

Impact of Mandatory Price Reporting on Fed Cattle Market Integration

Dustin L. Pendell and Ted C. Schroeder

Geographic fed cattle markets are important because cattle are bulky and perishable, and production and consumption areas are separated. These characteristics make cattle transportation costly and can contribute to segmented markets. This study uses USDA-AMS reported fed cattle market price data from five U.S. regional fed cattle markets to investigate the effects of mandatory price reporting on spatial market integration. Results indicate these markets have been, and remain, highly cointegrated after implementation of mandatory price reporting (MPR). Following introduction of mandatory price reporting, the five regional fed cattle markets have become more fully integrated (i.e., prices tend to move more closely one-for-one following introduction of MPR).

Key words: cattle markets, cointegration, mandatory price reporting, market integration, regime shift

Introduction

Understanding geographic markets in the cattle industry is important because cattle are bulky and perishable, and production and consumption areas are separated; hence, transportation is costly. As a result, potential for spatial market segmentation exists in fed cattle. Further, high levels of concentration in beef packing, with a four-firm concentration of about 80% in fed steer and heifer slaughter [U.S. Department of Agriculture/Grain Inspection, Packers and Stockyards Administration (USDA/GIPSA), 2004], makes ongoing monitoring of spatial cattle prices important for assessing market efficiency (Azzam and Anderson, 1996).

Market integration usually considers the time frame and the extent to which shocks are transmitted among spatially separated markets. Markets that are not integrated could reflect imprecise price information which may alter producer marketing decisions and could be evidence of market segmentation and/or potential manipulation. In addition, with declining cattle volumes in some regions and increasing cattle volumes in other regions, regional cattle prices could diverge because of poor information flow across regions. In the presence of these influences, price changes across market regions may not fully reflect relevant economic conditions (Goodwin and Schroeder, 1991).

Prior to livestock mandatory price reporting (MPR), producers relied on the USDA's Agricultural Marketing Service (AMS) livestock market news reports for fed cattle price

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information. These reports were generated from voluntarily reported prices to AMS market reporters by producers, packers, feedlot operators, and other participants in the cattle industry. However, over the past two decades, cattle feeding consolidated and shifted from smaller feedlots to the larger commercial feedlots. In addition, cattle feeders began to rapidly adopt alternative methods to sell cattle, including contracts and marketing agreements, which were not part of the AMS voluntary fed cattle price reports (Perry et al., 2005). By 2002, 44% of fed cattle marketed were sold through these alternative methods (USDA/GIPSA, 2004).

As a result of increased contracting and formula pricing agreements, frequently there are insufficient daily prices collected from regional fed cattle markets for AMS reporters to even report a market price quote (USDA, 2001). Consequently, the voluntary reporting system was criticized by some industry participants for not being representative of all cattle trade and not having a consistently reliable price publicly quoted (Grunewald, Schroeder, and Ward, 2004). To address these issues while attempting to help facilitate price discovery, encourage competition, and provide all market participants with timely price and transaction information, Congress passed the Livestock Mandatory Reporting Act of 1999.

In April 2001, MPR went into effect and required slaughtering plants (which slaughter 125,000 head of cattle or more, 100,000 head of swine or more, or slaughter/process 75,000 head of lambs or more annually) to report information on pricing, contracting for purchase, formulated sales, and supply and demand conditions twice daily to the AMS (Perry et al., 2005). With more complete price and transaction data available to the public than existed under voluntary reporting, arbitrage opportunities should decrease, and correspondingly, one would expect integration between spatial markets to increase.

In December 2004, when it was due to terminate, the Livestock Mandatory Reporting Act was extended until September 30, 2005. Because Congress could not agree on the length of an extension for MPR, the Act expired in the fall of 2005. However, USDA has continued the livestock reporting program on a voluntary reporting basis. On December 12, 2005, results from a review of MPR by the U.S. Government Accountability Office (GAO) were released. GAO made several recommendations including increasing transparency of market reports by improving market reporters' instructions regarding excluded transactions and reporting those effects of the excluded transactions, and auditing transactions from packers because of errors discovered by GAO in price reporting by packers (Ward, 2006).

The objective of this study is to empirically test how mandatory price reporting has influenced spatial market integration among five major U.S. regional fed cattle markets. After considerable controversy and problems surrounding MPR (e.g., see Grunewald, Schroeder, and Ward, 2004), a clearer understanding of market integration after MPR has important implications. These implications include price discovery efficiency, defining of geographic markets, overall market performance (since persistent deviations may imply arbitrage opportunities and/or segmented markets), and an assessment of MPR fed cattle price relationships.

Cointegration in Cattle Markets

Cointegration analysis is a popular tool for examining relationships among prices when investigating market integration because most price series tend to be nonstationary.

The Engle and Granger (1987) procedure has been the most commonly used tool in testing for cointegration (Ardeni, 1989; Baffes, 1991; Goodwin and Schroeder, 1991; Schroeder, 1997). Although this procedure for evaluating cointegration is easy to implement, it has been criticized for possessing several deficiencies. For example, in a two-variable case, results can depend upon which price series is used on the left-hand side. This problem is compounded when using three or more price series. In addition, there could be more than one cointegrating vector in multivariate time series. These problems can be dealt with by using Johansen's multivariate cointegration testing procedure (Johansen, 1988). However, Barrett (2001) and Miljkovic and Paul (2001) critique the methods used in analyzing market integration and efficiency in international markets. Barrett (2001) defines market integration as the condition where a product from one market is traded with another market, while market efficiency is related to the satisfaction of zero marginal benefit equilibrium conditions. He argued estimation of integration should rely on flow-based indicators of tradability, while efficiency should be measured with price-based tests for market equilibrium. These conditions apply well to international trade where physical geographic markets have natural barriers.

In domestic fed cattle markets, however, where considerable physical overlap in geographic boundaries is present, cattle flow in both directions—but this does not necessarily imply fully integrated prices if information is incomplete. Our concern here surrounds market information and how this is reflected through spatial price relationships. Given changes in cattle marketing methods over time and in price reporting systems, we are particularly interested in how MPR has changed price relationships, if at all, among regional fed cattle markets.

Cointegration analysis is used to provide a framework for investigating long-run price relationships among five major U.S. regional fed cattle markets. If cattle prices diverge from one another, prices are not cointegrated over time, suggesting segmented geographic markets. In contrast, if the fed cattle markets have cointegrated prices, then the markets are operating in stable long-run spatial price equilibrium.

Previous Research

A considerable body of research has investigated market integration issues both domestically and internationally (e.g., Asche, Bremnes, and Wessels, 1999; González-Rivera and Helfand, 2001; Goodwin, 1993; Goodwin and Piggott, 2001; Padilla-Bernal, Thilmany, and Loureiro, 2003; Sexton, Kling, and Carman, 1991). In addition, several studies have explicitly examined cointegration and dynamics of spatial price behavior in fed cattle markets (e.g., Bailey and Brorsen, 1985; Fausti and Diersen, 2004; Goodwin and Schroeder, 1991; Koontz, Garcia, and Hudson, 1990; Schroeder, 1997; Schroeder and Goodwin, 1990).

Bailey and Brorsen (1985) examined weekly fed cattle prices using a multivariate autoregressive framework in the Texas Panhandle, Omaha, Nebraska, Colorado-Kansas, and Utah-Eastern Nevada-Southern Idaho markets from January 1978 through June 1983. Cattle prices in the Texas Panhandle market led cattle prices in the other three regions, but there was feedback from the Omaha market.

Koontz, Garcia, and Hudson (1990) used Granger causality to identify dominant-satellite relationships. Four direct and four terminal markets were examined using

weekly fed cattle prices over the period January 1973 through December 1984. Direct markets were dominant, with the Nebraska Direct market being the most influential.

Schroeder and Goodwin (1990) examined 11 direct and terminal trade cattle markets from 1976 through 1987. A multivariate vector autoregressive (VAR) model was applied using weekly average slaughter steer price data. Cattle markets with larger volumes fully reacted to price changes at the other major cattle markets usually within one or two weeks. However, cattle markets with smaller volumes took two to three weeks to fully respond to price changes in larger-volume cattle markets.

Using weekly price data for slaughter steers over the January 1980 to September 1987 period, Goodwin and Schroeder (1991) tested cointegration and spatial price linkages for 11 U.S. regional slaughter cattle markets. They also examined how market characteristics were related to the strength of cointegration. Cointegration over time increased, but paralleled with increasing concentration in cattle slaughtering. Also, market pricing was influenced by distances between the cattle markets.

Schroeder (1997) investigated daily dressed fed cattle prices from March 23, 1992 through April 3, 1993, at 28 beef packing plants to determine spatial price relationships. Nebraska plants reacted the fastest to price changes, implying Nebraska plants were price leaders and a significant source of price information. Distances between cattle markets, size and ownership of packing plants, and procurement methods of cattle all affected the degree of cointegration.

Fausti and Diersen (2004) examined the relationship between voluntary reported prices for Nebraska Direct and mandatory reported spot market prices in South Dakota from September 1999 through March 2001. Daily fed cattle transaction data from the South Dakota Department of Agriculture and the Agricultural Marketing Service were used to assess price relationships. No evidence of strategic price reporting under voluntary price reporting systems was present relative to South Dakota's MPR system. The authors concluded that the voluntary price reporting system contributed as much to price transparency and discovery as did the mandatory system.

Our analysis extends the work of earlier studies in several important ways. First, aside from Fausti and Diersen (2004), all of these previous spatial fed cattle market studies use data that are more than 10 years old. Given the substantial changes that have occurred over the past decade in the way fed cattle are marketed (e.g., Schroeder et al., 2002), a current assessment of spatial fed cattle market integration is past due. To date, no previous published research has incorporated federal MPR data collected by the USDA in testing and assessing market integration. Mandatory price reporting was launched largely to facilitate price discovery by providing increased market transparency. If this objective has occurred, then we might expect regional cash market cattle prices to be more highly integrated since introduction of MPR. Mandatory price reporting data are integrated into this research to assess the impact of mandatory reporting on spatial market integration in livestock markets. Results can be used to draw implications for pricing efficiency within these regional cattle markets and to determine whether federal MPR has changed spatial market integration.

Methods and Procedures

The procedure used to examine how spatially distant fed cattle markets are linked together via prices (i.e., regional market prices should not diverge from one another in

the long run) utilizes a cointegration approach. Bivariate and multivariate time-series models are used when examining spatial market integration relationships. The first step in testing for cointegration in the bivariate or multivariate framework is to test each individual price series to determine if the series are nonstationary. The augmented Dickey-Fuller (ADF) unit root test can be used to test if the series contains a unit root. If the null hypothesis that the series contains a unit root is not rejected, then the series is nonstationary. If the price series are nonstationary in levels and their first differences are stationary, then the next step is to estimate the long-run equilibrium relationship.

To test for cointegration between two spatial markets, a procedure suggested by Engle and Granger (1987) was used. This widely applied method begins by using ordinary least squares (OLS) as follows.

$$(1) \text{ Model I, Standard Cointegration: } Y_t = \alpha_0 + \alpha_1 Z_t + e_t,$$

where Y_t and Z_t are the individual price series; α_0 and α_1 are the intercept and slope coefficients, respectively; and e_t is the error term. To determine if the price series are cointegrated, a test is conducted for stationarity of the estimated residual series from equation (1) via an ADF test. If there is a unit root, then the two price series are nonstationary, implying that Y_t and Z_t are not cointegrated.

Testing for cointegration in a multivariate framework is commonly performed using the Johansen Cointegration Test procedure. This multivariate framework follows that used by Asche, Bremnes, and Wessels (1999) and González-Rivera and Helfand (2001). Specifically, with prices in n locations and r cointegration vectors, there will be $n - r$ stochastic trends (Stock and Watson, 1988). If all of the five regional cattle market price series (i.e., n locations) have the same stochastic trend, then there must be four cointegrating vectors (i.e., $n - 1$ cointegrating vectors). If there are $n - 1$ cointegrating vectors present, this implies that all prices are pairwise cointegrated. If there is more than one common trend, the price series are not considered fully integrated.

Johansen (1988) suggests two test statistics (*trace* and *maximum eigenvalue*) to test for the number of cointegration vectors in the system. The null hypothesis for these two tests is that there are at most r cointegrating vectors. The alternative hypothesis for the trace test statistic is that there exist more than r cointegration vectors. The alternative hypothesis for the maximum eigenvalue test statistic is that there are exactly $r + 1$ cointegration vectors. Both of these test statistics follow a nonstandard distribution and the critical values are provided by Osterwald-Lenum (1992).

The potential for structural change in fed cattle price relationships may have occurred with the inception of mandatory price reporting by AMS. Structural change in the price series could result in a significant change among the cointegration parameters or even the existence of cointegrating relationships. Because mandatory price reporting could have caused a structural change in the long-run relationships among the regional prices, a procedure which allows for the possibility of a structural break at the introduction of MPR was used. Gregory and Hansen (1996) developed a set of residual-based tests for cointegration that allow for the possibility of a regime shift. Similar to the Engle-Granger method, the cointegrating relationship is estimated by OLS.

Equation (2) is used to model the cointegrating relation with a possible structural change. This model allows for structural change in the intercept and the slope vector (i.e., permits the equilibrium equation to rotate as well as have a parallel shift).

$$(2) \text{ Model II, Regime Shift: } Y_t = \alpha_0 + \alpha_1 D_t + \alpha_2 Z_t + \alpha_3 Z_t D_t + e_t,$$

where Y_t , Z_t , and e_t are as defined above. A dummy variable is represented by D_t (where $D = 1$ after implementation of MPR, and $D = 0$ otherwise); α_0 represents the intercept before the shift; α_1 represents the change in the intercept after the regime shift; α_2 denotes the cointegrating slope coefficients before the regime shift; and α_3 denotes the change in the slope coefficients following the regime change. An ADF unit root test is applied to the regression errors in equation (2) to test for cointegration. However, the critical values for the ADF test are different than equation (1) and are reported in Gregory and Hansen (1996).

Results from estimating equations (1) and (2) for each set of pairwise regional fed cattle markets provide us with important information to test several hypotheses. First, by comparing cointegration results between (1) and (2), we can determine whether launching of MPR materially affected the long-run price relationship from the perspective of cointegration. If all markets are (or are not) cointegrated under both model specifications, then we can conclude that introduction of MPR did not change the long-run spatial stable equilibrium among the regional markets. Second, information gleaned from particular coefficient estimates in (2) can provide further information about the level of integration among these markets pre- and post-MPR. For example, if α_3 is not statistically different from zero, this suggests that no change has occurred in how prices in one market respond to, or relate to, prices in the other market pre- and post-MPR. Alternatively, if α_3 is different from zero, we conclude that the nature of the price relationship has changed among regional markets post-MPR. Further, comparing the estimate of α_2 to $\alpha_2 + \alpha_3$ allows us to assess whether prices post-MPR move more or less on a one-for-one (i.e., perfectly integrated) basis relative to pre-MPR.

Data

The composite weighted-average weekly price series for both dressed and live steers and heifers were assembled for five U.S. regional markets over January 1992 to June 2006. A composite combined dressed and live steer and heifer volume-weighted-average price was constructed for each regional market to represent the fed cattle price at each market.¹ The data were all from AMS reports and obtained from the Livestock Marketing Information Center. Price data were collected for the regional cattle markets of Nebraska Direct, Colorado Direct, Western Kansas Direct, Texas-Oklahoma Panhandle Direct, and Iowa-Southern Minnesota Direct. These five markets were selected because they are the only markets for which fed cattle price data have been continuously collected and reported since inception of mandatory price reporting. In addition, these

¹The average price was calculated by first converting dressed prices to live prices for both steers and heifers. This was done by dividing the national average dressed weight for steers and heifers by the national average live weight multiplied by the respective reported dressed prices. A \$0.50/cwt live weight transportation cost was subtracted and the dressed prices were converted to live prices for both steers and heifers (i.e., converted dressed steer and converted dressed heifer prices). Next, a weighted-average of the converted dressed prices and live prices was calculated for both steers and heifers (i.e., combined live and dressed steer prices and combined live and dressed heifer prices). This was calculated by adding the number of live cattle marketed multiplied by the live price and number of dressed cattle marketed multiplied by the converted dressed price, all divided by the total number of live and dressed cattle for both steers and heifers. Finally, a weighted-average of the combined live and dressed steer prices and combined live and dressed heifer prices was constructed, resulting in the composite combined dressed and live steer and heifer volume-weighted-average price.

Table 1. Summary Statistics of Weekly Regional Fed Cattle Prices, January 1992–June 2006

Regional Market	No. of Observations	Mean (\$/cwt)	Std. Dev. (\$/cwt)	Minimum (\$/cwt)	Maximum (\$/cwt)
Colorado	754	71.99	9.29	55.20	112.41
Iowa-Minnesota	754	72.37	9.20	55.49	112.78
Kansas	754	72.62	9.12	55.92	107.21
Nebraska	754	72.40	9.05	55.66	112.80
Texas-Oklahoma	754	72.76	9.18	55.50	107.31

regional markets represent the vast majority of fed cattle marketed (e.g., they represented more than 80% of total U.S. fed cattle marketed in 2005). Summary statistics of the weekly price series are presented in table 1.

The five USDA weekly regional cattle markets had a small number of prices that were not reported. The total number of missing prices was 28, approximately 0.7% of the total data points across time and location. Missing prices were replaced by using predicted values from a regression of each series on the five-area weekly-weighted average price over the entire time period.

Results

Stationarity Tests

The first step in analysis of regional cattle market price integration was to test non-stationarity of the individual price series. The ADF unit root test was utilized to test the null hypothesis of a unit root in each of the five price series. Results indicate the price series were all nonstationary in levels at the 5% significance level. After first differencing the prices, all five data series were stationary at the 1% significance level, or they were integrated of order one [I(1)]. Given that the data series were all I(1), cointegration tests were applied to the price series in levels.

Cointegration Tests

Because the price series were nonstationary and integrated to the same order, Engle-Granger bivariate and Johansen's multivariate cointegration tests were used to investigate the long-run relationships between market prices. To determine whether MPR caused a structural change in regional market price relationships, Gregory-Hansen bivariate cointegration tests were used. The minimum value of the Akaike information criterion was used to determine appropriate lag lengths.² Two-week and three-week lags were used for bivariate tests and six-week lags for the multivariate test.

The ADF tests (table 2) for all of the bivariate tests for the standard cointegration model without allowing for structural change (Model I) supported cointegration at the 5% level across the five regional cattle markets. On a weekly basis there was a long-run

²The modeling process began with a single-week lag and lag lengths were added subsequently until the Akaike information criterion began to increase.

Table 2. Augmented Dickey-Fuller Cointegration Test Results of Weekly Regional Fed Cattle Prices

Dependent Market/Independent Market	Model I Test Statistic	Model II Test Statistic
Colorado/Iowa-Minnesota	-7.781*	-7.868*
Colorado/Kansas	-6.880*	-7.739*
Colorado/Nebraska	-7.439*	-7.558*
Colorado/Texas-Oklahoma	-6.976*	-7.487*
Iowa-Minnesota/Kansas	-6.664*	-7.291*
Iowa-Minnesota/Nebraska	-7.741*	-9.030*
Iowa-Minnesota/Texas-Oklahoma	-7.097*	-7.541*
Kansas/Nebraska	-6.732*	-7.120*
Kansas/Texas-Oklahoma	-11.844*	-12.120*
Nebraska/Texas-Oklahoma	-7.793*	-9.029*

Notes: An asterisk (*) denotes statistical significance at the 1% level. Critical values for Model I and Model II at the 1% significance level are -3.90 and -5.47, respectively.

spatial equilibrium price relationship among all five regional fed cattle markets, indicating prices did not significantly diverge from one another. Further confirmation of this result was made by conducting the Johansen trace and maximum eigenvalue tests. These test statistics indicated that there were four cointegrating vectors among the five regional fed cattle market price series (not reported in tabular form here).³ Therefore, prices across all five regional markets followed the same stochastic trend during this roughly 15-year period. These cointegration tests indicate that there is no need to test for a regime shift associated with MPR because the regional market prices were cointegrated even without considering a regime shift. However, additional information about market price relationships following introduction of MPR can be garnered from the regime shift analysis. Therefore, the regime change cointegration analysis was also performed.

Cointegration tests allowing for structural change in the regional fed cattle price relationships beginning with the launching of MPR in April 2001 were conducted. The null hypothesis of no cointegration was rejected at the 1% level using the regime shift bivariate cointegration tests. Therefore, these markets were all cointegrated with one another after allowing for a structural break in the five regional fed cattle price relationships following introduction of MPR (table 2).

Regime Shifts

Further analysis of the regime shift model reveals several interesting results. Although the cointegration tests imply there was no structural break in cointegration with introduction of MPR, the degree of integration among the regional fed cattle markets has changed. The statistically significant estimated regime coefficients in Model II (α_3) imply fed cattle prices between most of the regional markets have become more highly

³ Multivariate Johansen test results are not reported here to conserve space, but are available from the authors upon request.

Table 3. Parameter Estimates from the Regime Shift Model (Model II) of Weekly Regional Fed Cattle Prices

Dependent Market/ Independent Market ^a	Constant	α_2 State	α_1 Post-MPR Dummy	α_3 Post-MPR Regime	H ₀ : $\alpha_2 = 1$ (p-Value)	H ₀ : $\alpha_2 + \alpha_3 = 1$ (p-Value)
Colorado/ Iowa-Minnesota	-1.760** (0.559)	1.021** (0.008)	0.773 (0.750)	-0.014 (0.010)	0.01	0.29
Colorado/ Kansas	1.457** (0.485)	0.966** (0.007)	-1.937** (0.664)	0.038** (0.009)	0.00	0.51
Colorado/ Nebraska	-2.212** (0.440)	1.024** (0.006)	1.259** (0.588)	-0.014* (0.008)	0.00	0.04
Colorado/ Texas-Oklahoma	1.426** (0.488)	0.966** (0.007)	-2.252** (0.670)	0.039** (0.009)	0.00	0.42
Iowa-Minnesota/ Kansas	4.385** (0.619)	0.929** (0.009)	-3.000** (0.848)	0.058** (0.012)	0.00	0.05
Iowa-Minnesota/ Nebraska	0.017 (0.348)	0.997** (0.005)	0.584 (0.465)	-0.0004 (0.006)	0.51	0.33
Iowa-Minnesota/ Texas-Oklahoma	4.363** (0.648)	0.928** (0.009)	-3.186** (0.889)	0.057** (0.012)	0.00	0.05
Kansas/ Nebraska	-3.066** (0.587)	1.050** (0.009)	3.589** (0.785)	-0.056** (0.011)	0.00	0.34
Kansas/ Texas-Oklahoma	0.073 (0.286)	0.998** (0.004)	-0.172 (0.393)	-0.0001 (0.005)	0.62	0.53
Nebraska/ Texas-Oklahoma	4.345** (0.546)	0.931** (0.008)	-3.817** (0.750)	0.058** (0.010)	0.00	0.11

Notes: Single and double asterisks (*) denote statistical significance at the 10% and 1% levels, respectively. Values in parentheses are standard errors.

^a Based on the overall results, the conclusions do not change when the dependent variable and the independent variable are switched (i.e., the dependent variable moves from the RHS to the LHS and the independent variable moves from the LHS to the RHS).

integrated (table 3). For example, in the Colorado/Kansas (i.e., dependent/independent variables) model, the estimated price coefficient pre-MPR (α_2) for Kansas price is 0.966. This means a \$1/cwt increase in the price of Kansas fed cattle was typically associated with a \$0.966/cwt increase in Colorado fed cattle price. The estimated regime coefficient estimate (α_3) of 0.038 (statistically significant at the 1% level) implies after MPR was introduced the Colorado price increases one-for-one (i.e., $0.966 + 0.038 = 1.004$) with Kansas price. In other words, the Colorado and Kansas fed cattle prices are closer to fully integrated after introduction of MPR.

Formal tests were conducted across all pairwise market comparisons of two hypotheses testing for fully integrated markets pre- and post-MPR:

- H₀: $\alpha_2 = 1$ (full integration test pre-MPR), and
- H₀: $\alpha_2 + \alpha_3 = 1$ (full integration test post-MPR).

The first test of one-for-one integration pre-MPR was rejected at the 5% level in every pairwise model estimated except the Iowa-Minnesota/Nebraska; and Kansas/Texas-Oklahoma markets (table 3). These findings suggest that prior to introduction of MPR, these particular markets were integrated with one-to-one price relationships. This is not

surprising given the similarities of these two pairs of markets with each other in geographic location and cattle type. However, the remaining markets were not fully integrated (i.e., the null that $\alpha_2 = 1$ was rejected).

All the estimated models failed to reject the second null hypothesis ($H_0: \alpha_2 + \alpha_3 = 1$) at the 5% level, except Colorado/Nebraska; Iowa-Minnesota/Kansas; and Iowa-Minnesota/Texas-Oklahoma. Even for the noted exceptions where we rejected the second null, sums of the estimated coefficients on the state (α_2) and regime (α_3) variables were closer to one than was α_2 . This indicates that following introduction of MPR, most of these regional markets became more fully integrated, with one-for-one price changes tending to occur across location.

Conclusions and Implications

The importance of market integration has been documented by numerous studies. Specifically in cattle markets, spatial price relationships have important implications in defining geographic markets, promoting price discovery, and assessing market performance. This study contributes to the fed cattle market integration literature because it is the first study to explicitly examine the effects of spatial market integration as a result of the Livestock Mandatory Reporting Act enacted in April 2001. Because the legislation for the Act expired in the fall of 2005, and Congress continues to debate the possible extension of MPR, information about its impact and effectiveness is timely.

This study used both bivariate and multivariate cointegration tests to examine the price relationships among five regional cattle markets (Colorado, Iowa-Southern Minnesota, Kansas, Nebraska, and Texas-Oklahoma). All of the weekly price series were nonstationary in levels and stationary in differences. The Engle-Granger bivariate and Johansen's cointegration test indicated a long-run relationship among all five regional fed cattle markets. Gregory-Hansen bivariate tests also reveal that the markets are cointegrated regardless of whether we allowed for a structural change in the relationship at the onset of MPR. The implication is that these markets have been, and remain, highly cointegrated, and they do not tend to diverge from one another in the long run. This result is consistent with studies reporting that the AMS' voluntarily reported fed cattle prices have not been materially different from prices reported under MPR. This finding raises questions regarding the value of MPR from just the standpoint of cash market negotiated price reporting (e.g., Fausti, Qasmi, and Diersen, 2005). Other information introduced with MPR, such as reporting of contract and marketing agreement prices, is of course a separate issue related to the potential value of MPR and is deserving of future research.

However, following the introduction of MPR, the five regional fed cattle markets became more integrated. That is, prices tend to move more closely one-for-one following introduction of MPR across these markets. A couple of possible explanations exist. Perhaps MPR has increased the content of price information and the level of trust in the information by users prior to MPR. Perry et al. (2005) indicate that with MPR, more than 90% of commercial cattle slaughter was contained in market report summaries compared to less than 60% in the latter days of voluntary reporting. This is consistent with the information content increasing under MPR. In addition, MPR provided new price information not previously available about cattle sold under contracts and

marketing agreements, and this could enhance spatial market efficiency by providing market participants broader sets of information potentially relevant to price discovery. Perhaps market reporters who were using subjective price filters in reporting prior to MPR were causing reported prices to be less integrated than they actually were. However, the 2005 GAO report notes that even under MPR, filtered prices have potentially biased reported fed cattle prices.

Overall, this research increases our understanding of price relationships among regional fed cattle markets and the role mandatory price reporting has played in these relationships. Further investigation is needed as to what value additional information about contracts, marketing agreements, and boxed beef price reporting (launched with MPR) might have for price discovery efficiency. Of course, benefits of any increase in price efficiency that might be present would need to be compared to costs of the price reporting system.

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