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Fed cattle market integration in the post mandatory price reporting period in United States

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ABSTRACT

Price integration in regional fed cattle markets has been a significant subject of debate among Agricultural Economics researchers and industry participants. The issue stems from geographical distance between production and consumptions localities, perishable nature of fed cattle and considerable transportation cost. The Mandatory Price Reporting Act of 1999 improved the cointegration among the regional fed cattle markets. Using methodology of Pendell and Schroeder, it was discovered that prices remained highly cointegrated in the post Mandatory Price Reporting (MPR) period. In addition, findings of the research outlined that that following the annulment of MPR, the voluntary price reporting system is as efficient in reflecting precise information as was the Mandatory Price Reporting system.

Introduction

Price integration in fed cattle markets has been a significant subject of debate among Agricultural Economics researchers and industry participants. The issues derive its roots from geographical distance between production and consumptions areas, perishable nature of fed cattle and considerable transportation cost. All these factors accumulate to suggest a potential geographic segmentation in the fed cattle market. It is needless to say that price information is a vital component of supply and demand decisions. Imperfect information flow among regional markets can cause inaccurate information about prices. In this case price differences among markets may not reflect true economic factors (Schroeder and Goodwin, 1991).

Prior to 2001, fed cattle industry participants mostly, used to rely on reports generated by Agriculture Marketing Service (AMS) of United States Department of Agriculture, for price discovery. These reports that were generated based on voluntary price reporting system, began to come under question in late 1990s as farmers adopted alternative methods of selling cattle such as contracts and formula pricing. Information on these alternative sale methods was missing from AMS reports. By year 2002, 44% of the fed cattle were sold using these alternative methods (USDA/GISPA, 2004). To address this issue Mandatory Price Reporting Act of 1999 was passed by the US Congress. This Act that came into effect in April 1999, required slaughtering plants to report information of prices, purchase contracts and formula price agreements to AMS twice every day (Perry et.al, 2005). The MPR expired in September 2005 after which it was not renewed. Pendell and Schroeder (2006**)** tested the effect of increased information in the public domain due to MPR on the price integration in 5 regional fed cattle markets namely Colorado Direct, Iowa-Minnesota Direct, Western Kansas Direct, Nebraska Direct and Texas Oklahoma Direct. Their results suggested following the introduction of MPR the regional markets became more integrated.

Given that MPR became void in 2005, and basic source of information for price discovery is based on voluntary price reporting to AMS, whether the prices are still cointegrated is a question. The main objective of this research work was to estimate the effect of 'Mandatory Price Reporting' on the market cointegration of US fed cattle market. To obtain the market cointegartion, Pendell and Schroeder (2006**)** cointegration methodology was followed in the above mentioned regional markets on update data that ranges from May 2001 to March 2015.

Materials and Methods

The Engle-Granger (1987) methodology was followed to test any long run equilibrium relationship between the two price series. First was to test the unit root in each of the price series using Dickey Fuller and Augmented Dickey Fuller tests. The null hypothesis of unit root (non-stationarity) at 5 % significance level was failed to reject. However, after taking the first difference the series became stationary even at 1 % level, suggesting that price series are integrated of order one I(1). Next step was to test the bivariate long run relationship in the following form:

$$y_t = \propto + \beta x_t + \epsilon_t \quad \ldots (1)$$

Where y_t and x_t represent the two price series, $\propto, \beta \; and \; \epsilon_t$ are intercept, slope and error term respectively. In order to test the cointergartion of y_t and x_t the stationarity of the estimated residuals $\widehat{\epsilon_t}$ form equation (1) was tested. If the estimated residuals are stationary, y_t and x_t are cointegrated of order (1, 1). Dickey Fuller test on these estimated residuals was applied to test their order of integration the auto regression of estimated residuals is given as:

$$\Delta\widehat{\epsilon_t} = a_1\widehat{\epsilon_t}_{t-1} + \theta_t \quad \ldots. (2)$$

If the null hypothesis is failed to reject that $|a_1| = 0$, y_t and x_t are cointegrated of order (1,1) (Enders , 1995).

To test the multivariate cointegration Johansen (1988) method based on Trace Statistic and Maximum Eigen Value Static was followed. The basic rule is that if for n series it is obtaind n-1 cointegrating vectors all n series are pairwise cointegrated. However, if less than n-1 cointegrating vectors was obtained the series were not fully cointegrated. Additionally, Gregory-Hansen (1996) test was used to observe any structural changes in the price series.

Data description

Weekly price series for five regional markets namely Colorado Direct, Iowa-Minnesota Direct, Western Kansas Direct, Nebraska Direct and Texas Oklahoma Direct were assembled from AMS reports available at Livestock Marketing Information Center (For this exercise all the data was collected and provided by Dr. Ted C. Schroeder, Professor and Director of Center for Risk Management at Kansas State University). Price information was available for different qualities of both live and dressed steers and heifers. A composite combined price series (one for each market) was constructed for analysis simplification and other practical purposes. For this purpose firstly, weighted average price series for all qualities was calculated for steers and heifers separately for each respective market. Next step was to convert the dressed prices into equivalent live prices using following formula:

$$Converted\ Price_{ij} = \frac{National\ Average\ Dressed\ Weight}{National\ Average\ Live\ Weight} \times Average\ Dressed\ Price_{ij} - 0.5$$

where i=1,2,…,5 represents the five regional markets being analyzed and $j = 1,2$ represents steers and heifers. -0.5 represents \$0.5/cwt transportation cost. Now for each respective market, combined dressed and live prices for steers and heifers were calculated as follows:

$$Combined\ \ Price_{ij} = \frac{(N_{ij}^{Live} \times Average\ live\ Price_{ij}) + (N_{ij}^{Dressed} \times Converted\ Price_{ij})}{(N_{ij}^{Live} + N_{ij}^{Dressed})}$$

N_{ij}^{Live} means the number of live animals traded in market i for category j (steers or heifers). Similarly, $N_{ij}^{Dressed}$ means number of dressed animals traded in market i for category j. Finally, a composite combined volume weighted average price series including information on both steers and heifers, one for each market was constructed as follows:

$$Composite\ Combined\ \ Price_i = \frac{(N_{ij} \times Combined\ \ Price_{ij})|_{j=1} + (N_{ij} \times Combined\ \ Price_{ij})|_{j=2}}{(N_{ij}^{Live} + N_{ij}^{Dressed})}$$

Where N_{ij} represents number of animals traded in market i for category j.

The weekly price series range from May 2001 to March 2015. The summary statistics are illustrated in table 1. No trade occurred in first three weeks of October 2013 and this period has been removed from the analysis. There is an increasing trend in the price series over time as can be seen in the Figure 1.

Table 1. Summary statistics of weekly regional fed cattle prices, May 2001-March 2015

Regional Market	Number of Observations	Mean ($/cwt)	Std. Dev. ($/cwt)	Minimum ($/cwt)	Maximum ($/cwt)
Colorado	719	98.94	24.76	58.69	173.14
Iowa-Minnesota	719	98.83	24.69	61.82	170.33
Kansas	719	98.56	24.47	61.32	172.83
Nebraska	719	99.22	24.81	61.76	171.53
Texsas-Oklahoma	719	98.53	24.39	60.24	173.00

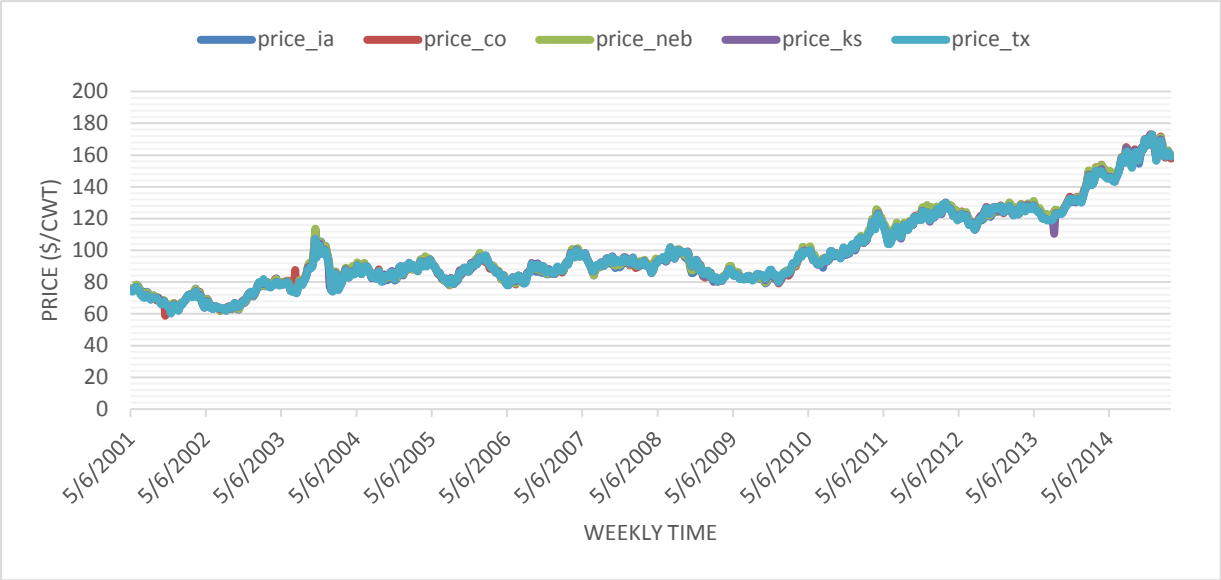

Figure 1. Weekly regional fed cattle prices ($/cwt) May 2001-March 2015

Results and Discussion

Stationarity Test

In graph 1, it was observed that the price series have an upward trend with time. To test whether this was a deterministic time trend stationary series: $y_t = \propto t + \varepsilon_t$ … (a) Or,
A random walk (non-stationary time series):$y_t = \propto + y_t + \varepsilon_t$ … (b)
A time trend in the standard Augmented Dickey Fuller Test is included as follows:
$\Delta y_t = \propto + \delta y_{t-1} + \gamma t + \varepsilon_t$ … (c)

Here term γt represents the time trend. The null hypothesis was tested that $\delta = 0$ against alternative hypothesis that $\delta < 0$ using Dickey Fuller Test and Augmented Dickey Fuller Test for each of five prices series. The results indicated that the null hypothesis of unit root at 5 % significance level was failed to reject. To check whether the series was integrated of order 1, first difference of each price series was taken and data series were tested for non-stationarity again. Now, price series were found to be stationary at 1% significance level. Hence the price series were declared to be integrated of order 1.

Table 2. Dickey Fuller and Augmented Dickey Fuller tests for unit root without differencing price series

Regional Market	Dickey Fuller Test	Augmented Dickey Fuller Test	
	5 % Critical value (-2.86)	2 Lags 5 % Critical value (2.86)	2 Lags (with trend) 5 % Critical value (-3.41)
Colorado	-0.533	-0.012	-2.033
Iowa-Minnesota	-0.123	+0.189	-1.859
Kansas	-0.283	+0.060	-2.009
Nebraska	-0.243	+0.211	-1.808
Texas-Oklahoma	-0.205	+1.89	-1.900

Table 3. Dickey Fuller and Augmented Dickey Fuller tests for unit root after taking first difference of price series

Regional Market	Dickey Fuller Test	Augmented Dickey Fuller Test	
	1 % Critical value (-3.43)	2 Lags 1 % Critical value (3.43)	2 Lags (with trend) 1 % Critical value (-3.96)
Colorado	-28.289	-18.131	-18.173
Iowa-Minnesota	-24.085	-16.591	-16.644
Kansas	-24.694	-17.008	-17.053
Nebraska	-24.149	-16.656	-16.705
Texas-Oklahoma	-24.394	-17.097	-17.148

Cointegration

Given that price series were all integrated of order 1, Gregory Hansen Bivariate test and Johansen's Multivariate Cointegration tests were applied to the price series in levels to examine any long run relationship among price series. The Gregory Hansen test was used to test four types of structural changes in regional market prices or put differently Four types of structural breaks in the cointegration vectors: i) Break in level, it specifies break in the constant term ii) Break in trend, it specifies break in the constant and trend iii) Change in regime, it specifies change in constant and slope iv) Change

in regime and trend, it specifies change in constant slope and trend. Lag length was selected according to the minimum Akaike information criterion. Generally the lag length was 3 for all bivariate tests. Table 4 illustrates the ADF t-statistic for all bivariate cointergration tests. The tests' results rejected the null hypothesis of no cointegration is rejected for all models at 1 % significance level, across all fed cattle markets.

In order to further investigate the results Johansen's test was used for cointegration in two formats; first with a linear trend in cointegration equation and second with an unrestricted constant in the model. The results for both formats are provided in Table 5(a) and Table 5(b). The results on both Trace Statistic and Maximum Eigen Value Statistic indicated that four conintegration vectors was observed when allowing for a linear trend in the cointegration equation. In other words price series in all five regional fed cattle markets observed the same stochastic trend. However, the results in Table 5(b) indicated that only three cointegration vectors implying that price series were not fully cointegrated.

Table 4. Augmented Dickey Fuller cointegration test results for weekly regional fed cattle prices

Dependent Market/ Independent Market	Break in Level	Break in Trend	Change in Regime	Change in Regime and Trend
Colorado/Iowa-Minnesota	-6.55	-6.63	-6.62	-6.89
Colorado/Kansas	-9.32	-9.41	-9.51	-9.64
Colorado/Nebraska	-6.98	-7.30	-7.04	-7.76
Colorado/Texas-Oklahoma	-8.96	-8.98	-9.19	-9.20
Iowa-Minnesota/Kansas	-7.03	-7.22	-7.15	-7.38
Iowa-Minnesota/Nebraska	-7.72	-7.90	-7.73	-7.92
Iowa-Minnesota/Texas-Oklahoma	-7.04	-7.18	-7.06	-7.29
Kansas/Nebraska	-7.42	-7.64	-7.58	-8.07
Kansas/Texas-Oklahoma	-16.31	-16.41	-16.34	-16.64
Nebraska/Texas-Oklahoma	-7.11	-7.26	-7.23	-7.60
1 % Critical Value	-5.13	-5.45	-5.47	-6.02

Table 5(a). Johansen's Tests for Cointegration with a Linear Trend in Cointegration Equation

Maximum Rank	Trace Statistic	5 % Critical Value
0	298.681	77.74
1	181.090	54.64
2	99.177	34.55
3	44.379	18.17
4	5.554	3.74
Maximum Rank	Maximum Eigen Value	5 % Critical Value
0	117.591	36.41
1	81.913	30.33
2	54.799	23.78
3	38.825	16.87
4	5.554	3.74

Table 5(b). Johansen's tests for cointegration with an unrestricted constant in the model

Maximum Rank	Trace Statistic	5 % Critical Value
0	267.342	68.52
1	169.463	47.21
2	87.775	29.68
3	38.805	15.41
4	0.0325*	3.76
Maximum Rank	Maximum Eigen Value	5 % Critical Value
0	97.879	33.460
1	81.688	27.070
2	48.971	20.970
3	38.772	14.070
4	0.033	3.760

Conclusion

Given that information on price plays a decisive role in supply and demand decisions, any inefficiency in price discovery can lead to imperfect decisions. More precise information flows in the integrated markets leaving less room for price difference and arbitrage opportunities. The Mandatory Price Reporting Act of 1999 surely improved the cointegration among the regional fed cattle markets (Pendell and Schroeder, 2006). In order to test whether the markets remained cointegrated following the annulment of Mandatory Price Reporting, the same methodology was followed as that used by Pendell and Schroeder, (2006**)** using price data ranging from May 2001 to March 2015 on the same regional markets. Engel-Granger, Gregory-Hansen bivariate test with structural breaks and Johansen's cointergation test allowing linear trend in the cointegration equation indicated that price series were cointegrated in all five markets. However, Johansen's cointegration test with an unrestricted constant term indicated that price series were not fully cointergrated. It can be

conveniently predicted that following the annulment of MPR, the voluntary price reporting system is as efficient in reflecting precise information as was the Mandatory Price Reporting system. Further investigation may be carried about the integration effects of disaggregated price levels such as different quality scales of fed cattle.

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