demographic characteristics (e.g., Kinsey, 1997). We know of no study in this part of Africa that has examined WTP for food quality, in this case for milk, among poor populations. This type of information is important for market development activities not only in the study area for milk, but more generally in Africa because local market development efforts in Africa will typically need to be targeted at relatively poor consumers.

Choice of Experimental Auctions as the Method to Elicit Valuation of Milk Characteristics

There continues to be a substantial discussion in the profession regarding the best method for eliciting values for new or improved (non-market) food products. Contingent valuation (stated preference) compared to revealed or observed preference methods are the two ends of the spectrum related to this discussion. Observed purchases (revealed preference) would be considered the preferred method for establishing WTP for products, but contingent valuation is still often used to elicit valuations for non-market goods and also public goods.

Experimental auctions provide a method for eliciting the value of new goods and services (in this case improved milk characteristics) that does not rely on the hypothetically rating of the survey participants as would be the case with contingent valuation methods. Lusk and Shogren (2007) argue that because contingent valuation methods inflict no consequences on those stating a valuation that "one response is a good as another from an economic standpoint because all responses have the same effect on a person's level of utility" (p.3). There is also evidence suggesting that persons' stated preferences are much higher than their actual WTP (List and Gallet (2001) and Kollmus and Agyeman (2002)). Experimental auctions place participants in an active market laboratory environment where market feedback is provided and choices result

in actual economic consequences (Lusk and Shogren (2007)). Although the results are achieved in an artificial environment, the fact that they are obtained in a market setting makes the bidding "incentive compatible." Because individuals submitting bids can be identified and individual information obtained using surveys following the experimental auction, it is possible to account for the heterogeneity in the valuations of participants in the auction (Lusk and Shogren (2007)). This provides significant advantages for identifying possible market niches for the product in question.

Obtaining observed market purchases with the same level of richness as experimental auctions would have been problematic in this study for a number of reasons. First, assuring the safety of participants was of paramount importance. Conducting a market test with non-processed milk in an open-air market presented unacceptable risks. Consequently, we choose to conduct and experimental auction in a controlled environment with participants who dealt in the open-air markets but with "safe" milk but which also had real quality differences in terms of its sensory characteristics. Second, obtaining the same level of data richness with individual information for purchasers would have been difficult if not impossible over a period of time given the difficult field circumstances associated with tracking purchases by individual buyers over time. Lastly, the costs of obtaining data on actual purchases would have been very costly given staff time and travel expenses. This led to the choice of experimental auctions as the method to elicit milk valuation in this study.[10]

Selection of Participants for the WTP Experiments

[10] Critics of experimental auctions suggest that sample sizes are too small from which to draw general conclusions. While this criticism may have some validity no general conclusion about the efficacy of experimental auctions has yet been reached (see http://www.eaae.org/eaae/images/docs/seminars/creda%20workshop-auctions%20final.pdf). In the meantime, some caution should be exercised relative to drawing general market conclusions using results from experimental auctions.

The experimental design for this study is motivated by Shogren et al. (1994) as modified, described, and applied by Dickinson and Bailey (2002 and 2005). However, the experiments in this study were carried out in the field under less than ideal conditions for recruitment and participation in the experiments. For example, developing a pool of participants meeting certain demographic characteristics (e.g., Dickinson and Bailey (2002 and 2005)) could not be done solely through a published recruiting announcement and self-selection process. Rather, this could only be accomplished through the help of key informants[11] in the markets. These informants were asked to help identify consumers by approximate income and also occupation. A mix of consumers with both low and high incomes was needed to test for the affect of income on WTP. Managers/owners of restaurants, hotels, and other eating establishments were also identified because their milk purchases were considered an important potential market for milk with average quality above that typically sold in the open air markets.[12]

Persons selected for the experimental auctions were responsible for milk purchases or making decisions on food purchase for his or her household or business. Participants were asked to participate in the study at two levels. First, participants were formed into focus group to determine their general perceptions of milk quality and marketing (Wayua et al. (2007)) (see Table 1 for a description of the steps used to select participants for the focus groups and then the experimental auctions). This included a discussion of methods the participants used to determine milk quality. Discussions during the focus groups centered on milk quality issues and did not broach the issue WTP so that bids in the auctions were not a function of consensus from the focus group discussions.

[11] Including Moyale District Livestock Production Officer, Moyale County officials, and village leaders.
[12] The only secondary information available about the milk market in Moyale was a focus group study conducted earlier by the authors (Wayua et al. (2007)). The focus groups were designed to ascertain consumer attitudes about milk quality in the Moyale market. Some findings from this author publication are referred to here when they relate to the findings of this study.

Insert Table 1 here.

We focus on consumer WTP in this paper because 1) the results of the focus groups are reported elsewhere (i.e., Wayua et al.(2007)) and 2) the methods for determining milk quality and what consumers are willing to pay for milk quality are two connected but separate issues. Thus, this paper concentrates on WTP and the connection between demographics and WTP for milk quality as we have defined it.

The focus groups were selected as a stratified, random sample based on income. Of course, "low" and "high" incomes are relative because the Moyale district is among the poorest in Kenya with the poverty level exceeding 90%. A random sample of business owners/manager stratified by the size of business was also done to include businesses that purchased milk.[13] As a result, participants were selected from three separate groups: 1) managers/owners of retail outlets such as restaurants, hotels, and eating places, 2) households with high incomes that purchased milk from locations other than the open-air market, and 3) households with low incomes that purchase essentially exclusively from the open-air markets in Moyale (see Table 1).[14]

The focus groups consisted of 6-8 participants with two focus groups held per consumer category. Following Dickinson and Bailey (2002 and 2005), a target of 12 participants was desired for each experimental auction. Consequently, at the end of each focus group session the focus group participants were requested to select among themselves six persons to participate in the experimental auctions (so as to make 6*2=12). In doing this selection, the focus group participants discussed freely among themselves and gave a list of six people per focus group to the study organizers. The people on these lists were then invited by the organizers to participate

[13] Only 48 such business were identified by the key informants necessitating the requirement for a level of opportunity sampling for the business manager group.
[14] Additional detail about size of different *ollas* and assignment by income category is available in Wayua (2007).

in the experimental auctions on a separate day. Table 1 also reports gender and income-level information for the auction participants.

Conducting the Experimental Auctions

After arriving at the experiment site, participants were endowed with Ksh 50[15] and a glass (one liter) of milk (endowed milk), and told to await instructions. The auction instructions[16] were given orally to the subjects and all clarification questions answered prior to commencement of the experiment. The instructions were explained orally because of high illiteracy rates in the study area. The experiments were conducted by three members of the research staff of the Kenya Agricultural Research Institute (KARI)-Marsabit.

As indicated above, three experiments were conducted; one with business owners/managers, one with high-income consumers, and one with low-income consumers. The experiment consisted of several rounds of subjects bidding in a theoretically demand-revealing (second-price) auction format. When subjects placed bids, they bid on what they would be willing to pay to exchange their endowed milk for each of the four alternative milks that were auctioned during the experiment. Each subject in each group placed bids on the four different auction milks. Descriptions of the baseline (endowed) milk and the four other milks that were auctioned are found in Table 2.

Insert Table 2 here.

Extreme care was taken to not expose participants to food safety risks. Consequently, the endowed milk was fumigated and pasteurized to ensure it was safe, but it was then adulterated with water to make it a proxy for lower quality milk (mixture of 75% milk and 25% water). This was considered the only "safe" procedure to determine the difference in WTP for the four

[15] At the time of the research, i.e. August 2007, the exchange rate was Ksh. 70.4 per 1 USD.
[16] Instructions were the same as those used by Dickinson and Bailey (2002 and 2005) and are provided as an appendix to this paper for purposes of review.

alternative "high quality" milks compared to the baseline "low quality" milk. Consequently, this was a proxy for actual conditions in the open-air market and could be considered as generating a lower bound on WTP for milk quality compared to the actual milk sold in Moyale open-air markets. Participants were allowed to inspect the baseline milk and four alternatives through sensory perceptions (i.e., taste and smell). Consequently, most appeared able to perceive that the baseline milk had water added to it although this was not indicated to them by those administering the auction. The four alternative milks that were auctioned as an exchange for the baseline milk during the experiments represented different types of processed milk

After all the subjects' questions were answered, bids from each subject were taken first for Milk 1, then Milk 2, then Milk 3, and finally Milk 4 (this constituted one round of the auction). Ten total rounds were conducted with each group, with minimum changes in bids being Ksh 1. Participants were informed that they could bid a negative price to exchange the auctioned milk for their baseline milk if they wished (would need to be paid to exchange for the baseline milk). Market price information (i.e., the second highest bid for each milk auctioned) was announced after each round and prior to eliciting the next round's bid for that milk. Subjects were told prior to the commencement of the auction that a random draw at the end of the 10^{th} round would be the binding round to determine which of the four auction milks would be sold to the "winner". They were also informed that a second random draw would determine which of the ten rounds for the randomly-selected milk would be the binding round.[17] Consequently, only one of the auction milks was actually auctioned in each experiment (Dickinson and Bailey (2002 and 2005)). Subjects were fully aware prior to starting the first round that there was a uniform chance that *any* round for any auction milk might be the binding auction.

[17]The purpose for randomly selecting the binding round and milk to be sold was so that each bid was a potential "winner."

At the end of the experiment the "winner" of the auction was identified by random selection of both the binding round and milk that was actually sold.[18] All subjects were then required to consume their milk (either the baseline milk or the auctioned milk in the case of the one "winner") prior to leaving the experiment with their experiment cash. Communication was not allowed among participants during the auction process. Instead participants were requested to ask any questions they had directly to the facilitator. At the end of the auction all participants filled out a brief questionnaire reporting their demographic characteristics and other information that might affect their demand for milk quality.

Testing for the Influence of Demographic and other Characteristics on Bids

Demographic and other participant characteristics are expected to influence the results of experimental auctions (i.e., Casari, Ham, and Kagel (2007); Umberger and Feuz (2004); and Dickinson and Bailey (2002 and 2005)). A brief questionnaire was administered to participants at the end of each auction to obtain these characteristics. The questionnaires were administered orally to those who were unable to fill out the questionnaire by themselves for reasons of literacy.

A regression equation was used to estimate the influence of demographic and other characteristics on participants' WTP for milk quality. The specification of this equation was the following:

$$(1)\quad BID_{ij} = \alpha_0 + \sum_{j=1}^{3} \alpha_j MILK_{ij} + \alpha_4 AGE_i + \alpha_5 GENDER_i + \alpha_6 CHILDREN_i + \alpha_7 INCOME_i + \alpha_8 NOTEDUC_i + \alpha_9 BUYER_i + \alpha_{10} NEWS_i + \alpha_{11} OPENMKT_i + \alpha_{12} ASSURE + \varepsilon_{ij},$$

[18] One of the ten bidding rounds was randomly selected at the "binding" round and one of the four alternative milks was selected as the milk that was sold as a result of that binding round.

where BID_{ij} was the average bid during the last five rounds by the i^{th} (i=1, . . . , 31) auction participant for the j^{th} milk (j=1,2,3,4). *MILK* represents intercept binary variables measuring differences in *BID* based on the milk being auctioned (Milk 4 was the omitted, base variable). *AGE* was the participant's age in years and *MALE* was a binary variable that took on the value of one if the participant was a male and zero if female. *CHILDREN* was the number of children in the household and *INCOME* was a binary variable with value one if participants fell into the highest income categories (10,000 KSH per month or more) for the sample and zero otherwise. *NOTEDUC* was a binary variable with value one if the person had no formal education and zero otherwise while *BUYER* was a binary variable assigned one if the person was the primary food purchaser for the household and zero otherwise. *NEWS* was the number of newspaper and other reports, such as radio reports, the person had read about food-borne illness during the previous six months and *OPENMKT* was a binary variable with value one if the participant thought the baseline milk was similar to what they could buy in the open-air market or zero otherwise. *ASSURE* ascertains whether or not the participants would be willing to pay for added assurances about food safety and had a value of one if respondents indicated they would place a high value on these types of assurances and zero otherwise.[19] α_0 is the intercept,. $\alpha_1 - \alpha_{12}$ are parameter estimates and ε is random error term.

The economic reasons for selecting the variables for the regression were that one would expect different average bids if participants perceived a difference in milk quality between the four alternative milks ($MILK_j$). However, there is no *a prior* expectation for preferences for Milks 1, 2, and 3 compared to Milk 4 because all four have enhanced characteristics compared to the baseline milk. The important point relating to quality is that each of the alternative milks

[19] *ASSURE* essentially became a proxy for the value of additional information that could be provided to consumers about milk safety and other characteristics.

received average bids that exceeded zero (were preferred to the baseline milk). One might expect that women tend to be more concerned about food safety than men because they are often given primary responsibility for the health of household members. Consequently, the sign of the parameter estimate for *MALE* was expected to be negative. Because food-borne illness can pose greater risks for children than adults, the parameter estimate on *CHILDREN* is expected to be positive.

Economic theory (Kinsey, 1997) suggests that respondents with high incomes are expected to be willing and able to pay more for milk quality so the parameter estimate for *INCOME* is expected to be positive. *NOTEDUC* may play a role in the demand for milk quality if it results in participants having more knowledge about the risks of bacteria in milk that is unrefrigerated. Consequently, uneducated people may not be willing to pay as much for high quality milk as people with more education and the expected sign for the parameter on *NOTEDUC* is negative.

Experienced food buyers would be expected to be more discerning about milk quality than others who do not have the primary responsibility for buying food for their household. This suggests that the parameter estimate on *BUYER* should be positive. Participants who have received relatively more information about food-borne illness than other participants in the recent past would be expected to be relatively more sensitive about milk quality than the less informed group. Consequently, the parameter estimate for *NEWS* was expected to have a positive sign. The sign for *OPENMKT* was an important part of the analysis because it indicates whether or not persons perceiving the baseline milk to be similar to what can be purchased from open-air markets would be willing to pay more for higher quality milk. One would expect that if participants perceived the baseline milk as roughly equivalent to what they could buy in the

open-air markets that the parameter estimate for *OPENMKT* should be positive assuming that such milk would be considered lower quality, on the average, than the auctioned milks. One would expect a positive parameter estimate for *ASSURE* given that participants would be expected to be willing to pay more for added assurances and information about food safety.

The White test was used to test for the presence of heteroskedasticity in the auction data (Greene, 2003). The test revealed that the null hypothesis of homoskedastic error terms for the model specified by equation (1) could not be rejected. Consequently, ordinary least squares (OLS) was used to estimate the parameters of equation (1). The parameters of equation (1) can reveal niches within the market in Moyale that are willing to pay for milk quality. This provides help to pastoralists as they are considering efforts to improve milk quality because it gives insights about which consumers are willing to reward those efforts with higher prices. The following section reports results of the experimental auctions, the parameter estimates for equation (1), and additional analysis regarding WTP for milk quality in the Moyale market are provided in the following section.

Experimental Results and Effects of Demographics and Other Characteristics on WTP

Table 3 reports the responses to the survey of participants and provides basic demographic and other information about the participants. There were a total of 31 participants in the experimental auctions. There were a few more females than males (17 females and 14 males) and almost all were married. The respondents reported having an average of almost four children and an average age of about 37. Over 25% of participants had no formal education (*NOTEDUC*) and 58% indicated that they were unemployed (*EMPLOYED*). A high percentage of participants (67.7%) had income under 5000 Ksh. per month. Less than 50% of the respondents indicated that they had at least some confidence in the government's current food

inspection system (*GOVTRUST*). A large percentage of participants indicated that they wanted more information and assurances about the food they consume (*ASSURE*, *TRACE*, and *PROCED*). In summary, the participants tended to be fairly young, poor people with limited education who have little confidence in their government's food safety inspection system and who would like more information and assurances about the food they buy.

Insert Table 3 here.

Figure 1 presents the summary data from the experiments (see also Table 1). Figure 1 shows the average percentage bids of the experiments by round. The percentage bids were calculated as the actual bid made by the auction participant divided by the value of the baseline milk as estimated by the participant. Average percentage bids were the average bids for each round over the 31 participants in the experimental auctions. The patterns of the average bids are very consistent with past studies such as Dickinson and Bailey (2002 and 2005) where average early-round bids tend to be relatively high compared with later-round bids which tended to converge to a stable value, especially during the last five rounds of bidding. The average percentage bids reported in Figure 1 provide evidence for WTP for quality in milk (i.e., WTP to exchange each of the auctioned milks for the baseline milk). However, additional information about the distribution of bids provides additional detail about the array of bidder opinions. That is, although the average percentage bid is positive for all auction participants, the range and frequency of bids helps one understand how uniform opinions were among the bidders.

Insert Figure 1 here.

Table 4 displays the empirical frequencies of bids for WTP to exchange the baseline milk. This helps to interpret and compare results because the distributions are not normally distributed thus making standard statistical tests not valid for comparing the distributions. The

average percentage bid during the last five rounds of bidding for each individual is used to build the bid frequencies reported in Table 4. Using the average bid for the last five round accounts for learning by auction participants and provides a more stable measure of WTP than if all 10 rounds were used in the calculation. An obvious outlier existed for one of the bidders for Milk 4 (see Table 4 extreme positive bid for Milk 4). The outlier was excluded when the regression analysis was performed.

Insert Table 4 here

The bid frequencies demonstrate relatively large variations in bids but the distributions are skewed to the right. For example, few participants (four bidding on Milk 1 and one bidding on Milk 3) placed negative percentage bids, but the vast majority of bids (95.9% of them) were positive thus indicating WTP for exchanging the baseline, adulterated milk. The variation in bidding raises questions about why opinions among the bidders varied as much as they did. The regression analysis helps to provide additional insights explaining some of the variation in the data.

The OLS parameter estimates for equation (1) are reported in Table 5. A number of useful results appear in Table 5. For example, Milk 2 and Milk 3 received statistically higher bids than Milk 4 suggesting that processed milk from PARMCO is perceived as being higher quality than UHT milk. This may make sense when one considers that UHT milk can sometimes have a slightly off flavor as a result of its processing at high temperatures. Consequently, this result may be revealing a preference for processed milk that has a flavor similar to fresh milk. The results provide strong statistical evidence that older, female participants in the experimental auctions were willing to pay more for milk quality than other participants (*MALE* and *AGE*).

There was also weak statistical evidence[20] that participants with no formal education were not willing to pay as much for milk quality as were participants with some formal education (*NOTEDUC*). This result suggests that literacy may be important in becoming informed about milk quality and is supported by the positive and statistically significant parameter estimate for *NEWS*. *INCOME* had an unexpected negative, though statistically insignificant sign as did *CHILDREN* and *BUYER*. Statistical evidence was exhibited suggesting that persons that thought the baseline milk was similar to what could be bought at the open-air markets (*OPENMKT*) were willing to pay more to exchange their baseline milk than those participants who thought the baseline milk was not similar to milk that could be purchased in the open-air markets. This would imply that participants in the open-air markets would respond positively to higher quality milk by paying higher prices for it than the milk that is currently sold there.

Insert Table 5 here.

Even though participants were poor, they indicated they have strong WTP for additional assurances about food safety (*ASSURE*). Food safety has been shown consistently to be an important characteristic related to WTP in other similar studies (e.g., Dickinson and Bailey (2002, and 2005)). It is especially important here because poor participants indicate they are willing to pay more than a 19% premium for assurances about milk safety.

While this experiment was a proxy for actual conditions in the market[21] the results imply that WTP exists in this market for milk that can demonstrate quality characteristics.[22] There appears to be a clear preference for processed milk that has not been heated to ultra-high

[20] *NOTEDUC* parameter estimate's p-value was 0.118.
[21] Food safety issues would not allow for using milk actually purchased in the open-air market to be used in the experimental auctions.
[22] This seems to be an obvious, yet powerful, result because it indicates that economic incentives exist for marketing milk that is higher quality than that marketed in the open-air markets of Moyale and other cities and towns in northern Kenya.

temperatures, but there are demographic characteristics of milk buyers that may also provide opportunities for selling unprocessed milk. For example, different types of certification schemes might be devised by pastoralists to ensure that milk has not been adulterated and this milk could have a target market of older females who have had some formal education. The affect of age appears to be linear because a test of age squared did not yield a significant parameter estimate. One illustration of WTP suggested by these results that should be considered with caution is that, on the average, a 40 year-old woman would be expected to be willing to pay about 20% more for quality milk than a 20 year-old woman *ceteris paribus* (0.010 * 20 years difference in age).

The results support the notion that consumers in Moyale, Kenya would be willing to pay more for milk if they perceive it to be of higher quality than milk typically sold in the open-air market. This essentially indicates that pastoralists should be considering methods for providing higher quality milk to buyers in Moyale and that they can expect that buyers will be willing to pay more for milk if they are confident of the milk's quality.

Conclusions and Recommendations

Conditions for this study were much more difficult than for similar studies held in the United States and elsewhere (e.g., Dickinson and Bailey (2002 and 2005)) because of more difficulty in recruitment and issues of illiteracy in a significant number of the auction participants. However, with a few modifications, such as using key market informants in recruiting; reading the instructions to participants; and helping those who were unable to read and write to fill out the questionnaire, this study was able to demonstrate that experimental auctions can be conducted successfully in this part of Africa to determine WTP for food characteristics. The results suggest that incentives exist in the market to improve milk quality because relatively large portions of the market (e.g., older, informed females) are willing to pay

for improved milk quality. The results also indicate that participants in this market are anxious to receive more information and assurances about the milk they consume. This may provide opportunities to pastoralists to devise methods for providing and certifying these types of assurances. Doing so may increase pastoralist incomes from milk sales while likely improving the overall quality of milk being sold in the Moyale market.

Many parts of Africa have market conditions similar to those in Moyale. The results suggest that economic incentives exist for improving the quality of milk sold in these markets. Some of this improvement may be marginal and slow because infrastructure issues create time and distance barriers to providing high quality fresh milk. However, even small improvements could potentially add value to the milk being sold in open-air markets. Pastoralists could also consider moving to town and perhaps purchasing feed for cows so that fresh milk could be provided in a timely manner to consumers. Participants in these markets appear hungry for more information about the milk they are buying. Pastoralists could provide this information and assurances as economic incentives appear to be present to do so.

Figure 1. Average Percentage Bids to Replace Baseline Milk with Four Alternative Milks, Moyale, Kenya.

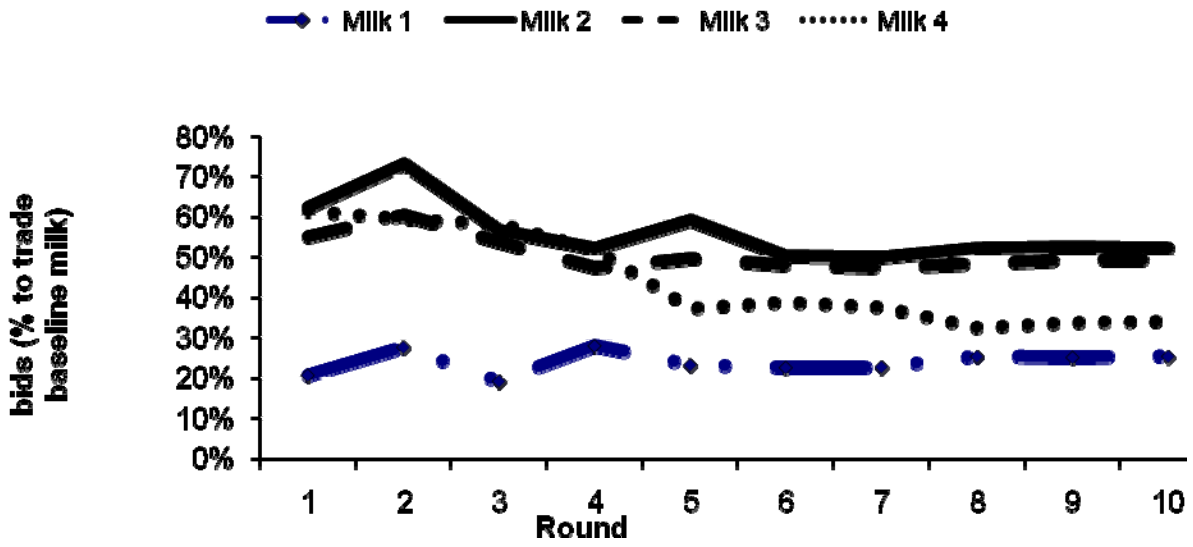

Table 1. Steps in Selection of Participants for Focus Groups and Experimental Auctions, August 16-28, 2007, Moyale, Kenya.

Step	Action and Result
Step 1	Identification of "key" informants in Moyale as contacts to help identify potential participants by income level and occupation. Informants were known to researchers and were familiar with Moyale.
Step 2	With informants help, villages (*ollas*) within Moyale were identified and assigned a general classification for income (low, medium, high).
Step 3	Informants identified business owners who purchase milk (hotel and restaurant owners by establishment size and sampling stratified based on size.
Step 4	Income-stratified (see Step 2) random sampling of *ollas* performed using the Red Cross's *Relief Register* to select participants in the focus groups. Number of participants was determined by an attempt to have 6-8 participants in each focus group. For example, the target number of participants from a particular *olla* and there were 56 households in the *olla*, then every 6t household (56/9) was selected for the sample.
Step 5	Six moderated focus groups formed by inviting selected participants (two groups high income, two groups low income, and two groups business owners/managers).
Step 6	Participants in focus groups ask to identify members to participate in the experimental auctions.
Step 7	Three experimental auctions held (one group high income (10 participants), one group low income (11 participants), one group business owners (10 participants)).

Experimental Auction Participants by Category:

	Male	**Female**	**Total**
Low-income	4	7	11
High-income	0	10	10
Managers of hotel, restaurants, or Other eating establishment	10	0	10
Total	14	17	31

Table 2. Auction milk descriptions provided to experiment participants

Milk type	Description
Baseline milk	Fumigated* pasteurized fresh milk (processed at a local milk cooperative, i.e. Pastoralist Resource Marketing Cooperative – PARMCO**), adulterated by adding water (milk: water = 75:25)
Milk 1	Factory processed UHT, purchased from shops in Moyale
Milk 2	Cultured fermented milk, with no sugar (processed at PARMCO)**
Milk 3	Non-fumigated pasteurized fresh milk (obtained from a nearby village in Moyale Kenya and processed at PARMCO)
Milk 4	Fumigated pasteurized fresh milk (processed at PARMCO)**

*Traditionally, milk containers are fumigated with smoke of wood chips from a special tree species/shrubs to preserve milk.
**Over 90% of milk processed at PARMCO is sourced from Ethiopia. All milk types were from cows.

Table 3. Survey Questions, Frequencies, and Mean Responses to Moyale, Kenya Survey.

Question and Value	Responses=Code	Frequencies[a]	Mean	Variable
Are you Male or Female?	Male: 1 Female: 0	14 17		*MALE*=1 if male, 0 otherwise
What is your age?			36.87	*AGE* continuous
What is your marital status?	Married: 1 Divorced: 2 Widowed: 4	28 2 1		*MARRIED*=1 if married, 0 otherwise
How many children do you have?			3.97	*CHILDREN* continuous
What is the highest level of education you have completed?	Primary School: High School: Not Educated:	16 7 8		*NOTEDUC*=1 if Not Educated, 0 otherwise
Who typically makes most decisions about food purchases in your household?	You? Someone else?	28 3		*BUYER*=1 if "you", 0 otherwise
What is your current employment status?	Unemployed Employed Herding	18 12 1	671.41	*EMPLOYED*=1 if employed, 0 otherwise
Are you a student?	Yes No	0 31		*STUDENT*=1 if a student, 0 otherwise
What is your best estimate of your monthly *household* income?	<Ksh 5000 Ksh 5000-Ksh 10000 Ksh 10000-Ksh 15000 Ksh 15000-Ksh 20000 >Ksh 20000	21 6 4 0 0		*INCOME*=1 if monthly income exceeded 10000 Ksh, 0 otherwise
Have you or your family had food poisoning?	Yes: 1 No: 0	14 17		*POISON*=1 if yes, 0 otherwise
Have recent reports about food borne diseases (e.g., Milk adulteration) affected your milk purchases?	Great Affect: 1 2 Some Affect:3 4 No Affect:5	3 5 12 2 9		*REPORTS*=1 if <3, 0 otherwise

Table 3. Survey Questions, Frequencies, and Mean Responses to Moyale, Kenya Survey Continued.

Question and Value	Responses=Code	Frequencies[a]	Mean	Variable
What is your best estimate of the number of news articles or reports that you have read or heard about on food-borne diseases in the last 6 months?			0.45	*NEWS* continuous
How much confidence do you place in your government's current food inspection and safety program?	Complete confidence: 1 2 Some confidence: 3 4 No confidence: 5	3 3 8 5 12		*GOVTRUST*=1 if <3, 0 otherwise
Would you value having additional assurances, beyond what is currently provided by your government, about milk safety?	Highly value:1 2 Some value:3 4 No value: 5	26 0 3 0 2		*ASSURE*=1 if <3, 0 otherwise
Would you value knowing the exact manyatta that produced the animals for the milk you consume?	Highly value:1 2 Some value:3 4 No value: 5	19 0 4 5 3		*TRACE*=1 if <3, 0 otherwise
Would you value knowing the procedures and processes used by the farmer to produce the animal for the milk you consume?	Highly value:1 2 Some value:3 4 No value: 5	17 1 6 1 6		*PROCED*-1 if <3, 0 otherwise
If you value the information from question 17, why?	More confidence about safety/ quality of the milk you purchase: a You want to be able to identify the source of the problem, should one arise: b Both Other	18 4 4 5		

Table 3. Survey Questions, Frequencies, and Mean Responses to Moyale, Kenya Survey Continued.

Question and Value	Responses=Code	Frequencies[a]	Mean	Variable
What would you normally pay for a milk similar to the one you were given at the start of the experiment?			15.65	
Where would you buy such milk from?	Open market Shop Regular customer brings to hotel	19 5 7		OPENMKT=1 if open market, 0 otherwise

Table 4. Bid Frequencies for Participants in Experimental Auctions, Moyale, Kenya.

Uneven Ranges for Average Bids During Final Five Rounds	Frequencies			
	Milk 1	Milk 2	Milk 3	Milk 4
-100% or less	1	0	0	0
-99% - 1%	4	1	1	0
0%	1	2	0	2
1% - 25%	12	10	15	13
26% - 50%	7	7	5	13
51% - 100%	6	5	6	2
101% - 150%	0	6	4	0
151% - 200%	0	0	0	0
200% +	0	0	0	1

Table 5. Estimated Parameters for Model Examining the Impact of Demographic and Other Characteristics on WTP for Milk Quality in Moyale, Kenya (One Outlier Observation for Milk 4 Eliminated).[a]

Independent Variable	Parameter Estimate
Intercept	-0.064 (0.177)
MILK 1	-0.024 (0.083)
MILK 2	0.249** (0.083)
MILK 3	0.219** (0.083)
MALE	-0.535** (0.086)
AGE	0.008* (0.004)
CHILDREN	0.006 (0.020)
NOTEDUC	-0.143 (0.091)
BUYER	-0.001 (0.112)
INCOME	-0.070 (0.114)
NEWS	0.132** (0.044)
OPENMKT	0.125 (0.073)*

Table 5. Estimated Parameters for Model Examining the Impact of Demographic and Other Characteristics on WTP for Milk Quality in Moyale, Kenya (One Outlier Observation for Milk 4 Eliminated) Continued.[a]

Independent Variable	Parameter Estimate
ASSURE	0.196**
	(0.098)
Adjusted R^2	0.363
N=123	

[a] Standard errors are in parentheses.

* Denotes statistically different than zero at the 10% level of confidence.

**** Denotes statistically different than zero at the 5% level of confidence.

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