The role of cattle attributes in buyers' choices in Benin

Thierry A. Kinkpé
Laboratoire d'Analyse et de Recherche sur les Dynamiques Economiques et Sociales (LARDES), Université de Parakou, BP 123 Parakou, Bénin. E-mail: kinthagosagro@gmail.com

Rodrigue V.C. Diogo
Département des Sciences et Techniques de Productions Animale et Halieutique, Faculté d'Agronomie, Université de Parakou, BP 123 Parakou, Bénin. E-mail: dcao_bj@yahoo.fr

Cokou P. Kpadé
Université Nationale d'Agriculture, BP 43 Kétou, Bénin. E-mail: kpadepatrice1@hotmail.com

Jacob A. Yabi
Laboratoire d'Analyse et de Recherche sur les Dynamiques Economiques et Sociales (LARDES), Université de Parakou, BP 123 Parakou, Bénin. E-mail: ja_yabi@yahoo.com

Luc H. Dossa*
Ecole des Sciences et Techniques de Production Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Cotonou Jéricho, Bénin. E-mail: dolhip@yahoo.com

*Corresponding author

Abstract

This article investigated the role of cattle attributes in buyers' choices and hedonic pricing in Benin. Cross-sectional data were collected on 347 market cattle transactions using the revealed preference method. Both statistical tests and hedonic price models were performed. The results show that the most important criteria guiding cattle buyers' choices were the health status of the cattle, and their body condition, price, age and category. The most important cattle attributes determining the price were the live weight, the subspecies and the breed, the origin, the category and the coat colour. In contrast to the zebu subspecies, taurine subspecies and related breeds had significantly positive hedonic prices. These findings suggest that taurine breeds, which are mainly kept by poor smallholder farmers and currently are neglected by national policies, should be promoted and preserved to improve rural livelihoods.

Key words: bovine; breeds; implicit price; market preferences; West Africa

1. Introduction

Worldwide, the main sources of animal protein for a healthy human diet are eggs, milk, red meat, fish and poultry (Speedy 2003). Cattle farming is an important source of food, income and social status for millions of households and contributes to economic growth in several African countries (Thornton 2010). For example, in the East African countries of Ethiopia, Kenya and Uganda, the beef supply is approximately 2 kg to 10 kg per capita per year; in Southern African countries, such as South Africa, Zambia and Zimbabwe, the beef supply is 4 kg to 20 kg per capita per year; whereas in the West African countries of Benin, Mali, Niger, Nigeria, Sierra Leone and Togo, the supply is 1 kg to 10 kg per capita per year (FAOSTAT 2017a). In Benin in particular, the beef supply is approximately 3 kg per capita per year (FAOSTAT 2017a). These quantities of beef supply correspond to approximately 58%, 30%, 16%, 36% and 20% of the meat consumption in East Africa, Southern Africa, West Africa,

the whole of sub-Saharan Africa (SSA) and Benin respectively (OECD 2017). Cattle production in Benin contributes to approximately 1% of the national gross domestic production and 3% of the total livestock subsector (FAO 2016). Domestic cattle production has increased steadily, by more than 25%, over the last decade (FAOSTAT 2017b). Accordingly, cattle markets in Benin have increasingly been attracting buyers from neighbouring countries (Kamuanga *et al*. 2008). Despite the importance of cattle farming and the need to develop market linkages to enable producers to respond to the increasing but rapidly changing market demand, there is very limited information on buyers' purchasing behaviour in Benin.

Several studies have investigated the importance of cattle attributes to buyers' choice and the hedonic price of these attributes in other SSA countries. Generally, these studies have included attributes such as age (Kassie *et al*. 2011), subspecies and breed (Jabbar & Diedhiou 2003; Kassie *et al*. 2011; Fadiga 2013), origin (Fadiga 2013), body condition (Fadiga 2013), category (Kassie *et al*. 2011; Fadiga 2013), coat colour (Kassie *et al*. 2011; Fadiga 2013), size and apparent health status (Kassie *et al*. 2009).

There are two cattle subspecies in West Africa: taurine cattle (*Bos taurus*) and zebus (*Bos indicus*). The taurine population in Benin essentially consists of the *Somba*, *Lagunaire* and *N'dama* breeds, whereas the zebu population includes the *Zebu Fulani*, *White Fulani*, *Red Fulani* and *Goudali* breeds (Youssao *et al*. 2013a). However, crossbreeding between the two subspecies, represented by the *Borgou* breed, accounts for up to 75% of the Benin cattle population (Porter *et al*. 2016). Zebu breeds are mostly present in the northern part of Benin (Houenou-Sedogbo 1993). The *Borgou* breed can be found throughout the country, whereas the taurine *Somba* and *N'dama* breeds are found mainly in the Atacora (North-West) region (Dossa & Vanvanhossou 2016), and the taurine *Lagunaire* breed is distributed across the southeast and central departments of Ouémé, Plateau, Zou and Collines (Houenou-Sedogbo 1993). However, the cattle on offer at different national cattle markets come both from different regions of the country and from other countries in the West African subregion (Youssao *et al*. 2013a).

Animals traded in the markets can be divided into three main categories: males (bulls/steers), heifers and cows (Kassie *et al*. 2011; Fadiga 2013). Coat colour is categorised into entirely or largely white, entirely or largely fawn, entirely or largely brown and entirely or largely black (Kassie *et al*. 2011; Fadiga 2013). An animal can be apparently healthy or sick (Kassie *et al*. 2009). Fadiga (2013) distinguishes between average and excellent body condition. However, one can use the body condition score (BCS) defined by Vall and Bayala (2004)[1] to assess an animal's body condition. Kassie *et al*. (2009) investigated the purchase behaviour of cattle traders and farmers in different markets in Ethiopia and reported some differences between the two groups of stakeholders. The price and body size of the cattle were the most important attributes considered by the traders, whereas the cattle's fertility, resistance to diseases, vigour of their offspring and, among cows, milk production were of paramount importance for farmers. Likewise, Kassie *et al*. (2011) show that breed, body size, category (heifer, cow, bull or calf) and coat colour significantly determined the price of cattle. Fadiga (2013) found that age, breed, body condition, physiological status (castrated or not) and coat colour were the most important cattle attributes that determined buyers' choices. This author further observed that, apart from coat colour, all these attributes significantly determined the prices paid by traders, while only body condition and coat colour affected the price paid by butchers. In Nigeria, the animal's breed and sex were the most valued attributes (Jabbar & Diedhiou 2003). However, all these studies targeted only one or some specific market segment(s) (cattle farmers or traders, for example).

[1] The BCS varies from 0 to 5 according to the frame of the cattle (Vall & Bayala, 2004). 0 corresponds to a cachectic animal, 1 corresponds to an emaciated animal, 2 corresponds to an animal with a generally lean appearance, 3 corresponds to an animal with a generally good appearance, 4 corresponds to an animal with a generally well-covered appearance, and 5 corresponds to an animal with a generally fat and smooth appearance.

Furthermore, most of them used declared preference methods to collect data. The present study targets all categories of cattle buyers in a single study, and uses the revealed preference method.

There are several methods for assessing the importance of the attributes that influence consumers' preferences. However, the hedonic pricing method, which allows an estimation of the economic value of attributes for consumers, is one of the most frequently used (Roessler *et al*. 2008; Terfa *et al*. 2013; Gustafson *et al*. 2016; Tindano *et al*. 2017). This study is the first attempt to analyse buyers' preferences for cattle in Benin using the hedonic price approach. Specifically, it analyses the cattle attributes preferred by buyers and assesses the economic value of each of these attributes. It provides useful information that could help in the design of rational cattle-breeding programmes and marketing policies that satisfy buyers' requirements and increase the consumption of animal protein, while contributing to improved food and nutritional security and increased income for cattle farmers.

2. Methodology

2.1 Study area

The study covered the entire Republic of Benin, which is located in West Africa (Figure 1). The population of cattle in Benin was estimated at approximately 2.2 million heads distributed across the four regions of the country: the northeast (Borgou and Alibori departments), the most important cattle-production zone; the northwest (Atacora and Donga departments), the second most important cattle-production zone; and the south (Ouémé, Plateau, Atlantique, Littoral, Mono and Couffo departments) and the centre (Collines and Zou departments), the least important cattle-production zones. Most animals are raised under extensive production systems (Alkoiret *et al*. 2009). Similar to small ruminant-marketing channels in West Africa (Tamini *et al*. 2014), the cattle-marketing channels in Benin include farmers, traders and butchers/caterers (Houenou-Sedogbo 1993).

There is no specific cattle market for specific cattle categories or breeds in Benin. At Benin cattle markets, all cattle are pooled in one place, regardless of their age, sex, physiological status, etc. Although their motives for buying are different, buyers in different categories purchase cattle at the same markets. The transactions are not based on weight, as the markets and traders themselves do not have an official scale for weighing live animals. Hence, for research purposes, some formulas have been developed to estimate the live weight of cattle (Dodo *et al*. 2001; Youssao *et al*. 2013b; Vanvanhossou *et al*. 2018) in the markets.

In total, 14 cattle markets across the country (Figure 1) were surveyed. These markets were chosen based on their geographic positions and the importance of the cattle population in the department where each market was located (FAO 2016); thus, the market sample can be considered representative of the whole country.

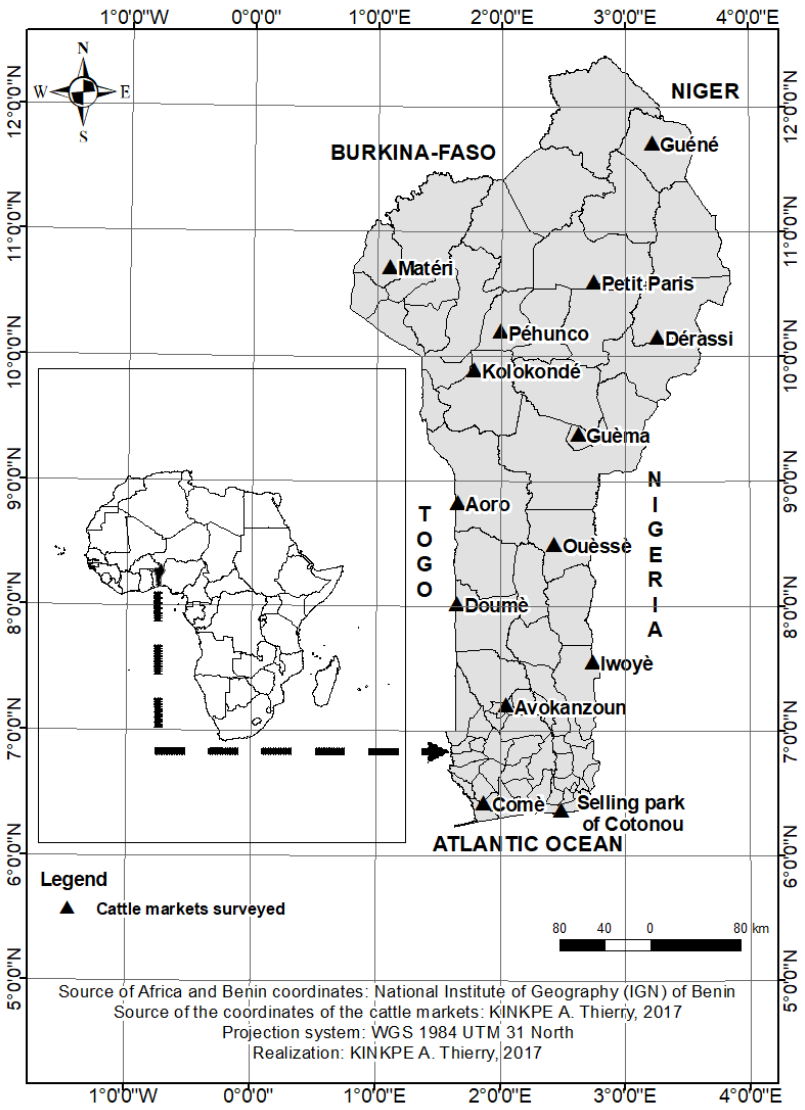

Figure 1: Map of Benin showing the locations of the investigated livestock markets

2.2 Cattle buyer sampling and data collection

Cross-sectional data were collected from mid-January to March 2017. This period excluded all special events, such as Tabaski, Christmas and New Year celebrations and transhumance, which could bias the reality in the markets.

In each market, buyers were approached randomly and individually and asked whether they had come to purchase cattle (Demont *et al*. 2017). To those who responded positively, the objective of the study was explained briefly and they were invited to participate in the study. All the transactions made by the buyers who agreed were surveyed. A total of 347 market cattle transactions were surveyed (Table 1).

The revealed preference method was used to collect data on the real choices of the buyers, based on the fact that each transaction implies a price and a real choice made by the buyer that reveals his/her real preference. The linear body measurements of each head of cattle purchased were taken using a measuring tape. The cattle's age was estimated from their teeth (Symoens & Hounsou-Vè 1990). For each animal, information on the purpose of purchase was collected from the buyer; the purchase price was recorded from observing the transaction and confirmed by both the buyer and the seller; information regarding the origin of the cattle was collected from the seller; and breed, category,

apparent health status and coat colour were collected by direct observation of the cattle. In addition, BCS was assessed (Vall & Bayala 2004). At the end of each transaction, the buyer was asked to list and rank the criteria that guided his/her choice.

Table 1: Distribution of surveyed cattle transactions at the cattle market

Region	Department	District	Cattle market	Number of studied transactions
Northeast	Alibori	Gogounou	Petit Paris	30
		Malanville	Guéné	30
	Borgou	Kalalé	Dérassi	30
		Parakou	Guèma	29
Northwest	Atacora	Matéri	Matéri	30
		Péhunco	Péhunco	22
	Donga	Bassila	Aoro	30
		Djougou	Kolokondé	25
Centre	Collines	Ouèssè	Ouèssè	20
		Savalou	Doumè	9
	Zou	Djidja	Avokanzoun	30
South	Littoral	Cotonou	Selling Park	30
	Mono	Comè	Comè	12
	Plateau	Kétou	Iwoyé	20
All				347

Source: Authors' tabulation

2.3 Data analysis

Kendall's concordance coefficient W (0 - 1) was used to test the concordance of the cattle buyers' ranking of their choice criteria. A higher coefficient indicates higher concordance.

2.3.1 Estimation of cattle live weight

The cattle's live bodyweight (BW) in kg was estimated using linear body measurements.

For cattle from the taurine subspecies, the BW was calculated as follows (Vanvanhossou *et al*. 2018):

$$\boldsymbol{BW = 0.000133C^{2.89}} \quad (1)$$

For zebus, it was as follows (Dodo *et al*. 2001):

$$\boldsymbol{BW = 0.02697C^2 - 4.250C + 1.535L + 96.145} \quad (2)$$

Concerning *Borgou* cattle, the calculation was as follows (Youssao *et al*. 2013b);

Firstly, for young males:

$$\boldsymbol{BW = 1.83C + 0.59H - 153.62} \quad (3)$$

And then for young females:

$$\boldsymbol{BW = 1.65C + 0.46L - 120.70} \quad (4)$$

For males:

$$\boldsymbol{BW = 1.55L + 2.62H - 323.15} \quad (5)$$

And for females:

$$\boldsymbol{BW = 1.82C + 0.70H - 163.83}, \quad (6)$$

where C, H, and L are the chest girth (cm), the height at the withers (cm) and the scapular-ischial length (cm) respectively.

2.3.2 Modelling the economic value of cattle attributes

The consumer theory of Lancaster (1966) asserts that goods provide utility to consumers through their attributes and do not constitute utility providers per se. Likewise, Rosen (1974) highlights that the price of a product depends on its attributes, and each of these attributes has an implicit price. Consequently, the price of a product is the sum of all the implicit prices of all its attributes, as suggested by Ladd and Suvannunt (1976). This price can be modelled as follows:

$$\boldsymbol{P = f(x)}, \quad (7)$$

where P denotes the price of the good and x denotes the set of its attributes. Although this study did not target the final consumers (meat consumers) of the cattle, it targeted the buyers, who also have utility function, as they express the demands of the real final consumers. Lancaster's (1966) and Rosen's (1974) theories were then adapted for this study.

In this study, a function without transformation of variables was used so that the coefficients of the cattle attributes directly reflect their hedonic price. This specification is illustrated by the following equation:

$$\boldsymbol{P_i = \alpha_i x_i + \epsilon_i}, \quad (8)$$

where x_i is the vector of the attributes of the purchased cattle i, α_i is the vector of estimated hedonic prices of the cattle i, and ϵ_i is a stochastic error term.

As the model of equation (8) was based on non-transformed variables, the ordinary least squares method was not appropriate because some basic assumptions related to this method were not verified on the database (Greene 2008). The price, which is the dependent variable, and most of the explanatory variables, had censured distributions. Consequently, the truncated regression model was used, as it was a suitable estimation method. A robust estimation correcting heteroscedasticity problems was specified and carried out using STATA 13 (StataCorp 2013).

Based on previous studies (Jabbar & Diedhiou 2003; Kassie *et al*. 2009, 2011; Fadiga 2013), the cattle attributes that could drive price are breed/subspecies, age, category (heifer, bull, steer or cow), body condition, size, health status, origin and coat colour. These attributes were considered in our hedonic price models. Instead of the category of body condition (average, excellent), as in Fadiga (2013), the BCS was used as an indicator of body condition (Vall & Bayala 2004). Furthermore, the live weight of cattle was used as an indicator of body size. For econometric modelling, all potential variables were first explored. The final list of explanatory variables was retained after a suitable multicollinearity test (Table 2) and the removal of conflicting variables. Due to the multicollinearity of the cattle subspecies and breeds and the importance of these attributes, two different models were specified for equation (8). The first included the subspecies, and the second included the breeds. Some variables were common to both models. As almost all the purchased cattle were apparently healthy, the variable related to health status was dropped from the models. Moreover, there were only eight steers among the 347 cattle purchased by the buyers. Therefore, they were combined with the bulls in a single variable, "Male". Age was highly correlated with live weight. Furthermore, following

Youssao *et al*. (2013b), the weight of a *Borgou* animal depends on its age. This means that there could be an endogeneity bias when age and weight are used together as explanatory variables in the same model. Accordingly, age was dropped from the models.

There are some specificities in the cattle market in Benin. All cattle are brought together in the same market, regardless of the category and the purpose of purchase. Cattle are not bought per kilogram, but negotiated directly per head. As a result, all cattle are pooled in the same model, and the price used in the model was the price per head.

Table 2: Explanatory variables of the two hedonic price models

Cattle attributes	Response for the dummy variables	Expected sign
Variables in the subspecies' model only [a]		
Pure taurine subspecies	1 = Yes, 0 = No	±
Pure zebu subspecies	1 = Yes, 0 = No	±
Variables in the breed model only		
Somba breed	1 = Yes, 0 = No	±
Goudali breed	1 = Yes, 0 = No	±
Zebu Fulani breed	1 = Yes, 0 = No	±
White Fulani breed	1 = Yes, 0 = No	±
Red Fulani breed	1 = Yes, 0 = No	±
Variables common to both models		
Raised in Benin	1 = Yes, 0 = No	±
Male	1 = Yes, 0 = No	+
Heifer	1 = Yes, 0 = No	±
White coat	1 = Yes, 0 = No	±
Live weight (kg)	-	+
Body condition score (0-5)	-	+

[a] The crossbreed *Taurine X Zebu* is considered the reference
Source: Authors' tabulation

3. Results

3.1 Attributes and prices of cattle

More than 98% of the purchased cattle were apparently healthy (Table 3). More than 70% were male, and approximately 19% were cows. The average age of the purchased cattle was approximately 54 months. The cattle of the zebu subspecies were the oldest. More than 95% of the cattle on sale were produced in Benin. The average live weight was 260 kg. However, the zebu breeds were significantly heavier than *Borgou* crossbreeds (p value = 0.000), and the *Borgou* animals were significantly heavier than the members of the pure taurine breeds (p value = 0.000). Figure 2 shows the purchased cattle prices according to the breed and subspecies. Irrespective of breed, the average price paid was approximately 770 FCFA[2] per kilogram of live weight. This price was significantly higher (p value = 0.000) for the taurine cattle than for zebu (1 200 FCFA/kg against 700 FCFA/kg on average per kilogram of live weight). Among the zebu breeds, the *Red Fulani* fetched lower prices than the *White Fulani*, *Goudali* and *Zebu Fulani*.

[2] FCFA 1 000 varied from US$ 1.61 to 1.66, for an average of US$ 1.63, during the data collection period.

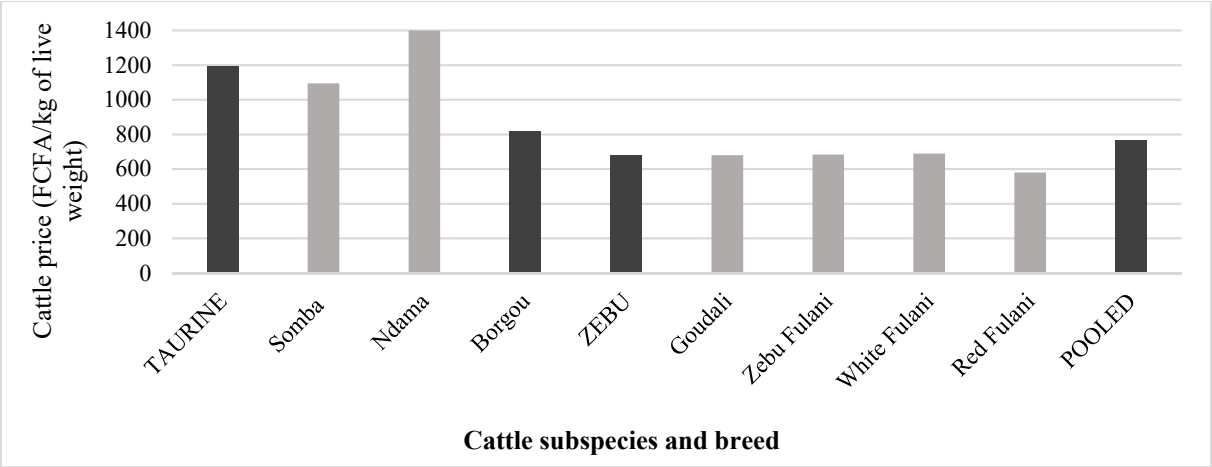

Figure 2: Cattle price by subspecies and breed at livestock markets across Benin
Source: Authors' results

Table 3: Distribution of surveyed cattle transactions at cattle markets

Attributes	**Subspecies and breeds**									**Pooled**
	Taurine (*Bos taurus*)			**Taurine X zebu**	**Zebu (*Bos indicus*)**					
	Somba	***N'dama***	**Pooled**	***Borgou***	***Goudali***	***Zebu Fulani***	***White Fulani***	***Red Fulani***	**Pooled**	
Apparent health status										
Sick (%)	0.00	0.00	0.00	1.78	2.86	3.70	0.00	0.00	1.85	1.73
Healthy (%)	100.00	100.00	100.00	98.22	97.14	96.30	100.00	100.00	98.15	98.27
Category										
Male (%)	63.64	80.00	68.75	61.54	88.57	83.33	76.36	66.67	80.25	70.61
Heifer (%)	0.00	20.00	6.25	17.16	0.00	0.00	10.91	5.56	4.32	10.66
Cow (%)	36.36	0.00	25.00	21.30	11.43	16.67	12.73	27.78	15.43	18.73
Origin										
Benin (%)	100.00	100.00	100.00	95.86	82.86	96.30	100.00	100.00	95.06	95.68
West African subregion (%)	0.00	0.00	0.00	4.14	17.14	3.70	0.00	0.00	4.94	4.32
Quantitative attributes (mean, with standard deviation in brackets)										
Age (months)	59.09 (36.25)	63.20 (32.55)	60.38 (34.10)	44.81 (30.04)	47.26 (29.30)	75.22 (24.99)	62.49 (26.74)	56.11 (37.00)	62.73 (30.08)	53.90 (31.44)
Estimated live weight (kg)	119.35 (26.32)	141.43 (42.16)	126.25 (32.36)	176.98 (45.53)	325.90 (129.30)	408.54 (105.13)	364.27 (117.73)	277.23 (126.19)	361.06 (123.75)	260.58 (130.97)
Body condition score (0-5)	3.73 (0.47)	4.20 (0.45)	3.88 (0.50)	3.51 (0.57)	3.91 (0.61)	3.96 (0.62)	3.98 (0.68)	3.78 (0.73)	3.94 (0.65)	3.73 (0.64)
Number of cattle	11	5	16	169	35	54	55	18	162	347

Source: Authors' results

3.3 Choice criteria for cattle consumption

Table 4 presents the criteria that guided the buyers' choice of cattle. The chi square value was significant at 1%, indicating that the ranks were to be considered. Kendall's W value indicated a good concordance of the ranks given by the buyers surveyed. Based on the nine recorded criteria, the most important choice criterion was apparent health status, followed by body condition, price, age, category, breed, coat colour, live weight and origin.

Table 4: Cattle buyers' ranking of choice criteria

Choice criteria	Mean rank	Rank
Breed	5.72	6th
Origin	7.03	9th
Age	5.18	4th
Category	5.18	4th
Body condition	3.10	2nd
Coat colour	6.32	7th
Apparent health status	1.59	1st
Live weight	6.64	8th
Price	4.26	3rd
Number of observations	347	
Kendall's W	0.49	
Chi^2 (df = 8)	1 360.97***	

*** $p < 0.01$

Source: Authors' results

3.4 Hedonic price models

The two hedonic price models were globally significant at 1%. Hence, the chi square test associated with the Wald statistic of the two models allowed the rejection of the hypothesis suggesting that the coefficients are equal to zero, showing that the variables correctly fit the models (Table 5). The subspecies and breeds presented significant coefficients in their respective models. In addition to these variables, the live weight and category of the cattle also significantly determined their price. The coat colour was not significant in the breed model, but significantly determined the price in the subspecies model. The BCS of the cattle did not significantly determine market prices. In the subspecies model, taurine subspecies presented a positive, implicit price of approximately 68 000 FCFA, whereas zebu subspecies had an implicit price of approximately -67 500 FCFA. Likewise, in the breed model, the taurine *Somba* presented an implicit price of almost 49 000 FCFA, while all zebu breeds presented negative implicit prices, ranging from approximately -77 000 FCFA to almost -60 000 FCFA.

The origin "Benin", i.e. cattle raised in Benin, presented negative implicit prices. Male cattle and heifers presented positive implicit prices. However, the attribute "male" had a higher price than "heifer". White coat presented a positive implicit price of almost 19 000 FCFA in the subspecies model. The live weight of the cattle presented a positive implicit price of more than 925 FCFA/kg. The ranking of standardised implicit prices showed that the cattle attributes can be ranked from the most expensive to the cheapest, as follows: live weight, breeds/subspecies, origin, category, coat colour, and body condition.

Table 5: Hedonic price models

Cattle attributes[b]		Model including subspecies		Model including breeds	
		Coefficients (standard error)	Standardised coefficients	Coefficients (standard error)	Standardised coefficients
Subspecies	Taurine	68 818 (12 536)***	5.49	_	_
	Zebu	-67 536 (11 562)***	-5.84	_	_
Breeds	*Somba*	_	_	48 628 (16 066)***	3.03
	Goudali	_	_	-75 306 (13 719)***	-5.49
	Zebu Fulani	_	_	-76 824 (13 820)***	-5.56
	White Fulani	_	_	-60 844 (12 503)***	-4.87
	Red Fulani	_	_	-74 215 (16 807)***	-4.42
Origin	Raised in Benin	-66 086 (14 317)***	-4.62	-65 432 (14 256)***	-4.59
Category	Male	25 887 (7 978)***	3.24	26 110 (7 935)***	3.29
	Heifer	22 379 (8 125)***	2.75	19 730 (8 631)**	2.29
Coat colour	White coat	18 602 (7 415)**	2.51	11 485 (8 966)	1.28
Weight	Live weight (kg)	936 (47)***	19.91	925 (49)***	18.88
Body condition	Body condition score (0-5)	1 233 (5 315)	0.23	4 215 (5 401)	0.78
Number of observations		346		346	
Wald chi^2		7 299***		7 225***	
Sigma		60 333 (15 307)***		61 028 (15 186)***	

[b]: the crossbreed *Borgou* was considered as the reference for both subspecies and breeds; the cow was the reference for the cattle categories; coats other than white were the reference for coat colour; and cattle from other West African countries were the reference for cattle origin

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Source: Authors' results

4. Discussion

The predominance of males and culled cows among the cattle on offer at the livestock markets in Benin, as found in the current study, seems consistent with other studies in northern Benin (Dehoux & Hounsou-Ve 1993; Toko *et al*. 2016), which reported a predominance of female animals (up to 80%) in traditional cattle herds. According to Toko *et al*. (2016), bulls, followed by old cows, are the first animals sold by cattle farmers when cash is needed and also when they need to ease the management of the herd; high proportions of breeding females and heifers in herds are maintained to ensure herd growth and the replacement of old cows. This finding can be further explained by the fact that selling young bulls before they reach maturity is a common practice among cattle farmers (Dehoux & Hounsou-Ve 1993). Male cattle are also sold at the market after being intensively used as draught animals. This could explain the presence of holes in the noses of most of the zebu cattle on sale at the different markets, which indicated that they had borne yokes.

This study further shows that breed, origin, age, category, body condition, coat colour, apparent health status, live weight and price are the criteria that most strongly determine cattle buyers' choices in Benin. This finding is consistent with those of Jabbar and Diedhiou (2003) and Fadiga (2013), who showed the importance of age, breed, body condition, category and coat colour to the choices of cattle buyers in Niger, Mali and Nigeria. This finding is also consistent with findings by Ouma *et al*. (2007) and Ruto *et al*. (2008), which showed that live weight, price, category, subspecies and body condition determined the preferences of cattle buyers in Kenya and Ethiopia. There are also similarities between the attitudes expressed by cattle buyers and those of live poultry buyers in Benin, as described by Vidogbèna *et al*. (2010) and Sodjinou *et al*. (2015).

As this study targeted all categories of buyers at the market, and not specifically and exclusively farmers, it did not directly take into account some production-specific attributes, such as cow fertility, milk production and resistance to diseases, that previous studies have shown to determine cattle buyers' choices (Ouma *et al*. 2007; Roessler *et al*. 2008; Woldu *et al*. 2016). However, as these attributes are commonly associated with cattle breeds (Mwai *et al*. 2015), they were indirectly considered in the attribute "breed".

Following Rosen (1974), the high level of significance of most of explanatory variables, except body condition, confirms that the cattle price is really the sum of the values of its attributes. The effects of significant variables contribute to explain the cattle price. The determinants of cattle price were subspecies/breed, live weight, origin, coat colour and category. These results are consistent with those obtained by Jabbar and Diedhiou (2003), Kassie *et al*. (2011) and Fadiga (2013) on cattle in other SSA countries. Similar results were also obtained for poultry by Sodjinou *et al*. (2015), who reported that breed, age, sex, body condition and plumage colour were the most important determinants of poultry price in Benin. These results are also similar to those obtained for sheep (Terfa *et al*. 2013; Tindano *et al*. 2017), goats (Woldu *et al*. 2016) and pigs (Roessler *et al*. 2008). Thus, despite the differences in the societal roles of cattle, sheep, goats and pigs, the attributes that determine their price and buyers' choices are similar.

One of the most important findings in this study is the ranking of attributes based on their standardised coefficients (Table 5). The most expensive cattle attribute in Benin is the live weight, followed by breeds/subspecies, origin, category, coat colour and body condition. Comparing these with the buyers' rankings (Table 4), it appears that an attribute could be important in buyers' choice criteria but less important regarding implicit price.

The negative implicit prices of the origin "Benin" implies that country-raised cattle fetched a lower price than imported cattle. This finding could be explained by the fact that almost 96% of the animals purchased were produced in Benin, implying that the market supply of country-raised animals was high. In addition, travel and transaction costs increase the prices of imported cattle. Furthermore, all imported cattle on the markets were purchased at higher prices by exporters. Nevertheless, this predominance of country-raised cattle confirms that cattle farming and related activities are important economic activities and deserve more attention from researchers, policy-makers and development programmes.

Although the attributes "male" and "heifer" had positive implicit prices, the price was higher for males than for heifers. Field observations showed that heifers were mostly bought by cattle farmers, who are upstream stakeholders in the cattle value chain. In contrast, male animals were bought by all stakeholders along the value chain, as they support the average price of cattle.

Although inconsistent with Woldu *et al*. (2016), the non-significant implicit price of cattle body condition could be explained by the fact that, on average, the large majority of the purchased cattle had a good BCS (3.73 ± 0.64). Likewise, although Roessler *et al*. (2008) demonstrate that the animal price is determined by its health status, the apparent health status was not included as an explanatory variable in our models because more than 98% of all purchased cattle were apparently healthy. However, the apparent health status of the cattle was the most important choice criterion regarding the cattle buyers' ranking (Table 3). As the final use of all cattle is slaughtering, buyers pay attention to their health status. This is certainly due to the systematic seizure by the national veterinary services of any meat from sick animals, followed by sanctions against the offending butcher.

Further results of this study are the higher price of the kilogram live weight fetched by taurine cattle. While these results contrast sharply with common beliefs and cattle farmers' ratings of taurine cattle

in terms of market value (Dossa & Vanvanhossou 2016), they could be explained by the aforementioned economic theory. Furthermore, the relatively low proportion of taurine cattle traded at the market is in line with the drastic regression of the taurine cattle populations of Benin (DE-MAEP 2004). In addition, as the final destination of almost all taurine cattle traded was butchery/ catering, another possible explanation for the observed higher price for taurine cattle than for zebu is that these buyers perceive, as shown by Salifou *et al*. (2013), that taurine cattle have better technological, organoleptic and sensory meat qualities than zebu.

Taurine cattle have continued to be overlooked in most national livestock development initiatives because they are considered less productive than zebus and other exotic breeds. However, it is very likely that this perceived low productivity is a result of the environment in which they are raised, rather than any low genetic potential. In addition, their small size and relative rusticity (Rege 1999) make taurine cattle relatively easier to manage than zebu and the most suitable cattle breeds for resource-poor people. This cattle type, represented largely by the *Somba* breed, is mainly kept in smallholdings in the department of Atacora, which is characterised by a high human poverty index and a high level of food insecurity (INSAE 2016). Better managed, these small herds could represent tangible liquid assets and living accounts for their owners, and thus a potential pathway out of poverty. These breeds have not received sufficient research and development interest. Consequently, there is no long-term improvement programme targeting these taurine breeds, which are currently threatened by indiscriminate crossbreeding and absorption by zebus (Porter *et al*. 2016).

These results provide further support for the need to develop programmes to improve local cattle production in general and, more specifically, to promote the rational use and conservation of taurine breeds to improve the availability of high-quality meat and the livelihoods of smallholder cattle farmers.

This paper was based on cross-sectional data, and hence did not capture the seasonality effects. In addition, the effect of important celebration periods, such as Christmas, New Year and other religious celebrations, was not captured. Further research should focus on these aspects for a better understanding of cattle price trends and buyers' behaviour and requirements in Benin.

5. Conclusions

The most important finding of this study is that taurine cattle attract higher prices than zebu per kilogram live weight. Taurine subspecies are further associated with positive hedonic prices, whereas zebu have negative hedonic prices. Benin cattle buyers base their choices on cattle attributes and price. The apparent health status of the animal was the most important choice criterion, and origin was the least important. Body condition, price, category and age were also important choice criteria. These results suggest that taurine cattle, which have long been neglected, should be promoted among resource-poor cattle farmers through the development and implementation of rational and participatory action-oriented improvement programmes. Moreover, cattle farmers should better manage their herds to produce apparently healthy cattle with good body conditions to ensure the quick sale of their product.

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