

**PRICE ANALYSIS OF INDIGENOUS GOAT TRAITS IN AFAR
REGION, NORTHEAST ETHIOPIA**

M.Sc. Thesis

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**June, 2016
Jimma, Ethiopia**

**PRICE ANALYSIS OF INDIGENOUS GOAT TRAITS IN AFAR
REGION, NORTHEAST ETHIOPIA**

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BY

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**June, 2016
Jimma, Ethiopia**

Jimma University College of Agriculture and Veterinary Medicine

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LIST OF ABBREVIATIONS

AIDS	Almost Ideal Demand System
AnGRs	Animal Genetic Resources
ANOVA	Analysis of Variance
ANRS	Afar National Regional State
APARDO	Afar Pastoral and Agro-pastoral Rural Development Office
CC	Contingency coefficient
CLR	Classical Linear Regression
CSA	Central Statistical Agency
ESCGIP	Ethiopian Sheep and Goat Productivity Improvement Program
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
HC	Heteroscedastic Consistent
HCCM	Heteroscedastic Consistent Covariance Matrix
iid	identical and independent distribution
MOFED	Ministry of Finance and Economic Development
NGOs	Non-Governmental Organizations
NICHE	Netherlands Initiative for Capacity Development in Higher Education
OLS	Ordinary Least Square
SSA	Sub-Saharan Africa
VIF	Variance Inflation Factor

TABLE OF CONTENTS

STATEMENT OF THE AUTHOR	iv
ACKNOWLEDGEMENTS	v
LIST OF ABBREVIATIONS.....	vi
LIST OF TABLES	ix
LIST OF FIGURES	x
LISTS OF TABLES IN THE APPENDIX.....	xi
ABSTRACT.....	xii
1. INTRODUCTION	1
1.1. Background	1
1.2. Statement of the Problem	3
1.3. Research Questions	5
1.4. Objectives	5
1.5. Scope and Limitations of the Study	6
1.6. Significance of the Study	7
1.7. Organization of the Thesis	7
2. LITERATURE REVIEW	8
2.1. Theory of Empirical Demand Analysis.....	8
2.1.1. The basic model of demand Analysis.....	8
2.1.2. Complete demand systems	9
2.2. Hedonic Pricing, Consumer Behavior and Implicit Price of Traits	10
2.3. Supply of and Demand for Goats in Ethiopia	14
2.4. Review of Empirical Literature on the Hedonic Price Model and Determinants of Livestock Price.....	17
2.5. Conceptual Framework of the Study	19
3. METHODOLOGY	22
3.1. Description of the Study Area	22
3.2. Sampling Procedure and Sample Size.....	23
3.3. Type, Source and Methods of Data Collection	25

TABLE OF CONTENTS (*Continued...*)

3.4. Methods of Data Analysis	27
3.3. Definition, Measurement and Hypothesis of Variables	30
4. RESULTS AND DISCUSSION.....	37
4.1. Description of the Sample Population.....	37
4.1.1. Characteristics of the indigenous goats in the study area.....	37
4.1.2. Market composition by buyer demographic and socioeconomic characteristics	40
4.1.3. Market characteristics by buyer purchase purposes	43
4.2. Determinants of the Indigenous Goat Price and their Implicit Prices	44
4.2.1. The influence of indigenous goat traits on the goat price and implicit price for the indigenous goat traits	45
4.2.2. The influence of demographic and socioeconomic factors on the goat price	48
5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.....	51
5.1. Summary and Conclusions	51
5.2. Recommendations	52
6. REFERENCES	54
7. APPENDICES	61

LIST OF TABLES

Table 1. Sample distribution across the sample markets	25
Table 2. Means of measurement of the goat traits and their levels.....	35
Table 3. Definition of variables used in the hedonic price model	35
Table 4. Characteristics of the goats in the study markets (% and average).....	39
Table 5. Demographic and socioeconomic characteristics of buyers (% and average)	42
Table 6. Buyer purchase purposes in the study markets (%)	43
Table 7. Estimation results of the Hedonic price model using OLS, HC2 and HC3	47

LIST OF FIGURES

Fig.1. Conceptual framework of the study (Own sketch)	21
Fig.2. Geographical location of the study area (by Melkamu Mamuye)	23

LISTS OF TABLES IN THE APPENDIX

Table 1. Categorical and dummy explanatory variables used in the hedonic price model; including recodes of the categorical variables	61
Table 2. Goat markets in the study area their average goat monthly transactions, and the stratification used	62
Table 3. Estimated age for goats with different numbers of erupted permanent incisors.....	62
Table 4. Link test for misspecification of the hedonic price model.....	62
Table 5. Breusch-Pagan/ Cook-Weisberg test of heteroscedasticity of explanatory variables included in the hedonic price model.....	63
Table 6. White's test of heteroscedasticity for explanatory variables included in the hedonic model	63
Table 7. Variance inflation factor (VIF) for multicollinearity test of continuous explanatory variables included in the hedonic price model	63
Table 8. Contingency coefficient for multi-collinearity test of discrete variables included in the hedonic price model	64

**PRICE ANALYSIS OF INDIGENOUS GOAT TRAITS IN AFAR REGION,
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ABSTRACT

Economic opportunities exist for small ruminant producers to supply animals to both the export and domestic markets. The growing demands of meat products at the domestic as well as international markets also increase the importance of goat in the national economy of the country. Despite the large size of the country's goat population, the productivity per unit of goat and the contribution of the goat sector to the national economy is relatively low. Understanding traits that are important in determining goat prices is vital to produce goats targeted to satisfy the increasing market demand so as to make producers grasp better benefits and improve their livelihoods. Therefore, this study was aimed at establishing a hedonic price analysis of indigenous goat traits in the domestic markets of the Afar region, Northeast Ethiopia with specific objectives of characterizing the major traits of indigenous goats; analyzing the implicit prices of the indigenous goat traits; and identifying demographic and socioeconomic factors influencing the indigenous goat price in the study area. A hedonic price model was fitted to analyze factors determining the observed goat prices. Multi-stage sampling technique was employed to select representative samples. The study was based on the transaction data from 200 goats and goat buyers generated through a formal survey conducted in three sample markets in Administrative Zone 1 of the Afar region. To analyze the collected data, the fitted hedonic price model was used with OLS and Heteroscedasticity consistent estimations. The statistical software STATA version 12 (STATA, 2011) was used for analysis of the collected data. Of the indigenous goat traits, body size, body condition, age of the goat, and castration and fattening significantly influenced the observed goat prices. The study also identified demographic and socioeconomic factors influencing the indigenous goat prices. Based on this, purpose of purchase, income level, literacy status, family size, from whom the goat was bought, distance from urban center, and buyer-seller prior relationships significantly influenced the goat price in the study area.

Key words: Hedonic price model, heteroscedastic consistent, goat traits, demographic and socioeconomic factors, Afar region.

1. INTRODUCTION

1.1. Background

Agriculture is still the backbone of Ethiopian economy. Engaging 85% of the population, the sector contributes 52% of the gross domestic product (GDP) and 90% of the total foreign exchange earnings (World Bank, 2007; and CSA, 2008). It is well known that Ethiopia has a large sheep and goat population that significantly contribute to the livelihoods of smallholder farmers. Generously endowed with livestock resources, the country is home for more than 24.1 million goat population, along with 25.5 sheep and 54 million cattle populations that makes the country the first in Africa. Of the total livestock population of the country, about 99.99% of the goat, 99.8% of the sheep and 98.95% of the cattle are local breeds. More specifically, Afar region has livestock population of about 1.9 million goats, 1.2 million cattle and 0.9 million sheep (CSA, 2013).

The livestock subsector contributes for about 16.5% of the national GDP and 35.6% of the agricultural GDP (Metaferia et al. 2011). The subsector also contributes for about 15% of the export earnings and 30% of agricultural employment (Behnke, 2010). It is important constituent of nearly all farming systems providing draught power, milk, meat, manure, hides, skins and other products (Funk et al., 2012).

Small ruminants contribute substantially to income, food (meat and milk), and non-food products like manure, skins and wool. They generate about 40% of the cash income earned by farm households and 25% of the total domestic meat consumption (Hirpa and Abebe, 2008). They also serve as part of the crop failure risk coping portfolio of enterprises, for asset wealth security as form of money saving and investment as well as many other cultural functions (Tibbo, 2006).

Goats (*Capra hircus*) are important and secure forms of investment, which happens to be major farming activity on vast areas of natural grasslands in regions where crop production is impracticable (Tadelle and Workneh, 2007). The goat production in Ethiopia has traditionally been an integral part of the farming systems in all agro-climatic conditions (Workneh, 1992). In semi-arid and arid parts of the country, such as the study

area, the pastoral communities depend mainly on their livestock for their livelihoods (Little *et al.*, 2001, Barrett *et al.*, 2003, Ouma *et al.*, 2007). The goat production in lowlands relies on browsing and grazing and goats are highly valued and reared mainly for milk and meat production (Tsegahun *et al.*, 2000). Usually goats receive little to no supplementary feeding and minimum health interventions; and are kept in large flocks by the pastoralists (Tsegahun *et al.*, 2000 and ESGPIP, 2008).

Currently, economic opportunities exist for small ruminant producers to supply animals to both the export and domestic markets and therefore no longer are sheep and goats subsistence livestock species only. The growing demands of meat products at the domestic as well as international markets also increase the importance of goat in the national economy of the country (Zewdie and Welday, 2015). Proximity of the country to large Middle Eastern markets demanding export quality sheep and goat carcasses, and an increase in the domestic demand for small ruminant meat is leading to a change in the importance and scale of sheep and goat production (ESGPIP, 2008). Adaptations of these markets to the Ethiopian indigenous animals are some of the advantages for the Ethiopian export markets (Belachew and Jemberu, 2003).

The indigenous livestock breeds/populations of Ethiopia have the capacity to cope with the harsh environmental conditions. They often have special adaptive traits for disease resistance, heat tolerance and ability to use poor quality feed which they have acquired through natural selection over hundreds of generations. Therefore, they need relatively less environmental modification to achieve increased productivity (Kiwuwa, 1992, and Azageet *et al.*, 2010).

A focus on prices is important as prices are an important measure of livestock market performance and efficiency, an indicator of producer incentives and a basis of government revenues from livestock market related services (Jabbar and Ayele, 2003). Knowledge of these factors affecting livestock price helps in developing strategies targeting development interventions that will enable improvement of the proportion of the total price of livestock that reaches pastoralists to motivate them for production of better quality animals and their marketing behavior. Understanding price formation allows insight into these issues, and also provides information critical for forecasting future trends. However, there has been

very limited empirical information on the determinants of market prices of livestock in Ethiopia where there is large number of small ruminant population (Teklewoldet *et al.*, 2009).

The Afar National Regional State (ANRS) is known for being one of the Ethiopian pastoral regions where livestock production is the base for livelihood. Most of the population in the region follows a pastoral, transhumant lifestyle keeping multispecies, multi-purpose livestock to provide sufficient milk and meat for consumption, social exchange and occasional sale (Getachew, 2001).

Pastoral regions contribution for agricultural GDP is not significant compared to the volume of livestock they have (Tesfaye, 2010). Likewise, the Afar region is one of the poorest and least developed regions of Ethiopia (MOFED, 2005). Hence, the reason to conduct this study is in the region is to provide important information on the topic of hedonic price analysis of the indigenous goats so as to improve the goat marketing system which can help to improve the production and marketing of the goat sector so increase benefits that the pastoralists deserve which in turn leads to improve their livelihood.

1.2. Statement of the Problem

Despite the huge resource potential, production and export opportunities, output of the goat production in Ethiopia is little and relatively undeveloped (Zewdie and Welday, 2015). This is associated with a number of complex and inter-related factors such as inadequate feed and nutrition, widespread diseases, poor genetic potential of local breeds, market problem, inefficiency of livestock development services with respect to credit, extension, marketing, and infrastructure (Benin *et al.*, 2003; and Negassa *et al.*, 2011). Inability to access markets and achieve maximum prices for livestock products has been a great challenge (Sara and Maki, 2008). There is lack of information on the sheep and marketing. Farmers need to be aware of the preferred characteristics of animals as well as price patterns so that they can plan breeding and fattening programs consistent with the market demand and consumers' preferences (Andargachew and Ray, 1993)

In the study area, Afar region, goats are very important sources of livelihood where their meat and milk production is highly valued. But, the production system which is traditional

pastoral can hardly help to produce goats more uniform and targeted to satisfy the growing demand for goat products and services due to the ever increasing human population (ESGPIP, 2008). This is because the goat farmers lack information of the preferred traits of animals; and thus production does not take the consumer's preferences and demand in to account; rather farmers simply produce and take goats to local markets when they face immediate cash needs.

Therefore, re-orientation of the sector towards consumer preferences and demands is crucial. Re-orientation of the production system which involves designing an effective and informed breeding program is a necessity to bring about improvements in productivity and in the production system of the sector. This entails proper valuation of both traded and non-traded products and services generated from the system (Terfaet *et al.*, 2013).

Moreover, proper identification and valuation of the different characteristics would make resource allocation decisions among the different livestock improvement interventions for commercialization of the system quite fast and smooth (Drucker *et al.*, 2001 and Kassie, 2008). This will also enable identification of goat market opportunities by identifying preferred traits of goats. This is because understanding traits determining the goat price and producing accordingly will help better grasp benefits and improve livelihoods of goat farmers. This is crucial as consumers' demand and preference is continuously changing over time.

Researchers have applied different economic valuation methods to understand the preference for and the value of animal traits in different contexts. Revealed and stated preference based models are the two most commonly used approaches. Jabbar (1998), Barret *et al.*, (2003); Jabbar and Diedhiou (2003); and Terfaet *et al.*, (2013) all used the revealed preference approach and showed that phenotypic traits, season, rainfall pattern, location, seasonal holidays, and restrictions do affect price. The study by Pollak and Wales (1981) also found that demographic variables such as family size and age composition are major determinants of household consumption patterns.

Although the focus of most of the studies are market oriented production systems, the importance of the attributes of livestock in determining prices observed in the market is a

key lesson to learn (Terfaet *al.*, 2013). Publications done on goat prices modeling in subsistence and/or semi-subsistence pastoral systems, such as the Afar region, are limited. Likewise, researches conducted to identify the determinants of prices of goat traits and find out the implicit prices of the traits in the study area limited.

This study investigated the major determinants of indigenous goat prices and analyzed the implicit prices of these traits in the study area by employing the hedonic pricing method. It tried to identify and characterize traits determining the goat price formation and further assessed implicit prices of the traits using hedonic price modeling. The demographic and socioeconomic factors influencing the indigenous goat price were also identified and further assessed.

1.3. Research Questions

The study endeavored to address the following research questions:

- What are the major traits of indigenous goats in the study area?
- Which indigenous goat traits influence the price of indigenous goats in the study area?
- What are the implicit prices of the indigenous goat traits in the study area?
- Which socioeconomic and demographic factors do influence the indigenous goat prices?

1.4. Objectives

The general objective of the study is to establish a hedonic price analysis of indigenous goat traits in Afar Region, Northeast Ethiopia.

The specific objectives of the study are:

- To characterize the major traits of indigenous goats;
- To analyze the implicit prices of the indigenous goat traits; and
- To identify demographic and socioeconomic factors influencing the indigenous goat prices.

1.5. Scope and Limitations of the Study

The study seeks to undertake a hedonic price analysis of goat traits in Afar region of Northeast Ethiopia using a cross-sectional data. It has geographical, methodological and theoretical scopes and certain limitations.

The study focused on the hedonic price analysis of indigenous goat traits in zone 1 of Afar region, which is located in Northeast Ethiopia, the one among five zones of the Afar region. It pursued to characterize and identify the major indigenous goat traits, and demographic and socioeconomic factors influencing the goat price in the study area. The study was restricted to the investigation of the indigenous goat traits; and demographic and socioeconomic factors influencing the goat price formation in the Administrative Zone 1 only. The study was conducted based on the data gathered in three selected markets believed to represent the Zone. Its findings may not hold true for other livestock markets of the region, and other regions of the country.

This study is cross-sectional type as the data used for the study were collected in a single period of time (within two months, December, 2014-January, 2015). The conclusions are therefore based on the findings of the data collected in these two months. Most of the data were collected from market survey through interviewing sample goat buyers with the help of interview schedule in the sample markets. Multiple linear regression analysis based on hedonic pricing model was used with the software STATA 12 (STATA, 2011) to analyze the influences of goat traits and demographic and socioeconomic factors on the goat price. The researcher doesn't conclude that these are the only tools to measure the factors affecting the indigenous goat price.

The other limitation goes to the data collection process. As the data collected from a survey through interviews are not free from enumerator's bias during the data collection period; it may comprise its own limitation on the finding of the study. Theoretically, in this study, the factors like the indigenous goat traits; and demographic and socioeconomic factors were analyzed. The study did not take in to account the influences of other factors such as season and public festivals due to the scope of the study.

1.6. Significance of the Study

The critical analysis of livestock traits determining price formation is very important for initiation and applying development issues of the sector including developing a profitable goat value chain. The study would give an idea on the major traits determining price of indigenous goats and find out their implicit prices of these traits in the study area. This information would be useful for both goat keepers (sellers) and buyers. Goat keepers could use the information to help decide the type of variety to produce and market so as to gain a better benefit. Buyers could take the advantages of price discounts that might be the result of production, while maintaining a desired level of goat traits.

Being the one of the few studies conducted on the goat sector of the region, it would also help a number of organizations and actors such as research and development organizations, farmers, traders, policy makers, governmental organizations and NGOs who aim to improve the performance of goats improvement sector the study area. Moreover, the document would also serve as a reference for researchers to embark upon similar or related work in other parts of the country.

1.7. Organization of the Thesis

With the above brief introduction, the remaining part of the thesis is organized as follows. Chapter two presents the review of literature on hedonic price analysis from different sources. Brief description of the study area and methodology is presented in the third chapter. Subsequently in chapter four, both descriptive and econometric results are presented and discussed in detail. Finally, chapter five deals with the drawn conclusions from main findings of the study and appropriate recommendations.

2. LITERATURE REVIEW

2.1. Theory of Empirical Demand Analysis

The empirical analysis of consumer behavior has always held a central position in econometrics and many of what are now standard techniques were developed in response to practical problems in interpreting the demand data. An equally central position in economic analysis is held by the theory of consumer behavior which has provided a structure and language for model formulation and data analysis. Demand analysis is, thus, in the rare position in econometrics of possessing long interrelated pedigrees in the theoretical and empirical sides. Demand analysis is referred to the study of commodity demands by consumers, most usually based on aggregate data but occasionally, and more so recently on cross-sections or even panels of households (Deaton and Muellbauer, 1980).

A flexible demand system called the Almost Ideal Demand System (AIDS) is developed by Deaton and Muellbauer (1980). Moschini (1998) explained the advantage of the AIDS model in such a way that it automatically satisfies the aggregation restriction and with simple restriction homogeneity and symmetry can be imposed. The concept of a flexible demand system is extremely useful for estimating a demand system with many desirable properties. In addition, the non-linear Engel curves of the AIDS model imply that an increase in income will lead to decrease in the share of income allocated to a particular commodity, as well as a decrease in the income elasticity of that good when it is less than one. However, the AIDS model may be difficult to estimate because the price index is not linear in terms of parameters estimated. Owning to its simplicity, the Linear Approximate/ Almost Ideal Demand System (LA/AIDS) is popular for empirical studies.

2.1.1. The basic model of demand Analysis

Demand models are variously classified based on the specifications of models, their estimation procedure, number of equations, etc. There are two approaches that can be followed to estimate the parameters of demand equations. One consists of specifying estimable single equation demand function in a pragmatic fashion without recourse to the

economic theory. Demand estimation from time series data falls under this category. The use of relative prices and real income in the equation as exogenous variable makes the demand equations homogenous of degree zero in prices and income. This ensures that there is no money illusion in demand in the sense that it is not affected by the proportional increase in all prices and incomes. Sadoulet and Janvry (1995) found that although this approach is simple, it has serious drawbacks such as

- i. The choice of functional form and of variables to be included is arbitrary.
- ii. The guidelines used are usually in combination of common sense, interest in specific elasticities, computational convenience, and goodness of fit in criteria.
- iii. This functional form postulates constancy of elasticities over all values of the exogenous variables. This can be true for only a short range of price and income for policy analysis and for normal goods.
- iv. The estimated variables, in general, do not satisfy the requirements of demand theory, particularly the budget constraint.

An alternative approach to the estimation of demand equation parameters uses the theory of demand as a guideline for the choice of functional forms and variables to be included. In particular, the theory allows the derivation of estimable functional forms of equations from mathematically specified models of consumer choice and imposition of constraints on demand parameters to reduce the number of independent parameters to be estimated to manageable numbers relative to data availability. The two popular demand systems under this are Linear Expenditure System (LES) developed by Stone (1954) and Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980).

2.1.2. Complete demand systems

Demand can also be modeled using direct and indirect utility concepts. Based on the source of data demand can be modeled using cross sectional data, time series data, and pooled data. Models such as profit function can be used to derive derived demand like demand for inputs such as labour, capital, etc. A demand model may be specified in linear or non-linear fashion depending on the fit and adequacy of the data. Demand model may be specified as single equation or the demand for all variables under study can be

estimated in a single frame of a set of equations which are simultaneously called as complete demand system (Sivaramane N., undated).

Classification of complete demand systems with examples

1. Additive Models:

- Linear Expenditure System (Stone, 1954)
- Addilog demand systems, (Houthakker, 1960)

2. A priori Models:

- Constant elasticity model (Byron, 1968)
- Quadratic expenditure system, (Pollak and Wales, 1978)

3. Non-additive Models:

- Translog systems, (Christensen *et al*, 1975)
- Almost Ideal System, (Deaton and Muellbauer, 1980)

2.2. Hedonic Pricing, Consumer Behavior and Implicit Price of Traits

Hedonic prices, defined as the implicit prices of attributes, are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them. A hedonic price function describes the equilibrium relationship between the economically relevant characteristics of a product and its price. Hedonic prices can be used to predict prices for new goods, to adjust for quality changes in the price of a good and to measure consumer and producer valuations of differentiated products (Rosen, 1974; and, Lucas, 1975). Hedonic pricing is a well-known method for decomposing the price effects of various attributes that make up multi-attribute goods (Sheppard, 1999).

A hedonic model of prices is one that decomposes the price of an item into separate components that determine the price (Martinez-Garmendia, 2010). It is a model that posits that goods are typically sold as a package of inherent attributes (Rosen, 1974). Hedonic methods were developed and employed in price indices long before their conceptual framework was understood (Triplett, 1986). Bartik (1987) claimed that the first formal contributions to hedonic price theory were those made by Court in 1941, although there were other informal studies. Etymologically, the term “hedonics” is derived from the

Greek word *hedonikos*, which simply means pleasure (Chin and Chau, 2003). The same author explained that, in the economic context, the term refers to the utility or satisfaction one derives from the consumption of goods and services.

Two main approaches contributed greatly towards the theoretical work on hedonic prices. The first approach was derived from Lancaster's (1966) consumer theory, and the second comes from the model postulated by Rosen (1974). Both of these approaches aimed to impute prices of attributes based on the relationship between the observed prices of differentiated products and the number of attributes associated with these products. Although the set of prices influencing characteristics is different across different markets, and the variables included in the hedonic price model are also constrained by the availability of data, this list should serve as a useful basic checklist for the application of the hedonic price model in different markets (Chin and Chau, 2003).

The Lancastrian model, Rosen's model, and the hedonic price model all surmised that goods possess a myriad of attributes that combine to form bundles of characteristics (or objectively measurable, utility-affecting attributes), which the consumer values; but these models have some fundamental differences. The Lancastrian model presumes that goods are members of a group, and that some or all of the goods in that group are consumed in combinations, subject to the consumer's budget. In comparison, Rosen's model assumes there is a range of goods, but that consumers typically do not acquire preferred attributes by purchasing a combination of goods. Rather, each good is chosen from the spectrum of brands and is consumed discretely. The hedonic price approach also does not require joint consumption of goods within a group. Thus, Lancaster's approach is more suited to consumer goods, whereas Rosen's model can be associated with durable goods (Chin and Chau, 2003).

Lancaster's theory also assumes a linear relationship between the price of goods and the characteristics contained in those goods. Implicit prices are constant over ranges of characteristic amounts. They can only change when there is a change in the combination of goods consumed. In contrast, Rosen postulated that unless it is possible for consumers to arbitrage attributes by untying and repackaging them, a nonlinear relationship between

the price of goods and their inherent attributes would be more probable. A nonlinear price function implies that the implicit price is not a constant, but a function of the quantity of the attribute being bought, and, depending on the actual functional form of the equation, on the quantities of other attributes associated with the good as well (Chin and Chau, 2003). The same author revealed that Rosen's model has two distinct stages. The initial stage serves to estimate the marginal price for the attribute of interest by regressing the price of a commodity or good on its attributes. The first stage develops a measure of the price, but does not directly reveal the inverse demand function. The second stage estimation is to identify the inverse demand curve or the marginal willingness to pay function, derived from the implicit price function estimated in the first stage.

As Rosen incorporated income directly into the budget constraint of the consumer, when income increases, the consumer's marginal willingness to pay for a certain implicit attribute may also change. It is assumed that the buyer's demand price or willingness to pay for an attribute is a function of the utility level, the buyer's income, and other variables which influence the goat price, such as age, literacy status, and so on. Rosen opined that the inverse demand function, which takes into consideration the changes in income and utility levels, can be estimated by using the marginal price as an endogenous variable in the second stage simultaneous equation. If it is possible to trace back the inverse demand function based on the implicit marginal price function, then measuring the utility change with respect to certain quality changes can also be estimated by integrating the inverse demand (Chin and Chau, 2003).

The price of a product in a competitive market excludes the attributes of buyer and sellers implying differentiation of products and not their markets, buyers or sellers. Therefore, in such a market, an implicit price is a function of the product attributes alone and not of individual consumer or supplier attributes. Utility-maximizing buyers and sellers interact to establish the market value for a given attribute. Goods are valued for their utility-bearing characteristics, not for the good itself. Each attribute can be evaluated by consumers when making a purchasing decision and an implicit price can be identified for each of them (Rosen, 1974; and, Oczkowski, 1994).

On the contrary, most studies have found that an implicit price is a function the product as well as related to the attributes of buyers or sellers. This is because markets in developing countries in general in Ethiopia setups in particular are hardly competitive due to the different sources of inefficiency and all other generic sources of market imperfections that entails the inclusion of factors apart from the attributes of the goods and services in the model specification (Andargachew and Brokken 1993; Jabbaret *et al.*, 1998; Abdulai, 2000; Ayele *et al.*, 2006; and Kassie *et al.*, 2011). This study therefore hypothesized the interplay of the goat as well as buyer and seller attributes to determine the price of goats in the study markets. This technique can be used in relating the price per animal to its various attributes and characteristics (Jabbar and Diedhiou, 2003).

The hedonic price model is a very useful scientific tool. With sufficient data, this tool allows us to estimate the individual effects of different attributes on prices. Because researchers cannot conduct controlled experiments in the laboratory, the hedonic price model is the major scientific method by which we can observe the effects of one or more attributes on prices of commodities or goods, other factors holding constant. This allows us to understand the behavior of players in the different markets and how these markets operate. This is very important for developers, development consultants, investment consultants, and policy makers (Chin and Chau, 2003).

However, the hedonic price approach is not without limitations. First, the hedonic price model is very data consuming. For some places, transaction data is simply not available (due to thin transactions), or is available at very high prices. Second, mis-specification of the function due to missing variables (data not available) may lead to bias in the estimates. The choice of functional form is also difficult to determine when no prior knowledge about how independent variables affect housing prices exists. Furthermore, the heterogeneous nature of housing makes it difficult to observe the parsimony principle. The more independent variables are included, the higher the chance of mis-specification of the hedonic price model. The coefficients tend to be very unstable when a large number of independent variables are included. A smaller homogenous sample can help reduce this problem, but the result is normally a sharp reduction in the number of usable transactions. Although recent developments in statistical theories help detect and resolve partially some

of these problems, the use of the hedonic price model in empirical studies requires not only technical skills, but also experience and judgments (Chin and Chau, 2003).

However, identification of the inverse demand function poses some problems because it depends on the assumptions made about the supply side of the implicit market for the attribute. If the supply of a commodity is perfectly elastic, or if the supply of an attribute is fixed, the marginal price of an attribute becomes exogenous in the estimation of the inverse demand function. Bartik (1987) did not agree with Rosen's approach of estimating the hedonic price model, and argued that the hedonic estimation problem is not the result of the interaction between demand and supply because the individual consumer cannot affect suppliers. Instead, the hedonic estimation problem is caused by the endogeneity of both prices and quantities of attributes in the context of a non-linear budget constraint. Hence, there is no necessity to model the supply side of the market.

According to Butler (1982), only attributes that are costly to produce and yield utility be considered in the regression equation. Moket *al.* (1995) concurred that biases due to missing variables are small, and have negligible prediction and explanatory power on the equation. Finally, measurement errors may also arise if proxy variables are used in the hedonic price model when actual data is unavailable. Consequently, the results generated will be biased and inconsistent. However, this study developed a hedonic price model based on a multiple linear regression as recommended by previous authors (Oludimu and Owakade, 1995; Williams *et al.*, 2003 and Maxa *et al.*, 2009). The study also conducted appropriate tests of classical linear regression assumptions (CLR) before selecting and using the model.

2.3. Supply of and Demand for Goats in Ethiopia

Developed countries consumed a consistent level of 77 kg of meat per capita annually, while developing countries struggled to maintain a diet with only 25 kg of meat per capita annually. Ethiopians remained slightly below the meat intake of all low-income countries and consuming 9 kg per capita annually (Abbey, 2004).

Negassa and Jabbar (2008) reported that the estimated Ethiopian domestic meat consumption for 2006–07 was 2.4 kg/capita per year for beef, 0.7 kg/ capita per year for sheep meat and 0.4 kg/capita per year for goat meat. The same source also found that the total meat consumption was close to 276 t in 2006–07, of which beef and mutton account for 68% and 21%, respectively. Pronounced differences have been identified between rural and urban patterns of meat consumption, particularly for beef and mutton. Aside from economic factors, rural and urban consumption differences can be explained by social and demographic characteristics such as age structure and the rigor of adherence to religion-based fasting (Negassa and Jabbar 2008).

Meat production per head of livestock is found to be low by the standards of other significant livestock producing African countries. The study of de Haan (2003) shows that production of cattle meat in Ethiopia is just 8.5 kg/head of cattle per year, which is significantly lower than in Kenya and Senegal (21 and 16 kg, respectively).

According to the FAO (1999), goats account an estimated 13.9% and 10.5% of the total meat and milk production of domestic animals. Although there is a prejudice against the consumption of goat milk and meat, they tend to replace sheep as the dominant small ruminant species in northern, eastern and western highlands. On the other hand, in the semi-arid mixed farming systems and in the arid pastoral lowlands, goat milk and meat are highly valued commodities. Milk production from goats is particularly important to poor smallholder farmers in the highland and semi-arid mixed farming systems. These farmers have neither the financial nor physical resources to maintain large ruminants (Zelealem and Fletcher, 1993).

In Ethiopia, goats are also sources of other valuable non-food products such as skins used as raw materials for various traditional household products manufactured in local cottage industries. In the country it is estimated that 14.6 million skins are produced annually, of which 90% of sheep and 70% of goat skins are recovered from the market (Zewdu, 1995). The Bati genuine skin is known for its quality and fetches premium prices on the world market. Goats are extensively milked and most milk is marketed and processed into curd and butter. In the lowlands (arid and semi-arid areas) where crop production is not

reliable, goat production has experienced success, with high commodity prices (Tsegahunet *al.*, 2000).

Human population growth in Ethiopia is forcing the conversion of many former grazing areas into croplands needed for increased food production. Raising large ruminants is becoming increasingly difficult as a result of the ensuing lack of grazing areas. Land holdings in densely populated areas are below 0.5 ha. In such places, the importance of sheep and goats in fulfilling the role once played by cattle for meat, milk and manure production is being increasingly recognized. The increased demand for sheep and goat meat has also increased their importance in lowland pastoral areas as a source of cash income, food security, etc (ESGPIP, 2008).

The ESGPIP (2008) also reported that sheep and goats contribute a quarter of the domestic meat consumption; about half of the domestic wool requirements; about 40% of fresh skins and 92% of the value of semi-processed skin and hide export trade. It is estimated that 1,078,000 sheep and 1,128,000 goats are used in Ethiopia for domestic consumption annually. The same source also explained that, there is also a growing export market for sheep and goat meat in the Middle Eastern Gulf States and some African countries. At optimum off take rates, Ethiopia can export 700,000 sheep and 2 million goats annually, and at the same time supply 1,078,000 sheep and 1,128,000 goats for the domestic market. The current annual off take rate of sheep and goats is, however, only 33 and 35%, respectively (ESGPIP, 2008).

The proximity of Ethiopia to Middle East and their adaptation to indigenous animals are some of the advantages for the Ethiopian export market (Belachew and Jemberu, 2003). However the international market for meat has become more competitive and the meat traders have had to adopt improved practices in production, processing and packaging of meat. Strict quality control measures to meet specific export market demands need to be implemented. Market requirements are also different both in size of the carcass and the level of fatness of the carcass (Ameha, 2006).

In General terms, the demand for Ethiopian sheep and goat meat has dramatically increased after market promotion by development projects in close collaboration with the government. This has created an opportunity for sheep and goat producers to sell more animals at better prices. Meat export performance has increased from 870 t in 1991 to 18,000 t in 2011–12 (Legeseet *al.*, 2014).

2.4. Review of Empirical Literature on the Hedonic Price Model and Determinants of Livestock Price

Empirical studies shows that animal attributes (sex, age, weight, body condition and color of marketed animals), type of breed, occasions of transaction, type of buyers and their literacy status are an important observable influencing factors for livestock price formulation (Andargachew and Broken, 1993; Ayeleet *al.*, 2006; Adugna, 2006; Dossa, Rischkowsky, 2007; Teklewoldet *al.*, 2009; Kassaet *al.*, 2011).

The body weight of animal has statistically significant influence on price as found by Kassaet *al.* (2011), Adugna (2006), Dossaet *al.* (2007) and Andargachew and Broken (1993). Contrary to the study of Andargachew and Broken (1993), Kassaet *al.* (2011) and Adugna (2006) concluded that weight has quadratic effect on price on primary level of market.

Body weight is taken using measuring instrument, whereas body condition is technical judgment of the animals by buyers. Thus, body condition is a good indicator for dressing percentage and meat quality of animals. Body condition of the animals (cattle, sheep and goat) has decisive influence on price setting (Adugna, 2006; Teklewoldet *al.*, 2009; Kassaet *al.*, 2011). In contrast, Andargachew and Broken (1993) argued that body condition of sheep have no influence on price setting at different market level.

Studies conducted in Ethiopia (Andargachew and Broken, 1993; Ayeleet *al.*, 2006; Teklewoldet *al.*, 2009; Kassaet *al.*, 2011; Kassieet *al.*, 2011) on different livestock species found that age of animals has significant influence on price. Some literature considered age as continues variables and others as categorical variable that finds literature review difficult.

Age of the animals has diminishing marginal effect on price of cattle (Kassieet *al.*, 2011) and small ruminant (Ayeleet *al.*, 2006). Teklewoldet *al.* (2009) found that age, specifically matured age, put its influence on price of goat. In general, age of the animals may or may not influence price of animals either at the same or different market level (Andargachew and Broken, 1993; Kassaet *al.*, 2011).

The influence of castration of male animals varies depending on the animal's species and market level. Adugna (2006) argued that castrated ox has no price variation with intact ox (that is not castrated). Studies conducted on the central high land of Ethiopia reveals that castrated rams have no influence on price on the primary market (Kassaet *al.*, 2011) rather on the terminal market (Andargachew and Broken, 1993). Studies conducted in Benin, found that castrated male goat has significant impact on price regardless of market level (Dossaet *al.*, 2007).

Contrary to Ayeleet *al.* (2006) price of small ruminant in pastoralist area, Kassaet *al.* (2011) concluded that female sheep fetches higher price than male sheep at redistributive market. Evidences from different literature shows that the influence of sex of the animals on price is inconsistent along different market level and production system.

Studies conducted in Ethiopia on the determinants of livestock price rarely included breed of animals as one determinant of price. However, certain literatures consider breed of animal, for instance, Jabbar and Diedhiou, (2003) found that in some cases buyers in Nigeria pay significantly different prices for certain breed of cattle consistent with their preferences.

Literatures that consider color as an important determinant of price of goat are rare. Among the two small ruminants (i.e., sheep and goat), buyers preference for coat color of goat are indifferent. As a result coat color of goat has no significant effect on price formation of goat in Ethiopia (Ayeleet *al.*, 2006). Likewise, in Benin color has no effect on price of goat (Dossaet *al.*, 2007). Likewise, this study does not include color as an important determinant of goat price.

Terfaet *al.*, (2013) conducted a study on valuation of traits of indigenous sheep of central Ethiopia using a hedonic price model; focusing on the main traits of traded sheep such as, body size, tail condition, age, and sex. They have generated and analyzed data on other factors affecting the sheep price such as the attributes of buyers and sellers, because markets in developing countries in general in their study area setups in particular are hardly competitive due to the different sources of inefficiency and all other generic sources of market imperfections that entails the inclusion of factors apart from the attributes of the goods and services in the model specification (Abdulai, 2000 and Kassieet *al.*, 2011). They have also captured seasonality of demand and supply.

According to Bloomquistand Worley; (1981); and Goodman (1978), a major empirical issue pertaining to the hedonic price model is the choice of the functional form. There are several basic functional forms such as linear, semi-log, and log-log forms that can be applied to the hedonic price model. An incorrect choice of functional form may result in inconsistent estimates). Butler (1982); and; Halvorsen and Pollakowski, (1981); similarly added that despite having a long history, the theory of hedonic pricing provides very little guidance on the choice of the proper functional form.

2.5. Conceptual Framework of the Study

This section presents a conceptual design to understand how price formation of the indigenous goats is affected by their traits. The underlying hypothesis of hedonic price analysis is that products have utility bearing attributes and that the values of those attributes contribute to the price of the products. A hedonic price function relates the price of a product (good or a service) to its various attributes or characteristics.

Many previous authors indicated how prices of products are determined by their utility bearing characteristics. Waugh (1928) and later Lancaster (1966) made early attempts to relate price to products characteristics. Rosen (1974) and Lucas (1975) advanced those ideas providing a theoretical framework for hedonic price analysis. The main focus of hedonic price analysis of the indigenous goats in the study area is the idea that goat price is the result of the hedonic attributes of the goats.

A hedonic price model was used to determine the effects of various factors affecting the goat price formation. The influences of goat traits such as body size (live weight), body condition, age of the goat, sex of the goat, and castration and fattening on the goat price were studied. This is due to the assumption that under competitive market conditions, implicit prices will normally be related to product attributes alone, without accounting for producer or supplier attributes.

However, as widely documented in the literature, rural markets in developing countries, particularly in sub-Saharan Africa (SSA) including the study area, are rarely competitive (Barrett and Mutabatsere, 2007). This is essentially due to poor communication and transport infrastructure, limited rule of law, restricted access to commercial finance, information asymmetry, all of which make markets function much less effectively. Several empirical studies have shown that prices are also related to the attributes of buyers, season and market location (Abdulai, 2000; Jabbar and Diedhiou, 2003).

Therefore, beyond the characterizing and identifying the goat traits, the study also identified and analyzed other factors influencing the goat price in the study area. The first important factor studied is demographic and socioeconomic factors on the goat price. Thus, influences of demographic and socioeconomic factors such as purpose of purchase, buyer family size, buyer income level, buyer literacy status, buyer access to market information on price, buyer prior relationship (acquaintance) with seller, and from whom the goat was purchased were assessed. In addition, the study also analyzed the impacts of market location (district) on the goat price. But due to the scope of time of data collection period was limited (only 2 months), the influence of other factors such as season and public festivals (such as holidays) on the goat price was not studied and included in the hedonic price model.

To generalize, the study was conducted following the framework of Rosen (1974), developed a multiple linear form of hedonic price model of dependent variable (goat price) and combined continuous and dummy explanatory variables to achieve the objectives. Hedonic model price was estimated by regressing price on quality attributes using OLS, and heteroscedasticity consistent standard error estimates (HC2 and

HC3) method in STATA 12 (STATA, 2011). It was conducted using the data on a sample of 200 goats and goat buyer characteristics in Zone 1 of the Afar region, Northeast Ethiopia. The overall conceptual framework of the study is shown in the figure below (Fig.1).

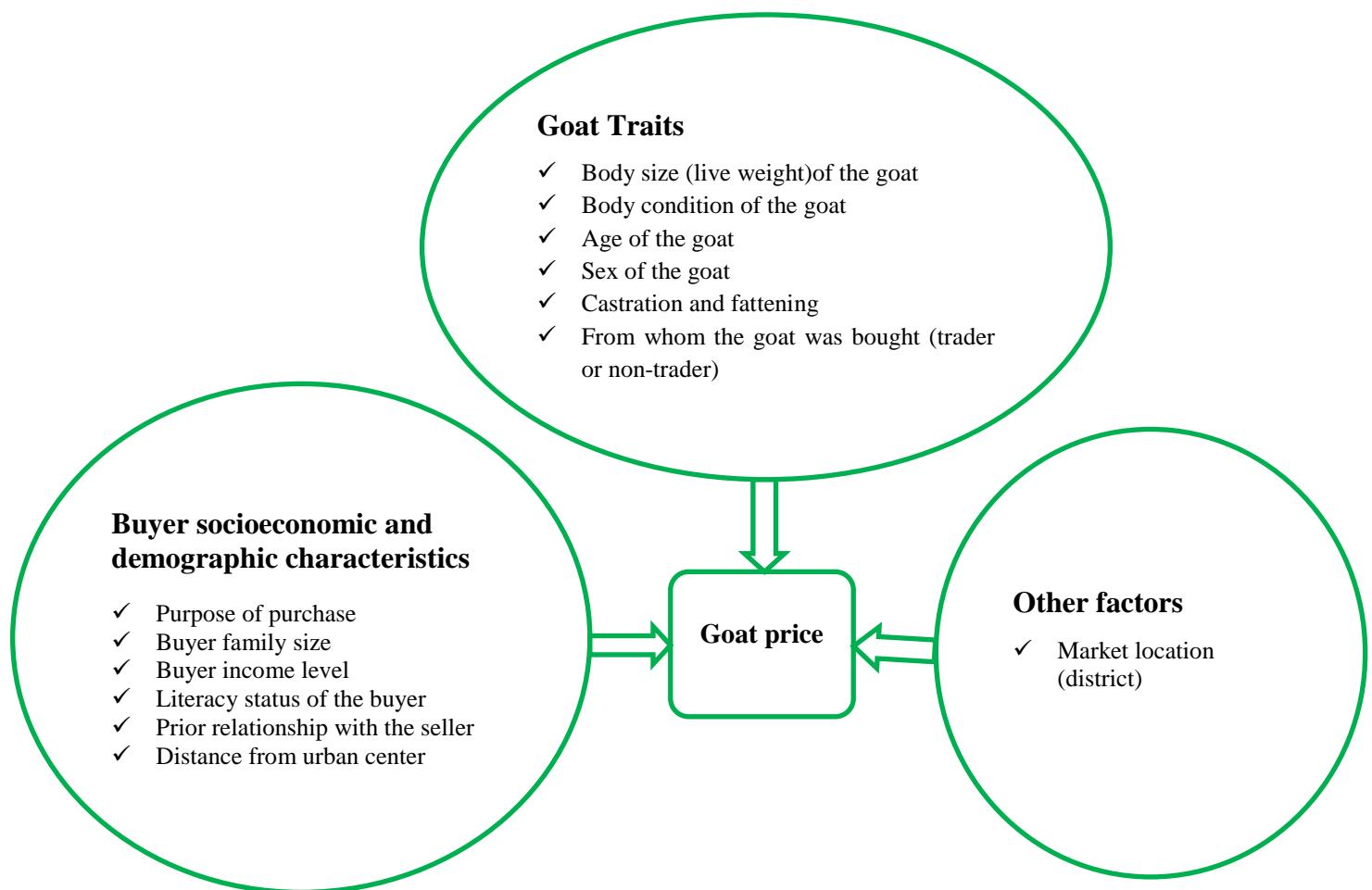


Fig.1. Conceptual framework of the study (Own sketch)

3. METHODOLOGY

3.1. Description of the Study Area

The study was conducted in the administrative Zone 1 of Afar National Regional State (ANRS). The ANRS is one of the nine regional states of the country. The region is located between $80^{\circ}45'$ to $42^{\circ}23'$ longitude east and covers an area of 100,860 km². The region has total population of 1, 678,000 of which 31.3% belongs to the study area (Administrative Zone 1). It is a semi-arid region of Ethiopia in which about 80% of the population is leading a pastoral life by rearing camels, cattle, goats, sheep and donkeys and the rest 20% represent agro-pastoral (CSA, 2013).

Afar region is found in the Great East African Rift Valley. The topography of the region varies from hilly escarpment in the western and southern edges with an altitude of 1000-1500 meters above sea level to lowland plains that fall in the altitude of 0-100 meters below sea level. Around 53% of the region has flat landscape with altitude decreasing towards Northeastern parts. The annual temperatures vary from 18°C to 45°C in higher elevations to 45°C in lower elevations. The rainfall is a bi-modal throughout the Region. It ranges from 500 mm in the semi-arid western escarpments to 150 mm in the arid zones (Solomon, 2006).

The region is located in Northeastern part of Ethiopia sharing international borders with Eritrea and Djibouti in the east, Somali and Oromia in the south, Tigray and Amhara in the west (Hundie, 2006). It is divided in to five zones and 32 districts (Figure 1). Zone 1 is one among the administrative zones located in Eastern part of the region. The Zone has eight districts namely, Afambo, Asayta, Chifra, Dubti, Adar, Elidar, Kori and Mille districts of which only 6 of them have modern goat markets. The Zone is bordered on the South by Administrative Zone 3, on the southwest by Administrative Zone 5, on the West by the Amhara Region, on the Northwest by administrative Zone 4, on the north by Administrative Zone 2, on the Northeast by Eritrea, and on the East by Djibouti. The geographical location of the study area is presented in the figure below (fig. 1).

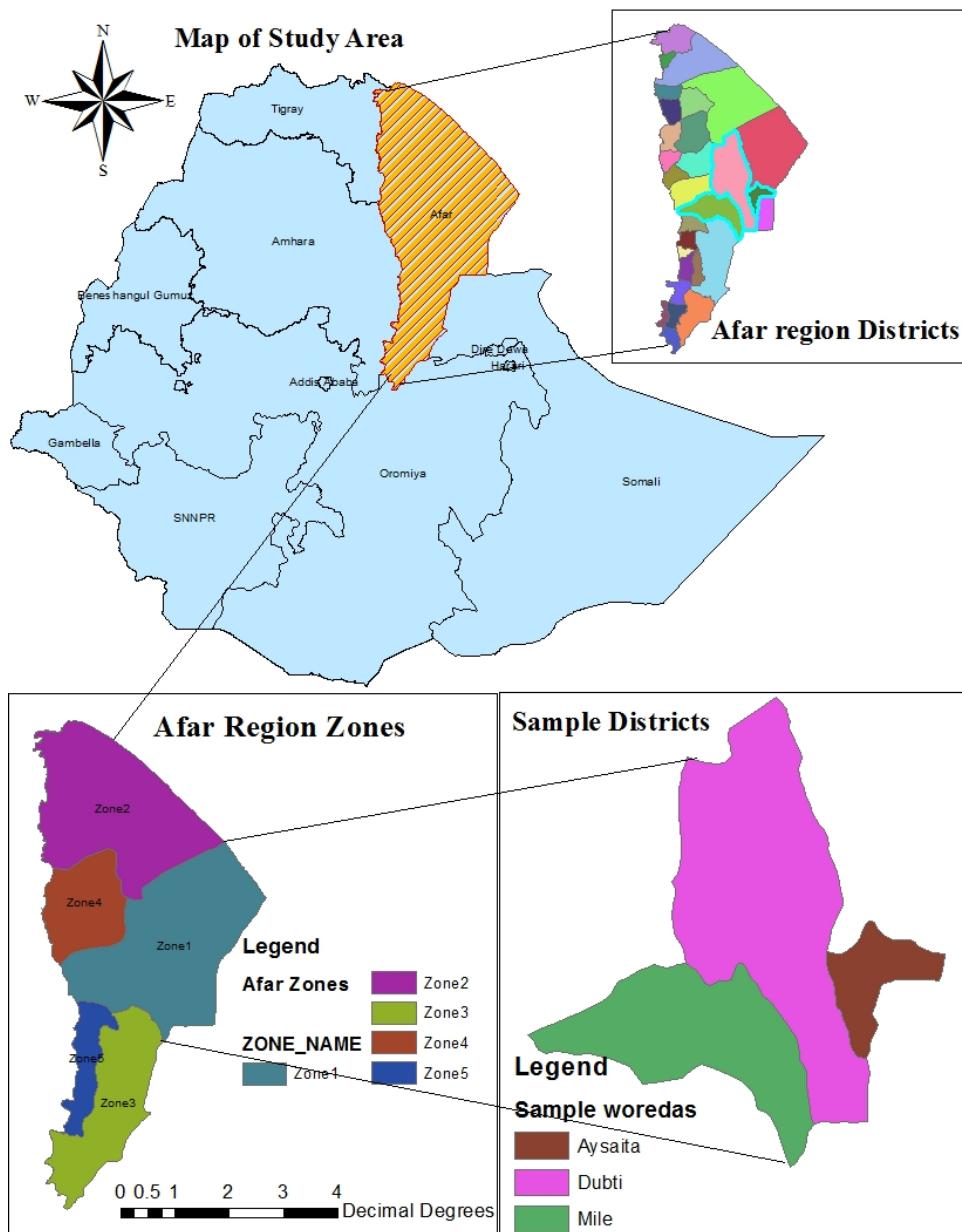


Fig.2. Geographical location of the study area (by MelkamuMamuye)

3.2. Sampling Procedure and Sample Size

A preliminary assessment of the study area was conducted prior to the main sampling. To make the purpose of the study clear and ensure collaborations during the study, discussions with the regional, zonal and district offices and professionals were held.

The survey was carried out using a multi-stage sampling method, based on the selection of the combination of different sampling methods. Purposive, stratified and simple random sampling techniques were employed to select representative samples from the population. The sample covered goats and goat marketers in selected markets of the zone which were selected on a Probability Proportional to Size (PPS) basis.

First, Zone 1 of the region was purposively selected among the other zones of the region based on its goat production potential. Then, markets of the Zone were stratified as small, medium and large goat markets based on their number of transactions. Next, after stratification of the markets, three sample markets, one from each stratum of markets were randomly selected using simple random sampling technique. Therefore, the Asayita, Mille and Dubti goat markets were selected to represent the small, medium and large stratum of markets respectively. Finally, simple random sampling technique was employed to select sample goat and goat marketers from the selected goat markets.

How much sample size can be representative for the population in this study was determined using the Cochran's probability proportional to sample size-sampling technique (Cochran, 1977).

$$n_0 = \frac{(1.96)^2 * (0.16)(0.84)}{(0.05)^2} \approx 207$$

Where;

n_0 , desired sample size

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.16 (proportion of population to be included in sample i.e. 16%)

$$q = 1 - P \text{ i.e. } (0.84)$$

N = total number of population

d = is degree of accuracy desired (0.05).

Finally, the final sample size was obtained by adjusting the initial sample size ($n_0=207$), using Cochran's finite population correction formula as;

$$n_1 = \frac{207}{(1 + 207/10,237)} \approx 200$$

Where;

n_0 , the initial sample size

n_1 , the final adjusted sample size

N = the total population size.

The above procedures were followed to select sample of 200 goats and goat marketers from the total population of 10,237. Finally, the total sample of 200 was distributed as 40, 68 and 92 for the Asayita, Mille and Dubti goat markets respectively. The distribution of sample across the sample markets is indicated in the table below (Table 1).

Table 1. Sample distribution across the sample markets

Name of the market	District of location	Relative size	Number of transactions	Sample size taken
Asayita	Asayita	Small	2,047	40
Mille	Mille	Medium	3,481	68
Logiya	Dubti	Large	4,709	92
Total			10,237	200

Source: Own computation from Afar pastoral and Agro-pastoral Rural Development Office (APARDO, 2014)

3.3. Type, Source and Methods of Data Collection

Both quantitative and qualitative data were used for this study. In order to generate these data, both secondary and primary data sources were used.

Primary data were collected in a formal survey and from key informants as well as informal discussions. The formal survey was undertaken through formal interviews with randomly selected buyers of the selected markets using pre-tested structured questionnaires. A checklist was used to guide the informal discussion conducted to generate data to supplement the data obtained from individual interviews in a formal survey.

Data on the traits of the goats marketed such as the agreed selling price, body size, body condition, goat sex, goat age, and market location (district) were collected. Age of the goat was measured by examining teeth and consulting goat sellers. The body size and body condition of the goat were based on their relative position of the goats as the preliminary assessment helped the researcher to observe the goats found in the study markets and estimate the relative sizes and body conditions. In addition, data on demographic and socioeconomic characteristics such as age, sex, marital status, family size, income level, literacy status, distance to urban center, prior relationship (acquaintance) with the seller, purpose of purchase and from whom bought goat (from trader or non-trader) were collected.

The secondary data used in the study were collected from different sources such as zonal and district office reports, magazines, CSA and FAO, different websites, previous studies etc.

Collection of the data was held for two months (December 2014- January 2015) on a weekly market day basis of the Asayita and Mille goat markets. Of the three study markets, the Asayita and Mille goat markets were weekly markets that set on once in a week on a designated day. But, the Dubti goat market operated throughout the week. The market infrastructure of the study area is very poor and there was no fence or shed in markets. Dubti was the only fenced goat market where goat and sheep together (shoat) are traded in a relatively organized manner. In all of these markets, transactions taken place after a long one-to-one bargaining between sellers and buyers on a per-head basis.

3.4. Methods of Data Analysis

Both descriptive statistics and econometric models were used in the study. The descriptive statistics used were means, percentages, ratios, chi-square and standard deviations in the process of examining and describing the goat markets and transactions, goat traits and demographic and socioeconomic characteristics. The chi-square and one-way ANOVA tests were used to compare group of categorical and continuous variables. The Multiple Linear Regression (MLR) model procedure of the software STATA 12 (STATA, 2011) was used for analysis of the collected data.

A hedonic pricing model was used to analyze how goat prices are formed. It was used to determine the effects of various factors on the goat price. The impacts of indigenous goat traits, and demographic and socioeconomic factors on the goat price of the study area were analyzed.

The implicit prices for the attribute of interest were estimated by regressing the price of the good on its attributes (Rosen, 1974), in this case, the goat selling price (P_i) on each of the goat traits; and demographic and socioeconomic factors (independent variables). The general form of the implicit price function is given in the equation;

Where,

P_i is the observed selling price of goats;

Q is a set of qualitative (discrete) variables; and

C represents a set of quantitative variables, and ε_i is the error term.

The partial derivative of the estimated function with respect to a quantitative variable is the implicit marginal value of the attribute. Qualitative attributes were represented by dummy variables. Therefore, the implicit price was analyzed as:

Where, P_{iC} = the marginal implicit price of quantitative attributes of the goat;
 ∂P_i is the partial derivative of implicit price with respect to quantitative attributes of the goat.

Model structure in general and functional form in particular is critical in building an accurate and consistent econometric model (Brown and Ethridge, 1995). This is even more with hedonic price equation estimations because functional form of the hedonic price equation is unknown and economic theory places few restrictions on the form of the hedonic function (Cropper, Deck and McConnell, 1988; Haab and McConnel, 2002). This implies lack of prior expectation on the functional form of the hedonic price function.

However, following Cropper *et al.* (1988), Bin (2000) and Haab and McConnel (2002), this study adopted the log-linear functional form for hedonic analysis of goat prices. In his study of estimation of implicit prices in hedonic price models using housing price, Bin, (2000) argue that the log-linear functional form is a benchmark parametric specification for hedonic price models. Likewise, other studies indicated that multiple linear regression analysis based on hedonic price model is appropriate technique to identify the impact of traits on the price (Oludimu and Owakade, 1995; Williams *et al.*, 2003 and Maxaet *et al.*, 2009). Following the framework of these authors, a model was developed to analyze the goat selling price as a dependent variable of independent variables which are composed of goat traits, and demographic and socioeconomic factors.

The model used for the goat price (P_i) was specified as:

$$\ln p_i = \mathbf{x}'\beta' + \varepsilon_i \dots \dots \dots \text{ (Equation 5)}$$

Where,

$\ln p_i$ = The natural log of selling price of goat ^{i} ;

\mathbf{x}' = A vector of independent variables including traits of goat and demographic and socioeconomic characteristics of market actors;

β' = A vector of parameters to be estimated; and

ε_i is the error term which is assumed to be iid normal.

Following Champ *et al.* (2003), the implicit price/market premium (Γ) for an attribute i is computed as:

$$\Gamma_i = 100 * (e^{\beta_i} - 1) \dots \dots \dots \text{ (Equation 6)}$$

Where, e is the natural logarithm (2.71828), and

β_i is the vector parameter (coefficient) obtained in estimation of the model

The conditional distribution of the errors given the matrix of explanatory variables has zero mean [$E\{\varepsilon_i\} = 0$], constant variance [$V\{\varepsilon_i\} = \sigma^2$], and zero covariance [$E\{\varepsilon_i \varepsilon_j\} = 0$]. The reliability of the estimates based on these assumptions hardly hold in estimating parametric model using OLS. As a result the model should be tested for normality, specification error, multicollinearity, and heteroscedasticity.

Given the problem of heteroscedasticity is common in small sample cross-sectional data, methods that correct for heteroscedasticity are essential for prudent data analysis. In the presence of heteroscedasticity, OLS estimates are still unbiased, but may be inconsistent and 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 the robust estimation procedure through the derivation of an alternative estimator that is efficient or using OLS with adjusted standard error that is consistent but not efficient (Verbeek, 2004).

The option employed in this study is using heteroscedasticity consistent Covariant Matrix (HCCM) estimators that provides consistent estimator of covariance matrix. The HCCM standard error is the recommended approach to correct heteroscedasticity of unknown form.(MacKinnon and White, 1985; Long and Ervin, 2000) The suggested alternative ways of correction using HC include HC0, HC1, HC2, and HC3. These alternatives are not equally powerful and perform differently under different conditions depending mainly on sample size. Based on Monte Carlo simulation, MacKinnon and White (1985), for example, recommended that in small samples one should use HC3. However, Davidson and

MacKinnon (1993) later recommended strongly that HC2 or HC3 should be used. Long and Ervin (2000), similarly, recommended for $N \leq 250$, tests based on HC2 and HC3 than those based on other HC. This Monte Carlo simulation result also shows HC3 is superior for tests of coefficients that are most affected by heteroscedasticity and HC2 is better for tests of coefficients that are least affected by heteroscedasticity. Accordingly OLS estimation using HCCM (HC2 and HC3) were employed to analyze hedonic price model and finally the HC3 was found outperformed and final conclusions were done using the results of HC3.

The OLS, HC0, HC1, HC2, and HC3 of covariance matrix estimator of the error terms following White (1980) are specified as:

$$HC_3 = (X' X)^{-1} X' \text{diag} \left[\frac{e_i^2}{(1 - h_{ii})^2} \right] X (X' X)^{-1} \quad \dots \dots \dots \text{(Equation 11)}$$

Where; n is the number of observations, k is the number of parameters, and $h_{ii} = X'(X'X)^{-1}$

3.3. Definition, Measurement and Hypothesis of Variables

In the course of identifying the determinants of prices of indigenous goats and estimate implicit prices of the determinants, both continuous and categorical variables were assumed. The following is the definition; measurement and hypothesis of the variables that were expected to influence the goat prices in the study area.

Natural logarithm of goat price (Inp): it is a continuous dependent variable used in the multiple linear regression equation. It is the natural logarithmic transformation of the actual selling price of the indigenous goats during the study period as measured in Ethiopian birr (ETB).

The explanatory variables expected to influence the dependent variable are the following:

Body size of the goat(BOSIZE): It is an ordinal variable referring to the relative body size of the goat compared with goats of the study area; and serves as a proxy for the body weight of the goat in its live state. The variable has three categories which are small, medium, and large. The variable has two dummies; the first dummy takes the value of 1 if the goat is medium sized and 0 otherwise, and the other dummy has a value of 1 if the goat is large and 0 otherwise. Rodriguez *et al.*,(1994); Oludimu and Owokade, (1995); Maxa *et al.*(2009), and Afzalet *et al.* (2011) all reported that live weight is a significant attribute affecting price formation. Therefore, body size of the goat is expected to affect the goat price both positively and significantly.

Body condition of the goat (BOCON): It is also an ordinal variable which refers to the relative fatness and appearance of the goat compared with the goats in the study markets. The variable is classified in to three categories namely, poor, medium, and good body conditions. The variable is represented by two dummies; the first dummy for this variable has a value of 1 if body condition of the goat is medium, 0 otherwise; the other dummy has a value of 1 if body condition of the goat is good, 0 otherwise. Studies found that body condition had a significant positive impact as it increases to good (Afzalet *et al.*, 2011; Kassieet *et al.*, 2012 and Terfaet *et al.*, 2013). Gezahegnet *et al.*, (2006) also added that there was significant price penalty as body condition became bad compared to the good condition in case of both sheep and goats. Body condition indexes are hypothesized to have positive influence on the selling price if they are medium and good, whereas bad body condition will have a negative impact on the selling price. Therefore, in this study, goat price is expected to increase as body condition of the goat increases from poor to good body condition.

Age of the goat (AG):an ordinal variable measured in years, having five categories namely; AG<1, 1≤ AG≤2, 2≤ AG≤3, 3≤AG≤4, AG>4 and four dummies as1 if 1≤AG≤ 2, 0 otherwise; 1 if 2≤ AG≤ 3, 0 otherwise; 1 if 3≤ AG ≤ 4, 0 otherwise; and 1 if AG>4, 0 otherwise. Studies showed that the meat and other benefits from goats will increase as their age increases and therefore, it is hypothesized to influence the goat selling price positively. Teklewoldet *al.* (2009) found that prices are highest for matured animals for all sheep, goat, and cattle relative to the immature and young. On the other hand, the findings of Gezahegnet *al.* (2006) revealed that too older goats will not be needed and therefore beyond a certain level age will negatively contribute to the selling price. The findings of Gezahegnet *al.* (2006) further explained that price per animal increases with age but declines for older or over mature animals for both sheep and goats. In other studies, Terfaet *al.*, (2013) found that age has a significant and positive influence on the selling price, whereas Afzalet *al.*, (2011) found that as age of the animal increases, its selling price lessens on yearly basis. Therefore, age of the goat is hypothesized to have both positive and negative effects on its selling price as stated by the previous studies.

Sex of the goat (SEXGO):It is also a nominal variable having three categories (female, intact male and castrated male) and two dummies. The first dummy is with a value of 1 if the goat is intact male and 0 otherwise, and the other dummy with a value of 1 if the goat is castrated male and 0 otherwise. Other things being equal, price per animal was significantly higher for males compared to females for both goats and sheep (Andargachew and Brokken, 1993; Gezahegnet *al.*, 2006; Williams *et al.*, 2006; Dossaet *al.*, 2007; Afzalet *al.*, 2011; Naanepet *al.*, 2012; and Terfaet *al.*, 2013). One possible reason is that most marketed females are old culled animals which passed their productive age. Also some consumers do not want to buy female animals for slaughtering due to the possibility of pregnancy as it is ethically unacceptable in Ethiopian society to slaughter pregnant animals (Andargachew and Brokken, 1993; and Gezahegnet *al.*, 2006, and Kassieet *al.* 2012).

Market location/district (DISTRI): It is a nominal variable which consists of three categories namely Asayita, Dubti and Mille markets, which are again classified in to two dummies as; the first taken a value of 1 if the market is Asayita, 0 otherwise; and the other dummy with value of 1 if the market is Mille, 0 otherwise. Previous studies found that

prices vary with different market places; as the demand varies with differences in the number of buyers of the markets (Terfaet *al.*, 2013). This is related to the differences between the markets in access to information, access to production potential etc. The variable is hypothesized to influence the goat price both positively or negatively depending on the situations of the market places.

Purpose of purchase (PURP): It is a nominal variable which refers to the purpose that the buyer intended when s/he purchases the goat i.e, for what purpose the goat is purchased. The variable has four categories namely; goat trading (if the goat is bought for the purpose of profit by resale), butcher and restaurant (if the goat is bought for use of butcher and restaurants), home consumption (if the goat is bought for home/family consumption), and goat reproduction (if the goat is purchased for goat farming/reproduction). The variable is represented by three dummies; as 1 if purposeofpurchase is goat trading and 0 otherwise; 1 if purpose of purchase is butcher and restaurant and 0 otherwise; 1 if purpose of purchase is home consumption and 0 otherwise. According Jabbar and Diedhiou (2003); and Teklewoldet *al.* (2009), purpose of purchase is an important attribute influencing price formation. Other things being equal, consumers pay significantly higher prices compared to other types of buyers in case of goats where as farmers paid significantly lower prices compared to traders, consumers, and butchers and restaurants in case of sheep (Gezahegnet *al.*, 2006 and Teklewoldet *al.*, 2009). In this study, higher prices are expected for the buyers of the purpose home consumption whereas lower prices are expected for buyers with purpose of goat trading/profit.

Income level of the buyer (log-transformed) (INCOME): it is a continuous variable that refers to the average monthly income of the buyer as measured in Ethiopian Birr (ETB). Buyer demand for a goat is expected to increase with an increase in the income level of the buyer. Therefore, income level of a buyer is hypothesized to have a direct and positive influence on the goat selling price.

Literacy status of the buyer (LITE): It is a dummy variable that refers whether the household can read and write or not. It takes a value of 1 if the buyer is literate (can read and write) and 0 if illiterate (if not able to read and write). The variable is used as a proxy for bargaining power assuming that bargaining power of buyers increases as a household

gets education (*Terfaet al.*, 2013). In this study, therefore, the variable is hypothesized to have a negative influence on the goat price meaning that goat price will be lower for literate buyers.

Family size of the buyer (FSIZE): it is a continuous variable measured in number of family size i.e, to the number of persons living in the same household with the buyer. It is hypothesized that goat price will increase with family size of a buyer as higher family sized household will demand a relatively larger goats and which will be bought by higher prices.

From whom the goat was bought (STYPE): it is also dummy variable consisting of 1 if the goat is bought from a trader and 0 if it is bought from non-trader. According to *Gezahegn et al.* (2006), market actors which are non-traders, for example, goat farmers received significantly lower prices than goat traders which could be partly because they operate at the bottom end of the market chain and traders being profit motivated may try to pay the lowest price possible in any bargain or negotiation. In addition, *Gezahegn et al.* (2006) explained that farmers are often forced to sell their animals for reasons other than profit motives in situations of dire cash needs, so may accept lower prices than traders.

Distance from urban center (DISTA): it is a continuous variable, measured in kilometers, that refers to the distance buyer residence to the urban center. It is a variable that is used as a proxy for buyers' access to market information which again is a key determinant of buyers' ability to bargain in deciding the goat price. This is because buyers' decisions are based on their market information and lack of market information may lead them inefficient bargains leading to buy at higher price levels since sellers may use the information gap to set higher prices. *Teklewold et al.* (2009) found that market information is a significant factor that influence the price paid by buyers; that buyers having access to market information pay significantly lower prices than those who don't have any. Similarly, *Musemwa et al.* (2007) found that the provision of market information will strengthen negotiating ability during transactions and consequently prevent the possible exploitation of buyers by better-informed sellers. In this study, it is hypothesized that distance from the nearest market affects goat price positively implying that goat price

increases as the distance to the nearest market increases. In other words, it is expected that if a buyer is located in an area far away from the market place s/he will have limited access to market information and will pay higher prices and vice versa.

Buyer-seller prior relationship/acquaintances (PRELA): It is a dummy variable taking the value of 1 if there is a prior buyer-seller relationship, and 0 if not. Teklewoldet *et al.* (2009) found that prices are relatively lower when buyers and sellers do not have any prior friendship and/acquaintances. This is because of the softness (shyness) that buyers feel to strongly negotiate with a person whom they have some sort of social relation in order to maintain their loyalty. In his study also, the variable is expected to influence goat price positively in such a way that price will be higher if there is a prior relationship between buyers and sellers.

Table 2. Means of measurement of the goat traits and their levels

Goat Trait	Means of Measurement	Categories (levels) used
Body size	Observation	Small, medium, large
Body condition	Observation	Poor, average, good,
Goat sex	Observation	Male, female
Goat age (AG)	Teeth examination and discussion with the seller	$AG < 1$, $1 \leq AG \leq 2$, $2 \leq AG \leq 3$, $3 \leq AG \leq 4$, $AG > 4$

Table 3. Definition of variables used in the hedonic price model

Variable name	Type(s) of variable(s) and measurement	Expected impact on goat price (+/-)
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Dependent variable		
Price per head of goat (ETB)	Continuous	
Explanatory variable		
Body size of the goat	Categorical (Small, Medium, Large)	+
Body condition of the goat	Categorical (Poor, Average, Good)	+
Age of the goat (AG) in years	Categorical (AG<1, 1≤ AG ≤ 2, 2≤ AG ≤3, 3≤ AG≤ 4, AG > 4)	+
Sex of the goat	Categorical (female, intact male, castrated male)	-+
Market location	Categorical (Asayita, Dubti, Mille)	+-
Purpose of purchase	Categorical (goat trading/profit, butcher and restaurants, home consumption, goat reproduction)	+-
Income level of the buyer	continuous	+
Literacy status of the buyer	Dummy (literate, illiterate)	-
Family size of the buyer	Continuous	+
From whom the goat is bought	Dummy (Trader, non-trader)	+
Distance from urban center	Continuous	+
Buyer-seller prior relationship (acquaintance)	Dummy (Yes, No)	+

4. RESULTS AND DISCUSSION

4.1. Description of the Sample Population

The chapter deals with the findings, descriptive statistics and econometric model on hedonic price analysis of indigenous goat traits especially on the major traits of indigenous goats, implicit prices of the goat traits, and the demographic and socioeconomic characteristics influencing prices of the indigenous goats in the study area.

4.1.1. Characteristics of the indigenous goats in the study area

Table 5 shows the summary of the characteristic of goats marketed in the study area including price per head of goat, and the goat traits that are considered to be important in determining the goat price in the markets of the study area. The average price per of the goat in the study area was 692 ETB. The average goat selling price of goats was about 768 ETB in Dubti market which was higher than the goat markets of Asayita (655 ETB) and Mille (611 ETB). The one way ANOVA test revealed that there is a significant difference among the selling prices of goats in the three markets at 5% significance level. This showed that goats were relatively expensive in the Dubti market and cheaper in Mille market. One possible reason for this may be the difference in the income level of buyers that could affect buyer demand for goats (the ability and willingness to buy); and was found to be higher in the Dubti market and lower in the Mille goat market. In other words, it may be related with the fact that the number of population in the capital of the region (Samara, which is found in the Dubti) increases the demand of goats and thus the goat price.

The data on the body size of the goats were found to be composed of 31% small, 53% medium and 16% large body sized goats. The chi-square test revealed that there is a significant difference in body size of goats among the three markets at 5% significance level. The composition of small goats in Mille market (43%) was the highest, whereas it was lowest in Dubti market (24%). On the other hand, medium sized goats were prevalent in Asayita market (60%) than Dubti (53%) and Mille (49%) markets. Large sized goats

were much highest in number in the Dubti goat market (23%) than the Asayita (12.5%) and Mille (9%).

Data on the body condition of the goat which indicate the relative fatness and appearance were found to be composed of 5.5% poor, 47.5% average and 48% good. To describe the distribution of the poor body condition goats, it was about 7.5%, 5% and 4% for the Asayita, Dubti and Mille markets. The average body conditioned goats were about 37.5%, 48% and 51% in Asayita, Dubti and Mille markets, whereas the percentage of good body condition goats in the three markets were 55%, 47% and 44% respectively.

Age of the goat was categorized in to five classes as AG<1, 1≤ AG≤ 2, 2≤ AG≤ 3, 3≤ AG≤ 4 and AG > 4 where; 1, 2, 3, 4 and 5 are age of the goat in years and AG stands for age of the goat. Generally, most of the goats in the study markets were aged between 1 and 2 years and were consisting of about 47.5, whereas the least age category belongs to those goats above 4 years (4%). To look in detail, goats aged below 1 year were found much in Mille market (34), however they were the least in the Dubti goat market (14%). In the Asayita market goats aged below 1 year were consisting of about 17.5% in the Asayita goat market. On the other hand, the Mille goat market had about 49% of goats aged between 1 and 2 years which were greater than both of the Asayita (42.5%) and Mille (45%) goat markets. Goats aged between 2 and 3 years were about 25% in the Asayita goat market which were greater than both of the Dubti (21%) and Mille (12%) goat markets. Goats aged between 3 and 4 years were dominant in Dubti market (14%) where as they were only about 5% in Asayita and 3% in Mille markets. Goats aged above 4 years were about 10% in the Asayita market which were greater than the Dubti (8%) and Mille (3%) markets. The chi² result showed that there is a significant difference on the age groups of goats among the three study markets at 1% level of significance.

Based on their sex, goats were categorized as intact male, female and castrated male were observed and that intact male goats (52.5%) were found to be dominant over female goats (37.5%) and castrated and fattened (10%) goats. Looking the three markets in a detailed manner, female goats were higher in Mille market (44%) than the Dubti (36%) and Asayita (30%) markets. On the other hand, intact male goats were dominant in

Asayita(67.5%) than Mille (51%) and Dubti (47%). Higher number of castrated goats was found in Dubti market (17%) than the markets of both Mille (5%) and Asayita (2.5%). The ANOVA result revealed that there is a significant difference in goat sex among the three markets. In the observed goat transactions of the three markets, about 63% of the traded goats were males. One possible reason for this may be that female goats are less frequently marketed as they are usually kept for reproduction (herd replacement) and less for generating cash. This result is consistent with the findings of Terfaet *al.* (2013).

Table 4. Characteristics of the goats in the study markets (% and average)

Goat characteristic		N=40	N=92	N=68	N=200	X ² /t-value
		Asayita	Dubti	Mille	Total	
Price per head (ETB) of goat		655	768	611	692	6.60**
Body size of the goat	Small	27.5	24	43	31	10.70**
	Medium	60	53	49	53	
	Large	12.5	23	9	16	
Body condition of the goat	Poor	7.5	5	4	5.5	4.20
	Average	37.5	48	51	47.5	
	Good	55	47	44	48	
Age of the goat (AG)	AG<1	17.5	14	34	21.5	26.90***
	1≤ AG ≤ 2	42.5	33	47	39.5	
	2≤ AG ≤ 3	25	21	12	12	
	3≤ AG≤ 4	5	21	4	8.5	
	AG>4	10	12	3	4	
Sex of the goat	Female	30	36	44	37.5	13.20***
	Intact male	67.5	47	51	52.5	
	Castrated	2.5	17	5	10	
and fattened						

N=Sample size, ***, ** represent statistically significant at 1% and 5% significance levels respectively.
Source: Own survey, 2015

4.1.2. Market composition by buyer demographic and socioeconomic characteristics

Demographic and socioeconomic characteristics of the sample buyers which are defined in terms of age, sex, marital status, literacy status, family size, income level, prior relationship with the seller (buyer-seller prior relationship); and distance from urban center are presented in the table below (Table 6).

To start with household age, the average age of the buyers in the study area was found to be 35 years. The age of buyers in the Dubti goat market (37 years) was greater than that of the Asayita goat market (36 years) and Mille goat markets (35 years). However, the one-way ANOVA test revealed that there are no significant differences on average household age in the three markets.

Result of the survey also revealed that about 83% of the sample buyers were males. The proportion of male buyers in the Asayita, Dubti and Mille goat markets were about 83%, 87% and 76% respectively.

With regard to marital status, 80% of the sample buyers were found to be married. On the other hand, the composition of married buyers in the Dubti goat market was about 85% which was greater than both of the Asayita 78% and Mille (75%) goat markets.

The other buyer demographic characteristic was family size which refers to the number of the persons living in the same household with the buyer. The study also indicated that the average family size of buyers in the study markets was each household is 4 members.

To deal with the literacy status of sample buyers, about 71% of the sample buyers were found to be literates whereas the rest 29% were illiterates. In the Asayita goat market, literate buyers constituted 75% of the sample buyers, whereas their composition was similar (71%) in both the Dubti and Mille goat markets. However, the chi-square test revealed that there is no significant difference in literacy status among the sample buyers of the three markets.

Income level of the buyer was also the other socioeconomic variable that the study assumed to have an impact on the demand and thus on the goat price. The average monthly income of the sample buyers in the study area was about 1599 ETB. The monthly income of buyers in the Dubti market was found to be the highest of the three markets (1826 ETB), whereas buyers with the least income level were found in the Mille market (1252 ETB). The study also revealed that buyers in the Asayita goat market had a monthly income of 1669 ETB. The one way ANOVA test revealed that there is a significant difference in the average monthly income of buyers among the three markets at 1% significance level. This may be due to the differences in sources of income, for example, the reason for buyers in the mille market to be the least may be the absence of desert allowance in the salary of government employees and; the reason for buyers in the Dubti market to the highest may be due to the presence of desert allowance and the market is found in the capital city of the region (Samara) that people living there are in a highest level of educational that their salary is relatively higher.

Regarding from whom bought the goat i.e, the type of goat seller; it was found that goats were bought from either of sellers which are goat traders and or non-goat traders. Generally speaking, the study found that the dominant goat sellers in the study markets are non-traders (much of them goat farmers) constituting about 72.5% of the goat sellers, whereas goat traders constituted the rest 27.5% of the goat sellers. Looking the specific results of each market, there was no significant difference on the type of sellers that the goat was bought among the three markets even at a 10% significance level. The study indicated that the composition of farmer sellers in the Dubti market (82%) were higher than that of Asayita (73%) and Mille (60%) markets. On the contrary, the composition of traders is higher in Mille market (40%) and lower in Dubti market (18%). The Asayita goat market had about 28% trader sellers.

A prior relationship between buyers and sellers was also hypothesized to have an influence on the goat price. In this regard, about 15% of the buyers were found to have prior relationships (acquaintances) with sellers. The one way ANOVA test revealed that there is a significant difference among buyers of the three markets on buyer-seller prior relationship at a 5% significance level. Buyer-seller prior relationship was higher in the Mille goat market (24%) than the Asayita (10%) and Dubti (11%) goat markets.

The study also examined buyers' distance from urban center. The average distance of buyers from urban center was found that to be 8.79 km. However, the average distance of buyers from urban center in the Asayita, Dubti and Mille goat markets were about 8.38, 6.1 and 10.27 km respectively.

Table 5. Demographic and socioeconomic characteristics of buyers (% and average)

Buyer characteristics		N=40	N=92	N=68	N=200	X ² /t-
		Asayita	Dubti	Mille	Total	value
Age	Year	36	37	32	35	3.08
Sex	Male	83	87	76	83	2.98
Marital status	Single	20	12	22	17	3.17
	Married	78	85	75	80	
	Widowed	3	3	3	3	
Family size		4	4	4	4	4.09
Literacy status	Literate	75	71	71	71	0.30
Monthly income level	ETB	1669	1826	1252	1599	29.51***
From whom bought the goat	Trader	73	82	60	72.5	3.31
	Non-trader	28	18	40	27.5	
Buyer seller prior-relationship	Yes	10	9	24	15	7.81**
Buyer distance from urban center	km	8.38	6.1	10.27	8.79	0.44

N=sample size; ***, **, * represent statistically significant at 1%, 5% and 10% significance levels respectively.

Source: Own survey, 2015

4.1.3. Market characteristics by buyer purchase purposes

The table below shows summary of the purchase purposes of buyers during the study period (Table 7). The survey revealed that much of the buyer purposes in the Asayita goat market goes to home consumption (45%) followed by butchers and restaurants (25%), goat trading (17%) and goat reproduction (13%). Similarly, the dominant purchase purpose in the Dubti goat market was home consumption (38%) followed by butcher and restaurants (32%), goat trading (23%), and goat reproduction (7%). Purchase purposes in the Mille goat market were home consumption (40%), butcher and restaurants (25%), goat trading (18%), and goat reproduction (17%). Home consumption was found to be the dominant of all the other purchase purposes in the study area (40%) following by butcher and restaurants (28%), goat trading (20%), and goat reproduction (11%). Buying goats for the purposes of wedding and funeral ceremonies were included under the purposes of home consumption. The possible reason for home consumption to be the dominant of all other purposes may be due to the data collection season being time of holidays of Ethiopian Christmas (Genna) and Ethiopian Epiphany (Timket). These holidays are times in which peoples' experience of buying goats and other animals for home consumption is relatively higher. The χ^2 result revealed that there is a significant difference on the purpose of buyers among the three markets.

Table 6. Buyer purchase purposes in the study markets (%)

Purchase purposes	Names of the market					χ^2 -Value
	N=40		N=92	N=62	N=200	
	Asayita	Dubti	Mille	Total		
Goat trading (resale for profit)	17	23	18	20	12.16*	
Butcher and restaurants	25	32	25	28		
Home consumption	45	38	40	39		
Goat reproduction	13	7	17	11		

NB: N=sample size, * represents statistically significant at 10% level of significance.
Source: Own survey, 2015

4.2. Determinants of the Indigenous Goat Price and their Implicit Prices

Analysis of the influence of major indigenous goat traits on the goat price; and assessing their implicit prices was found to be important to recognize the major traits preferred by markets and improve so as to grasp better benefits from the goat sector. Similarly, the influences of demographic and socioeconomic factors on the goat prices were expected to be important to be identified and assessed.

In this respect, explanatory variables which are composed of indigenous goat traits; and demographic and socioeconomic factors were hypothesized to affect the goat prices. Of the explanatory variables, some are continuous, some are dummy; others are categorical that contain many dummy variables under them. Multiple linear regression models were employed to identify the factors determining goat prices in the study area. For the parameter estimates to be efficient, assumptions of Classical Linear Regression (CLR) model should hold true. Hence, model specification, multicollinearity and heteroscedasticity detection test were performed using appropriate test statistics for each as follows.

Test for misspecification the model: Link test was used to test if there is a problem of model specification. It showed that hatsq is insignificant implying that there is no problem of model specification (Appendix Table 4).

Test for multicollinearity: All VIF values are less than 10. This indicates absence of serious multicollinearity problem among independent continuous variables (Appendix table 6). Likewise, contingency coefficient results indicated absence of serious multicollinearity problem among the independent dummy variables as all CC values are less than 0.75 (Appendix table 8).

The problem of heteroscedasticity was also tested by appropriate tests (Appendix tables 5 and 6). Since there is heteroscedasticity problem in the data set, the parameter estimates of the coefficients of the independent variables cannot be BLUE. Therefore, to overcome the problem, Robust OLS analysis with heteroscedasticity consistent covariance matrix (HCCM) was estimated (Table 8).

The results of the hedonic price model from both OLS and HC regressions are given in the table below (Table 8). The table summarizes the coefficients of the variables used in the hedonic price model, and standard errors of both the OLS and heteroscedasticity consistent (HC2 and HC3) estimations. HC estimation was used as an adjustment to the OLS model since cross-sectional and small sample price data are intrinsically heteroscedastic.

As anticipated, the coefficients of the variables for all OLS, HC2 and HC3 estimators are the same. The difference of the three estimators is revealed on their standard errors. Therefore, the efficiency differences of HC2 and HC3 estimators are clearly based on the standard errors of coefficients particularly that are mostly affected by heteroscedasticity. The standard error of HC2 estimation for all coefficients was lower than the HC3 estimation. Thus, the t-value of the former are inflated possibly leading to erroneous rejections of the null hypothesis. Hence, it could not be reliable to draw inferences. In a situation like this, MacKinnon and White, (1985) concluded that HC3 outperforms HC2. Therefore, in this study, the HC3 estimation results were used for inferences.

4.2.1. The influence of indigenous goat traits on the goat price and implicit price for the indigenous goat traits

The major indigenous goat traits that were found to significantly influence the goat price in the study area are the following.

Body size of the goat: The variable was used as a proxy to assess the influence of live weight of the goat on the goat price. The hedonic price model result revealed that body size of the goat influenced the goat price in the study area both positively and significantly. Both medium and large body sized goats were highly significant in determining the goat selling prices ($p<0.01$). Intuitively, goats with a large body size received higher prices and hence medium and large body size goats fetched price premiums of about 26.12% and 48.94% compared with the small body sized goats (the base level). Large body sized goat were also known to fetch price premiums of about 28.82% compared to medium body sized goat.¹ In summary, the result showed how much

¹Price premium of large over medium body size is computed as price premium of large over small minus price premium of medium over small body size.

body size of the goat is a very important goat trait in fetching higher price implying that an increase in body size of the goat from small to large also increases price.

Body condition of the goat: Body condition was also found to be a very important goat trait that significantly and positively affected the goat price in the study area. The model result revealed that goats marketed with a good body condition commanded prices premiums of about 50.78% than goats of poor body condition (the base level) and 18.66% higher than the average body conditioned goats. This result clearly showed the importance of quality of the animal in the goat price formation which is in line with the findings of Teklewoldet *al.* (2009) who found a strong positive association between body condition and goat selling price.

Age of the goat: In line with the hypothesis, the trait had influenced the goat price both positively and significantly. The hedonic price model analyzed the impact of goat age on their price and revealed that goat price increased as age is increases. The result indicated that a goat aged between 1 and 2 years ($1 \leq AG \leq 2$ years) commanded prices that are about 24.63% higher compared to goats aged less than one year ($AG < 1$ years) which is the base level. Similarly a goat with age of between 2 and 3 years ($(2 \leq AG \leq 3$ years), ($1 \leq AG \leq 2$); and above 4 years ($AG > 4$ years) fetched prices premiums of about 31.01%, 52.37% and 105.65% respectively as compared to the base level ($AG < 1$ year). This is in line with the basic feature of the low input goat production system in the area. That is, under a low input production system, goats need a longer period of time to attain the required body condition and size to command a good price. This finding is consistent with the result of Teklewoldet *al.* (2009).

Sex of the goat: Of the goat sex dummies, significantly higher prices were offered only for castrated and fattened goats since castrated and fattened goats are preferred for their fattest body condition. Castrated and fattened goats commanded prices that are about 12.78% higher than the female goats (the base level). This result is consistent with the finding of (Dossaet *al.*, 2007). The model result also revealed that intact male goats fetched fewer prices, even than the female goats (the base level).

Table 7. Estimation results of the Hedonic price model using OLS, HC2 and HC3

ln(price)	Coefficient	OLS SE	HC2 SE	HC3 SE
Constant	3.9694	0.338***	0.540***	0.603***
Medium body size	0.2320	0.043***	0.079***	0.089***
Large body size	0.3984	0.077***	0.079***	0.088***
Average body condition	0.2785	0.057***	0.133**	0.150*
Good body condition	0.4107	0.0602451***	0.147***	0.166**
1≤AG≤2 years	0.2202	0.053***	0.118**	0.131*
2≤AG≤3 years	0.2701	0.075***	0.120**	0.152*
3≤AG≤4 years	0.4212	0.105***	0.176**	0.223*
AG>4 years	0.7210	0.131***	0.254***	0.352**
Intact male goat	-0.0322	0.031	0.035	0.039
Castrated and fattened goat	0.1203	0.069*	0.058**	0.064*
Asayita market	0.0138	0.039	0.039	0.043
Mille market	-0.0090	0.034	0.029	0.031
Butcher and restaurants	0.0402	0.050	0.030	0.032
Home consumption	0.0615	0.047	0.031**	0.033*
Goat trading	-0.0756	0.056	0.042*	0.045*
Income level of the buyer (log-normalized)	0.2206	0.046***	0.065***	0.072***
Literacy status of buyer	-0.0060	0.032	0.033	0.036
Family size of the buyer	0.0225	0.011**	0.010**	0.011**
From whom the goat is bought	0.0886	0.037**	0.036**	0.039**
Distance from urban center	0.0150	0.005 ***	0.005***	0.005***
Buyer-seller prior relationship	0.1141	0.050**	0.067*	0.074*
No. of observations=200		F (21, 178) =54.83		
Prob> F = 0.0000		Root MSE= .18301		
R-squared= 0.8661		Adj R-squared = 0.8503		

NB: The dependent variable is the lnprice (natural logarithm of goat price). SE represents Standard Error;
***, **, and * represent statistical significance at 1%, 5% and 10% levels of significance respectively.

Source: Own computation from survey, 2015

4.2.2. The influence of demographic and socioeconomic factors on the goat price

The determinants of goat price other than the indigenous goat traits were demographic and socioeconomic factors. From the table above, one can also see the summary of influences of the major demographic and socioeconomic factors on the goat price of the study area (Table 8).

Purpose of purchase: The hedonic price model analyzed the influence of buyer purchase purposes on the indigenous goat prices of the study area. The result revealed that only goat trading and home consumption significantly influenced on the observed goat prices. Goat traders affected the goat prices negatively and significantly whereas, the home consumption had a significant positive impact on the goat price of the study markets. Other things being constant, buyers with the purpose of home consumption paid prices of about 6.34% higher compared to buyers of the purpose goat reproduction (the base level). On the other hand, goat traders paid about 7.85% less prices compared to buyers with purpose of goat reproduction (the base level).

Income level of the buyer: The other most important socioeconomic factor significantly and positively influenced the indigenous goat price was income level of the buyers. The hedonic model result revealed that, other things kept constant, goat selling price increased by 21.97% as the income level of the buyer increased by a unit. This is due to the fact that buyer's demand, which is both the ability and willingness to buy, increases as income of the buyer increases.

Family size of the buyer: The study also found family size of buyers as an important factor influencing goat prices in the study markets. It was found that goat prices increased by 2.28% as family size of the buyer is increased by a unit. This may due to the need of buying a relatively larger goat to feed a larger family size that makes smaller sized goat not to be demanded by family of larger size. This finally leads the goat price to be higher.

From whom the goat was bought (type of goat seller): It was also found to be another factor significantly influenced the goat price in the study markets. The variable refers to

the type of seller (i.e from whom the goat was purchased) whether it is goat trader or not, expecting higher price if the goat is purchased from a goat trader. The hedonic price model tested how prices might vary depending on the type of goat seller. After controlling other factors, the result showed that significantly lower price was offered by a seller which is non-trader which is in line with the expectation. The result further revealed goat prices being higher by 9.27% if goats are bought from goat traders. The higher price offered by goat traders seems because traders are with a relatively better market information and/or their motive is to generate profit.

Buyer's distance from urban center: This variable was also significantly and positively influenced the indigenous goat prices in the study area. The distance from urban center was used as a proxy access to market information in order to measure the influence of market information on the goat price, assuming that buyers in nearest to urban centers have better access to market information. The model result showed that the price buyers paid increased by 1.51% as their distance to urban center increases by 1 km. The result revealed that buyers who had access to market information paid significantly lower prices compared to those buyers who didn't have any. Because, the market information system of the study area is not well developed, information was kept as secret to make use of the ignorance of competitors and sellers as an advantage.

Buyer-seller prior relationship: Prior relationship/acquaintance between buyers and was also observed as important determinants of the goat price formation. About 92% of the goat transactions in the study markets were carried out with no buyer-seller prior relationships, while the remaining 8% were managed through prior friendship and/acquaintances. The model result showed that prices are relatively lower when there is no any prior buyer-seller friendship and/acquaintances. Goat market transactions with no any buyer-seller prior relationships had prices of about 12.08% lower than those carried between actors having prior friendship/acquaintance. The reason for this may be may be the softness (shyness) that buyers feel to strongly negotiate with a person whom they have some sort of social relation in order to maintain their loyalty.

On the other hand, variables such as market location and buyer literacy status had no significant influence on the goat prices even at 10% level of significance. However, the model result found that literacy status had a negative impact on the price of goats implying the importance of education on market information and bargaining power of buyers. Likewise, the hedonic price model found that goat price in the Asayita and Mille goat markets were lower than the goat prices in the Dubti goat market (the base level) implying that differences in market location has influences on the goat price.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

It can be concluded that the overall study found evidence for the hedonic price analysis of the indigenous goat traits in Zone 1 of the Afar region. Indigenous goat traits of the study area were characterized, and their impact on the goat price was assessed; and finally their implicit prices were identified.

The study also identified major demographic and socioeconomic factors influencing the indigenous goat prices; and further analyzed how and how much the influence of these factors is on the goat prices of the study area.

The major traits significantly affect the observed prices of the indigenous goats are body size of the goat, body condition of the goat, age and sex of the goat (castration and fattening of male goats).

The study indicated that goat buyers assign high values for the attributes such as big body size, good body condition, castrated and fattened male goats, when choosing goats in the market which clearly indicates their high value attached to the amount and quality of meat.

On the other hand, demographic and socioeconomic factors also influence prices of the indigenous goats. Of the demographic and socioeconomic factors, purpose of purchase, income level of the buyer, family size of the buyer, from whom the goat was bought (type of the seller), buyer distance from urban center, prior buyer-seller relationships significant influence the indigenous goats prices in the study area.

5.2. Recommendations

The results of the study showed that the influences of most goat traits on the goat price are related with the amount and quality of meat. Body sizes, body condition, age of the goat, and sex of the goat (castration and fattening of male goats) are all important factors determining goat prices. Thus, there should be a proper market information system that updates producers and/breeders with these requirements so that they will try to adjust their marketing activities accordingly.

Careful consideration of buyer preferences for the goat traits should be made before introducing or reinforcing crossbreeding efforts meant to enhance only a few of the traits or the purposes goats are kept for. This is because any business including the goat business to be profitable; it must take in to account the traits most valued by the market.

Because goat price increases with an increment in age of the goat, it has to be known that the goat production system needs to be improved. The low input goat production system in the area needs to be changed to market oriented in that the longer time needed to attain required body condition and size to command a good price could be reduced.

Similarly, those actors involved in goat business should also update themselves in accordance with factors other than the goat traits which can significantly influence the goat price formation. This is due to the fact that the goat market in the study area in particular and Ethiopia in general are in-competitive that the price formation is also highly influenced by non-goat traits such as characteristics of the goat market, buyers and sellers too. Therefore, businesses engaged with the goat sector (all goat keepers, breeders and marketers) should understand and adjust their strategy to fulfill the demographic and socioeconomic factors influencing goat prices in their business environment.

Distance to the marked had significant influence on the goat price implying that buyer's access to market information is a significant factor influencing the indigenous goat prices. Therefore, establishing a market information system and improving communication infrastructure is highly recommended.

It is also recommended that there will be benefit from coordinated fattening, breeding, and marketing programs to take the highest advantage from the preferred goat traits and selected markets.

Finally, we recommended the need to conduct further study on implicit price analysis using a year rounded data especially to understand the price variability within the different seasons of the year. The influence of other variables such as holidays (both Christian and Muslim) and fasting seasons (for both Christian and Muslim) must be studied and compared with normal time prices.

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7. APPENDICES

Appendix I. Tables

Appendix Table 1. Categorical and dummy explanatory variables used in the hedonic price model; including recodes of the categorical variables

Variable name	Type of variable and measurement	Number of dummies and the codings used
Body size of the goat	Categorical (Small, Medium, Large)	2 (1=Medium; 0=Otherwise; and 1=Large; 0=Otherwise)
Body condition of the goat	Categorical (Poor, Average, Good)	2 (1=Medium; 0=Otherwise; 1=Good; 0=Otherwise)
Age of the goat (AG) in years	Categorical ($AG < 1$, $1 \leq AG \leq 2$, $2 \leq AG \leq 3$, $3 \leq AG \leq 4$, $AG > 4$)	4 (1= $1 \leq AG \leq 2$; 0=otherwise; 1= $2 \leq AG \leq 3$; 0=otherwise; 1= $3 \leq AG \leq 4$; 0=otherwise and 1= $AG > 4$; 0=otherwise)
Sex of the goat	Categorical (female, intact male, castrated male)	2 (1=intact male; 0=otherwise and 1=castrated male; 0=otherwise)
Market location (district)	Categorical (Asayita, Dubti, Mille)	2 (1=Asayita, 0=Otherwise and 1=Mille, 0=Otherwise)
Purpose of purchase	Categorical (goat trading/profit, butcher and restaurants, home consumption, goat reproduction)	4 (1=Goat trading; 0=Otherwise 1=Butcher and restaurants; 0=Otherwise; 1=home consumption; 0=otherwise)
Literacy status of the buyer	Dummy (literate, illiterate)	1=literate, 0=illiterate
From whom the goat is bought	Dummy (Trader, non-trader)	1= Trader; 0=non-trader
Buyer-seller prior relationship (acquaintance)	Dummy (Yes, No)	1=Yes; 0=No

Appendix Table 2. Goat markets in the study area their average goat monthly transactions, and the stratification used

Name of the market	District of location	Average no. of transactions	Relative market size
Eli Wuha	Adar	1,664	Small
Asayita	Asayita	1,047	Small
Afambo	Afambo	2,435	Medium
Mille	Mille	3,481	Medium
Chifra	Chifra	4, 275	Large
Logiya	Dubti	4,709	Large

Source: APARDO, 2015

Appendix Table 3. Estimated Age for Goats with Different Numbers of Erupted Permanent Incisors

No. of Permanent Incisors and Estimated Age range of Goat

Incisors	Estimated Age in years
0 pair	Under 1 year (<1 year)
1 pair	1-2 years
2pairs	2-3 years
3 pairs	3 -years
4 pairs	> 4 years
Broken mouth	Aged

Source: Adopted from Vattaet al, 2006 (cited in Desta, 2009)

Appendix Table 4. Link test for misspecification of the hedonic price model

Inprice	Coefficient	Standard Error	t	P> t
_hat	2.02463	.6621121	3.06	0.003
_hatsq	-.0790138	.0510057	-1.55	0.123
_Cons	-3.30679	2.143474	-1.54	0.125

F (2, 197) =553.40

Prob> F = 0.0000

Source: Own computation from survey result, 2015

Appendix Table 5.Breusch-Pagan/ Cook-Weisberg test of heteroscedasticity of explanatory variables included in the hedonic price model

H0: Constant variance

Variables: Fitted values of lnprice

Chi2 (1) = 83.08

Prob> chi2=0.0000

Appendix Table 6. White's test of heteroscedasticity for explanatory variables included in the hedonic model

White's test for H_0 : homoscedasticity

Against Ha: unrestricted heteroscedasticity

Chi2 (186) = 199.86

Prob>chi2 = 0.0000

Cameron & Trivedi's decomposition of IM-test

Source	Chi2	df	P
Heteroscedasticity	200.00	198	0.4468
Skewness	49.40	25	0.0025
Kurtosis	1.09	1	0.2960
Total	250.49	224	0.1081

Source: Own computation from survey result, 2015

Appendix Table 7. Variance inflation factor (VIF) for multicollinearity test of continuous explanatory variables included in the hedonic price model

	VIF	1/VIF
DISTA	1.79	0.560109
FSIZE	1.69	0.590571
INCOME	1.37	0.729957
Mean VIF	1.62	

According to Gujarati (2004), VIF can be defined as:

Where, R^2 is the square of multiple correlation coefficients that results when one explanatory variable (X_i) is regressed against all other explanatory variables. The larger

the value of VIF (x_i) the more “troublesome” or collinear the variable X_i is. As a rule of thumb, if the VIF of a variable exceeds 10, therefore, there is no multicollinearity problem in the model (Appendix 7).

Appendix Table 8. Contingency coefficient for multi-colinearity test of discrete variables included in the hedonic price model

	BOSI	BOCO	AG	SEXG	DISTRI	PURP	LITE	STYPE	PRELA
BSIZE	1								
BCON	0.302	1							
AG	0.545	0.375	1						
SEXGO	0.203	0.127	0.223	1					
DISTRI	0.225	0.075	0.144	0.109	1				
PURP	0.208	0.227	0.116	0.180	0.089	1			
LITE	0.142	0.215	0.118	0.144	0.039	0.328	1		
STYPE	0.062	0.272	0.444	0.309	0.128	0.252	0.100	1	
PRELA	0.495	0.335	0.584	0.388	0.215	0.352	0.153	0.436	1

Source: Own computation from survey result, 2015

Where, CC= Coefficient of contingency, χ^2 = Chi-square random variable and N = Total sample size

Contingency coefficient is used to check multicollinearity or association between discrete variables. The value ranges between 0 and 1, with 0 indicating no association between the variables and value close to 1 indicating a high degree of association between variables. If the value of CC is greater than 0.75, the variables are said to be collinear.

Appendix II: Questionnaires

Interview Schedules

Remark: The personal profile obtained from respondents with regard to the theme will be kept confidential and will not have any consequence on the respondent in any ways. Please give correct answers to the following questions.

Instructions to Enumerators:

- Make brief introduction before starting any question, introduce yourself to the farmers, greet them in local ways and make clear the objective of the study.
- Please fill the interview schedule according to the farmers reply (do not put your own feeling).
- Please ask each question clearly and patiently until the farmer gets your points.
- Please do not use technical terms and do not forget local units.
- During the process write answers on the space provided.
- Prove that all the questions are asked and the interview schedule format is properly completed.

Objectives of the study

- To identify and characterize the major traits of the indigenous goats;
- To assess the implicit prices of the indigenous goat traits/attributes; and
- To identify demographic and socioeconomic factors influencing the indigenous goat prices in the study area.

Demographic and Socioeconomic Aspects

Part I: Household Characteristics of buyers

1.1. Name of the respondent: _____ Sex 1. Male 2. Female

1.2. Age of the respondent _____ (years)

1.3. Which language you can communicate? 1. Amharic 2. Afarigna (Afaraf) 3. Tigirigna 4. Oromic 5. Others (specify) _____

1.4. Religion of the interviewee 1. Muslim 2. Orthodox 3. Protestant 4. Catholic 5. Any other (please specify) _____

1.5. Current marital status of the respondent 1. Single 2. Married 3. Divorced 4. widowed

1.6. Family size _____ Male _____ Female _____ Total _____

1.7. Number of working person (18-64 ages) Male _____ Female _____ Total _____

please fill the following table.

Age group	Male	Female
< 10		
10-13		
14-16		
17-60		
>60		

1.8. Number of dependents in the household Male _____ Female _____ Total _____

1.9. What is position of interviewee in the household? 1. Household head 2. Other Member of the household

1.10. What is the educational status of the respondent? 1= Literate 0= Illiterate

1.11. If your answer for Q 1.13 is '*literate*' what is the highest level of education achieved by the respondent? 0= No formal education 1= Primary (1-8), 2= Secondary/high school 3= Tertiary (College/Diploma) 4= University (Specify; Undergraduate, Graduate, PhD) 5= Technical (e.g. Tailoring, Carpentry etc.) 6= Others (Specialty)

1.12. Summary of Age, sex, and education level of family members

Name	Age	Sex (1=Male, 0=Female)	Education level (use code from Q.1.14)

Part II: Resources and Means of Livelihood

2.1. Average land holding of the household _____ hectares

2.2. Land under cultivation _____ hectares

2.3. Fallow land _____ hectares

2.4. Grazing land _____ hectares

2.5. Homestead _____ hectares

2.6. What is occupation of the buyer? 0= Farming 1=Trade 2=Both farming and trade

3=Daily laborer 4=Government employee 5= Others (specify)_____

2.7. If you are a farmer, what is your main farming activity? 0= Livestock production 1= Crop production 2= Mixed farming 3= Others (Specify) _____

2.8. Which is/are among the major crops grown? 0=Maize 1=Sorghum 2= Sesame 3= Vegetables 4= Cotton 5= Others (please specify) _____

2.9. Do you have additional incomes that supplement your major occupation? 1= Yes 0= No

2.10. If your answer is for Q 2.9 is 'yes', state all in order of their importance.

Code	Category of additional income	Order
0	Sales of crop production	
1	Sales of animals and animal products	
2	Earnings from daily laborer	
3	Petty trading	
4	Selling fuel wood and charcoal	
5	Remittance/gift	
6	Others (specify)	

2.11. What is your experience in farming and non-farming activity?

1=Farming _____ years of experience

0=Non farming _____ years of experience

2.12. Describe the condition of your house. Type of house owned 1=Grass roofed 2=Iron sheet roofed 3=Both types 4= Others (specify)_____

2.13. Do you have the following household goods and valuables? 1= Radio 2= Wrists watch 3= Metal bed 4= Fanos 5=Kerosene stove 6= plowing tools (MoferKenber, maresha) 7= Animal cart 7=Others_____

2.14. Current livestock ownership of the household of the respondent: Please indicate the type and number of livestock owned by the household.

Category of livestock	No.	Name of the livestock	Number
Cattle	1	Oxen	
	2	Cows	
	3	Heifer	
	4	Bulls	
	5	Calves	
		Sub total	
Goat and sheep	6	Sheep	
	7	Goats	
		Sub total	

Equines	8	Camels	
	9	Horse	
	10	Mule	
	11	Donkeys	
		Sub total	
Poultry and swarm	12	Chicken	
	13	Bee colony	
		Sub total	
Others (specify)	14		
		Sub total	
		Total	

2.15. What are the sources of household cash income? Please rank in descending order.

No.	Income source	1=Yes ,No =0	Rank	Remark
1	Selling of live animal			
2	Selling of livestock product			
3	Crops and vegetables			
4	Forest and forest product			
5	Others			

2.16. What is your estimated income level in ETB?

Per month _____ ETB

Per year _____ ETB

Part III: Summarized data on the characteristics of buyers, the goats transacted

1. Age of the buyer _____ Years
2. What is the purpose of buying goats? 1. Profit by re-sale 2. Hotel and restaurants 3 Home consumption. 4. Reproduction of the goats
3. Sex of the buyer 1= Male 0= Female
4. Family size of the buyer _____
5. Literacy status of the buyer (LS) 1= Literate 0= Illiterate
6. Occupation of the Buyer 0= Farmer 1= Trader 2= Consumer 3= Butchers and restaurants 4=Others (Specify) _____
7. Distance from urban center _____ kilometers
8. Buyer's Access of Market Information (BAMI) 1= Yes 0= No
9. Prior Relationships of the buyer with the seller 1= Yes 0= No
10. Age of the Seller _____ Years
11. Sex of the buyer 1. Male 0= Female
12. Family size of the Seller _____
13. Literacy status of the buyer (LSB) 1= Literate 0= Illiterate
14. Type of goat seller 1. Trader 2. Non-trader
15. Distance from urban center _____ kilometers
16. Agreed selling price of the goat _____ ETB _____ Cents
17. Coat Color of goat 1=white 2=brown 3=black 4=white mixed, 5= creamy white 6= Red
18. Age of the goat in years _____
19. Presence of horn 1= Yes 0= No
20. Body size of the goat 1= Small, 2= Medium, 3=Large
21. Sex of the Goat 1= Male, 0= Female
22. Body condition of the goat 1= Poor 2=Average 3= Good

Part III. Checklists for Focus Group Discussion

1. What do you think are the livelihoods of the society in this area depend on?
2. What do you think are the roles of goat for livelihoods?
3. What roles do goats have as a staple food and source of cash?
4. What are the cultural and religious factors that affect the household's economic activity and their holdings?
5. How do you decide the price of goat in the market?
6. Would you discuss the goat marketing in your district?
7. What supportive services do goat producers get from development agents (DAs)?
What are the formal partnerships and institutional linkages among extension service providers? Please explain.
8. What are the existing policies in relation to agriculture in general and goat marketing in particular and how do you view them?
9. What are the indicators for wealth ranking according to the local community standards?
10. What are the off farm activities available in the region?
11. What do you think are the major determinants of goat selling prices in this locality?
Please discuss the relationships of goat selling price with:
 - a. Body size of the goat
 - b. Body condition of the goat
 - c. Age of the goat
 - d. Sex of the goat and, castration and fattening
 - e. Purpose of purchase
 - f. From whom the goat bought (trader or non-trader)
 - g. Literacy status of the buyer
 - h. Buyer access to market information on price
 - i. Buyer-seller prior relationships
 - j. Market location (district)
12. Do you think that goat prices are different with differences in types of sellers?
13. Do you think that goat prices are different with differences in types of buyers?
14. Which type of sellers gain higher prices from markets? Which type of buyers pay highest prices? Please explain.

15. What do you think are the impacts of long distances of sellers and buyers from urban center on the goat prices? Please explain.
16. What are the possible origins of goats marketed in the district's market place?
17. Who are the major participants of this goat market place? 1. Goat traders 2. Home consumer 3. Farmers 4. Butchers 5. Others (specify)_____
18. What are the average selling prices of goats in this market place? What do you think are the reasons for this? Explain it in relation to the types of goats, the participating buyer and seller characteristics of the market?
19. Which part of the society (males or females) are highly engaged with goat production and marketing?

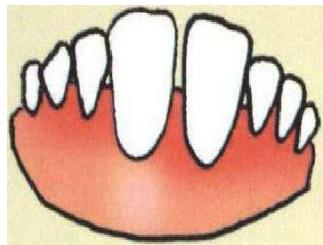
END OF THE INTERVIEW

THANK YOU VERY MUCH FOR RESPONDING THE QUESTIONS!

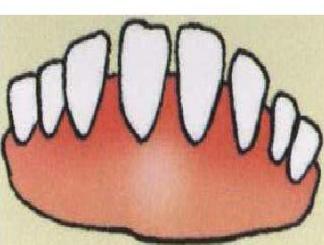
Appendix C. Figures and Pictures

Dentition Showing the Estimated Ages of Goats

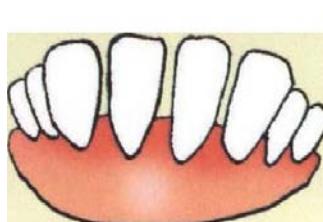
Milk teeth



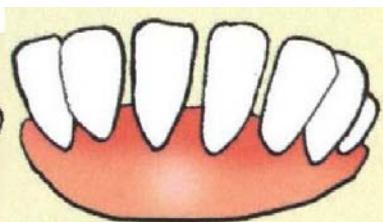
2 permanent (central) teeth



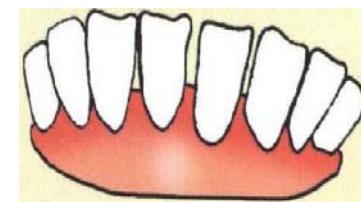
4 permanent teeth



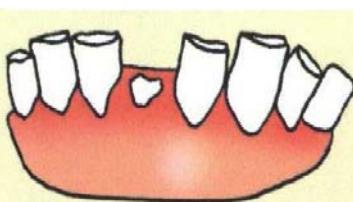
6 permanent teeth



Full mouth – 8 permanent teeth



Broken mouth



Source: Adopted from Vatta et al, 2006 as cited in Desta, 2009



Own photo taken during survey

Source: Own picture, 2015



Sample photo taken at the Mille goat market

Source: Own picture, 2015

THE END!