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**Mandatory Versus Voluntary Price Reporting:
An Empirical Investigation of the
Market Transparency Controversy**

by

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ABSTRACT

The ability of the former voluntary price reporting system to generate market transparency in U.S. livestock markets was called into question by producer groups and academic research prior to the new federal system of mandatory price reporting being implemented. The market transparency issue is investigated by comparing price data collected from the former AMS voluntary price reporting system to mandatory price reporting data for live slaughter steers collected by the State of South Dakota before the advent of the new federal system. The relationship between a set of public price report series and the South Dakota mandatory price series is analyzed using cointegration techniques. The empirical findings indicate a strong long-run and short-run integrated relationship between the mandatory price series and a majority of the selected public price reports. We conclude that in the cash market for live steers in South Dakota, the former voluntary price reporting system did foster market transparency and aided in the price discovery process.

Mandatory Versus Voluntary Price Reporting: An Empirical Investigation of the Market Transparency Controversy

Introduction

Political momentum behind passage of mandatory price reporting legislation at both the state and federal levels originated from lobbying efforts by producer groups concerned over the effects of increased packer concentration and thinning public livestock markets on the accuracy of voluntary price reports, price discovery, and market transparency. The reliability of the former voluntary price reporting system was called into question by proponents of mandatory price reporting, claiming that 1) market transparency was degraded as a result of industry participants failing to report an estimated 30 to 40 percent of all transactions;¹ and 2) there is a propensity for buyers and sellers in the cash market to behave strategically when voluntarily reporting market transactions. This selective price reporting behavior is hypothesized to be the result of strategic behavior of the part of some buyers and sellers to influence publicly reported market prices.² One possible outcome of this type of strategic behavior is the lack of integration between the voluntary price reporting system and actual market transactions,³ with a consequence of ineffective price discovery and market inefficiency. However, only circumstantial empirical evidence has been offered to substantiate the claim that the voluntary price reporting system did not reflect actual market transactions in the fed cattle market before the advent of federal mandatory livestock price reporting regulations.

¹ Wachenhiem and DeVuyst (2001) discuss the issue of price transparency in livestock markets. They report an Agricultural Marketing Service (AMS) estimate that 35% to 40% of all negotiated spot market cattle transactions are not reported under the voluntary price reporting system. Note: Under the former voluntary price reporting system the AMS reported only confirmed transactions to the public.

² Koontz (1999) discusses the issue of strategic price reporting by buyers and sellers under the voluntary price reporting system. Koontz does find empirical evidence to support his hypothesis that packers and feedlots do engage in strategic price reporting and concludes that public price reporting is inefficient under certain market conditions.

³ Lack of "integration" implies that the information contained in public price reports does not accurately reflect market conditions and therefore market transparency is degraded.

The relationship between the former voluntary price reporting system and actual market transactions is at the heart of the debate over mandatory price reporting. The linkage between the former voluntary price reporting system and actual market transactions is investigated using South Dakota Mandatory Price Report (SDMPR) data collected before the implementation of the federal mandatory price reporting system. This issue has national implications because the legislation authorizing the federal mandatory reporting system has a sunset clause and renewal of the legislation will be debated in the near future on the floor of the U.S. Congress.⁴ The debate will likely focus on the cost imposed on the packing industry by mandatory price reporting requirements versus the gain in market transparency.

Our objective is to empirically investigate the relationship between the weekly Agricultural Marketing News Service regional voluntary price reports (AMS 1999-2001) and actual market transactions in the cash market for live steers in South Dakota. The focus is the long-run and short-run spatial relationships between the market information contained in the weekly voluntary price reports and the mandatory report on spot market prices for live steers in South Dakota before the implementation of federal mandatory price reporting rules. The price series data sets will be analyzed to determine if any two price series are cointegrated, which indicates a long-run relationship. If a long-run relationship exists between two price series, then an error correction modeling procedure will be utilized to empirically determine the nature of the short-run relationship.

An empirical investigation into the spatial link between the market information contained in the voluntary price reports and actual market transactions will contribute to the policy debate over the robustness of the former voluntary livestock price reporting system. At this time, the literature contains only ad hoc empirical studies reporting results which cast doubt on the effectiveness of the former voluntary livestock price reporting system for fed cattle. This gap in the literature clouds any policy discussion

⁴ The legislative authorization for federal mandatory livestock price reporting expires October of 2004.

concerning the contribution of the former voluntary price reporting system to price discovery and issues concerning market transparency. We believe our contribution to the literature will promote a more prudent discussion of the issues surrounding the mandatory versus voluntary price reporting debate.

Mandatory vs Voluntary Price Reporting in the Cash Market for Fed Cattle: A Discussion of the Issues

Five states (Iowa, Minnesota, Missouri, Nebraska, and South Dakota) passed variants of mandatory price reporting legislation prior to passage of federal legislation. National mandatory livestock price reporting legislation was passed in October 1999 and the first publicly issued mandatory price report was released on April 2, 2001. The US Congress delegated the responsibility for collecting and reporting transaction data to the AMS. The selection of the AMS was obvious since the AMS has been responsible for operating the national voluntary livestock price reporting system since 1946 (LMPR Review Team 2001).

The passage of federal mandatory price reporting legislation created a new mandatory price reporting system for livestock markets, replacing the system of voluntary price reporting. The information structure of livestock markets and in particular the cash market for live cattle has changed structurally under the new price reporting regime. A number of regional price reports published under the former voluntary system have been discontinued. They are the Montana Direct, South Dakota Direct, California Direct/Arizona Direct/Nevada Direct, Indiana/Michigan/Ohio Direct, Illinois Direct, Wyoming/South Dakota/Nebraska Direct, and Washington/Oregon/Idaho Direct.⁵ These smaller-area regional voluntary price reports have been replaced with more aggregated mandatory price reports. The advantage of these new reports is the breakdown of direct sales into negotiated, formulated, and forward contract reports. The disadvantage is the potential loss of transparency of local market conditions. Aggregation may mask any divergence of local market conditions from conditions reported in aggregate price reports.

⁵ Diersen (2002) discusses the change in the information structure of livestock markets under the new mandatory price reporting regulations.

Critics of the former voluntary price reporting system argued that the reliability of the former reporting system was diminished as a result of increased concentration in the livestock industry and the decline of terminal livestock markets.⁶ As a consequence of these negative factors associated with structural changes in the livestock industry, proponents of mandatory price reporting argued that market efficiency and overall competition have been compromised. However, opponents of mandatory price reporting speculate that the passage of legislation will negatively impact the packing industry because of 1) increased reporting cost, and 2) a loss of confidentiality which may lead to collusive behavior.⁷

Empirical research on the consequences associated with the shortcomings alluded to by the detractors of the former voluntary price reporting system has been limited. An empirical study by Koontz (1999) investigated the potential existence of strategic behavior on the part of buyers and sellers in the spot market for fed cattle. He finds empirical evidence of selective reporting on the part of meat packers and feedlots. Koontz concludes that mandatory price reporting may be necessary. Several experimental economic studies using Oklahoma State University's Fed Cattle Market Simulator reported that increasing public information to participants in the study improves price discovery and market efficiency (Anderson et al. 1998 and Bastian et al. 2001). These experimental studies imply that there is a potential for market inefficiency resulting from the failure of the former voluntary reporting system to provide information on all market transactions.

⁶ Increased concentration in both the packing and feedlot industries, the use of alternative marketing arrangements (marketing agreements, forward contracts, etc.), has resulted in the movement away from terminal market transactions by market participants over the last 30 years. In the spot market for cattle, the use of terminal markets has declined from 30% in 1977 to 13% in 1999 (GIPSA 2002), with the four largest packers controlling 82% of steer and heifer slaughter but only making 3.7% of total slaughter purchases from terminal markets. A number of economists have concluded that these structural changes in the cattle industry have resulted in thinning markets, which hamper price discovery and reduce market transparency. For example see Tomek (1980).

⁷ See Wachenheim and DeVuyst (2001) for a discussion of these issues.

Methodology

The use of cointegration to examine commodity price relationships and regional market spatial relationships began to find its way into the agricultural economics literature in the late 1980s and the early 1990s (e.g. Ardeni 1989, Goodwin and Schroeder 1991). Cointegration is especially useful for investigating long-run relationships between economic variables with non-stationary I(1) time-series processes. Engle and Granger (1987) demonstrate that a linear combination of two I(1) series can produce a stationary series of I(0).

Two variables are cointegrated over time if individually they follow a unit root process but jointly move together over time in the long run. The requirement that each variable follows a unit root process implies that individually each variable's movement over time appears random and unpredictable, but the location of one variable provides information of the other variable's location if they are cointegrated. The application of cointegration is well suited for investigating whether the former voluntary price reporting system accurately reflected actual market transactions in South Dakota.

We intend to empirically investigate the relationship between a set of publicly reported price series and the SDMPR series for live slaughter steers during the time period just before federal mandatory price reporting rules went into effect. Specifically, we will test if the information contained in a spatially relevant public price report accurately reflects actual cash market transactions. The application of cointegration will provide empirical evidence on the possible existence of a long-run relationship between the information contained in a selected set of spatially relevant publicly reported price series and the information contained in South Dakota's mandatory price series. If a long-run relationship is found, then an error correction mechanism (ECM) approach will be used to investigate the short-run disequilibrium adjustment process.

Assume Y_t denotes the South Dakota mandatory price series for the weekly live direct price for slaughter steers. Let X_t denote a public price report series for the weekly direct live price for slaughter steers. To test for a cointegrating relationship between Y_t and X_t , the first step is to determine if these price series

have a unit root. The process formally begins by modeling the price series as an autoregressive process

AR(p):

$$1) Y_t = \alpha + \beta_1 Y_{t-1} + \dots + \beta_p Y_{t-p} + \epsilon_t$$

$$2) X_t = a + b_1 X_{t-1} + \dots + b_p X_{t-p} + e_t$$

The existence of a unit root is tested for by either using the Augmented Dickey-Fuller (ADF) test or the Dickey-Fuller (DF) test as proposed by Dicky and Fuller (1979 and 1981). The decision criterion for test selection is based on if there is a serial correlation problem when the first difference of Y_t (i.e., ΔY_t) is regressed on Y_{t-1} . If serial correlation is detected, then the order of the autoregressive process (AR=n) on which the ADF test is based is determined empirically.⁸ After evaluating the data, as suggested by Gujarati (2003, pp.816-17), a random-walk-with-drift model was selected for the unit root test.⁹ The unit root test result for each of the individual price series used in this study is provided in Table III.

If it is established that both of the two price series under consideration have a unit root, then the estimated residuals from regressing Y_t on X_t are generated using the ordinary least squares procedure. To determine if Y_t and X_t are cointegrated, the estimated residual series from the cointegrating regression is

⁸ Conducting the ADF unit root test was done in a multi-step procedure as suggested by Gujarati (2003, p.817). First, the simple Dickey-Fuller test is conducted by regressing the first difference of Y_t on Y_{t-1} using an OLS procedure (SAS ETS 1993). A Durbin-Watson d test statistic was estimated to detect the presence of serial correlation. If serial correlation was detected, based on 5% critical value, a first order autoregressive model was estimated using OLS. If serial correlation was detected, then a second order autoregressive model was estimated, and so until the error term of the ADF equation was determined to be serially uncorrelated. Higher order models used Durbin's t-test, based on a 5% critical value, as suggested in the SAS ETS manual.

⁹ For a discussion of unit root testing procedures and testing for cointegration between non-stationary time series variables see Gujarati (2003). The general form of the ADF test is based on:
 $\Delta Y_t = Y_t - Y_{t-1} = \delta_1 + \Theta Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-i} + v_t$. Where $\Theta = 1 - \beta_1$. The unit root hypothesis test is: $H_0: \Theta = 0$, $H_1: \Theta < 0$. If the null hypothesis is rejected, then the series is stationary.

evaluated by using either the ADF or DF test for detecting the existence of a unit root in the estimated residual series.¹⁰ The cointegration test results are summarized in Table IV.

Data

In July of 1999 South Dakota Codified Law: Chapter 40-15B (SDCL 2000) required mandatory livestock price reporting in South Dakota to begin on Sept 1, 1999. The legislation required that all private livestock transactions were to be reported to the South Dakota Department of Agriculture. The Department of Agriculture collected data until federal mandatory price reporting began. The Secretary of Agriculture's office supplied all of the collected data to the Department of Economics at South Dakota State University. The South Dakota mandatory price reporting data was used to construct a weekly price series for all live weight steer transactions occurring in the state during the 19-month period prior to implementation of federal mandatory price reporting. This data provides a unique opportunity to test if voluntary public price reports reflected actual market conditions in South Dakota during the period just prior to the implementation of federal mandatory price reporting.

To explore the issue of how accurately voluntary public price reports reflected actual market transactions in South Dakota, we will compare a set of voluntary public price series to the South Dakota mandatory price series. The AMS sets of voluntary price series selected are 1) the Five Area Weekly Weighted Average Direct Slaughter Cattle report, 2) Wyoming-Western Nebraska-Southwestern South Dakota report, 3) Nebraska Weekly Direct Weighted Average report, 5) South Dakota Direct Feedlot report, and 6) the publicly reported Sioux Falls Live Cattle Auction report. All of the above price series represent the cash market for live steers. Daily reports were converted into weekly weighted average price series based on volume.

¹⁰ The issue of serial correlation was addressed for each residual series in the same manner discussed in footnote 8. The cointegrating regression is: $Y_t = \gamma + \theta_1 X_t + \epsilon_t$. The residual regression is: $\epsilon_t - \epsilon_{t-1} = \delta_1 + \Phi \epsilon_{t-1} + \sum_{i=1} \alpha_i \Delta \epsilon_{t-i} + v_t$. The unit root hypothesis test is: $H_0: \Phi=0$, or $H_1: \Phi < 0$. If the null hypothesis is rejected, then the series is stationary.

The South Dakota Mandatory Price Reporting data set contains 80 weeks of weekly weighted average price data for the direct sale of live steers in South Dakota. The data set contains 60,013 head and 301 recorded transactions. Table I contains the summary statistics on the price series used in the empirical analysis.

TABLE I
CASH MARKET FOR LIVE STEERS SUMMARY STATISTICS (\$/cwt.)¹

| Price Series | # of Wkly Obs. | Mean | Standard Deviation |
|---------------------------|----------------|---------|--------------------|
| AMS Five Area Wt. Avg. | 83 | \$70.91 | \$4.55 |
| Wy-Neb-SWSD | 78 | \$70.59 | \$4.54 |
| Neb Direct | 83 | \$70.77 | \$4.62 |
| SD Direct | 44 | \$69.17 | \$3.89 |
| Sioux Falls Auction | 83 | \$70.20 | \$4.52 |
| SD Mandatory Price Report | 80 | \$69.89 | \$4.35 |

1. The mandatory price reporting data set supplied to Dept. of Economics at SDSU by the State of South Dakota contains transaction data on over 600,000 head of cattle. Dressed weight sales, grid sales, forward contract sales, marketing agreement transactions, heifer and holstein transactions were excluded from the sample. Voluntary price report data collected from various issue of the AMS Livestock, Meat and Wool Weekly Summary and Statistics report (1999-2001).

Table II offers empirical evidence that the mean price differential is statistically non-zero between SDMPR price series and the Five Area series, Nebraska Direct series, and the Wy-Neb-SWSD series. Empirical results indicate a statistical equivalence between the SDMPR series and Sioux Falls Auction series and the SD Direct Feedlot series. This set of empirical results is consistent with spatially integrated markets and previous work on spatial arbitrage in the slaughter cattle industry (Koontz 1996, Goodwin and Schroeder 1991). The statistically significant price differentials seem to be reasonable estimates for the transaction costs associated with transporting South Dakota live steers to high volume markets.

TABLE II
MATCHED PAIRS MEANS TEST BETWEEN PRICE SERIES(\$/cwt.)¹

| Price Series | # of Wkly Obs. | Matched Pair: Mean Difference Test | P-Value Null Hyp. Ho: $U_y - U_x = 0$ |
|---------------------------------|----------------|------------------------------------|---------------------------------------|
| SDMPR Five Area | 80 | -\$0.88 | .001 |
| SDMPR Wy-Neb-SWSD | 75 | -\$0.76 | .001 |
| SDMPR Neb Direct | 80 | -\$0.74 | .001 |
| SDMPR SD Direct | 44 | -\$0.22 | .105 |
| SDMPR Sioux Falls Auction | 80 | -\$0.20 | .153 |

1. A set of paired difference between populations means: a matched pairs test (Newbold 1995) was conducted to determine if an average price differential existed between SDMPR series and the voluntary price reporting series along with the Sioux Falls auction price series for live slaughter cattle. The use of parametric or non parametric testing procedures was dependent on normal distribution of paired differences. The Anderson-Darling normality test (Gujarati 2003, p.147) was applied and the test results indicate that the distributions for SDMPR-NEB and SDMPR-Sioux Falls were not normally distributed. In these cases the Wilcoxon Signed Rank test was applied to test the null hypothesis that the mean of the pair differences was zero.

Empirical Results: Testing for Unit Roots and Cointegration

Table III presents the DF and ADF test statistics, the associated p-values for the unit root tests, for each of the price series. The associated test statistics for detecting the presence of serial correlation are either the Durbin-Watson d or Durbin's t, depending on if a lagged dependent variable was needed to whiten the error structure of the unit root test. Lagged terms were added to the ADF equation until the error structure was empirically verified as whitened. The unit root tests are based on the null hypothesis that a price series has a unit root and is non-stationary versus the alternative that the series does not have a unit root and is stationary.¹¹

¹¹ If serial correlation was not detected in the initial DF test, then the autoregressive order is zero. If ADF test was used and the initial data set had missing observations, then, as a result of an additional lagged dependent variable being included in the ADF test, the number of observations declined. The missing observation problem only seriously affects the South Dakota Direct Feedlot price series. According to Kevin Meyer, SAS consultant, the econometric implication is an increased probability of making a type II error. Serial correlation tests were conducted at the 5% level. According to Savin and White (1978) the test results from the Durbin Watson d test are still valid, but

TABLE III
UNIT ROOT TEST RESULTS

| Price Series | Obs. | Tau Statistic | P-Value |
|---|------|---------------|---------|
| AMS Five Area Weekly Weighted Average Slaughter Cattle report. ¹ | 81 | -1.02 | 0.74 |
| Wyoming-Western Nebraska-Southwestern South Dakota report. ² | 72 | -1.33 | 0.61 |
| Nebraska Weekly Direct Weighted-Average report. ³ | 80 | 1.02 | 0.74 |
| South Dakota Direct Feedlot report. ⁴ | 28 | -1.22 | 0.65 |
| Sioux Falls Live Cattle Auction report. ⁵ | 82 | -0.83 | 0.80 |
| South Dakota Mandatory Price Reporting Data. ⁶ | 73 | -1.17 | 0.68 |

-
1. The order of the autoregressive model selected for the ADF test is AR(1). Durbin's $t = 1.453$
 2. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat=1.699
 3. The order of the autoregressive model selected for the ADF test is AR(2). Durbin's $t = 0.1861$
 4. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat=1.766
 5. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat=1.848
 6. The order of the autoregressive model selected for the ADF test is AR(1). Durbin's $t = -1.19$

The unit root hypothesis test results indicate that all of the price series are non-stationary (Table III). Engle and Granger (1987) state that if two series are $I(1)$ then it is possible that a linear combination of the two series is $I(0)$. Engle and Granger propose a *cointegrating regression*: regressing one $I(1)$ series on another $I(1)$ series. The residual series generated by the cointegration regression is tested for the existence of a unit root. If the unit root test indicates that a unit root exists, then it is concluded that the two series are not cointegrated and there is no long-term relationship between the two time series variables. The cointegration results are presented in Table IV.

power of the test is diminished when there are missing observations.

TABLE IV
SDMPR COINTEGRATION TEST RESULTS

| Price Series Cointegrating Regressions | Number Of Obs. ¹² | <u>Cointegrating Regression</u> | | Tau Statistic | P-Value |
|--|------------------------------------|---------------------------------|-----------------------|------------------|---------|
| | | Intercept Estimate | Parameter Estimate | | |
| SDMPR & Wy-Western Neb SWSD ¹ | 75 | 4.55 | 0.924 | -6.10 | 0.001 |
| SDMPR & AMS Five Area Weekly Wt. Avg. ² | 80 | 4.27 | 0.927 | -6.81 | 0.001 |
| SDMPR & Nebraska Wkly Dir. Wt. Avg. ³ | 80 | 5.35 | 0.913 | -6.74 | 0.001 |
| SDMPR & SD Direct. ⁴ | 44 | 2.62 | 0.959 | -2.19 | 0.214 |
| SDMPR & Sioux Falls Terminal Market. ⁵ | 80 | 4.21 | 0.937 | -6.92 | 0.001 |

1. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat = 1.806.

2. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat = 2.030.

3. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat = 2.029.

4. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat = 1.747.

5. The order of the autoregressive model selected for the ADF test is AR(0). DW d test stat = 1.990.

The results of the cointegration analysis indicate that all but one of the former regional voluntary price series selected for this study are cointegrated with actual transaction data collected by the State of South Dakota during the 19-month period covered in this study. The rejection of cointegration between the South Dakota mandatory price reporting series and South Dakota Direct Feedlot price series may have been influenced by the lack of observations in the South Dakota direct series.¹³

¹² The number of observations reported are for the cointegrating regression.

¹³ The tau statistic estimated for testing if the SDMPR/SD direct price series are cointegrated is based on 28 observations or only 35% of total. The failure to reject the null hypothesis most certainly could have been affected by the large percentage of missing observations.

The empirical evidence reveals an integrated relationship between the information provided by the former AMS voluntary price reporting system on reported transactions in the spot market for live steers and actual cash transactions in South Dakota. The cointegration results suggest that the findings of Anderson et al. (1998), and Bastian et al. (2001) may not be applicable to the question of robustness of the former voluntary price reporting system. In South Dakota's cash market for live steers, empirical evidence of price series integration suggest that market transparency was not degraded in the long run.

To further investigate the question of whether the former voluntary price reporting system was an efficient mechanism for transmitting market information, an empirical analysis of the relationship between the Sioux Falls terminal market price series and the set of voluntary price series was conducted. The empirical results indicate that the Sioux Falls terminal series was not only cointegrated with the SDMPR series but also with all of the voluntary price series except for the South Dakota Direct Feedlot series (see Table V).

TABLE V
SIoux FALLS TERMINAL MARKET COINTEGRATION TEST RESULTS

| Price Series Cointegrating Regressions | Number Of Obs. ¹⁴ | Cointegrating Regression | | Tau Statistic | P-Value |
|--|------------------------------------|--------------------------|-----------------------|------------------|---------|
| | | Intercept Estimate | Parameter Estimate | | |
| Sioux Falls & Wy-Western Neb SWSD ¹ | 78 | 2.40 | 0.960 | -4.03 | 0.002 |
| Sioux Falls & AMS Five Area Weekly Wt. Avg. ² | 83 | 2.55 | 0.954 | -4.58 | 0.001 |
| Sioux Falls & Nebraska Wkly Dir. Wt. Avg. ³ | 83 | 3.40 | 0.940 | -4.49 | 0.001 |
| Sioux Falls & SD Direct. ⁴ | 44 | -1.01 | 1.010 | -1.72 | 0.400 |

1. The order of the autoregressive model selected for the ADF test is AR(0). DW t test stat = 2.023.

2. The order of the autoregressive model selected for the ADF test is AR(0). DW t test stat = 2.149

3. The order of the autoregressive model selected for the ADF test is AR(0). DW t test stat = 2.056

4. The order of the autoregressive model selected for the ADF test is AR(1). Durbin's t = -0.155.

The empirical evidence in Tables IV and V clearly indicates that in the long run: 1) the Sioux Falls Stockyards continues to be a relevant terminal market, 2) the Sioux Falls terminal market was an efficient conduit of market information for South Dakota markets during this 19-month period; 3) there is no evidence that the former voluntary price reporting system did not provide market information consistent with terminal market transactions in South Dakota, 4) South Dakota producers received prices consistent with what was being reported by the AMS for the region, 5) the price series relationships between the voluntary price reports, the terminal market price report, and the mandatory price series were highly cointegrated, and these integrated relationships did foster market transparency and price discovery in South

¹⁴ The number of observations reported are for the cointegrating regression. The tau statistic estimated for testing cointegration of the Sioux Falls/ SD direct price series is based on 16 observations or only 20% of total. The failure to reject the null hypothesis most certainly could have been affected by the large percentage of missing observations.

Dakota's cash markets, and 6) the loss of the two regional voluntary price reports (WY-NEB-SWSD and SD Direct) should not degrade market transparency or hinder price discovery in South Dakota's cash market for live steers (given the presence of a strong terminal market). While plausible empirical implications are drawn from available regional data, our empirical evidence does indicate the former voluntary price reporting system was more robust than the conclusions arrived at in previous research (i.e., Anderson et al. 1998, and Bastian et al. 2001).

However, the empirical evidence of highly integrated price series over the 19-month period under consideration in this study does not tell us anything about short-run deviations away from the empirically established long-run relationship between the former voluntary price reporting series for live cattle, the Sioux Falls terminal market, and the SDMPR series. Short-run divergence from the long-run equilibrium relationship may result from the alleged flaws in the former voluntary price reporting system. Koontz (1999) suggested this possibility. To investigate this issue an error correction mechanism will be employed to investigate the effect of short-run anomalies on the empirically established long-run relationship discussed above.

ERROR CORRECTION MODEL

In the last section we established empirically that there is a long-run integrated relationship between selected former regional voluntary price series, the Sioux Falls terminal market price series, and the South Dakota Mandatory price series. While the estimated long-run integrated relationship is statistically significant, there is still room to speculate that sustained short-run deviations from the long-run equilibrium relationship could degrade market transparency and hinder price discovery. Sustained short-run deviations would be evidence of the failure of the voluntary price reporting system to act as an efficient mechanism or conduit for the transmission of changing market conditions to the public.

An error correction modeling procedure is therefore utilized with the following set of premises concerning price determination in the cash market for slaughter steers. It is assumed here that the

equilibrium cash price of slaughter steers is determined by market conditions at the national level. Packers engaged in the direct cash purchase of live slaughter steers in South Dakota are aware of the current national market conditions for beef and the transactions costs associated with placing South Dakota steers into the national supply channel. As discussed by Goodwin and Schroeder (1991), arbitrage activities create spatial price linkages across regional markets and eliminate price differentials over and above transaction and transportation costs across regions.¹⁵ This assumption is consistent with our empirical findings of a statistically significant long-run integrated relationship between price series. Furthermore, it is assumed here that the trend in transaction and transport cost was relatively flat during the time period covered by this study.¹⁶ Given these assumptions, a price shock to the live slaughter steer cash market at the national level will eventually be reflected in the direct price paid to South Dakota producers. Simply stated, a price shock of x dollars per cwt. at time t at the national level will disrupt the long-run equilibrium between the national market price and the price paid to South Dakota producers. The disequilibrium condition will persist until the South Dakota market fully adjusts to the price shock in some future period $t+n$, where n is the number of periods (weeks) needed for full adjustment to take place. It is during this period of disequilibrium that market transparency can be effected.¹⁷ The length of time (n) it takes for the transmission of a price shock opens a window of opportunity for profitable arbitrage activities to occur in smaller regional markets like South Dakota.¹⁸

¹⁵ Goodwin and Schroeder found empirical evidence that spatial linkages between regional markets were strengthening over time.

¹⁶ During the time period covered by this study the average Midwest retail weekly #2 diesel price per gallon was \$1.41 and the standard deviation was 12 cents (U.S. Dept. Of Energy, Energy Information Administration).

¹⁷ Koontz (1996) reported that packers and feedlots are more likely to withhold transaction information during periods of sharp price movements.

¹⁸ The possibility of excess profit potential arising in this type of situation has been alluded to by Goodwin and Schroeder (1991) and Tomek (1980).

The answer to the question of how effective in the short run the former voluntary price reporting system was in promoting market transparency and facilitating price discovery in South Dakota markets will be based on how robust the price shock transmission mechanism was between the former voluntary price reporting system, the terminal market price series, and the South Dakota mandatory price reporting series. To empirically test if a price shock to the long-run equilibrium relationship between the mandatory, terminal market, and voluntary price series has a sustained negative effect on market transparency, we will analyze short-run deviations from long-run equilibrium with an error correction modeling procedure.

Based on the work by Granger (1981, 1983), the Granger Representation Theorem states that if two time series variables are cointegrated, then the relationship between them can be expressed as an error correction mechanism (ECM). If two time series variables are cointegrated, there is a long-run equilibrium relationship. The error term of the cointegrating regression is treated as the equilibrium error, reflecting a short-run divergence from long-run equilibrium if the equilibrium error is non-zero. This error term can be used to link the long-run behavior of South Dakota's mandatory price series to its short-run behavior during periods of short-run deviations from its long-run equilibrium relationship with the former voluntary price reporting system.

Formally, the error correction mechanism for a pair of cointegrated series is defined as,

$$3) \Delta Y_t = \gamma_0 + \gamma_1 \Delta X_t + \gamma_2 \epsilon_{t-1} + z_t.$$

Where Δ is the first difference operator, z_t is the random error term, and ϵ_{t-1} is the equilibrium error term estimated from the cointegrating regression defined in footnote 10, lagged one period. The variables Y_t and X_t are the price series defined in equations 1 and 2. The regression parameters are γ_0 , γ_1 , and γ_2 . The parameter γ_0 is the intercept coefficient. The parameter γ_1 is the slope coefficient and is interpreted as the short-run relationship between ΔY_t and ΔX_t . The parameter γ_2 is interpreted as the "speed of adjustment" coefficient to short-run deviations from long-run equilibrium (Gujarati 2003, p.825).

The error correction model was estimated using OLS for each of the cointegrating relationships listed in Table IV.¹⁹ The empirical estimates are provided in Table VI.

TABLE VI
ERROR CORRECTION MODEL OLS ESTIMATES

| Price Series ECM Regressions | Number Of Obs. | ECM Regression Estimates ¹ | | |
|---|----------------------|---------------------------------------|-----------------|--------------------------------|
| | | Intercept Est. | Slope Est. | Speed of Adjustment Est. |
| Δ SDMPR & Δ Wy-W. Neb -SWSD | 75 | 0.11 (0.88) | 0.77 (7.08) | -0.698 (-6.31) |
| Δ SDMPR & Δ AMS Five Area Weekly Wt. Avg. | 76 | 0.04 (0.33) | 0.80 (6.42) | -0.76 (-6.81) |
| Δ SDMPR & Δ Nebraska Wkly Dir. Wt. Avg. | 76 | 0.01 (0.14) | 0.928 (7.52) | -0.75 (-6.59) |
| Δ SDMPR & Δ Sioux Falls Terminal Market. | 76 | 0.008 (0.06) | 0.934 (8.96) | -0.778 (-6.73) |

1. Student t test statistics are given in parentheses below the respective parameter estimate.

Table VI indicates that all of the intercept estimates are statistically zero. For all of the paired price series listed in Table VI, this result implies that the long-run equilibrium relationship is stationary if there are no price shocks affecting the system.

Table VI indicates that all of the slope parameter estimates are highly significant and have p-values of less than .001. The slope parameter estimates indicate that 1) for a price shock affecting the Wy-Neb-SWSD price series in period t , 77% of that shock will be reflected in the SDMPR series in period t , 2) for a price shock affecting the Five Area price series in period t , 80% of that shock will be reflected in the

¹⁹ The ECM model could not be applied to the SDMPR-SD Direct series because the empirical evidence indicated that they are not cointegrated.

SDMPR series in period t , 3) for a price shock affecting the Neb price series in period t , 92.8% of that shock will be reflected in the SDMPR series in period t , and 4) for a price shock affecting the Sioux Falls Terminal price series in period t , 93.4% of that shock will be reflected in the SDMPR series in period t . Comparing the short-run slope parameter estimates in Table VI, it is clear that the SDMPR series is integrated to a greater degree with the Nebraska voluntary price series and the terminal market series than with the highly aggregated Five Area series or the regional Wy-W.Neb-SWSD series.

Table VI indicates that all of the “speed of adjustment” parameter estimates are highly significant and have p-values of less than .001. The “speed of adjustment” parameter coefficient estimates indicate the proportion of the price-shock-residual remaining after period t that will be transmitted to the SDMPR series in period $t+1$.

For instance, in the case of a price shock affecting the Wy-Neb-SWSD price series in period t , the ECM slope parameter estimate indicates that 77% of the price shock will be transmitted to the SDMPR series in period t . The residual of that shock that was not transmitted in period t is 23% of the shock. Thus the long-run equilibrium relationship is disrupted in period t . In period $t+1$, the “speed of adjustment” coefficient indicates that 69.8% of the residual resulting from the price shock will be transmitted in period $t+1$. Therefore, in period $t+1$, 93% of the price shock has been transmitted to the SDMPR series one week after the shock.²⁰ This adjustment process continues until the long-run equilibrium relationship is restored. The faster a price shock is transmitted from one series to another the greater is the degree of integration between the two series. Table VII provides empirical estimates of the speed of adjustment process for each of the cointegrated price series reported in Table IV.

²⁰ The price adjustment estimate is calculated as follows: $77\% + (.698)(23\%) = 93\%$.

TABLE VII
SOUTH DAKOTA MANDATORY PRICE REPORTING SERIES:
"SPEED OF ADJUSTMENT" OVER TIME TO A PRICE SHOCK AT TIME t

| Price Series Cointegrating Regression | TIME | | |
|--|-------|-------|--------|
| | t | $t+1$ | $t+2$ |
| SDMPR & Wy-Western Neb SWSD ¹ | 77% | 93% | 97.9% |
| SDMPR & AMS Five Area Weekly Wt. Avg. | 80% | 95.2% | 98.85% |
| SDMPR & Nebraska Wkly Dir. Wt. Avg. | 92.8% | 98.2% | 99.55% |
| SDMPR & Sioux Falls Terminal Market. | 93.4% | 98.5% | 99.66% |

The "speed of adjustment" estimates lead to the conclusion that the SDMPR series was highly integrated with all of the price series listed in Table VII. The highest degree of integration existed between SDMPR and the Sioux Falls terminal series and the Nebraska voluntary series.

The Five Area voluntary report is the most representative of the national market for live-weight slaughter steers sold on a cash basis and it includes the Nebraska series. The estimated (Table IV) long-run equilibrium relationship between the Five Area and the SDMPR series indicates that, *ceteris paribus*, if the long-run equilibrium Five Area price changes by one dollar per cwt., then the long-run equilibrium price received by South Dakota producers will change by 92.7 cents per cwt. In the short run, if a price shock affects the national market for live steers in week t , disrupting the long-run equilibrium, then 80% of that shock was reflected in prices paid in South Dakota in week t . By the following week, 95% of the shock was incorporated into prices paid to South Dakota producers (Table VII). The relationship between the SDMPR

series and the Nebraska voluntary series was even stronger, with 92.8% of a price shock reflected in South Dakota prices in the same week and 98.2% by the following week.

The “speed of adjustment” estimates for the selected voluntary price reports are consistent in magnitude with the Sioux Falls terminal price series “speed of adjustment” estimate. This indicates a high degree of integration between the two different sources of public market information. This empirical evidence also implies that the information contained in the voluntary price reports did contribute to market transparency and promoted price discovery in South Dakota.²¹

Conclusions and Summary

The debate over whether the former voluntary price reporting system engendered market transparency and promoted price discovery engaged our interest once we learned of the existence of a mandatory price data set comparable with price data generated by the former voluntary price reporting system. The uniqueness of the transaction data collected by South Dakota’s Department of Agriculture provided us with an opportunity to empirically gauge the robustness of the former AMS voluntary price reporting system before federal mandatory price reporting rules came into existence. All previous studies looking at the reliability of the voluntary price reporting system used simulated data or secondary data supplied by private firms in their analysis. Empirical findings discussed in this paper have implications for future rule making and contribute to the debate over mandatory versus voluntary price reporting in the cattle industry.

Empirical analysis using cointegration techniques was conducted to determine if there is any evidence of integration between AMS voluntary price reports on market transactions in regional spot markets with actual transactions occurring in South Dakota’s cash markets for live cattle. The results of the

²¹ According to Lawrence et al. (1996), auction price reports are an important source of information used by participants in livestock markets during the price discovery process. Lawrence et al. reported results from a survey of Iowa livestock producers buying and selling feeder cattle. The results indicated that 84% of the buyers and 72% of the sellers used auction prices as a price discovery tool to make short-term marketing decisions.

empirical analysis suggest that there is a robust integrated relationship between the information contained in the former regional voluntary price reports on market transactions and actual market transactions in South Dakota. We conclude that the presence of integration between regional voluntary price reports and actual cash transactions in South Dakota indicates that the former voluntary price reporting system contributed to market transparency and the price discovery process in the South Dakota cash market for slaughter steers.

Empirical evidence suggests that only one of the discontinued regional price reports, the Wyoming/South Dakota/Nebraska Direct, did contribute to price discovery and market transparency in South Dakota's live cattle market. However, this report was the least integrated relative to the other price series listed in Table VII. The empirical evidence also indicates that the South Dakota Direct Feedlot report did not contribute to price discovery. The problem with this particular series is the large number of missing observations. The inconsistency in reporting live cattle transactions was a shortcoming associated with the South Dakota Direct Feedlot report. We conclude that the discontinuation of the voluntary regional price reports providing information on South Dakota markets will not have an adverse effect on market transparency and price discovery in South Dakota's cash market for live steers.

The cointegration and ECM results suggest that the market information generated by the Sioux Falls terminal auction market was integrated to a greater degree with actual South Dakota transaction data than all of the voluntary price reports. The empirical results provided in Tables IV, V, and VI indicated that there is a high degree of consistency between the former voluntary price series and the terminal market series with respect to their degree of integration with the SDMPR series. This high degree of consistency is an indication that market transparency was not degraded as a result of voluntary price reporting system. This finding of highly integrated relationships implies that the voluntary price reporting system did promote price discovery in South Dakota. This conclusion is further supported when viewed in the light of previous studies indicating that producers rely on auction market reports when engaged in the price discovery process.

The overall conclusion from the empirical evidence presented is that the former voluntary price reporting system was fostering market transparency and promoting price discovery in the cash market for live slaughter steers in South Dakota. Evidence indicates that, in the case of South Dakota, the former voluntary price reporting system was an efficient mechanism for promoting market transparency and price discovery. This study is the first to provide empirical evidence that the former voluntary price system was not as flawed as previous ad hoc studies had concluded. While our study only covers one small corner of the livestock sector, it raises the question that if the former voluntary price reporting system was an efficient mechanism for promoting market transparency and price discovery in the cash market for live steers in South Dakota, what about other regions and other types of livestock? We are not advocating that the former voluntary price reporting system is more robust than the new federal mandatory system, but we are saying there is ample evidence that the former system was not as flawed as previous research has suggested. Therefore, it is not necessarily valid to justify the need for mandatory price reporting based on the assertion that the former voluntary price reporting system degraded market transparency.

We conclude that additional research is needed to answer these questions: 1) What are costs and benefits associated with the new federal mandatory price reporting system and should they be identified before the renewal issue is debated on the floor of Congress?, 2) Is the loss of market information from smaller discontinued regional voluntary price reports hindering market transparency and price discovery in those local markets where voluntary price reports were discontinued? In the South Dakota live cattle cash market case, the answer is no. However, the answer may be different for the other regions or other livestock categories where the voluntary price report was discontinued, and 3) Are there other regional cattle markets or other types of livestock markets where the former voluntary price reporting system was an efficient mechanism for promoting market transparency and price discovery? Answers to these questions are needed before an informed debate on the current structure of the federal mandatory livestock price reporting system can begin.

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