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Establishing the Dominant Milk Marketing Channel in Nyandarua District, Kenya: A Cumulative Density Function Approach

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Abstract: *This paper uses data from a survey of 186 dairy households in two divisional administrative zones in the Kenya highlands to establish the dominant milk marketing channel based on net returns. Cumulative density function results show that, the private channel dominates over all the other channels except at the 0.8 probability level of choice where the cooperative channel dominates overall. Although most smallholder farmers in Kenya market milk through the traditional channel, the net returns that would accrue from their enterprise if they used the traditional and cooperative channels is still considerably higher. It is however apparent that the traditional channel is being replaced, albeit slowly, giving rise to the need of a policy to breach the quality gap between the traditional and the modern channels by making popular training and certification programs for small scale milk traders and processors.*
Keywords: *Dominant, Marketing channel, Net returns,*

I. Introduction

Post liberalization of the dairy sector in Kenya has permitted formal, private processors to compete intensely with both cooperative processed milk market and traditional market. Due to this, several private milk processing firms have emerged in the Kenyan dairy Market. Furthermore, supermarkets and retail chains have sprung up in the food market which includes milk in its scope (MoLD, 2010). However, one of the most controversial issue in international development is that the rise of modern marketing chains (especially under private ownership) could have negative effects on income distribution. Several research findings have opined that the poor will suffer from this process (Elizabeth *et al*., 2000). The debate is ongoing in countries like India although not of consequence to the Kenyan dairy sector.

Dairy processing has simultaneously developed with production through the Kenya Cooperative Creameries (KCC), the largest dairy cooperative in Kenya. It had been a monopoly up until 1992 with a countrywide network of 11 processing plants and 11 cooling centres with 26 sale depots (Kiurah, 2006). Its collapse as a state monopoly in the 1990s came due to political intervention and inefficient management. Subsequently, private sector participation through other large-scale processors was encouraged. Industry statistics by the Kenya Dairy Board in 2010 put the estimates at 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars (Wambugu *et al*., 2011).

Recently, milk processing in Kenya has been dominated by the new KCC, Brookside Dairy Limited and Githunguri Dairy Farmers Cooperative and Processors (Mburu *et al.,* 2007). In 2010 alone, Brookside had a 40 percent share of the Kenyan dairy market, with milk sourced from approximately 120000 suppliers. Seven percent of these were commercial farmers and the rest were small scale producers (Business daily posted Friday, February 19, 2010). However, there is a dearth of information on the dominant milk marketing channel particularly in terms of monetary incentives to the farmer from the dairy enterprise. Most studies have sought to establish dominance premised on the proportion of the populace that use a certain marketing channel as opposed to using the net returns (Kumar and Staal, 2011; Kumar, 2010; Wambugu *et al*., 2011). Contrary to this, the objective in this study sought to determine dominance of the milk marketing channels based on the net returns from the dairy enterprise and at various probability levels of choice.

II. Methodology

A multi-stage sampling procedure was used to select a sample of smallholder dairy households for the study. Nyandarua County was purposively selected in the first stage because of its large number of small scale dairy producers. Within Nyandarua County, Nyandarua North district was also purposively selected based on the fact that small scale dairy farming is dominant and growing at the moment. Furthermore, it reflects significant differences in structure of the dairy marketing industry. Two administrative divisions (Mutanga and Ndaragwa) were then selected through stratified sampling. Finally, simple random sampling was used to select the sample villages and subsequently the sample milk producing households was determined by proportionate to size sampling methodology (Anderson *et al*., 2007). Thus, a total of 186 households were selected. Using a semi structured questionnaire, data were gathered for these 186 households covering a wide range of information on costs and the gross dairy income in Kenya shillings (KES).

2.1 Econometric model

Kernel Density Estimation (KDE) and Cumulative Density Function (CDF) were used in the analysis to establish the dominant marketing channel. Preference for the approach was due to the fact that it best approximates the density function of a variable based on the observations. Furthermore, it predicts the possible outcomes and probabilities of their occurrence thereby using accumulated data to reflect the differences between individuals (Othmar, 2009). Kernel density estimation has been used by (Salgado-Ugarte *et al*., 1993 and Cox, 2005) while the CDF used by Zwillinger and Kokoska, (2010) and Gentle, (2009). An alternative approach suggested is Probability Mass Functions (PMF) but one advantage of CDF models over it is the simplicity of representing multivariate heavy-tailed distributions (Huang and Frey, 2008). On the other hand an alternative suggested to kernel density is the use of a histogram. Kernel density is however smarter than a two way histogram in that its default width is not a fixed constant and it is convolved with samples. Furthermore histograms specify a number of bins while kernel density specifies the width leading to more accurate statistical modeling of sample data (Yoon *et al*., 2007).

2.1.1 Kernel Density estimation

The kernel estimate is formed by summing the weighted values calculated with the Kernel function K and its band width. The two determine the accuracy of estimated statistical distributions of the continuous variable in question. The Kolmogorov–Smirnov and Omnimbus test statistics are used to test for normality of distribution although the former is limited to test for normality in 2 data sets. The Omnibus test statistic on the other hand is an obvious one to use in comparing more than two density distributions because it is simply a kernel estimate analog of an ANOVA sum of square statistics. A kernel density estimate equation is expressed as follows:

$$\hat{f}_K = \frac{1}{qh}\sum_{i=1}^{n} w_i K\left(\frac{x_i - x}{h}\right) \qquad (1)$$

where x is the variable for which we wish to estimate the kernel, n is the number of observations, h is the window width or bandwidth which determines how many values are included in estimating the density at each point w_i are the weights that we wish to estimate,

$q = \sum_i w_i$ if weights are frequency weights or analytic weights, and $q=1$ if weights are importance weights. Incase weights are not used, then $w_i=1$, for $i=1,\ldots\ldots, n$

K is a kernel function for any value.

If K is a rectangular function, the density estimation becomes:

$$\hat{P}_h(x) = \frac{Number\ of\ x_i\ subject\ to\ |x_i - x| \le h/2}{Normalization\ factor\ (e.g., N\ .h)} \qquad (2)$$

2.1.2 The cumulative density function

The CDF records the same probabilities associated with X, but in a different way. The CDF function of X is defined by:

$$F(x) = P(X \le x) \qquad (3)$$

$F(x)$ gives the "accumulated" probability 'up to x'. This immediately shows the relationship between probability density functions and CDF:

$$F(x) = P(X \le x) = \int_{-\infty}^{x} f(m)dm \qquad (4)$$

(since x is used as a variable in the upper limit of integration, we use some other variable, say "m", in the integrand) since we are dealing with probability it follows that:

$F(x) \ge 0$ and that

$$\lim_{x\to\infty} F(x) = \lim_{x\to\infty} \int_{-\infty}^{x} f(m)dm = \int_{-\infty}^{\infty} f(m)dm = 1 \text{ and} \tag{5a}$$

$$\lim_{x\to-\infty} F(x) = \lim_{x\to-\infty} \int_{-\infty}^{x} f(m)dm = \int_{-\infty}^{-\infty} f(m)dm = 0 \text{ and that} \tag{5b}$$

$$F'(x) = f(x), \tag{5c}$$

The CDF is therefore an antiderivative of the probability density function. The CDF can be generalized to describe the results of a random event that can take on one of K possible outcomes with each outcome separately specified. There is no underlying ordering of the outcomes but numerical labels are attached for convenience. Parameters specifying the probabilities of each outcome are under constraint by the fact that each must be in range 0 to 1, and all must sum to 1.

It follows that if the distribution of variable *x* is based on a discrete variable with more than two possible outcomes (categorical random variable) its equation is expressed as:

$$F(x) = \begin{cases} 0 & for\ x \le 1 \\ \sum_{j=1}^{i} p_j & for\ x \in [i, i+1) \\ 1 & for\ x \ge k \end{cases} \tag{6}$$

where *x* is the random variable, *k* is the total number of categories,

i is the household and P_j is the probability of category *j* = (1,2…….*K*).

From the CDF graph generated, we will proceed to check whether there is dominance of any channel over the others by going beyond the visual inspection.

Empirically, three kernel density functions were separately estimated for the traditional, private and cooperative channels. Net returns from the dairy enterprise for each channels based on the 12 month period was used as the variable to estimate the Kernel. The non-parametric specification of the model is as follows:

$$\hat{f}_K = \frac{1}{qh} \sum_{i=1}^{n} Mktch_{ij} K\left(\frac{\ln(net\ returns)_{ij} - x}{h} \right) \tag{7}$$

where $Mktch_{ij}$ is the milk marketing channel for individual *i* in channel *j*=(1,2,3 for traditional, private, and cooperative channel respectively) for household *i*,

ln (net returns$_{ij}$) are the natural logarithims of net returns for household *i* in channel *j*=(1,2, and 3) for traditional, private, and cooperative channels respectively, and *h* is the band width.

On the other hand, the CDF empirical estimation is expressed as:

$$F(x) = \begin{cases} 0 & for\ \ln(netreturns) \le 1 \\ \sum_{j=MKTCH1}^{i} MKTCH_j & for\ \ln(net\ returns) \in [i, i+1) \\ 1 & for\ \ln(net\ returns) \ge cooperative \end{cases} \tag{8}$$

where $MKTCH_j$ is the marketing channel *j*= (1-Traditional, 2-private, 3-coopertaive,)

III. Results And Discussions

3.1 Kernel density estimation

Fig 1 presents the face value results for kernel density estimates which show a normal distribution for the three channels namely: traditional, private and cooperative while Table 1 shows the Kolmogorov-Smirnov test of equality of distribution. The probability density functions for net returns (Table 1) depicted equality of distribution in the kernel estimation, ascertained by the p-values for combined estimates of (traditional, private) and (traditional, cooperative) both significant at 5%, while the private channel combined with the cooperative showed significance at 10%. Comparison of the three channels based on the net returns was thus warranted.

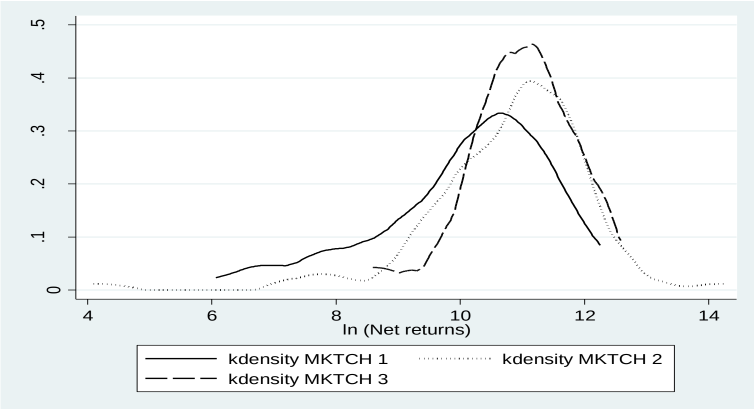

Figure 1: Probability density distribution plots for net returns in the marketing channels

Affirming the equality of distribution in the probability densities is the significance mean difference between the average net returns within each channel as depicted in Table 7.2, the f- values from the ANOVA resemble the Omnimbus test statistic for equality of distribution for more than 2 density functions.

Table 1: Kolmogorov-smirnov test of equality of distribution

Combination	Marketing channel	p-values	Net returns
Traditional, private	Traditional	0.013	73045.56
	Private	0.987	68107.72
	Combined	0.026	
Traditional, cooperative	Traditional	0.015	73045.56
	cooperative	1.000	41311.56
	Combined	0.030	
Private , cooperative	Private	0.190	68107.72
	Cooperative	0.830	41311.56
	Combined	0.081	

Source**:** Survey data, 2013

Table 2: Net returns mean distribution in the marketing channels.

Variable	Pooled data	Traditional	Private	Cooperative	f-value
	N=184	N=78	N=84	N=22	
	Mean	Mean	Mean	Mean	
NET_RETURNS	65568.3	32951	85333.5	78420.4	2.07*

Source**:** Survey data, 2013

3.2 Cumulative distribution Density estimation

Fig 2 shows the cumulative distribution of frequencies of net returns presenting a cross section of simultaneously existing 'statistical counting units' or elements that yield a stationary picture, as if frozen in time. It further reveals features about the underlying parameter that are not noticed in the corresponding frequency distribution. The CDF was built by adding successively the grouped frequencies of net returns in all channels, usually as "the frequencies of all channel intervals below the upper limit of the given class", beginning with the first channel interval, continuing up to the last, basically an open-ended channel interval.

The cumulative frequencies of all ogives are expressed as fractions of the total of all frequencies. The dotted line representing net returns of farmers participating in the traditional channel presented the lowest returns as compared to either the cooperative or private channel. This is evidenced by the net returns at various probability choice levels given the whole set of channels for instance at 0.5, if a farmer chose to use the traditional channel he/she would get annual net returns of KES 34894 as compared to KES 50109 and KES 55275 from the private and cooperative channels respectively. The low returns as compared to the other channels lies across 0.6, 0.7, 0.8 and 0.9 probability levels of choice (Table 3). This implied that participating in the traditional channel in the long run gave less returns as compared to the other channels and was thus dominated by the others. The observed scenario is in line with Kumar and Staal (2010) findings where the prices per liter of milk were considerably lower in the traditional channel (11.90 rupees/litre) as compared to (14.90 rupees/litre) for the cooperative and (14.80rupees/litre) for the private channel. This showed that the traditional market was less competitive and cost-effective in linking consumers and producers. It is also possible that high transaction costs and issues of hygiene and quality of milk being sold through it worked to its disadvantage.

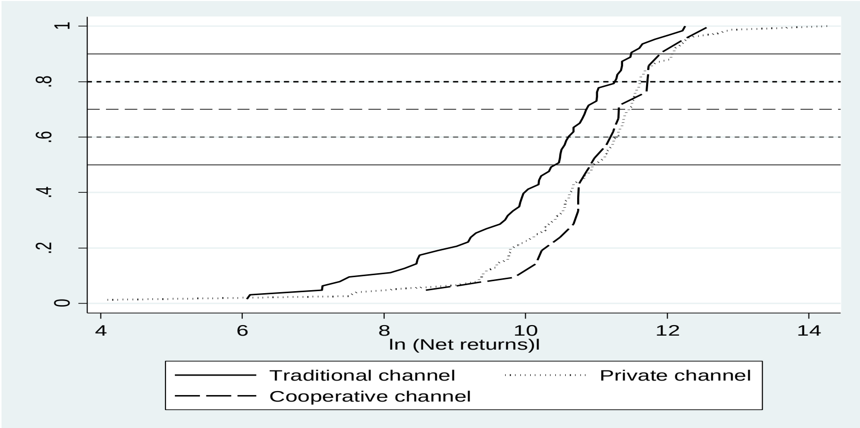

Figure 2: Net return differentials at probability levels

The cooperative channel represented by the dashed line (Fig 2) dominated over the traditional across all probability levels of choice. However it was less dominant than the private channel at all probability levels of choice except at the 0.8 level where it had KES 110202 as compared to 123017 of the cooperative (Table 3). The findings are consistent with Vijay *et al*. (2007) who found that participation in the cooperative channel had more advantages than marketing through the traditional market.

The observed dominance of the cooperative channel over the traditional may be explained by the services it offers which are cost reducing in the long run, these are: milk cooling centres which reduce loss due to the perishability, credit facilities and subsidized deworming and artificial insemination services. The reduced costs will ultimately have a positive effect on the net returns in the long run.

The private channel dominated over all the other channels except at the 0.8 probability level of choice as indicated above. Represented by the dotted line (Fig 2), a farmer who would opt to use it to market produce would get higher returns as compared to either traditional or cooperative in the long run at 0.5, 0.6, 0.7, 0.9 probability levels of choice. In other words, if a farmer was given a set of markets envisaged in the three channels to choose from to market his/her produce and decided to use all but marketing different proportions of milk to each, marketing more milk using the private channel as shown by the above proportions would give him/her higher returns as compared to him/her marketing the same proportion using either of the other channels. The finding is consistent with Staal, *et al*. (1997) and Leksimono, *et al*. (2006) who found that since the dairy sector liberalization in 1992; private firms had injected a new level of price competition into the market not seen before. Dairy farmers able to sell to such firms had clear benefits and their profits rose. In addition, private channel farmer participants who were probed said that in terms of other services a channel offers, the private channel was definitely better placed where the extent of service provided by them particularly in breeding and veterinary services was higher than in the other channels. Furthermore it offered training and field visits to model farms, activities crucial to improving the human resource capacity and for maintaining food safety of milk. The private channel's payment policy gave it an upper hand over the cooperative channel as it paid its producers every day while the co-operatives paid weekly or fortnightly as was found in Rajendran and Mohanty, (2004). Coupled with higher price per litre, the above advantages of the private channel over either of the other channels is a sure proof of dominance in terms of net returns.

Table 3 Net returns at different Probability levels of choice

Probability	Marketing Channel		
	Traditional channel	Private channel	Cooperative channel
0.5	34894	58109	55275
0.6	41360	80023	77658
0.7	52055	97741	84126
0.8	76885	110202	123017
0.9	97741	174569	147278

Source: Survey data, 2013

IV. Conclusions

The study shows that there are indeed net return differentials between the channels in the long run. From the results, it is clear that there was no distinguishable difference in prices offered by the cooperative and private channel, except when farmers sold milk through the traditional channel. Although most smallholder farmers in Kenya market milk through the traditional channel, the net returns that would accrue from their enterprise if they used the modern organized channels is still considerably higher. Nonetheless, it is apparent that the traditional channel is being replaced, albeit slowly, with dairying taking a commercial turn. In addition, the private and cooperative channels appear to be inclusive and farmers less endowed in terms of resources are not excluded.

The informal market still has a role to play till the food safety issues and traceability consolidate the position of the private and cooperative channels. Moreover, there still needs to be a further expansion of the modern channels which can be facilitated by the establishment of milk collection infrastructural facilities at the farm gate, incentive pricing and rewards for quality produce. Till these goals are reached, the quality gap between the traditional and the modern channels should be addressed to a large extent by making popular training and certification programs for small scale milk traders and processors. Such a policy would allow informal players to up their performance, including control quality which would serve the interests of both small producers and consumers.

References

[1]. Business Daily posted Friday, February 19, 2010.

[2]. C. Leksimono, J. Young, N. Hooton, H. Muriuki, and D. Romney. Informal Traders Lock Horns with the Formal Milk Industry: The role of research in pro-poor policy shift in Kenya, ODI/ILRI *Working Paper* 266, 2006.

[3]. D. R. Anderson, J. D. Sweeny, T. A. Williams, J. Freeman and E. Shoesmith. Statistics for business and Economics. Thomson Learning. 2007.

[4]. D. Zwillinger, and S. Kokoska. *CRC Standard Probability and Statistics Tables and Formulae*. CRC 2010. 49ISBN 978-1-58488-059-2.

[5]. I. H. Salgado-Ugarte, M. Shimizu, and T. Taniuchi. Snp6: Exploring the Shape of Univariate Data Using Kernel Kensity Estimators. Stata Technical Bulletin 16: 8–19. Reprinted in Stata Technical Bulletin Reprints, 3, 1993, 155–173. College Station, TX: Stata Press.

[6]. J. Staal,and V. Kumar. Is Traditional Milk Marketing and Processing Viable and Efficient? An empirical Evidence from Assam, India. *Quarterly Journal of International Agriculture*, 49, 2010, 213-225.

[7]. J.C. Huang, and B. J. Frey. Cumulative Distribution Networks and the Derivative-sum-product Algorithm. Proceedings of the Twenty-Fourth Conference on Uncertainty in Artificial Intelligence (UAI), 2008, 290-297.

[8]. J.E. Gentle.*Computational Statistics*. (Springer. ISBN 978-0-387-98145-1. 2009), Retrieved 2010-08-06.

[9]. K. Rajendran, and S. Mohanty. Dairy Cooperatives and Milk Marketing in India. Constraints and Opportunities. *Journal of Food Distribution Research*, 35(2), July, 2004, 34-41.

[10]. K.S. Kiura. A survey of perception of consumers towards plastic packaging used by firms in the dairy industry in Kenya. Unpublished MBA research project, School of Business, University of Nairobi, 2006.

[11]. V. Kumar. Milk Marketing Chains in Bihar: Implications for Dairy Farmers and Traders. *Agricultural Economics Research Review*, 23, 2010, 469-477.

[12]. L. M. Mburu, W. Wakhungu and K.M. Gitu. Determinants of Smallholder Dairy Farmers' Adoption of Various Milk Marketing Channels in Kenya Highlands" Livestock Research for Rural Development 19 (9) 2007, Nairobi, Kenya.

[13]. M. Elizabeth, M. Farina and T. Reardon. Agrifood Grades and Standards in the Extended Mercosur: Their Role in the Changing Agrifood System. *American Journal of Agricultural Economics*, 82(5), 2000, 1170-76.

[14]. Ministry of Livestock Development. National Dairy Master Plan volume II: Action Plan and Implementation Strategy, 2010, Nairobi.

[15]. N. J. Cox. Speaking stata density probability plots. *Stata Journal* 5, 2005, 259–273.

[16]. S. Staal, C. Delgado, and C. Nicholson. Smallholder Dairying Under Transaction Cost in East Africa. *World Development* 25 (5), 1997, 779-794.

[17]. S. Vijay, K. Kalpesh, and S.Raj. Determinants, Costs, and Benefits of Small Farmer Inclusioin in Restructured Agri-food Chains.A Case Study of India. Micro study report of Component 1 (India).Regoverning MarketsProgramme. Indian Institute of Management, 2007.

[18]. S. Wambugu, L. Kirimi, and J. Opiyo. Productivity Trends and Performance of Dairy Farming in Kenya. Tegemeo working paper no 43. Tegemeo Institute of Agricultural Development and policy, Egerton University, 2011.

[19]. S.C. Yoon, K.C. Lawrence, B. Park and W.R. Windham,. Optimization of Fecal Detection Using Hyperspectral Imaging and Kernel Density Estimation. *American society of Agricultural and Biological Engineers*. 2007.