



Factors affecting the selling prices of calves in auctions in Santa Catarina State, Brazil

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ABSTRACT - The objective of this study was to investigate the effects of genetic group and calf sex on selling prices in auctions in the state of Santa Catarina (SC), Brazil. We evaluated 33,143 animals, representing 3,587 lots in 47 auctions from 2009 to 2014. The calves were classified according to genetic groups: British breed or crossbreed (BX); Continental breed or crossbreed (CX); Zebu breed or crossbreed (ZC); British and Continental crossbreed (BC); and *Bos taurus* and *Bos indicus* crossbreed (TI). The lots were composed of male and female calves. The years presenting low and high changes in the price of calves were similar to the variation in the price of beef cattle and, in 2014, the calf price reached its highest value (R\$5.36). Male calves were sold at prices higher than female calves (average 7.8%), but this difference was driven by year of analysis, in which the closest approach occurred during periods of reduction in the price of live cattle in SC (2012 and 2013). Calves of genetic groups ZX and TI received, on average, lower prices (R\$4.49 and R\$4.64, respectively) compared with the other groups. In 2013, males from the BX group had greater variation in price compared with CX (3.9%) and BC (5.7%). On the other hand, female heifers from the BX group received higher average prices in 2011 compared with the CX, BC, IT, and ZX groups (8.1, 8.5, 14.7, and 16.5%, respectively). Recently, female British heifers have had a greater appreciation in auctions held in SC, possibly for their reproductive performance potential of beef cows. Thus, sex and different genetic groups are factors that impact the selling price of calves in the SC region.

Key Words: animal production, beef cattle, genetic parameters, marketing, price

Introduction

In Brazil, the livestock market occurs mainly either by direct sales between buyers and sellers or through auctions, in which buyers compete for the desired lot by bidding (Machado Filho, 1994). The price of a cow/calf is affected by condition factors of supply and demand, including physical characteristics (e.g., sex, breed, live weight, frame, and handling) and market conditions (e.g., lot size, number and uniformity of animals in the lot, feed, and future prices) (Christofari et al., 2009; Willians et al., 2012; Koetz Junior et al., 2014). However, many of these factors are very subjective and producers believe that feeder cattle prices are inconsistent.

Buyers appraise individual characteristics as predictions of quality and quantity of animals to adjust their bids accordingly. This linkage between numbers of livestock

and the level of prices is based upon demand considerations only. The selling prices of feeder cattle vary from region to region or over time, in which the producers adjust their production systems (Troxel and Barham, 2012).

The state of Santa Catarina (SC) has a cattle herd of 4,285,931 heads (IBGE, 2014) and is the only state in Brazil that blocks the entry of any live bovine animal due to sanitary conditions, which makes it an internal livestock market. Due to the land consolidation policies imposed by the SC State, the beef cattle are concentrated in the Serrana Region by large-scale farms and experience similar weather conditions for grazing production systems (CEPA, 2014). In addition, the main beef cattle operations use livestock auctions, which are considered a centralized system that simultaneously brings together many feeder calf producers and the beef chain industry to provide a reliable product indicator (Christofari et al., 2014).

Price differences among livestock markets are a source of concern to cattle producers and buyers and it is important to understand market conditions to maximize the efficiency of the production system. However, in SC, information about the factors affecting prices paid for beef cattle is still scarce. Thus, the objective of this study was to investigate the influence of certain physical characteristics of calves

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(i.e., sex and genetic group) on the price of animals sold at auctions in SC, Brazil.

Material and Methods

Data were collected from an auction company in the Serrana Region of SC and corresponded to 3,587 lots, which were marketed at 47 auctions in the autumn season from 2009 to 2014. This study comprised a total of 33,143 calves sold through these livestock auctions. The certified livestock company contained data on each lot of cattle sold that included the following: live weight, genetic group, number of animals (head), uniformity, sex, and average price obtained by each lot in Brazilian currency (Reais; R\$) per kilogram of body weight (R\$ kg⁻¹ as BW). All marketed male (M) calves were castrated as a requirement of the auction company. Genetic groups of calves were based on phenotypic characteristics of the animal biotype that prevailed in each lot and also from the information provided by the owner.

To determine the genetic group, the lots were classified into five groups according to their breed characteristics (Table 1). The British crossbreed (BX) group consisted of animals classified as British breeds (Polled Hereford, Hereford, Aberdeen Angus, Red Angus, and Devon) or animals crossed between them. Similarly, the Continental crossbreed group (CX) consisted of breeds such as Charolais, Limousin, Simmental, and crosses between them. The Zebu crossbreed group (ZX) was composed of the Nellore, Brahman, Tabapuã, and their crosses. In addition, lots comprising crosses between British and Continental (BC) breeds and *Bos taurus* and *Bos indicus* mixed breeds (TI) were also analyzed.

The average selling price of all animals was obtained by the total number of animals in each lot from the ratio between the price paid in Brazilian currency per animal and the average weight (kg) of calves from each lot. All nominal marketed prices (R\$ kg⁻¹) were deflated by the General Price Index - Internal Supply (Índice Geral de Preços - Disponibilidade Interna; IGP-DI) for May 2014,

which corresponds to the date of the last evaluated auction to allow for comparison between auctions over time (years). All selling prices paid for calves were compared to live beef cattle prices in the state, according to Agrolink (2015), which represents the accurate information system used for the studied region.

All data were tabulated in Microsoft Excel® spreadsheets and descriptive analysis was performed, including calculation of frequencies, means, and standard deviations of the price per year, sex, and genetic groups. Because of the unbalanced nature of the data, we performed a non-parametric analysis using the Friedman and Kruskal-Wallis (*post-hoc* Dunn) tests with a minimum significance level of 5%, to evaluate the differences between the prices according to the treatments (year, sex, and genetic groups). To test the correlations between the price of calves and the price of live beef cattle, Spearman's correlation was applied. A generalized model (Equation 1) was used to evaluate the interaction of each variable with the price of calves.

$$P_i = \gamma_i + \rho_j + \delta_k + \gamma_i * \rho_j + \gamma_i * \delta_k + e_i,$$

in which P_i = final price (R\$) per live weight of i -th year; γ_i = observed year of the auction ($i = 2009, 2010, 2011, 2012, 2013, \text{ and } 2014$); ρ_j = sex of the animal ($j = M$ - male and F - female); δ_k = genetic groups ($k = BX$ - British crossbreed, CX - Continental crossbreed, ZX - Continental crossbreed, BC - crosses between British and Continental and TI - Mixed breeds; and e_i = experimental error of i -th year.

Results and Discussion

The state of SC, contrary to other states, has a sanitary status without vaccination that makes the beef cattle prices differentiated and the calves are marketed within the state boundaries (CEPA, 2014). These conditions affect the average price of live beef cattle in the state compared with the national and Rio Grande do Sul State average prices (7.5 and 2.9%, respectively) (Agrolink, 2015).

An exploratory analysis was conducted to accurately assess the marketing of calves in this study. This information includes six years of data collection that provides an evaluation of 33,143 calves (males and females) distributed into five different genetic groups (Table 2).

The average price (R\$ kg⁻¹ as BW) of the calves marketed in SC changed significantly: the year 2011 showed an increase of 19.9% over the selling price (R\$5.00) compared with 2010 (R\$4.17), followed by a decrease in 2012 and 2013 (R\$4.78 and R\$4.63, respectively) and by a further increase of 15.0% in 2014 (Figure 1). Indeed, this variation in calf prices followed the tendency in the price of live beef cattle in both regional and national markets.

Table 1 - Genetic groups of beef calves sold in auctions in the Serrana Region of Santa Catarina from 2009 to 2014

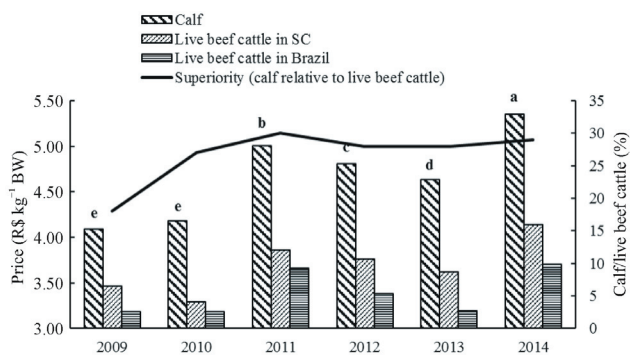
Classification	Genetic group	Number of observations (n)
BX	British breed or crossbreed	922
CX	Continental breed or crossbreed	1144
ZX	Zebu breed or crossbreed	356
BC	British and Continental crossbreed	541
TI	<i>Bos taurus</i> and <i>Bos indicus</i> crossbreed	624

The price of live beef cattle is the main variable that determines the price of other categories of animals in beef cattle. Consequently, when the live price of beef cattle is low, in general, farmers have fewer incentives to purchase animals for replacement, which will result in a reduction in its price (Christofari et al., 2010). In the state of Mato Grosso, the correlation between the price of live beef cattle and calves was 0.89 (Agrolink, 2015), which was nearly equivalent in our study, 0.90 ($P < 0.001$) (Figure 1). Similar results were also described by Sachs and Martins (2007) and Sachs and Pinatti (2007) in São Paulo State, where they showed that there is a marked influence of the price of live beef cattle on the price of steers and calves.

Table 2 - Descriptive analysis and average selling price of beef calves in auctions in the Serrana Region of Santa Catarina from 2009 to 2014

Variable		Lot (n)	Animal (n)	Frequency percentage (lot)	Average price (R\$ kg ⁻¹ ±SD)
Year	2009	365	3642	10.17	4.10±0.45
	2010	606	5662	16.89	4.19±0.44
	2011	499	5246	13.91	5.01±0.63
	2012	614	5614	17.12	4.81±0.54
	2013	729	6362	20.32	4.64±0.64
	2014	774	6617	21.58	5.36±0.78
Sex	Male	2011	18893	56.06	4.88±0.64
	Female	1576	14250	43.94	4.57±0.84
Genetic group	BX	922	8661	25.70	5.09±0.92
	CX	1144	10725	31.89	4.66±0.66
	ZX	356	3086	9.93	4.34±0.51
	BC	541	5139	15.08	4.80±0.63
	TI	624	5532	17.40	4.59±0.62

BX - British breed or crossbreed; CX - Continental breed or crossbreed; ZX - Zebu breed or crossbreed; BC - British and Continental crossbreed; TI - *Bos taurus* and *Bos indicus* crossbreed; SD - standard deviation.



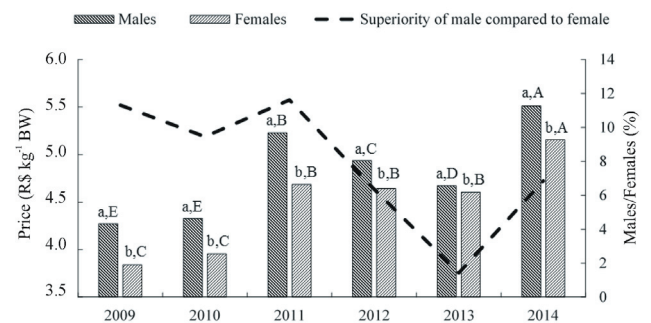
Different letters differ statistically ($P < 0.05$).
BW - body weight.

Figure 1 - Average price behavior per kilogram of body weight (R\$ kg⁻¹ as BW) in auctions in the state of Santa Catarina in relation to price of live beef cattle from 2009 to 2014.

In the evaluation of market price of male (M) and female (F) calves, we observed the interaction between sex and year ($P < 0.05$). The price of M has always been higher compared with F; however, this superiority decreased 10% between 2009 and 2011, 6.35% in 2012, and 1.46% in 2013 (Figure 2). Similarly, the price of both categories in 2013 is mainly related to a reduction in the price of M caused by the decline in the price of live beef cattle and not to the increase in the value of F animals.

The stability became evident in the price of the F animals from 2011 to 2013, and the increased price in 2014 may have been a consequence of the increased demand for this category by producers (Figure 2). The increase in the supply of F compared with previous years (40.5% in 2009 and 47.3% in 2013) shows that producers continued their investments in this animal category. This result is explained by the higher allocation of funds by financial institutions for agricultural and livestock investment, which increased gradually between 2009 and 2014, reaching 46.1% in the 2013/14 period (MAPA, 2015). In addition, the mountainous region of SC consists of areas of land used mainly for breeding activity concentrated in marginal areas (Fachin et al., 2014). In fact, even with the reduction in the price of calves and live beef cattle, producers continued to replace the breeding cows by F calves.

Our study showed that the higher prices of M calves compared with F were also in agreement with Koetz Junior et al. (2014), who demonstrated that M are on average 11.5% more valuable than F calves marketed in the state of Paraná. Similar results were found in auctions studied by Crespo et al. (2006) in Uruguay and by Troxel and Barham (2007) in the state of Arkansas, USA, in livestock auctions where most animals were finished in confinement at the



Different lowercase letters differ statistically for sex in each year ($P < 0.05$). Different uppercase letters differ statistically for each sex along the years ($P < 0.05$).
BW - body weight.

Figure 2 - Average selling price (R\$ kg⁻¹ as BW) and the percentage prices of male and female calves in auctions in the Serrana Region of Santa Catarina from 2009 to 2014.

end of the analysis period. These results demonstrated that M calves are always more valued than F, regardless of the production system.

The highest price recorded for M may be related to their potential for live weight body gain, less length during rearing and fattening, and their final value for slaughter. On the other hand, the acquisition of F by producers is generally used for replacement, which, at the end of reproductive life, are sold with a lower price than live beef cattle (Barcellos et al., 2011). For this reason, one of the F price indicators in auctions, either used for breeding or destined for finishing, may be the lowest price paid to this category at the end of the production cycle, which is lower than live beef cattle prices.

The genetic group of calves from the evaluated auctions held in SC influences the marketed price. In agreement, studies reported that higher valuations are reached using particular genetic groups (Halfman et al., 2009; McHugh et al., 2010; Koetz Junior et al., 2014). However, Barham and Troxel (2007) reported that no specific breed or breed type was marketed for higher prices and the superiority of a given group is dependent on the region where the sale occurred and the future prices for the coming years. We also observed an interaction ($P < 0.05$) in the market price change between genetic groups and years of commercialization. The changes occurred in price of both M or F in the different racial groups were dependent on the analyzed year (Table 3).

Genetic groups were more valued compared with each year evaluated for both M and F calves. Males from the BX, CX, and BC lots showed higher values compared with other groups; however, only in 2013 did the BX have the highest price compared with the CX and BC groups (3.9 and 5.7%, respectively). We observed that ZC had the lowest market prices during the evaluated period. Interestingly, the year

2013 was marked by a fall in the price of the M that may have influenced producers to choose for certain different groups of animals to be commercialized. For F animals, except for 2009 and 2010, the BX group presented higher average prices of 8.1, 8.5, 14.7, and 16.5% compared with the CX, BC, TI, and ZX groups, respectively (Table 3).

The highest price paid for F from the BX genetic group is related to its final destination for this category, since they are mainly acquired for replacement of cows, as the British breeds and their crosses with zebu breeds are considered to have fertility precocity and maternal ability compared with continental races (Pelicioni et al., 1999). In addition, the study area has a transition tendency to commercialized British breeds as breeding cows; this may be the reason that producers pay more for F compared with M calves.

The increased demand in the BX group is related to the emergence of incentive programs by the associations of British breeders in Brazil. These associations aim to strengthen and integrate the beef production chain, taking into account the consumer market criteria based on different payment for loyalty programs and certification, especially for Angus and Hereford breeders (ABHB, 2015; Silva, 2015). These programs started in Rio Grande do Sul and were only inserted into Santa Catarina in 2014; however, dissemination of the British breeds demonstrates the advantages of each breed in the production system used in the region for market animals. In addition, there was a livestock modernization efficiency in recent years, observed by the reduction of the production cycle with the decrease in the age at slaughter and precocity of females. Thus, consumers began to demand quality meat and finishing producers are willing to pay more for quality animals (Barcellos, 2011).

Table 3 - Average selling price (R\$ kg⁻¹ BW) and standard deviation of male and female calves in auctions in the Serrana Region of Santa Catarina from 2009 to 2014

Genetic group	2009	2010	2011	2012	2013	2014
Male						
BX	4.46±0.58Ca	4.41±0.34Ca	5.49±0.50Aa	5.13±0.37Ba	4.93±0.42Ba	5.79±0.65Aa
CX	4.30±0.26Dab	4.39±0.30Da	5.39±0.57ABa	5.05±0.33Ba	4.70±0.40Cb	5.58±0.42Aa
ZX	4.02±0.38Ec	4.08±0.26Ec	4.84±0.35Bc	4.70±0.34Cb	4.29±0.30Dd	5.00±0.37Ab
BC	4.35±0.22Cab	4.39±0.32Ca	5.27±0.53ABab	4.99±0.34Ba	4.62±0.33Cbc	5.57±0.42Aa
TI	4.16±0.32Cbc	4.25±0.25Cb	4.98±0.38Abc	4.67±0.31Bb	4.52±0.41Bcd	5.28±0.44Ab
Female						
BX	3.90±0.54Ca	4.28±0.67Ca	5.03±0.61ABa	5.07±0.84Ba	5.20±1.07Ba	5.79±1.24Aa
CX	3.83±0.33Da	3.90±0.32Dab	4.82±0.59ABa	4.56±0.41BCb	4.41±0.44Cbc	4.96±0.62Ab
ZX	3.73±0.27Ca	3.73±0.28Cb	4.22±0.39ABc	4.33±0.52ABc	4.04±0.38BCd	4.42±0.31Ac
BC	3.84±0.29Ca	3.90±0.37Cab	4.65±0.46ABb	4.53±0.45Bbc	4.51±0.47Bb	4.98±0.64Ab
TI	3.89±0.48BCa	3.80±0.49Cb	4.34±0.43Bc	4.38±0.63Bc	4.21±0.50Bcd	4.78±0.64Abc

BX - British breed or crossbreed; CX - Continental breed or crossbreed; ZX - Zebu breed or crossbreed; BC - British and Continental crossbreed; TI - *Bos taurus* and *Bos indicus* crossbreed.

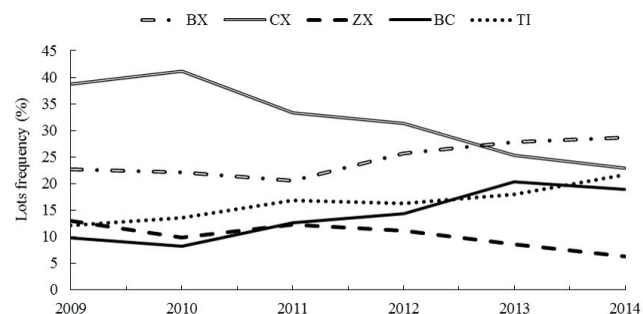
Different uppercase letters within rows differ statistically ($P < 0.05$); different lowercase letters within columns differ statistically ($P < 0.05$).

In the state of Rio Grande do Sul, Christofari et al. (2008) observed that there is a preference for synthetic and European breeds, demonstrated by increased liquidity of selling these groups when compared with zebu crosses and mixed breeds; this was similarly observed in our study in SC. In the state of Paraná, zebu calves were sold at a price 5.5% lower compared with taurine calves (Koetz Junior et al., 2014). Reports performed in Arkansas (USA) compared two years of commercialization of M and F calves confined in the region (2000 and 2005) and showed that Angus × Hereford and Angus × Charolais crosses had an increase in the price in 2005 compared with 2000, while lots of Brahman, Charolais, Limousin, and Charolais × Limousin decreased the market selling prices (Troxel and Barham, 2007).

The crosses between *Bos indicus* × *Bos taurus* result in higher heterosis compared with *Bos taurus* × *Bos taurus*. Thus, it is possible to increase the productivity of commercial herds in environments with higher nutritional deficiency and high levels of stress (Roso and Fries, 2000). However, in SC, this feature was not able to increase the price of calves, since the TI lots show lower valuation of crossbred animals from 2009 to 2013.

Additionally, it was observed that CX lots showed the highest offers in the first two years of specialized auctions in SC (2009 and 2010). Furthermore, they were gradually replaced by lots of BC and TI calves, showing the beginning of changes in the auctions of breeds and possibly reflecting a new racial group profile in the region. There was an increase in the offering of calves for the BX group from 2011 that increased until 2014. In addition, the offer of the ZX group remained lower when compared with the others (Figure 3).

Christofari et al. (2008) found a predominant supply of lots constituted by calves crossed with British and Zebu breeds, which exceeded 60.0% of lots offered and may be



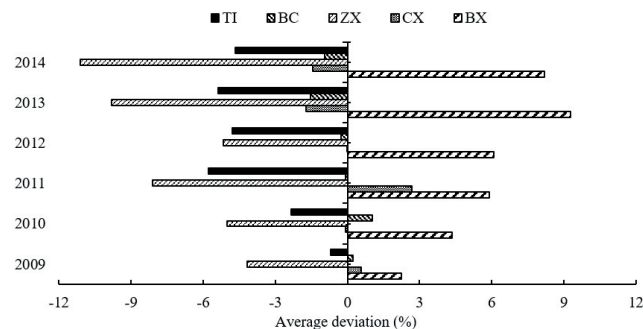
BX - British breed or crossbred; CX - Continental breed or crossbred; ZX - Zebu breed or crossbred; BC - British and Continental crossbred; TI - *Bos taurus* and *Bos indicus* crossbred.

Figure 3 - Lot frequency for different genetic groups in auctions in the Serrana Region of Santa Catarina from 2009 to 2014.

associated with the growth of synthetic breeds in Rio Grande do Sul. In Paraná, auctions from 2012 to 2013 showed that the supply of Nelore calves was similar to calves crossed with taurine breeds (48.2 and 51.8%, respectively) (Koetz Junior et al., 2014). This study shows that in SC, the largest supply of animals belongs to the BX and CX groups, which is in agreement with studies performed in Rio Grande do Sul and Paraná, where there is a large number of *Bos taurus* calves offered in the southern regions compared with other regions of Brazil. Thus, this increase in BX and CX calves in SC is explained by the fact that *Bos indicus* adaptation to tropical environments is predominant in other states in Brazil.

Variations in calf sellers can be explained by the price that each genetic group received during the analyzed years. In our study, there was a migration of breeds offered in auctions observed by the BX-valued group as a result of the direct production of calves to meet production demand and to replace the zebu cows, thus making the activity more profitable.

The increase in beef market price made the BX group a differentiated product in beef cattle in the studied region. Moreover, the increase in the supply of the BX group was not enough for the increase in animal demand in SC, which could be seen by the higher market prices compared with the average prices of each year of 2.2%, 9.3%, and 8.2% for 2009, 2013, and 2014, respectively (Figure 4). The average CX group prices suffered variation over the years with a reduction of 18.0% in supply for 2010 and 2014; furthermore, the prices were higher (2009 and 2011) and became lower (2013 and 2014) compared with the overall average price of auctions held each year. In contrast, the ZX group showed negative and decreased prices until 2014, except 2012, according to the slight reduced demand for supply (Figure 4).



BX - British breed or crossbred; CX - Continental breed or crossbred; ZX - Zebu breed or crossbred; BC - British and Continental crossbred; TI - *Bos taurus* and *Bos indicus* crossbred.

Figure 4 - Deviation from overall average price in relation to the annual average price of calves in auctions in the Serrana Region of Santa Catarina from 2009 to 2014.

Generally, the liquidity of all lots exceeded 99.0%, demonstrating that there is a preference for the majority of calf lots in SC. In fact, buyers of SC acquired virtually all offered animals and were willing to pay more for certain genetic groups and sexes of calves. However, the values of these characteristics can increase or decrease depending on the market situation during the year. Decisions concerning animal management and genetic group used in livestock production can determine optimal performance levels for these factors to improve feeder calf value and total returns.

Conclusions

Our results suggest that the factors affecting the selling price of calves can be addressed through genetic selection and the market selling price of calves follows the general behavior of the live beef cattle prices in Santa Catarina. In addition, the selling prices of male calves are higher than female with greater price variation over time (years) and zebu males have been commercialized at lower prices than the other groups since the British females in recent years have had a greater appreciation in auctions held in the state.

Acknowledgments

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