What determines the price of Bonga sheep at the market level in Southwestern Ethiopia? A Hedonic Price Analysis

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Research

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Abstract

Bonga sheep is a mutton type breed with long-fat-tail and higher body weight at maturity. The breed is mainly located in Kaffa, Bench-Majji and Sheka zones of the southwestern mid and highland land areas of Ethiopia. Currently, the breed was well known in Ethiopia and also its price is higher as compared to other breeds in the country. However, empirical evidence is lacking on price determinants of the breed in Ethiopia. Therefore, this research was attempted to analyze the factors that determine the market prices of Bonga sheep in southwestern Ethiopia. Data from 300 traded sheep and sheep marketers were collected from five major sheep marketing centers in the Kaffa zone. The hedonic pricing models adjusted for heteroscedasticity were employed to analyze the collected data. The analysis result confirmed that the attributes of the sheep were the important guiding criteria in price formulation. The result also showed that the attributes of the sheep like age, sex, colour, body condition, tail type and presence of horn as well as types of buyers, market place and season were the significant determinants of sheep price. Therefore, targeting in systematic selection the attributes demanded by the market and establishment of community-based selection breeding program in Kaffa and neighboring zones to make sheep improvement sustainable and sheep keepers benefit from the intervention. Besides, effort should be geared to transform the system into a market-oriented system using a value chain framework by improving linkages to markets, access to market information systems.

1 Introduction

Sheep production is a major component of livestock farming in Ethiopia and it is mostly kept by smallholders and the rural poor, including women-headed households (Aynalem et al. 2019). About 31.30 million sheep populations are estimated to be found in Ethiopia (CSA 2018). Sheep contribute substantially to the livelihoods of smallholder households as a source of income, food and raw materials (Asfaw and Jabbar 2008). They also serve as a means of risk mitigation during crop failures, savings and investments in addition to other socio-economic and cultural functions. In terms of breed compositions, about 99.81 percent of sheep in Ethiopia are indigenous breeds (CSA 2018). Of this diverse indigenous sheep breeds, at least 9 breeds and 14 traditional sheep populations are distributed across diverse ecology, production systems and communities in Ethiopia (Gebremariam 2019). Ethiopia adopted breeding strategies over the last several decades and is focused on importing exotic breeds for crossbreeding (Aynalem et al. 2019).

However, the strategies at farming communities' level were not applicable because of the communities' different indigenous production systems (Gizaw et al. 2013). This underlines the need to characterize the breeding practices and objectives of a community as bases for designing indigenous breed improvement strategies. From the strategies, characterizations of indigenous breeds and improvement sheep by selection is given priority. As a result, for the long past Bonga sheep breed was considered as the same breed with Horro sheep breed was characterized and the results indicated significant genetic differentiation among them (Solomon et al. 2007). Also, the study by Ede (2008) phenotypically characterized the breed by considering different types of traits and indicated that the Bonga sheep is distinctly different from Horro sheep.

Currently, Bonga sheep is one of the largest breed among indigenous Ethiopian sheep breeds specifically native of the Kaffa zone of Southern Ethiopia (Metsafe et al. 2017a). The sheep is a long-fat-tail type and is the most prolific breed (Metsefa et al. 2017b). It is also of mutton type breed and with a higher body weight at

maturity (Zelalem 2018). This breed is mainly located in the Kaffa, Bench-Majji and Sheka zones of southwestern mid and highland land areas of Ethiopia.

The price of Bonga sheep is high as compared to other breeds, both for breeding and fattening purposes in Ethiopia (Gutu et al. 2015). However, why Bonga sheep price is higher and what is its determinants are not answered questions. Most of the study suggested that the attributes of the animal, socio-economic characteristics of the buyer and seller, market access (preference) are the main determinants of the animal price (Girma et al. 2009; Hysen et al. 2015; Girma et al. 2011; Zelalem et al. 2013; Asresu et al. 2018). Proper identification and valuation of the different attributes of the animal would make resource allocation decisions among the different livestock improvement interventions for commercialization of the system quite fast and smooth (Ouma et al. 2007; Girma et al. 2011; Nadhem et al. 2014).

There is a large body of published literature on identification observed sheep price determinants in Ethiopian markets (Andargachew and Brokken 1993; Adugna 2006; Gezahegn et al. 2006; Feven 2009; Teklewold et al. 2009; Beneberu et al. 2011; Getachew et al. 2012; Aklilu et al. 2013; Zelalem et al. 2013; Kenfo et al. 2019). All these studies revealed that the effects of animal attributes on price formulation vary across breeds and markets. This shows that targeted and rigorous studies for each sheep breed across the market and/or regions is vital. However, among these studies, none of them considered Bonga sheep breed while the breed has a high market price and increasing demand at the national level as compared to other sheep breeds in the country (Tarekegn et al. 2016).

Like other developing countries, sheep marketing in Ethiopia is dominated by traders (Gezahegn et al. 2006). Even though the research in sheep marketing area has great significance, it is generally very haphazard, variable and poorly studied. Analysis of revealed prices should be based on the fundamental assumption that the observed price of a sheep is a composite of the implicit values of its attributes (Ahmad et al. 2019). Therefore, producers who target their production and marketing towards consumers that attach high utility to specific attributes possessed by their flock are expected to fetch a higher premium. Due to lack of open auction, classification or grading system of livestock in Ethiopia, the pricing mechanism of sheep also depends on the location and type of the market; the seasonality and social or religious event (Zelalem et al. 2013).

At the village level, the price is negotiated between the sheep trader and the producer. The producer estimates the reservation price based on his past experiences, village-level information obtained from other producers and various attributes of the animal-like age, sex, live weight, etc. The sheep trader guesses the price of the animal based on the expected price of the animal in the intended market where the animal will be sold, transport costs, distance, various taxes and fees, personal costs involved and the profits he wants to make (Tarekegn et al. 2016).

This understanding helps producers to formulate better strategies for production and marketing of sheep. Hence, this current study aimed to analyze the Bonga sheep attributes considered by traders and producers at the market level and the association of the attributes and other socio-economic factors with the price in the Kaffa zone. This is crucial in continuously changing consumers' demand and preference over time for sheep in the market. Thus, valuation of the attributes is important for making breeding, production and efficient

marketing decisions based on the market preferences for specific attributes (Zelalem et al. 2013). It also gives indications about the market (bargaining) price of sheep to the buyers.

2 Research Methodology

2.1 Sampling and data collections methods

A two sampling technique was used to select sampled sheep and sheep traders. In the first stage, five largest sheep markets namely Boka, Oda, Daka, Bonga and Gojeb were selected purposively from Kaffa zone based on their Bonga sheep marketing channels. In the second stage, 20 samples of sheep traders were selected randomly from each selected market in three rounds to capture the seasonality of sheep price (Table 1). Data on 300 traded sheep and sheep marketers' attributes were collected after sheep transactions have been carried out.

Table 1
Distributions of samples across market places

Market place	Freq.	Percent
Boka	83	27.67
Bonga	52	17.33
Gojeb	58	19.33
Daka	67	22.33
Oda	40	13.33
Total	300	100.00

The data collection was done in three rounds at the market spots in 2018/2019. The first round data was conducted at the end of August 2018 (Ethiopian New-year season). The second round has been done in January 2019. This is a period with no important festival and it overlaps with the time when farmers have completed crop harvesting. The third round was undertaken in March 2019. This period corresponds to the fasting season. The collection of the data primarily focused on the price of the sheep, characteristics of the sheep of sellers and buyers, the purpose of purchase, market location and attributes of the sheep preferred by buyers and sellers (color, body condition, tail type, size, age and sex).

2.2 Analytical framework

Different economic valuation methods were applied by researchers to understand the preference and to value of animal traits in different contexts. Price discovery in any given market for a commodity formed base on willingness to pay (WTP) process (Asresu et al. 2018). Economic theory on revealed and stated preference establishes that WTP depends on the perceived utility from the different attributes or consumable features of the commodity in question (Rosen 1974; Ben-Akiva et al. 1994; Adamowicz et al. 1997). Revealed preferences-based valuation methods record and analyze actual payments on observable transactions for the

commodities/services of interest while stated preference-based valuation methods make use of data on hypothetical choices and implicit payments (Hensher et al. 2005 and Kinkpe et al. 2019).

As well analyses of stated and revealed preferences for agricultural commodities in general and livestock, in particular, have shown that attributes play a key role in determining observed prices in rural markets of Ethiopia (Girma et al. 2011; Zelalem et al. 2013; Asresu et al. 2018). Hedonic modeling using revealed prices is an important analytical framework in identifying factors that determine price formulation and variability (Girma et al. 2011; Zelalem et al. 2013; Ahmad et al. 2019). The brief review of different studies (Richards and Jeffrey, 1996; Jabbar, 1998; Williams et al. 2006; Gezahegn et al. 2006; Chang et al. 2010; Girma et al. 2011; Zelalem et al. 2013; Asresu et al. 2018; Ahmad et al. 2019; Kinkpe et al. 2019) have shown the relevance and extensive application of hedonic price models for estimation of implicit prices of attributes to characterize differentiated products.

Hedonic pricing models indirectly measure utility consumers derive from different attributes of products and estimating, in monetary terms their valuation of the different attributes (Srinivas et al. 2013). The underlying assumption in hedonic pricing models is that the attributes of a given product determine its price where the different attributes of the product are evaluated and combined by the buyer or seller to form a price for the product (Ouma et al. 2007; Parmenter and Pope 2013; Lawal et al. 2016). Therefore, in this study market price of a sheep is determined based on buyers' willingness to pay for different sheep attributes along with the characteristics of buyers, markets and seasons. Samuelson's revealed preference theory (Samuelson 1938) and Lancaster's characteristics theory of value (Lancaster 1966) show that the preferences of consumers can be revealed through their purchasing habits. Of the revealed preference analysis, the hedonic pricing postulates that agents have preferences over the attributes that goods embody which provide utility for the consumer rather than having preferences over these goods directly (Blow et al. 2008).

According to Brown and Ethridge (1995), the structure of the model in general and functional form, in particular, are critical in building an accurate and consistent econometric model. Whether the attributes are unobserved variable or proxied by other variables, regardless of the model goodness of fit, the linear and quadratic functional forms give the smallest mean square error of the true marginal value of attributes, (Cropper et al. 1988).

When choosing a functional form, Bin (2000) argues that the log-linear functional form is a benchmark parametric specification for hedonic price models. Therefore, following Haab and McConnel (2002), Bin (2000), Cropper et al. (1988), this study adopted the log-linear functional form for analysis of hedonic sheep prices. The model is specified as follows:

$$\ln(price) = X\beta + \varepsilon \qquad (1)$$

Where: X is the vector of independent variables including sheep attributes, market place, and seasonally and socioeconomic characteristics of market actors; β is a vector of parameters to be estimated, and ε is an independent and identically distributed error term.

The reliability of the estimates hardly holds in analyzing the survey data based on independent and identically distribution assumptions for error term (Aseras et al. 2018). Hence, the basic model for specification error or

omitted variable, multicollinearity, heteroscedasticity and normality test were applied. Test for specification error was used to capture the endogeneity problem due to omitted variables hence violating the ordinary least squares (OLS) assumptions and making our OLS estimates biased and inconsistent (Greene 2008). The omitted variable test was carried out in the model using Ramsey omitted variable test to check whether there were omitted variables in the model. Also, the presence of multicollinearity among the variables seriously affects the parameter estimates of any regression model if its degree is not ignorable. As a result, the OLS statistical quantities pose substantial problems that may result in unstable OLS estimates, larger standard errors of the estimates, and wider confidence intervals (Muhammad 2014). The Variance Inflation Factor (VIF) technique was employed to detect the problem of multicollinearity for the independent variables (Gujarati and Sangeetha 2007).

The heteroskedasticity the problem that exists when the variances of error terms are not constant, leading to consistent but inefficient parameter estimates (White 1980). The assumption of the absence of heteroscedasticity was detected by using the Breusch Pagen test. Finally, to test the normality assumption of the dependent variable, Shapiro-Wilk's W test was recommended for small and medium samples of up to n = 2000 (Royston 1982 and Garson 2012). Besides, visual inspection of the distribution of error terms by normal probability plot (a very simple method of checking the normality assumption) was the recommended option (Dessie et al. 2019). Thus, to test the normality of a Shapiro-Wilk's W test and normal probability plot were used in this study.

In the presence of heteroscedasticity, the OLS estimator of the vector of regression parameters is no longer efficient in the class of linear and unbiased estimators, but it remains unbiased, consistent and asymptotically normal (Francisco and Maria 2014). Hence, the usual tests of significance are generally inappropriate and their use can lead to incorrect inference (Long and Ervin 2000). This requires the use of a robust estimation procedure through the derivation of an alternative estimator that is efficient. Alternatively, OLS can be used with adjusted standard errors (SEs) that are consistent but not efficient (Verbeek 2004).

Of the alternatives ways of corrections, White's (1980) formula was generally used in the empirical literature to obtain heteroscedastic-consistent standard errors (Hayes and Cai 2007). However, simulation-based results indicate that it is a bit too small matrix and a bit too optimistic white estimator resulting in larger asymptotic t-ratios (Greene 2008). To overcome the issues, MacKinnon and White (1985) employed the heteroscedastic-consistent covariance matrix (HCCM) estimator that provides a consistent estimator of the covariance matrix. Alternative covariance matrix estimators taken into account are HC0, HC1, HC2 and HC3. Lately, Davidson and MacKinnon (1993) suggest three (HC0, HC2, and HC3) alternative ways of corrections. The alternative covariance matrix estimators of the error term, including the OLS and that of White (1980), are specified as:

$$\mathrm{OLS} = \frac{\sum e_i^2}{n-k}(X'X)^{-1} \tag{2}$$

$$\mathrm{HC0} = (X'X)^{-1}X'\mathrm{diag}[e_i^2]X(X'X)^{-1} \tag{3}$$

$$\mathrm{HC1} = \frac{n}{n-k}(X'X)^{-1}X'\mathrm{diag}[e_i^2]X(X'X)^{-1} \tag{4}$$

$$\mathrm{HC2} = (X'X)^{-1}X'\mathrm{diag}\left[\frac{e_i^2}{1-h_{ii}}\right]X(X'X)^{-1} \tag{5}$$

$$\mathrm{HC3} = (X'X)^{-1}X'\mathrm{diag}\left[\frac{e_i^2}{(1-h_{ii})^2}\right]X(X'X)^{-1} \tag{6}$$

The conditional distribution of the errors given the matrix of explanatory variables has zero mean [E(ε) = 0], constant variance [V(ε) = σ2] and zero covariance [E (εX) = 0].

The difference among these alternative covariance matrix estimators lies in the SEs where the one with the largest SE is more robust (Davidson and MacKinnon, 1999). As well, Long and Ervin (2000) suggested that the least square residuals from HC0 and HC1 tend to be very small implying that the estimates from HC0 and HC1 become less robust. While, HC2 and HC3 are the best possible covariance matrix estimators, the superiority of one over the other lies in its properties when testing coefficients that are most strongly affected by heteroscedasticity (Francisco and Maria, 2014). As a result, this study adopted both the HC2 and HC3 estimators.

The efficiency differences between HC2 and HC3 estimators are based on the SEs of coefficients. The HC2 SEs for all coefficients were found to be lower than those for HC3 (Hayes and Cai 2007; Terfa et al. 2013; Ahmad et al. 2019). The lower SE is inflated the t-values possibly leading to erroneous rejections of the null hypothesis. As a result, making inferences from HC2 unreliable and shows that HC3 outperforms HC2 (Hayes and Cai 2007). Therefore, in this study, the HC3 estimation results were used for inferences.

The hypothesized explanatory variables used in hedonic price model can be categorized as sheep attributes, market locations, seasons, market agents' characteristics were explained in Table 2 below.

Table 2
The hypothesized of variables and their measurement

Variables	Means of measurement
Age of sheep	Continuous; Arrangement of teeth in months
Sex of sheep	Dummy; 1 = Male, 0 = Female
Coat color	Categorical; 1 = Red, 2 = white-mixed, 3 = brown, 4 = others (black, creamy, gray)
Body condition	Categorical; 1 = Good, 2 = Average, 3 = Poor
Tail type	Categorical; 1 = Very fat, 2 = Fat tailed, 3 = Thin tailed
Horn type	Dummy; 1 = Horny, 0 = Hornless
Buyer type	Categorical; 1 = Farmer 2 = Consumer 3 = Trader
Seller type	Categorical 1 = Farmer 2 = Part time trader 3 = Trader
Purpose of purchase	Categorical; 1 = Consumption(home, hotel/restaurants), 2 = Resale, 3 = Rearing
The market place	Categorical; 1 = Boka, 2 = Bonga,3 = Gojjeb,4 = Daka, 5 = Oda
Seasons of sheep sold	Categorical; 1 = Holiday seasons, 2 = Fasting seasons, 3 = Normal season

3 Results And Discussions

3.1 Descriptive statistics

Prices usually build-up toward a peak or down based on the influence of different factors. In the study area, the price of sheep was set by visual inspection of the animals. It is also accompanied by traditional methods of body condition scoring. There was no weighing or grading of animals for sale in the market. The marketing of animals through visual inspection was quite subjective and hence favorable to middlemen at the expense of producers (Kenfo *et al*. 2018). This study categorized, the determinants of sheep the price as market actors' characteristics, market locational, season of marketing and attributes of sheep sold or bought.

Characteristics related to market actors as determinants of price formation

Sheep were the most traded live animals than large ruminants during the market days of the respective study markets. Therefore it is important to study the marketing systems such as whom they sell or purchase sheep to suggest some policy issues to benefit the smallholder farmers. Sheep for local markets are mainly channeled through farmers, local traders and big traders and these actors get supplies from other market participants. As indicated in Table 3, a large proportion of sheep (52%) was bought for trading and about 26% was for slaughter purposes (home, restaurant and hotel consumption). Among the buyers of sheep, a larger proportion of sheep transactions was carried out by traders (42.66%), while the remaining 35% and 22.33% were by producers and butchers/restaurants, respectively (Table 3). Concerning sex of buyers, 78 percent of the sellers of sheep were male farmers and 22% were females. Among the sellers of the sheep, the part-time traders (traders that participated in livestock rearing and trading equally) take a larger proportion.

Table 3
Characteristics of sheep buyers with their mean price in Ethiopian Birr (ETB)

Variables	Responses	Av. Price	Std	Max	Min	N	%
Purpose of purchase	Resale/trading	2310.476	584.770	5100	1500	156	52
	Rearing	1937.742	431.464	2800	1280	63	21
	Consumption	2552.041	607.170	5400	1450	78	26
Buyer type	Farmer	2107.333	571.942	5100	1180	105	35
	Traders	2264.453	541.911	4000	1450	128	42.66
	Butchers/hotel	2770.896	659.382	5400	1450	67	22.33
Seller type	Farmers	2203.399	615.761	4400	1180	153	51
	Part-time traders	2265.267	563.058	4200	1250	131	43.66
	Traders	2756.25	512.794	4600	1900	16	5.333
Sex of buyer	Male	2439.356	591.557	5400	1280	233	77.66
	Female	2213.636	579.558	4200	1400	66	22

Characteristics related to the market place and season

The five markets selected for this study were the major sheep marketing place in the Kaffa zone, where the large proportions of sheep were marketed. Considering Table 4, the highest price was recorded in Bong and

Gojeb market places. This may because of the proximity of the markets to Jimma and Shebe markets where the large traders of sheep participated.

Table 4
Market place and sheep marketing seasons

Market place	Mean	Std	Max	Min	%
Boka	2503.133	564.3881	4500	1450	27.666
Bonga	2750.962	316.9231	4300	1900	17.333
Gojjeb	2959.483	596.0732	5400	1750	19.333
Daka	2355.224	473.2331	3500	1500	22.333
Oda	2355.25	323.3774	4800	1280	13.333
Season					
Fasting season	2194.34	364.6205	4400	1280	17.666
Holidays season	3261.932	515.785	5400	2450	53
Normal time	2708.931	552.8735	5100	1450	29.333

Concerning seasonality of sheep marketing, a large number of animals were traded around the festival seasons. As expected, the highest price was also recorded during the festive seasons like Christian and Muslim holiday times. Also, the price of sheep varies across months in the year (Fig. 1). The result shows that the highest price was recorded in September, January, April, and August. This may be because of this months are mostly holiday season months.

Attributes of the animal

Among the attributes of the sheep, body condition is the main factor to be considered during the price formation by buyers in the study area. The body condition was classified by visual inspection of an animal as poor, average and good. Among the sampled sheep, 26, 46 and 27% had good, average and poor body conditions, respectively (Table 5). There is a visible price difference among the group indeed, it was noticed during the survey that almost all the sheep buyers palpate or grasp the chest, lumbar and tail areas to choose the best sheep of their interest within the limits of their paying capacity.

Table 5 indicates that there is a price difference with regards to sex, age and color of the animal marketed. Among the colour, the most marketed sheep colours in the study area were red and brown and also have the highest price as compared to other colours. Sometimes, buyers prefer a particular color while buying an animal either because of cultural reasons, e.g. animals bought for sacrifice may require to be of a certain color, or because of one's personal liking for a particular color.

Tail type is also one of the major considered attributes of sheep in the study area for price setting. Apart from inherent breed characteristics, the degree of fatness of the tail may also determine the price of sheep in the

markets. Among sample sheep, 46, 22 and 32% were thin tailed, fat-tailed and very fat-tailed, respectively (Table 5). Among tail types, a highly fatted tail was highly preferred by buyers.

Table 5
Descriptive statics of sheep attributes and buyers characteristics

Variables	Responses	Mean Price	Std	Max	Min	N	%
Body condition	Poor	1792.716	366.606	2950	1180	81	27
	Average	2177.05	374.580	3400	1400	139	46.333
	Good	2776.875	647.827	5400	1800	80	26.666
Colour	Red	2308.067	620.476	5100	1400	119	39.666
	Brown	2228.629	594.698	5400	1200	124	41.333
	White-mixed	2158.108	461.656	4000	1500	37	12.333
	Others(black–	1955.5	461.559	2900	1180	20	6.666
Tail type	Very fat-tailed	2603.788	786.243	5400	1450	66	22
	Fat-tailed	2263.381	432.030	3800	1250	139	46.333
	Thin tailed	1931.684	453.168	3400	1180	95	31.666
Horn type	Horney	1740	355.1682	2300	1180	37	12.333
	Hornless	2302.624	580.410	5400	1180	263	87.666

3.2 Hedonic price model results on determinants sheep price

Before fitting the hedonic pricing model, the hypothesized explanatory variables were checked for the existence of multicollinearity, omitted variable, heteroscedasticity and normality problems. Before running the regression, the variation in the price of sheep was checked by using a box plot and revealed that the price of sheep is not normal. To overcome this problem, log-transformation was implemented (Appendix Fig. 1). After the regression, the test result for multicollinearity from variance inflation factor (VIF) was 1.93 (Appendix Table 4) and shows that there no serious collinearity between the independent variables since the VIF value was less than 10 (Gujarati and Sangeetha 2007).

A model specification test was carried out for the OLS regression model using the Ramsey RESET test. The test with the (null) hypothesis that the model has no omitted variables generated an F (3, 274) value of 0.43; prob > F = 0.7321 (Appendix Table 1); implying non-rejection of the hypothesis that there are no specification problem and no omitted relevant explanatory variables. Similarly, to check heteroscedasticity, Breuschpagan/ Cook-Weisberg test was performed (chi2 (1) = 27.01; prob > chi2 = 0.0000) (Appendix Table 2). Hence, we rejected the null hypothesis of constant variance (homoscedasticity) at the 1% level of significance and concluded that the presence of heteroscedasticity problem. We used alternative ways heteroscedasticity consistent standard errors (heteroscedasticity consistent – 0, 2, 3 (HC0, HC2 and HC3) to correct the issue (White 1980). According to Long and Ervin (2000), HC3 is a superior test for coefficients that are most affected

by heteroscedasticity among the alternatives. Therefore, we considered HC3 for testing coefficients of the hedonic model. Besides, the normality test for sheep price transformed to the natural logarithm (lnPricesheep) by Shapiro-Wilk's test (Appendix Table 3) confirms that lnPricesheep is normally distributed since the test statistics is insignificant. While the normality test for error terms by normal probability plot ((Appendix Fig. 2) shows that there no problem with the issues as the normal probability plot for residuals approaches to normality line.

The descriptions of the attributes on sheep prices discussed in the above section are econometrical analyzed by using a hedonic price model (HC3) and the result is presented in Table 6. The goodness of fit of the estimated model (Adjusted R2) was 0.898 that passed the tests and indicating about 90% of the variation in the price of sheep at the market was explained by the variables included in this model (Table 6). HC3 estimations indicate that season, market location, age, body condition, coat colour, the purpose of bought and buyer type are the most important determinants of sheep prices in the rural markets of Kaffa zone.

The regression result revealed that the place where the sheep sold had a significant influence on the prices of sheep sold. Among market locations, the sheep prices were significantly higher in the Gojeb market as compared to prices in the Boka market (base category) by 12% followed by the Bonga market (11%) (Table 6). Daka and Oda markets are statistically insignificant with a negative sign implying a lower price in these markets as compared to Boka. This price variation among markets could be the people who are served by Gojeb and Bonga markets are more proxy to the big city in southwestern Ethiopia (Jimma). Srinivas et al. (2013) and Ahmad et al. (2019) also found that animal prices paid to vary significantly among markets.

The body condition of sheep has a significant overall effect on sheep prices among all sample markets. In all sample markets, higher prices were obtained for sheep in good body condition than the poor one. As evident from the results of the regression estimation, a sheep with good and average body condition has received a higher price premium of 26.7% and 10.4% than the poor, respectively (Table 6). This indicates that the price of Bonga sheep increases with improved body condition. This result agrees with the findings of Beneberu (2006); Feven (2009); Zelalem et al. (2013); Zewdie and Teferi (2017).

The coat color of a sheep is also one of the attributes considered by buyers during purchasing. The coefficients for the coat color attribute considered by buyers are statistically significant. The econometric estimations show that brown, others (black) colors negatively affects the price of sheep as compared to red color. For instance, red-colored sheep have a price premium of 7.86% and 13.4% over brown and black color, respectively. The black color exhibits the lowest value among the colors included in the model due to maybe society's perception of the colour as a sign of sadness. This result is consistent with the finding of Zelalem et al. (2013).

Table 6

Results of the OLS and Heteroscedastic Consistent (HC0, HC3, HC3) Hedonic Models.

Explanatory variables	Coef. (OLS Std. Err.)	Coef. (HC0 Std. Err.)	Coef. (HC2 Std. Err.t)	Coef. (HC3 Std. Err).
Market place(Boka base category)				
Bonga	0.111*** (0.0235)	0.111*** (0.0225)	0.111*** (0.0225)	0.111*** (0.0234)
Gojeb	0.120*** (0.0224)	0.120*** (0.0244)	0.120*** (0.0244)	0.120*** (0.0254)
Daka	0.0156(0.0276)	0.0156(0.0272)	0.0156(0.0273)	0.0156(0.0285)
Oda	0.0173(0.0242)	0.0173(0.0302)	0.0173(0.0302)	0.0173(0.0315)
Sex of sheep sold (Male base category)				
Female	-0.1396*** (0.0154)	-0.1396*** (0.0154))	-0.1396*** (0.0155)	-0.1396*** (0.0161)
Age	0.0322*** (0.00575)	0.0322*** (0.00784)	0.0322*** (0.00788)	0.0322*** (0.00824)
Body condition (Poor base category)				
Average	0.104*** (0.0197)	0.104*** (0.0169)	0.104*** (0.0170)	0.104*** (0.0178)
Good	0.267*** (0.0248)	0.267*** (0.0245)	0.267*** (0.0245)	0.267*** (0.0256)
Coat color (Red base category)				
White-mixed	-0.0101(0.0225)	-0.0101(0.0181)	-0.0101(0.0181)	-0.0101(0.0190)
Brown	-0.0786*** (0.0292)	-0.0786** (0.0312)	-0.0786** (0.0315)	-0.0786** (0.0332)
Others (Black)	-0.134*** (0.0154)	-0.0134*** (0.0160)	-0.0134*** (0.0159)	-0.0134*** (0.0165)
Tail type of the sheep(Very fat base category)				
Fat tailed	-0.0629*** (0.0188)	-0.0629*** (0.0201)	-0.0629*** (0.0201)	-0.0629*** (0.0209)
Thin tailed	-0.0933*** (0.0216)	-0.0933*** (0.0218)	-0.0933*** (0.0218)	-0.0933*** (0.0227)
Purpose of purchase(Resale base category)				
Rearing	-0.0387** (0.0196)	-0.0387** (0.0166)	-0.0387** (0.0166)	-0.0387** (0.0173)

Note: - Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Explanatory variables	Coef. (OLS Std. Err.)	Coef. (HC0 Std. Err.)	Coef. (HC2 Std. Err.t)	Coef. (HC3 Std. Err).
Consumption	0.0236(0.0213)	0.0236(0.0200)	0.0236(0.0201)	0.0236(0.0210)
Seller type (Farmers bas category)				
Part time traders	0.00956(0.0145)	0.00956(0.0143)	0.00956(0.0143)	0.00956(0.0149)
Traders	0.00502(0.0314)	0.00502(0.0284)	0.00502(0.0287)	0.00502(0.0304)
Buyer type (Farmers bas category)				
Traders	0.00408(0.0182)	0.00408(0.0159)	0.00408(0.0159)	0.00408(0.0166)
Butcher/hotel/restaurants	0.0106(0.0252)	0.0106(0.0234)	0.0106(0.0234)	0.0106(0.0244)
Season of sheep sold (Fasting season base category)				
Holidays season	0.271*** (0.0233)	0.271*** (0.0235)	0.271*** (0.0236)	0.271*** (0.0247)
Normal time	0.0201(0.0279)	0.0201(0.0280)	0.0201(0.0282)	0.0201(0.0295)
Horn type (Hornless base category)				
Horny	-0.104*** (0.0233)	-0.104*** (0.0233)	-0.104*** (0.0235)	-0.104*** (0.0248)
_cons	3.350*** (0.0471)	3.350*** (0.0443)	3.350*** (0.0446)	3.350*** (0.0468)
Observations = 300; F(22, 277) = 49.57; Prob > F = 0.0000, R-squared = 0.898;				
Note: - Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1				

The purposes for which sheep were purchased are taken as a proxy variable for buyers bargaining power was observed to be an important determinant of sheep prices. From the regression result, among the purposes of sheep purchase, rearing for breeding and fattening purposes is statistically significant. The model result shows that as compared to sheep purchased for reselling purpose, the price of sheep at market level decrease by 3.87% for rearing purpose purchased sheep (Table 6). One possible reason may be that farmers as buyers are more prevalent in local markets while traders operate in all markets and dominate the secondary markets. Besides, farmers usually purchase animals for breeding and fattening and not for resale and consumption like traders and other consumers do. Thus they may prefer small animals at lower prices. A similar result was found by Feven (2009).

Sex of sheep plays an important role in the determination of sheep prices. As expected sex of sheep affects the price of sheep i.e. the price of male sheep is significantly higher in all markets than the price for female sheep. There is a significant variation in price due to the sex of the animal. The model result in Table 6 suggests that for male sheep, buyers pay a 14% higher premium than for female sheep. This is probably because, on religious occasions, people generally prefer to buy males than females (Gezahegn et al. 2006).

Jabo and Adamu (2018) also reported that prices of male animals were significantly higher than female animals in the Kaduna State of Nigeria but a study by Nadhem et al. (2014) in Kenya contradicted the idea.

Horn type of sheep is an important determinant of price in the study area. Based on the results of the hornless sheep have a price premium of about 10% over horny ones. This may that horn sheep in the Kaffa zone are not preferred due to low demand in the market that results in low willingness to pay. However, a study by Asresu et al. (2018) indicated that goats with horns have a price premium over goats that are not horned.

The age of the sheep is also another variable in determining the price of sheep at the market level. It can be determined by the type and number of teeth break out. The regression result shows as the age sheep increases by one month, the sheep receive a premium price of 3% indicating a positive and significant relationship between age and price of sheep. A study by Feven (2009) and Ahmad et al. (2019) found a similar result that confirms a positive relationship between age and price of animals sold.

Tail type of sheep is an important determinant of the price of sheep in the study area. The regression coefficient for the tail type is significant with a negative sign, which means fat and thin-tailed sheep received a lower priced premium than the very fat-tailed sheep. Based on the results very fat long-tailed sheep have a price premium of about 6% and 9% over fat and tin tailed sheep, respectively (Table 6). Gezahegn et al. (2006) also find similar results.

The season in which the animal sold is the most important factor that determines the price of sheep because of the seasonal nature of the consumption habit of our society. The regression result shows that the price of sheep during the holiday season is significantly higher by 27% than the reference season (fasting season) when the demand for sheep increases in local and terminal markets (Table 6). This may be that most of the Ethiopian society consume sheep mutton during the holiday than normal season. This result is consistent with the works of Andargachew and Brokken (1993), Gezahegn et al. (2006), Teklwolde et al. (2009).

4 Conclusion

Sheep price formulations were influenced by many animal attributes in Southwestern Ethiopia. The result has shown that there are relationships between price and attributes of sheep in the study area. The attributes like age, colour, tail type, sex, horn type and body condition, were found to be the most influential determining factors of the sheep price. The heterogeneity in the types of buyers has also a significant effect on price formation reflecting the lack of competitiveness in the sheep markets. From buyers' and sellers' characteristics, buyer type and purpose of buying are significant variables that affect sheep prices in the study area. The results also indicate that controlling for attributes of the animals and the buyers and sellers, there were significant differences in prices between seasons and markets.

Understanding the sources of price variation may be helpful for producers to understand buyers’ preferences for different characteristics of the animal. As a result, sheep producers can target breeding time, feeding practices and place of sale to gain more from existing market opportunities (Zelalem et al. 2013). This may require the application of proper sheep production technologies, selection of appropriate breeding rams, identification of occurrence and severity of diseases and parasites, and their solutions for improving the performance of sheep animals. Thus, the research institutions and livestock offices/departments should focus

on the improvement of the attributes that affect mostly the sheep price at market like body condition, coat colour, tail type.

Finally, the significance of season and market place in influencing price paid for sheep as well justifies the need for targeting season and market places so that smallholder sheep keepers could benefit from the required transformation in the sheep production system to improve their returns. Inadequate information about prices results in poor integration of spatially dispersed markets (Aklilu et al. 2013) and high margins for the intermediaries. Therefore, the communication of price information to sheep producers can improve their competitiveness and profitability. Thus, the government departments should also work on improving market access for sheep producers to reduce transaction costs and to maximize their profits by enhancing competitiveness in the market. Even additionally, linking producers to urban markets where there is a high demand for sheep would be an important step to improve farmers' return from the system.

Declarations

Availability of data and materials

The datasets are used and/or analyzed during the current study available from the corresponding author on request.

Competing interests

I declare that the author does not have any competing interests.

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Author's contributions

KT contributed to research proposal writing, data collection, data analysis, data interpretation and article writing.

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Figures

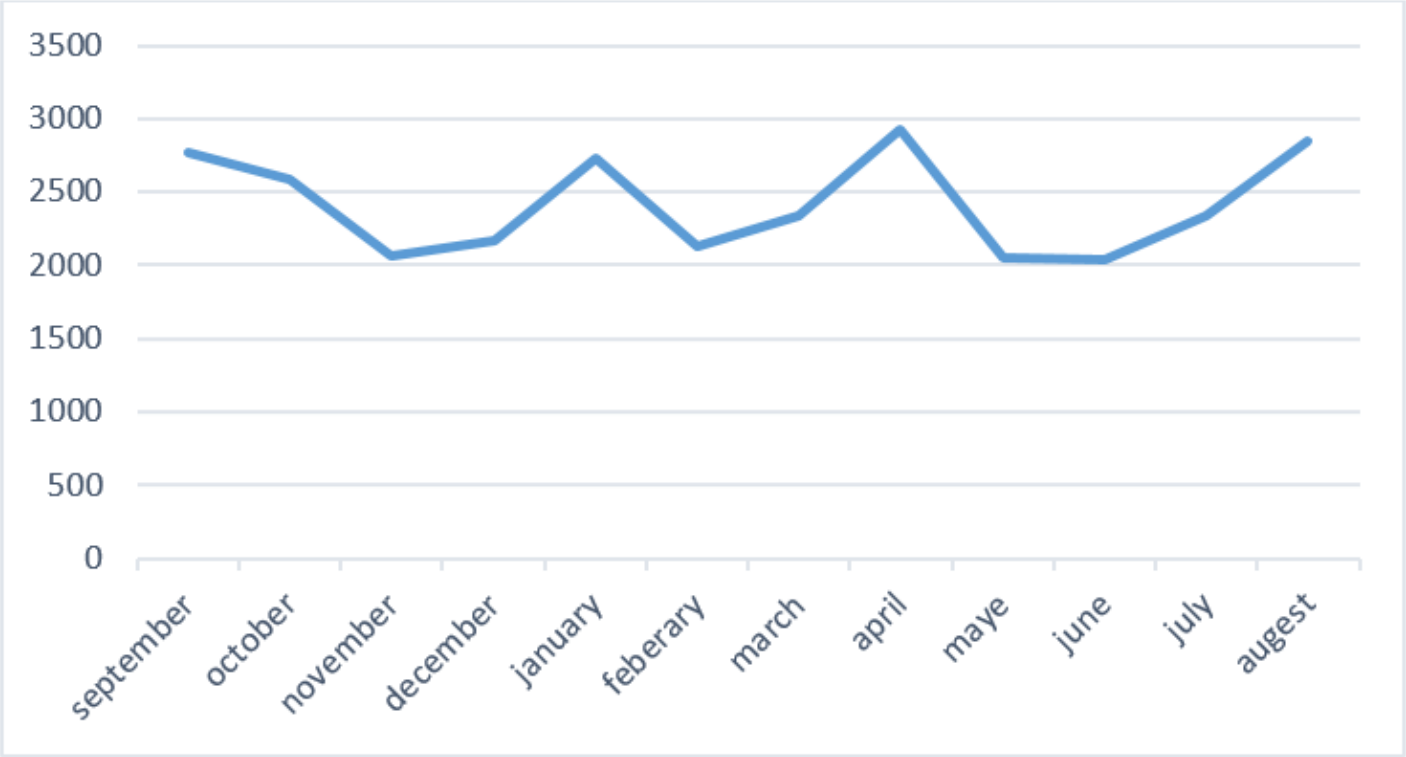

Figure 1

Price of sheep across months in year 2018/19

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