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DEVELOPING A CASH SETTLEMENT PRICE INDEX FOR LIVE HOG FUTURES

by Kevin Kimle and Marvin Hayenga*

Agricultural commodity futures market contracts in the United States typically permit making or accepting delivery of the cash commodity. The actual transfer among buyers and sellers of the commodity was occasionally facilitated by this contract provision and the threat of making or taking delivery brought the futures and cash prices in alignment as the contract expired. In the last decade, many financial instrument and stock index futures contracts have used cash settlements. In addition, the Chicago Mercantile Exchange feeder cattle futures contract was changed to a cash settlement contract in an attempt to minimize basis variability which discouraged industry use of the contract.

Currently, the live hog futures contract requires delivery of 40,000 pounds of hogs meeting various weight and grade specifications at any one of eight alternative terminal markets. However, the marketing of hogs to packers through terminal markets has declined from 16.3 percent of reported volume in 1972 to 6.3 percent in 1987 (USDA, Packers and Stockyards Administration). In 1988, market hogs purchased directly at packer plants, buying stations or from independent dealers reached 89.5 percent of packer purchases (terminal market volumes are no longer reported separately). As these 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 potentially costly for anyone accepting delivery to resell the hogs. That could reduce speculative interest in the contract and affect the basis as the contract expires. Therefore, exploration of cash settlement as an alternative to the current settlement mechanism would offer insight into the potential performance of the live hog contract if changes need to be made. The objective of this study is to explore the factors that are important when considering cash settlement for the live hog contract, and to simulate and evaluate the performance of some various example price indices.

Many studies have generally discussed the advantages and disadvantages of a cash settlement procedure for agricultural futures contracts, and evaluated some of the various implications. Cohen and Gorham explored the differences which should be anticipated by hedgers and speculators for cash settlement versus physical delivery. Paul reviewed historical difficulties that have arisen when cash settlement has been used for agricultural commodities, and explored various issues that would affect implementation of a cash settlement procedure. Garbade and Silber explored the possible benefits of cash settlement over physical delivery, and noted that the price index used for settlement must be a reliable indicator of the true commercial value of the underlying commodity and went on to model a price series and explore various issues of cash settlement.

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-Index Construction-

The challenge presented by livestock markets when attempting to construct a cash settlement index lies in the complex structure of the cash markets. Prices differ across geographical areas often. 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. Cash livestock markets in the long term would be expected to differ according to transportation costs, but on a day to day basis a great deal of variability may be present. Therefore, a cash settlement index based on one livestock market probably would not be a perfect reflection of prices paid at any other market on the same day.

A cash settlement index can be basically thought of as an arithmetic average of cash market prices.[1] 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. These simple averages can be constructed from current day cash prices or an average of current and past prices. Thus, a general form for a simple average index is:

$$(1) \qquad I = 1/(nm) \sum_{t=1}^{m} \sum_{i=1}^{n} P_t^i$$

Where I = Cash settlement index price
P_t^i = Today's Cash price in market i, i=1,...n
m = Number of days in the index, t=1,...m

A one day simple average index composed of prices from markets 1 and 2 would be computed as:

$$(2) \qquad I = 1/2 \ (P_t^1 + P_t^2)$$

A more complicated index would be a 2 day index for markets 1 and 2:

$$(3) \qquad I = 1/4 \ (P_t^1 + P_{t-1}^1 + P_t^2 + P_{t-1}^2)$$

A more complex index can be constructed from weighted averages of the cash markets. The weights attached to particular cash prices can reflect the significance of the price in terms of volume in the market, for instance. A weighted average index would take the general form:

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[1] Cash settlement indices do not necessarily have to be constructed as arithmetic averages. For example, a median price, geometric or other averages might be used.

$$(4) \qquad I = \sum_t \sum_i \alpha_i P_t^i$$

$$\text{Where } \sum_{i=1}^{n} \alpha_i = 1$$

The simple or weighted average indices can be constructed to reflect any number of markets over any number of days. The index would then be used as the price for settling the futures contract upon expiration.

Analysis of Basis Variance

The statistical relationships that affect basis variability offer some insight into why certain cash settlement indices perform as they do with regard to basis variability. Noting that the basis is simply a sum of random variables multiplied by constants, the variance of the basis for some market ($Var(B^0)$) for a simple average index can be expressed in terms of the variance and covariance of markets involved:

$$(5) \quad Var(B^0) = var[P_t^0] + 1/(nm)^2 \sum_t \sum_i var[P_t^i] + 2/(nm)^2 \sum_t \sum_{i<j} cov[P_t^i P_t^j] - 2/(nm) \sum_t \sum_i cov[P_t^0 P_t^i]$$

Where P_t^0 = cash price in some market
B^0 = Basis $(P_t^0 - I)$

For a weighted average index:

$$(6) \quad Var(B^0) = var[P_t^0] + \sum_t \sum_i \alpha_i^2 var[P_t^i] + 2 \sum_t \sum_{i<j} \alpha_i \alpha_j cov[P_t^i P_t^j] - 2 \sum_t \sum_i \alpha_i cov[P_t^0 P_t^i]$$

As an example, 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 ($Var(B^I)$):

$$(7) \quad Var(B^I) = Var[P_t^I] + Var[P_t^I] - 2\, Cov[P_t^I P_t^I] = 0$$

A cash settlement index constructed as a simple average of the one day prices of Iowa-Southern Minnesota Direct (I) and Peoria (P) would result in the following basis variance for market '0', based on the market variances and covariances. Indices which are constructed using more markets or more days than this example would involve a larger number of terms.

$$(8) \quad Var(B^0) = var[P_t^0] + 1/4\ var[P_t^P] + 1/4\ var[P_t^I] - 1/2\ cov[P_t^P P_t^I] - cov[P_t^0 P_t^I] - cov[P_t^0 P_t^P]$$

As the correlation between a market price and the market prices used in the cash settlement increases, the variability of the basis for that market decreases. As the number of markets and market days included in the index is increased, the basis variability may increase. For example, if a fringe or outlying market area is added to the cash settlement index, the variability of the basis for that market and for some of its adjacent markets may decrease, but the basis variability for many of the remaining markets, including the higher production areas, will probably increase.

Another observation is that adding a market to a price series that is adjacent to (and very highly correlated with) a market already in the index will increase basis variability across markets, thereby improving nothing in the way of index performance.[2] Conversely, if a market is added to the index that is highly correlated with non-index markets that experience high basis variability under the original index, the overall performance of the index may improve as the variability of the basis for their basis variability decreases without significantly increasing that of others.

One aspect of cash settlement indices that is more difficult to illustrate is their susceptibility (if any) to manipulation. A concern when constructing an index is that it not be able to be manipulated. Concentration in the pork slaughter industry in some geographic areas is high, and some terminal markets are thinly traded. To protect against the possibility that prices or price reports in cash markets could be manipulated in order 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 packer(s), producer groups, or speculators acting individually or in concert could effectively manipulate the cash price index. The manipulability has been discussed in previous research, such as that of Paul, who suggested that the risk of manipulation for cash settlement index might actually be less than that of physical delivery given the thin trade in terminal markets.

-Procedures & Results-

The market hog price data used for this study were USDA daily prices for 230-250 lb., U.S. 1-2 barrows and gilts.[3] The terminal, direct market, and auction market prices were from January 1985-September 1990, with the exception of Indiana direct and Indianapolis (1987-1990).

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[2] For example, it can be shown using Equation (6) that when one market is added to a two market, one day index that is highly correlated with one or both of the markets already in the index, the variability of the new index will be larger than that of the first.

[3] **Direct Markets:** Iowa-S.Minnesota(IAMN), Indiana(IND), 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). **Auction Markets:** Springfield, Missouri (SPGFLD).

Simple correlation analysis was performed to get a basic idea of how geographically dispersed cash hog prices move or don't move together. The prices were then used to generate a number of different cash settlement indices and evaluate their effect on cash hog markets in terms of basis levels and basis variability. The analysis was designed to demonstrate the tradeoffs among basis variability for important producing areas and the associated risk of market manipulation which would be lower as more geographic areas or days of the week are included in the index. 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 were used in the analysis. The number of markets included in the index was varied, and the number of days ranged from one to five.

The simulated cash settlement indices were evaluated by analysis of the associated basis variability across markets. The futures contract is more useful to hedgers when it has a stable relation to its underlying cash market. Indeed, in the case of live hog cash markets we know that price differentials across geographic regions exist, but nonetheless the live hog futures price should have a predictable relationship to cash markets. Thus basis predictability or variability becomes the important criterion for how well cash settlement performs. A cash settlement index could be constructed to achieve a basis that on average is zero. But if the variability of that basis is such that it can be one dollar above or below zero its usefulness is lessened. An index which minimizes basis variability is desirable, aside from the actual level of the basis in differing geographic regions.

An unpredictable basis for a futures contract upon expiration makes it difficult for both speculators and hedgers to use the contract. For the hedger, uncertainty about the local market basis makes hedging a more risky market alternative. For the speculator, predicting futures market moves according to the fundamental characteristics of the cash market becomes more difficult, since an unpredictable basis pattern at expiration raises uncertainty regarding how the futures market will move.

Structure of Cash Markets

Simple correlation analysis of these cash hog price series was performed (Table I). The simple correlations of undifferenced prices were very high. Most were .99 or above, with only some markets distant from the Corn Belt being slightly lower (the lowest was .978).

The simple correlations of first differenced prices were high as well (.60-.90). The lower correlations of price changes in the fringe areas of hog production relative to midwest prices were more evident, especially for the South Carolina-Georgia region.

Live hog cash markets are characterized by consistently higher prices in the general Iowa area, with prices becoming slightly lower as you move in either direction. The markets appear to be highly integrated 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. The high correlations exhibited by most live hog cash markets suggests that the live hog futures

TABLE I – Correlations of daily cash hog market prices (1985–90)

	IAMN	OMAHA	PEORIA	STPAUL	SXCITY	SPGFLD–	SCAROL	STJOE	NTLSTYD	OH–DIR	KC–MO	KENTKY	GAALFL	NCAROL	IND–DIR	INDAPOLI	GA–DIR	WISCSN	TENN
IAMN	1.000	0.996	0.996	0.980	0.997	0.996	0.989	0.997	0.996	0.991	0.993	0.993	0.980	0.993	0.996	0.995	0.979	0.997	0.996
OMAHA	0.996	1.000	0.994	0.996	0.998	0.992	0.987	0.997	0.994	0.989	0.992	0.992	0.977	0.987	0.992	0.991	0.979	0.993	0.992
PEORIA	0.996	0.994	1.000	0.995	0.995	0.998	0.991	0.996	0.998	0.995	0.997	0.997	0.980	0.993	0.998	0.998	0.980	0.996	0.997
STPAUL	0.980	0.996	0.995	1.000	0.997	0.993	0.988	0.996	0.994	0.990	0.992	0.992	0.980	0.992	0.994	0.993	0.978	0.994	0.993
SXCITY	0.997	0.998	0.995	0.997	1.000	0.993	0.988	0.998	0.994	0.990	0.993	0.993	0.980	0.990	0.994	0.993	0.977	0.993	0.994
SPGFLD–	0.996	0.992	0.998	0.993	0.993	1.000	0.987	0.994	0.997	0.991	0.996	0.996	0.975	0.992	0.997	0.997	0.980	0.997	0.997
SCAROL	0.989	0.987	0.991	0.988	0.988	0.987	1.000	0.989	0.992	0.994	0.993	0.993	0.991	0.997	0.994	0.993	0.984	0.991	0.993
STJOE	0.997	0.997	0.996	0.996	0.998	0.994	0.989	1.000	0.995	0.991	0.994	0.994	0.980	0.990	0.994	0.993	0.978	0.993	0.995
NTLSTYD	0.996	0.994	0.998	0.994	0.994	0.997	0.992	0.995	1.000	0.995	0.996	0.998	0.981	0.994	0.998	0.998	0.981	0.996	0.999
OH–DIR	0.991	0.989	0.995	0.990	0.990	0.991	0.994	0.991	0.995	1.000	0.991	0.997	0.986	0.994	0.998	0.997	0.983	0.992	0.996
KC–MO	0.997	0.997	0.997	0.996	0.998	0.995	0.988	0.999	0.996	0.991	1.000	0.994	0.979	0.990	0.995	0.994	0.978	0.994	0.995
KENTKY	0.993	0.992	0.997	0.992	0.993	0.996	0.993	0.994	0.981	0.998	0.994	1.000	0.994	0.994	0.999	0.998	0.981	0.995	0.999
GAALFL	0.980	0.977	0.980	0.980	0.980	0.975	0.991	0.980	0.981	0.986	0.979	0.994	1.000	0.990	0.983	0.979	0.991	0.984	0.986
NCAROL	0.993	0.987	0.993	0.992	0.990	0.992	0.997	0.990	0.994	0.994	0.990	0.994	0.990	1.000	0.994	0.993	0.987	0.992	0.994
IND–DIR	0.992	0.998	0.994	0.994	0.997	0.994	0.994	0.998	0.998	0.995	0.999	0.983	0.986	0.994	0.983	0.983	0.983	0.995	0.998
INDAPOLI	0.991	0.998	0.993	0.993	0.997	0.993	0.993	0.998	0.997	0.994	0.998	0.979	0.984	0.993	0.983	0.979	0.981	0.994	0.998
GA–DIR	0.979	0.979	0.980	0.978	0.977	0.980	0.984	0.978	0.981	0.983	0.978	0.981	0.991	0.987	0.983	0.981	1.000	0.981	0.982
WISCSN	0.997	0.993	0.996	0.994	0.993	0.997	0.991	0.993	0.996	0.992	0.994	0.995	0.984	0.992	0.995	0.994	0.981	1.000	0.995
TENN	0.996	0.992	0.997	0.993	0.994	0.997	0.993	0.995	0.999	0.996	0.995	0.999	0.986	0.994	0.998	0.998	0.982	0.995	1.000

First difference daily price correlations (1987–90)

	DOMAHA	DNCAROL	DIA–MN	DPEORIA	DSt.PAUL	DSXCITY	DSPGFLD	DSCAROL	DST.JOE	DNTLSTY	DOH–DIR	DKC–MO	DKENTKY	DGAALFL	DINDIA–D	DINDIPOLI	DGA–DIR	DWISCONS	DTENN
DOMAHA	1.000	0.657	0.794	0.677	0.797	0.887	0.710	0.321	0.851	0.687	0.688	0.870	0.685	0.310	0.674	0.598	0.535	0.636	0.668
DNCAROL	0.657	1.000	0.801	0.909	0.717	0.668	0.900	0.620	0.715	0.914	0.936	0.726	0.921	0.586	0.924	0.911	0.567	0.800	0.892
DIA–MN	0.794	0.801	1.000	0.793	0.807	0.773	0.846	0.480	0.781	0.807	0.811	0.792	0.815	0.357	0.801	0.726	0.549	0.704	0.791
DPEORIA	0.677	0.909	0.793	1.000	0.720	0.663	0.907	0.559	0.699	0.850	0.912	0.713	0.857	0.449	0.870	0.855	0.523	0.745	0.835
DSt.PAUL	0.797	0.717	0.807	0.720	1.000	0.800	0.753	0.329	0.828	0.741	0.740	0.830	0.735	0.300	0.732	0.658	0.509	0.645	0.718
DSXCITY	0.887	0.668	0.773	0.663	0.800	1.000	0.697	0.325	0.850	0.681	0.685	0.875	0.666	0.295	0.671	0.603	0.559	0.654	0.651
DSPGFLD	0.710	0.900	0.846	0.907	0.753	0.697	1.000	0.580	0.745	0.899	0.911	0.756	0.903	0.454	0.904	0.846	0.574	0.775	0.882
DSCAROL	0.321	0.620	0.480	0.559	0.329	0.325	0.580	1.000	0.316	0.611	0.628	0.359	0.615	0.650	0.634	0.599	0.335	0.500	0.606
DST.JOE	0.851	0.715	0.781	0.699	0.828	0.850	0.745	0.316	1.000	0.748	0.726	0.958	0.745	0.330	0.725	0.629	0.549	0.659	0.723
DNTLSTY	0.687	0.914	0.807	0.850	0.741	0.681	0.899	0.611	0.748	1.000	0.919	0.756	0.963	0.583	0.937	0.851	0.570	0.775	0.960
DOH–DIR	0.688	0.936	0.811	0.912	0.740	0.685	0.911	0.628	0.726	0.919	1.000	0.744	0.920	0.586	0.940	0.895	0.569	0.794	0.896
DKC–MO	0.870	0.726	0.792	0.713	0.830	0.875	0.756	0.359	0.958	0.756	0.744	1.000	0.748	0.332	0.742	0.651	0.559	0.676	0.725
DKENTKY	0.685	0.921	0.815	0.857	0.735	0.666	0.903	0.615	0.745	0.963	0.920	0.748	1.000	0.581	0.933	0.848	0.555	0.763	0.951
DGAALFL	0.310	0.586	0.357	0.449	0.300	0.295	0.454	0.650	0.330	0.583	0.586	0.332	0.581	1.000	0.567	0.548	0.317	0.465	0.579
DINDIA–D	0.674	0.924	0.801	0.870	0.732	0.671	0.904	0.634	0.725	0.937	0.940	0.742	0.933	0.567	1.000	0.887	0.592	0.806	0.911
DINDIPOLI	0.598	0.911	0.726	0.855	0.658	0.603	0.846	0.599	0.629	0.851	0.895	0.651	0.848	0.548	0.887	1.000	0.538	0.821	0.819
DGA–DIR	0.535	0.567	0.549	0.523	0.509	0.559	0.574	0.335	0.549	0.570	0.569	0.559	0.555	0.317	0.592	0.538	1.000	0.923	0.562
DWISCONS	0.636	0.800	0.704	0.745	0.645	0.654	0.775	0.500	0.659	0.775	0.794	0.676	0.763	0.465	0.806	0.821	0.923	1.000	0.645
DTENN	0.668	0.892	0.791	0.835	0.718	0.651	0.882	0.606	0.723	0.960	0.896	0.725	0.951	0.579	0.911	0.819	0.562	0.645	1.000

contract should be fairly well suited to developing a cash settlement procedure which could perform well.

Example Indices

Nine cash settlement indices were computed from the USDA price data. Seven were based on simple averages, and one index was computed based on a weighted average. The indices were based on one to ten markets, and 1,2,3, and 5 day averages.

1)IAMN - simple average of the Iowa-S. Minnesota direct price. This price represents the largest direct market of those included in the USDA price series.

2)IAMN-IND - simple average of the Iowa-Minnesota direct price and the Indiana Direct price.

3)IAMN-IND-OH - the Ohio Direct price was added to the simple average.

4)IAMN-IND-OH-NC - buying station prices from the North Carolina price series (non-USDA) were added to the simple average.

5)Weighted - A weighted average of 4) was computed as:

$$I = .48IAMN + .32OH + .12NC + .08IND$$

6)ALL DIRECT - A broad simple average index was computed from the ten direct market price series that were available (Iowa-S.Minnesota, Ohio Direct, Indiana Direct, North Carolina, Wisconsin, Kentucky, Tennessee, Georgia Direct, Georgia-Alabama-Florida, and South Carolina).

7)Terminals - A simple average was computed for current Chicago Mercantile Exchange delivery points (Omaha, Peoria, Kansas City, Sioux City, St. Paul, St. Joseph, National Stockyards-E. St. Louis).

8)OM-IAMN-PE - A simple average index was constructed from the Omaha Terminal price, Peoria Terminal price, and Iowa-S. Minnesota direct prices.

9)OM-IAMN-PE-STJOE-OH-NC - The St. Joseph Terminal price, Ohio direct, and North Carolina prices were added to the simple average.

The particular weights for each price series used in the weighted index were found using a procedure designed to approximately minimize basis variability for a given price index. This procedure employs the least squares regression of the different price series used in construction of a cash settlement index on the cash price series of interest. The least squares regression procedure, in fitting a cash settlement index on a cash price, minimizes the squared errors between the cash price and index which is in fact basis variability.

For example, if attempting to find the minimum basis variability for the St. Joseph cash price and the IAMN-IND one day index the one day Iowa-S. Minnesota and Indiana direct prices would be regressed on the St. Joseph cash price:

$$P_{SJ} = \alpha_{IAMN}P_{IAMN} + \alpha_{IND}P_{IND}$$

The α coefficients can then be applied to the IAMN and IND price series to form a weighted average cash settlement index that will result in the minimum basis variability for the St. Joseph price for this particular index.

A simplified procedure was used to find these coefficients for the simple average cash settlement indices that were constructed. A cash price series (AVGWGT) was constructed that reflected the relative volumes of markets represented by the USDA price series. The Iowa-S. Minnesota direct price represents the largest number of transactions for a given day so it was weighted the most heavily in forming (AVGWGT), with other price series being weighted according to their own hog marketings.

The components of the various price indices that had been constructed (the components of the one day indices are simply the same day prices of the markets that are in the index) were than regressed on AVGWGT to get some approximations of how they might be weighted. For illustrative purposes the IAMN-IN-OH-NC index was chosen. The weights in the regression equation were applied to construct a cash settlement index:

$$I = .48P_{IAMN} + .32P_{OH} + .12P_{NC} + .08P_{IN}$$

The main purpose of this procedure was to find if a more complex weighted average can offer significant advantages to its simple average corollary.

Index Performance

The resulting average basis values and standard deviations from the 9 indices for the 19 markets are shown in Tables II and III and are summarized in Figures 1-2.

The level of the actual basis values remained about the same as more market days were added to the index. This was anticipated, as the expected value of a one day price for a particular market and the expected value for its average over a number of days are equivalent.

The average basis values were fairly small for all the cash settlement indices. The largest basis values resulted from indices of the narrowest geographic construction. The single market index (IAMN), and OM-IAMN-PEOR index resulted in average basis values of near -$.55/cwt. Since live hog cash prices tend to decrease as you move out from the high production areas of the Corn Belt, the basis values for markets in the Eastern U.S. tended to be higher as the indices were constructed with heavy midwestern market representation.

A general observation that can characterize the basis values resulting from the cash settlement indices is that, as expected, the variability of the basis values increases as the number of days included in the index is increased (Figures 3 and 4). These indices resulted in standard deviations in the range of $.50-.70/cwt. for the 1 day indices, with the 2-5 day indices being higher. On average, the standard deviation of the basis increases 10-15 percent for every market day that is added to an index. Probability distributions of the basis values show that the basis is within 1 standard deviation of its average approximately 70 percent of the time for a one day index, 60 percent of the time for a two day index, 50-55 percent of the time for a three day index, and 45-50 percent of the time for a five day index. Figures 5 and 6 give two examples of frequency distributions of basis values.

The two examples where basis variability is relatively constant as days were added to the index are the two broad indices, TERMINALS and ALL DIRECT. A possible cause for this differing characteristic may be that the variability of these two indices is substantially higher than that of the other indices.

Effects of Various Indices on Basis in Specific Areas

The addition of Indiana Direct to Iowa-S.Minnesota in the cash settlement index (IAMN-IND) improved performance over that of the IAMN index in most respects. Basis variability was substantially decreased for all markets except for the slight increase for IAMN, Omaha, Sioux City, and the Missouri markets. Average basis narrowed substantially for all markets with the same exceptions.

The addition of Ohio direct prices to the index (IAMN-IND-OH) improved basis performance less dramatically. Improvements in basis variability were slight for the Ohio general area, and somewhat more substantial for the Carolinas and Georgia. Markets in and around the Corn Belt saw fairly large increases in basis variability.

The addition of North Carolina to the index to form IAMN-IND-OH-NC had similar effects. Decreased basis variability in the Carolinas and Georgia, as well as a slight decrease in Ohio, characterized this index. The basis tended to widen and become more variable in markets in western hog producing areas, with the standard deviation of the basis being as high as $.86/cwt. in Omaha and Sioux City for the 1 day index.

The effects of weighting the IAMN-IND-OH-NC index as described earlier was to decrease basis variability slightly on average, with fairly significant reductions in the major producing areas of the midwest, which were most heavily represented in the cash price that was fitted to the index. The average basis over all markets narrowed by $.26/cwt. for the 1 day weighted index versus the 1 day simple average index. Thus, the weighting procedure did have some effect on the performance of this particular index, but it also has the disadvantage of being more complex.

The ALL DIRECT and TERMINALS indices exhibited the poorest performance of any of those constructed. Both were composed of a number of markets. ALL DIRECT was composed of ten prices from a disperse geographic area. Many of these markets are quite small (e.g. Tennessee, Wisconsin, Kentucky) and

TABLE II - Average Basis in 19 Markets Associated with 9 Cash Settlement Indices - 1985-90

--dollars\cwt.--

Price Index	---Markets---																		
	IAMN	PEORIA	NATLSTY	IND-DR	INDPOLIS	OMAHA	SXCITY	ST PAUL	STJOE	SPGFLD-	KC-MO	OH-DIR	NCAROL	WISCONSI	KENTY	TENN	GA-AL-F	GADIR	SCAROL	AVG.
IAMN (DIR)																				
DAYS-1	0.00	0.08	-0.17	-1.08	0.15	0.17	0.34	-0.72	-0.15	-0.39	-0.16	-1.40	-1.71	-1.41	-0.89	-0.71	-1.64	-1.15	-0.90	-0.62
DAYS-2	0.01	0.08	-0.17	-1.07	0.16	0.18	0.35	-0.72	-0.15	-0.38	-0.15	-1.39	-1.70	-1.40	-0.88	-0.70	-1.63	-1.14	-0.89	-0.61
DAYS-3	0.01	0.09	-0.16	-1.06	0.17	0.18	0.35	-0.71	-0.14	-0.38	-0.15	-1.38	-1.69	-1.39	-0.88	-0.70	-1.62	-1.13	-0.88	-0.60
DAYS-5	0.03	0.10	-0.14	-0.99	0.19	0.18	0.36	-0.67	-0.12	-0.35	-0.13	-1.28	-1.59	-1.30	-0.82	-0.65	-1.51	-1.05	-0.82	-0.56
IAMN-IN (DIR)																				
DAYS-1	0.49	0.60	0.37	-0.54	0.64	0.69	0.85	-0.18	0.38	0.15	0.36	-0.84	-1.19	-0.86	-0.35	-0.17	-1.05	-0.60	-0.35	-0.08
DAYS-2	0.00	0.60	0.36	-0.53	0.64	0.68	0.84	-0.18	0.37	0.15	0.36	-0.83	-1.18	-0.85	-0.35	-0.17	-1.04	-0.60	-0.34	-0.11
DAYS-3	0.01	0.59	0.35	-0.53	0.64	0.67	0.83	-0.19	0.37	0.15	0.35	-0.82	-1.17	-0.84	-0.35	-0.17	-1.04	-0.60	-0.34	-0.11
DAYS-5	0.01	0.55	0.32	-0.49	0.61	0.61	0.78	-0.18	0.33	0.13	0.32	-0.76	-1.10	-0.79	-0.34	-0.17	-0.97	-0.56	-0.32	-0.11
IAMN-OH-IN (DIR)																				
DAYS-1	0.69	0.85	0.63	-0.24	0.87	0.93	1.08	0.10	0.64	0.41	0.62	-0.56	-0.91	-0.57	-0.07	0.11	-0.72	-0.30	-0.06	0.18
DAYS-2	0.54	0.84	0.62	-0.23	0.86	0.92	1.07	0.09	0.63	0.40	0.62	-0.55	-0.90	-0.56	-0.07	0.11	-0.71	-0.30	-0.05	0.17
DAYS-3	0.53	0.82	0.60	-0.23	0.84	0.90	1.04	0.09	0.62	0.40	0.61	-0.53	-0.88	-0.54	-0.07	0.11	-0.68	-0.28	-0.05	0.17
DAYS-5	0.53	0.73	0.53	-0.20	0.76	0.79	0.94	0.07	0.55	0.35	0.54	-0.47	-0.79	-0.48	-0.08	0.09	-0.60	-0.25	-0.04	0.16
IAMN-OH-NC-IN (DIR)																				
DAYS-1	0.75	1.01	0.80	0.01	1.02	1.07	1.20	0.29	0.81	0.57	0.80	-0.27	-0.69	-0.33	0.16	0.34	-0.43	-0.06	0.18	0.38
DAYS-2	0.79	0.98	0.77	0.01	0.99	1.04	1.17	0.28	0.78	0.56	0.78	-0.26	-0.67	-0.33	0.15	0.32	-0.42	-0.06	0.17	0.37
DAYS-3	0.79	0.95	0.74	0.01	0.96	1.00	1.12	0.27	0.75	0.54	0.75	-0.25	-0.65	-0.31	0.14	0.31	-0.40	-0.04	0.17	0.36
DAYS-5	0.77	0.80	0.62	-0.01	0.83	0.83	0.97	0.22	0.63	0.45	0.63	-0.23	-0.57	-0.28	0.10	0.25	-0.34	-0.04	0.14	0.30
WEIGHTED (IAMN-.48;OHDIR-.32;NCAR-.12;INDDIR-.08)																				
DAYS-1	0.66	0.73	0.52	-0.27	0.76	0.79	0.93	0.01	0.53	0.30	0.52	-0.55	-0.97	-0.60	-0.11	0.06	-0.71	-0.28	-0.10	0.12
DAYS-2	0.64	0.71	0.50	-0.26	0.75	0.76	0.90	0.01	0.51	0.29	0.50	-0.54	-0.95	-0.58	-0.12	0.05	-0.69	-0.28	-0.09	0.11
DAYS-3	0.61	0.68	0.48	-0.26	0.72	0.73	0.86	0.01	0.49	0.28	0.49	-0.52	-0.91	-0.56	-0.11	0.05	-0.66	-0.26	-0.09	0.11
DAYS-5	0.52	0.57	0.40	-0.25	0.70	0.61	0.74	-0.01	0.41	0.22	0.47	-0.50	-0.80	-0.55	-0.12	0.04	-0.64	-0.26	-0.08	0.08
ALL DIRECT																				
DAYS-1	0.41	0.69	0.51	-0.14	0.68	0.71	0.84	0.05	0.49	0.36	0.49	-0.39	-0.77	-0.48	-0.02	0.13	-0.63	-0.28	-0.04	0.14
DAYS-2	0.94	0.66	0.49	-0.14	0.65	0.68	0.81	0.04	0.47	0.34	0.47	-0.38	-0.75	-0.47	-0.02	0.12	-0.62	-0.28	-0.04	0.16
DAYS-3	0.91	0.60	0.45	-0.14	0.61	0.61	0.74	0.02	0.42	0.31	0.42	-0.36	-0.72	-0.45	-0.03	0.10	-0.59	-0.27	-0.05	0.14
DAYS-5	0.88	0.46	0.34	-0.14	0.46	0.45	0.56	-0.01	0.29	0.22	0.30	-0.31	-0.61	-0.40	-0.05	0.05	-0.51	-0.25	-0.05	0.09
TERMINALS																				
DAYS-1	-0.03	0.13	-0.12	-0.58	0.15	0.27	0.40	-0.56	-0.08	-0.45	-0.12	-1.01	-1.33	-0.78	-0.69	-0.59	-1.14	-0.69	-0.54	-0.41
DAYS-2	-0.03	0.13	-0.11	-0.57	0.16	0.27	0.40	-0.56	-0.08	-0.44	-0.12	-0.99	-1.31	-0.77	-0.67	-0.58	-1.13	-0.67	-0.53	-0.40
DAYS-3	-0.04	0.12	-0.11	-0.54	0.15	0.25	0.37	-0.54	-0.08	-0.44	-0.12	-0.95	-1.25	-0.73	-0.65	-0.56	-1.07	-0.63	-0.50	-0.39
DAYS-5	-0.03	0.11	-0.09	-0.45	0.15	0.22	0.34	-0.46	-0.06	-0.38	-0.09	-0.80	-1.08	-0.63	-0.56	-0.48	-0.91	-0.50	-0.43	-0.32
OM-IAMN-PEOR																				
DAYS-1	0.15	0.02	-0.24	-0.72	0.06	0.15	0.29	-0.72	-0.22	-0.60	-0.26	-1.20	-1.51	-0.94	-0.83	-0.75	-1.34	-0.56	-0.69	-0.52
DAYS-2	0.15	0.03	-0.23	-0.71	0.07	0.15	0.29	-0.70	-0.21	-0.58	-0.25	-1.17	-1.48	-0.92	-0.81	-0.73	-1.32	-0.54	-0.67	-0.51
DAYS-3	0.16	0.03	-0.23	-0.70	0.07	0.16	0.29	-0.70	-0.20	-0.58	-0.25	-1.16	-1.47	-0.91	-0.80	-0.73	-1.30	-0.54	-0.66	-0.50
DAYS-5	0.16	0.05	-0.19	-0.62	0.09	0.16	0.29	-0.63	-0.17	-0.52	-0.21	-1.04	-1.33	-0.82	-0.72	-0.65	-1.17	-0.48	-0.59	-0.44
OM-IAMN-PEOR-STJOE-OH-NC																				
DAYS-1	0.60	0.48	0.24	-0.30	0.37	0.60	0.71	-0.21	0.26	-0.11	0.22	-0.63	-1.01	-0.52	-0.31	-0.23	-0.73	-0.25	-0.15	-0.05
DAYS-2	0.58	0.47	0.23	-0.28	0.37	0.58	0.70	-0.20	0.26	-0.11	0.22	-0.61	-0.98	-0.50	-0.30	-0.22	-0.71	-0.24	-0.15	-0.05
DAYS-3	0.57	0.46	0.23	-0.27	0.36	0.57	0.68	-0.19	0.26	-0.10	0.22	-0.59	-0.94	-0.48	-0.29	-0.21	-0.68	-0.23	-0.14	-0.04
DAYS-5	0.49	0.41	0.20	-0.23	0.32	0.49	0.60	-0.16	0.23	-0.09	0.19	-0.49	-0.80	-0.41	0.00	-0.17	-0.56	-0.19	-0.11	-0.02

ALL DIRECT = IOWA-MINNESOTA, OHIO DIRECT, INDIANA DIRECT, NORTH CAROLINA, WISCONSIN, KENTUCKY, TENNESSE, GEORGIA DIRECT, GA-AL-FL, SOUTH CAROLINA
TERMINALS = OMAHA, PEORIA, KANSAS CITY, SIOUX CITY, ST. PAUL, ST. JOE, NATIONAL STOCKYARDS

DAYS-5	0.49	0.41	0.20	-0.23	0.32	0.49	0.60	-0.16	0.23	-0.09	0.19	-0.49	-0.80	-0.41	0.00	-0.17	-0.56	-0.19	-0.11	-0.02

ALL DIRECT = IOWA-MINNESOTA, OHIO DIRECT, INDIANA DIRECT, NORTH CAROLINA, WISCONSIN, KENTUCKY, TENNESSE, GEORGIA DIRECT, GA-AL-FL, SOUTH CAROLINA
TERMINALS = OMAHA, PEORIA, KANSAS CITY, SIOUX CITY, ST. PAUL, ST. JOE, NATIONAL STOCKYARDS

TABLE III – Basis Variability in 19 Markets Associated with 9 Cash Settlement Indices – 1985-90
--standard deviations in dollars/cwt.--

Price Index	--Markets--																			
	IAMN	PEORIA	NATLSTY	IND-DR	INDPOLIS	OMAHA	SXCITY	ST PAUL	STJOE	SPGFLD-	KC-MO	OH-DIR	NCAROL	WISCONSI	KENTY	TENN	GA-AL-F	GADIR	SCAROL	AVG.	4 Mkt.
IAMN (DIR)																				
DAYS-1	0.00	0.48	0.51	0.68	0.58	0.55	0.50	0.55	0.53	0.53	0.50	0.88	1.06	0.76	0.64	0.60	1.35	1.39	0.87	0.68	0.43
DAYS-2	0.31	0.51	0.51	0.69	0.57	0.68	0.65	0.70	0.65	0.57	0.63	0.88	1.08	0.78	0.64	0.60	1.33	1.43	0.79	0.74	0.55
DAYS-3	0.51	0.64	0.62	0.77	0.66	0.80	0.78	0.83	0.79	0.68	0.77	0.94	1.14	0.86	0.73	0.68	1.36	1.50	0.80	0.83	0.68
DAYS-5	0.70	0.79	0.76	0.91	0.78	0.92	0.92	0.97	0.92	0.83	0.91	1.06	1.28	1.01	0.87	0.82	1.45	1.59	0.92	0.97	0.83
IAMN-IN (DIR)																				
DAYS-1	0.34	0.42	0.37	0.34	0.51	0.66	0.61	0.57	0.55	0.44	0.53	0.60	0.86	0.62	0.36	0.36	1.21	1.26	0.71	0.60	0.44
DAYS-2	0.47	0.51	0.44	0.43	0.55	0.78	0.74	0.71	0.69	0.53	0.67	0.64	0.91	0.67	0.43	0.42	1.20	1.32	0.64	0.67	0.55
DAYS-3	0.60	0.64	0.56	0.57	0.65	0.87	0.84	0.82	0.80	0.66	0.78	0.73	0.99	0.77	0.56	0.54	1.24	1.39	0.67	0.77	0.67
DAYS-5	0.75	0.79	0.72	0.75	0.80	0.96	0.96	0.93	0.91	0.81	0.90	0.86	1.12	0.91	0.71	0.69	1.32	1.47	0.81	0.90	0.81
IAMN-OH-IN (DIR)																				
DAYS-1	0.51	0.54	0.46	0.24	0.61	0.78	0.75	0.64	0.64	0.54	0.62	0.40	0.75	0.61	0.31	0.34	1.11	1.16	0.63	0.61	0.52
DAYS-2	0.61	0.62	0.53	0.37	0.66	0.88	0.86	0.77	0.75	0.62	0.74	0.48	0.81	0.67	0.40	0.42	1.10	1.22	0.57	0.69	0.62
DAYS-3	0.69	0.73	0.63	0.51	0.74	0.95	0.94	0.84	0.84	0.72	0.83	0.59	0.89	0.75	0.53	0.54	1.14	1.29	0.60	0.78	0.72
DAYS-5	0.81	0.85	0.75	0.68	0.86	1.01	1.03	0.91	0.93	0.83	0.92	0.74	1.00	0.86	0.66	0.66	1.21	1.34	0.72	0.88	0.84
IAMN-OH-NC-IN (DIR)																				
DAYS-1	0.62	0.67	0.56	0.27	0.75	0.86	0.86	0.60	0.70	0.59	0.69	0.35	0.56	0.53	0.35	0.39	1.00	1.05	0.52	0.63	0.60
DAYS-2	0.69	0.74	0.62	0.38	0.80	0.94	0.94	0.72	0.79	0.66	0.79	0.43	0.64	0.58	0.43	0.46	0.98	1.12	0.43	0.69	0.69
DAYS-3	0.76	0.82	0.70	0.51	0.86	0.99	1.00	0.79	0.87	0.74	0.87	0.53	0.73	0.66	0.54	0.56	1.02	1.17	0.46	0.77	0.77
DAYS-5	0.84	0.90	0.79	0.63	0.94	1.02	1.07	0.84	0.92	0.82	0.92	0.65	0.85	0.74	0.64	0.65	1.08	1.21	0.58	0.85	0.85
WEIGHTED (IAMN-.48;OHDIR-.32;NCAR-.12;INDDIR-.08)																				
DAYS-1	0.45	0.54	0.46	0.34	0.63	0.73	0.71	0.54	0.58	0.50	0.57	0.46	0.72	0.58	0.35	0.36	1.09	1.04	0.57	0.59	0.51
DAYS-2	0.54	0.62	0.51	0.48	0.70	0.81	0.81	0.67	0.69	0.57	0.73	0.57	0.78	0.67	0.48	0.47	1.09	1.11	0.49	0.67	0.61
DAYS-3	0.63	0.71	0.61	0.54	0.74	0.88	0.88	0.75	0.77	0.66	0.77	0.61	0.86	0.71	0.54	0.52	1.11	1.13	0.51	0.73	0.69
DAYS-5	0.72	0.79	0.70	0.67	0.83	0.92	0.95	0.82	0.83	0.75	0.84	0.73	0.97	0.80	0.64	0.62	1.17	1.16	0.62	0.82	0.77
ALL DIRECT																				
DAYS-1	1.14	1.13	0.99	1.06	1.08	1.13	1.31	1.10	1.12	0.95	1.13	1.10	1.16	1.08	1.00	0.97	1.31	1.29	1.03	1.11	1.11
DAYS-2	1.16	1.15	1.01	1.08	1.09	1.18	1.34	1.14	1.17	0.98	1.18	1.12	1.19	1.09	1.02	1.00	1.31	1.34	1.01	1.14	1.14
DAYS-3	1.17	1.16	1.02	1.09	1.11	1.18	1.35	1.15	1.18	1.00	1.19	1.13	1.21	1.11	1.03	1.01	1.30	1.35	1.00	1.14	1.15
DAYS-5	1.10	1.12	1.00	1.06	1.06	1.10	1.28	1.10	1.12	0.97	1.12	1.11	1.21	1.08	1.01	0.98	1.29	1.30	0.98	1.11	1.09
TERMINALS																				
DAYS-1	1.00	0.99	0.94	0.75	0.50	1.06	1.09	1.13	1.03	1.06	1.02	1.21	1.34	0.91	1.05	0.98	1.49	1.31	1.07	1.05	0.95
DAYS-2	0.93	0.94	0.88	0.80	0.58	1.02	1.05	1.10	0.99	1.01	0.98	1.15	1.30	0.96	1.00	0.92	1.42	1.37	0.96	1.02	0.92
DAYS-3	0.91	0.94	0.89	0.83	0.62	1.01	1.04	1.09	0.99	1.01	0.98	1.16	1.32	0.98	1.01	0.93	1.42	1.39	0.96	1.03	0.92
DAYS-5	0.92	0.97	0.93	0.87	0.67	1.02	1.05	1.11	1.00	1.04	1.00	1.19	1.36	1.00	1.05	0.98	1.42	1.37	1.01	1.05	0.94
OM-IAMN-PEOR																				
DAYS-1	0.39	0.39	0.48	0.76	0.41	0.39	0.43	0.55	0.41	0.56	0.40	0.88	1.04	0.95	0.67	0.56	1.37	1.15	0.92	0.67	0.48
DAYS-2	0.59	0.47	0.47	0.76	0.40	0.59	0.62	0.71	0.57	0.61	0.56	0.89	1.07	0.96	0.68	0.57	1.31	1.17	0.81	0.73	0.60
DAYS-3	0.74	0.63	0.60	0.81	0.48	0.74	0.76	0.84	0.72	0.72	0.71	0.95	1.14	1.00	0.77	0.67	1.32	1.20	0.82	0.82	0.73
DAYS-5	0.85	0.78	0.75	0.87	0.58	0.85	0.88	0.97	0.84	0.86	0.84	1.06	1.26	1.04	0.90	0.81	1.37	1.22	0.91	0.93	0.84
OM-IAMN-PEOR-STJOE-OH-NC																				
DAYS-1	0.54	0.42	0.41	0.42	0.53	0.54	0.58	0.53	0.41	0.53	0.42	0.58	0.75	0.65	0.46	0.40	1.15	0.85	0.66	0.57	0.48
DAYS-2	0.68	0.52	0.43	0.44	0.54	0.68	0.72	0.67	0.57	0.59	0.57	0.61	0.79	0.66	0.49	0.43	1.09	0.87	0.53	0.63	0.58
DAYS-3	0.78	0.64	0.55	0.51	0.59	0.78	0.82	0.78	0.69	0.68	0.69	0.70	0.88	0.70	0.61	0.55	1.10	0.90	0.53	0.71	0.68
DAYS-5	0.85	0.77	0.68	0.59	0.65	0.85	0.90	0.87	0.78	0.77	0.77	0.81	1.00	0.75	0.00	0.67	1.12	0.92	0.63	0.76	0.77

4 Mkt.Avg. = Average Basis Variabilty of 4, large select markets (IOWA-MINNESOTA, PEORIA, INDIANA DIRECT, OMAHA)
These 4 mkt. approximately represent Iowa, Illinois, Minnesota, Nebraska, and Indiana which produce about 60% of U.S. hogs

FIGURE 3

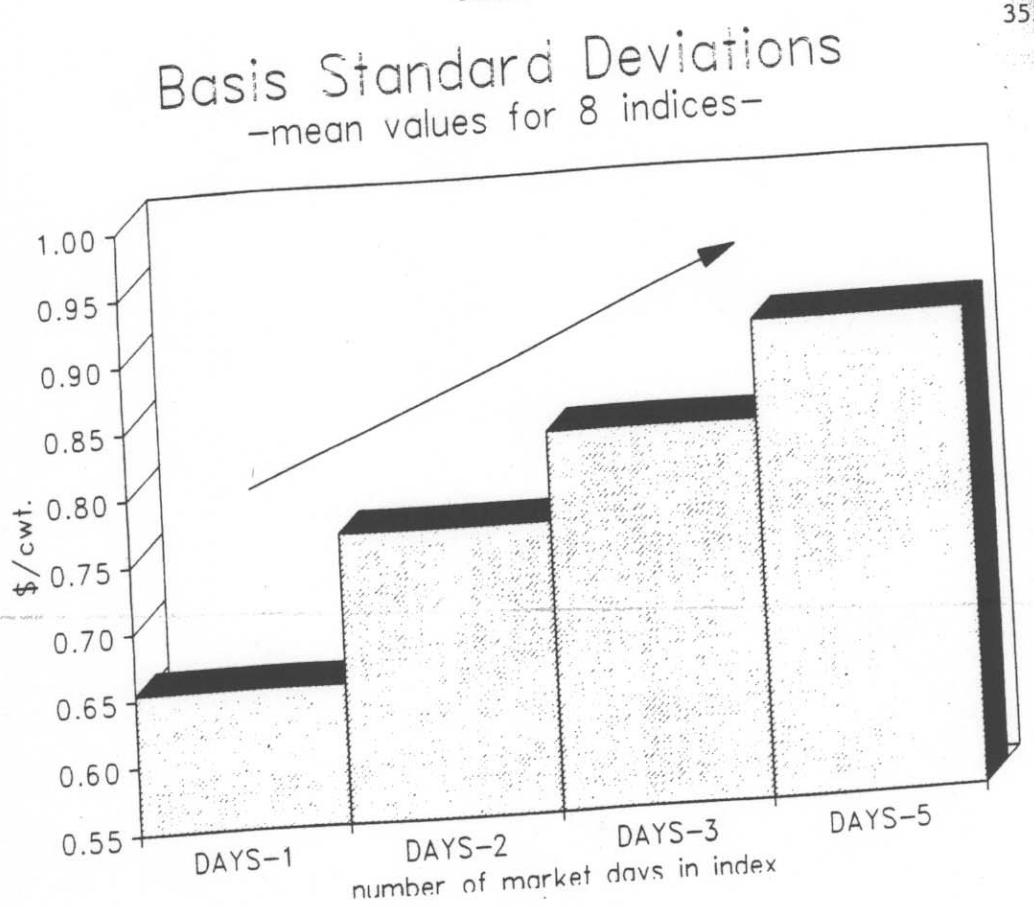


FIGURE 4

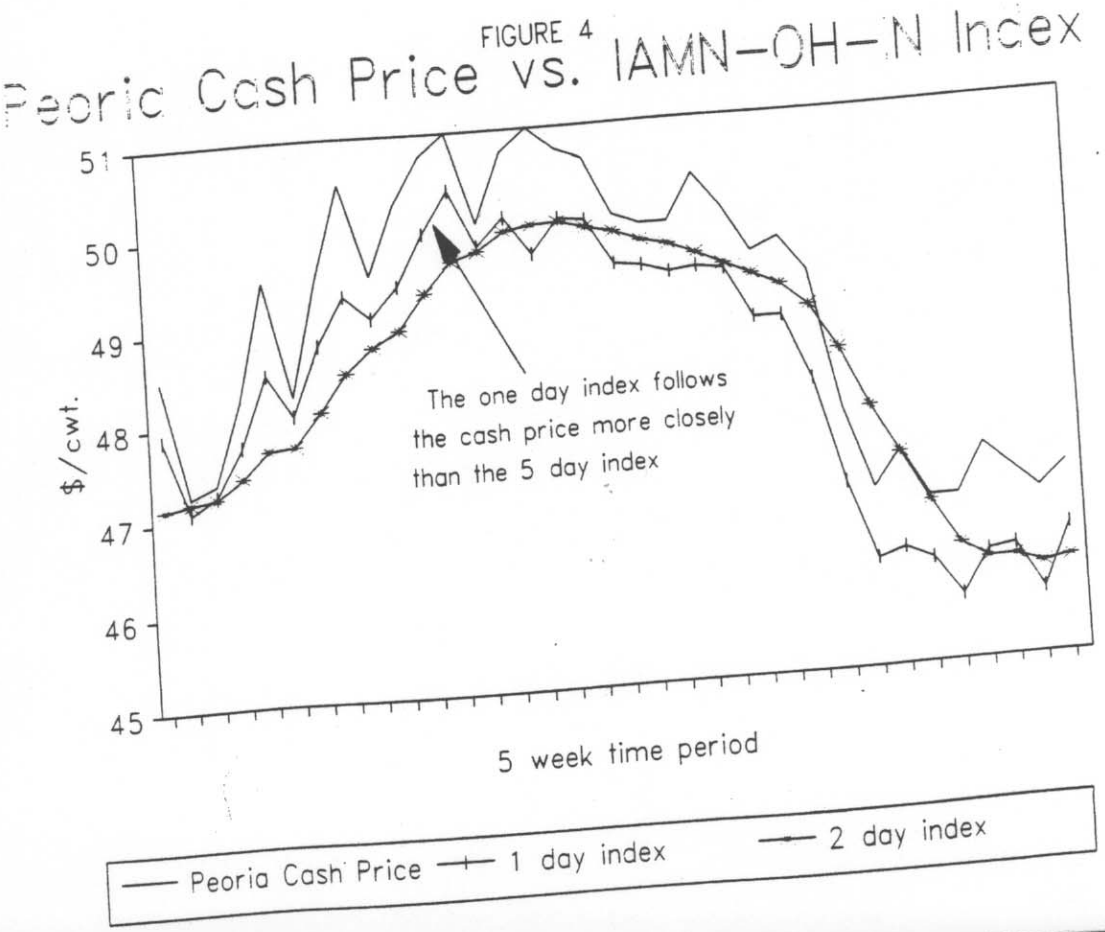


FIGURE 5

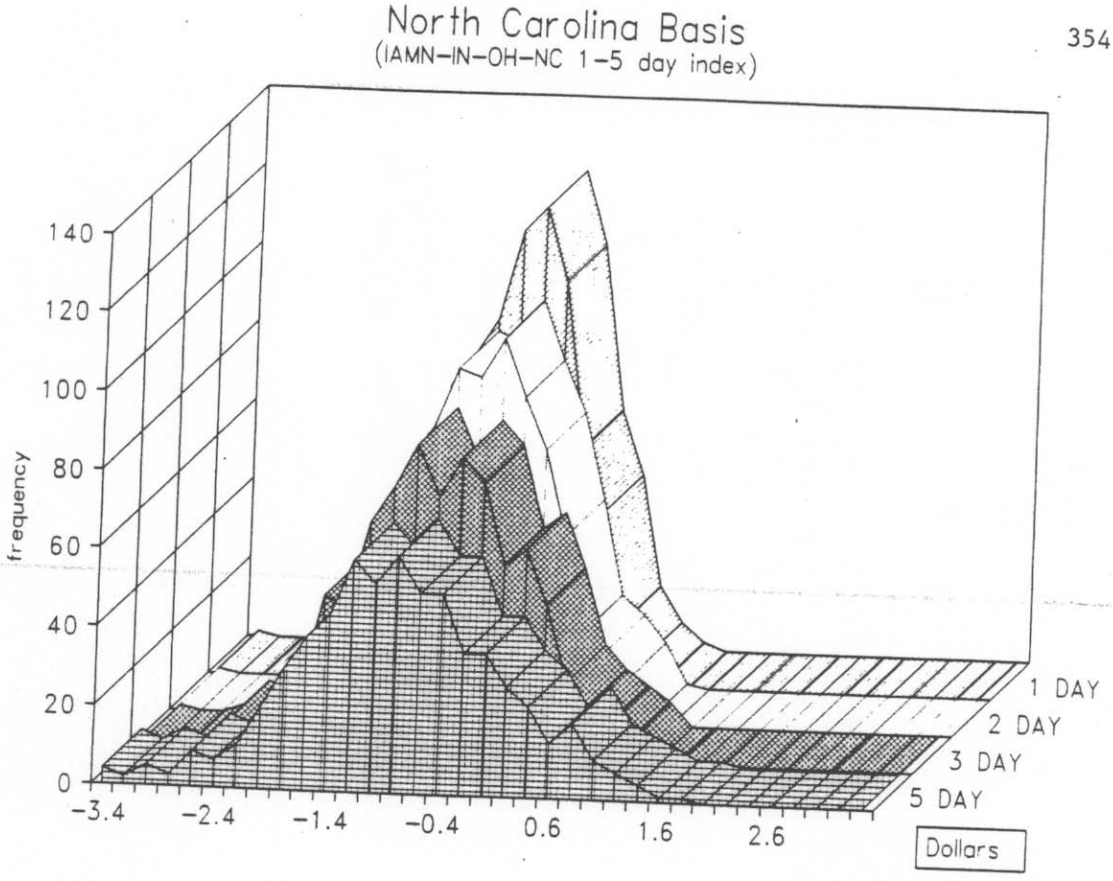
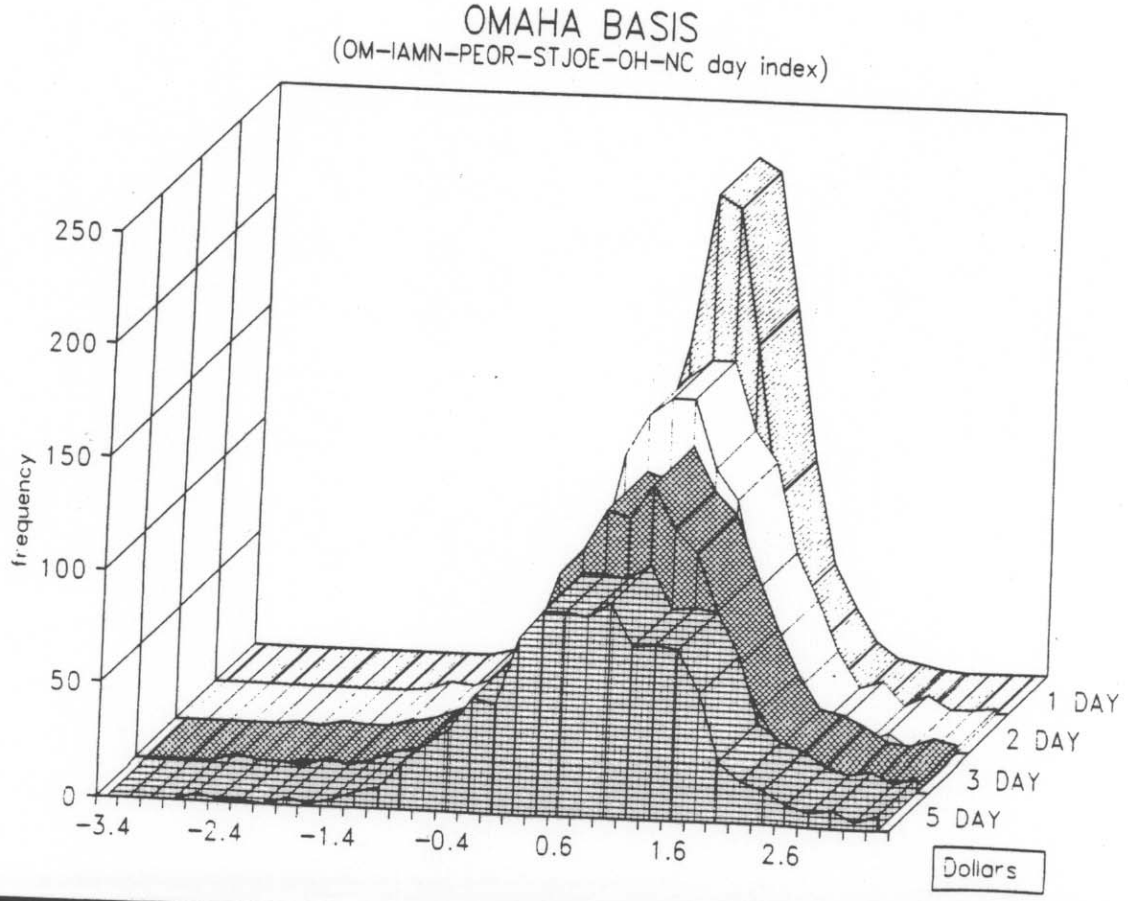


FIGURE 6



offered little in the way of improved performance to the index. In contrast, the TERMINALS index is composed of markets that are located in the major producing areas of the midwest. Many of the markets are located close to one another, and placing them all in an index is probably adding a degree of redundancy.

Two more indices were computed for other combinations of major hog producing markets. OM-IAMN-PEOR and OM-IAMN-PEOR-STJOE-OH.DR-NC performed fairly well in terms of basis value and variability, with the additional markets included in the latter index improving performance significantly over the former. The OM-IAMN-PEOR-STJOE-OH.DR-NC index is fairly broad, but is composed of prices of major hog production in markets in a disperse geographic area, and performs slightly better than the other indices.

Comparison with Delivery Point Basis Values

Basis values on expiration days of the live hog futures contract for the 19 cash markets were compared to the basis values that would have arisen had the cash settlement indices that were computed been in place in the 1985-90 time period. As the table and figure on the next page show, the standard deviations of the basis values for actual basis arising from the current settlement mechanism were significantly higher than that of the cash settlement indices. The cash settlement indices resulted in basis values on expiration days very close to those computed over the entire range of trading days, with the range of the mean standard deviations for the given indices being in the range of $.60-.65/cwt. The mean standard deviation of basis values that actually were present on expiration days was $1.29/cwt., significantly higher than that of the cash settlement indices.

Conclusions

The correlation of hog markets is the important factor in determining how a cash settlement index for the live hog futures contract will perform. Correlation in and between both major hog production areas and fringe production areas determines exactly how a given cash settlement index will perform across markets. Given the high correlation of live hog cash markets, this study indicates that the live hog futures contract is a viable candidate for cash settlement. A number of different cash settlement indices can be constructed that perform well in terms of basis variability.

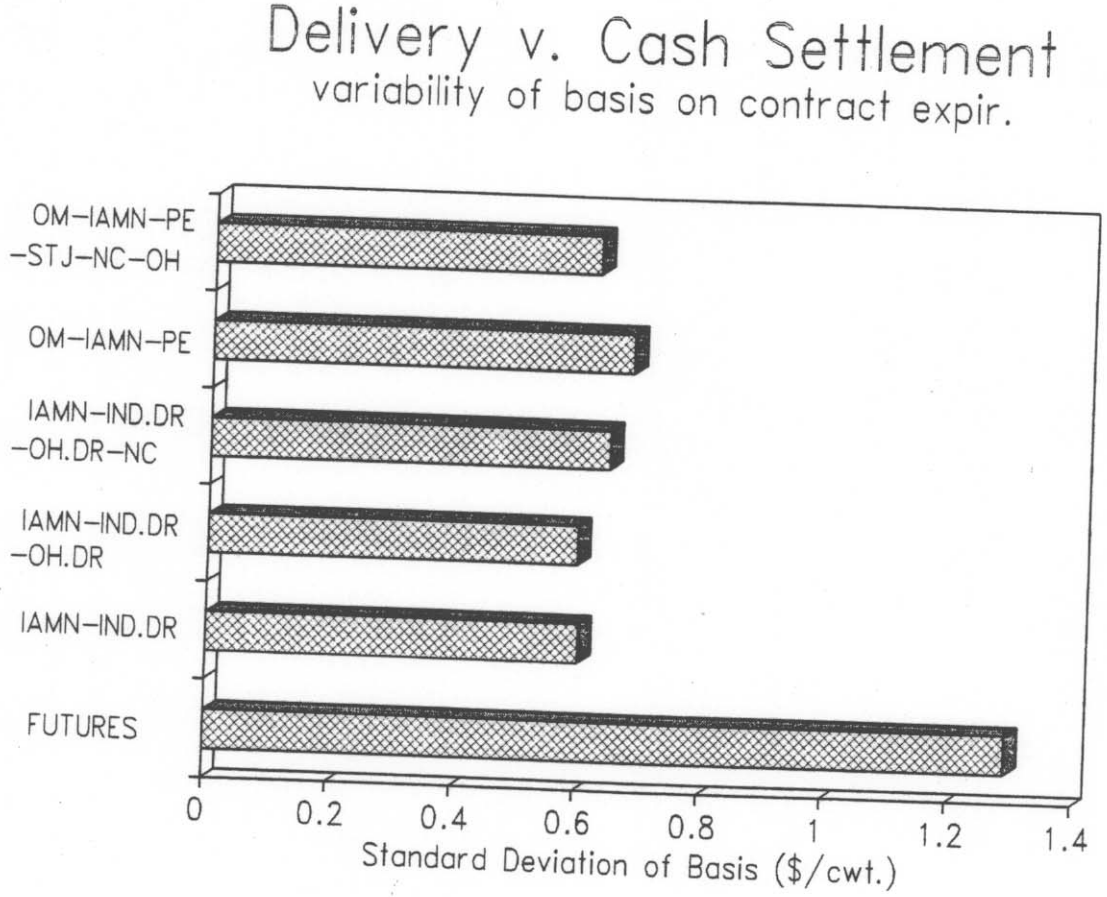
Well integrated live hog markets in the U.S. first imply that relying on a small number of markets in a cash settlement should not cause undue basis volatility in markets not included in the index. A number of relatively narrow indices were constructed that performed quite well across markets. Well integrated hog markets also insure that outlying or fringe markets will have reasonably good basis performance even if they are omitted from the cash settlement index.

In general, it was shown that the less markets and market days that have to be included in the index, the less variable basis may be across markets. It was shown that increasing the number of days in an index reduces the

Delivery vs. Cash Settlement - Standard Deviation of Basis on Contract Expiration Days for 1985-90

	FUTURES	IAMN-IN	IAMN-IN-OH	IAMN-IN-OH-NC	OM-IAMN-PE	OM-IAMN-PE STJOE-OH-NC
OMAHA	1.00	0.76	0.86	0.97	0.48	0.61
IA-MN	1.25	0.43	0.57	0.71	0.39	0.54
PEORIA	1.29	0.54	0.63	0.79	0.47	0.45
S.SL.PAUL	1.19	0.52	0.54	0.59	0.52	0.56
SIOUXCITY	1.34	0.74	0.85	1.00	0.47	0.57
SPGFLD-MO	1.16	0.43	0.42	0.56	0.57	0.57
S.CAROL	1.38	0.63	0.57	0.50	0.92	0.77
ST.JOE	1.29	0.48	0.59	0.72	0.41	0.44
NATL-STKY	1.15	0.34	0.44	0.59	0.17	0.42
OHIO-DIR	1.31	0.56	0.38	0.31	0.79	0.58
KC-MO	1.36	0.50	0.62	0.75	0.42	0.46
KENT-DR	1.25	0.34	0.26	0.31	0.61	0.44
GA-AL-FL	1.73	1.13	1.02	0.91	1.40	1.30
NCAROL	1.28	0.93	0.82	0.62	0.98	0.74
INDIA-DR	1.36	0.39	0.23	0.26	0.78	0.47
INDIPOLIS	0.97	0.60	0.71	0.86	0.41	0.58
GA-DIR	1.49	1.07	0.97	0.94	1.32	1.20
TENNESSE	1.25	0.31	0.24	0.33	0.54	0.44
WISCONSIN	1.50	0.72	0.63	0.54	0.98	0.71
AVERAGE	1.29	0.60	0.60	0.64	0.68	0.62

*FUTURES = Basis using expiration day values of futures contract from 1985-90.
The basis values of the cash settlement indices were computed for the same days.



performance of an index as basis variability increases substantially for every market day added to the index.

Less definitive answers can be offered for addressing how many markets can be included in an index without sacrificing a great deal of performance. Again this depends on the exact relationships of the markets in question. Based on this study it is clear that adding too many markets to an index will result in substantially higher basis variability. However, based on the indices that were constructed it would appear 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 markets in the eastern production areas such as Indiana-Ohio perform quite well across all markets.

Finally, this analysis shows that cash settlement would have provided for better convergence of cash prices and the futures price for hogs over the 1985-90 period when compared to physical delivery. Basis variability across markets was substantially lower when comparing the simulated cash settlement indices on expiration days with the basis values that actually existed.

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