DEPARTMENT OF AGRICULTURAL ECONOMICS AND ECONOMICS

The Impact of Cattle Hide and Byproduct Values on Cattle Price Declines in 2020

BY

GARY W. BRESTER

AND

KOLE SWANSER

STAFF PAPER 2021-1

COLLEGE OF AGRICULTURE
COLLEGE OF LETTERS AND SCIENCE

MONTANA
STATE UNIVERSITY

THE IMPACT OF CATTLE HIDE AND BYPRODUCT VALUES ON CATTLE PRICE DECLINES IN 2020

Gary W. Brester and Kole Swanser

Abstract

Several published studies indicate that cattle hide values and edible and inedible cattle slaughtering byproducts influence cattle prices. Most cattle processing byproducts are exported. The worldwide COVID-19 pandemic interrupted many international trade supply chains and fed cattle futures prices declined from $127.43/cwt in January 2020 to $83.83/cwt at the end of April 2020. Much of this decline was the result of uncertainties in supply chains, reductions in the demand for beef by the HRI sector, and disruptions in international trade. In addition, lower hide and edible/inedible byproduct values also contributed to lower cattle prices. We show that 0.6% (or $0.54/cwt) of the reduction in cattle prices was associated with lower non-hide byproduct values. A larger reduction (6.5% or $6.30/cwt) was associated with a 50.3% decline in hide values.

The financial and data assistance provided by the Leather and Hide Council of America is greatly appreciated.

THE IMPACT OF CATTLE HIDE AND BYPRODUCT VALUES ON CATTLE PRICE DECLINES IN 2020

Introduction

The production of cattle hides and edible/inedible slaughtering byproducts results from processing cattle. Economic theory and previous research indicates that byproduct values are related to cattle prices. This is not unexpected given that the value of cattle slaughter byproducts represents about 10% of the total value of live cattle (Peel, 2019). In fact, the value of wholesale beef produced from a fed steer (or heifer) is often equal to the amount that processing companies pay for the live animal itself. Hence, byproduct sales often provide the revenue to pay for the costs of slaughtering cattle. Consequently, increases in byproduct values increase the profitability of cattle processing. Hence, cattle processors increase (decrease) cattle price bids as the price of byproducts increase (decrease).

Past research indicates that the relative size of byproduct values on cattle prices is relatively small but not inconsequential. In addition, the processing of fed cattle, cull cows, and cull bulls produces substantial quantities of byproducts. That is, only about 40% of the live weight of cattle becomes edible beef products. The remaining weight is in the form of byproducts. Byproducts consist of both edible (e.g., hearts, kidneys, etc.) and inedible (e.g., hides, tallow, bone meal, etc.) products. Historically, hides represent about one-half of all byproduct value. Hides are generally exported and used by leather and leather product manufacturing companies.

Fed cattle prices declined significantly between January and April 2020. The closing price of nearby live cattle futures reached a high of just over $127/cwt in mid-January 2020, which exceeded its closing price for all of 2019. However, by early April, nearby live cattle futures price had declined to just below $84/cwt (a 34.2% decrease). Most of this decline was caused by the worldwide COVID-19 pandemic, as the human disease outbreak interrupted or created uncertainty in meat supply chains. The pandemic also reduced beef demand in the HRI sector and caused international beef trade disruptions. In addition, lower hide and edible/inedible byproduct values also contributed to lower cattle prices. We quantify the impact of reductions in byproduct values on cattle prices.

Background and Literature Review

Although somewhat dated, several studies have found that cattle slaughter byproduct values are positively related to cattle prices. Brester and Marsh (1983) used annual data from 1960-1980 to estimate various beef and cattle industry supply and demand equations. Their fed steer price equation included cattle farm byproduct values as an explanatory variable. Hides are the primary component of cattle farm byproduct values. They estimated the short run price elasticity of fed steer prices with respect to farm byproduct values to be statistically significant but relatively inelastic (0.10). That is, a 10% increase in farm byproduct values generated a 1.0% increase in fed steer prices.

Marsh and Brester (1989) used weekly data from January 1982 through December 1985 to estimate reduced form models for the price of boxed beef, the price of carcasses, and the price of fed steers. Farm byproduct values were included as a regressor in the steer price equation. Their results indicate that, in the short run, the elasticity of fed steer prices with respect to the

price of farm byproducts (which includes hides) was 0.16. In the long run, the elasticity was estimated to be 0.34. That is, a 10% increase (decrease) in farm byproduct prices caused a 3.4% increase (decrease) in fed steer prices. In addition, the long run elasticity of boxed beef prices with respect to the price of carcass byproducts was found to be 0.16.

Using annual data from 1970-1988, Brester and Marsh (2001) considered the impact of technological change on the cattle and hog processing industries. Their reduced form fed steer price equation indicated that a $0.10/lb increase in farm byproduct value caused an $0.80/cwt increase in fed steer prices. Using the means of the data, a short run elasticity of the change in fed steer prices with respect to a change in farm byproduct prices is calculated as 0.02. That is, a 10% increase in farm byproduct prices caused a (very inelastic) increase in fed steer prices of 0.20%.

Brester and Marsh (2004) used annual data to investigate changes in cattle/beef marketing margins. They estimated a slaughter steer price equation that included farm byproduct values as an explanatory variable. The empirical results show that a $0.10/lb increase in the price of cattle slaughtering byproducts increased the price of cattle by $4.00/cwt. Relative to the earlier $0.80/cwt impact reported by Brester and Marsh (2001), it appears that cattle prices responded to changes in byproduct values to a larger degree during the 1990s compared to the 1980s. Using their data and regression results, the short run elasticity of fed steer prices with respect to farm byproduct values was, nonetheless, relatively inelastic (0.10). That is, a 10% increase in farm byproduct values caused a 1.0% increase in fed steer prices. In addition, the long run elasticity of fed steer prices with respect of farm byproduct values was also quite inelastic (0.16).

Model Specification

We specify a reduced form equation in which the price of fed steers is the dependent variable. Previous research used fed steer prices as a proxy for the price of all fed steers and heifers because the data are more consistently reported. In addition, steers represent about two-thirds of total fed cattle slaughter. The use of steer prices and slaughter numbers has been shown to be a good representation of all fed cattle slaughter.

The regression specification is a reduced form model, as both supply and demand factors are included as explanatory variables. A reduced form approach is used rather than the specification and estimation of separate demand and supply functions. The latter approach is valuable for many applications, but usually involves an (often insurmountable) identification problem. In addition, reduced form equation are often used for evaluating factors that affect cattle prices (e.g., Brester and Marsh, 1989, 2001; McKendree, *et al*., 2020).

In general form, we use the following specification:

$$(1) \qquad P_t^s = f(Q_t^{ss},\ P_t^{fc},\ P_t^c,\ P_t^w,\ V_t^{os},\ P_t^{sh})$$

where P_t^s is the price of fed steers (in time period *t*); Q_t^{ss} is the quantity of fed steers slaughtered; P_t^{fc} is the price of feeder cattle; P_t^c is the price of corn; P_t^w is the price of wholesale beef; V_t^{os} is the value of other steer byproducts (i.e., excluding hides); and P_t^{sh} is the price of steer hides.

The quantity of cattle slaughtered (Q_t^{ss}) in any time period is expected to have an inverse relationship with the price of fed steers (P_t^s). The price of feeder cattle (P_t^{fc}) and the price of corn (P_t^c) represent input costs into the production of fed steers. Consequently, increases in these prices cause the supply of fed cattle to decline, which increases the price of fed cattle. The price of wholesale beef (P_t^w) represents the price of the primary output produced by beef processing plants. Hence, the expectation is that the price of wholesale beef is positively related to the price

of fed steers. The rationale is that, as the price of beef produced by cattle processing firms increase, those firms can profitability increase their bid prices for fed steers (and heifers).

Most previous studies have designated cattle processing byproduct values as either being "farm byproducts" or "carcass byproducts." This is primarily the result of the manner in which byproduct values have been historically reported by the USDA ERS. In this study, we use USDA AMS data to differentiate byproducts produced by the cattle processing sector as either being hides or non-hide (i.e., both edible and inedible) byproducts. The values of each are expected to have a direct relationship with the price of fed steers.

Because of data availability, the final specification of equation (1) is:

$$(2) \qquad DP_t^{lc} = f\left(Q_t^{ss},\ DP_t^{fc},\ DP_t^{c},\ DP_t^{w},\ DV_t^{os},\ DP_t^{sh}\right)$$

where DP_t^{lc} is the deflated price of nearby Chicago Mercantile Exchange (CME) live cattle future contracts; Q_t^{ss} is the quantity of fed steers slaughtered; DP_t^{fc} is the deflated price of nearby CME feeder cattle futures contracts; DP_t^{c} is the deflated price of corn received by farmers; DP_t^{w} is the deflated price of wholesale beef; DV_t^{os} is the deflated value of other byproducts (i.e., excluding hides) obtained from steers; and DP_t^{sh} is the deflated price of butt branded steer hides (which also represents the value of hides per animal).

Data

Data sources, means, and coefficients of variation for all variables are presented in table 1. We obtained data on cattle hide values from the U.S. Department of Agriculture's Agricultural Marketing Service (USDA AMS). A consistent series of average per animal hide prices were available on a daily basis from 1995 through 2019 (USDA AMS). The most consistently reported and lengthy series were steer hide prices. Several different steer hide prices were

Table 1. Variable Definitions, Data Sources, and Descriptive Statistics.

Variable	Source	Symbol	Mean	Coefficient of Variation
Live Cattle Futures Price (dollars/cwt, deflated)	Quandl, LC1	DP^{lc}	\$116.06	0.17
Quantity of Steer Slaughter (million head – quarterly)	USDA ERS Livestock & Meat Domestic Data	Q^{ss}	4.272	0.08
Feeder Cattle Futures Price (dollars/cwt, deflated)	Quandl, FC1	DP^{fc}	\$138.31	0.23
Price of Corn (dollars/bushel, deflated)	USDA ERS Feed Grains Yearbook	DP^{c}	\$4.11	0.35
Price of Wholesale Beef (dollars/pound, deflated)	USDA ERS Meat Price Spreads	DP^{w}	\$2.97	0.16
Value of All Steer Byproducts (dollars/cwt of live animal, deflated)	USDA Agricultural Marketing Service	n.a	\$12.22	0.18
Price of Butt Branded Steer Hides (dollars/head, deflated)	USDA Agricultural Marketing Service	DP^{sh}	\$83.91	0.23
Dressed Weight of Fed Steers (pounds/head)	USDA ERS Livestock and Meat Domestic Data	n.a.	830.7	0.05
Live Weight of Fed Steers (pounds/head)	Author Calculation	n.a.	1,318.6	0.05
Total Value All Steer Byproducts (dollars/head, deflated)	Author Calculation	n.a.	\$161.26	0.19
Value of Other Steer Byproducts (dollars/head, deflated)	Author Calculation	DV^{os}	\$77.35	0.29
Gross Domestic Product Implicit Price Deflator (2019,4=100)	Federal Reserve Bank of St. Louis	n.a.	n.a.	n.a.

collected, and the simple average of daily data were used to form weekly data. Weekly steer hide prices were aggregated to quarterly values using simple averages. Although the prices of several different hide types were reported over the time period, the price of butt branded steer hides were the most consistently reported series. USDA AMS also uses the price of butt branded steer hides in developing daily drop-value reports.

In addition to steer hide prices, we obtained data on the value of all byproducts attributable to steer slaughter for the years 1995 through 2019 from daily drop-value reports (USDA AMS). Daily steer byproduct value data were averaged and aggregated to quarterly values.

Hide values were reported on a per animal (i.e., per hide) basis, while the value of all byproducts were reported on a per hundredweight of live animal basis. Data on the average live weight of fed steers slaughtered were not available. However, the monthly average dressed weight of steers was available for the entire data period (USDA ERS). Steer dressing percentages average 63% (Gould, Lindquist, and Schweihofer, 2018). Therefore, we estimate the monthly average live weight of fed steers by dividing fed steer dressed weights by 63%. The simple average of these monthly values was used to construct quarterly values. The value of all steer byproducts was then multiplied by the number of hundredweights per head of fed steers to obtain a total byproduct value per head. The price of hides (which is also the per head value) was subtracted from the value of all byproducts to obtain the value of all non-hide steer byproducts.

We use the weekly average of daily closing values from nearby CME live cattle futures contracts for the price of fed steers and CME feeder cattle futures contracts for the price of feeder cattle (Quandl). Futures prices were used because a consistent monthly/quarterly price

series for fed steer and feeder cattle prices was unavailable for the time period considered. Weekly values were aggregated to quarterly values using simple averages.

Corn prices represent the per bushel price of number 2 yellow corn received by farmers (USDA ERS). The data were obtained on a monthly basis, and simple averages were used to develop quarterly prices. The price of wholesale beef was obtained from USDA ERS. The prices are reported in cents per pound on a monthly basis but were converted to dollars per pound for the analysis. Quarterly values were obtained by a simple average of monthly values. The number of steers slaughtered were obtained on a monthly basis and then summed to quarterly values (USDA ERS).

All price variables were deflated by the GDP Implicit Price Deflator. The deflator was scaled so that the fourth quarter of 2019 was set equal to 100.0. The purpose for this scaling is to put all price data into (nearly) current dollar valuations so that empirical results are more relevant to current market situations.

Model Estimation

Ordinary Least Squares was initially used to estimate equation (2). Initial regression results indicated the presence of first-order autocorrelation among the residuals. This is a common occurrence when using time-series data. Therefore, final estimates were obtained from the Generalized Least Squares estimation of equation (2) so that the standard errors of the regression coefficients were consistently estimated. The statistical software package *R* (2012) was used for the regression analysis.

Several variations of equation (2) were estimated, and the specification was augmented in several ways. For example, binary seasonal (quarterly) variables were included in several initial regressions because of the seasonality of U.S. cattle production. However, the steer slaughter

quantity variable (Q_t^{ss}) appears to account for this effect. Consequently, seasonal binary variables were not included in the final specification. In addition, a lagged dependent variable (DP_{t-1}^{lc}) was included in several specifications. Lagged dependent variables are often included in time-series regressions to account for industry dynamics. However, the lagged dependent variable was not statistically significant in any of the initial models.

The final regression specification and results are reported in equation (3):

$$(3) \quad DP_t^{lc} = \underset{}{44.80} - \underset{(-8.65)}{8.68}\, Q_t^{ss} + \underset{(9.50)}{0.24}\, DP_t^{fc} + \underset{(6.09)}{1.86}\, DP_t^{c} + \underset{(8.96)}{16.39}\, DP_t^{w}$$

$$+ \underset{(1.48)}{0.046}\, DV_t^{os} + \underset{(8.70)}{0.181}\, DP_t^{sh} + \underset{(2.01)}{0.20}\rho_{t-1}$$

Number of Observations: 100
Degrees of Freedom: 93
Adjusted R^2: 0.974
Standard Error of Regression: 3.10
Durbin-Watson Statistic: 1.572

where ρ_{t-1} represents a first-order autocorrelation parameter, and the values in parentheses are *t*-values.

The numbers in parentheses in equation (3) represent *t*-values. All of the coefficient estimates are highly statistically significant with one exception. The *t*-value for the deflated value of other (non-hide) steer byproducts (DV_t^{os}) is 1.48, which is statistically significant at the 85% probability level. Given that excluding the variable from the specification is likely to cause a specification error, we retained the variable in the final model specification.

The estimated coefficient (-8.68) on the steer slaughter variable (Q_t^{ss}) in equation (3) indicates that a 1 million head increase in quarterly steer slaughter (about a 25% increase) would

cause the price of steers to decline by $8.68/cwt. The other coefficients in the model all have a direct relationship with fed steer prices. For example, a $1/cwt increase (decrease) in the price of feeder steers (DP_t^{fc}) would cause a $0.24/cwt increase (decrease) in the price of fed steers. The other "cost" driver in the reduced form equation is the price of corn (DP_t^{c}). A $1/bushel increase (decrease) in the price of corn would cause a $1.86/cwt increase (decrease) in the price of steers.

The remaining variables in equation (3) represent the value of output produced by cattle processors. When the price of wholesale beef (DP_t^{w}) increases by $1/lb (about 33% of the mean value), the price of fed steers increases by $16.39/cwt. Non-hide steer byproducts result from processing cattle. When the value of non-hide steer byproducts (DV_t^{os}) increases by $1/head, the price of fed steers increases by $0.046/cwt, assuming that the estimated coefficient is statistically different from 0.

Finally, the price (value) of steer hides (DP_t^{sh}) is also positively related to the price of steers. The estimated coefficient of 0.181 indicates that a $1/head increase in hide value (which is synonymous with a $1 increase in the price of butt branded steer hides) causes a $0.18/cwt increase in steer prices. Given that the mean value of steer prices in the data set is $116.06/cwt (table 1), an $0.18/cwt increase is quite small.

The Impact of Hide Values on Cattle Prices

Using the regression results and the means of the data, the elasticity of fed steer prices with respect to the value of cattle hides is 0.13. Thus, for a 10% decrease in hide prices, fed steer prices decline by 0.13%. This value is very similar to elasticities reported in other published research with respect to farm byproduct values (Brester and Marsh, 1983; Marsh and Brester, 1989, 2004). By April of 2020, hide values had declined from $36.50 per steer at the start of the

year just to over $18 per steer -- a decrease of 50.3%. Consequently, cattle prices declined by 6.5% (or $6.30/cwt) as the result of lower hide values.

The Impact of Non-Hide Byproduct Values on Cattle Prices

The elasticity of fed steer prices with respect to the value of non-hide byproducts is calculated to be 0.03. Thus, for a 10% decrease in non-hide byproduct values, fed steer prices decline by 0.3%. By April of 2020, the value of non-hide byproducts had declined from over $96 per steer at the beginning of the year, to under $79 per steer -- a decrease of 18.6 %. Consequently, cattle prices declined by approximately 0.6% (or $0.54/cwt) as the result of lower non-hide byproduct values.

Summary and Conclusions

The processing of fed cattle, cull cows, and cull bulls produces substantial quantities of byproducts. Byproducts represent about 10% of the value of a live beef animal and consist of both edible (e.g., hearts, kidneys, etc.) and inedible (e.g., hides, tallow, bone meal, etc.) products. Historically, hides represent about one-half of all byproduct value. Hides are generally exported and used by leather and leather product manufacturing companies. Several published studies indicate that cattle hide values and edible and inedible slaughtering byproducts influence cattle prices. Although the size of these impacts is relatively small, they are not inconsequential.

The worldwide COVID-19 pandemic interrupted many international trade supply chains. The closing price of nearby live cattle futures reached a high of just over $127/cwt in mid-January 2020, which exceeded its closing price for all of 2019. However, by early April, the nearby live futures cattle price had declined to just below $84/cwt. Much of this decline was the

result of uncertainties in supply chains, reductions in the demand for beef by the HRI sector, and disruptions in international trade. Because most cattle processing byproducts are exported, international trade disruptions also reduced hide and edible/inedible byproduct values.

During the first two quarters of 2020, fed cattle futures prices declined from $127.43/cwt to $83.83/cwt ($43.6/cwt or a 34.2% total decrease). We show that 0.6% (or $0.54/cwt) of this reduction in cattle prices was caused by lower non-hide byproduct values. A larger reduction in cattle prices (6.5% or $6.30/cwt) was caused by a 50.3% decline in hide values.

References

Brester, Gary W., and John M. Marsh. "The Effects of U.S. Meat Packing and Livestock Production Technologies on Marketing Margins and Prices." *Journal of Agricultural and Resource Economics*. 26,2(December 2001):445-462.

Brester, Gary W., and John M. Marsh. "A Statistical Model of the Primary and Derived Market Levels in the U.S. Beef Industry." *Western Journal of Agricultural Economics*. 8(July 1983):34-49.

Federal Reserve Bank of St. Louis. Economic Research Division. *Federal Reserve Economic Data.* FRED Graph Observations: Gross Domestic Product: Implicit Price Deflator, Index 2012=100, Quarterly, Seasonally Adjusted. https://fred.stlouisfed.org

Gould, Kevin, Jerry Lindquist, and Jeannine Schweihofer. "Grain Fed Freezer Beef Pricing Worksheet." March, 2018. Michigan State University Extension. https://www.canr.msu.edu/meat_marketing_processing/uploads/files/Grain%20Finished%20Freezer%20Beef%20Pricing%20Example%20Mar%202018.pdf

Marsh, John M., and Gary W. Brester. "Wholesale-Retail Marketing Margin Behavior in the Beef and Pork Industries." *Journal of Agricultural and Resource Economics*. 29,1(2004):45-64.

Marsh, John M., and Gary W. Brester. "Intertemporal Price Adjustments in the Beef Market: A Reduced Form Analysis of Weekly Data." *Western Journal of Agricultural Economics*. 14(December 1989):235-245.

McKendree, Melissa G.S., Glynn T. Tonsor, Ted C. Schroeder, and Nathan P. Hendricks. "Impacts of Retail and Export Demand on United States Cattle Producers." *American Journal of Agricultural Economics*. 102,3(May 2020):866-883.

Peel, Derrell. "Weak Hide Values Impacting Cattle Prices." Drovers Journal News. July 29, 2019. https://www.drovers.com/article/weak-hide-values-impacting-cattle-prices

Quandl. Wiki Continuous Futures: Feeder Cattle Futures, Continuous Contract #1 (FC1) (Front Month). https://www.quandl.com/data/CHRIS/CME_FC1 (2020-11-16).

Quandl. Wiki Continuous Futures: Live Cattle Futures, Continuous Contract #1 (LC1) (Front Month). https://www.quandl.com/data/CHRIS/CME_LC1 (2020-11-16).

R Core Team. "*R*: A Language and Environment for Statistical Computing." *R* Foundation for Statistical Computing, Vienna, Austria. 2012. ISBN 3-900051-07-0, URL http://www.R-project.org/

U.S. Department of Agriculture, Agricultural Marketing Service. Wholesale Meat Quotations: Form LS-179 Simple Averages 1995-2019. Provided via email on 2020-11-11.

U.S. Department of Agriculture, Economic Research Service. *Feed Grains Data: Yearbook Tables*. Feed Grains Data-All Years. Table 9. https://www.ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables/

U.S. Department of Agriculture, Economic Research Service. *Meat Price Spreads*. Beef. https://www.ers.usda.gov/data-products/meat-price-spreads/meat-price-spreads/

U.S. Department of Agriculture, Economic Research Service. Quick Stats. Cattle, GE 500 lbs, Slaughtered, Commercial, Measured in lb/Head, Live Basis. https://quickstats.nass.usda.gov/results/69706CB9-1378-38B8-9F61-CD307EBECF57

U.S. Department of Agriculture, Economic Research Service. *Livestock & Meat Domestic Data*. All Meat Statistics, Historical: Table 2. https://www.ers.usda.gov/data-products/livestock-meat-domestic-data/livestock-meat-domestic-data/