An Economic Analysis of the Price Discount for Over Thirty Months of Age Cattle

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Abstract:

On December 23, 2003, the first confirmed United States case of Bovine Spongiform Encephalopathy, or BSE, was discovered in Washington State. Following this incident, weekly exports of United States beef fell from 13,819 metric tons of beef the week before the incident to 130 metric tons of beef to by the second week of January of 2004. Since 2004, annual United States beef exports have increased from 460 million pounds to 2.6 billion pounds in 2014.

Cattle priced on formulas or on grids are discounted if older than 30 months. BSE related regulations limit the ability to export beef from cattle over 30 months old. Data on over thirty month price discounts began in January 2004. The discount is also related to maturity grading with A maturity being younger animals and B maturity capturing older animals.

This analysis indicates that the discount has grown steadily larger since 2004. Yet, the discount has become smaller relative to fed cattle price as beef supplies have tightened. Changing trade regulations are shown to have had a statistically significant effect on the discount magnitude.

Key Words**:** Beef, Grid Pricing, Premiums and Discounts, BSE, Over Thirty Months

JEL Classification: *Q13*

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On December 23, 2003, the first confirmed case of Bovine Spongiform Encephalopathy, or BSE, was discovered in Washington State. Following this incident, weekly exports of United States beef fell from 13,819 metric tons of beef the week before the incident to 130 metric tons of beef to by the second week of January of 2004 (LMIC, 2014). The world, effectively, closed their beef markets to United States beef. Since then the United States has been successfully working to reopen world beef markets, although there are more regulations that surround world beef trade. With the probabilities of BSE occurring in cattle under thirty months being negligible, the international standard considers beef from cattle under thirty months to be at a low risk of contamination. Countries like South Korea and Mexico placed restrictions of not importing beef from cattle over thirty months of age, and Japan did not allow beef from cattle older than twenty-one months of age to be imported. These global restrictions created a new discount in beef grid pricing in the United States. Any cattle over the age of thirty months are discounted.

BSE is a neurological disease in cattle that is transmitted by feeding meat and bone meal from ruminant based animals to cattle. There have been four confirmed cases of BSE in the United States. The first, nicknamed the "Cow That Stole Christmas," mentioned above, occurred on December 23, 2003 in Washington State and was a dairy cow imported from Canada. The second and third cases were United States born and raised calves in 2005 and 2006. The fourth case was found in 2012 and was an atypical BSE case. Currently, the United States is considered a negligible risk for BSE, the least amount of risk as ranked by the World Organization for Animal Health. BSE is formed from transmissible spongiform encephalopathies, or TSE, in the

animal's body through long incubation periods. Due to the length of the incubation period, an infected cow will rarely exhibit symptoms of BSE before thirty months of age.

The over thirty month discount price is applied when using the grid pricing method of marketing cattle in the beef industry. Grid pricing in the beef industry is designed to increase the quality of beef through monetary incentives (premiums) for higher quality beef and disincentives (discounts) for lower quality beef. The cattle's carcass is graded on quality and yield. USDA's quality and yield grades have four quality grades and five yield grades. The quality grades in descending order from highest quality to lowest quality are premium, choice, select, and standard. The yield grades in descending order from highest yield to lowest are yield grade 1, 2, 3, 4, and 5. Grid pricing systems may have more quality or yield categories. Often choice and yield grade 3 is the base of the grid and animals that grade as such receive the base price. The base price is the starting price for a carcass where no premiums or discounts, or the premium and discount is equal to zero, are assigned. Premiums are awarded to carcasses that exhibit desired traits such as grading prime or scoring a yield grade of one or two, while discounts are assigned to those carcasses who exhibit undesirable traits such as grading select or standard or scoring a yield grade of four or five. Additional premiums and discounts may be assigned for other various characteristics. The over thirty month discount price is an additional discount. A typical grid is contained in Table 1.

The over thirty month discount price has grown larger over time. Meanwhile, the discount price relative to the steer price increased and decreased over time. The purpose of this paper is to analyze the effects that economic factors, such as exports, prices and supplies, have upon the discount price directly and on the relative discount price. This paper will provide insight into why the discount price is changing over time.

Table 1: An Example of a Beef Price Grid ($/dressed cwt.)

	Yield Grade							Other Factors
Quality Grade	1-2	2-2.5	2.5-3	3-3.5	3.5-4	4-5	>5	Over Thirty Month
Prime	23.78	21.07	20.96	18.05	18.05	8.33	3.31	-16.42
Choice	5.73	3.02	2.91	0	0	-9.72	-14.74	
Select	-.49	-3.2	-3.31	-6.22	-6.22	-15.94	-20.96	
Standard	-13.69	-16.4	-16.51	-19.42	-19.42	-29.14	-34.16	

Literature Review:

The over thirty month discount in beef grid pricing stems from the over 30-month regulations that countries affected by BSE have put into place. With the BSE epidemic in the United Kingdom (UK), the UK Government issued the over 30-month rule in March of 1996 (Smith and Bradley, 2003). This rule required that meat from cattle over thirty months of age "be de-boned and the obvious nervous and lymphatic tissue removed and treated as SRM" or specified risk materials (Smith and Bradley, 2003). In October, 2005, the US Food and Drug Administration proposed the rule that the brains and spinal cords from cattle at least thirty months of age cannot be used in food or feed of all animals (FDA, 2008). Typically, BSE will not appear in infected cattle until after thirty months of age, and the last animal naturally infected with BSE younger than thirty months was 29 months in 1996 (BSEinfo.org, 2016). The incubation period for BSE is on average five years (Smith and Bradley, 2003). Due to the long incubation periods and the negligible risk for cattle to be infected with BSE while younger than thirty months, this age has become the benchmark for trade and processing regulations.

In 2003, the US was the third largest exporter of beef and veal and held 18% of the world's market share (Hanrahan and Becker, 2008). 90% of the US beef exports went to four countries, Japan, South Korea, Mexico and Canada (Hanrahan and Becker, 2008). Following the BSE emergence in the US, their market share fell to 3% in 2004 (Hanrahan and Becker, 2008). These four countries, along with other countries the US exports beef to, immediately banned US beef in December of 2003. Since then all four countries have reopened their markets to US beef trade, but have set restrictions. Canada opened their markets to US beef in January of 2004, and Mexico in March of the same year (Southard, 2004). Both countries set restrictions to only allow beef from cattle under thirty months of age (Southard, 2004). In June, 2006, Canada reduces the restrictions to allow beef from all ages to be imported from the US and Mexico follows suit in April, 2014 (LeBlanc, 2008. USDA GAIN, 2014).

Korea first lifted the ban on US beef products in September, 2006, with the restrictions of only allowing boneless beef from cattle under 30 months of age, but closed their markets in October of 2007 after bone fragments were found (Hanrahan and Becker, 2008). The market reopened in April, 2008 and allowed for boneless and bone-in beef from the US that are from cattle under 30 months old (Giamalva, 2013). Japan reopened their markets to allow beef from cattle under 20 months old for the short period of December, 2005 to January, 2006, and reopened the market in October, 2007 under the same restrictions (Hanrahan and Becker, 2008). Since then, the US has been working to with Japan to reduce these restrictions, and in February, 2013, Japan eases the restrictions to allow beef from cattle under 30 months of age, rather than 20 (Strom and Tabuchi, 2013).

Many studies have been conducted on grid pricing in beef. These studies typically consist of comparing grid pricing to more traditional beef marketing methods, like live or

dressed weight marketing. Studies conducted by Feuz, Fasti and Wagner (1993, 1995), Graff and Schroeder (1998), and Anderson and Zeuli (2001) showed that, generally, average prices per head, increase as you shift from live weight to dressed weight to grid pricing methods. The studies often show that the shift in marketing method increases the variability in prices. Other studies found what market signals are being sent back to producers using grid pricing. Johnson and Ward (2006) found that weight sent a stronger signal for better cattle and characteristics sent a stronger signal for lower quality cattle.

Very little research has been conducted to explain the movement of grid pricing premiums and discounts, particularly with the over thirty month discount. Although, Fausti and Qasmi (1999) analyzed the movement of premiums and discounts used in a grid and found that the cash market for fed cattle had no explanatory value in the movement of these prices. Also, it was found that the previous time period was the best predictor of the premiums or discounts (Fausti and Qasmi, 1999).

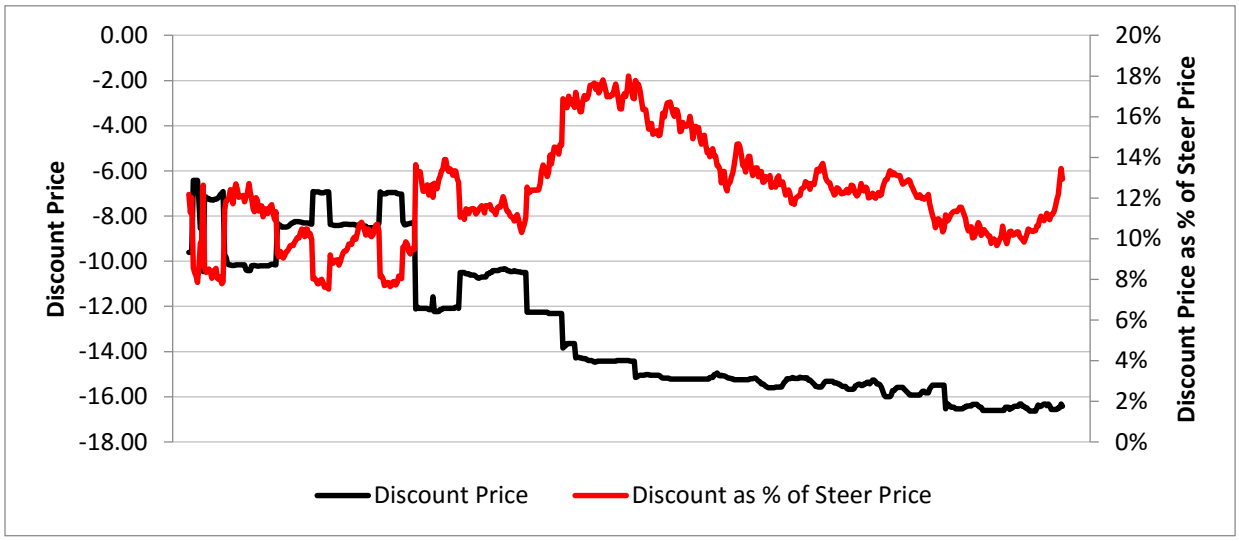
Data:

The data used for this study consists of weekly data for the over thirty month cattle discount price, steer price, the amount of federally inspected cattle, and beef exports. All of the data used for this analysis was collected by the USDA-AMS and compiled by the Livestock Marketing Information Center (LMIC), and covers the January 19, 2004 to October 13, 2015 time period.

Over this time, the over thirty month cattle discount price grew from $9.60/cwt to $16.42/cwt, and the relative discount price, or the discount as a percent of steer price, increased from 8% in 2004 to 18% by 2010, then decreased to 10% by 2014. Figure 1 shows the changes in these values over time. The over thirty month discount price is the weighted average of the discounts from Texas, Oklahoma, New Mexico, Kansas, Nebraska, Colorado, Iowa and

Minnesota packers. The steer price is the weighted average steer prices negotiated on a live FOB basis for Texas, Oklahoma and New Mexico.

Figure 1: Over Thirty Month Discount for Cattle



The percentage of non-steer and heifers is the percentage of federally inspected cattle that were not identified as steers or heifers. This value was found by dividing the total amount of federally inspected steers and heifers by the total amount of federally inspected cattle, and subtracting this percentage from one. This method is designed to provide the study with a relative value to use as the supply of cattle older than thirty months. These percentage ranges from 14% to 26% with a strong seasonality component, but overall the percentages are not trending up or down.

Japan is a major importer of US beef, with weekly exports of beef to Japan being 20% to 40% of the total exports in the past year. This, coupled with Japan's age restrictions on the beef imported from the US, causes Japan's demand for US beef to be an influencing factor on the over thirty month discount price. The percentage of US beef exports to Japan has increased steadily over the time period. This percentage has increased from 0% in 2004 to 39% in 2015. This value will give us a relative demand for US beef in Japan. Weekly US beef exports

increased from 154 metric tons of beef in 2004 to 19.4 thousand metric tons in 2011, and decreased to 11.7 thousand metric tons in 2015. Weekly US beef exports to Japan has increased from zero exports in 2004 to 5700 metric tons in 2014.

The summary statistics of the data on the discount price, the discount as a percent of steer price, steer price, percent of non-steers and heifers, and the percentage of US beef exports to Japan is in Table 2.

Table 2: Summary Statistics of Price Discount and Economic Data

	Mean	Min	Max	St. Dev.
Over 30 Month Discount	-12.97/cwt	-16.63/cwt	-6.42/cwt	3.184
Discount as a % of Steer Price	12.22%	7.52%	17.99%	.024
Steer Price	107.07/cwt	74.92/cwt	172.00/cwt	24.823
% of FI Non-Steers and Heifers	19.68%	13.94%	25.60%	.023
% of US beef exports to Japan	13.75%	0.00%	39.44%	.104

Methods:

Two models are analyzed using a time series ordinary least squares regression method. The first of the two models shows the relationship between the over thirty month discount price and the economic factors. The second model evaluates how these same economic factors affect the discount as a percent of steer price. By evaluating the discount price as a percent of steer price, a relative discount price is formed and we can see how these economic factors affect the over thirty month discount price as the overall market fluctuates.

The theoretical model that analyzes at how economic factors affect the over thirty month discount price directly is:

1) $OTMWA_t=f(Trend, OTWMA_{(t-1)}, STPR, \%NS\&H, \%JAPEXP,$ Monthly Seasonal Variable)

The second theoretical model, which analyzes the discount price as a percent of steer price under the same economic factors, is:

2) $DSP_t=f(Trend^2, DSP_{(t-1)}, STPR, \%NS\&H, \%JAPEXP,$ Monthly Seasonal Variable)

Where for the first model OTMWA is the over thirty month cattle discount price weighted average, Trend is the weekly trend, $OTMWA_{(t-1)}$ is the dependent variable lagged by one month, STPR is the steer price, %NS&H is the percentage of non-steers or heifers, and %JAPEXP is the percentage of US beef exports to Japan. For the second model, DSP is the discount price as a percent of steer price, $Trend^2$ is the weekly trend squared and $DSP_{(t-1)}$ is the dependent variable lagged by one month.

The discount price as a percent of steer price is calculated using the following formula:

3) DSP=-(OTMWA/STPR)

The percentage of federally inspected carcasses that are not from steers or heifers is found using the following formula:

4) %NS&H=1-((FIST-FIH)/FICAT)

Where FIST is the number of federally inspected carcasses from steers, FIH is the number of federally inspected carcasses from heifers, and FICAT is the total number of federally inspected carcasses. Typically, steers and heifers will be younger than thirty months old when slaughtered. This variable then is designed to capture the supplies of cattle other than steers or heifers, which have a higher probability of being over thirty months old, relative to the total supply.

The percentage of US beef exports to Japan is found using the following formula:

5) %JAPEXP=JAPEXP/EXP

Where JAPEXP is the weekly metric tons of US beef exported to Japan and EXP is the total weekly US beef export. This variable will show how the importance of US beef exports to Japan affects the over thirty month cattle discount price directly and the relative discount price.

Plugging formulas (3), (4) and (5) into formulas (1) and (2), we see that the over thirty month cattle discount price and the relative discount price is effected by time, the lagged dependent variables, steer price, the number of federally inspected steers, heifers, and total cattle, the volume of US beef exports and the amount exported to Japan. Using the theoretical models from formulas 1) and 2), the following regressions are estimated:

6) $OTMWA_t=b_0 + b_1Trend + b_3OTMWA_{(t-1)} + b_4STPR + b_5\%NS\&H + b_6\%JAPEXP + b_7Jan + b_8Feb + b_9Mar + b_{10}April + b_{11}May + b_{12}June + b_{13}July + b_{14}Aug + b_{15}Sept + b_{16}Oct + b_{17}Nov + e$

7) $DSP_t=b_0 + b_1Trend^2 + DSP_{(t-1)} + b_4STPR + b_5\%NS\&H + b_6\%JAPEXP + b_7Jan + b_8Feb + b_9Mar + b_{10}April + b_{11}May + b_{12}June + b_{13}July + b_{14}Aug + b_{15}Sept + b_{16}Oct + b_{17}Nov + e$

Results:

The results from the regression estimated in equation (6) and (7) are contained in Table 3. Model 1, equation (6), yielded an R^2 of 0.977 and the R^2 of the second model, equation (7), was 0.937. These results indicate that 97.7% of the variation in the discount price and 93.7% of the relative discount price is explained by the independent variables.

Over Thirty Month Discount Price Model

For the model analyzing the over thirty month discount price directly, the trend, the lagged dependent variable, and the percent of non-steers and heifers are all statistically significant at the 95% confidence level, and the steer price is significant at the 90% confidence

level and the percent of US beef exports to Japan is statistically significant at the 85% confidence level. The coefficient for the trend variable is negative, and the lagged dependent variable is relatively close to one, indicating that the discount price is decreasing over time with small amounts of variability. Those relationships can be seen in Figure 1.

The coefficient for the steer price variable is positive with a value of 0.002. This estimate means that as if the steer price per hundred weight increased by one dollar, then the discount price would decrease, or move closer to zero, by 0.2 cents per hundred weight. If we rescale these values, we see that if the steer price increased by $10/cwt, then the discount price would decrease by $.02/cwt.

The coefficient for the percentage of non-steer and heifer variable is negative with a coefficient value of -7.638. This value estimates that as the percentage of beef carcasses not classified as steers or heifers, increases, the discount price will increase, or move further away from zero. Indicating that as supply of over thirty month cattle increases, the discount price increases.

The percentage of US beef exports to Japan variable coefficient is also negative with a value of -0.978. This estimate indicates that as the percentage of US beef exports to Japan increases, the discount price will increase. The value of the coefficient estimates that if the percent of US beef exports to Japan increases by 1% the discount price would increase by $.978/cwt.

The values and significance levels of these coefficients indicate that the discount price is affected directly by the prices in the market, the supply of federally inspected beef carcasses and the US beef exports.

Over Thirty Month Discount Price as a Percent of Steer Price Model

In the second model, which analyzes the relative discount price, the trend squared, the lagged dependent variable, steer price, and the percentage of non-steer and heifer are statistically significant at the 95% confidence level and the percentage of US beef exports to Japan is statistically significant at the 90% confidence level. The coefficient for the time squared variable is positive, and the lagged dependent variable is relatively close to one. The positive time squared coefficient value indicates that the relative discount price percentage values increased in the beginning of the time period analyzed and have fallen in the latter part of the time period. While the lagged dependent variable coefficient indicates small changes from period to period in the relative discount percentage price values.

The coefficient for the steer price variable estimate is negative with a value of -3.20E-04. This value indicates that if the steer price were to increase by one dollar per hundred weight, the discount price as a percent of steer price would decrease, or move closer to zero, by 0.0032%.

Both the percent of non-steer and heifer and the percent of US beef exports to Japan have a negative impact on the relative discount price, with coefficient values of -0.113 and -0.012, respectively. This means that if either of these percentage values increase, the relative discount price will increase, or move further from zero. If the percentage of non-steer and heifers increased by one percent, then the relative discount price will increase by 11.3%. If the percentage of US beef exports to Japan increases by one percent then the relative discount price will increase by 1.2%.

Table 3: Regression Results

	OTMWA	DSP
R^2	.977	.937
Intercept	.056	.026*
Trend	-.001*	
$Trend^2$		4.61E-08*
$OTMWA^{(t-1)}$	.859*	
$DSP^{(t-1)}$		.823*
STPR	.002**	-3.20E-04*
%NS&H	-7.638*	.113*
%JAPEXP	-.978***	.012**

* indicates significance at the α=.05 level
** indicates significance at the α=.1 level
*** indicates significance at the α=.15 level
**** None of the seasonality variables were significance at the α=.05, .1, or the .15 levels

Conclusions:

In this paper we have attempted to analyze the impacts that economic factors, such as exports, prices and supplies, have upon the over thirty month discount price and on the relative discount price. This was accomplished with time series modeling using the ordinary least squares method to model these impacts. The results from these models show that these economic factors do have a significant impact on both the discount price directly and the relative discount price. The economic factors influence the discount and the relative discount the same direction. If the steer price increases then the discount price and the relative discount price will decrease, or move closer to zero, indicating a higher demand for beef from cattle over thirty months of age. If the percent of non-steers and heifers or the percent of exports to Japan increases, then the discount

price and the relative discount price will increase, indicating there is less demand for beef from cattle over thirty months. Overall, cattle exports, prices, and supplies effect the over thirty month discount price in beef grid pricing. This paper provides insight into what factors affect the discount price, while future advancement on this topic should look to incorporate costs associated with beef production from cattle over thirty months.

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