Factors affecting the intensity of market participation of smallholder sheep producers in northern Ethiopia: Poisson regression approach

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Abstract: Sheep marketing is playing a great role in improving the livelihoods of smallholder farmers in Ethiopia. Although it plays a great role, the smallholder farmers are not sufficiently participating in the sheep market so they are poor. Therefore, this study was designed to analyze the factors affecting the intensity of sheep market participation in Northern Ethiopia. The data were collected from 289 randomly selected sample households. Descriptive statistics and Poisson regression was used to analyze the identified data. The descriptive statistics revealed that the number of sheep market participants were 148 (51.21%), but the average number of sheep sold in the market was three. The Poisson regression model showed that the age of household head, education of household head, number of sheep owned, selling price of sheep, market access, distance to the nearest market, availability of grazing land, and availability of feed appeared to be significant in determining the intensity of sheep market participation significantly. The study suggested that improving the market infrastructure (market information, road construction, selling price), educational level (by providing frequent extension service/training about sheep marketing) and productivity of grazing land could enhance the intensity of sheep market participation.

Subjects: Supply Chain Management; Small Business Management; Retail Marketing

Keywords: Sheep; market participation; Poisson model; Sayint Adjibar; Ethiopia

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PUBLIC INTEREST STATEMENT
In Ethiopia, Sheep and its marketing is playing a great role in improving the livelihood of smallholder farmers and living banks for their owners and serve as a source of immediate cash and insurance against crop failure. Although it plays a great role, the smallholder farmers are not sufficiently participating in the sheep market. Even the participants were sold a very small numbers of sheep in the market due to different factors. Thus, this research identified the different factors that reduce the number of sheep sold in the market and improve the intensity of sheep market participation through providing a necessary information for the responsible body/stakeholders for designing the best strategies and policies.
2. Introduction
In Ethiopia, agriculture is the pillar of its economic growth and development, contributing about 43% of the GDP, 90% of the export value, and 70% of the industrial raw materials for domestic industries (NBE, 2014; Mohammeda et al., 2016). From agricultural production, livestock production is one of the major activities of the farmers in Ethiopia, of which cattle constitutes the largest population at 49 million heads of cattle, in addition to 25 million heads of sheep, 22 million heads of goats, and 38 million of poultry (CSA, 2009). It is the means of the livelihood (60–70%) of most Ethiopian farmers, particularly for pastoralists (Tesema et al., 2010a). Because it generates income to farmers or export earnings (15%), creates job opportunities (30%), and contributes to the national GDP (16.5%), and the agricultural GDP (35.6%). Besides, it is used for ensuring food security (sources of meat, milk, and egg production), providing services (sources of draft power and means of transport), contributing to an asset, social, cultural and environmental values, and sustain livelihoods of many farmers in the country (Metaferia et al., 2011; Sintayehu, 2017). Therefore, livestock production has a great role for many smallholder farmers in Ethiopia.

Small ruminants are the most important livestock type in both the high land (sheep) and lowland areas (goat) of the country (Ayele et al., 2003), and plays a great role in improving the livelihood of the farmers. The farmers reared them both for consumption and markets; they are important sources of both tangible (income, meat, milk, skins, and manure) and intangible (saving, insurance, cultural, and ceremonial) benefits (Gebremedhin et al., 2007; I S, 2004; Tibbo, 2006). However, their marketing plays a minimal role due to short- and long-term obligations as a primary factor (Solomon et al., 2010).

Smallholder farmers and pastoralists mainly practice sheep production and marketing in Ethiopia. The sheep production and marketing has steadily been increasing over the years because of its high market price, high market demand, immediate returns, ease of management, suitability for home consumption, and use of harmonizing benefits and risks (Tadesse et al., 2015). Besides this, since sheep have greater environmental adaptability, shorter production cycles and faster growth rates, low investment capital, and low feed requirements as compared to large ruminants, its production is increasing (Millkas & Gebre, 2017). Even though it is increasing, the sheep production is still small, compared to its higher opportunities, due to lack of grazing land, inadequate veterinary services, feed shortages, marketing problems, diseases, insufficient financial services, and low levels of technical inputs (Akllilu, 2008; Solomon et al., 2010; Tadesse et al., 2015).

Sheep markets have an important role in improving the livelihoods of the smallholder farmers through the generation of income. This means that supplying and selling the live sheep, its skin, hair, and meat in the market can generate income for the smallholder farmers. Thus, participating in sheep markets has a prominent role for the smallholder farmers, vital for the sustainability of interventions in improving production. Besides, it improves the economic growth of the country, by increasing the benefits through the growing export value of meat and live sheep. Despite this, the smallholder farmers in Ethiopia (particularly in the study area) are not participating in the sheep market, and they are rearing their sheep without considering the market demands. Moreover, their contribution to the agricultural and the overall national economy is far below the potential (Legese & Fadiga, 2014).

Empirical findings in the country indicate that there are studies conducted on livestock/its products market participation and its intensity. Among these findings, Holloway and Ehui (2002) studied about expanding market participation among smallholder livestock producers. Besides, Kuma et al. (2014) have done a research on the factors affecting milk market participation and volume of supply in Ethiopia. Additionally, Goitom et al. (2018) studied about the factors that determine poultry market participation and its supply to the market in Adwa Wereda, Central Zone of Tigray, Ethiopia. also studied on the determinants of beef cattle market participation decision by smallholder farmers in Dugda and Bora Districts, Oromia Regional State, Ethiopia. Nevertheless, there is a limited study on sheep market participation and its intensity in the country. These
studies focus mainly on the market participation decision. This shows that the previous studies did not focus on the intensity of the sheep market except the study conducted by Terfa (2012), who studied about sheep market participation of rural households in Western Ethiopia.

The previous studies also showed that there is a variation in the volume of sheep sold in different parts of the country (Terfa, 2012). Again these studies have not addressed all areas of the country, and to the best of my knowledge, there is no empirical study conducted on sheep market participation and its intensity in the study area. Besides, the study area is more favorable for sheep production and marketing. Nevertheless, a small number of sheep are supplied and sold in the market due to different factors, and these factors are not identified in the study area (District report, 2019). Therefore, this study has focussed on identifying the different factors affecting the intensity of sheep market participation.

3. Research methods

3.1. Description of study area

The study was conducted in Sayint Adjibar (Amhara Sayint) district of Amhara Region in Ethiopia. It is located 587 km north of Addis Ababa, the capital city of Ethiopia, and 187 km southwest of Dessie, the zonal city of south Wollo. The major town of the district is Sayint Adjibar. The altitude of the district ranges from 500 to 3700 m above sea level. The total population of the district is 144,972 with a population density of 100.86 (CSA, 2007). The total number of households in the district was 34,999 households and the majority of the inhabitants practice Orthodox Tewahido Christianity (83.59%) and speak the Amharic language (99.97%).

Both crop production and livestock rearing are practiced in the district; the residents get their income from those products. The dominant types of crops cultivated in the district are wheat (Triticum vulgar), barley (Hordeum vulgar), field pea (Pisum sativa), bean (Vicia faba), potato (Solanum tuberosum), teff (Eragrostis teff), onion (Allium cepa), and pulses. The dominant livestock in the areas are sheep, cattle, horses, bees and poultry, and sheep are by far the most important, bringing a big slice of household incomes; further cash comes from butter from the cow’s milk, hides/skins, chickens, eggs, and honey (District report, 2019).

3.2. Data types and source, and methods of data collection

In this study, both qualitative and quantitative data were collected from both primary (sample respondents) and secondary data sources (published/unpublished documents and study area reports). The qualitative data were the socio-demographic characteristics of the sample household. The quantitative data included the number of sheep reared, price of sheep, size of grazing land in hectares, and number of livestock other than sheep.

To collect the primary data, the structured questionnaire was employed and pretested on some respondents to add the excluded inquiries and reduce the poor proxy inquiries. Then, using the modified questionnaire, the sample respondents were interviewed to gather the primary data in the study area. Besides, the primary data were collected by asking key informants who have knowledge about it. The secondary data were collected by reviewing it from published documents and agricultural reports in the district.

3.3. Sampling technique and sample size

A two-stage sampling procedure was used to draw the sample respondents. In the first stage, with the help of agricultural office and development agents, the potential sheep producer kebeles were identified purposively from the district. In the second stage, from the identified potential sheep producer kebeles, three sheep producer kebeles (Shengo-defer, Ashinga, and Fers-bar) were randomly selected. Finally, 289 sample respondents, using the Yermene formula (1967), were drawn randomly from three kebeles; proportionally 106, 103, and 80 sample respondents were selected from Shengo-
Table 1. The selected kebeles, total population, proportion, and number of respondents

| No | Kebeles      | Total Population | Proportion | Sampled respondent |
|----|-------------|-----------------|------------|--------------------|
| 1  | Ashinga     | 737             | 0.36       | 103                |
| 2  | Shengo-defer| 758             | 0.37       | 106                |
| 3  | Fers-bar    | 572             | 0.28       | 80                 |
|    | Total       | 2067            | 1.00       | 289                |

Source: Woreda’s statistical report, 2017; own computation, 2018

defer, Ashinga, and Fers-bar Kebeles, respectively (Table 1). The determined sample size was mathematically calculated as follows: $n = \frac{N}{1 + \ln(\text{e}_{i})} = \frac{2067}{1 + 2067(0.05)} = 289$

Where N is the total household population of the sampled respondents, n is the sample size and e is the error term.

3.4. Methods of data analysis

Using the appropriate statistical software (SPSS and STATA), the data collected were analyzed; descriptive and econometric analysis were used for analyzing the data. Descriptive statistics like mean, percentage, frequency, and standard deviation were used to analyze the socio-demographic characteristics of the sampled households and the challenges and opportunities of sheep marketing.

The factors affecting the intensity of sheep market participation was analyzed empirically using the Poisson regression analysis. The intensity of sheep market participation was measured in terms of the number of sheep sold in the market, which is counted. Thus, the Poisson regression analysis is appropriate for analyzing such data, counted data. The Poisson regression model can be estimated using the quasi-maximum likelihood approach because it overcomes the problems associated with over-dispersion, which leads to grossly deflated standard errors and inflated t-statistics in the output, and is consistent under this condition (Cameron and Trivedi, 2005; Verbeek, 2004; Wooldridge, 2000). Therefore, Poisson maximum likelihood estimation (QMLE) was used to estimate the regression coefficients.

$$\Pr(Y = y) = \frac{e^{(x)(\mu)}}{y!}, y = 0, 1, 2, \ldots n$$

(1)

Where Y is number of sheep sold, $\mu$ is the intensity or rate parameter.

The distribution is stated as $p(\mu)$. The distribution of the Poisson regression model assumes equidispersion meaning that the mean and variance of the outcome are equal for a given covariate pattern, i.e. mean $E(Y) = \mu$ and variance $V(Y) = \mu$ (Hardin & Hilbe, 2015; Wang & Famoye, 1997). The standard approach of the Poisson regression is to use the exponential mean parameterization: $\mu_i = Exp(X_i \beta)$, $i = 1, 2, 3 \ldots N$ .......................................................... (2)

where $\mu_i$ is the predicted number of sheep sold, $x_i$ is a vector of explanatory variables and $\beta$ is a vector of unknown coefficients to be estimated. The given equations one and two, and the assumption that the observations $y_i|x_i$ are independent; the most natural estimator is maximum likelihood. The log-likelihood function for the Poisson regression model is therefore given as:

$$\ln L(\beta) = \sum^{N}_{i=1} \{y_iX_i\beta - e^{(x)(\mu)} - \ln(y)\}$$

(2)
3.5. **Dependent and independent variables**

To analyze the factors affecting the intensity of market participation of smallholder sheep producers, the number of sheep sold in the market was considered as a dependent variable. The dependent variable is a countable dependent variable, which is measured in number and represents actual volume of sheep sold per day per household in the market. The dependent variable mentioned above is affected by different factors and the study hypothesized the following factors based on the previous researchers (Ayele et al., 2014; Kuma et al., 2014; Terfa, 2012) and the study area perspectives. The independent variables used in this study include the age, sex, family size, experience in sheep market, educational status, access to market, livestock (excluding sheep), amount labour supply, number of sheep reared, access to grazing land, credit use, distance to the nearest market, availability of sheep house, availability of feed, type of breed and access to veterinary service (Table 2).

4. Result and discussion

4.1. **Descriptive information of sample household**

The variables used in the Poisson regression analysis are given in the following table (Table 3; Table 4). The descriptive analysis showed that the number of sheep market participants and nonparticipants were 148 (51.21%) and 141 (48.79%) respectively (Table 3). This indicated that almost half of the respondents were nonparticipants in sheep markets. Nevertheless, the average number of sheep sold in the market was three.

As the survey result indicated, 83.78% of the sample households were male-headed whereas 16.22% of them were female-headed households (Table 3). Male-headed households were participating in the sheep market than female-headed households. Besides, male-headed household heads sold many numbers of sheep in the market. This is due to the fact that male producers could travel long distances to get to the market, and they made a quick decision to rear many numbers

| Table 2. Summary of variables used in econometric model with the expected sign |
|---------------------------------|-----------------|-----------------|
| **Variables**                  | **Type of data** | **Expected sign** |
| Age of household (AGE)         | Continuous      | ±               |
| Sex of household (SEX)         | Dummy           | +               |
| Family size (FAM)              | Continuous      | -               |
| Experience in Sheep market (EXMKT) | Continuous    | +               |
| Educational status (EDUCATION) | Continuous      | +               |
| Access to market (MKTACCESS)   | Dummy           | +               |
| Livestock (excluding sheep) (TLUEXCSH) | Continuous | -               |
| Amount labour supply (LSS)     | Continuous      | +               |
| Number of sheep reared (SHEEP) | Continuous      | +               |
| Access to Grazing Land (GLAND) | Dummy           | +               |
| Credit use (CREDIT)            | Dummy           | +               |
| Distance to the nearest market (DISTANCE) | Continuous | -               |
| Availability of sheep House (HOUSE) | Dummy         | +               |
| Availability of feed (FEED)    | Dummy           | +               |
| Type of breed (BREED)          | Dummy           | +               |
| Access to veterinary service (AVS) | Dummy         | +               |
of sheep in the market than the female-headed households. As a result, they sold more numbers of sheep, compared to female-headed households.

The result revealed that, on average, 10.03%, 47.75%, 28.37%, 54.67%, 16.96%, and 12.46% of the sample households had access to sheep house, market, veterinary service, credit, grazing land, and modern type of sheep breed, respectively. The average age of the sample household head was 49.45 years (52.21 years for participants and 46.56 years for nonparticipants in sheep markets) (Table 4). This indicates that most of the sheep market participants were young and at a productive age so that they could benefit from different sheep markets by spanning different areas. However, they were mostly speculative traders rather than producers, so that they were not as profitable as expected.

The average family size of the sample households was 4.58 (almost five members). This was nearly equal to the family size of the sheep market participants. The average educational level of the sample household was grade four (3.9) (Table 4). This indicates that the sample households were not amply educated that is why they were not productive/effective in sheep markets in the study districts. The other most important variable was the number of sheep reared (herd size) that is used in the model. The survey result showed that the average number of sheep reared by the sample household was five sheep.

The survey result reveals that the average selling price of sheep in the sample household was 1761.60ETB (50 US Dollar), which was very low. This was due to the absence of sheep feeding/ grazing land, and the farmers produce the traditional breeding type so that the size of sheep was very small. As a result, the selling price of sheep in the district was very low in the market. Averagely, the distance between the producer's home and the nearest market was 1.17 Km, very near to the village market (Table 4).

| Variables                        | Participant (N = 148) | Non participant (N = 141) | Total (N = 289) | X² |
|----------------------------------|-----------------------|---------------------------|-----------------|----|
|                                  | N        | %      | N        | %      | N        | %      |                |                |
| Sex (Male)                       | 124      | 83.78  | 109      | 77.30  | 233      | 80.62 | 1.94           |                |
| Market access (Yes)              | 78       | 52.70  | 60       | 42.55  | 138      | 47.75 | 2.98*          |                |
| Credit (Yes)                     | 85       | 57.43  | 73       | 51.77  | 158      | 54.67 | 0.93           |                |
| Access to veterinary service (Yes)| 51       | 34.46  | 31       | 21.99  | 82       | 28.37 | 5.53**         |                |
| Availability of house (Yes)      | 12       | 8.11   | 17       | 12.06  | 29       | 10.03 | 1.25           |                |
| Feed availability (Yes)          | 38       | 25.68  | 7        | 4.96   | 45       | 15.57 | 23.56***       |                |
| Grazing land (Yes)               | 44       | 29.73  | 5        | 3.55   | 49       | 16.96 | 35.16***       |                |
| Type of breed (Modern)           | 16       | 10.81  | 20       | 14.18  | 36       | 12.46 | 0.75           |                |

Note: ***, **, and * are significant at 1%, 5%, and 100% significance level
Source: Survey results, 2019
Table 4. Test statistics for sheep market participants and nonparticipants for continuous variables (t-test)

| Variables     | Participant (N = 148) | Non participant (141) | Total (N = 289) | St.dv | t-test |
|---------------|-----------------------|------------------------|-----------------|-------|--------|
| AGE           | 52.20946              | 46.56028               | 49.45329        | .8379172 | -3.4325*** |
| FAM           | 4.966216              | 4.177305               | 4.581315        | 1.685662 | -4.0837*** |
| EDUCATION     | 3.898649              | 3.93617                | 3.916955        | 3.878362 | 0.0821  |
| SHEEP         | 8.844595              | 1                      | 5.017301        | 5.231088 | -19.2613*** |
| TLUEXCSH      | 2.672653              | 1.602999               | 2.150781        | 1.671633 | -5.7301*** |
| SELPRICE      | 1760.358              | 1762.901               | 1761.599        | 462.6092 | 0.0466  |
| DISTANCEAR    | 1.134595              | 1.202199               | 1.167578        | 1.004365 | 0.5713  |

Note: *** indicates significant at 1%, 5%, and 100% significance level

Source: Survey results, 2019

4.2. Econometric analysis

The Poisson regression model was used to analyze the determinants of the intensity of sheep market participation. The Poisson regression model result showed that age of household head, education of household head, number of sheep owned, selling price of sheep, market access, distance to the nearest market, availability of grazing land, and availability of feed significantly influenced the intensity of sheep market participation at the household level (Table 5).

**Age of household head (AGE)**: The age of the household head significantly influenced the intensity of sheep market participation at 1% significance level, keeping other variables constant. The incidence rate ratio of this variable indicates that if the age of the household head increased by 1 year, the rate of the number of sheep sold by the household would increase by a factor of 1.013304, keeping other variables constant. This implies that the matured household heads are probably more experienced in the sheep market than the younger ones so that more number of sheep would sell. This is in line with Gemeda et al. (2018), who got a positive association between the age of the households and dairy product market participation. Nevertheless, it contrasts the finding of Ayele et al. (), who found that the younger people are more enthusiastic to participate in the beef cattle market than the older people are. As a result, they sell more number of sheep in the market.

**Education of household head (EDUCATION)**: As expected, the educational level of the household head had a significant and positive relationship with the number of sheep sold in the market at a 10% significance level. This means that as the educational level of the household head increases by 1 year, the number of sheep sold will increase by a factor of 1.020742, ceteris paribus. This shows that education improves the knowledge of the sheep producers to participate and sell more number of sheep in the market, thereby reducing the fear of expected market risks, to get more profit. This confirms the finding of Ehiu Simeon, Benin Samuel and Paulos Zelekwark (2003), who found a positive significant relationship between educational level and a number of live animals sold in the market.

**Number of sheep owned (SHEEP)**: The number of sheep owned (flock size) has a positive significant effect on the number of sheep sold in the market at 1% significant level. This was because as the number of sheep owned by the sample household increased by one sheep, the number of sheep sold in the market would increase by a factor of 1.171138, ceteris paribus. The finding is in line with Terfa (2012), who found that the number of sheep owned significantly and positively affected the intensity of sheep market participation.
Selling price of sheep (SELPRICE): As per prior expectation, a significant and positive relationship was existed between the selling price of sheep and the number of sheep sold in the market at 1% significant level. This was because of the price of sheep in the market is high, the farmers increase their sheep supplied to the market to get profit from selling sheep. Therefore, the higher the sheep price is, the higher the number of sheep supplied and sold in the market.

Market access (MKTACCESS): Households, who have market access, are expected to have a rate of 1.185 times higher for a number of sheep sold compared with those who have no market access, ceteris paribus. This implies that if the sheep producers/traders has market access, more number of sheep will be supplied in the market. In other words, the farmers who have price information prior to marketing tend to sell more of their sheep than those without. The study confirms the finding of Kibara (2019), who found that livestock information had a significant positive relationship with the level of shoat market participation.

Distance to the nearest market (DISTANCNEAR): The number of sheep sold in the market would increase by a factor of 1.09342 if the distance between the household’s home and the nearest market increased by 1 km, ceteris paribus. This was due to the fact that if the distance between the market and the producers’ home is long, the producers can rear many number of sheep because of the availability of the vacant space (grazing land) for their production than the towns, where the nearest market existed. In addition to this, the one whose production site is far from the market, could sell all of his sheep come to the market as a result of fearing the death/tiredness of his sheep due to many returns/trips from market to home and vice versa. This is in contrary to the finding of Goitom et al. (2018) and Kibara (2019), who found a negatively significant relationship between distance to the nearest market, and level of poultry and shoat market participation, respectively.
Availability of grazing land (GLAND): The availability of grazing land had a significant effect on the degree of sheep market participation at 1% significant level. The incidence rate is 1.435096 indicating that the household head, ceteris paribus, who have grazing land, is expected to have a rate of 1.435096 times higher for the number of sheep sold compared with those who have no grazing land. Hence, the feeding system in the study area was mainly depending on the natural pasture and free grazing land. However, there is a limited availability of pasture and grazing land so that those who use natural pasture as a feed for their sheep are not rearing more number of sheep.

(1) Availability of feed (FEED): This is the most decisive factor for sheep sold in the market, significant at 1% significance level. As compared to the sample household who have not to feed access to their sheep, the household who have feed access were higher, at a rate of 1.491468 times, to sell their sheep in the market, ceteris paribus. This indicated that the sheep producers did not use different types of feed other than limited grazing land. As a result, the number of sheep sold in the market was very low.

4.3. Conclusion and policy implication
The small ruminants in general and sheep, in particular, plays a great role in improving the livelihoods of the smallholder farmers in Northern Ethiopia. However, this is only true if the smallholder farmers rear their sheep based on market information (market orientation) and participate in sheep markets. The results showed that 51.21% (148) of the respondents were participated in sheep markets whereas 48.79% (141) were nonmarket participants. The average number of sheep sold by the sample household was three. Thus, the existing government should enhance the intensity of sheep market participation through promoting the transformation of smallholder farmers from subsistence to market-oriented production, via developing the appropriate policies.

The Poisson regression model results showed that age of household head, education of household head, number of sheep owned, selling price of sheep, market access, distance to the nearest market, availability of grazing land and feed were significantly affected the intensity of sheep market participation at the household level.

The age and educational status of the household were the important determinants for the number of sheep sold in the market. This implied that as the age of the household increases, more information or knowledge about the importance of selling sheep in the market would gain for the sample households. Thus, the development agents should strengthen the provision of extension services and the government should strengthen the improvement of the educational program for alerting the sheep producers.

The number of sheep owned, availability of feed, and grazing land had important implications for the intensity of sheep sold in the market. Thus, the government should develop a policy by laying emphasis on sheep production and marketing through providing feed and allowing them to get grazing land. The other most important factors that affect the intensity of sheep market participation was the availability of market access. Thus, the government should improve the market access including road construction, market information, and reduction of transportation cost.

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Competing Interests
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