CASH SETTLEMENT AS AN ALTERNATIVE SETTLEMENT MECHANISM FOR THE LIVE HOG FUTURES CONTRACT

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The use of cash settlement as a method of settling futures contracts is a relatively new concept [Rowsell and Purcell (1990)]. Historically, futures contracts were for commodities, and actual delivery was the most logical means of linking the futures contract with its underlying commodity. With the development of financial futures, however, alternative means of settlement began to emerge.

Cash settlement was first used for Eurodollar and stock futures contracts in 1981. Soon thereafter proposals involving cash settlement as an alternative to physical delivery began to emerge for agricultural futures markets. Currently the Chicago Mercantile Exchange (CME) live hog futures contract uses a physical delivery settlement. It allows delivery of 40,000 pounds of hogs meeting various weight and grade specifications at any one of seven (previously eight) alternative terminal markets as a means of settlement.

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The dramatic decline in volume at these terminal markets over the last 20 years has brought into question the continuing feasibility of physical delivery at terminal markets. The marketing of hogs to packers through terminal markets where delivery takes place has declined from 16.3% of U.S. marketings in 1972 to less than 5% currently [Packers and Stockyards Administration (1987)]. Recently the Kansas City terminal market closed; this was one of the eight delivery points for the live hog contract. In addition, the Peoria terminal market will no longer have a U.S. Department of Agriculture price reporter, although it will remain open and serve as a delivery point. Other low-volume delivery points may be candidates for closing in the near future, and require restructuring of the contract. Over 90% of slaughter hog marketings are direct from producer to packers.

Jones (1982) noted that cash settlement represents an improvement over physical delivery if availability of deliverable supply at delivery points becomes a problem. As terminal markets decline in volume, the number of days each week when sufficient volume is available to establish market prices also declines. Not only does the information base for futures market participants suffer, but the reduction in terminal market volume can make it more costly for anyone accepting delivery to resell the hogs, or make it more difficult to acquire the hogs necessary to fulfill delivery requirements.

Garbade and Silber (1983) pointed out that the high costs involved in physical delivery for a commodity can also be a problem. High delivery costs impair the convergence of cash market prices and futures prices at contract expiration. The major purpose of providing for delivery on a futures contract is to cause convergence of the futures price and cash price during the delivery period [Jones (1982)]. This convergence is important for futures contracts both because cash market expectations are a primary factor influencing the price of futures contracts, and because it allows the contract to serve as a hedging instrument for cash market participants. The higher the delivery costs, the wider the range of prices within which no arbitrage opportunities will exist as the explicit costs of either making or taking delivery increase, and as the risk of incurring those costs in the delivery process increases [Cohen and Gorham (1985)]. Speculative and hedging interest in the contract may be reduced if the basis at expiration becomes more volatile.

Early studies of cash settlement focused on its possible benefits on basis relationships that were highly variable for the CME feeder cattle contract. Before cash settlement was implemented for the feeder cattle contract in 1986, Elam (1988) concluded that hedging risk would

be decreased by two thirds for feeder cattle producers due to cash settlement. Schroeder and Mintert (1988) conducted analysis of the feeder cattle contract after implementation of the cash settlement, but the reductions in hedging risk were found to be more moderate.

Other studies have examined the possibility of using a cash settlement procedure for the CME live cattle contract. Paul (1987) suggested that disenchantment with futures trading in live cattle would spread as hedging results become poorer due to problems with delivery to declining public stockyards. Kahl, Hudson, and Ward (1989) simulated a series of cash settlement indices for the live cattle futures contract and found that the contract could be improved if an acceptable index could be identified.

In light of the lack of volume in the terminal markets where delivery is allowed, exploration of cash settlement as an alternative settlement mechanism for the live hog futures contract is warranted. After considering some of the important factors in determining the relative performance of cash settlement for the live hog futures contract, a number of alternative cash settlement indices will be simulated, and their effects on basis levels and variability for various cash markets will be estimated. The comparative performance of the cash settlement indices and the current contract settlement mechanism will be examined.

CONCEPTUAL FRAMEWORK FOR CASH SETTLEMENT

The methods used to construct a cash settlement index can vary significantly. A cash settlement index is typically illustrated as an arithmetic average of cash market prices. The average can be simple or weighted, composed of many or few markets, and can be constructed to reflect time in many different ways. The simplest possible index would be composed of the current cash price from a single market. Broader indices can be constructed as a simple average of cash prices from several areas.

The challenge presented by livestock markets when attempting to construct a cash settlement index lies in the complex structure of the cash markets. Prices often differ across geographic areas because of transportation costs and local supply and demand conditions. For example, cash hog prices in Peoria may tend to be $1.50 above that at a buying station in Indiana, but this relationship varies. Geographically dispersed cash livestock markets in the long term would be expected to differ by no more than transportation costs between market locations,

but from day-to-day a great deal of variability may be present. Therefore, a cash settlement index based on one location probably would not be a completely accurate reflection of prices paid at any other location on the same day.

It is known that price differentials across regions exist in the live hog cash markets, but the live hog futures price should nonetheless have a predictable relationship to cash markets. A cash settlement index could conceivably be constructed to achieve a basis that, on average, is zero. But, if the variability of that basis is such that it frequently can be one dollar above or below zero, its usefulness is lessened. Therefore, the standard deviation of basis values resulting from a settlement mechanism is an important indicator of its potential performance, and will be used in evaluation of simulated cash settlement indices later in the article.

The second criterion by which a cash settlement index should be evaluated is its simplicity. A desirable aspect of a cash settlement is that all traders be able to understand how the cash settlement index is constructed. If the index is too complex, traders may not have a clear idea of what the actual value of the index will be based on their knowledge of the cash markets, and this perceived risk may reduce hedgers' and speculators' interest in using the contract. The CME feeder cattle contract cash settlement index was recently revised to reflect a more narrow range of markets with a more transparent price basis and volume weighing procedure, and contract volume has increased as the index has become more predictable.

Another factor that should be used in evaluation of a cash settlement, but one which is more difficult to illustrate, is its susceptibility (if any) to manipulation. If potential users of a futures contract consider the probability of an adverse price manipulation to be insignificant, they will be more likely to participate. Manipulation involves building disparate positions in the cash and futures markets, such that losses from a position in one market are more than offset by gains in the other. In cash settlement, manipulation may involve altering cash market prices or reported cash prices. While hog production has an atomistic structure, buyer concentration in the hog slaughter industry is high in some geographic areas, and some terminal markets are thinly traded. To protect against the possibility that prices or price reports in cash markets could be manipulated to gain in the futures market, increasing the geographic scope and the number of days involved in the price index would reduce the probability that any packers, producer groups, or speculators acting individually or in concert could effectively manipulate the cash price index. Also, elimination of price extremes in the index

or weighing certain price series in the index could make manipulation more difficult.

Issues of futures market manipulation have been addressed by several authors [see Anderson (1984)]. Kyle (1984, p. 169) concludes that cash settlement has no effect on the incentive to engage in squeezes, and that it only transfers some of the manipulative activity into the cash market from the futures market because there is no longer the possibility of exploiting the delivery mechanism. Paul (1987) suggests that the risk of manipulation for cash settlement of livestock contracts might actually be less than that of physical delivery given the thin trade in terminal markets. He argues that the short-run supply curve for spot delivery at one location has greater slope than the aggregate supply curve across several locations included in a cash settlement index, implying greater capital requirements to drive cash prices up for cash settlement than physical delivery.

Practical analysis of cash hog markets shows that despite high concentration in certain geographic areas, competition for hogs extends over broad geographic areas. For example, IBP slaughters over 40% of Iowa hog production in its plants in the state. This may raise concerns regarding use of cash price reports from Iowa. However, packers from states adjacent to Iowa and sometimes as far away as Michigan, Tennessee, and California buy hogs in Iowa. Markets for live hogs are highly integrated as competition for hog supplies overlaps from region to region. This fact suggests that it would be very costly for any packer to manipulate cash prices to any significant degree in most parts of the primary hog production areas, because a process of arbitrage among packers and hog producers tends to keep price movements similar across regions.

The integration of hog markets can be confirmed by simple correlation analysis. Stigler and Sherwin have noted that correlations of direct or differenced time series can be used as adequate indicators of geographic or product markets. The simple correlations of daily cash hog prices are 0.978 to 0.99 in the 19 markets analyzed (described later in the article), and the correlations of daily price changes usually range from 0.60 to 0.90. The lowest correlations of price changes occur in fringe areas of hog production relative to midwestern prices (as low as 0.3), especially for the South Carolina–Georgia–Florida–Alabama region which has relatively small market volume. Overall cash hog markets are closely linked with extremely high correlation between same day price series in Iowa, Illinois, Minnesota, and Missouri, and slightly less correlation with midwest

prices as you move into the Indiana–Ohio regions and further east and southeast.[1]

Thus, while it is a concern in constructing a cash settlement index, inclusion of several price series from primary hog producing areas should minimize the possibility of price manipulation in spite of concentration of large packers in some areas. While the focus of manipulation risk is transferred from the futures to cash market, the possibility of exploiting the delivery mechanism is eliminated and the risk associated with cash settlement may be much less than that of thinly traded terminal markets currently used for physical delivery.

Theoretical Analysis of Basis Variance

If cash settlement presents a viable alternative for settlement of the live hog futures contract, will adding markets to the index affect hedging effectiveness (basis variance)? Theoretical examination of simple average indices offers some indication of the tradeoff between hedging effectiveness and the number of markets or market days included in an index. Noting that the basis is simply a sum of random variables multiplied by constants, the variance of the basis for some market [$\mathrm{Var}(B^0)$] for a simple average index can be expressed in terms of the variance and covariance of markets involved:

$$\begin{aligned}\mathrm{Var}(B^0) = {} & \mathrm{var}[P_t^0] + 1/(nm)^2 \sum_t \sum_i \mathrm{var}[P_t^i] \\ & + 2/(nm)^2 \sum_t \sum_{i<j} \mathrm{cov}[P_t^i P_t^j] \\ & - 2/(nm)^2 \sum_t \sum_i \mathrm{cov}[P_t^0 P_t^i] \end{aligned} \tag{1}$$

Where P_t^0 = cash price in some market

B^0 = Basis $(P_t^0 - I)$, where I = cash settlement index value

Using eq. (1), examples of particular cash settlement indices can be used to illustrate basis variability. For a cash settlement index constructed from only the Iowa–S. Minnesota price, the basis in Iowa–S. Minnesota (I) would be zero as well as the basis variance [$\mathrm{Var}(B^I)$]:

$$\mathrm{Var}(B^I) = \mathrm{Var}[P_t^I] + \mathrm{Var}[P_t^I] - 2\mathrm{Cov}[P_t^I P_t^I] = 0 \tag{2}$$

[1] Correlation tables are available from the authors.

The basis variance for some other market [$\text{Var}(B^0)$] would most likely not be equal to zero using an index composed of only the Iowa–S. Minnesota price, however.

$$\text{Var}(B^0) = \text{Var}[P_t^0] + \text{Var}[P_t^I] - 2\text{Cov}[P_t^0 P_t^I] \quad (3)$$

The addition of a number of price series (locations or market days) to an index can significantly increase basis variance across markets in many cases. For example, if a fringe or outlying market area is added to the cash settlement index, the variance of the basis for that market and for some of its adjacent markets may decrease; but the basis variance for many of the remaining markets, including the higher production areas, will increase. This could lead to a contradiction of Kahl et al. who stated "basis is easier to predict when the futures price represents the average value of several . . . locations."

CASH SETTLEMENT INDEX SIMULATIONS

Prior discussion indicates that cash settlement is a viable settlement alternative if it is an effective hedging instrument due to predictable basis variability, and does not present a significant risk for manipulation. While incorporating more geographic locations or more days into an index may clearly reduce the risk of manipulation, a significant empirical issue is the impact of different index designs on basis variability. The comparative basis variability of cash hog prices from around the U.S. is used to evaluate various cash settlement indices, and to compare them with the hedging effectiveness of the physical delivery settlement mechanism.

The market hog price data used for this study are U.S. Department of Agriculture daily prices from 19 reported states or markets for 230–250 lb., U.S. 1–2 barrows and gilts.[2] The terminal and direct market prices are from January 1985–September 1990, with the exception of Indiana direct and Indianapolis (1987–1990). The only non-USDA price series is that for North Carolina, which is the buying station price from a state reporting service.

[2]Direct Markets: Iowa–S. Minnesota (IAMN), Illinois (IL), Indiana (IN), Ohio (OH), North Carolina (NC), Wisconsin (WIS), Kentucky (KENTY), Tennessee (TENN), Georgia–Alabama–Florida (GA–AL–FL), Georgia (GADIR), S. Carolina (SCAROL). Terminals: Peoria (PE), Indianapolis (INDPOLIS), Omaha (OM), Sioux City (SXCITY), S.St. Paul (STPAUL), St. Joseph (STJOE), Kansas City (KC–MO), National Stockyards (NATLSTY).

Simulated Cash Settlement Indices

A number of illustrative cash settlement indices are constructed from the U.S. Department of Agriculture price data. The arithmetic average indices are based on one to ten markets, and 1-, 3-, and 5-day moving averages. These indices are evaluated based on their effect on basis levels and basis variability for each cash hog market. Since any particular time when a contract would expire can be viewed as a sample of all the business days when the markets are open, all daily price report observations ($n = 1500$) are used in the analysis. Ten selected cash settlement indices are reported. Simulated indices include:

1. IAMN—The Iowa–S. Minnesota direct price. This price represents the largest direct market of those included in the USDA prices series.
2. IAMN–IN—The simple average of the Iowa–S. Minnesota price and the Indiana direct price.
3. IAMN–IN–IL—The simple average of the Iowa–S. Minnesota, Indiana direct, and Illinois direct prices.
4. IAMN–IN–IL–OH—The simple average of the Iowa–S. Minnesota, Illinois, Indiana, and Ohio direct prices.
5. WEIGHTED—The price series in index 4 are volume weighted using December 1 USDA market hog inventory data. The weights are assigned according to each price series proportion of total hogs in Iowa, Minnesota, Illinois, Indiana, and Ohio. The weights are: IAMN—0.60, IL—0.18, IN—0.15, OH—0.07.
6. IAMN–IN–OH–NC—The simple average of the Iowa–S. Minnesota, Indiana, Ohio, and North Carolina direct prices.
7. IAMN–NC—The simple average of the Iowa–S. Minnesota and North Carolina prices.
8. DIRECT(10)—A simple average index is computed from ten direct market price series (Iowa–S. Minnesota, Ohio, Indiana, North Carolina, Wisconsin, Kentucky, Tennessee, Georgia, Georgia–Alabama–Florida, and South Carolina).
9. TERMINALS—A simple average was computed for Chicago Mercantile Exchange delivery points (Omaha, Peoria, Kansas City, Sioux City, St. Paul, St. Joseph, National Stockyards–E. St. Louis during 1985–1990) for which data are available from the USDA.
10. MEDIAN—The median of prices from Sioux City, Iowa–S. Minnesota, Peoria, Indiana direct, Ohio direct, North Carolina, and St. Joseph.

Table I reports the standard deviations of basis values for these cash settlement indices at 19 locations. The average standard deviation of the basis is lowest across all those markets for the IAMN–IL–IN AND IAMN–IL–IN–OH indices ($0.56/cwt.).[3] These indices result in low basis standard deviations for the major hog production areas of Iowa, Minnesota, Illinois, and Indiana of $0.40/cwt. or less, while still resulting in relatively low standard deviations for fringe production areas in the southeastern U.S.

Weighing the IAMN–IL–IN–OH series by their relative market hog population leads to a slight increase in average basis variability. Trying to do the same weighing process on a daily or weekly basis would require reliance on USDA market reporter estimates of market volume of all slaughter hogs. Such a weighing scheme could lead to greater hedger/trader uncertainty regarding the likely settlement price unless known volume data are employed in calculating the weighted index.

The DIRECT(10) and TERMINALS indices exhibit the poorest performance of any constructed. DIRECT(10) is composed of ten prices from widely dispersed geographic market areas. Many of these markets have small hog volumes (e.g., Tennessee, Wisconsin, and Kentucky). In contrast, the TERMINALS index is composed of small volume markets that are located in the major producing areas of the midwest, and currently are used as CME delivery points. Many of these markets are relatively close to one another, but not high volume; so small swings in daily volume might lead to more volatile reported prices in these thinly traded markets relative to most direct markets.

The MEDIAN cash settlement index is the middle price of the same day prices from Sioux City, Iowa–S. Minnesota, Peoria, Indiana Direct, Ohio Direct, North Carolina, and St. Joseph. Using a median price index might protect against manipulation since the closeness of other market prices to the median market would limit the effect of any potential manipulator of a single market, and manipulation of most markets would have no impact on the settlement price. In a simple average index, manipulation of one market on one day would affect the index, though the inclusion of more markets and more days reduces that effect.

The performance of the median index reflects the geographic characteristics of the cash hog markets. These markets are characterized by higher prices in the midwest due to excess slaughter capacity

[3]Note that any difference between standard deviations is statistically significant due to the high degrees of freedom ($n = 1500$). The Wilks generalized likelihood-ratio statistic and chi-squared distribution can be used to compare standard deviations in this simulation (Morrison, 1985, p. 250).

TABLE I

Basis Standard Deviations for 19 Markets Associated with Various Cash Settlement Indices (1985–1990 in $/cwt.)

	Markets									
Price Index	*IAMN*	*IL*	*PE*	*NATLSTY*	*IN*	*INDPOLIS*	*OM*	*SXCITY*	*STPAUL*	*STJOE*
IAMN										
1-Day	0.00	0.53	0.48	0.51	0.68	0.58	0.55	0.50	0.55	0.53
3-Day	0.51	0.68	0.64	0.62	0.77	0.66	0.80	0.78	0.83	0.79
5-Day	0.70	0.83	0.79	0.76	0.91	0.78	0.92	0.92	0.97	0.92
IAMN–IN										
1-Day	0.34	0.44	0.42	0.37	0.34	0.51	0.66	0.61	0.57	0.55
3-Day	0.60	0.66	0.64	0.56	0.57	0.65	0.87	0.84	0.82	0.80
5-Day	0.75	0.81	0.79	0.72	0.75	0.80	0.96	0.96	0.93	0.91
IAMN–ILL–IN										
1-Day	0.36	0.24	0.39	0.31	0.42	0.48	0.61	0.64	0.48	0.48
3-Day	0.52	0.46	0.54	0.45	0.54	0.58	0.73	0.77	0.65	0.65
5-Day	0.65	0.60	0.63	0.53	0.66	0.65	0.82	0.84	0.76	0.76
IAMN–ILL–IN–OH										
1-Day	0.49	0.36	0.51	0.40	0.27	0.57	0.71	0.74	0.48	0.55
3-Day	0.68	0.60	0.70	0.62	0.52	0.74	0.86	0.90	0.69	0.74
5-Day	0.81	0.74	0.83	0.74	0.64	0.83	0.96	1.01	0.81	0.85
Weighted (IAMN–0.60, ILL–0.18, IN–0.15, OH–0.07)										
1-Day	0.23	0.37	0.37	0.36	0.49	0.49	0.59	0.56	0.54	0.5
IAMN–OH–NC–IN										
1-Day	0.62	0.59	0.67	0.56	0.27	0.75	0.86	0.86	0.60	0.70
3-Day	0.76	0.74	0.82	0.70	0.51	0.86	0.99	1.00	0.79	0.87
5-Day	0.84	0.82	0.90	0.79	0.63	0.94	1.02	1.07	0.84	0.92
IAMN–NC										
1-Day	0.55	0.63	0.61	0.56	0.38	0.75	0.74	0.76	0.58	0.61
3-Day	0.72	0.78	0.79	0.70	0.49	0.80	0.92	0.95	0.82	0.82
5-Day	0.81	0.87	0.91	0.82	0.58	0.85	1.00	1.05	0.92	0.91
Direct (10)										
1-Day	1.14	0.95	1.13	0.99	1.06	1.08	1.13	1.31	1.10	1.12
3-Day	1.17	1.00	1.16	1.02	1.09	1.11	1.18	1.35	1.15	1.18
5-Day	1.10	0.97	1.12	1.00	1.06	1.06	1.10	1.28	1.10	1.12
Terminals										
1-Day	1.00	1.06	0.99	0.94	0.75	0.50	1.06	1.09	1.13	1.03
3-Day	0.91	1.01	0.94	0.89	0.83	0.62	1.01	1.04	1.09	0.99
5-Day	0.92	1.04	0.97	0.93	0.87	0.67	1.02	1.05	1.11	1.00
Median										
1-Day	0.87	0.80	0.86	0.77	0.15	1.08	1.10	1.10	0.82	0.92

there with price decreasing as one moves east. The median of prices from western Iowa to North Carolina usually is represented by the Indiana or Ohio prices. The Indiana price is the median 44% of the time, with Ohio (40%), North Carolina (12%), and St. Joseph (4%). While this type of index would be less susceptible to manipulation than an index based on market averages, MEDIAN does not perform particularly well in terms of

TABLE I. Continued

Markets									
KC–MO	*OH*	*NC*	*WIS*	*KENTY*	*TENN*	*GAALFL*	*GADIR*	*SC*	*AVG.*
0.50	0.88	1.06	0.76	0.64	0.60	1.35	1.39	0.87	0.68
0.77	0.94	1.14	0.86	0.73	0.68	1.36	1.50	0.80	0.83
0.91	1.06	1.28	1.01	0.87	0.82	1.45	1.59	0.92	0.97
0.53	0.60	0.86	0.62	0.36	0.36	1.21	1.26	0.71	0.60
0.78	0.73	0.99	0.77	0.56	0.54	1.24	1.39	0.67	0.77
0.90	0.86	1.12	0.91	0.71	0.69	1.32	1.47	0.81	0.90
0.46	0.68	0.93	0.65	0.37	0.32	1.15	1.07	0.63	0.56
0.63	0.74	0.99	0.73	0.49	0.45	1.14	1.14	0.60	0.67
0.75	0.82	1.05	0.82	0.58	0.55	1.20	1.24	0.71	0.77
0.53	0.51	0.80	0.57	0.26	0.26	1.02	0.97	0.55	0.56
0.73	0.64	0.89	0.69	0.51	0.52	1.05	1.08	0.59	0.72
0.84	0.71	0.93	0.77	0.63	0.64	1.07	1.12	0.68	0.82
0.48	0.73	0.96	0.68	0.46	0.43	1.29	1.27	0.75	0.61
0.69	0.35	0.56	0.53	0.35	0.39	1.00	1.05	0.52	0.63
0.87	0.53	0.73	0.66	0.54	0.56	1.02	1.17	0.46	0.77
0.92	0.65	0.85	0.74	0.64	0.65	1.08	1.21	0.58	0.85
0.62	0.55	0.55	0.50	0.52	0.50	1.08	1.03	0.58	0.64
0.82	0.68	0.74	0.58	0.67	0.64	1.06	1.15	0.47	0.77
0.90	0.79	0.89	0.66	0.78	0.75	1.10	1.20	0.61	0.86
1.13	1.10	1.16	1.08	1.00	0.97	1.31	1.29	1.03	1.11
1.19	1.13	1.21	1.11	1.03	1.01	1.30	1.35	1.00	1.14
1.12	1.11	1.21	1.08	1.01	0.98	1.29	1.30	0.98	1.11
1.02	1.21	1.34	0.91	1.05	0.98	1.49	1.31	1.07	1.05
0.98	1.16	1.32	0.98	1.01	0.93	1.42	1.39	0.96	1.03
1.00	1.19	1.36	1.00	1.05	0.98	1.42	1.37	1.01	1.05
0.91	0.35	0.65	0.68	0.46	0.53	0.98	0.95	0.67	0.77

basis variability (except for the Indiana and Ohio markets). The resulting one day index's standard deviation across all markets is $0.77/cwt.

Given the structure of cash hog prices across the U.S. at this time, it would appear that a median index of this type would not be particularly useful. The geographic differences in prices are great enough on a consistent basis that if a series of high and low prices are excluded in

some systematic fashion, the resulting index will consist of the same prices a high proportion of the time. If more markets are used in selecting the median index, this would likely reduce the frequency of any one market serving as the median to some extent, and limit the impact of any successful manipulation of the median market. Until regional supply and demand conditions result in cash hog prices which are somewhat closer in value, or more market locations are considered, a median index will not perform as well as an arithmetic average.

For the full set of indices generated, one through five market day price averages are computed for each cash settlement index. Figure 1 shows that, as would be expected, the three- and five-day moving average indices result in greater basis variability than their one-day analogs. The standard deviation of the basis increases 10–15% for every market day that is added to an index. Probability distributions of the basis values show that the basis is within one standard deviation of its average approximately 70% of the time for a one-day index, 60% of the time for a two-day index, 50–55% of the time for a three-day index, and 45–50% of the time for a five-day index.

Expiration Day Simulation

Basis values on expiration days of the live hog futures contract for the 19 price reporting locations are compared to the basis values that would arise if the cash settlement indices that are simulated were in place in the 1985–1990 time period. The cash settlement indices resulted in basis values on expiration days very close to those computed over the entire range of trading days. As Figure 2 shows, the standard deviations of the basis arising from the current contract delivery mechanism are

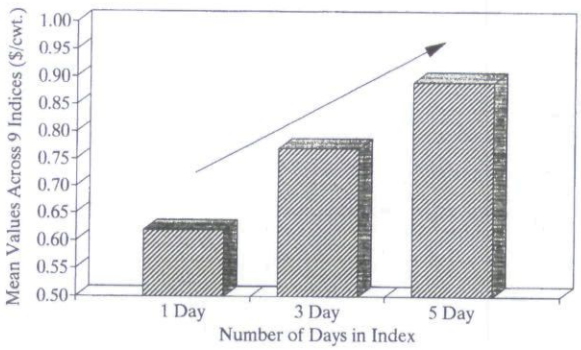

FIGURE 1
One versus multiple day indices (standard deviations).

significantly higher than for the cash settlement indices.[4] The mean standard deviation of basis values for the delivery contract on expiration days is \$1.29/cwt., versus \$0.60–0.64/cwt. for the simulated cash settlement indices.

Some expert traders offer the hypothesis that the closing futures price on expiration days might not reflect cash prices on that day, but rather the expected cash prices several days in the future when delivery is contemplated. As a test of this hypothesis, the basis of the expiration futures price and actual cash prices in the several days following expiration are computed and compared to the basis on the day of expiration. The expired futures–cash price basis in the following days is larger and more variable than that of the expiration day. For example, the standard deviation of the basis from the expiration day futures price and cash price one, three, five, and seven days later are \$1.36/cwt., \$1.48/cwt., \$1.79/cwt., and \$1.94/cwt., respectively. Thus, the traders' hypothesis is not consistent with price behavior over the last five years. Consequently, the basis variability on the date of expiration is the best standard for comparison with the current contract delivery performance. While basis variability prior to the expiration date is often a matter of concern for traders, it is impossible to test how that would change, since the level and the variability of futures prices would likely change with the introduction of the new contract specifications.

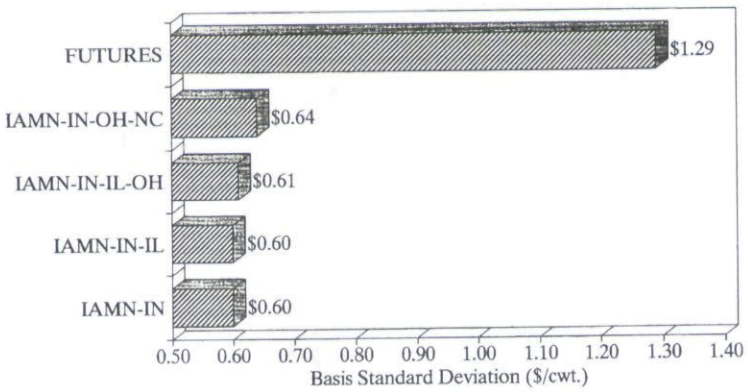

FIGURE 2
Delivery versus cash settlement (Basis variability at contract expiration).

[4]The differences between the standard deviations of the basis for cash settlement and physical delivery are statistically significant at the 1% level using the Wilks generalized likelihood-ratio statistic and the chi-squared distribution (Morrison, 1985, p. 250).

CONCLUSIONS

The integration of geographically dispersed cash hog prices is the important factor in determining how various cash settlement indices for the live hog futures contract will perform. Correlation of prices in and between both major hog production areas and fringe production areas determines how a given cash settlement index will perform across all markets.

Well-integrated live hog markets in the U.S. imply that relying on a small number of markets in a cash settlement should not cause undue basis volatility in markets not included in the index. A number of relatively narrow indices are constructed that perform quite well across all markets.

The number of market days included in the cash settlement index can be increased as a protection against manipulation. However, there is a cost associated with doing this, as more market days included in the index lead to a substantially more variable basis across markets.

Less definitive answers can be offered in addressing the tradeoffs associated with increasing the number of price reporting locations included in an index. It is clear that adding too many markets to an index tends to increase basis variability. However, based on the indices that are constructed, it appears that a well performing index can be constructed for the live hog contract from two to four price series. As shown in the examples, indices with about this number of markets with heavy representation in the Corn Belt and lesser representation of production areas farther east perform quite well across all markets.

There is a trade-off between hedging performance of a cash settlement index and its potential for manipulation. Possible manipulation is a factor deserving careful attention. However, while the top four slaughter firms now control approximately 45% of industry slaughter, few firms operate plants in more than two states and they often buy hogs from several states. The number of competitors for hogs in most major hog-producing states appears sufficient to keep any one firm from effective cash market manipulation. Therefore, the likelihood of manipulation of prices in any index should be able to be kept at a minimum with appropriate index construction.

Finally, cash settlement provides for better convergence of cash prices and the futures price for hogs over the 1985–1990 period when compared to physical delivery. Basis variability across markets for the simulated cash settlement indices on expiration days is approximately

one half of the basis variability that actually existed under the current futures delivery contract.

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