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The Voluntary Reporting System's Ability to Provide Price Transparency in the Cash Market for Dressed Steers: Evidence from South Dakota

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The informational value of USDA's former voluntary price reporting system is investigated for dressed-weight slaughter steers sold by South Dakota producers. The ability of the former system to promote price transparency in the cash market is evaluated using state-level mandatory price reporting data collected from September 1999 to April 2001. The empirical framework examines the informational value of public price reports according to the criteria established in the market integration literature. The empirical results indicate that in the South Dakota cash market for dressed weight steers, the voluntary price reporting system fostered price transparency, and thus contributed to the price discovery process. Empirical evidence is also presented suggesting that strategic price reporting by market participants to influence the voluntary price reporting system was not detected during the period covered in this study.

Key words: cointegration, competitive spatial equilibrium, error correction model, mandatory price reporting, marketing integration, price transparency, slaughter cattle spot market, voluntary price reporting

Introduction

The goal of public price reporting is accurate and timely market price reports (Lawrence, Shaffer, and Hayenga, 1996). Accurate and timely market price reports are necessary for price discovery and for market efficiency (Ward, 1987). Political momentum behind the passage of mandatory price reporting (MPR) legislation at both the state and federal levels originated with lobbying efforts by producer groups who were concerned about the effects of increased packer concentration and thinning public livestock markets on the accuracy of voluntary price reports, market transparency, price transparency, and price discovery.

Market transparency refers to a market environment where all relevant information about market conditions necessary to efficiently complete transactions is publicly available to all market participants.[1] All relevant information pertains to the public

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[1] In the financial equities literature, market transparency is defined as the real time public release of trade, quote, and information on demand and supply conditions. In the price analysis literature, transparency in a commodity market requires complete and unbiased information, with respect to factors affecting demand and supplies of a commodity, is available to all traders (Tomek and Robinson, 1981).

dissemination of transaction price, volume, carcass quality, current supply and demand conditions, etc. Analogous to the financial equities literature (Bloomfield and O'Hare, 1999; Pagano and Roell, 1996), market transparency plays a fundamental role in ensuring fairness and efficiency in livestock markets by promoting competition and efficient price discovery. The lack of market transparency results in less informed market participants trading at a competitive disadvantage. One important component of market transparency is price transparency. Price transparency is defined as a market condition where all relevant information on transaction prices is publicly available to all market participants.

Several features of the South Dakota livestock industry make this an interesting case study to test the validity of different price reporting mechanisms. While not ranking among the biggest feedlot states, South Dakota has a large and stable feedlot sector. Thus, major structural changes in the feedlot industry have not adversely impacted South Dakota's feedlot industry. In theory, feedlots in South Dakota appear to have a choice to sell to multiple packers in multiple states. South Dakota also has a relatively large number of farmer-feeders—feedlots with fewer than 1,000 head capacity. Hence, concerns about transparency should be easier to identify in the presence of a relatively large number of market participants such as exist in South Dakota. Finally, a unique data set allows for detailed insights not available for other states.

The accuracy of voluntarily reported prices to the USDA's Agricultural Marketing Service (AMS) is investigated here by using South Dakota Mandatory Price Report (SDMPR) data that were collected prior to the implementation of the federal MPR system. Our objective is to investigate the empirical relationship between daily voluntary price reports released by the AMS and transactions mandatorily reported in the cash market for dressed weight steers in South Dakota. Specifically, we want to know if the AMS Nebraska Direct voluntary price series (NEVPR) for dressed steers accurately reflected spot market prices reported in South Dakota. The answer may provide insight as to whether the former voluntary price reporting (VPR) system failed to provide price transparency to the cash market, as asserted by livestock industry groups in favor of MPR legislation prior to its passage.

Mandatory versus Voluntary Price Reporting: A Discussion of the Issues

The reliability of the former VPR system was called into question by proponents of MPR, who claimed that (*a*) market transparency was degraded because industry participants failed to report as much as 35% to 40% of transactions;[2] and (*b*) a propensity existed for buyers and sellers in the cash market to behave strategically when voluntarily reporting market transactions.[3] The questions raised are of concern because incomplete or inaccurate voluntary price reports have the potential to distort the flow of information between voluntarily reported prices and actual market transactions.

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[2] The Agricultural Marketing Service (USDA/AMS, 2000) asserted that 35% to 40% of all negotiated cattle transactions were not reported under the voluntary price reporting system. Note, under the former voluntary price reporting system, the AMS reported only confirmed transactions.

[3] Koontz (1999) suggested there is potential for this type of behavior to occur. Several computer simulation studies concluded that public price reporting is inefficient under certain market conditions (Bastian, Koontz, and Menkhaus, 2001; Anderson et al., 1998). The Grain Inspection, Packers and Stockyards Administration (GIPSA) was also investigating this issue (USDA/GIPSA, 1998).

The concern raised over the accuracy of the VPR system was deemed credible by policy makers in a number of states prior to passage of MPR regulations at the federal level. Five states (Iowa, Minnesota, Missouri, Nebraska, and South Dakota) passed legislation requiring MPR prior to passage of federal regulations. Legislation implementing national livestock MPR was passed in October 1999, and the first publicly issued mandatory price report was released on April 2, 2001. Upon implementation of federal MPR regulations, all state reporting requirements ended. The U.S. Congress delegated the responsibility for collecting and reporting transaction data to the USDA's Agricultural Marketing Service. The selection of the AMS was an obvious choice because the AMS had been responsible for operating the existing national voluntary livestock price reporting system since 1946 (Livestock Mandatory Price Reporting Review Team, 2001).

Because the new MPR system for livestock markets replaced the system of VPR, the structure of information in livestock markets, and in particular the cash market for slaughter cattle, has changed. A number of regional price reports published under the VPR system were discontinued following the implementation of MPR. These series were 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. These regional voluntary price reports have been replaced with more aggregated mandatory price reports. The advantage of the new reports is the breakdown of direct sales into negotiated, formulated, and forward contract categories. Ironically, the disadvantage of the new reports is the potential loss of transparency of local market conditions—i.e., aggregation may mask any divergence between local market prices and aggregate prices.

The legislation authorizing the federal mandatory reporting system has a sunset clause.[4] Potential policy concerns that may arise during the legislative process include: (*a*) the cost imposed upon the packing industry by MPR requirements compared to the benefits realized from improved market transparency and price discovery; (*b*) concern over the loss of regional market information resulting from the loss of regional AMS voluntarily reported prices, e.g., Montana Direct; and (*c*) the potential for collusive behavior by the packing industry as a consequence of full information, under MPR, being provided to an oligopoly industry.

This last issue has sparked some debate in the MPR literature. Wachenhiem and DeVuyst (2001) discuss the issue of market and price transparency in livestock markets. They argue that increased transparency under mandatory price reporting may reduce competition in the fed cattle market. Njoroge (2003) reaches a similar conclusion. Azzam (2003) arrives at the opposite conclusion in a recent paper about MPR. Discussing the robustness of transparency in terms of uncertainty over livestock prices under an MPR system relative to a VPR system, Azzam (p. 388) concludes increased market information under MPR reduces price uncertainty relative to VPR. Azzam refers to Fed Cattle Market Simulator results reported by Anderson et al. (1998) indicating a variance-reduction effect of increased public information. The underlying premise of Azzam's assumption is that increased uncertainty in an MPR system is a consequence of fewer transactions being reported under a VPR system, resulting in increased price dispersion relative to actual dispersion of market transaction prices. In simple terms, Azzam characterizes the issue as analogous to a sampling size issue.

[4] The legislative authorization for federal mandatory livestock price reporting expired in October of 2004.

Price Transparency and Market Integration: A Discussion

Price transparency is associated with the concept of market integration. The literature establishes this link by addressing the relationship between competitive spatial equilibrium and market integration. For example, it has been demonstrated that competitive spatial equilibrium and market integration are related but distinctly different concepts (Barrett and Li, 2002; McNew, 1996; McNew and Fackler, 1997). When interregional trade is nonnegative, Barrett and Li (2002, p. 293) note that a long-run competitive spatial equilibrium condition holds when marginal profit from arbitrage activity is equal to zero. Furthermore, regional price differentials move one-for-one with the costs associated with spatial arbitrage when trade is positive.

On the other hand, market integration, as discussed in the contestable market literature "implies the transfer of Walrasian excess demand from one market to another, manifest in the physical flow of commodity, the transmission of price shocks from one market to another, or both" (Barrett and Li, 2002, p. 293). Barrett and Li discuss the possibility of spatially linked markets being integrated, but not in competitive equilibrium. This market condition is the result of marginal profit from spatial arbitrage being nonzero when trade is positive. They refer to this market outcome as imperfect integration. Under this scenario, a stable long-run equilibrium interregional price differential would not exist. If the zero marginal profit condition from spatial arbitrage does not prevail, then even with complete transmission of price shocks from one market to another, price transparency will not be provided to market participants because nonzero profits distort regional price differentials. The nature and magnitude of the distortion will not be transparent to all market participants. This market outcome results in market inefficiency because transaction cost is not minimized.

Barrett and Li (2002, pp. 293–294) define perfect integration as an interregional spatial relationship possessing the following properties: "two markets are both integrated and in long-run competitive spatial equilibrium." We assert that the market condition of perfect integration is the necessary and sufficient condition for the existence of spatial price transparency. Spatial price transparency is defined as price transparency existing between spatially linked interregional markets.[5]

South Dakota exports a majority of fed cattle production to Nebraska for processing. South Dakota has minimal processing facilities located in the state, implying fed cattle flow is unidirectional. It is assumed competitive spatial arbitrage exists between the two cash markets. Therefore, the spatial relationship between Nebraska and South Dakota cash markets is consistent with the market conditions required for perfect integration and the use of linear cointegration techniques for empirical analysis, i.e., marginal profit to spatial arbitrage is zero, trade is unidirectional and continuous, and transaction costs are stationary.[6]

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[5] Note that the individual market conditions of marginal profit from arbitrage being zero and the existence of market integration are the only necessary conditions for the existence of spatial price transparency.

[6] The caveats raised in this literature that would render linear cointegration techniques inadequate for spatial market analysis are also discussed by McNew (1996) and McNew and Fackler (1997). In the empirical results section, empirical evidence of stationary transaction costs is provided. Note: South Dakota had two small cow slaughter plants operating during the period covered by this study.

Barrett and Li's (2002) definition of perfect integration requires the existence of two conditions between Nebraska and South Dakota cash markets. The first condition is for spatial equilibrium to exist between the Nebraska cash market and the South Dakota cash market. The second condition is for the complete and timely transmission of price shocks occurring in the Nebraska cash market to be transmitted to the South Dakota cash market. If these two conditions are met, then spatial price transparency exists between the Nebraska and South Dakota cash markets. However, the existence of spatial price transparency between these cash markets predisposes, but does not ensure, the NEVPR system is an efficient price transmission mechanism. Empirical evidence is needed to support the proposition that the NEVPR system provided accurate and timely price information on Nebraska's cash market in a manner consistent with the existence of spatial price transparency between these two cash markets.

Whether or not the NEVPR system can be considered an efficient price transmission mechanism for South Dakota producers depends on if the existence of spatial price transparency can be verified empirically. Testing the proposition that the NEVPR system transmitted price information consistent with the definition of spatial price transparency is based on two determinants: (*a*) given unidirectional trade and regional competitive spatial arbitrage, Nebraska's cash market determined prices in South Dakota's cash market for slaughter steers; and (*b*) South Dakota's MPR mechanism collected all reported non-auction transaction data in South Dakota (South Dakota Codified Law, 2000).[7] Given these conditions, the following testable hypotheses are proposed:

- South Dakota's cash market has a long-run spatial equilibrium relationship with the Nebraska cash market, and this relationship is reflected in the spatial relationship between the SDMPR series and the NEVPR series.
- Price shocks to Nebraska's cash market are accurately reflected in the NEVPR series and transmitted rapidly and completely to the SDMPR series in a manner consistent with the existence of spatial price transparency between these spatially linked markets.

Methodology

We investigate empirically the spatial relationship between the NEVPR series and SDMPR series for dressed weight slaughter steers during the time period just before federal MPR rules went into effect. Specifically, a test is conducted to determine if the information contained in the NEVPR series accurately reflects cash market transactions in South Dakota. Cointegration tests are applied to time-series data to determine if there is evidence indicating the existence of a long-run spatial relationship between the information contained in the NEVPR series and the information contained in the SDMPR series. If a long-run relationship is found, then the next step is to employ an error correction model (ECM) to investigate the short-run disequilibria adjustment process. If empirical evidence from the error correction model indicates a robust transmission of price shocks from the NEVPR series to the SDMPR series, then there is

[7] This assumption assumes full compliance with price reporting regulations by all market participants. Therefore, the expected value of collected transaction prices is an unbiased estimate of equilibrium price and is consistent with Tomek (1980).

evidence of spatial price transparency between the cash markets, and the NEVPR system accurately reflected this market characteristic. This implies that the NEVPR system was an accurate and efficient mechanism for transmitting price information to South Dakota producers.

The use of cointegration tests to examine commodity price relationships and spatial relationships across regional markets is common in the literature (e.g., Ardeni, 1989; Goodwin and Schroeder, 1991). Cointegration techniques are especially useful for investigating long-run relationships between economic variables exhibiting a nonstationary I(1) time-series process. 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 they individually follow a unit root process but jointly move together over time. 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 on the other variable's location if they are cointegrated. The application of cointegration is well suited for investigating whether the NEVPR system accurately reflected actual market transactions in South Dakota because the spatial relationship between the cash markets is not encumbered by the caveats raised in the spatial integration literature.

Assume $SDMPR_t$ denotes the daily dressed weight cash price series for South Dakota slaughter steers. Let $NEVPR_t$ denote the daily direct dressed weight cash price series for slaughter steers in Nebraska. To test for a cointegrated relationship between $SDMPR_t$ and $NEVPR_t$, the first step is to determine if these price series have a unit root. The process begins by modeling the price series as an autoregressive process AR(p):

$$(1) \qquad SDMPR_t = \alpha + \beta_1 SDMPR_{t-1} + \ldots + \beta_p SDMPR_{t-p} + \varepsilon_t,$$

$$(2) \qquad NEVPR_t = a + b_1 NEVPR_{t-1} + \ldots + b_p NEVPR_{t-p} + e_t,$$

Testing for the existence of a unit root is done by using the Dickey-Fuller (DF) test or the Augmented Dickey-Fuller (ADF) test as proposed by Dickey and Fuller (1979, 1981). The decision criterion for test selection is based on the presence or absence of a serial correlation problem when the first difference of $SDMPR_t$ (i.e., $\Delta SDMPR_t$) is regressed on $SDMPR_{t-1}$. If serial correlation is detected, the ADF test is used. The order of the autoregessive process (AR = p) on which the ADF test is based is determined empirically.[8] After evaluating the data, as suggested by Gujarati (2003, pp. 816–817), a random-walk-with-drift model was selected for the unit root test.[9]

If it is established that both of the price series under consideration have a unit root, then estimated residuals are obtained from regressing $SDMPR_t$ on $NEVPR_t$ using ordinary least squares. Then to determine if $SDMPR_t$ and $NEVPR_t$ are cointegrated,

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[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 the variable of interest, Y_t, on Y_{t-1} using an OLS procedure (SAS Institute, Inc., 1993). A Durbin-Watson d test statistic was estimated to detect the presence of serial correlation. If serial correlation was detected, based on a 5% critical value, a first-order autoregressive model was estimated using OLS. If serial correlation was detected in this step, then a second-order autoregressive model was estimated, and so on 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 User's Guide*.

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

these residuals are evaluated by using either the DF or ADF test for detecting the existence of a unit root in the residual series.[10] Test selection is again based on if serial correlation is detected.

Data

In July of 1999, South Dakota Codified Law, Chapter 40-15B (SDCL, 2000) required mandatory livestock price reporting in South Dakota. There was a period of time when the South Dakota Department of Agriculture formalized the reporting rules, and data collection began in late August of 1999. All private livestock transactions were to be reported, while public auction purchases were excluded from the reporting requirement. Civil and criminal penalties for noncompliance were incorporated into the legislation. The Department of Agriculture collected data until federal MPR began. The Secretary of Agriculture's office supplied all of the collected data to the authors in July of 2001.

The data contained daily transactions from September 1999 through March 2001. The complete MPR data set supplied by the State of South Dakota contains transaction data on over 900,000 head of cattle reported by lots. There were a small number of transactions where the number of head in a lot was missing or not known with certainty at the time of reporting. Included in the data were transactions for slaughter cows, bulls, and mixed lots. Transactions for fed steers, fed heifers, and mixed lots of fed steers and heifers covered 720,678 head over the entire collecting period. During calendar year 2000, packers purchased 400,486 head of fed cattle. By comparison, USDA's National Agricultural Statistics Service (USDA/NASS, 2001) reported that South Dakota feedlots marketed 624,000 head in 2000, some of which would have been finished cows and bulls. However, we do not suspect any noncompliance, as several fed-cattle auctions were likely markets for the remaining head not covered in the series.

Live weight sales, grid sales, forward contract sales, marketing agreement transactions, and heifer and Holstein transactions were excluded from the sample. The SDMPR data include only daily weighted average transaction data for dressed weight steers, and contain 87,533 head and 803 recorded transactions.[11]

The VPR series selected for this study is compiled from the NEVPR for steers sold on a dressed weight basis. Only the prices for dressed weight steers were used, and the AMS reported prices on a weighted average basis. The Nebraska series was selected because it represents a major market and processing area for South Dakota's slaughter cattle. Table 1 reports summary statistics for the price series used in the empirical analysis.

Table 2 offers empirical evidence that the mean price differential is statistically equal to zero between the SDMPR price series and the NEVPR series. The statistically insignificant price differential has an interesting interpretation. When selling slaughter

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[10] The issue of serial correlation was addressed for each residual series in the same manner discussed in footnote 8. The cointegrating regression is: $Y_t = \gamma + \theta_1 X_t + \varepsilon_t$. The residual regression is: $\varepsilon_t - \varepsilon_{t-1} = \delta_1 + \Phi\varepsilon_{t-1} + \Sigma_{i=1}^{n} \alpha_1 \Delta\varepsilon_{t-i} + v_t$. 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.

[11] One packer was dropped from the data set because it was determined this packer purchased cattle that had specific characteristics demanded by niche markets. This packer participated in only 55 cash transactions and purchased 1,462 head during the period covered by the study. Individual daily South Dakota transactions were converted into a daily weighted average price based on volume using the sales volume of a single transaction as a percentage of total transaction volume for the day to determine the weight given to a single transaction price. We rely on the rationale offered by Tomek (1980) for using a weighted average price.

Table 1. Summary Statistics of Cash Markets for Dressed-Weight Steers (September 1999–March 2001)

Price Series	Number of Daily Observations	Mean ($/cwt)	Standard Deviation ($/cwt)
NEVPR	131	$111.79	$7.21
SDMPR	131	$111.90	$7.24

Notes: Voluntary price reporting (VPR) data were collected from USDA/AMS report No. WH_LS130 (various dates). The number of daily dressed weight cash transactions in South Dakota varied from week to week. Data represent a concordance between South Dakota and Nebraska based on matched transaction dates.

Table 2. Matched Pairs Means Test Between Price Series

Price Series	Number of Daily Observations	Matched Pair: Mean Difference Test ($/cwt)	p-Value Null Hypothesis (H_0: $U_y - U_x = 0$)
SDMPR and NEVPR	131	$0.11	0.49

Notes: The Anderson-Darling normality test (Gujarati, 2003, p. 147) was applied, and the test results indicate that the distributions for the paired differences were not normally distributed. The Wilcoxon Signed Rank test was selected to test the null hypothesis that the mean of the pair differences was zero (Newbold, 1995, p. 391).

cattle on a dressed weight basis, the price paid is based on delivery at the plant. Thus, the implication of a zero price differential is that South Dakota producers are receiving the same price for cattle sold dressed weight as Nebraska producers.[12] This suggests there is no statistical evidence of strategically selective voluntary price reporting as has been suggested by some proponents of MPR. Strategic price reporting by packers or feedlots might be reflected in a positive price differential if packers understated transaction prices, or negative if feedlots overstated transaction prices. For example, assume prices voluntarily reported by packing plants in Nebraska to the AMS do not include all cattle purchased at a price above the average transaction price during a specific trading window, but all prices paid during that trading window in South Dakota are reported as a result of state MPR regulations. This scenario would result in a positive price differential occurring in the data, in the favor of South Dakota producers selling in the Nebraska market. The positive price differential might be the result of the packing industry in Nebraska engaging in selective price reporting of transaction prices to create a negative bias in the NEVPR. This type of strategic price reporting behavior was being investigated by the USDA/Grain Inspection, Packers and Stockyards Administration (GIPSA) prior to implementation of the current federal mandatory price reporting system (USDA/GIPSA, 1998). The empirical results reported in table 2 indicate there is no direct evidence of this type of behavior occurring during the period SDMPR was in effect.

[12] Dressed weight price quotes do not include transport cost or pencil shrink.

Empirical Results: Testing for Unit Roots and Cointegration

Table 3 presents the DF or ADF test statistics and the associated p-values for the unit root tests for each of the price series. The associated test statistic for detecting the presence of serial correlation is the Durbin-Watson or Durbin's t.[13] Lagged terms were added to the ADF equation until the error structure was empirically verified as whitened.

As observed from table 3, the unit root hypothesis test indicates both price series are nonstationary. 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 that regresses 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 determines the existence of a unit root, then the two series are not cointegrated and no long-term relationship exists between the two time-series variables. The cointegration test results are presented in table 4.

The results of the cointegration analysis indicate that the NEVPR series is cointegrated with actual transaction data collected by the State of South Dakota during the 19-month period covered in this study. The parameter estimate in table 4 can be interpreted as the long-run relationship between the two price series. The estimate's value being nearly one supports our early conclusion that there is no direct evidence of strategic price reporting.

We conclude that the empirical evidence supports our first hypothesis (i.e., the existence of a long-run spatial price equilibrium relationship). The economic interpretation is that competitive spatial arbitrage forged a long-run equilibrium relationship between the Nebraska and South Dakota cash markets. This equilibrium relationship could only be reflected in the NEVPR and SDMPR data if the NEVPR series and the SDMPR series were accurately reporting actual market transactions in their respective markets.

As indicated by the empirical evidence in table 4, in the long run, producers in South Dakota received prices consistent with what was being reported by the AMS for the region. However, the empirical evidence of highly cointegrated price series over the 19-month period does not provide insight on interregional market response to short-run deviations away from the empirically established long-run relationship. The MPR literature suggests that the ability of the VPR system to provide price transparency to the market was degraded compared to an MPR system. If this conjecture is correct, then short-run divergence from the long-run equilibrium relationship would persist and, by definition, spatial price transparency is not possible. To investigate this issue, an error correction mechanism is employed to examine the effect of short-run anomalies on the empirically established long-run relationship discussed above.

Empirical Results: Error Correction Model

We have established empirically that a long-run equilibrium relationship existed between the NEVPR series and the SDMPR series, which supports the hypothesis that a long-run relationship existed between the Nebraska and South Dakota cash markets.

[13] Serial correlation tests were conducted at the 5% level.

Table 3. Unit Root Test Results

Price Series	Number of Daily Observations	Tau Statistic	*p*-Value
NEVPR[a]	130	-0.84	0.82
SDMPR[b]	130	-0.96	0.85

[a] The order of the autoregressive model selected for the unit root test is AR(0), indicating the DF test is appropriate (DW = 2.085).

[b] The order of the autoregressive model selected is AR(1), indicating the use of the ADF test (Durbin's $t = -1.05$).

Table 4. SDMPR Cointegration Test Results

		Cointegrating Regression			
Price Series Cointegrating Regressions	No. of Daily Observations	Intercept Estimate	Parameter Estimate	Tau Statistic	*p*-Value
SDMPR and NEVPR	131	0.641	0.995	-11.05	0.001

Note: The order of the autoregressive model selected is AR(0), indicating the DF test is appropriate (DW = 2.002).

While the estimated long-run spatial relationship is statistically significant, it is still possible to speculate that sustained short-run deviations from the long-run equilibrium relationship could pose a barrier to spatially linked markets achieving spatial price transparency and hinder price discovery. Sustained short-run deviations would be evidence of the failure of the VPR system to act as an efficient public mechanism for the transmission of information about changing market conditions. An ECM modeling procedure is used to investigate this issue.

A price shock to the Nebraska cash market 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 will disrupt the long-run equilibrium price relationship between Nebraska and South Dakota cash markets. 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 needed for full adjustment to take place. It is during this period of disequilibrium that spatial price transparency can be affected.[14] The length of time (n) it takes for the transmission of a price shock opens a window of opportunity for short-run profitable arbitrage activities to occur and disrupt price transparency.[15] However, if a market distortion occurs which allows positive marginal profit from arbitrage activities to persist in the long run, then spatial price transparency disappears. Barrett and Li (2002) refer to this scenario as imperfect integration. However, the empirical evidence does not support the existence of this possible market outcome.

The answer to the question of how effective the former VPR system was in facilitating price transparency and promoting price discovery in the short run depends on how robust the price shock transmission mechanism was between Nebraska and South Dakota's cash markets and how accurate the NEVPR and SDMPR data reflected the

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

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

Table 5. Error Correction Model OLS Estimates

Price Series ECM Regressions	No. of Daily Observations	ECM Regression Estimates		
		Intercept Estimate	Slope Estimate	Speed-of-Adjustment Estimate
SDMPR and NEVPR	130	0.014 (0.19)	0.915 (15.35)	-0.963 (-10.85)

Notes: Student *t* test statistics are given in parentheses below the respective parameter estimate. The ECM model tested negative for the presence of serial correlation (DW *d*-statistic = 1.99).

shock. To empirically test if a price shock to the long-run equilibrium relationship has a sustained negative effect on spatial price transparency, analysis of short-run deviations from long-run equilibrium will be carried out with an ECM 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 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. The error term reflects the short-run adjustment mechanism that links long-run behavior to short-run behavior during periods of short-run deviations from long-run equilibrium.

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

$$\Delta SDMPR_t = \gamma_0 + \gamma_1 \Delta NEVPR_t + \gamma_2 \varepsilon_{t-1} + z_t, \tag{3}$$

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, lagged one period. The variables $SDMPR_t$ and $NEVPR_t$ are the price series defined in equations (1) and (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 $\Delta SDMPR_t$ and $\Delta NEVPR_t$. 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. The empirical estimates are provided in table 5.

The intercept estimate in table 5 cannot be rejected as being statistically different from zero, implying that the long-run equilibrium relationship is stationary if there are no price shocks affecting the system. This result provides empirical evidence that transaction costs were stationary during the period covered in this study. Therefore, the stationary caveat raised by Barrett and Li (2002) does not apply to the econometric modeling procedure selected for this study.

The slope parameter estimate (table 5) is significant, with a *p*-value of less than 0.001. The slope parameter estimate indicates that if a price shock affects the Nebraska price series in period *t*, then 91.5% of this shock will be reflected in the SDMPR series in period *t*.

The "speed-of-adjustment" parameter estimate (table 5) is also significant, having a *p*-value of less than 0.001. This parameter represents the average proportion of the price-shock-residual remaining after period *t* that will be transmitted to the SDMPR

series in period $t + 1$. For instance, the ECM slope parameter estimate indicates 91.5% of the price shock affecting the NEVPR series in period t will be transmitted to the SDMPR series in period t. The residual of the price shock that was not transmitted in period t is 8.5%. Thus, the long-run equilibrium relationship is disrupted in period t. In period $t + 1$, the "speed-of-adjustment" coefficient shows that 96.3% of the residual resulting from the price shock will be transmitted in period $t + 1$. Therefore, in period $t + 1$, 99.68% of the price shock has been transmitted to the SDMPR series and consequently will be reflected in the next daily transaction period occurring after the shock.[16] The faster a price shock is transmitted from one series to another, the greater is the degree of spatial price transparency between the two series.

The "speed-of-adjustment" estimate leads to the conclusion that spatial price transparency existed between the South Dakota and Nebraska cash markets, and the SDMPR and the NEVPR series accurately reflected this market characteristic. The empirical evidence also implies the information contained in the NEVPR did contribute to price transparency and aided producers in the price discovery process in both the Nebraska and South Dakota cash markets.

Conclusions and Summary

The debate over whether the VPR system engendered price transparency and promoted price discovery is an empirical issue left unanswered in the literature. Empirical evidence provided here supports the view that the goal of public price reporting to provide accurate and timely market price reporting was achieved for the markets discussed here.

Our empirical results provide insights into two issues raised in the literature regarding the robustness of the VPR system as it existed before federal MPR regulations went into effect. First, we found empirical evidence of spatial price transparency, and the SDMPR and NEVPR data reflect this market characteristic. Second, comparing the SDMPR series to the NEVPR series provided empirical evidence that suggests strategic voluntary price reporting did not occur during the period MPR was in effect in South Dakota, although this result may not be true nationwide.

This study is the first to offer empirical evidence that the VPR system provided accurate information on market prices. While our study only covers one small part of the livestock sector, it raises the question that if the former VPR system was an efficient mechanism for promoting price transparency in the cash market for dressed weight steers in South Dakota, was VPR also effective in other regions and for other types of livestock? Although we are not advocating that the VPR system was more robust than the new federal MPR system, there is evidence showing the former system was not as flawed as proponents of MPR suggested. But, it is not necessary to justify the need for MPR based on the assertion that the former voluntary price reporting system degraded price transparency in the cash market for slaughter cattle. Our analysis reveals South Dakota provides one case study where this assertion is questionable.

Finally, we conclude that additional research is needed to answer the following important questions:

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[16] The price adjustment estimate is calculated as follows: 91.5% + (0.963)(8.5%) = 99.68%.

- What are the costs and benefits associated with the federal MPR system?
- Is the loss of market information from smaller regional voluntary price reports hindering market transparency and price discovery in markets where voluntary price reports were discontinued?
- Are there other regional cattle markets or other types of livestock markets where the former VPR system was an efficient mechanism for promoting market transparency and price discovery?

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