**A Case Study of Livestock Prices in Nicaragua**

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***Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2021 Virtual Annual Meeting, February 6-9, 2021***

**Abstract**

Growing at an annual rate of 3.7%, the Latin American[1] livestock sector surpasses the average global livestock growth rate of 2.1% (FAO, 2020a) and has become the leading region for beef and poultry exports worldwide (FAO, 2020a). We conduct a case study of livestock prices in Nicaragua, the leading meat producing country in Central America. Nicaragua's livestock production is non-intensive and is expected to exhibit a growth rate of 24% between 2017 and 2018 (NCB, 2017). Using data on futures on feeder cattle prices from the Chicago Mercantile Exchange Group (CME) supplemented with data on 2,520 sales transactions from 99 auctions from 2017 to 2018 from the Nicaraguan Cattle Auction (NCA), this study conducts a hedonic price analysis for cattle auctioned in Nicaragua. In particular, the study empirically identifies factors affecting price differentials for cattle and examines its correlation with the futures market. Our results showed that weight, lot size (head), and class are all statistically significant factors impacting livestock auction prices while their correlation with the futures market is significant for six out of the eight futures variables corresponding to the contract months at the CME. The results of the study are of importance to buyers and sellers of cattle in their decision-making process and help them understand information from the futures market to predict price differences and reduce price risk and uncertainty.

Key words: hedonic analysis, feeder cattle, futures market, livestock auction data, Nicaragua

JLE codes: Q110, Q210

[1] Honduras, Nicaragua, El Salvador, Guatemala, Costa Rica and Panama.

## Introduction

The cattle industry is vital to the economy of Latin America in terms of food security and cultural traditions. According to the Food and Agricultural Organization (FAO, 2020a), 46% of the Gross Domestic Product (GDP) of the region comes from the livestock sector and 20% of families' food budget is spent on meat and dairy products. Moreover, the cattle industry is tied to cultural values as cattle are passed on through generations. As such, owning cattle provides a feeling of pride to families because it reflects the hard work of their ancestors (Raish and McSweeney, 2003).

Latin America is the leading region in the world in terms of beef and poultry exports, and livestock in general has been growing at an annual rate of 3.7% (FAO, 2020a). Nevertheless, such growth has been impeded with several challenges. High costs of animal feed are one of the barriers to the intensification of the livestock industry because they represent between 60-70% of total production costs under an intensive production model (TechnoServe-USDA, 2016). Among other issues are the lack of good quality of forage and the inefficient use of natural resources such as land, mainly resulting from the inability to adopt an intensive model. Nicaragua, for instance, has the lowest cattle production density in the region (2.82 cows per acre), despite being the leading country in beef exports in Central America (TechnoServe-USDA, 2020).

According to the United States Department of Agriculture (USDA, 2020), from 2014 to 2019, El Salvador witnessed an increase of 5.3% in beef production (from 19 to 20 thousands metric tons carcass weight equivalent[2] (MT CWE), followed by Honduras (from 63 to 65 thousands of MT CWE or 3.2%), Nicaragua (from 161 to 165 thousands of MT CWE or 2.5%) and Guatemala (from 72 to 73 thousands of MT CWE or 1.4%). The only Central American countries for which beef

[2] Carcass Weight Equivalent, i.e., the animal weight after slaughtering and processing.

production decreased during the same period were Panama (from 83 to 72 thousands of MT CWE or 13%) and Costa Rica (from 88 to 87 thousands of MT CWE or 1.1%) (USDA, 2020).

For the period 2014-2019, beef consumption in Central America rose by 4% (from 335 to 347 thousands of MT CWE) mainly due to a steep increase in consumption from Honduras and El Salvador (Central America Data, 2020). Nevertheless, beef consumption plunged by 50% (from 34 to 17 thousands of MT CWE) in Nicaragua for the same period as reported by the Nicaraguan Central Bank (NCB, 2017). This is a result of the sharp increase in beef price in Nicaragua. According to the Nicaraguan Central Bank (NCB, 2017), beef price per pound jumped from $2.46 to $2.68[3] over the period of 2014-2019. One of the reasons why demand for meat is so elastic in Nicaragua is because most of the population lives with less than one dollar per day in income. As a matter of fact, in 2017, meat consumption shifted from beef to chicken which can be seen by a 15% increase in the latter (from 126.2 to 145.15 thousands of MT CWE) (NCB, 2017).

According to USDA (2020), Guatemala is the country in Central America where beef is consumed the most (93 thousands of MT CWE), as of 2019 Followed by Panama and Costa Rica (both with 71 thousands of MT CWE for the same year) (USDA, 2020). According to USDA (2020),from 2014 to 2019, beef consumption in El Salvador stunningly grew by 65% (from 40 to 66 thousands of MT CWE) followed by Guatemala (from 76 to 93 thousands of MT CWE or 22.4%), and Honduras (from 60 to 63 thousands of MT CWE or 5%). For the same period, beef consumption in Panama and Costa Rica decreased by 14% (from 82.2 to 71 thousands of MT CWE) and 4.1% (from 74 to 71 thousands of MT CWE), respectively (USDA, 2020; Economic Commission for Latin America and the Caribbean (ECLAC), 2020a).

[3] This is before the inflation which was 27.59% over the same period. The numbers have been deflated using the CPI provided by the Nicaraguan Central Bank.

According to USDA (2020), as a result of an increasingly growing demand for beef not completely satisfied by the domestic production over the period of 2014-2019, beef imports in Guatemala grew by a notable rate of 177.8% (from 9 to 25 thousands of MT CWE) followed by El Salvador (from 21 to 46 thousands of MT CWE or 119%), Costa Rica (from 8 to 15 thousands of MT CWE or 87.5%) and Honduras (from 2 to 3 thousands of MT CWE or 50%). Nicaragua's beef imports remained low (at 1 thousand of MT CWE) whereas Panama's beef exports plummeted by 73% (from 1.5 to 0.4 thousands of MT CWE) (USDA, 2020; ECLAC, 2020a). On the other hand, according to USDA (2020), in terms of beef exports, Costa Rica and Nicaragua led the way with respective growth rates of 40.9% (from 22 to 31 thousands of MT CWE) and 16.4% (from 128 to 149 thousands of MT CWE), respectively, for the period of 2014-2019. In the case of Guatemala and Honduras, beef exports remained low and steady (at 5 thousands of MT CWE each) (USDA, 2020). Finally, El Salvador and Panama are primarily importers in the beef industry as they both exported less than one tenth of a metric ton (ECLAC, 2020a). Beef and veal production, consumption, exports and imports by country in Central America in 2019 are reported in Figure 1.

As of 2016, there was a total of 135,000 cattle ranchers in Nicaragua divided into 90% of small-sized producers and 10% of large and medium-sized producers (TechnoServe-USDA, 2016). The vast majority of them operate a dual-purpose cattle production system meaning that milk is produced on a daily basis and meat is sold intermittently, mainly calves after they are weaned. The beef industry is the main meat industry in Nicaragua. Between 2016 and 2017, beef production increased by 24% (from 118.89 to 147.42 thousands of MT CWE), followed by swine (from 11.43 to 12.56 thousands of MT CWE or 9.9%) and poultry (from 138.94 to 140.75 thousands of MT CWE or 1.3%) (NCB, 2017). As of 2017, Nicaragua consumed only 10.7% of the total beef produced domestically while the remaining production consisting of 129.55 thousands of MT CWE of beef and offal was exported (NCB, 2017). This contributed to a total of $500 million to the Nicaraguan

economy. As a matter of fact, Nicaragua ranks thirteenth worldwide in terms of beef exports and also is the leader for Central America as it exports 3.6 times more beef than all of the remaining Central American countries combined (USDA, 2020).

Although relatively small, swine consumption in Nicaragua slightly grew by 3% (from 18.19 to 18.73 thousands of MT CWE) in 2017 (NCB, 2017). Because the swine industry in Nicaragua is weak, swine imports amounted to 6.58 thousands of MT CWE which surpassed domestic production by more than 50% (NCB, 2017). Regarding poultry consumption, the country is yet to be self-sufficient but is expected to be over time based on the production trends. In 2017, Nicaragua only imported 4.4 thousands of MT CWE, which represents 3% surplus in poultry consumption (NCB, 2017).

Figure 2 illustrates the importance of the cattle industry to the Nicaraguan economy, as production is almost ten times more than domestic consumption. According to the United Nations COMTRADE database (UN-COMTRADE, 2020), the top three markets for Nicaraguan beef exports are the United States, followed by Costa Rica and Venezuela. According to ECLAC (2020b), the cattle industry in Nicaragua represents 10.4% of domestic total exports in 2018 and occupies the third place among all products exported. Agriculture and its related activities in general are also the third major contributor to the GDP of Nicaragua and are the employment source of more than one third of the workforce (FAOSTAT, 2020b).

However, the cattle industry in Nicaragua faces many challenges. One of these challenges is the non-efficient use of natural resources manifested through the low production density. These challenges alongside with others jeopardize the profitability of this sector. This study examines cattle prices in Nicaragua and their relationship with the futures market as a price risk management tool for cattle sellers and bidders. Apart from market characteristics, lot and animal characteristics are all

factors found to impact cattle prices. While there are many studies on feeder cattle prices based on quality attributes in the U.S., this study is unique in that there have not been similar studies for Nicaragua nor any country in Central America. The general objective of this study is to empirically quantify both intrinsic and extrinsic factors that affect cattle prices in auction sales in Nicaragua.

## Literature Review

Hedonic pricing models have been widely used in literature since the twentieth century as a method to estimate commodities' prices based on physical characteristics. As the first of its kind in Central America, this study examines the extent to which physical, lot and market characteristics impact cattle cash prices given the livestock auction sales in Nicaragua. Premiums and discounts received will provide insight about particular characteristics or attributes buyers value most. As such, the hedonic analysis will provide both buyers and sellers with a better understanding of the cattle cash market and the value of cattle quality attributes.

The cattle industry is divided into four different subsectors because of the challenges it presents for a single firm to be vertically integrated and also the risks associated with vertical integration. These four subsectors are cow-calf operations, stocker operations, feedlot operations and processing operations. Cow-calf operations refer to the production of calves for later sale. These calves are sold to stocker operators after weaning mainly because it takes high quality pasture and requires specific management facilities which many cow-calf firms lack as noted by Eldridge (2005). Stocker operators put weight on the cattle before selling them to feedlot operators that further add weight on feedlot cattle and market cattle ready for slaughter to beef packers. Finally, these, in turn, process the meat and deliver beef ready for consumption to supermarkets and wholesalers. Failure in the former stages will eventually impact in a negative manner the later stages as their input represent the output of former production stages. As such, demand for calves is a derived demand from stoker

operations demand up to demand for beef. Thus, it is extremely important for all of these subsectors to work in coordination to ensure the flow of quality beef production.

Cattle auction markets are usually the primary markets where cattle are sold and prices depend upon genetic, management, market and marketing factors. Hedonic pricing models show their usefulness by providing a strong correlation between price determination and the futures market. Feeder cattle auction prices has been analyzed under two different approaches: the basis approach and the bid price approach (Burdine, 2011). Basis refers to the difference between cash prices and futures prices. A negative basis implies that futures prices are higher than local prices and vice versa (Minter et al., 2002). Basis has been found to be a more robust indicator due to its less variation compared to bid prices (Bailey, Gray and Rawls, 2002; Trapp and Eilrich, 1991). However, Dhuyvetter et al. (2008) noted that basis predictability decreases as we move further away from contract specifications.

Based on literature (Mathews, 2007; Zimmerman, 2010; Burdine, 2011), factors affecting cattle cash prices can be classified into two categories which are intrinsic and extrinsic (also referred to as endogenous and exogenous factors). Factors that ranchers can control to some extent are known as intrinsic factors whereas those that go beyond their control are extrinsic factors. Extrinsic factors consist of market variables (fed cattle price, diesel price, corn futures price, etc.), seasonality and environment (rain, snow, mud, relative humidity, temperature, etc.). On the other hand, intrinsic factors include lot (uniformity, size, commingling state,[4] etc.), management (implant status,[5] horn status, parasite management practices, health, vaccination program, nutrition program, condition score, etc.), genetics (breed influence, sex, muscling, horn presence, frame size, color, frame score,[6]

[4] Practice that consists of mixing cattle from different operations.
[5] Pellet placed under the animal skin to stimulate growth.
[6] A numeric description of cattle skeletal size.

etc.) and marketing (age-verification status, weight uniformity, fill,[7] sale date, delivery date, source verification,[8] market location, etc.) variables.

Williamson et al. (1961) quantified the effect of sale, size, lot size, average weight and breed on the price of steers and heifers using sales data from 9,481 lots of cattle sold at the Virginia auction market. The five-year sales data showed that the optimal lot size for steers is between 21 and 30 head and the optimal weight range of feeder cattle is between 400 and 500 pounds. Lopez, Bankole and Wahrmund (2017) analyzed sales of pre-conditioned calves from 22 North East Texas auctions to determine price differentials in feeder cattle based on physical attributes. Variables such as lot size, sex, weight, breed and feeder cattle futures prices were all found to be statistically significant.

In 1986, Faminow and Gum used sales data for 368 lots of feeder cattle in Arizona auction markets to analyze the influence of weight and lot size on feeder cattle prices. Results showed that heifers weighing more than 615 pounds received notable discounts and the lot weight that maximized profit was 32,000 pounds which is close to truck capacity for transportation. The authors also acknowledged that factors such as region and season of the year cause optimal lot size to vary. Regarding feeder cattle weight, lighter animals received premiums compared to heavier animals. Schulz, Boetel and Dhuyvetter (2018) studied the relationship between price and weight for feeder cattle sold at Wisconsin auction markets analyzing a total of 125,645 lots of cattle. The empirical results suggested greater premiums for lightweight cattle compared to heavyweight cattle. Similarly, Burdine (2011) found an inverse relationship between cattle weight and prices.

[7] Injection of liquid into the animal cavities to correct defects.
[8] Ability to trace cattle back to the farm where they were born.

The results from a study by Dunkel (2000) showed that commingling reduced sale time by 30%, benefiting all the parties involved. Moreover, commingled lots garnered a premium between $7/cwt and $8/cwt compared to non-commingled lots. Contrarily, Mathews (2007) in his study found that non-commingled feeder cattle lots received a premium for lot size below 17 head compared to commingled lots which had a discount of $4.94/cwt.

Mathews (2007) used a six-year sales data to measure the impact of value-added characteristics such as source verification on feeder cattle prices sold through value-added programs at Joplin Regional Stockyard (JRS). Data were gathered from one regular feeder cattle auction and two value-added programs. The results showed that cattle sold through value-added programs received premiums of $4.53/cwt and $5.71/cwt compared to cattle sold through regular cattle auctions. She also found that commingled lots were discounted compared to non-commingled lots up to 17 head where the negative effect is offset.

With the objective to understand how management at the cow-calf level impact value-added calves' prices sold through video markets, Zimmerman (2010) used a multiple regression analysis with sales data from the Superior Livestock Auction (SLA) for the period 1995-2009. The estimation results found premiums for value-added cattle when health and genetic claims can be verified. Additionally, heifers received a $15 per hundredweight (cwt) discount compared to steers, uniform lots received a premium and horn presence was discounted for an amount of $0.80/cwt. The findings also showed that vertical coordination is transcendental to capture better premiums because it allows all actors to focus their interest on the need of the final consumers and be more efficient.

Burdine (2011) examined factors that influence feeder cattle basis using Kentucky internet auctions and Certified Preconditioned for Health (CPH) sales. A total of 1,600 observations from 2008 to 2011 was used to design a hedonic model. According to the results, premiums of $1.35/cwt

were garnered for age and source verification alone and $2.18/cwt for natural designation alone. Moreover, cattle certified as natural were 57% more likely to be age and source-verified. However, producing natural cattle implies a low gain in weight compared to other types of cattle where growth hormones are used. As a result, he recommended natural cattle producers to analyze production costs because of the tradeoff associated with weight gain. Regarding lot size, an increase in one head per lot led to a premium of $0.02/cwt. However, this relationship was found to be non-linear due to the negative coefficient of the lot size squared variable. Consistent with Zimmerman (2010), heifers were discounted by $6.99/cwt compared to steers.

## Model

Ladd and Martin's analysis in 1976 provides the basis for the hedonic model used in our study. Their theory states that a good's worth depends on its individual physical characteristics. Put differently, hedonic prices reflect the total monetary value of a commodity's individual attributes as opposed to the commodity's price itself (Rosen, 1974). As such, the absence or the inadequacy of any single attributed will negatively affect the price of the commodity. Rosen (1974) added that market forces and market characteristics impact the value of single attributes. Our basic hedonic model, put together, is then a function of cattle physical characteristics (C) and the market forces (M) at the time of the sale (Buccola, 1980). Schroeder et al. (1988) formulated the hedonic model in the following way:

$$Price_{it} = \Sigma\, V_{ikt} C_{ikt} + \Sigma\, R_{ht} M_{ht} \qquad (1)$$

with $i$ representing the specific lot, $k$ representing the animal trait, $h$ representing the market influence (market forces) and $t$ representing the auction date. In addition, $V$ is the value of a specific attribute and $R$ is the effect of market forces on cash price at the auction time. The fundamental assumption of

this model is that demand for feeder cattle relies on physical traits when supply is given (Faminow and Gum, 1986).

An ordinary least squares (OLS) method was used to estimate the regression model given in (1) based on selected variables reported in the data. The purpose of the multiple regression used is to estimate the relationships, if any, between the response variable and the predictor variables. Statistical Analysis Software (SAS) 9.4 was used to run the model. The expanded hedonic cash price model is:

$$\begin{aligned} P_{cashit} = {} & \beta_0 + \beta_1 Lot_{it} + \beta_2 Lot_{it}^2 + \beta_3 Weight_{it} + \beta_4 Weight_{it}^2 + \beta_5 Heifer_{it} + \beta_6 Bull_{it} + \beta_7 February + \\ & \beta_8 March + \beta_9 April + \beta_{10} May + \beta_{11} June + \beta_{12} July + \beta_{13} August + \beta_{14} September + \beta_{15} October \\ & + \beta_{16} November + \beta_{17} December + \beta_{18} JanuaryFutures + \beta_{19} MarchFutures + \beta_{20} AprilFutures \\ & + \beta_{21} MayFutures + \beta_{22} AugustFutures + \beta_{23} SeptemberFutures + \beta_{24} OctoberFutures + \\ & \beta_{25} NovemberFutures + \varepsilon_t \end{aligned} \quad (2)$$

where $P_{cashit}$ is the cattle cash price ($/cwt) given for a specific lot *i* at a particular sale date *t*, $Lot_{it}$ is the number of head in the lot, $Lot_{it}^2$ is lot size squared, $Weight_{it}$ is the mean weight of feeder cattle lot in pounds, $Weight_{it}^2$ is mean weight squared, *Heifer* is a dummy variable for heifer (1 if heifer and 0 otherwise), *Bull* is a dummy variable for bull (1 if bull and 0 otherwise), *February* through *December* are dummy variables for the sales months, the *JanuaryFutures*, *MarchFutures*, *AprilFutures*, *MayFutures*, *AugustFutures*, *SeptemberFutures*, *OctoberFutures*, and *NovemberFutures* are futures contract variables for the feeder cattle closing price closest to the sale date, the betas are the parameters to be estimated, and $\varepsilon_t$ is an error term.

*Lotsize*, as shown in table 1, is expected to have a positive impact on cash prices. This means an increase in lot size will lead to an increase in cash prices. However, this relationship is not linear. $Lotsize^2$ accounts for the non-linearity of the variable. *Weight* is expected to be inversely

related to cash prices as concluded by Schulz et al. (2018) and other researchers. Similarly, the squared version of *Weight* was used because after a certain weight the negative effect is offset. *Heifer* and *Bull* are both dummy variables having steer as base. Both are expected to be negative because heifers as well as bulls have been found to be discounted compared to steers. The monthly dummy variables are expected to capture the seasonality (the month of January is left out and is used a reference group). The months of the rainy season are expected to have a negative sign whereas the coefficients associated with the months of the dry season are expected to be positive. Finally, the eight future month variables correspond to the CME futures contract along the year and their signs vary across literature.

## Data

Cattle auction data were obtained from Comergasa, the second largest livestock auction house in Nicaragua, located in Managua. In terms of sales volume, Comergasa follows Suganar and precedes La Chontaleña, the remaining two livestock auction houses in the country. Auction sales are held on Wednesdays and Fridays, every week. During the winter months, an average of 5,000 cattle head is generally sold at the Comergasa auction. All the three livestock auction houses charge a 3% commission per animal sold.

Compared to the United States, the requirements for sellers to auction their animals are simpler. According to Comergasa's manager, sellers have to show proof of ownership by presenting legal documents and their animals must be equipped with traceability earrings. Data such as auction dates, weight, lot size, sex and cash prices were provided for the period of 2015-2019.

One of the constraints of the data is that color and breed were not reported. Moreover, data were reported for all the months only for 2017 and 2018. For 2015, 2016 and 2019, data were obtained for only a few months. The data exhibited seasonal patterns for the years 2017 and 2018.

The remaining years were discarded because they were incomplete; and therefore, did not allow to account for seasonality. Thus, the final model was estimated with 2,520 out of the initial 3,214 transactions for the period of 2017-2018.

Check payments are collected from buyers prior to the auction date and cattle sold through the auction are delivered the same day. Depending on whether the actual transaction monetary value was above or below the initial check amount issued, refunds are made, or additional check payments are requested. Representatives of slaughterhouses, municipal butchers, intermediaries and individual producers are the main bidders at Comergasa.

For the period 2017-2018, the 2,520 sale transactions from 99 auctions comprised 2,520 separate lots covering a total of 34,408 cattle head. Steers and heifers were represented with the highest frequencies, 57.38% and 33.22%, respectively (Figure 3). Bulls, in turn, accounted for 6.86%, oxen accounted for 2.11%, and, finally, calved cows[9] accounted for 0.43%. Given that calved cows were not representative, they were not taken into account in the analysis. Bulls and oxen were combined into one category, similar to Schulz et al. (2010) as they accounted for almost 10% of the data.

Overall, the summary statistics in Table 2 show an average of 16.02 animals per lot, varying widely from 1 to 179 cattle head. Across all lots, the average weight per animal was 849.61 pounds and ranged from 55.13 to 2,039.27 pounds. Lot prices averaged $70.79/cwt[10] and ranged from $13.07 to $153.03 per hundredweight with a standard deviation of $11.72/cwt. For the 2017-2018 period, Figure 4 displays the average price ($/cwt) per cattle type per month. On the other hand,

[9] By calved cows, we refer to cows exhibited with their recently borne calves.
[10] Prices were converted from Córdobas (national currency) to US dollars, then from nominal prices to real prices using the consumer price index (CPI) provided by the Nicaraguan Central Bank and finally from per kilogram to per hundredweight.

the descriptive statistics of select variables by sex are shown in Table 3. The mean difference in price between both sex is $14.22/cwt, and the average weight difference is 205.95 pounds with heifers getting the lowest averages in both cases.

Daily feeder cattle futures prices were obtained from the Chicago Mercantile Exchange (CME) for the period 2017-2018. The CME provides futures contract prices for eight months of the year. These months are January, March, April, May, August, September, October and November. For the period 2017-2018, the average price ($/cwt) for each futures month, together with other descriptive statistics, are depicted in Table 2 and Figure 5. The closing price of the feeder cattle futures contract on the auction date or nearest to it was used for each of the futures month variables, similar to Feuz et al. (2008), Zimmerman (2010) and Burdine (2011).

## Results

A total of 2,520 observations were used to estimate the parameters of the hedonic regression model in equation (2). The dependent variable, cash price, was estimated as a function of intrinsic and extrinsic variables. The PROC REG procedure in SAS 9.4 was used to estimate the model. Additionally, the keyword WEIGHT was included in the PROC REG to account for lot size. Table 4 reports the values of the Ordinary Least Square (OLS) parameter estimates, standard errors, t values, and p-values alongside with the measures of goodness of fit. The values of the coefficients corresponding to each of the dummy variables indicate the premium or discount associated with that variable and can be interpreted as an increase or decrease in cash price ($/cwt) when there is an increase of 1 unit in the explanatory variables. In terms of goodness of fit, 58.82% of the variation in the dependent variable (i.e., cash price) is explained by the regression model. Moreover, the F value 129.11 supports the claim that at least one of the independent variables is statistically significant at all the conventional significance levels.

The value of the intercept indicated that the base price per cattle head is $55.46/cwt when all the coefficients of the explanatory variables equal zero, ceteris paribus. The parameter estimates associated with the lot variables (i.e., *Lotsize*, $Lotsize^2$) and the variables for physical characteristics (i.e., *Weight*, $Weight^2$, *Heifer*, and *Bull*) had the expected signs, except for the bull parameter estimate. However, all of the lot and physical characteristic variables, including *Bull*, were found to be statistically significant at the 0.05 significance level. The seasonal dummy variables (i.e., the included dummy variables for the months of February to December) were all statistically significant., except for the month of August, September, October and December. Regarding the variables corresponding to futures contract months, six out of eight, excluding the April and September future variables, were statistically significant at the 5 percent significance level.

As expected, the lot size coefficient was positive and statistically significant (p-value= 0.0124) while the lot size squared coefficient was negative and statistically significant (p-value = 0.0001). This suggests the cash price initially increases at a decreasing rate as lot size increases but eventually decreases (Figure 6). In fact, increasing *Lotsize* by 1 head increases *Price_cwt* by $0.0379/cwt. That is, an additional head in the lot increases cash price by $0.0379/cwt. These results are consistent with the one by Mathews (2007) and Burdine (2011). Following Mathews (2007) and Burdine (2011), the optimal lot size is 47 cattle head after which cash price starts decreasing (Figure 6). Mathews (2007) and Burdine (2011) calculated the optimal lot sizes in Missouri and Kentucky to be 133 and 328 animals per lot, respectively.

The coefficient corresponding to the variable *Weight* was negative and statistically significant , while the coefficient corresponding to the variable $Weight^2$ was positive and statistically significant but practically insignificant. In other words, the heavier the animal, the higher discount the animal tends to receive. In this case, an increase of one pound leads to a decrease of $0.016/cwt in cash price. Burdine (2011) found a very similar discount of $0.025/cwt for an increase of one pound in the

feeder cattle weight at internet auctions in Kentucky for the period 2008-2011. Bidders prefer smaller animals as they are more likely to make a profit after putting weight on the animal. Stated differently, heavier animals are less prone to gain weight which hinders the effort of buyers to fatten them and sell them for a better price at the next production stage. Additionally, because of the lack of animal records in Nicaragua, bidders experience uncertainty regarding the acquisition of heavy cattle as their nutrition and health records are unavailable most of the times. Similar to the lot size variable, the non-linear relationship between weight and cash price is captured by the negative coefficient of the variable $Weight^2$. Although significant, the value of the $Weight^2$ coefficient is very small. According to the parameter estimates of *Weight* and $Weight^2$, the highest discount for weight is given at 635 pounds after which the monetary penalty for weight starts being smaller and smaller (Figure 7).

As anticipated, the coefficient for the variable *Heifer* was negative and statistically significant . According to this parameter estimate, heifers received a discount of $14.38/cwt compared to steers, holding everything else constant. That is because steers are more likely to grow faster as they have a better feed-conversion rate compared to heifers (Eldridge, 2005). Another reason for heifers being discounted is the risk associated with heifers in terms of potential difficulties when giving birth. As a result, buying a steer instead of a heifer means having the animal ready for sale in a less period of time and maybe at a lower cost. Williams et al. (2012) found a similar discount of $11.78/cwt at the Oklahoma Quality Beef Network (OQBN) program based on data recorded in 2010. Likewise, Lopez spell out the last names, there is only 3 people in this. (2017) found a lower discount of $8.37/cwt ( for heifers compared to steers in auctioned pre-conditioned feeder cattle in Northeast Texas for the period 2010-2013.

Surprisingly, the variable *Bull* had a significant and a positive coefficient (. Generally, bulls are known to receive a discount compared to steers. Williams et al (2012) found a discount of $5.78/cwt for lots of bulls . However, there are butchers among the bidders at Comergasa, which

means they do not intend to put weight on the cattle but to slaughter them and sell the meat to supermarkets. This is a possible reason why bulls where favored with a slight premium of $1.755/cwt. Moreover, the average mean weight for bulls was 1,169.14 pounds whereas the average mean weight for steers was 582.78 pounds. Put differently, bulls were typically two times heavier than steers.

Dummy variables for each month of the year were included in the model to capture a possible seasonal pattern. Unlike the United States, where all four seasons of the year are observed, in Nicaragua, there are mainly two seasons throughout the year, the rainy season and the dry season. Descriptive statistics regarding weight (lbs.) and prices ($/cwt) for each month are reported in Table 5 together with the rainy and dry seasons. Because of higher grass quality and better grass availability during the rainy season, from June through November, cattle will be heavier during those months, which leads to a drop in cattle cash prices  at the auction houses. As it can be seen in Table 5, the mean weight in pounds for the rainy season is higher compared to the dry season (853.67 versus 846.12) while the average mean price  per animal was lower for the rainy season ($69.73/cwt versus $72.06/cwt).

This is also supported by the noticeable decrease in the coefficients corresponding to the dummy variables for the months of June through December (Table 4). The parameter estimates revealed that significant premiums (p were given for cattle sold at Comergasa starting February through July for the period 2017-2018. Such premiums ranged from $4.411/cwt to $13.182/cwt ( May). In short, the data for the period 2017-2018 suggested that, the best month to sell cattle at Comergasa was May. The remaining months of the year (from August to December) were all insignificant, the base of the dummy variables months, except for the month of November which is associated with a significant discount of $3.18/cwt (p-value < 0.001). Figure 8 exhibits the seasonal pattern of the premiums and discounts found in the data for the period 2017-2018 with the base

month being January.

Finally, all the futures month variables had a significant effect on the cash price , except for the April and September futures variables (p-value > 0.05). Feeder cattle prices in the United States have been found to have a positive correlation with cash prices from at cattle auctions in many national studies (Schroeder et al., 1988; Mathews 2007; Lopez et al. 2017). As such, an increase in any of the futures prices was expected to trigger an increase in the cash price of feeder cattle at auction sales and vice-versa. Based on the data for the period of 2017-2018, January futures, March futures, August futures and November futures were found to positively affect cash prices of cattle at Comergasa (p-value < 0.05). The highest premium was associated with January futures with a coefficient of 0.853 meaning that an increase of $1/cwt in feeder cattle futures price for January led to a $0.853/cwt increase in cattle cash prices at Comergasa, *ceteris paribus*. However, unexpectedly, the May futures and October futures variables had negative and statistically significant coefficients (p-value < 0.0001) of -1.265 and -1.202, respectively. In other words, an increase of $1/cwt in feeder cattle futures price for May led to a $1.26/cwt decrease in cattle cash prices at Comergasa for the period 2017-2018, everything else being held constant. This discount was approximately the same ($1.202/cwt) for the October feeder cattle futures price variable. In short, feeder cattle futures and cash prices were positively associated only for four out of the eight futures contract months reported by the CME.

## Conclusions and Recommendations for Future Research

Nicaragua is the leading country is Central America in terms of cattle production and beef exports (USDA, 2020). As of 2019, Nicaragua beef exports represented more than 3.5 times the total beef exports of the remaining Central American countries combined (USDA, 2020). Moreover, in 2019, 89.3% of the total beef produced in Nicaragua was exported (USDA, 2020). These numbers

highlight the importance of the cattle industry to the Nicaraguan economy. In fact, the cattle industry is the third major component of the GDP of Nicaragua representing more than 10% of the total exports (ECLAC, 2020b).

Despite the relevance of the cattle industry in Nicaragua, it faces several challenges. The use of land for cattle production is underemployed as Nicaragua sets records for having the lowest production density in Central America. This can be attributed to an inefficient cattle production model characterized by a lack of investment (TechnoServe-USDA, 2016) and partly due to ongoing property rights disputes for farmlands as more than 35% of all land in Nicaragua is subject to conflicting ownership claims (Landlinks-USAID, 2020). Based on the growth trends, cattle production may eventually spread over protected lands rich in arable soil as severe drought seasons strike the country (TechnoServe-USDA, 2016). As such, the sustainability of this sector is at risk if cattle producers do not start the transition to a more intensified production model. Nevertheless, intensifying the Nicaraguan cattle industry implicitly means a significant increase in costs. In order to efficiently raise cattle and harness the return on their investments, it is crucial for Nicaraguan cattle ranchers to know what physical and lot characteristics cattle buyers are willing to pay for premiums. The main objective of this research study was to quantify intrinsic and extrinsic factors that shape cattle prices in livestock auction sales in Nicaragua.

The cattle data from Comergasa included variables such as transaction date, lot size, animal weight, animal class, and cash prices for the period 2015-2019. However, only the period 2017-2018 was used in this study because the data was incomplete for the remaining years. The data for the period 2017-2018 consisted of 2520 transactions from 99 auctions. Lot sizes ranged from 1 to 179 cattle head, the mean weight was 849.61 pounds, and the average price was $70.79/cwt. Additionally, feeder cattle futures prices were obtained from the Chicago Mercantile Exchange (CME) group for the period 2017-2018 to analyze the impact of futures prices on cash prices at Comergasa.

A hedonic regression model was used to estimate the effect of intrinsic and extrinsic independent variables on the dependent variable cash price. The coefficient of determination obtained from the SAS 9.4 ordinary least squares results indicated that 58.82% of the variation in cash prices is explained by the regression model (i.e., the explanatory variables). Similarly, the *F*-test statistic suggested that overall, the model was statistically significant (p-value = 0.001).

All the physical and lot characteristics were significant, seven out of the eleven monthly dummy variables for seasonality were significant, and two out of the eight futures contract variables were significant (p-value < 0.05). In particular, the variable *Lotsize* had a positive effect on cash price at a diminishing marginal rate with the optimum being 47 cattle head. The *Weight* variable had a negative correlation with cash prices but also at a diminishing marginal rate which is explained by the positive coefficient of the variable $Weight^2$. The empirical results revealed that the variable *Weight* was associated with a discount for unit increases up to 635 pounds. Heifers received a $14.38/cwt discount compared to steers and surprisingly, bulls received a $1.75/cwt premium compared to steers. The statistical significance of the dummy variables for each of the months confirmed the seasonal pattern of the data and revealed that premiums started to decrease from May to November and started to increase from December to May. Finally, the January, March, August and November futures-price variables had a significant positive impact on cash prices while May and October futures-price variables had a significant negative impact on cash prices (p-value < 0.05).

One of the limitations of this study is that it does not takes into consideration cattle breeds since these were not reported in the sales sheets. According to an interview with one of the managers of La Chontaleña, the third major livestock auction house in Nicaragua, generally, buyers pay more for Brahman, Guzerat[11], Simbra[12] and any cross that involves Brahman whereas dairy breeds are

[11] Gray cattle originary from northern India and characterized by long, lyre shaped horns.
[12] Mix of Simmental and Brahman

discounted. Including the breed variable in future research may support this claim and reveal to what extent premiums or discounts are garnered for those breeds.

Moreover, it should be clarified that the premiums found in this study do not take into account production costs of each of the cattle producers. As such, future research can conduct a cost-benefit analysis to assess whether or not it is worth investing in specific breeds of animals. Although production costs widely vary among cattle producers, including the net utility rather than the mere cash price may further help practitioners in their decision-making process.

Also, a basis approach instead of having cash prices as an independent variable may further improve the model as variations between cash prices and futures prices are reduced (Trapp and Eilrich, 1991). In this case, the impact of the explanatory variables on basis rather than on cash prices would be evaluated. Burdine (2011) found that the use of basis tends to improve the hedonic model used, *ceteris paribus*. Price volatility is the main concern of researchers when using basis. Essentially, basis is designed to reduce price volatility. Thus, the use of basis may be a better risk management tool.

Finally, there is huge potential for value added programs for cattle in Nicaragua in terms of specific management practices such as source verification and grazing style. So far, in Nicaragua, there is a lack of marketing to communicate the value of such programs to both producers and bidders. Value added programs are programs designed to create additional value through management practices. While it remains unsure unclear? whether or not such programs would outweigh their participation cost, they will standardize the quality of beef produced and also be a great support for small and independent producers. There may also be potential for Nicaraguan beef producers to benefit from increased marketing efforts related to better marketing grass fed and organic beef.

## References


Bailey, D., W. Gray and E.L. Rawls. "Factors Affecting the Basis for Feeder Cattle." Managing Cattle for Today's Market and Beyond. March 2002.

Buccola, S.T. "An Approach to the Analysis of Feeder Cattle Price Differentials." *American Journal of Agricultural Economics* 62(1980):574-80.

Burdine, K.H. "Factors Affecting Feeder Cattle Prices in the Southeast." Ph.D. dissertation, University of Kentucky, Lexington, KY, 2011. Internet site: http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1001andcontext=agecon_etds

Chicago Mercantile Exchange Group. "Cattle Futures and Options." Internet site: https://www.cmegroup.com/trading/agricultural/files/fact-card-cattle-futures-options.pdf (Accessed October 2020).

Dhuyvetter, K.C., K. Swanser, T.L. Kastens, J.R. Mintert, and B. Crosby. "Improving Feeder Cattle Basis Forecasts." Selected paper presented at the 2008 Western Agricultural Economics Association Meeting, Big Sky, MT, June 2008.

Dunkel, J. "Factors Affecting the Performance of a Feedlot Cattle." Feedlot Magazine Volume V111 No.1, 2000.

Economic Commission for Latin America and the Caribbean-United Nations. "Statistics and Indicators." Internet site: https://estadisticas.cepal.org/cepalstat/WEB_CEPALSTAT/EstadisticasIndicadores.asp?idioma=i (Accessed September 2020a).

Economic Commission for Latin America and the Caribbean-United Nations. "Nicaragua: National Economic Profile." Internet site: http://interwp.cepal.org/cepalstat/Perfil_Nacional_Economico.html?pais=NICandidioma=english (Accessed September 2020b).

Eldridge, R. W. "Kentucky Feeder Cattle Price Analysis: Models for Price Predictions and Grazing Management." Master's Thesis, University of Kentucky, Lexington, 2005. Internet site: http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1175&context=gradschool_theses

Faminow, M.D. and R.L. Gum. "Feeder Cattle Price Differentials in Arizona Auction Markets." *Western Journal of Agricultural Economics* 46(1986):156-163.

Feuz, D.M., C. Harris, D. Bailey and G. Halverson. "Transportation and Quality Adjusted Basis: Does the Law of One Price Hold for Feeder Cattle?" Selected paper presented at the Western Agricultural Economics Association Annual Meeting, Big Sky, Montana, June 2008.

Food Agricultural Organization of the United Nations. "Livestock Production in Latin America and the Caribbean." Internet site: http://www.fao.org/americas/prioridades/produccion-pecuaria/en/#:~:text=The%20livestock%20sector%20in%20Latin%20America%20has%20grown%20at%20an,global%20growth%20rate%20(2.1%25).andtext=Although%20Latin%20America%20and%20the,of%20poultry%20at%20global%20level (Accessed August 2020a).

Food and Agricultural Organization of the United Nations – FAOSTAT. "Nicaragua." Internet site: http://faostat.fao.org/static/syb/syb_157.pdf (Accessed August 2020b).

Ladd, G.W. and M.B. Martin. "Prices and Demands for Input Characteristics." *American Journal of Agricultural Economics* 58(1976): 21-30.

Landlinks-USAID. "Nicaragua" Internet site: https://land-links.org/country-profile/nicaragua/#:~:text=LAND%20DISPUTES%20AND%20CONFLICTS,assertions%20of%20indigenous%20land%20rights (Accessed December 2020).

Lopez, J.A., T. Bankole, and J. Wahrmund. "A Hedonic Analysis of Feeder Cattle Auction Prices in Northeast Texas." Selected paper presented at the Southern Agricultural Economics Association's 2017 Annual Meeting, Mobile, Alabama, February 4-7, 2017. Internet site: https://ageconsearch.umn.edu/bitstream/252732/2/2017-SAEA-Lopez-Bankole-

Wahrmund.pdf

Mathews, C.D. "Measuring Value-Added Characteristics in Feeder Cattle." Master's Thesis, Texas A&M University, August 2007. Internet site: http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/ETD-TAMU-1404/MATHEWS-THESIS.pdf?sequence=1andisAllowed=y

Martinez, J. Personal Communication. La Chontaleña Livestock Auction, October 2020.

Nicaraguan Central Bank. "Trading, Consumption and Production plan, 2017-2018 trade cycle". 2017. Internet site: https://www.bcn.gob.ni/publicidad/img/landscape/Plan%20de%20Producci%C3%B3n%20Consumo%20y%20Comercio%20Ciclo%202017%202018.pdf (Accessed September 2020)

Raish C. and A.M. McSweeney. "Economic, Social, and Cultural Aspects of Livestock Ranching on the Española and Canjilon Ranger Districts of the Santa Fe and Carson National Forests: a Pilot Study." USDA Forest Service, Rocky Mountain Research Station, 2003. Internet site: https://www.fs.fed.us/rm/pubs/rmrs_gtr113.pdf

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *The Journal of Political Economy* 82(1974):34-55.

Schroeder, T., J. Mintert, F. Brazle, and O. Grunewald. "Factors Affecting Feeder Cattle Price Differentials." *Western Journal of Agricultural Economics* (1988):71-81. Internet site: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.528.7242andrep=rep1andtype=pdf

Schulz, L., K.K. Dhuyvetter, J. Harborth, and J. Waggoner. "Factors Affecting Feeder Cattle Prices in Kansas and Missouri." Special Report, Cooperative Extension Service, Kansas State University, 2010. Internet site: http://www.agmanager.info/livestock/budgets/production/beef/Factors%20Affecting%20Feeder%20Cattle%20Prices%20%28Nov2009--RevisedMar2010%29.pdf

Schulz, L., L. Boetel and C. Dhuyvetter. "Price-Weight Relationship for Feeder Cattle: An Updated Dairy-Beef Assessment." *Economics Publications*. 697(2018).

Solis, O. Personal Communication. Comergasa Livestock Auction, August 2020.

TechnoServe-United States Department of Agriculture (USDA). "Building a Competitive and Inclusive Livestock Sector in Nicaragua." Internet site: https://www.technoserve.org/wp-content/uploads/2016/12/case-study-building-a-competitive-and-inclusive-livestock-sector-in-nicaragua.pdf (Accessed October 2020).

Trapp, J. and F. Eilrich. "An Analysis of Factors Affecting Oklahoma City Feeder Cattle Basis." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. 1991.

United Nations (UN) – COMTRADE database. "Trade Statistics." Internet site: https://comtrade.un.org/data (Accessed October 2020).

United States Department of Agriculture (USDA) – Foreign Agricultural Service. Production, Supply and Distribution Online Database. Internet site: https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery (Accessed September 2020).

Williams, G., K. Raper, E. DeVuyst, D. Peel and D. McKinney. "Determinants of Price Differentials in Oklahoma Value-Added Feeder Cattle Auctions." *Journal of Agricultural and Resource Economics,* 37(2012), 114-127. Internet site: http://www.jstor.org/stable/23243052

Williamson, K.C., R.C. Carter, and J.A. Gaines. "Effects of Selected Variables on Prices of Calves in Virginia Feeder Calf Sales." Journal of Farm Economics 43(1961):697-706.

Zimmerman, L.C. "Factors Influencing the Price of Value-Added Calves at Superior Livestock Auction." Master's Thesis, Department of Agricultural Economics, Kansas State University, Manhattan, 2010. Internet site: http://krex.k-

state.edu/dspace/bitstream/handle/2097/6991/LanceZimmerman2010.pdf?sequence=3andisAllowed=y

## Tables

**Table 1.** Expected signs of regression coefficients.

| Variable name | Sign |
|---|---|
| LOT | + |
| $LOT^2$ | - |
| WEIGHT | - |
| $WEIGHT^2$ | + |
| HEIFER | - |
| BULL | - |
| FEBRUARY | + |
| MARCH | + |
| APRIL | + |
| MAY | + |
| JUNE | - |
| JULY | - |
| AUGUST | - |
| SEPTEMBER | - |
| OCTOBER | - |
| NOVEMBER | - |
| DECEMBER | + |
| FUTURES | + or - |

**Table 2.** Descriptive statistics from Comergasa sales and CME future prices, 2017-2018.

| Variable | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| Lot size (head) | 16.02 | 23.87 | 1.00 | 179.00 |
| Weight (lbs) | 849.61 | 417.21 | 55.12 | 2039.27 |
| Price ($/cwt) | 70.79 | 11.72 | 13.07 | 153.03 |
| January Futures | 136.31 | 10.95 | 110.85 | 161.53 |
| March Futures | 134.93 | 10.32 | 109.25 | 158.35 |
| April Futures | 135.07 | 10.66 | 109.18 | 158.33 |
| May Futures | 135.15 | 10.95 | 108.90 | 157.60 |
| August Futures | 140.73 | 12.36 | 109.90 | 160.10 |
| September Futures | 142.21 | 12.44 | 109.53 | 159.35 |
| October Futures | 143.39 | 12.00 | 111.75 | 159.18 |
| November Futures | 144.35 | 11.30 | 116.40 | 160.88 |
| Steers ($/cwt) | 72.11 | 11.63 | 13.07 | 153.03 |
| Heifers ($/cwt) | 59.63 | 9.21 | 21.57 | 92.80 |
| Bulls ($/cwt) | 76.21 | 6.80 | 42.19 | 101.31 |

**Table 3.** Descriptive statistics by sex from Comergasa sales, 2017-2018.

| | Male bovine (Steers and Bulls) | | | | Female bovine (Heifers) | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **Std. Dev.** | **Min** | **Max** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| Cash price ($/cwt) | 73.85 | 10.08 | 13.07 | 153.03 | 59.63 | 9.21 | 21.57 | 92.80 |
| Lot size (head) | 16.47 | 21.49 | 21.49 | 137.00 | 30.64 | 34.26 | 1.00 | 179.00 |
| Weight (lbs) | 831.81 | 418.97 | 55.12 | 2039.27 | 625.90 | 356.00 | 55.12 | 1818.81 |

**Table 4.** Ordinary-least-squares parameter estimates from livestock auction house Comergasa at Nicaragua, 2017-2018.

| **Variable** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > \|t\|** |
|---|---|---|---|---|
| Intercept | 55.4618 | 4.9122 | 11.29 | <.0001 |
| *Lot size* | 0.0379 | 0.0151 | 2.5 | 0.0124 |
| *Lot size*$^2$ | -0.0004 | 0.0001 | -3.89 | 0.0001 |
| *Weight* | -0.0162 | 0.0024 | -6.88 | <.0001 |
| *Weight*$^2$ | 0.0000127 | 0.0000 | 7.54 | <.0001 |
| *Heifer* | -14.3824 | 0.4077 | -35.27 | <.0001 |
| *Bull* | 1.7551 | 0.8238 | 2.13 | 0.0332 |
| *February* | 4.4117 | 1.0280 | 4.29 | <.0001 |
| *March* | 7.1729 | 1.0351 | 6.93 | <.0001 |
| *April* | 10.5004 | 1.8766 | 5.6 | <.0001 |
| *May* | 13.1818 | 1.3618 | 9.68 | <.0001 |
| *June* | 6.5862 | 1.2865 | 5.12 | <.0001 |
| *July* | 5.0091 | 0.9243 | 5.42 | <.0001 |
| *August* | 0.9939 | 0.8131 | 1.22 | 0.2217 |
| *September* | -0.1698 | 1.3308 | -0.13 | 0.8985 |
| *October* | 0.0969 | 1.2612 | 0.08 | 0.9388 |
| *November* | -3.1797 | 0.9076 | -3.5 | 0.0005 |
| *December* | -0.6187 | 0.8443 | -0.73 | 0.4637 |
| *January Futures* | 0.8539 | 0.1194 | 7.15 | <.0001 |
| *March Futures* | 0.7486 | 0.2435 | 3.07 | 0.0021 |
| *April Futures* | -0.2625 | 0.2489 | -1.05 | 0.2917 |
| *May Futures* | -1.2645 | 0.1621 | -7.8 | <.0001 |
| *August Futures* | 0.7485 | 0.3556 | 2.1 | 0.0354 |
| *September Futures* | -0.1562 | 0.5001 | -0.31 | 0.7549 |
| *October Futures* | -1.2018 | 0.2942 | -4.09 | <.0001 |
| *November Futures* | 0.6500 | 0.1320 | 4.93 | <.0001 |
| $R^2$ | 0.5882 | | | |
| *F*-value | 129.11 | | | <.0001 |

**Table 5.** Descriptive statistics for months and seasons with respect to weight and prices, 2017-2018.

| | Weight (lbs) | | Price ($/cwt) | |
|---|---|---|---|---|
| | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| Rainy season | 853.67 | 411.65 | 69.73 | 12.53 |
| Dry season | 846.12 | 423.01 | 72.06 | 10.54 |
| January | 880.88 | 425.67 | 70.91 | 8.86 |
| February | 815.54 | 430.82 | 70.84 | 10.00 |
| March | 847.29 | 413.40 | 72.16 | 9.54 |
| April | 858.68 | 425.29 | 75.08 | 9.51 |
| May | 762.81 | 405.18 | 76.02 | 11.04 |
| June | 822.97 | 433.92 | 75.98 | 9.89 |
| July | 868.92 | 421.56 | 75.30 | 13.07 |
| August | 864.84 | 395.20 | 68.07 | 10.99 |
| September | 816.48 | 412.15 | 63.29 | 12.28 |
| October | 861.10 | 401.42 | 67.94 | 12.49 |
| November | 865.86 | 414.47 | 68.04 | 11.74 |
| December | 931.39 | 428.97 | 68.68 | 12.36 |

## Figures

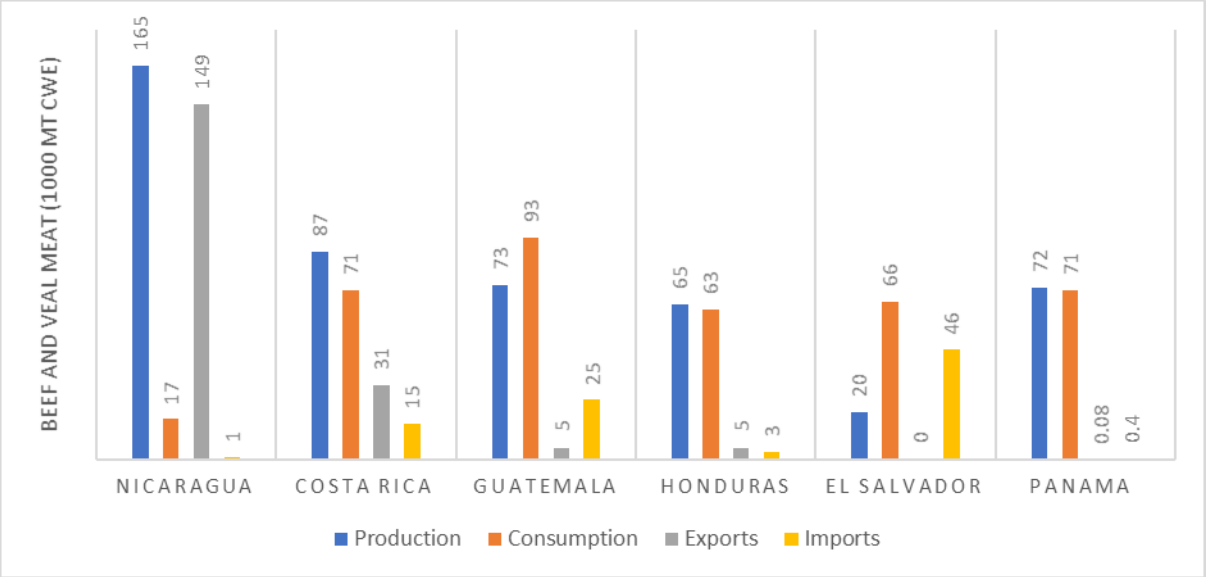


**Figure 1.** Beef and veal production, consumption, exports and imports by country in Central America in 2019.

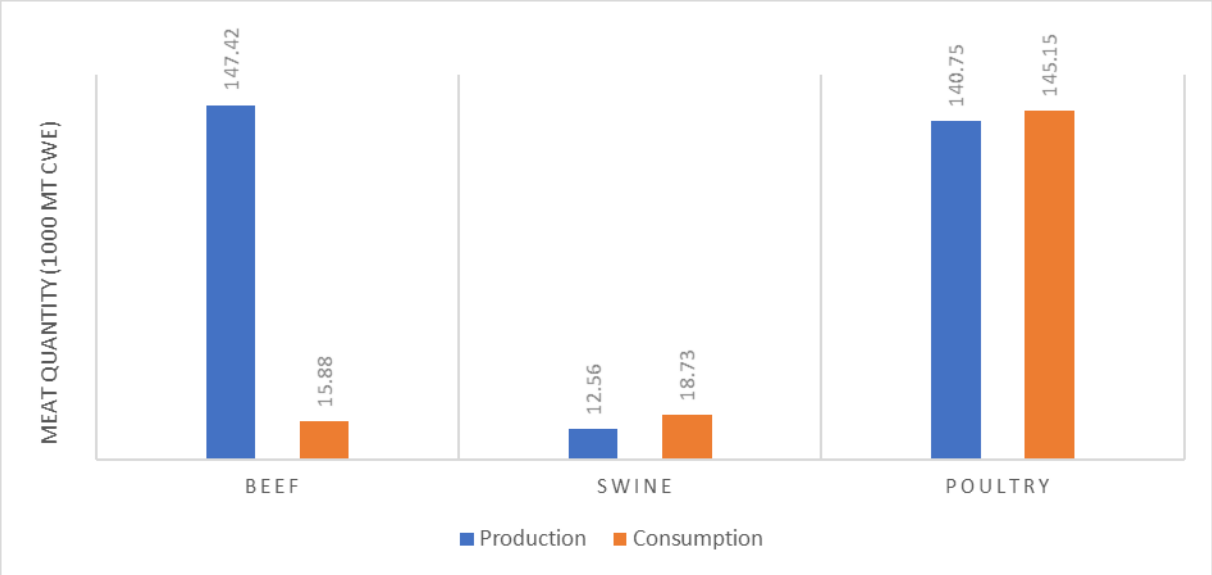


**Figure 2.** Meat production and consumption in Nicaragua in 2017.

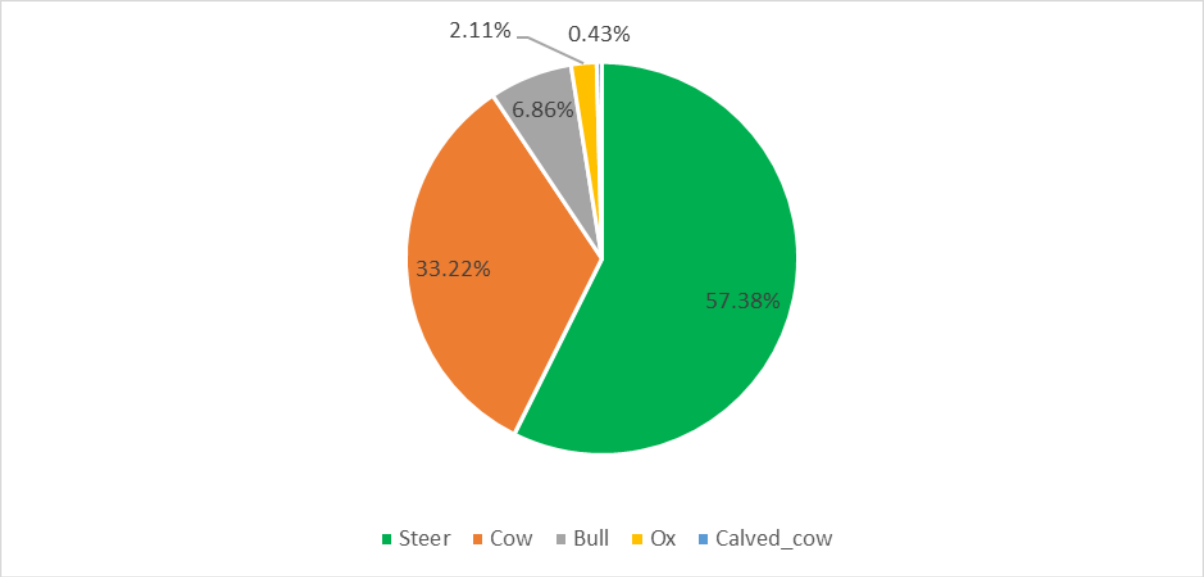


**Figure 3.** Relative frequency of sales transactions by cattle category at Comergasa, 2017-2018.


**Figure 4.** Average price (cwt) per category per month, 2017-2018.

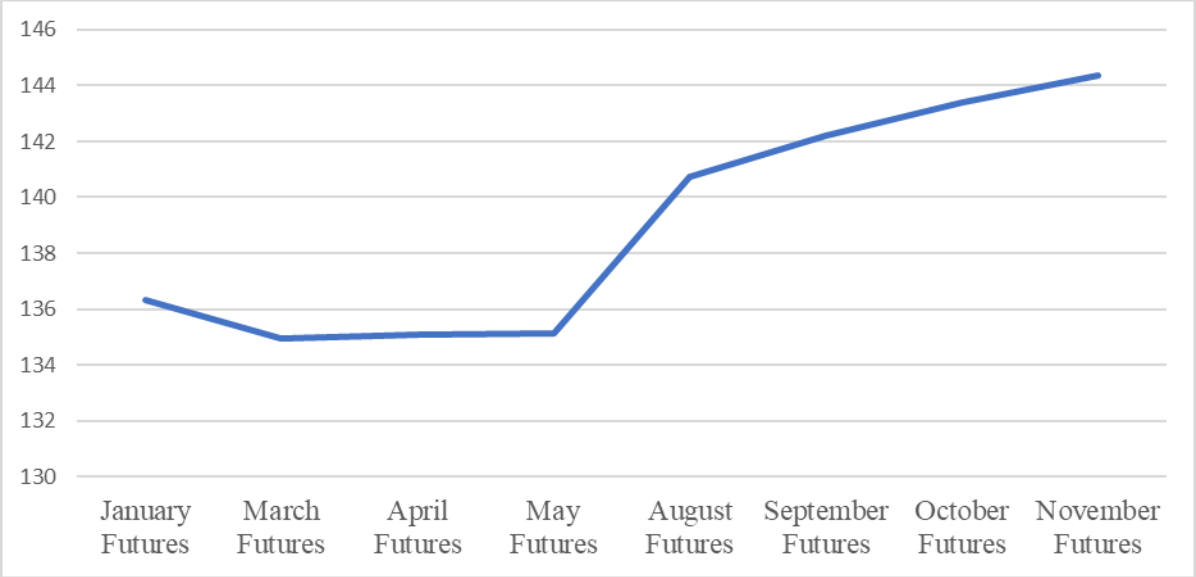


**Figure 5.** Average feeder cattle futures prices ($/cwt) per month, 2017-2018.

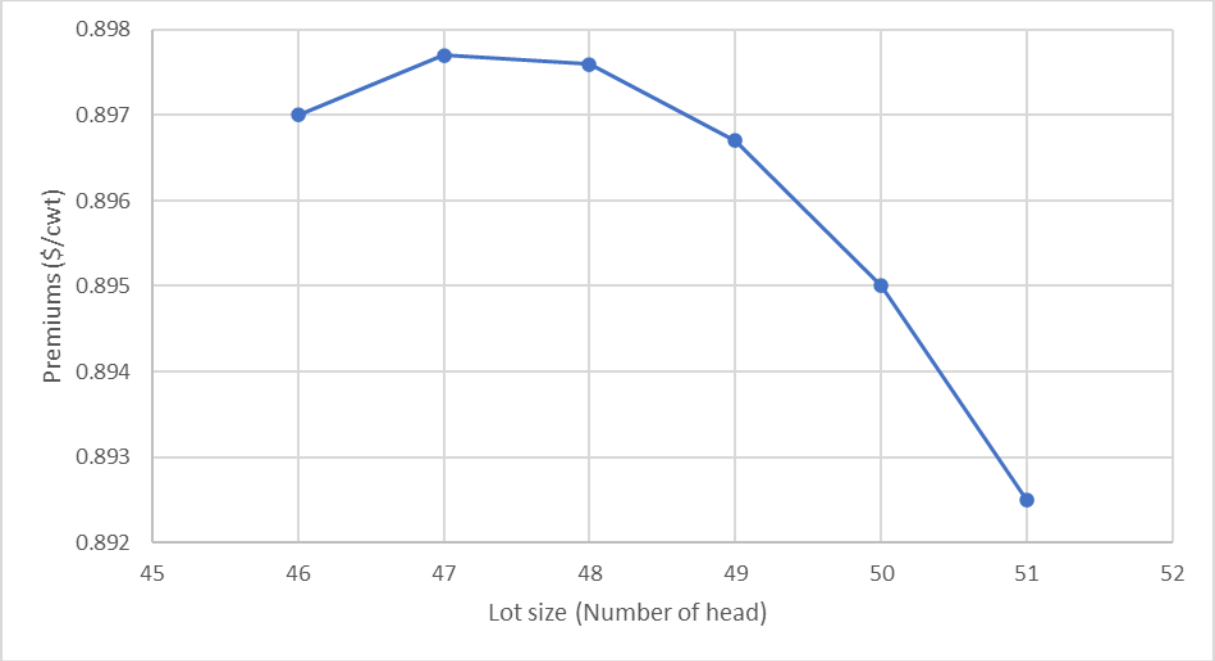


**Figure 6.** Visual representation of the maximum premium given for lot size at Comergasa, 2017-2018.

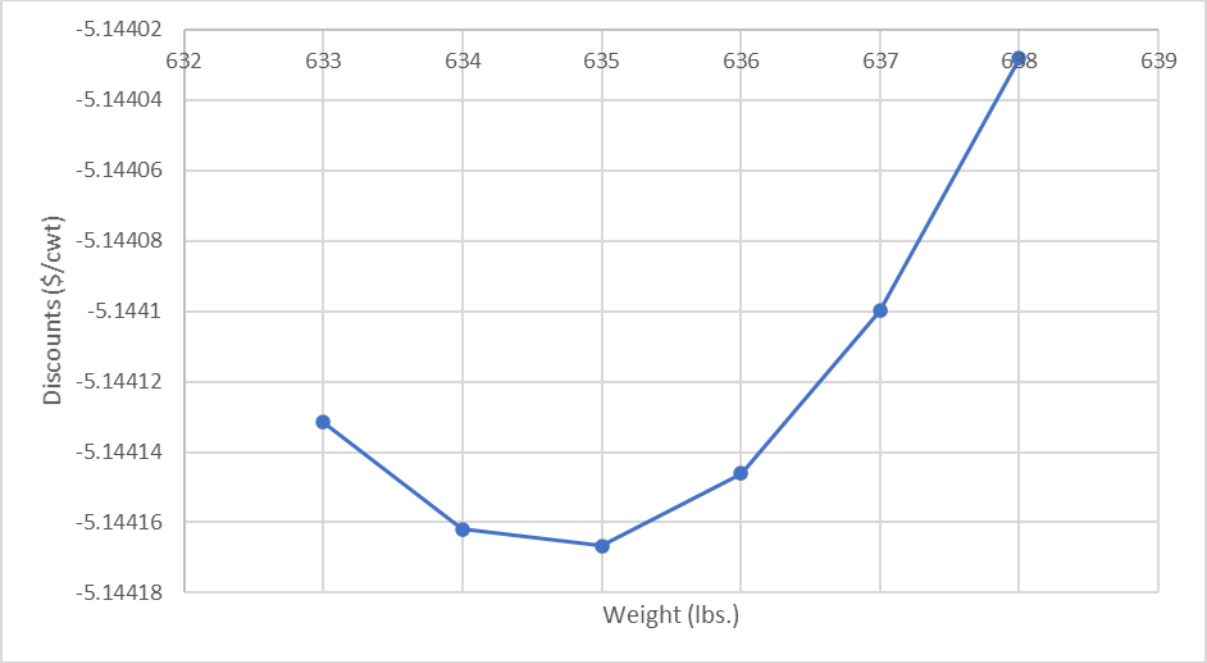


**Figure 7.** Visual representation of the maximum discount given for weight (lbs.) at Comergasa, 2017-2018.

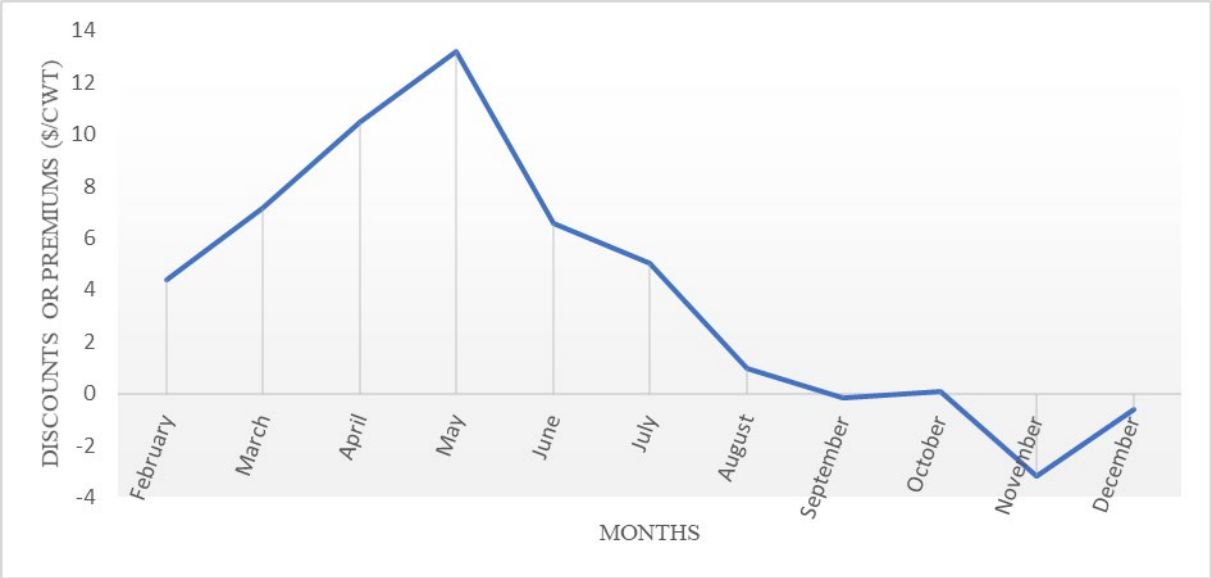


**Figure 8.** Seasonal pattern of premiums and discounts for cattle ($/cwt) given at Comergasa, 2017-2018.