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by

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AN ANALYSIS OF THE FACTORS INFLUENCING THE ILLINOIS CORN BASIS, 1971-1981

Philip Garcia and Darrel L. Good*

Corn producers can make direct use of the futures market in a variety of ways as part of their marketing programs. Three uses stand out as important: forward pricing a crop before harvest, forward pricing a stored crop, and delayed pricing of a crop beyond the time of delivery and transfer of title. Successful use of the futures market in implementing corn pricing decisions requires that the producer know and understand basis, that is, the relationship between cash and futures prices. Producers must be able to estimate what a given futures price means in the way of the cash price at his local market at a given point in time. "For example, farmers need to know, for corn, what the local price has been in years past at harvest relative to the December futures, in February relative to the March futures, in April relative to the May futures, and in June relative to the July futures. This knowledge need include, not only the central tendancy, but the ranges as well" (Hieronymus, p. 206-207). In addition, producers need to understand those factors which determine the magnitude of basis in order to anticipate the basis. The importance of understanding these relationships is highlighted by the marked increase in volatility in recent basis movements (Figure 1).

The objective of this paper is to identify and quantify those factors which determine the magnitude of the corn basis in Illinois. The theory of the basis is reviewed to identify the appropriate explanatory variables. A model is formulated to explain variations in local basis.

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The Theory of Basis in Storage Markets

Basis is defined as the difference between the price of a cash commodity at the delivery point and the price of the nearby or dominant futures contract. Basis can be and often is calculated for locations other than the delivery point and futures other than the nearby or dominant futures.

The study of cash and futures price relationships is separate from the field of price analysis. The relationship between cash and futures prices over time is based on the theory of the carrying charge. A commodity such as corn is produced only one time during the year but is used uniformally throughout the year. Corn must be stored and there are costs associated with storing and maintaining the quality of any grain such as corn. These costs include storage (warehouse charges), interest, and insurance. These costs can be substantial. On the other hand, the cost of owning futures contracts is negligible. These facts suggest that cash prices should increase relative to the futures price as the storage season progresses. Furthermore, the prices should be equal at the delivery point during the delivery month as cash and futures contracts become indentical commodities. However, uncertainties about delivery (time, place, and quantity) make cash and futures somewhat different commodities. As a result, the basis at the delivery point in the delivery month is not always zero.

Based on the theory of the carrying charge, the price of cash corn in Chicago at harvest, for example, should be below the December futures by the cost of carrying corn from harvest to December. December futures should be below March futures by the cost of the carrying corn from December to March. The same is true for the relationships among March, May, and July futures.

In markets away from the delivery point, the magnitude of the basis should also reflect the cost of transportation.

Observation of historical price relationships indicates that the corn basis and spreads behave in a pattern generally consistent with the theory of the carrying charge and transportation costs. However, cash prices do not always increase in relation to the futures at a uniform rate nor at a rate consistent with changes in cost. In addition, differences among futures are often less than a full carrying charge. Occasionally, the market becomes completely inverted, with the cash price above the futures and the nearby futures premium to the more distant futures. This suggests that the magnitude of the basis may be influenced by factors other than storage and transportation costs.

"The basis and spreads, then, are the going market price of storage, based on the principle of the cost of storing the cash commodity, but modified by the specific supply-demand situation" (Hieronymus, p. 160). "In the final analysis, the nearby basis and spreads boil down to the supply of and demand for space. When stocks at the terminal are large and grain is flowing to market rapidly, the cash price is weak in relation to the nearby future and spreads are wide. But when stocks are small, the commodity is flowing to market slowly, and the demand for shipment is vigorous, the price of storage decreases" (Hieronymus, p. 160).

Tomek and Robinson make the point as follows: "In its simplest form the supply-of-storage concept states that the price of storage (basis) is mainly a function of the size of current inventories" (p. 242). "Theoretically the equilibrium level of price of storage and the size of the inventory at a point in time is jointly determined by the supply of and demand

for storage. The demand for storage is related to consumption demand (p. 244). "New information about the level of inventories, rates of use out of inventories, possible quality deterioration of inventory, and so forth, may influence the price of storage (basis)" (p. 247).

In order to explain the historical magnitude of basis the above discussion suggests that one must not only consider the cost of storage and transportation, but the supply and demand for storage. Supply and demand for storage is presumably determined by the size of stocks, the rate of flow of the commodity to market, and the demand for shipment. Large stocks, rapid movement or weak demand could lead to a weaker basis than suggested by storage and transportation costs. Small stocks, slow movement to market or a strong demand for shipment could lead to a "strong" basis. The magnitude of the basis, then, is influenced by three sets of factors: cost, stock, and flow factors.

Cost Factors

In the case of corn, storage costs vary considerably from one location to another. In addition, on-farm storage costs may be perceived differently than commercial storage costs. The structure of storage costs have trended up over time, but tend to be fixed within crop years. The most variable component of ownership costs is the interest on the value of the stored commodity. The interest cost per bushel varies with the market rate of interest and the level of corn prices.

Most corn in Illinois moves out of state either by rail or barge (Hill, et al., p. 12). However, rail rates have had a history of regulations. While rates have trended up over time, they have tended to be constant within the year. Until recently, rail rates did not fluctuate to

reflect the variation in supply of and demand for transportation service within a crop year. On the other hand, barge rates have not been regulated. Fluctuations in these rates, as reflected by the spot cash market, should reflect changes in the supply of and demand for transportation services within a crop year as well as from season to season. To the extent that transporation influences the magnitude of basis, barge rates should more nearly reflect the "demand for shipment" component of basis as well as the "transportation cost" component of basis.

Stock Factors

As explained by Hieronymus, the size of stocks should be expected to influence the magnitude of the basis. When considering the local corn basis, the stocks of all grains competing for storage space should be important. At harvest time, stocks include carryover from the previous year as well as the current year's harvest.

In the short run (e.g. during the harvest period) the supply of permanent storage facilities and the magnitude of stock or demand for storage is essentially fixed. Over time, the supply of storage space can change as new facilities are added. The demand for storage function can also shift. Tomek and Robinson point out that the primary shifter is the change in production from year to year. For a given time period, the ratio of storage capacity to stocks is the most appropriate measure of the stock factor. In effect, this standardizes the supply of storage function so that comparisons can be made across years. A positive relationship is expected between the stock variable and basis fluctuations as large stocks relative to available storage space result in a high demand for services and a wide basis.

Flow Factors

Two types of flow factors would be expected to influence the magnitude of the corn basis. One would involve the rate at which producers deliver corn to the market. The other would consist of the rate at which the market is consuming corn. That is, tight farmer holding would be expected to result in a "strong" basis and vice versa. A high rate of use would be expected to result in a "strong" basis and vice versa. The rate of demand relative to the rate of marketings is probably the appropriate measure.

As stated earlier, the level of corn prices probably influences farmer's decisions relative to storage and marketing (Thomson). Low prices can be expected to restrict the flow of corn to market and support the basis. High prices result in heavy marketings and a "weak" basis. The level of prices also reflects the changing demand for corn relative to the supply. The price level, then, is probably the best indicator of corn flow.

The cash price, rather than the futures price, more accurately reflects the price level important to producers. Producers tend to be flat price traders. In addition, the cash price is independent of the basis, but futures prices are not. That is, "the lines of causation are from supply-demand determined cash commodities value to futures prices" (Good, et al., p. 135).

Data and Model

A primary objective of this study is to examine the factors that influence local basis for corn in Illinois. To accomplish this, time-series and cross-section data were assembled for seven Illinois Market regions for

the period 1971-81 (Figure 2). The market regions are consistent with the Market News Service price reporting areas throughout the state. This regionalization scheme was used because it divides the state into logical areas with rather similar production and marketing characteristics, and more importantly because cash price information for these regions was and will continue to be readily available. This should permit future updating of the estimated relationships.

As mentioned in the discussion of the theory of the basis, basis must be clearly specified. In this study, local basis is defined as the difference between Thursday's average cash price of reporting elevators in a region and the closing nearby futures price on that date. The weekly basis represents a nearby basis - i.e. October and November calculated from the December contract, December through February calculated from the March contract, etc. The weekly Thursday bases for a given month, then, are averaged to obtain a monthly average basis for each market region for each year.

As previously discussed, the local basis is hypothesized to be influenced by factors associated with cost, stocks and flows. The model used to explain local market basis is specified as

$$\text{Basis}_{jit} = f(\text{ILLSTO}_{jt}, \text{TPRST}_{it}, \text{TRAN}_{jt}, \text{REGDV}_{it}, \text{INC}_{jit}, \text{CP}_{jit}, \text{TREND}_{t}, \text{MDV}_{j}, \text{DV}_{jt})$$

where Basis is the local market basis in cents per bushel per month j, region i, for the crop year t; ILLSTO is the ending stocks of corn and soybeans in the state relative to permanent commercial storage capacity associated with month j in crop year t; TPRST is the total production of

corn and soybeans relative to permanent commercial storage capacity in region i for year t. TRAN is the average barge rate from Peoria, Illinois to New Orleans in month j for crop year t; REGDV is a set of dummy variables for the i regions; INC is a calculated interest charge (cash price times the monthly prime interest rate) in cents per bushel corresponding to the number of months from which the nearby basis is calculated; CP is the monthly average cash price in region i and month j for crop year t; TREND is a linear trend variable (i.e., 1971 = 1, 1972 = 2,...); MDV are monthly dummy variables for months j; and DV_j is a dummy variable which corresponds to specific pricing aberrations associated with month j in crop year t.

The first two variables (ILLSTO and TPRST) are included to reflect the expected relationships between the size of crop, stocks and the price of storage at various market points. It is hypothesized that high levels of corn and soybean stocks represent a high demand for storage, ceteris paribus, high price of storage and a wider basis.[1] Regional production of corn and beans relative to available commercial storage space (TPRST) should provide an indication of local demand for storage relative to local supply of storage.[2] A positive relationship also is expected between local production, the local demand for storage and the magnitude of the basis.

Barge rates (TRAN), regional dummy variables (REGDV), monthly dummy variables (MDV), and interest charge (INC) are included to reflect the relationships between costs and basis behavior. Much of Illinois corn is destined for export so the barge rate (TRAN) is included to reflect the variability in transportation costs over time. The regional dummy variables (REGDV) should account for regional transportation costs within the state. The monthly dummy variable set (MDV) is included to account for monthly

transportation marketing costs not explicitly accounted for by the barge rates. The interest charge (INC) is included to estimate the effect of interest rates on the costs of and supply of storage and the magnitude of the basis. The linear trend variable (TREND) in included to reflect the fact that the structure of storage costs have increased gradually over time. A positive relationship is anticipated between the basis and the interest charge as higher interest charges increase the direct marginal costs of storage.

The price variable is included in the model to account for the impact of the price level on farmer marketing decisions. It is hypothesized that farmers base their marketing decisions on the level of price as well as returns to storage (Thomson). A positive relationship between the basis and the cash price is anticipated. During periods of low prices, farmers restrict their sales, the flow of corn to markets is light and the basis is supported. High prices result in heavy marketings, large demand for marketing services and a "weak" basis.

A dummy variable is included to assess the impact of the Russian Grain Embargo placed by the Carter Administration which began in January, 1979.

The data are observations for the period 1971-81. Data for Illinois corn price, regional production and off-farm storage were obtained from the Illinois Department of Agriculture publications, Illinois Grain and Livestock Market News and Illinois Agricultural Statistics. Futures prices were obtained from the annual Chicago Board of Trade Yearbook for early observations and the Wall Street Journal for more recent observations. The interest rate was obtained from the Federal Reserve Bulletin.

Estimation Results

The above model was estimated with an analysis of covariance framework for the period 1971-81. During the estimation, the monthly bases were grouped into three seasonal time periods - Harvest (October through December), Post-Harvest (January through April), and Distant-Harvest (May through July). This was done to increase the variability among independent variables (relative to estimating equations on a month by month basis (Martin, L., et al., 1980) and still permit the estimated coefficients to assume different values in time periods of relatively similar demand and supply conditions. Initially, all the variables were included in the estimating equations. Where preliminary estimations resulted in t-values of less than 1.0 on variables other than the regional dummy variable set, those variables were deleted and the model was re-estimated.

The final equations are presented in Table 1 for the three time periods - Harvest, Post-Harvest and Distant-Harvest. In general, the estimated equations explain a reasonably high level of the variation in the Illinois local basis. Inspection of various coefficient estimates across equations indicates that their importance varied in different time periods. In terms of production and stock variables, Illinois Stocks of corn and beans relative to commercial storage capacity (ILLSTO) and local production relative storage (TPRST) have a strong positive impact during the Harvest period, a time when the demand for storage is greatest. Illinois stocks continue to influence local basis during the Post-Harvest and Distant-Harvest periods. Their importance, as measured in percentage terms, diminishes slightly during the latter periods (Table 2 and Table 3).

The importance of the cost variables likewise appears to vary across time periods. The coefficients of the regional dummy variables, which are included to capture the spatial dimension of the basis, are similar for the Post-Harvest and Distant-Harvest periods. In general, they reflect a pattern of the largest basis in the northern regions, and a movement of grain in a southern direction which is consistent with expectations about the flow of corn. Considerably smaller bases were encountered in regions 5 and 7, reflecting lower barge rates on the lower Mississippi and Ohio Rivers. The regional dummy variable set for the Harvest period behaves somewhat differently. The basis for regions 1, 3 and 4 appears to have widened. These are large corn producing areas. This large local production probably is influencing these coefficients. The transportation variable (TRAN) enters in the estimated equations in the latter two periods, but only becomes statistically significant in the Distant-Harvest period. During the first period, the sign was correct but the magnitude of the coefficient was small relative to its standard error.[3] Possibly, the specification of the variable does not completely reflect the seasonal demand for transportation and other marketing services over time throughout the state. In this case, the coefficients of monthly dummy variables (DV NOV - DV JULY), in part, are capturing this seasonal demand for transportation and other marketing services. Signs of these variables are consistent with anticipated demand for these services - heavy demand through October and November which reduces sharply in December and appears to decrease gradually. The basis then widens as farmers begin to market grain in anticipation of the new crop. The interest charge variable (INC) is significant in all three equations. At the 5 percent level of significance, the coefficient is not statistically different

from one during the three periods. That is, a one cent change in the interest charge resulted in approximately a one cent change in local basis. The trend variable (TREND) is positive and significant during the first two periods, reflecting the increase in the structure of storage costs over time. During the Distant-Harvest period, however, it was insignificant and its sign tended to vacilate with various model specifications. This fact, along with the decrease in importance in the interest charge variable, suggests that the overall structure of storage costs has a less significant influence on basis outside of the Harvest and Post-Harvest periods.

It was hypothesized that farmers base their marketing decisions on the level of price as well as returns to storage. The price variable included to measure the impact of the price level on farmer marketing decisions clearly is an important factor in influencing local basis. Lower price levels are associated with farmers' reticence to market their corn and a strong basis. Higher prices result in heavier marketings and a wider basis. The importance of this factor seems to decrease throughout the marketing year.

A dummy variable was included to examine the effect of the Russian Grain Embargo in 1979. This variable has a rather strong impact on basis relationships. Apparently local cash demand for corn dropped with reduced level of exports. Given that a considerable portion of Illinois grain is destined for export perhaps this is not unexpected.

Summary and Conclusions

This study has examined basis relationships for corn in Illionis from 1971 to 1981. Review of basis theory for storable commodities and knowledge of the industry suggests that basis patterns are influenced by three sets of facts: stock, cost and flow factors. Empirical analysis of recent Illinois basis movements for seven regional market areas revealed several points concerning basis behavior. First, basis patterns are fairly systematic. A considerable amount of the variation in basis patterns are explained by the specified relationships. During the fall months, local production and stocks relative to available storage capacity demonstrate considerable impact in basis movements. Interest charges, the structure of storage costs and the level of prices also have their strongest impact on basis fluctuations during the Harvest period. Measured in terms of elasticities, basis fluctuations become gradually less sensitive to stocks, levels of prices, interest charges and the structure of storage costs during the Post-Harvest and Distant-Harvest periods. Only the transportation cost variable increases in importance in the latter periods. During the immediate harvest period, the impact of the stock and production variables probably overwhelms transportation cost. That is, higher production and stocks relative to available storage capacity appear to be highly associated with the demand for transportation services. Second, evidence from the analysis supports the notion that farmers tend to be flat price sellers. That is, the farmers have their marketing decisions on the level of price as well as returns to storage. During periods of low prices, farmers restrict sales, the flow of corn to market is light and the basis is supported. High prices result in

heavy marketings, large demand for marketing services and a "weak" basis. Third, in general, the statewide basis pattern is consistent with reported grainflows and differences in barge rates along certain waterway segments. Fourth, the impact of the 1979 crop year Grain Embargo on Illinois farms was rather pronounced and prolonged. A reduction of about 5.5 cents per bushel was experienced during the Post- and Distant-Harvest periods.

While the estimated relationships do explain a considerable amount of the variation in local basis, it should be clear that further research is needed in the area of local basis behavior. Several areas stand out as being worthy of further investigation. These include: 1) specification of variables and collection of data to more appropriately reflect local supply of and demand for marketing services; 2) specification of variables to reflect producers' expectations of future price behavior; and 3) examination of how the changing conditions of the futures market (i.e., open interest and its composition) might influence basis behavior. Nevertheless, from a practical viewpoint, this analysis provides preliminary information that is useful to local producers and market participants in understanding the factors which affect the basis.

Table 1. Equations for Illinois Corn Basis (1971-81)[a]

	Harvest	Post-Harvest	Distant-Harvest
Constant	-16.17 (-2.72)	-.75 (-.14)	-7.58 (-2.79)
D2	-4.10 (-2.08)	-1.82 (-1.92)	-1.73 (1.35)
D3	-2.31 (-.99)	-4.63 (-4.89)	-4.29 (-3.37)
D4	-1.22 (-.57)	-4.18 (-4.43)	-3.75 (-2.93)
D5	-11.33 (-5.60)	-11.66 (-12.29)	-10.92 (-8.45)
D6	-3.14 (-1.89)	-5.97 (-6.32)	-5.78 (-4.54)
D7	-6.97 (-4.19)	-12.17 (-12.82)	-11.89 (-9.27)
ILLSTO	12.08 (4.91)	7.92 (2.43)	21.41 (6.79)
TPRST	5.17 (3.26)	--	--
CP	.074 (7.04)	.034 (3.87)	.034 (4.10)
INC	1.23 (4.58)	1.26 (5.59)	.68 (2.63)
TRAN	--	.022 (1.01)	.150 (3.43)
TREND	.72 (3.53)	.44 (2.34)	--
DV11	-10.63 (-6.53)	--	--
DV12	-18.05 (-11.06)	--	--
DV02	--	.89 (.79)	--
DV03	--	1.00 (.70)	--
DV04	--	3.02 (1.40)	--
DV06	--	--	4.27 (4.08)
DV07	--	--	8.65 (5.75)
DV79	--	5.37 (5.44)	5.67 (4.40)
$\bar{R}^2$	.67	.74	.63
N	231	308	231

[a]Harvest refers to basis to October through December; Post-Harvest for January through April; and Distant-Harvest through July. Numbers in parentheses are t-values.

Table 2. Estimated Elasticities for Illinois Corn Basis, 1971-1981[a]

	Harvest	Post-Harvest	Distant-Harvest
ILLSTO	.70	.49	.69
TPRST	.44	--	--
CP	.59	.41	.50
INC	.18	.22	.11
TRAN	--	.02	.16
TREND	.15	.14	--

[a]See Table 1 for a desciption of the time periods. Elasticities are estimated at mean values.

Table 3. Estimated Effect of a 10 Percent Change from the Mean of the Selected Factors on Illinois Corn Basis, 1971-1981[a]

	Harvest	Post-Harvest	Distant-Harvest
10% Change in Corn Stocks	1.54	.76	.96
10% Change in Annual Regional Corn Production	.86	--	--
10% Change of Interest Rate	.24	.25	.15
10% Change in Cash Price	1.92	1.18	.99
10% Change in Barge Rates	--	.04	.26

[a]See Table 1 for a description of the time periods. Figures are in cents per bushel and, except for the 10% change in the interest rate from its mean, reflect the average values for the period. In the case of the interest rate, the figures are in cents per bushel month.

FOOTNOTES

1. The variable is calculated as the sum of corn and soybean stocks (a commodity which competes with corn for storage space), divided by state commercial storage capacity. Data on the storage capacity are available annually. The reported figures (as of January 1) are assumed to apply throughout the previous calendar year. Monthly corn and soybean stocks are calculated by adjusting quarterly stock data by production, quantity consumed and the percentage of crop harvested.

2. Information on stocks, quantity consumed and percentage of crops harvested is available at the state level only. This variable is included to reflect the geographic differences across the state in local production and storage space availability.

3. Deletion of these monthly dummy variables increases the size of the transportation variables (TRAN) only marginally.

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FIGURE 1. NOVEMBER CORN BASIS FOR REGION I (1971-1981)

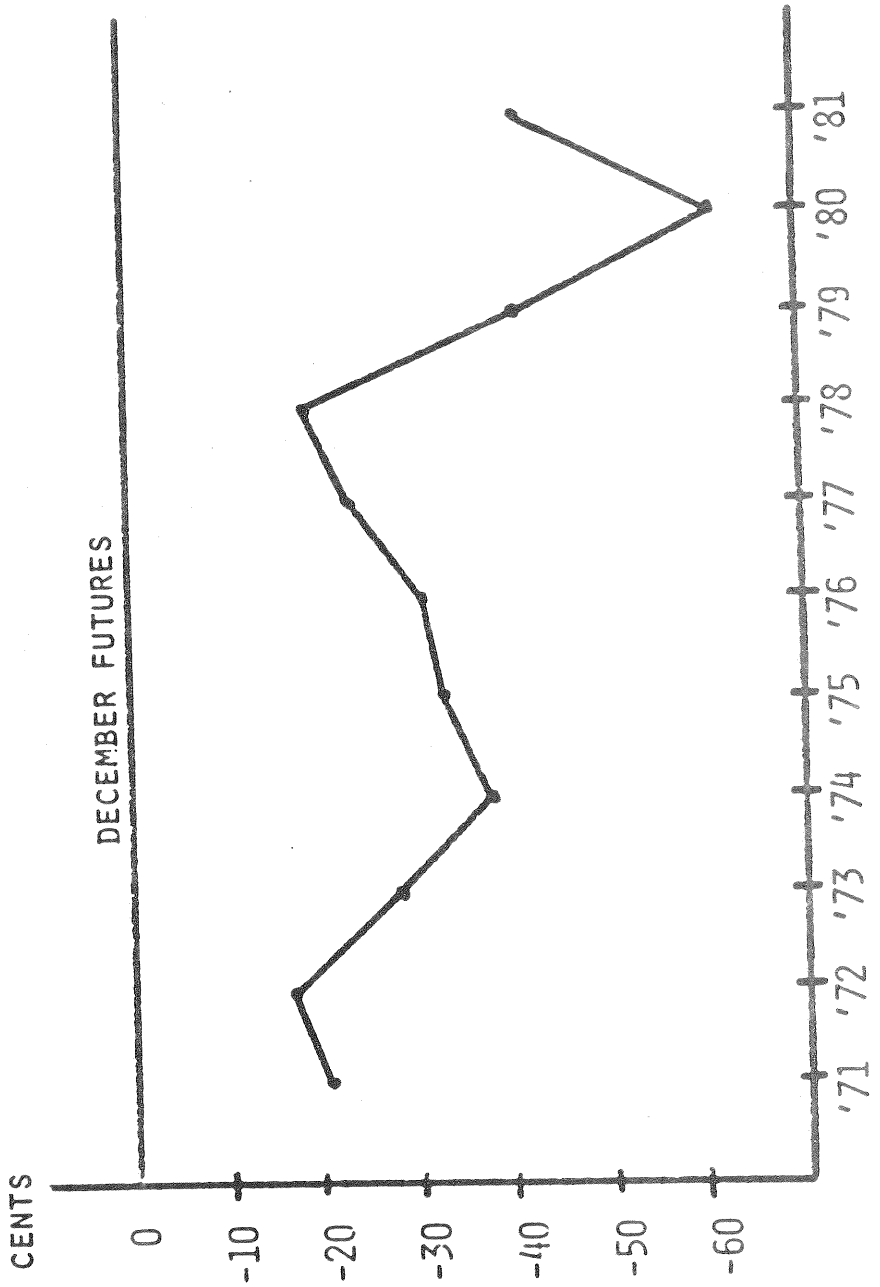

FIGURE 2. ILLINOIS MARKET REGIONS