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Household-Level Livestock Market Participation among Southern Rangeland Kenyan Pastoralists

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Despite the well-known potential benefits of engaging in markets, very low levels of market participation are observed among smallholder farm households throughout most of Sub-Saharan Africa. So, what motivates some smallholder pastoral households to produce and participate in the livestock markets in Kenya while others do not? A Double Hurdle model was applied that involved two sequential stochastic processes. The results indicate that livestock farmers make little use of livestock markets, that prices matter with regard to the extent of participation, and that transaction costs matter both in terms of the probability and extent of participation; offering additional evidence in favor of a well-known behavioral irregularity. Policy interventions aimed at facilitating pastoralists' access to education, productive assets such as pasture land, and at reducing transaction costs are central to stimulating pastoral farmers' market participation and escaping semi-subsistence livestock production traps.

Keywords: Pastoralist; Market participation; Transaction costs; Kenya

1. Introduction

Markets and improved market access are critical to improving rural incomes and lifting rural households out of poverty traps, particularly in developing countries (Barrett 2008). Despite the well-known potential benefits of engaging in markets, very low levels of market participation are observed among household farmers throughout most of Sub-Saharan Africa (SSA) (Poulton et al. 2006). However, in spite of low level of markets participation, there is overwhelming evidence that practically all rural farmers depend on trading for some household needs, and hence seek income generating activities (Siziba et al. 2013). This increased dependence on markets puts a premium on understanding household market participation behavior as the foundation for development strategies. This justifies the need for market analyses as it represents a principal guide to the formulation of sectoral and microeconomic policies that aim to improve the welfare of agricultural households. This is because market-based development strategies may fail to facilitate wealth creation and poverty reduction if many households do not participate actively in markets or do not respond to market signals.

As observed by Asfaw et al. (2010), the pathway out of the poverty trap for many SSA countries (such as Kenya) depends on growth and development of the agricultural sector, which in turn creates market opportunities for other sectors either directly or indirectly. The main focus should be to stimulate the integration of subsistence farmers into the input and output markets of agricultural products with a view to increasing their productivity and income levels and hence reducing poverty

(Holloway–Ehui 2002). However, agricultural households often face imperfect or incomplete markets for some goods and factors, which are then non-tradable, and this market failure is associated with costs resulting from distance to markets, poor infrastructure, imperfect information and supervision, and incentive costs (Sadoulet–de Janvry 1995). These are the reasons why many scholars in the world have taken an interest in the effects of transaction costs on market participation (e.g. Goetz 1992, Key et al. 2000, Holloway et al. 2005, Poulton et al. 2006, Bellemare–Barret 2006, Ouma et al. 2010, Amankwah et al. 2012, Kgosikoma et al. 2016). As a result, the reduction of transactions costs, as a means of increasing market participation, has been identified as the main limitation to the development agenda, and therefore this paper is largely restricted to the transaction costs framework, but also considers other non-transaction costs variables in explaining the possible cause of market failures in the livestock industry in Kenya.

In Kenya, there are numerous studies on market participation by smallholders growing crops (e.g. Alene et al. 2008, Omiti et al. 2009, Olwande–Mathenge 2012, Fischer–Qaim 2014) but those focusing on the livestock industry are largely limited to dairy production (e.g. Burke et al. 2015). To the best of my knowledge, there is no nationwide empirical study on the pastoral livestock market participation except for a Kenya-Ethiopia cross border study by Bellemare and Barret (2006). The conceptual and limited empirical evidence available on pastoral livestock farmers' market participation casts some doubt on attempts to facilitate national "self-sufficiency" in livestock commodities or, more generally, to induce vigorous supply response or broad-based rural welfare gains through trade and price policy instruments alone, as instituted in Kenya three decade ago (GoK 1997). The present study attempts to bridge this gap of information with a special focus on pastoral livestock marketing in the southern rangelands (SR) zone of Kenya. This zone was found fit for this analysis because it is one of the potential livestock producing and marketing areas in Kenya, accounting for over 32.8% of the total 75.8% of the national livestock herd found in arid and semi-arid lands of Kenya (GoK 2010). In this zone, it is also common to see some agricultural pastoral households who participate in livestock markets and respond to market signals. So, what motivates some households to produce and participate in the livestock markets while others do not? This study addresses this question with the objective of determining the effect of farm and household characteristics as well as market performance and institutional factors on the decisions to participate and sell livestock in the SR of Kenya. The novel aspects of the study are twofold: Firstly, the probability of market participation by agricultural pastoral household and the intensity of participation are incorporated in the same analysis. Secondly, the focus of the study is on livestock markets in the SR of Kenya, which is often neglected by researchers and policy makers, due to data limitations (the gathering of which requires a significant investment in time and money) and the difficult terrain in which the livestock are produced. It is basically an output-oriented microeconomic analysis incorporating transaction cost factors.

In trying to understand the possible reasons why some household participate in the livestock market while others do not, the rest of the paper is organized into three sections. In section two, I review the various theoretical frameworks of household market participation and present an analytical framework appropriate for this analysis,

which will assist in model formulation and estimation procedure. Section three follows in describing the farm survey data and the methodologies used, before presenting and discussing the econometric results. The last section closes the paper with concluding remarks and policy implications.

2. Theory Background and Literature Review

Many authors have recognized that analysis of smallholder market participation cannot be carried out using standard microeconomic models. Special theoretical and empirical models are required to understand the behavior of smallholder farmers in market participation. This section provides the keys theoretical frameworks in the market participation literature. Subsequently, the theoretical model of market participation is discussed, which provides the main constituents of the framework for the study of livestock market participation behavior among pastoral farm households in the SR of Kenya.

2.1. Theoretical Framework of Market Participation

The theory of market participation has developed various theoretical approaches and prominent among the critical ones are asset-based theory (ABT), transaction cost theory (TCT) and agricultural developmental theory (ADT). The ABT is well summarized by Boughton et al. (2007), who held that market participation depends fundamentally on households' initial asset endowments with market-based development strategies favoring initially wealthier household. The ADT views market participation as both a cause and a consequence of economic development[4] (Barrett 2008). The TCT, which is part of the New Institutional Economics (NIE), postulates that economic activity does not occur in a frictionless environment, but rather is always accompanied by the transaction costs of carrying out the exchange which are directly influenced by the efficiencies of the institutions (Key et al. 2000, Renkow et al. 2004). From the time TCT was coined, the theory has gained popularity in explaining farmer market participation in different production enterprises (e.g. Williamson 2000, Alene et al. 2008, Ouma et al, 2010). The present study contributes to this momentum and TCT nested in the NIE forms the theoretical foundation for gaining insight into the reasons why some pastoral farm households will participate in the livestock market while others will not, applying cross sectional data of farmer-specific and input variables for smallholder pastoral livestock farmers residing in southern rangelands of Kenya.

[4] Cause of Economic Growth because market participation may stimulate an increase in aggregate demand for products (inputs and outputs), which may further stimulate a rise in agricultural output if the economy has unused resources. Consequence of Economic Growth because an increase in agricultural output can improve people's income and living standards. Further, higher agricultural output and incomes increase government tax revenue (both foreign and domestic), making it easier for governments to finance measures to reduce poverty, increase health care provision and raise educational standards, without having to raise tax rates.

Market participation depends on the status of institutions, and institutions are transaction cost minimizing arrangements which may change and evolve with changes in the nature and sources of transaction costs. TCT is a major theory of NIE; a school of economics that resulted following a refinement of the old institutional school pioneered by Commons, Veblen and Hamilton's which argued that institutions were a key factor in explaining and influencing economic behavior. However, critics of the old institutional school of thought argued that it operated outside of neoclassical economics, since the school did not provide any quantitative theory from which reliable generalizations could be derived or sound policy choices could be made. The NIE by Williamson acknowledges the important role of institutions, but argues that one can also analyze institutions within the framework of neoclassical economics. Therefore, under the NIE, the assumption of self-seeking individuals attempting to maximize an objective function which is subject to constraint(s) still holds, but some of the assumptions of neoclassical economics such as perfect information, zero transaction costs, and full rationality are relaxed. The NIE thus represents an expanded economics that focuses on the choices people make, while at the same time allowing for factors such as occurrence of information and human limitations on the processing of information, evolution of norms, and the willingness of people to form bonds of trust, which all contribute to cost of exchange or transaction costs. The costs of exchange depend on the efficiency of institutions of a country, which includes the legal system, political system, social system, educational system, culture, the financial system, market system, and so on. In effect, it is the institutions that govern the performance of an economy by minimizing the transaction costs economic agents incur in market participation. Since the majority of agricultural farm households in the SR of Kenya are located in remote areas with poor transport networks and market infrastructure, contributing to the high transaction costs faced, then TCT framework seems ideally suited in explaining the market participation behavior of its pastoralists.

2.2. Theoretical Model of Market Participation analysis

Pursuant to the underlying theoretical background of TCA in NIE framework, this paper considered livestock farmers' participation in the market and hypothesized that the household pastoral farmers always tend to avoid participation in the market if transaction costs are high. As a result, the reduction of transaction costs as a means of increasing market participation is identified as a goal of development policy. Therefore, in this context, those factors that influence the decision to participate as well as the level of participation are commonly referred to as transaction costs. These costs are attributable to endogenous factors related to household characteristics and other factors, which are exogenous to the household. The choice to participate in the market is always influenced by expected net returns that are assumed to be guided by transaction costs. Positive net returns result in market participation while negative net returns lead to non-market participation (Boughton et al. 2007).

Pastoralist households in the SR of Kenya routinely make decisions as to whether to sell livestock, the principal form of wealth in the region. Under the hypothesis maintained, that market behavior is driven by a household's objective of maximizing profit it enjoys, one can usefully focus attention on the choice problem

that relates optimal and, of course, non-negative quantities sold, Q_s, to household attributes and the environmental factors that condition market behaviors. Recognizing that smallholder pastoral farm households in the SR of Kenya typically face natural, market and social uncertainties that influence their decision behavior, the optimal level becomes unattainable and therefore they are forced to 'satisfice' (settle on an acceptable level) often referred to as 'bounded rational' behavior. Bounded rationality can be expressed by assuming complexity in the transaction cost function, which includes observable and non-observable costs associated with livestock marketing, making the farmer unable to evaluate and process the available information in time, the so-called cognitive limitations of their minds. For a representative household, we assumes that the cost function may depend on household specific characteristics that include education attainment, gender, household size and age reflected in the vector (Z), household endowment such as land size and livestock number reflected in the vector (G), information asset such as television and mobile phones reflected by vector (A), and institutional factors represented by livestock prices, access to extension service, access to market information, access to financial institution and group affiliation reflected in vector (Y) and others such as off-farm sources of income or liquidity which may be earned or unearned (K), and household wealth index reflected by vector (D).

$$C = c(Z, G, A, Y, K, D) \quad (1)$$

The households' choice to satisfice profit (π), subject to the complex cost function represented as;

$$Max\ f(\pi) = PQ_s - c(Z, G, A, Y, K, D) \quad (2)$$

Subject to the constraint that $\pi = R - C \geq \pi^*$
Where P and Q_s are as earlier defined and π^* is the firm specific minimum acceptable profit level referred to as lower bound.

In this profit function, transaction costs are the major impediments and determinants of market participation. Although a livestock market does exist in the SR of Kenya, the gains for a particular household may be below or above cost, with the result that some households will use the market while others will not. The definition of market failure is thus household specific and not commodity specific, as the same commodity can be a tradable for one household while being a non-tradable for another. Another impediment in solving equation (2) is that a smallholder does not possess perfect knowledge of the transaction costs contained in the cost function constraints in this theory. This information asymmetry forces the farmer to have only two decision; first, the decision whether or not to participate in the livestock market and second, the number of livestock to supply in order to maximize household welfare given the fixed and variable transaction costs faced by the household (to be revisited in section 3.2). The two decisions may be made in a single (simultaneous) or a sequential two-step process. In the sequential process, the farmer decides whether or not to participate in the market and, if they choose market participation, the next step in the decision is about the quantity to sell. An increasing body of research on

sequential decisions on market participation has been accumulated in recent years (e.g. Holloway et al. 2005, Boughton et al. 2007, Omiti et al. 2009). Simultaneous decision-making means that the farmer makes choices about market participation and quantity at the same time (Abdoulaye–Sanders 2005). In this study, a sequential mode of decision making is assumed because pastoral households make the discrete participation decision at home, not yet knowing information available only at the market. In the second stage, those households that have chosen to participate in the market proceed to market, received additional information, and would make their continuous sales.

3. Material and Method

This section describes materials and specific methods used in the present study. The study is based on national household survey data on livestock production for the SR of Kenya. The section is organized into three sub-sections. Study areas and database used are described in section 3.1, while the econometric model of market participation applied in the study is explained in section 3.2. In this section, special theoretical models that are required to understand the behavior of smallholder pastoral farmers in market participation are discussed. And finally, the variables used in empirical model are presented.

3.1. Study area and Data

The main task of this study was to appropriately analyze the constraints limiting pastoral farm household in participating in livestock markets. I therefore used the national cross-sectional farm household data that was collected jointly by the University of Nairobi and the Kenya Agricultural and Livestock Research Organization during September to October 2013[5]. In this survey, Ellis's (1993) definition of peasants was adopted to define agricultural pastoral farm households as a group of persons who derive their livelihoods mainly but not exclusively from agriculture, predominantly utilize family labor in farm production, are characterized by a partial engagement in input and output markets, and are both producers and consumers of agricultural goods and services. However, the term peasant was avoided due to the negative connotations usually associated with it in preference for the more neutral term, households. Indeed, the agricultural pastoral farm household defined conforms with the recent paradigm production trend manifested by a gradual shift from the traditional nomadic pastoralism to sedentary pastoral farming (Mwang'ombe et al. 2009, Bebe et al. 2012). Therefore, the model of smallholder pastoral farm household behavior hypothesized in this study describes a semi-commercial family farm. And in total, 1512 pastoral households were selected for analysis and were confined to ten counties, namely Kajiado, Makueni, Kitui, Machakos, Narok, Taita-Taveta, Tana-River, Lamu, Kwale and Garissa, all in the SR of Kenya and the predominent production systems (agro-ecological zones) available within each county

[5] Household sampling and data collection were generously funded by the Swedish Government under the Agricultural Sectoral Development Support Program.

were considered during selection. The basis for selecting these counties was because livestock farming is the mainstay among the households and cattle grazing is generally carried out in association with goat and sheep production and, to a lesser degree, cropping. Output and input data were extrapolated on the basis of the prevailing market values. In this study, it is also worth noting that household analyses were grouped into two classes based on the livestock production enterprises: cattle representing large ruminant, and shoats representing small ruminants i.e. sheep and goat. The grouping of sheep and goat together was prudent because the two species of livestock share the same inputs and are marketed together, and therefore the reason for market participation among such households is assumed to be the same.

3.2. Econometric Model of Market Participation

There is a considerable number of studies on agricultural household market participation that have largely modeled both/either output and/or input market participation decisions as a single or sequential two-step decision process. These studies have used either the sample selection model of 1979 by Heckman, the Tobit model of 1958 or the double-hurdle models developed by Cragg in 1971. The sample selection model of Heckman is ideally used to deal with non-random samples as a result of survey design, non-response to survey questions, sample attrition or the specific attributes of the variable being analyzed. The Heckman model also addresses the problem associated with zero observations generated by non-participation decisions, arguing that an estimation on a selected subsample, as is the case with Tobin model (i.e. censored estimation), results in sample selection bias. The Heckman model overcomes these problems by undertaking a two-step estimation procedure (known as Heckit). This is done by computing a selection term or Mills ratio from the first equation (selection model) and including it as a regressor to correct for self-selection in the second stage regression involving observations from the selected sample usually referred (Dow–Norton 2003, Wooldridge 2010). This selection bias was viewed by Wooldridge (2010) as the omitted variable in the selected sample which is corrected by this procedure. The model also assumes that different sets of variables could be used in the two-step estimations. As opposed to the Heckman model, the Tobin model is a type of corner solution outcome and accounts for the clustering of zeros due to non-participation. The Tobit estimator fits conceptually well when we think of decisions on market participation and degree of participation in livestock markets as being made simultaneously. However, a major limitation with the Tobit model is that it assumes that the same set of parameters and variables determine both the probability of market participation and the level of transactions, and the model is too restrictive as it assumes all zeros to be the respondents' deliberate choices.

Cragg (1971) modifies the Tobit model to overcome the restrictive assumptions inherent in it and developed the 'Double Hurdle' (DH) or 'Two-stage' model to tackle the problem of too many zeros in the survey data by giving special treatment to the participation decision and also allowing different mechanisms to determine the discrete probability of participation and the level of participation. In this model, two hurdles must be crossed which are decisions to participation and the level of participation. Since the decision to participate in a livestock market and

supply are assumed sequential, the DH model was found ideal as it allows for a separation between the initial decisions to participate (Y>0 vs Y=0) and the decision of how much Y given Y>0. Further, the DH model is appropriate for analyzing the possibility that the factors influencing a farmer's decision to participate in the livestock market may not affect the quantity sold. In addition, the model allowed us to consider that the same factor can potentially affect participation and the amount sold in different ways. Although more recently Burke et al. (2015), tried to modify the Tobin model and described a triple-hurdle model of the ordered Tobit model that includes non-producers, the focus for this analysis was purely on farmers engaging on livestock production, and since our aim was to provide an insight into those factors that would influence their decisions on market participation, therefore the DH model was found to be most appropriate.

The DH model applied in this research is a parametric generalization of the Tobit model, in which two separate stochastic processes determine the decision to participate and the level of participation. The first equation in the DH model relates to the decision to participate and can be expressed in Probit formulation as follow:

$$P(Y_i = 1|X_i) = P(Y_s > 0) = f(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_K x_K + \varepsilon_i)$$
$$P(Y_i = 1|X_i) = f(X_i \beta_i) + \varepsilon_i \quad (3)$$

Where $f(.)$ is a function taking on values strictly between zero and one for all real numbers and *Y* takes the value of one if a household made any positive decision to participate in the livestock market and zero if not. *X* is a matrix of factors (transaction and other non-transaction cost factors which include household characteristics, household endowment, transport assets, information assets, institutional asset etc.) that affect the discrete probability of participation by pastoral farmers, β_i is a vector of parameters and ε is the error term assumed to be normally distributed disturbance with mean zero and standard deviation of σ; and captures all unmeasured variables.

The second hurdle, which closely resembles the Tobit model, is expressed by a truncated regression function. The main advantage of the truncated normal distribution over the lognormal mostly applied under Heckman procedure is that it nests the usual Tobit Model (Wooldridge 2010). The model was specified as follows;

$$Q_i^* = Z_i' \gamma_i + \mu_i \quad (4)$$
$$Q_i = Q_i^* > 0 \text{ and } Y_i > 0$$
$$Q_i = 0 \text{ Otherwise}$$

Here, Q is the proportion of number of livestock sold; i = Cattle, sheep and goat (shoats henceforth); Z defines a matrix of factors that determine intensity of participation and $\gamma_i$is a vector of parameters; μ is the random disturbance for unit i for intensity equation. Since the decisions by pastoral household are assumed to be sequential, following Smith (2003), then the error terms ε_i and μ_i are independently

and normally distributed: $\varepsilon_i \sim N(0,1)$ and $\mu_i \sim N(0, \sigma^2)$, and thus we have the following expression: $\begin{pmatrix} \varepsilon_i \\ \mu_i \end{pmatrix} N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{matrix} 1 & 0 \\ 0 & \sigma^2 \end{matrix}\right]$[6].

Because of the stochastic nature of Market Participation and outcome model, I used the maximum likelihood (ML) estimation procedure. The two stages or double hurdle are estimated separately based on the assumption that the respective error terms (ε and μ) are not correlated. The dependent variable in the Probit model (3) was whether or not a farmer participated in the market while in the truncated regression models (4) represent the quantities sold. Since the probability equation does not show by how much a particular variable increases or decreases, the likelihood of participating in the livestock product market was considered by comparing probabilities of that result when dummy variables take the values 1 if participated in livestock product markets and zero otherwise, while holding other independent variables at their sample mean values (Wooldridge 2010). Now, if we assume that we have a random sample of size N, the ML estimate of β is the particular vector $\hat{\beta}^{ML}$ that gives the greatest likelihood of observing the sample $\{q_1, q_2, .. q_N\}$ conditional on the explanatory variables x. By assumption, the probability of observing $\{q_1 = 1\}$ is $f(x\beta)$ while the probability of observing $\{q_1 = 0\}$ is $f(1 - x\beta)$. It follows that the probability of observing the entire sample is

$$L(q|x;\beta) = \prod_{i\in l} f(x_i\beta) \prod_{i\epsilon m}[1 - f(x_i\beta)] \quad (5)$$

where l refers to the observations for which $q = 1$ and m to the observations for which $q = 0$. We can rewrite this as:

$$L(q|x;\beta) = \prod_{i=1}^{N} f(x_i\beta)\,[1 - f(x_i\beta)]^{(1-q_i)} \quad (6)$$

Because when $y = 1$ we get $f(x_i\beta)$ and when $y = 0$ we get $1 - f(x_i\beta)$, the log likelihood for the sample is:

$$lnL(q|x;\beta) = \sum_{i=1}^{N}\{q_i ln\, f(x_i\beta) + (1 - q_i) ln[1 - f(x_i\beta)]\} \quad (7)$$

From equation 7, we can get the ML estimates of β that maximizes this log likelihood function. If $f(x_i\beta)$ is the standard normal cumulative distribution function (CDF) we get the Probit estimator as:

$$lnL(q|x;\beta) = \sum_{i=1}^{N}\{q_i ln\, \Phi(x_i\beta) + (1 - q_i) ln[1 - \Phi(x_i\beta)]\} \quad (8)$$

The second hurdle involves the truncated normal regression model (equation 4) and I followed the Wooldridge (2010) estimation procedure. The classical model assumptions are μ must not only be independent of Z, but also normally distributed,

[6] Alternatively, if both decisions are assumed to be made jointly then the error term could be defined as $(\varepsilon_i, \mu_i) \sim N(0, \theta)$ where $\theta = \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}$

$\mu|\boldsymbol{z}\sim N(0,\sigma^2)$. To estimate γ_i (along with σ) we need the distribution of Q_i given that $Q_i \leq c_i$ and $\boldsymbol{z_i}$. This can be expressed as:

$$g(Q|\boldsymbol{z_i}, c_i) = \frac{\mathrm{f}(Q|\boldsymbol{z_i}\gamma_i,\sigma^2)}{\mathrm{F}(c_i|\boldsymbol{z_i}\gamma_i,\sigma^2)},\ Q_i \leq c_i \quad (9)$$

where $\mathrm{f}(Q|\boldsymbol{z_i}\gamma_i,\sigma^2)$ denotes the normal density with mean $\gamma_0+Z_i'\gamma_i$ and variance σ^2 and $\mathrm{F}(c_i|\boldsymbol{z_i}\gamma_i,\sigma^2)$ is the normal cdf with the same mean and variance, evaluated at c_i. By taking the log of equation 9, summed across all i, and maximizing the result with respect to γ_i and σ^2, then we obtain the maximum likelihood estimators which leads to consistent approximately normal estimations.

3.3. Variables used in model estimations

The dependent variable, market participation, is measured by both the probability of participation and the number of livestock sold in the market. Thus, there are two dependent variables for each household. The first variable indicates whether the household participates in the market. This is an indicator variable, which takes the value of one if the household participates, and zero otherwise. For those who participate, the second variable indicates the total number of livestock marketed, which constitutes the level of participation. The average market participation is about 35.9% and 45.3% for cattle and shoats respectively, and that of the degree of participation is 1.488 and 3.651 for cattle and shoat respectively. These results indicate a moderate market orientation of poor pastoral smallholders households in the study area and confirmed the long-observed and puzzling limited use of livestock markets by east African pastoralists, who hold most of their wealth in the form of livestock, and who are regularly confronted with climatic shocks that plunge them into massive herd die-offs and loss of scarce wealth (Bellemare–Barrett 2006, Barrett 2008).

To determine factors affecting participation and intensity of participation, a number of covariates analyses were conducted to reflect the potential effects of observed covariates and the transaction costs[7]. Transaction costs are the barriers of access to market participation by resource-poor smallholders, and are normally defined as all costs of entering into contracts, exchange or agreement, searching for trading partners, screening potential candidates, obtaining and verifying information, bargaining, transferring the product, monitoring, controlling and enforcing the transaction (Randela et al. 2008). At best, these costs are partly observable. The variables that were included in the two models and their description statistics are summarized in Table 1. The choice of the variables used in this study is largely based on work by Bellemare and Barrett (2006), Barrett (2008), Randela et al. (2008), Alene et al. (2008), Ouma et al. (2010) and Rutto et al. (2013) who extensively reviewed factors that influence farmers to participate in marketing. Based on the reviewed literature, it was found that market participation cannot be explained by a single factor (such as price incentives), but other variables classified as household characteristics, household endowment, transport assets, information asset, and institutional asset.

[7] Note the result covariant analysis is not presented.

Table 1 Descriptive statistics of the variables used in Double hurdle estimation

	Cattle (N=1245)			Shoats (N=1512)		
Variable Name	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Dependent variables						
Market participation	0.359±0.480	0	1	0.453±0.498	0	1
Livestock sold*	1.488±4.492	0	80	3.651±7.801	0	105
Independent variables						
Household characteristics						
Gender	0.868±0.338	0	1	0.859±0.349	0	1
Age	48.818±15.030	15	102	49.281±14.962	15	102
Education level	6.160±5.209	0	19	6.006±5.131	0	19
Household endowments						
Land asset (ha)	33.388±158.851	0.13	3002	28.758±144.864	0.13	3002
Livestock produced	18.378±49.463	1	958	33.284±72.003	1	1,307
Transport assets						
Own Car	0.0305±0.1721	0	1	0.0284±0.1663	0	1
Own Motorcycle	0.0996±0.2996	0	1	0.0893±0.2853	0	1
Information assets						
Own TV	0.13656±0.3435	0	1	0.1389±0.3459	0	1
Own Radio	0.68196±0.4659	0	1	0.6528±0.4762	0	1
Own cell phone	0.7575±0.4288	0	1	0.7579±0.4285	0	1
Institutional factors						
Distance to market	9.578±14.273	1	85	11.042±15.51	1	85
Average selling price*	25,812 ±11,941	1700	80,000	3,378 ±1,135	250	9,500
Credit services	0.0129±0.1127	0	1	0.0099±0.09914	0	1
Veterinary services	0.36467±0.4815	0	1	0.3307±0.4706	0	1
Livestock information	0.15347±0.3605	0	1	0.1138±0.3176	0	1
Market information	0.25067±0.4335	0	1	0.2474±0.4316	0	1
Others						
Off-farm Income	76,940±196,217	0	3,420,000	76,388±183,126	0	3,420,000
Per capita wealth	84.35±181.93	0	2,417.71	78.75±174.50	0	2417.71

Note: * Cattle, N=447; Shoats, N=683

Source: Own construction from National household data of September-October 2013

The household characteristics included were gender, age and education level of the household. The descriptive statistic indicates that more than 85% percent of the households are male-headed. This variable was categorical with 1 representing if the household is male-headed and 0 otherwise. This variable capture differences in market orientation between males and females, with males expected to have a higher propensity to participate in livestock markets than females, hence positive sign is expected. The other variable in this category was age of household head, which was measured in years. The average age of the sampled household was 49 years which indicate that majority of the sampled households are relatively old adult, which is expected to have a positive influence on both livestock production and market participation. Older producers are expected to be more experienced, have established contacts and hence easier market access. Next in line was the number of years the household head had spent acquiring formal education. More years are assumed to be a proxy for better education, and hence for better negotiation skills and better use of available information, and thus a positive effect on market participation. For the sampled households, the average level of education was about 6.0 years with a high

standard deviation of over 5.1 years indicating that a large proportion of the sampled households do have formal education of at least one year; a figure which shows a significant rise in literacy among pastoral communities.

On household endowments assets, two variables were included in this category. One of them was the number of livestock owned measured in livestock head count. The greater the number the more wealth and more surpluses for the market. For the sampled households, total livestock owned averages 18.378 cattle and 33.284 shoats, respectively. The other variable in this class was pasture land size and was measured in hectares. More hectares imply higher number of livestock production and excess marketed surplus; hence a positive effect is expected. On average, the sampled household operates on about 28.758 hectares of land though the variation is quite large across households as is evident in the large standard deviation of more than 144.864. In addition, security of land tenure is a wealth indicator and also influences the production objective function and types of initiatives that a household would undertake.

On transport assets, dummy variables for car or motorcycle ownership were included to assess households' ease of transportation to livestock markets and therefore a positive relationship was expected. However, less than 1% indicated owning a transportation asset. A positive relationship was expected between information assets and household market participation. Ownership of communication assets eases access to information on prices and other market incentives. To capture access to information and communications technology, the author used a dummies representing proxy for the information assets variable such as mobile phone, TV or radio. Mobile phone penetration topped with over 75% of the population followed by radio with over 65%. This is very close to the observation by Wickramasinghe et al. (2014) on smallholder agricultural households in Papua New Guinea.

The author also included various proxies for capturing the institutional factors that are considered transaction cost minimizing arrangements; hence positive contribution to market participation. Transaction costs are not measurable using available data and are approximated by distance to markets, access to credit and market information; a common approach in empirical research. In this study, rural farm households in the study area are on average about 10 km away from nearest market center. For a better and more efficient livestock market, prices are expected to act as an incentive to market participation, hence a positive effect. In this study, the average prices, ranges from Ksh 25,812.75 and Ksh 3,378.45 for a cattle and shoats respectively. Access to credit and the use of veterinary services is limited with the latter provided to a mere 36% of the farm households, while the credit facilities are extended a little less than 1%. Access to market and livestock information is hypothesized to play a significant positive role in influencing market participation. The result also shows that equivalent to 25% of all households rearing livestock had access to market information, while only 15% accessed information related to livestock production and marketing.

Other variables included in the analysis were off-farm income and per capital income; and the descriptive statistic shows that farmers operate at a different wealth index. Off-farm income was viewed as an alternative to livestock cash incomes and was therefore expected to result in an increase in market access and a reduction in entry barriers. Per capital wealth is expected to have a controversial effect on

market participation. High per capita wealth per day may reduce market entry barriers for smallholder producers resulting in a high level of sale. Similarly, high per capita wealth per day may limit number of livestock offered for sale, hence a negative effect.

4. Results and discussion

In this section, I discuss the results of the analysis of market participation behavior of pastoral farm households of the SR of Kenya. The results are organized under two main topics. The first topic presents and discusses the econometric results of the double-hurdle estimation that corresponds to the model of sequential household choice. In this section, the determinants of the probability of livestock market participation and the degree of participation are presented and discussed. In the second topic, I present and analyze the degree of market participation.

4.1. Determinants of the Probability of Livestock Market participation

This section discusses results of the significant factors that determine the probability of market participation by poor pastoral farm households. As explained when the model was specified, the dependent variable used in determining the probability of market participation is "market participation". The Probit regression was designed to use a mix of continuous and categorical predictor variables to predict a categorical outcome – "market participation". All variables mentioned in Table 1 were considered for the Probit model and the results are summarized in Table 2 below. The analysis find three household characteristics that influence market participation: the gender, age and education level of the household head. On gender, the coefficient had the expected sign (although significant in case of cattle) suggesting that being a male-headed household increases the likelihood of market participation. This seems to suggest that male-headed households face less resource constraint for effective engagement in markets. A closely related result was found by Bellemare and Barrett (2006) where female-headed households among pastoralists were found to participate less by buying and selling fewer animals than their male counterparts. The negative significant of age contrary to the *a priori* expectation confirms the general observation that farming operations in the study area are increasingly manned by the elderly (as old as 102 years). A possible explanation that can be advanced for this is that older farmers view farming as a way of life rather than as a business and have a strong emotional or almost biological connection with farming and land. The result is also found to be consistent with the Alene et al. (2008) argument that market participation declines with age since the older people are perceived to be risk averse and reluctant to adopt technology. Lower education level is inversely related to the probability of market participation but propensity to participate increases with advancement in education (variable Education level squared). High level of education gives an indication of the household's ability to have better access to understanding and interpretation of information than others, which may lead to the reduction of search, screening and information costs.

Table 2 Determinants of livestock market participation decision

	Cattle		Shoats	
Variable Name	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Constant	0.02556	0.21881	0.3171*	0.18666
Household characteristics				
Gender	0.48240***	0.12513	0.05444	0.09892
Age	-0.01174***	0.00273	-0.00918***	0.00238
Education level	-0.17947***	0.02691	-0.07991***	0.02305
Education level squared	0.00866***	0.00159	0.00238*	0.00140
Household endowments				
Land asset (ha)	0.00115***	0.00044	0.00194***	0.00068
Livestock produced	0.00265***	0.00103	0.00313***	0.00068
Transport assets				
Own Car	0.25585	0.23657	0.18995	0.21948
Own Motorcycle	0.26886**	0.13314	0.30384**	0.12405
Information assets				
Own TV	0.19449	0.12045	0.02383	0.10680
Own Radio	0.20582**	0.09053	0.05091	0.07492
Own cell phone	-0.10996	0.09591	-0.02772	0.08161
Institutional factors				
Distance to the market	-0.01414***	0.00323	0.00132	0.00234
Credit services	0.29621	0.32694	0.17448	0.32967
Veterinary services	0.16275*	0.08458	0.21289***	0.07330
Livestock information	-0.10598	0.11144	-0.01285	0.10793
Market information	-0.06210	0.09415	0.07126	0.08048
Others				
Off-farm Income	-0.18101***	0.06681	-0.02634	0.04956
Per capita wealth	0.00224***	0.00048	0.00008	0.00027
LR chi2(18)	205.98***	-	149.05***	-
Pseudo R2	0.1271***	-	0.0718***	-
Marginal effects	0.35191	-	0.4594	-

*Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.
Source: own calculations.

One of the biggest challenges to the pastoral household involvement in the process of agricultural transformation in Kenya can be associated with the nature and quantity of household endowment factor at the farmer's disposal (Manyeki–Kotosz 2018). Household endowment of assets was measured in terms of number of livestock and size of the land in hectares owned by the household. Both variables exhibited the expected positive impact on the likelihood that participation will occur. This result is supported by Heierli and Gass (2001) who found that acquisition and ownership of productive assets (e.g. cattle) can pave the way for a family to participate in economic activities. Ownership of transport equipment such as motorcycles has a positive impact on market participation by reducing the cost of transporting output from the farm to the market. A similar finding was reported by Key et al. (2000). On

information assets, ownership of radios was found to be positive as expected and statistically significant. This result concurs with Ouma et al. (2010) findings, though in Ouma's case, ownership of radios turned out to be statistically insignificant in influencing market participation for both sellers and buyers. This is possibly because communication assets are more useful in accessing market information and in facilitating transactions in the region. In Kenya, currently there has been an increase in radio stations in local languages and agricultural production price information is nowadays also announced through these channels.

Turning to the institutional factors, two variables found to be significant and to have the expected sign were distance to market and access to veterinary services. Distance to market is considered a proxy for transaction costs and, the farther away a household is from the market, the more difficult and costly it would be to get involved. Thus, greater distance to the market increases transaction costs, which are associated with institutional failures. Access to veterinary services had the expected positive sign and was statistically significant. Veterinary activities make vital contributions to all stages of livestock production from 'farm to fork' by reducing animal diseases at farm and market level and public health risks, and attaining food quality and safety standards. The coefficient for off-farm income was negative and significant, a result that did not conform to expectations that households with access to off-farm income would result in increase in market access and reduction in entry barriers. A possible explanation for this result could be that farmers may be involved in substitute high-value enterprises rather than livestock farming, thus motivating them to subsistence livestock production rather than producing surplus for sale. The coefficient for per capita income was positive and significant. This implies that, high per capita wealth per day would reduce market entry barriers for smallholder producers resulting to high level of sale. The Chi-square value (LR chi2(18)) showed that likelihood ratio statistics are highly significant ($P < 0.000$) suggesting that the model had strong explanatory power.

4.2. Determinants of the Level of Livestock Market Participation

Having established the important factors that influence the probability of smallholder market participation, the question remains as to why there exists such a low rate of participation (36% and 45% for cattle and shoat, respectively, of the total observations). This question was addressed by determining the factors influencing the extent of market participation in livestock marketing. The truncated regression model was estimated with the livestock sale volumes being endogenous variable. A step by step process of deletion of insignificant variables reduced the number of significant variables to thirteen, as shown in Table 3. Here, age, education, number of livestock produced, cell phone and shoats' and cattle price, distance to market, access to veterinary services and livestock information and per capital income emerged as the significantly factors that influence the household behavior toward livestock marketing. With the exception of access to the veterinary services that had the unexpected negative sign, all the other significant variables portrayed the a priori expected influence on the degree of market participation. Health of an animal is an important determinant of the market price it can obtain. However, the negative

influence to shoats marketing could perhaps mainly be due to an inadequate recognition of the contributions shoats make to the livelihoods of the poor pastoralists, resulting in underutilization of professional health services following animal health services liberalization.

Table 3 Determinants of level/degree of livestock market participation

	Cattle		Shoats	
Variable Name	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Constant	2.383186*	1.29742	0.62503	1.19595
Household characteristics				
Gender	0.27852	0.19948	-0.02964	0.17119
Age	-0.00781**	0.00375	-0.00471	0.00336
Education level	-0.03026***	-0.0108	-0.00556	0.00985
Household endowments				
Livestock produced	0.00447***	0.00089	0.002832***	0.00039
Transport assets				
Own Motorcycle	-0.04679	0.13837	-0.21717	0.13689
Information assets				
Own cell phone	0.30865***	0.11511	0.12124	0.10536
Institutional factors				
Distance to market	-0.00250	0.00500	-0.01017*	0.00539
Credit services	0.39071	0.49844	-0.98364	0.61863
Veterinary services	0.03394	0.10909	-0.19773*	0.10398
Livestock information	0.11325	0.13724	0.26281*	0.13585
Price of cattle	0.03560	0.08700	0.18144**	0.08737
Price of shoats	-0.19286*	0.10308	-0.04630	0.09211
Others				
Per capita wealth	0.00036	0.00022	0.00042*	0.00022
/sigma	0.66596***	0.03862	0.74178***	0.03410
Wald chi2(13)	62.65***	-	112.98***	-

**Significant at 10% level; **Significant at 5% level; ***Significant at 1%*
Source: own calculations.

Price information is a vital instrument during marketing because it informs the farmers about marketing conditions. Farmers who have price information prior to marketing tend to sell more of their produce than those without. However, the analysis produced varying results, with livestock own price in both cases being insignificant. Cattle price was found to have a complementary effect to the extent of shoat market participation while shoats prices portray a substitution effect to cattle market participation. The Wald Chi-square value (Wald chi2(13)) showed that statistical tests are highly significant ($P < 0.000$) suggesting that the model had strong explanatory power.

5. Conclusion

This paper contributes to empirical evidence of the probability of market participation by the Kenyan SR agricultural pastoral household, and intensity of their participation, which is often neglected by researchers due to data limitations. Applying the Double Hurdle estimation reveals that market participation is governed by two independent decisions: the decision to participate in the market and the decision on the extent of participation. The empirical results show that pastoralist households in the southern rangelands counties of Kenya make relatively little use of livestock markets with an average market participation ranging between 35.9–45.3% and intensity of participation between 1.488-3.651 animals annually. The estimation results show that these two separate decisions are determined by different sets of factors. The results confirmed the existence of a significant relationship between gender, age and education level of household head and household livestock market participation. This finding brings to the fore the importance of a demographic policy which takes into account equity in resource distribution, literacy and youth empowerment. In addition, physical linkage of production areas to markets is a policy that could improve local and national livestock trade. Such linkages include the establishment and maintenance of roads and road security, as well as market information services, thus reducing the transaction cost. These high transaction costs emanate from, among other factors, the long distances involved in trekking animals to market and high transport costs. Other issues that hamper the effective participation of producers include their limited education and poor knowledge of the national language. However, a finding worth noting is the effect of land size towards household livestock market participation. The positive direction of the impact of land size is probably an indication that increased market participation is also a function of land productivity. This holds true from our earlier studies (Manyeki– Kotosz 2017, 2018). It therefore implies that any initiative in the livestock industry to increase land size must be preceded with efforts to increase the productivity of the land currently at farmers' disposal.

In summary, the policy and programmatic implication of these results is not that the ongoing public investment effort in market access in Kenya has no role to play in increasing market participation, but that, with current levels of production technology, increased private asset endowments (such as herd size and land quality) appear necessary for households to be able to take advantage of the reasonably open access to livestock markets in Kenya, and of any associated public investments in improving market information flow or physical access to markets. However, it is important to note that the study uses cross-sectional data that mainly focused on the production side and that did not capture changes over time. A longitudinal study would serve to capture changes over time with regard to smallholder pastoral livestock production and marketing. In addition, a consideration of other supporting market infrastructural facilities such as slaughterhouses, cooling facilities, meat processing and climate could help in better understanding the phenomenon. Future research could also investigate whether there is a possibly that farmers decisions are made simultaneously.

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