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# RURAL ECONOMY



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**Comparison of Liquidity Costs Between the  
Kansas City and Chicago Wheat Futures Contracts**

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Staff Paper 91-14

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## **Comparison of Liquidity Costs Between the Kansas City and Chicago Wheat Futures Contracts**

### **INTRODUCTION**

Recent research (Thompson and Waller 1988) indicates that liquidity costs are important when studying futures markets. This study examines liquidity costs from the Chicago and Kansas City wheat futures markets to determine which wheat futures contract is more liquid. The Chicago contract takes delivery of hard and soft winter wheats, and some spring wheats. The Kansas City contract takes delivery of hard winter wheat. Earlier studies (Working, Gray, Gray and Peck) suggest that the Chicago wheat futures is a more liquid contract than the Kansas City wheat futures contract, and that lower liquidity in Kansas City may reduce hedging effectiveness in that market (Wilson). This study attempts to quantify this by measuring liquidity costs in both markets and comparing them. Regression analysis is used to test other variables that may influence liquidity costs. The results of these tests could be helpful to hedgers, speculators, pit traders and the general public when trying to decide on which wheat futures market to trade.

### **OBJECTIVES AND HYPOTHESES**

The first objective of this study is to compare liquidity costs from each exchange. The Thompson-Waller Measure (TWM), which is the mean absolute value of intra-day price changes ( $\times 100$ ), will be used to measure liquidity costs as manifested in the bid-ask spread. Another objective of the study is to test whether price variability, volume of contracts traded, and

exchange effects represented by intercept and slope dummy variables are significantly related to liquidity costs. These objectives will help evaluate the following relationships/hypotheses:

- The Chicago wheat futures contract is more liquid than the Kansas City contract. This should be true at least in part because of the larger volume of trading in Chicago than in Kansas City, and perhaps in part because of other factors peculiar to each exchange that influence liquidity.
- A determinant of liquidity is price variability which is measured by the first difference of the variance of daily prices (DVAR). This variable reflects the degree of informational uncertainty in the futures market, with increases in price variability associated with increases in uncertainty. It has been shown in past research that the more risk a scalper faces trading the bid-ask spread, the more scalpers increase their spread. An increase in risk is seen as an increase in costs faced by the floor trader. Thus, a larger DVAR reflecting greater uncertainty creates a riskier contract to trade and greater liquidity costs. Hence, the first difference of the variance of prices is expected to be positively related to liquidity costs.<sup>1</sup>
- A determinant of liquidity is trading volume. Low levels of volume should lead to slower rates of inventory turnover for the scalper which increases the risk of price change while holding a futures position. It is another aspect of the risk faced by the traders providing liquidity. That is, in two markets with similar volatility of prices, the one with lower volume should have higher costs for providing liquidity. Additionally, market makers thrive on volume, earning a small return on many transactions under competitive conditions. The

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<sup>1</sup> Because of the similarity in calculation between TWM and the daily variance, riskiness is measured here as the first difference in the daily variance.

natural log of daily trading volume (LOGVOL) is used to represent these effects in the analysis because scalpers are considered to be more sensitive to variations in trading volume at lower levels of trading activity than at higher levels. Therefore, LOGVOL is expected to be negatively associated with liquidity costs. However, it is possible that under certain circumstances that trading volume would be positively associated with liquidity costs. If the availability of market makers is limited, as may be the case in generally thin markets, a temporary increase in trading activity may be associated with increases in liquidity costs because the supply of market-making services is not perfectly elastic.

- A determinant of liquidity is the exchange on which the contract is traded. Aside from differences in trading volume and price variability, differences in liquidity may be attributable to institutional factors peculiar to each exchange, to the price behavior of the different classes of wheat traded on each exchange, to differences in information received at each market, to the risk attitudes of traders at each exchange, and to differences in the composition of traders at each exchange. Moreover, the exchange on which a contract is traded may affect the relationship between price variability and liquidity costs and volume and liquidity costs.
- A determinant of liquidity is the contract month traded. Some contract months may be riskier to trade than others due to inherent uncertainty regarding the contract's equilibrium value upon contract expiration. For example, futures which expire during the growing season may be particularly illiquid due to uncertainties regarding the size of the new crop and the demand for storage between old and new crop years.

- A determinant of liquidity is near versus distant time to maturity. Aside from trading volume effects, the number of months to contract maturity may influence liquidity costs if there is some additional cost or risks to market making in distant contracts. There may also be differences in liquidity costs in the expiration month as compared to other periods of trading in a contract if the greater likelihood of becoming involved in the delivery process makes trading futures contracts less attractive to speculators during the delivery month.

## DATA

The intra-day price data used for the analysis is extracted from a Chicago Board of Trade (CBT) Profile Data Set and a similar data set from the Kansas City Board of Trade (KCBT). The price data analyzed are taken from a consecutive record of intra-day prices on a tick basis where one tick in wheat futures contract is 1/4 of a cent. Every time a trade occurs at a price different from the last price, a price observation is recorded. Although intra-day data were available from the KCBT on a transaction-to-transaction basis, tick data are analyzed because that is the only form of intra-day price data available from the CBT.

The price data used for this study are described in table 1. Seven sets of intra-day price observations taken from six months of trading are used for analysis. The monthly sets of price observations are taken from January through June of 1985 at different times to contract maturity (0 months, 1 month, 2 months, 3 months, 4 months and 7 months) and therefore provide a good distribution of trading activity close to and far from maturity. 1985 data are evaluated because the only months of data that could be obtained from the KCBT were January through June of



1985. Seven sets of price observations are studied per futures exchange for a total of fourteen observation periods.

Two expiration months were chosen for analysis to analyze the effects on liquidity costs of trading in these characteristically low volume periods that also include the added risk of becoming involved in the delivery process. Trading in the March contract is analyzed during January and March (the expiration month). The May contract has one observation period - the expiration month. May is also the last contract month traded involving the old crop and is also at the end of the growing season for wheat. The May contract may be a particularly risky contract since new crop supplies are not yet known with certainty and the demand for storage of wheat between old and new crop years is not fully resolved.

The July contract has three observation periods (March, April and June). Three observation periods were chosen for the July contract because July represents the first "new crop" future in wheat and is generally the contract that attracts the greatest volume of trading. Trading volume in wheat usually peaks between May and July on both exchanges. The September contract has one observation period, February, seven months from maturity. The September contract was chosen for analysis because it is the contract with sufficiently numerous price observations furthest from maturity. It is also the month in which the planting of red winter wheat occurs.

A statistical computer program developed by Waller (1987) was obtained and used to compute the Thompson-Waller liquidity cost measure (TWM). As mentioned earlier, TWM is the mean of the absolute value of price changes. It is calculated using tick data in daily intervals. The mean and standard deviation of daily values of TWM, as well as minimum and maximum values for TWM, are calculated for each monthly observation period. The mean, standard

deviation, minimum and maximum of trading volume (VOL) and price variability (DVAR) are also calculated for each monthly observation period.

## RESULTS

### Summary Statistics

Summary statistics for TWM, VOL and DVAR for each observation set on each exchange are presented in tables 2 through 8. Table 2 presents the results from the March contract observed in January; table 3 is the September contract observed in February; table 4 is the March contract observed in March; table 5 is the July contract observed in March; table 6 is the July contract observed in April; table 7 is the May contract observed in May; and table 8 is the July contract observed in June. Also presented in each table are the number of observations for each set representing the number of days of trading in the contract analyzed.

A comparison of the means from each observation set reveals differences in liquidity costs (the TWM results) from month to month and between exchanges. One quarter cent is the smallest possible tick in wheat futures contracts. Thus, the minimum possible value for TWM is 25, representing \$12.50 for a 5000 bushel contract. The closer a monthly TWM mean is to 25 the lower the liquidity costs or the more liquid the market.

Liquidity costs in several observation months taken from the CBT are close to the minimum value of 25. For all Chicago contracts except those observed in the expiration month, mean liquidity costs are extremely close (within one one-hundredth of a cent) to minimum values. Standard deviations of TWM for these contracts are also very small--in the neighborhood or less than one one-hundredth of a cent. TWM values from the two expiration months in Chicago differ from the other months analyzed and from each other. Mean liquidity costs for the Chicago

March contract observed in March are not much higher than those in the other months analyzed (27 hundredths of a cent), although the standard deviation of TWM is much greater (4.5 hundredths of a cent). In contrast, mean liquidity costs for the Chicago May contract observed in May are much higher than those in other months analyzed (over 43 hundredths of a cent), as is the standard deviation of liquidity costs in this month (10 hundredths of a cent).

Liquidity costs in all observation months taken from the KCBT are uniformly greater than the comparable months traded in Chicago. None of the mean values of TWM in the Kansas City contracts are as close to the minimum value of 25 as are the Chicago values. Standard deviations of TWM are also greater for the Kansas City contracts than for the Chicago contracts. The months with the lowest mean liquidity costs in Kansas City are those close to maturity but not in the expiration month. Liquidity costs for these contracts range between 28 and 35 hundredths of a cent, with standard deviations ranging from approximately 3 to 15 hundredths of a cent. Mean liquidity costs in the expiration months and in the month distant from maturity in Kansas City are more than twice minimum values, ranging from 52 hundredths of a cent to 65 hundredths of a cent, with standard deviations ranging between 16 and 30 hundredths of a cent.

These results indicate that liquidity costs are greater in Kansas City than in Chicago, that liquidity costs are greater in contracts distant from maturity in Kansas City, and that liquidity costs are greater in the expiration month in both Kansas City and Chicago.

There are also differences between Kansas City and Chicago in mean levels of trading volume and in the relationship between mean values of VOL and TWM. Volume of trading is consistently greater in Chicago contracts than in the comparable Kansas City contracts. As hypothesized, higher mean values of VOL are associated with lower mean values of TWM in

both Chicago and Kansas City. There is no obvious difference between mean values of DVAR in Chicago and Kansas City. However, as hypothesized, mean values of DVAR are positively associated with mean values of TWM in both Chicago and Kansas City. These relationships are explored further below.

### Regression Analysis

Due to the finding that mean liquidity costs in Chicago contracts are so close to minimum values for all except expiration contracts, regression analysis concentrates only on data from expiration months in Chicago. Although Kansas City liquidity costs are greater than minimum in all contracts analyzed, only data from expiration months in Kansas City are included in the analysis to maintain comparability with Chicago. Thus, only data from the March contract observed in March and the May contract observed in May in both Chicago and Kansas City are analyzed further. Data from the four contracts are pooled in a regression testing the relationship between liquidity costs, price variability, and volume. Slope and intercept shifters indicating the exchange on which the contract is traded and the contract month are also included in the regression model.

The regression analysis uses data from the Chicago and Kansas City wheat futures markets. The form of the relationship between TWM and its determinants is assumed linear. That is,

$$(1) \text{LOGLM}_{ij}^k = \beta_0 + \beta_1 \text{DVAR}_{ij}^k + \beta_2 \text{LOGVOL}_{ij}^k + \beta_3 \text{KC}_{ij}^k + \beta_4 \text{MAR}_{ij}^k \\ + \beta_5 \text{KCLV}_{ij}^k + \beta_6 \text{KCDVAR}_{ij}^k + \beta_7 \text{MARLV}_{ij}^k + \beta_8 \text{MARDVAR}_{ij}^k + e_{ij}^k$$

For the  $i$ th market (Kansas City or Chicago) in the  $j$ th time period (January through June of 1985) for the  $k$ th contract (March, May, July, and September) LOGLM is the natural logarithm of the Thompson-Waller Measure of liquidity; LOGVOL, the natural logarithm of daily trading



volume; DVAR, the first difference of the daily price variance; KC, an intercept dummy variable representing the exchange with Chicago=0 and Kansas City=1; MAR, an intercept dummy variable representing contract month with March=1 and May=0; KCLV, the interaction of KC and LOGVOL; KCDVAR, the interaction of KC and DVAR; MARLV, the interaction of MAR and LOGVOL; MARDVAR, the interaction of MAR and DVAR; and e, an error term.

Initial estimates of equation 1 by OLS had expected signs. That is, increased volume decreased liquidity costs. The impact of volume on liquidity costs was larger for the Kansas City exchange and the March contract. Increased risk (as measured by DVAR) caused increased liquidity costs and, again, the impact was larger for Kansas City and the March contract. Intercept dummies suggest that liquidity costs are higher in Kansas City and lower for the March contract. However, the Breusch-Pagan test (BP) for heteroskedasticity was significant (25.5 with 8 degrees of freedom; the 0.05 critical level is 15.51). Thus, while the OLS coefficient estimates are unbiased, they are inefficient and their standard errors are biased and inconsistent, invalidating any hypothesis tests performed using the OLS estimates of equation 1.

The BP test is a general test for heteroskedasticity. To correct the problem, some restrictions on the form of the changing variance must be postulated. It was hypothesized that the variance is constant within an observation month at each exchange, but varies from month to month and between exchanges. To test this hypothesis, the data set was divided into the four different observation months, representing the two expiration months from the two different exchanges. A regression of daily values of LOGLM on DVAR and LOGVOL was performed for each observation period. This isolated the months so that if the variance is constant within months but changes from month to month, no heteroskedasticity should appear in the regressions which

considered each month separately. None of the BP tests performed for the four separate regressions was significant. Thus, our hypothesis that the variance is constant within months but not between months was supported.

To correct for the non-constant error variance in this final regression, maximum likelihood estimates of sigma from the appropriate monthly regressions were scaled to sum to the number of observations and used in a weighted least squares procedure. The scaling has the effect of leaving the overall estimate of the variance from the final regression unchanged. The results of the final regression equation are presented in table 9. No significant heteroskedasticity was detected in this regression (BP = 7.79 with 8 degrees of freedom; the critical value is 15.51).

The results of the final regression indicate that, in Chicago and in May, liquidity costs are negatively, although insignificantly, related to trading volume, and positively and significantly related to changes in price variability.

Tests were performed of the joint significance of KC, KCLV, and KCDVAR, and of MAR, MARLV and MARDVAR to determine if the relationships involving LOGVOL and DVAR are different between exchanges and contracts. The null hypotheses of no difference between exchanges and contracts are rejected at the 5% level according the Wald test (Wald statistic = 13.34 with 3 degrees of freedom for the first test, and Wald statistic = 29.13 with 3 degrees of freedom for the second test). The intercept shifter KC indicates that (everything else held constant) liquidity costs are higher in Kansas City than in Chicago. The significantly negative slope shifter involving KC and LOGVOL indicates that liquidity costs are more sensitive to volume in Kansas City than in Chicago. The positive, but insignificant, slope shifter involving KC and DVAR indicates that liquidity costs are also more sensitive to changes in price

variability in Kansas City than in Chicago. The March contract intercept shifter and the slope shifter involving the MAR and LOGVOL are both small and insignificant. However, the positive slope shifter involving MAR and DVAR is significant and indicates that liquidity costs are more sensitive to changes in price variability in March contracts than in May contracts.

## SUMMARY AND CONCLUSIONS

The objectives of this paper were to: 1) show that trading in wheat futures is more liquid at Chicago than it is at Kansas City; and 2) to determine the factors which influence liquidity in these two markets. Liquidity, as measured by mean absolute value of intra-day price changes (TWM), is found to be higher on average at Chicago. Monthly averages of TWM, the cost of liquidity, are from 10% to 100% higher in Kansas City, depending on contract expiration and observation period. Comparisons of these monthly averages to those of volume (VOL) and price variability (DVAR) further indicate that liquidity and volume are positively related, while price variability is negatively associated with liquidity.

To analyze these relationships further, a regression model was specified relating TWM to VOL and DVAR. Data from expiration months only was used in the regression model due to minimal variation in liquidity costs during other periods in Chicago contracts. Initial estimation revealed severe heteroskedasticity in the errors. The changing error variance was shown to be related to contract month and observation periods. That is, for a given contract and monthly trading period, the variance is constant, but it changes from contract to contract and month to month. This finding led to the use of variance estimates from monthly regressions in a weighted

least squares procedure. Results of the final specification do not reject the hypothesis of homoskedasticity.

Regression results suggest that there are significant differences in liquidity costs between Chicago and Kansas City. The intuition that this is in part due to the lower volume traded at Kansas City is supported by the sign and significance of KCLV. However, there appears to be a significantly higher cost of doing business at Kansas City which is independent of trading volume, as reflected in the significant increase in the intercept for Kansas City. While, on average, liquidity costs are lower in March than in May, this difference is ameliorated by the increased sensitivity to risk in March ( $MARDVAR > 0$ ).

The results of this study must be interpreted with caution because data from only one short time period were analyzed. It is possible that some of the effects observed are peculiar to this time period rather than attributable to effects of individual contract months (e.g., the effects associated with the March contract in the regression analysis). Further, because the regression analysis concentrated on data from expiration months alone, it is not possible to determine whether time to maturity has an effect separate from that of trading volume on liquidity costs. A possible future extension of this work would expand the time period and number of contracts considered to test these effects more fully.



TABLE 1 OBSERVATION MONTH, CONTRACT, AND MONTHS TO EXPIRATION

Contract	Periods of Observation					
	Jan.	Feb.	Mar.	April	May	June
Mar.	2 mo.	---	0 mo.	---	---	---
May	---	---	---	---	0 mo.	---
July	---	---	4 mo.	3 mo.	---	1 mo.
Sept.	---	7 mo.	---	---	---	---

The observation year is 1985.

TABLE 2 1985 March wheat contract observed in January

Variables N Mean Std. Dev. Min. Max.

Chicago

TWM	22	25.069	0.123	25.000	25.336
VOL	22	5390	2128.81	2526	10853
DVAR	22	419.14	8298.45	-18137.84	16503.98

Kansas City

TWM	18	28.359	7.053	25.000	56.048
VOL	18	2360	749.47	1029	4205
DVAR	18	59.86	7203.19	-19042.61	20189.55

TABLE 3 1985 September wheat contract observed in February

Variables N Mean Std. Dev. Min. Max.

Chicago

TWM	18	26.038	1.098	25.000	28.571
VOL	18	366	177.43	72	788
DVAR	18	31.17	3761.37	-7695.46	10700.94

Kansas City

TWM	19	53.830	15.997	37.500	112.500
VOL	19	157	124.04	18	514
DVAR	19	205.42	2463.82	-4333.33	5495.36

TABLE 4 1985 March wheat contract observed in March

Variables	N	Mean	Std. Dev.	Min.	Max.
Chicago					
TWM	14	27.535	4.502	25.000	41.741
VOL	14	1093	335.22	522	1692
DVAR	14	3825.06	13178.00	-6185.31	46853.30
Kansas City					
TWM	14	52.383	26.398	25.000	116.667
VOL	14	193	220.62	17	630
DVAR	14	256.10	21518.71	-53565.05	55000.00

TABLE 5 1985 July wheat contract observed in March

Variables	N	Mean	Std. Dev.	Min.	Max.
Chicago					
TWM	21	25.604	0.886	25.000	28.095
VOL	21	2980	1688.54	858	7922
DVAR	21	135.61	5227.36	-8561.98	10647.33
Kansas City					
TWM	21	30.014	3.338	25.000	38.462
VOL	21	529	262.74	156	1143
DVAR	21	226.25	3053.19	-6282.73	5258.86

TABLE 6 1985 July wheat contract observed in April

Variables	N	Mean	Std. Dev.	Min.	Max.
Chicago					
TWM	21	25.212	0.387	25.000	26.356
VOL	21	4381	2715.06	1325	13215
DVAR	21	-35.55	5998.75	-12653.86	11398.42
Kansas City					
TWM	21	31.264	10.796	25.000	76.220
VOL	21	1036	633.84	182	2770
DVAR	21	-226.58	7425.93	-18146.05	21796.93

TABLE 7 1985 May wheat contract observed in May

Variables	N	Mean	Std. Dev.	Min.	Max.
Chicago					
TWM	15	43.473	10.358	29.630	71.212
VOL	15	435	382.08	101	1354
DVAR	15	27297.76	103080.74	-25593.44	394934.77
Kansas City					
TWM	14	64.688	29.643	35.000	150.000
VOL	14	141	204.66	6	697
DVAR	14	251.51	9321.79	-19794.97	20401.75



TABLE 8 1985 July wheat contract observed in June

Variables	N	Mean	Std. Dev.	Min.	Max.
Chicago					
TWM	20	25.204	0.457	25.000	27.020
VOL	20	3873	1758.87	1965	7778
DVAR	20	418.54	5098.80	-13160.78	10167.98
Kansas City					
TWM	20	35.121	14.692	25.000	84.848
VOL	20	1750	563.29	922	3489
DVAR	20	204.13	9189.50	-29042.03	19920.56

TABLE 9 FINAL REGRESSION ANALYSIS RESULTS

Variable Name	Estimated Coefficient	Standard Error	T-ratio
LOGVOL	-0.025	0.057	-0.433
DVAR	0.037*	0.012	3.000
KC	1.034*	0.375	2.755
KCLV	-0.152*	0.070	-2.169
KCDVAR	0.141	0.120	1.176
MAR	-0.095	0.332	-0.285
MARLV	-0.041	0.054	-0.760
MARDVAR	0.150*	0.050	2.985
CONSTANT	3.838*	0.333	11.516

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Durbin-Watson Statistic = 2.014  
 R-squared = 0.794  
 Breusch-Pagan Statistic = 10.552 with 3 degrees of freedom

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\* Indicates significance at the 0.05 level.

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