

# Transaction Costs and Market Participation Among Livestock Producers in Southern Rangelands of Kenya

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**Abstract:** This paper aims to investigate the role of transaction costs in determining market participation of smallholder livestock farmers in the southern rangelands of Kenya. A double-hurdle model was used to establish whether or not a household participated in cattle and small ruminants markets, and how much they sold conditional upon having decided to be market participants. Secondary data from the Agricultural Sectoral Development Support Program belonging to 1512 households spread across 10 pastoral and agro-pastoral counties was used in estimating the model. The transaction costs that influence the level of market participation include ownership of transport facility, access to veterinary services, distance to the livestock market, pasture land size, and size of the tropical livestock units. Those that hindered market participation included access to off-farm income while those who have large pasture lands and tropical livestock units, and access to veterinary services, motorcycles, or radio are more likely to participate. Policy measures, such as policies dealing with land reform and extension services are necessary while others require indirect intervention and private sector involvement such as road networks, market availability, and macro-credit facilities.

**Keywords:** Transaction costs, double-hurdle, market participation, smallholder households, livestock, Kenya.

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## I. INTRODUCTION

In Kenya, the livestock sector is integral to the county's agricultural sector, contributing significantly to the national gross product(GDP) and employment. The livestock sector provides over 42% of the country's agricultural GDP and about 88% of employment, (Manyeki et al., 2019). In Kenya, the bulk of livestock production takes place in the Arid and Semi-Arid lands (ASALs) counties which host 70% of the country's livestock herd (KEPZA, 2005; Salami, et al., 2010). Southern rangelands counties are part of the ASALs regions of Kenya where livestock production is a significant economic activity and a major source of household livelihood. More than 50% of the southern rangelands are under livestock production, carried out primarily in two modes of production: large-scale ranching and agro-pastoralism (Katiku et al., 2013). While there is a general agreement that improving market access of livestock keepers has a high potential for economic development and poverty reduction, there remain multiple challenges in making progress (Kihui and Amuakwa-Mensah, 2016). Unfortunately, the literature provides inadequate information on the market integration of pastoral communities.

Several studies that have attempted to address market access by smallholder livestock farmers aim at identifying the constraints and the corresponding interventions that are important for improving market participation. Among the different types of constraints identified are related to transaction costs, risks, and resources. Transaction costs form the main barriers to market access by resource-poor smallholders and this explains the reasons why many scholars in the world are interested

in the effects of transaction costs on market participation (Key et al., 2000; Holloway et al., 2005; Bellemare and Barret, 2006; Ouma et al., 2010; Amankwah et al., 2012). This paper aims to investigate the transaction and other non-transaction cost variables that can cause market failures in the livestock industry of Kenya. The paper seeks to address the general hypothesis that the reduction of transaction costs as a means of increasing market participation forms the main limitation to the development agenda.

The concept of transaction costs economies has been used widely in crop sectorial research in Kenya (Alene et al., 2008; Omiti et al., 2009; Olwande and Mathenge, 2012; Fischer and Qaim, 2014). However, there is a dearth of information on the drivers of market participation and selling decisions among livestock farmers. One notable study by Staal et al. (1997) aimed at empirically investigating the notion that high transaction costs limit market participation by asset- and information-poor smallholder dairy farmers of Kenya and Ethiopia. The study found that transaction costs are a major impediment, as evidenced by the low percentage of milk production that is commercialized in Kenya and Ethiopia. Transactions cost was observed to increase with distance, and they attributed it to increased costs of information and risk of dairy product spoilage before a buyer is found, although based on Bakucs et al. (2012) finding, distance and information costs may be asymmetric or cognitively different for agents. A similar study on live animals undertaken by Bellemare and Barret (2006) in the cross-border part of Ethiopia and Kenya found livestock product prices matter to the extent of participation, and fixed transaction costs matter both in the participation and in the extent of participation decisions, thus offering additional evidence in favor a well-known behavioral anomaly. Until now, there is no country-level empirical study on the pastoral livestock market participation in Kenya that can be applied to policy development and this forms the premise of this study.

The remainder of this article is organized as follows. First, a review of the literature on the theoretical and empirical model, followed by a description of the data source and the variable used in the analysis. Next, the results are presented that include factors determining the probability and level of market participation. The article concludes with a summary of the main findings and some policy recommendations.

## II. THEORY BACKGROUND AND EMPIRICAL MODEL

In analyzing market participation behaviors transaction cost approach (TCA) is widely applied because of its micro-econometric nature, compared to others such as the asset-based approach (Boughton et al., 2007) and the agricultural developmental approach (Barrett, 2008). The TCA is based on New Institutional Economics (NIE) that postulates that economic activity does not occur in a frictionless environment, but is always accompanied by the transaction costs of carrying out the exchange which is directly influenced by the efficiencies of the institutions (Omamo 1998; Key et al., 2000; Renkow et al., 2004). Under the NIE, some of the assumptions of neo-classical economics (such as perfect market information, zero transaction costs, and full rationality) are relaxed but the assumption of self-seeking individuals attempting to maximize an objective function that is subject to the constraint(s) still holds. Therefore, TCA is predominantly concerned with economizing these transaction costs, which depends on the efficiency of the institutions of a country. Thus, the general theory behind TCA is that institutions are transaction cost-minimizing arrangements, which may change and evolve with changes in the nature and sources of transaction costs (Williamson, 2000). However, the choice to participate in the market is guided by transaction costs and is directly influenced by expected net returns with positive net returns resulting in market participation while negative net returns leading to non-market participation.

For this study, it is maintained that the hypothesis that market behavior is driven by a household objective of maximizing the profit it enjoys. Thus, the focused attention is on a choice problem that relates to optimal and non-negative quantities sold  $Q_s$ , household attributes, and the environmental factors that condition market behaviors. For a representative smallholder household, it is assumed that the cost function (C) depends on household-specific characteristics that include educational attainment, gender, household size, and age reflected in the vector (H), household endowments such as land size and livestock number reflected in the vector (E), information assets such as television and mobile phone reflected by the vector (IF), and institutional factors proxied by livestock prices, access to extension service, market information, financial institution, and group affiliation reflected in vector (IS) and others variables such as off-farm sources of income or liquidity which may be earned or unearned (K) and household wealth index reflected by the vector (O).

$$C = c(H, E, IF, IS, K, O) \quad (1)$$

The smallholder households' choice to maximize profit ( $\pi$ ), is subject to the complex cost function specified as:

$$\text{Max } f(\pi) = PQ_s - c(H, E, IF, IS, K, O) \quad (2)$$

Subject to the constraint that  $\pi = R - C \geq \pi^*$

Where P and R present the livestock products prices and gross receipts respectively, while  $\pi^*$  is the farmer-specific minimum acceptable profit level – referred to as the lower bound.

Under the classical theoretical framework, the optimal levels can be determined by differentiating the above profit function with respect to  $Q_s$  and inputs. Beyond the theoretical sphere, the information asymmetry on transaction cost structure forces the farmer to have only two decisions; first, the decision whether or not to participate in the livestock market and second, the number of livestock to supply to maximize household welfare given the fixed and variable transaction costs faced. The two decisions may be made in a single (simultaneous) or a sequential two-step process. In the sequential process, the farmers decide whether or not to participate in the market, and if they choose market participation, the next step is the decision about the quantity to sell (Holloway et al., 2005; Boughton et al., 2007; Omiti et al., 2009; Simtowe et al., 2017). Simultaneous decision-making means that the farmers make choices about participation and quantity at the same time (Abdoulaye and Sanders, 2005). In this study, sequential decision-making is assumed because smallholder pastoral households targeted make the discrete participation decision at home with limited market information, only available at the market. In the second stage, those households that have chosen to participate proceed to market receive additional information, and make their continuous sales.

Under the sequential decision-making process, the econometric specification preceding equation 2 consists of market participation decision equations and livestock supply equations assumed to be mutually exclusive. In the market participation analysis, most of the studies apply either the sample selection model (Heckman 1979), Tobit's (1958) model, or the Cragg (1971) double-hurdle model. In this study, the mutual exclusivity assumption renders the participation decision as a set of discrete choices, and DH models were found ideal as they allow for a separation between the initial decisions to participate ( $Y > 0$  vs  $Y = 0$ ) and the decision of how much quantity, Q given  $Q > 0$ . Further 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. Using  $Q_s$  to denote the quantity of livestock sold by households, from equation (2), a set of structural equations can be envisioned to assess the market participation specified as;

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

$$P(Y_i = 1|X_i) = f(X_i \beta_i) + \varepsilon_i \quad (3)$$

Where equation (3) relates to the decision to participate and is expressed in Probit formulation. Term  $f(.)$  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. Term  $X$  is a matrix of factors that affect the discrete probability of participation by pastoral farmers and  $\beta_i$  is a vector of parameters;  $\varepsilon$  is a normally distributed disturbance with mean zero and standard deviation of  $\sigma$  and captures all unmeasured variables.

The second hurdle, which closely resembles the Tobit model, is expressed by a truncated regression function;

$$Q_i^* = Z_i' \gamma_i + \mu_i \quad (3)$$

$$Q_i = Q_i^* > 0 \text{ and } Y_i > 0$$

$$Q_i = 0 \text{ Otherwise}$$

Under the second stage,  $Q$  presents the proportion of the number of livestock sold;  $i$  = Cattle, sheep, and goat (sheeps henceforth);  $Z$  defines the matrix of factors that determine the intensity of participation and  $\gamma_i$  is a vector of parameters;  $\mu$  is the random disturbance for unit  $i$  for the intensity equation. Since the decisions by pastoral households are assumed to be sequential, following Smith's (2003) exposition, the error terms  $\varepsilon_i$  and  $\mu_i$  are independently and normally distributed:  $\varepsilon_i \sim N(0,1)$  and  $\mu_i \sim N(0, \sigma^2)$ , and thus the following expression:  $\begin{pmatrix} \varepsilon_i \\ \mu_i \end{pmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right]$ .

### III. METHODOLOGY

#### Data Source

This study aims at investigating the constraints limiting pastoral-farm households to participate in livestock markets using the national farm-level household dataset which was collected from September – October 2013 and was collaborated by synthesized data from various 2019 Kenya Population and Housing Census Reports. This dataset was costly-donor funded under the Agricultural Sector Development Support Program and was deemed credible because it was intensively structured and managed in a way that ensured high data quality by a multi-disciplinary team comprising experts from the Agriculture and Livestock Research Organization and the University of Nairobi. The sample size comprises a total of 1512 smallholder pastoral households who were randomly selected from ten counties that are found in the southern rangelands of Kenya namely Kajiado, Makueni, Kitui, Machakos, Narok, Taita-Taveta, Tana-River, Lamu, Kwale, and Garissa. 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. Additionally, these counties were deemed representative of many livestock production zones in Kenya and also of sub-Saharan African countries.

#### Contextual variables and hypothesis

The contextual variables and hypothesis used in estimating the level of market participation are presented Table I below. The first dependent variable is an indicator variable, which takes the value of one if the household is participating in the market 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% and the level of participation is 1.488 and 3.651 for cattle and goats, respectively. These results indicate a moderate market orientation of smallholders' pastoral households in the study area and confirmed the long puzzle of the limited use of livestock markets by east African pastoralists who hold most of their wealth in the form of livestock and who regularly confront climatic shocks that plunge them into massive herd die-offs and loss of scarce wealth (Bellemare and Barrett, 2006; Barrett, 2008).

Past studies have categorized independent variables influencing livestock market participation decisions into fixed and variable transaction costs. In either case, transaction costs are partly observable as the barrier to access to market participation. The descriptive statistics of independent variables and their expected signs are summarized in Table 1 and are categorized as household characteristics, transaction costs (that include transport assets and information assets), and institutional assets. Besides, the study also included production enhancing assets variables presented as 'household endowment' as control variables.

The transaction costs associated with household characteristics include human capacity presented by the gender, age, and education level of the household head. The variable for the gender of the household head has been included in market participation studies since it influences market participation and market volume as it is linked to financial and labor resources access. For instance, Olwande and Mathenge's (2011) study found a lower likelihood for female-headed households to participate in the market. However, in Alene et al. (2008) study, an average male-headed household was 10% less likely to participate than a female-headed household. In our current study, males (86% of the sample) are expected to have a higher propensity to participate in livestock markets.

The age of the household head is an indicator of experience in farming and is measured in years. In most cases, years of experience are positively related to the probability of participating in the market as a seller. For instance, Bellemare and Barrett (2006) have shown that successfully repeated contacts, gained through long-term marketing relationships, enhance trust, an essential element in market exchange. In contrast, experience acquired by age can also be expected to be negatively associated with market participation, as found in Ehui et al. (2009) study that older household heads tend to have more dependents and hence more subsistence production activities. In this study, it is expected that older producers to be more experienced and have established contacts, which may enhance mutual trust and allow trading opportunities to be undertaken at lower costs

Education is an important tool, but only if the education system reaches the right people with the right content (Heierli and Gass 2001). The variable was measured by the number of years the household head had taken in acquiring formal education. More years in school is assumed as a proxy for better educated hence a greater ability to use the information and thus a positive effect on market participation (e.g., Alene et al., 2008; Olwande and Mathenge, 2011; Wickramasinghe et al.,

2014). However, the expectation may be reversed as observed by Lapar et al. (2003), especially when there are competing and more remunerative employment opportunities available in the area that require skills that are enhanced by more education (Ouma et al., 2010). To capture the non-linear effects of education on market participation, the study included a squared term.

In this paper, the non-transaction costs associated with assets are referred to as household endowment assets and were introduced as control parameters in the analysis. Household endowments increase their probability of participating in market transactions (Randela et al., 2008). Under this category, two variables were included. First, the number of livestock (measured in tropical livestock units or TLU) owned by the smallholder household is expected to positively impact market participation in line with previous studies (Heierli and Gass, 2001; Bellemare and Barrett, 2006). Second, it is expected that the larger the size of pastureland a household uses, the higher the production levels are likely to be, and the higher the probability of market participation (Ouma et al., 2010). In contrast, Randela et al. (2008) reveal the existence of an unexpected negative relationship between land size and level of market participation; an indication that increased market participation is also a function of land productivity.

According to Barrett (2008), there are two distinct layers of transaction costs; one that is household-specific and another that is product-and-location-specific. Due to data limitations, the study focuses on the former. Key et al. (2000) draw attention to high transaction costs resulting from remoteness with poor transport and market infrastructures. In this regard, distance to the market is considered a proxy to fixed transaction costs and, thus, hypothesized to affect market participation negatively. The study used ownership of motorized transport assets (such as cars or motorcycles) as a determinant of market access costs. Randela et al. (2008) and Ouma et al. (2010) found a positive effect on participation and the intensity of participation by reducing the cost of transporting output to the market. In contrast, Olwande and Mathenge (2011) observed that ownership of transport equipment is associated with the decision to sell rather than the decision on how much to sell any of the commodities investigated in their study. Ownership of information assets eases access to information on prices and other market incentives for smallholder agricultural households (Wickramasinghe et al., 2014). Randela et al. (2008) found that access to market information is not only a significant influence on market participation but also the probability of commercial farming. Access to a communication facility (such as mobile phones or TV/radio) can substantially mitigate the fixed costs of accessing information and is thus expected to facilitate market entry.

Institutional factors are said to be transaction cost-minimizing arrangements, and this category of the variables was measurable using proxies such as average livestock product prices, access to credit, and livestock market information. Prices are expected to act as an incentive for market participation (Manyeki et al., 2016). Access to credit raises the probability of market participation for buyers (Ouma et al., 2010, Key et al., 2000). In contrast, Olwande and Mathenge (2011) observed that the lack of access to credit for poor households could also partly explain the low market participation because it may limit their ability to access inputs to improve their production. More recently, Rutto et al. (2013) found access to credit as a production-enhancing input while Stephen and Barrett (2011) found that households with access to credit transact more in the product markets. Building on the above studies enabled us to conclude that the unavailability of credit can inflate transaction costs in both input and output markets and, therefore, in this research, it is hypothesized that its availability would impact positively on farmers' ability to participate in markets.

In a similar vein to Randela et al. (2008), access to livestock market information is hypothesized to play a significant decisive role in influencing market participation. Balirwal and Waholi's (2019) study observed that those who access veterinary services are more likely to receive technical knowledge for improved productive performance leading to higher yields and hence surplus, which precipitates participation decisions and market sales. It is expected that livestock farming households who have access to veterinary services generally have healthier animals, and this is likely to influence the market participation decision of a household positively. Additionally, veterinary services and advisory services (either through extension or agricultural research), may lead to more technical inefficiency (Manyeki and Kotosz, 2019).

As Randela et al. (2008) and Ouma et al. (2010) stated, access to off-farm income (mostly off-farm employment) may lead to risk reduction in household decision-making and, with it, increased propensity to undertake higher-risk activities, notably livestock producing for the market. As Alene et al. (2008) noted, non-farm income contributes to more marketable output if invested in farm technology and other farm improvement activities; therefore, it is expected a reduction in entry barriers and, hence an increase in market access. The household per capita income variable is expected to have either a positive or

negative effect on market participation; high per capita income per day may be expected to reduce market entry barriers for smallholder producers resulting in a high level of sales or, conversely, may limit the number of livestock offered for sale, hence the negative effect

**Table I: Descriptive statistics of the variables used in Double-hurdle estimation**

Variable Name	Cattle	Shoats	Expected Sign
Market participation	0.359±0.480	0.453±0.498	NA
Livestock sold*	1.488±4.492	3.651±7.801	NA
Household characteristics			
Gender	0.868±0.338	0.859±0.349	+
Age	48.818±15.030	49.281±14.962	+
Education level	6.160±5.209	6.006±5.131	+
Household endowments			
Land asset	33.388±158.851	28.758±144.864	+
Livestock produced	18.378±49.463	33.284±72.003	+
Transport assets			
Own Car	0.0305±0.172	0.0284±0.166	+
Own Motorcycle	0.0996±0.300	0.0893±0.285	+
Information assets			
Own TV	0.13656±0.344	0.1389±0.346	+
Own Radio	0.6820±0.466	0.6528±0.476	+
Own cell phone	0.7575±0.429	0.7579±0.429	+
Institutional factors			
Distance to market	9.578±14.273	11.042±15.51	-
Average selling price*	25,812±11,941	3,378±1,135	+
Credit services	0.0129±0.113	0.0099±0.09914	+
Veterinary services	0.3647±0.482	0.3307±0.471	+
Livestock information	0.1535±0.361	0.1138±0.318	+
Market information	0.2507±0.434	0.2474±0.432	+
Others			
Off-farm Income	76,940±196,217	76,388±183,126	+
Per capita wealth	84.35±181.93	78.75±174.50	±

Note: \* Cattle, N=447; Shoats, N=683; NA = not applicable.

**IV. EMPIRICAL RESULTS AND DISCUSSING**

**Livestock Market Participation Decision**

This section discusses the results of the significant factors that determine the probability of market participation by smallholder pastoral farm households. All variables mentioned in Table II were considered using a step-by-step process of deletion of highly insignificant variables (obviously by a cross-check on p-value and standard deviation), reducing the number of variables included in the estimation of Equation 3 to eighteen as shown in Table 2. In addition, the test of multicollinearity through the computation of variance inflation factors (VIF) and conditional number for each of the selected variables was conducted and all the independent variables exhibited  $VIF_i < 5$  (with an average  $VIF_i < 1.2$  and conditional index of about 17 ( $< 30$ ) which suggests that there is no significant, multicollinearity, and therefore these variables were eligible for inclusion in the model estimation. The estimate of Pseudo R2 was significantly different from zero at the 1% level. This suggests that the random disturbances in the smallholder livestock market participation decisions are affected in positive directions by random shocks. The sample value of the likelihood ratio is 205.98 and 149.05 for cattle and shoats respectively, and with a critical value of  $\chi^2_{18, 0.01} = 20.09$ , is highly statistically significant ( $p < 0.000$ ) suggesting that the independent variables are taken together influence market participation decisions. Some of the transaction costs proxies tested influence the level of market participation significantly, and the signs of the estimated coefficients are consistent with a priori expectations.

As expected, the size of pastureland per household is one of the critical factors of production that enable households to produce a surplus for the market turned out to have positive and significant effects on market participation. The number of tropical livestock units provides households with leverage to invest in market participation. This is supported by the probit results which indicate a positive relationship between the number of tropical livestock units owned by the household on the probability of market participation. Ownership of transport equipment such as motorcycles has a significant positive impact on market participation by reducing the cost of transporting output from the farm to the market. This implies that households that own transport assets are more likely to participate in the livestock market than those without, perhaps owing to the long distance to the markets that were reported in Table 1. On information assets, ownership of radio had the expected positive sign and was statistically significant. The other determinants of transaction cost are distance to the market, access to veterinary services, and per capita income. Greater distance to the livestock markets increases transaction costs which are associated with institutional failures. The sign of the coefficient for distance to the market is negative and in line with a priori expectation. Access to veterinary services had the expected positive sign and was statistically significant. The coefficient for per capita income was positive and significant.

Turning to significant transaction costs with unexpected a priori signs, the probit analysis found the number of years in formal education (Education level) to be inversely related to the probability of market participation but the propensity to participate increases with an increase in years of schooling (variable education level squared). More years in school indicates 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. The negative and significant effect of age contrary to the a priori expectation confirms the general observation that farming operations in the study areas are increasingly manned by the elderly. 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 connection with farming and land. 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 increase market access and reduction in entry barriers. A possible explanation of 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 partial effects of the discrete variables are calculated by taking the difference of the probabilities estimated when the value of the variable changes from 0 to 1. With regards to continuous variables, the magnitude of the partial effect of the significant variables computed at sample means, on the probability of household livestock market participation is positive but very small. However, the partial effect of the probability of livestock market participation portrayed by lower education level and off-farm income variables ranges from -0.032 to -0.067 respectively. This means that the probability of livestock market participation decreases by 0.032 to 0.067 (about 3-6.7%) for a one-unit increase in education level or off-farm income. When it comes to discrete variables, a positive and significant relationship was found between gender, owning a motorcycle and/or radio, and access to veterinary services. According to Table 2, a shift from having no access to veterinary services, owning a motorcycle and a radio ( $X_i = 0$ ) to access to veterinary services, owning a motorcycle and a radio ( $X_i = 1$ ) increases the probability of market participation by 6.1%, 10.3%, and 7.5% respectively. Similarly, being a female-headed household in the pastoral community decrease the probability of livestock market participation by 16.4% and 25% respectively.

**Table II: Determinants of livestock market participation decision**

<i>Variable Name</i>	<i>Cattle</i>		<i>Shoats</i>	
	<i>Coef.</i>	<i>Partial effects</i>	<i>Coef.</i>	<i>Partial effects</i>
Constant	0.026±0.219	-	0.317±0.187*	-
Household characteristics				
Gender	0.482±0.125***	0.164±0.038	0.054±0.099	0.022±0.039
Age	-0.012±0.003***	-0.004±0.001	-0.009±0.002***	-0.004±0.001
Education level	-0.179±0.027***	-0.067±0.010	-0.080±0.023***	-0.032±0.009
Education level squared	0.009±0.002***	0.003±0.001	0.0024±0.0014*	0.001±0.001
Household endowments				
Land asset (ha)	0.001±0.000***	0.0004±0.0001	0.002±0.001***	0.001±0.000

Livestock produced	0.003±0.001***	0.001±0.000	0.003±0.001***	0.001±0.000
Transport assets				
Own Car	0.256±0.237	0.098±0.093	0.190±0.219	0.076±0.087
Own Motorcycle	0.269±0.133**	0.103±0.052	0.304±0.124**	0.121±0.049
Information assets				
Own TV	0.194±0.120	0.074±0.047	0.024±0.107	0.010±0.042
Own Radio	0.206±0.090**	0.075±0.032	0.051±0.075	0.020±0.030
Own cell phone	-0.110±0.096	-0.041±0.036	-0.028±0.082	-0.011±0.032
Institutional factors				
Distance to the market	-0.014±0.003***	-0.005±0.001	0.001±0.002	0.0005±0.0009
Credit services	0.296±0.327	0.115±0.130	0.174±0.330	0.070±0.131
Veterinary services	0.163±0.085*	0.061±0.032	0.213±0.073***	0.085±0.029
Livestock information	-0.106±0.111	-0.039±0.040	-0.013±0.108	-0.005±0.043
Market information	-0.062±0.094	-0.023±0.035	0.071±0.080	0.028±0.032
Others				
Off-farm Income	-0.181±0.067***	-0.067±0.025	-0.026±0.049	-0.010±0.020
Per capita wealth	0.002±0.0005***	0.0008±0.0002	0.00008±0.0003	0.00003±0.000
LR chi2(18)	205.98***	-	149.05***	-
Pseudo R2	0.1271***	-	0.0718***	-
Marginal effects	0.3519		0.4594	

Note: \*Significant at 10% level; \*\*Significant at 5% level; \*\*\*Significant at 1%

### 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. The truncated regression model was estimated with the livestock sale volumes being the endogenous variables. Again, a step-by-step process of deletion of insignificant variables and a check of multicollinearity by computing VIF show the  $VIF_i < 5$  and conditional index ( $< 30$ ) reduced the number of significant variables to thirteen, as shown in Table III. 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. The coefficient for livestock prices displayed insignificant effects on the intensity of participation. However, cattle price was found to have a complementary effect to the intensity of shoats market participation while shoats prices portray a substitution effect to cattle market participation. With regard, per capita income to shoats was significant though very low in magnitude. The Wald Chi-square test (Wald chi2(13)) showed that the model had strong explanatory power ( $P < 0.000$ )

Table III. Determinants of level/degree of livestock market participation

Variable Name	Cattle	Shoats
	Coef.	Coef.
Constant	2.383±1.297*	0.625±1.196
Household characteristics		
Gender	0.279±0.199	-0.030±0.171
Age	-0.008±0.004**	-0.005±0.003
Education level	0.030±0.011***	-0.006±0.010
Household endowments		
Livestock produced	0.004±0.0009***	0.003±0.0004***
Transport assets		
Own Motorcycle	-0.047±0.138	-0.217±0.137
Information assets		
Own cell phone	0.309±0.115***	0.121±0.105
Institutional factors		
Distance to market	-0.003±0.005	-0.010±0.005*
Credit services	0.391±0.498	-0.984±0.619
Veterinary services	0.034±0.109	-0.198±0.104*



Livestock information	0.113±0.137	0.263±0.136*
Price of cattle	0.036±0.087	0.181±0.087 **
Price of shoats	-0.193±0.103*	-0.046±0.092
<hr/>		
Others		
Per capita wealth	0.0003±0.0002	0.0004±0.0002*
/sigma	0.666±0.039 ***	0.742±0.034***
Wald chi2(13)	62.65***	112.98***

Note: \*Significant at 10% level; \*\*Significant at 5% level; \*\*\*Significant at 1%  
 Source: Own construction

## V. DISCUSSION AND POLICY IMPLICATION

The descriptive statistics in Table 1 revealed an average market participation of about 35.9% and 45.3% for cattle and shoats, and that the level of participation is 1.488 and 3.651 for cattle and shoats respectively. These results indicate a moderate market orientation of poor smallholders' pastoral households in the study area and that there is still room for improving livestock market participation by ensuring efficiency in the production and marketing support institutions. This is corroborated by Bellemare and Barrett (2006) and Barrett (2008) who find limited use of livestock markets by east African pastoralists. who hold most of their wealth in the form of livestock and who regularly confront climatic shocks that plunge them into massive herd die-offs and loss of scarce wealth.

Overall, the econometric analysis displays different relations between factors and livestock marketing participation. With regards to household characteristics, the age of the household head had an inverse effect on market participation; an indicator that livestock farmers in the study areas are relatively old and perhaps this may reduce their commitment to livestock farming and profit maximization. This result is consistent with Alene et al. (2008) who found that market participation declines with age since older people are perceived to be risk-averse and reluctant to adopt the technology. Although most of the livestock farmers in the SR of Kenya were found to be within the productive age bracket (between 30-50 years) suggested by Skirbekk (2004), older farmers may reduce their commitment to livestock farming and profit maximization as other priorities take over. The positive effect on gender shows men generally have greater and easier access to livestock ownership than women. 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. Similarly, in the smallholder livestock producers case study by Lapar et al. (2003), only the gender status of the household head appears to be significant, with participants originating mainly in male-headed households. Prevailing gender inequalities may therefore constrain the net benefit for many women and a policy that ensures intentional adjudication of land property rights to all genders would play a vital role in enhancing equal participation in the livestock industry. When it comes to education, a significant negative effect was observed that can be associated with high illiteracy levels. Education is most important to farmer market participation in a rapidly changing technological or economic environment; similarly, many challenges facing smallholder farmers today are connected to illiteracy (Manyeki and Kotosz, 2019). In the spirit of promoting literacy among smallholder farmers who constitute over 78% of the population, a well-targeted adult training program needs to be instituted. Such a program will improve adult literacy development among farmers' hence easing access to modern technologies and the complex communications world.

Various transaction costs were also found to be barriers to market participation by resource-poor smallholders. For instance, nearness to livestock markets and ownership of transport assets such as motorcycle help to reduce marketing costs, and thus are found to encourage market participation; a result that concurs with the finding by Key et al. (2000) and Randela et al. (2008). This implies that the further away the smallholder household is from the livestock market, and in the absence of transport facilities, the more difficult and costly it would be to get involved. The role of marketing costs in completely hindering or limiting the level of smallholder market participation has been examined by several authors (e.g. Key et al., 2000; Barrett, 2008; Alene et al., 2008).

Our analysis also showed a clear relationship between some institutional and information proxies such as veterinary services, market information, and ownership of radio and cell phones. Veterinary services make vital contributions to all stages of livestock production from 'farm to fork' by reducing animal diseases at the farm and market level and public health risks and attaining food quality and safety standards. In the case of veterinary services delivery, our analysis indicated a significant positive influence on market participation and a significant negative effect on intensity on shoats market

participation. The latter confirms the finding by Perry et al. (2002) who found worm infestation, especially in small ruminants continues to be a major challenge, in the tropics and subtropics, thus limiting the number available for sale. The negative result could be partly due to inadequacies in the veterinary technical service or most farmers appear unwilling to pay for the services perhaps because it equally makes no economic sense among farmers to buy veterinary services for shoats production. With regards to market information access for smallholder farmers, the positive relationship to market participation concurred with Ouma et al. (2010) findings. This is possible because communication assets are more useful in accessing market information and facilitating transactions in the region. Thus, the more information the household has on livestock marketing, the fewer transaction costs will be thus increasing market participation. The policy and programmatic implication of this result is that with current levels of technology, any associated public investments in improving market information flow or physical access to markets would enhance market efficiency. In this case, innovative technology delivery approaches such as mobile phone systems, and radio-based training coupled with pro-pastoral field schools, represent a major opportunity for improved market access (Manyeki and Kotosz, 2019).

One of the biggest challenges to pastoral household involvement in livestock marketing is associated with the nature and quantity of household factor endowment such as the size of pastureland and livestock tropical units at the farmers' disposal (Manyeki and Kotosz, 2019). Although the size of pastureland displayed the expected positive significant effect on market participation, currently, only 6% of the total land area has been registered under individual titles, and some 80% (majorly occupied by pastoral communities) comprises tribal land areas waiting for adjudication and registration. Multiple titles exist on many parcels and the rights of family members, especially women, are not well defined. As observed by Sadoulet and de Janvry (1995), when agricultural factor markets are imperfect, ownership of the factors matters for efficiency and productivity and in this case, when land markets are imperfect, households with larger farm holdings may be more likely to be more market-oriented and have higher market participation. Therefore, ensuring the security of land tenure can be a policy option as would influence the production objective function and types of initiatives that a household would undertake. The size of livestock herd owned by households positively influences market participation decisions. This result is also consistent with Heierli and Gass (2001) who found acquisition and ownership of productive assets (such as cattle) can pave the way for a family to participate in economic activities.

The price information is a vital instrument during marketing decision-making because it informs the farmers about marketing conditions (Manyeki et al., 2016). It is expected that farmers who have price information before marketing tend to sell more of their products than those without. However, own livestock price's effects on the intensity of market participation were insignificant and the only significant positive relationship observed was that between the shoats supply and cattle prices (Manyeki et al., 2016). A possible explanation for this is that, if cattle prices at the consumption level are high, a slight increase in the price of cattle prices would reduce the demand suppressing the producer prices and this would result in a reduction in the cattle supply and an increase in shoats' supply. Finally, the positive and significant coefficient on the per capita income variable implies that its increment would reduce market entry barriers for smallholder producers resulting in a high level of sales. Resolving the inequality in per capita income may require a concerted effort to provide rural finance for farm capitalization and livestock productivity as well as public goods in the form of animal disease prevention and animal management extension.

## VI. CONCLUSION

This paper provides empirical evidence of the significant transaction and non-transaction-related factors influencing livestock market participation decisions. 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 smallholder pastoral households in the SR counties of Kenya make relatively little use of livestock markets and the two separate decisions are determined by different sets of factors. The hypothesis that transaction costs and other closely related factors influence livestock market participation was tested using the probit regression model. It should be acknowledged that transaction costs are not easy to measure; thus, proxy variables were used. These high transaction costs emanate from, among other factors, the long distances involved in transporting animals to the market; livestock tropical units and pastureland size, access to off-farm income, and availability of means of transport represented by ownership of a motorcycle or a radio. The empirical analysis revealed that smallholder households are less likely to decide to participate in the livestock market if they have less access to off-farm income while those who have large

pasturelands and tropical livestock units, access to motorcycles, or radio are more likely to participate in the livestock market.

However, a finding worth noting is the effect of land size on 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 earlier studies (Manyeki and Kotosz, 2019). It, therefore, implies that any initiative in the livestock industry to increase land size must be preceded by efforts to increase the productivity of the land currently at the farmers' disposal. As the Kenyan Ministry of Agriculture State Department of Livestock aims to revive the livestock sector, the findings suggest that various tenure reform arrangements need to be explored to increase livestock marketable surplus. It is therefore recommended that institutions that promote efficient use of land should receive priority attention in policymaking.

In the spirit of promoting literacy among smallholders, a properly targeted adult training program needs to be instituted. Such a program will improve adult literacy development among farmers' hence easing access to livestock markets. Prevailing gender inequalities may therefore constrain the net benefit for many women and youth and a policy that ensures intentional adjudication of land property rights to all genders would play a vital role in enhancing livestock market participation. An innovative veterinary service delivery approach such as radio-based training represents a major opportunity for improved market participation by smallholder pastoralists

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