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

by

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## INTRODUCTION

Recent research (Thompson and Waller 1987,1988) has indicated that liquidity costs are an important consideration when studying futures markets. This study will examine 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 contract 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 will attempt to quantify this by measuring liquidity costs in both markets and comparing them. Regression analysis will be 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, 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:

(1) 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.

(2a) 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

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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.

(2b) 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. Market makers in general thrive on volume, earning a small return on many transactions under competitive conditions. The natural log of daily trading volume (LOGVOL) is used 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.

(2c) 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.

(2d) 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. In particular, "new crop" futures may be less liquid than "old crop" futures because supply uncertainty is greater for new crop futures due to the fact that stocks of grain available after harvest are hard to predict.

(2e) 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 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 AND PROCEDURES

The intra-day price data used for the analysis were 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 sample periods are used for analysis that provide a good distribution of trading activity close to and far from maturity. The seven sample periods are from January through June of 1985. Each of the sample periods are taken at different times to contract maturity (0 months, 1 month, 2 months, 3 months, 4 months and 7 months). 1985 data are evaluated because the only months of data that could be analyzed from the KCBT were January through June of 1985. Seven months of trading in four different contracts 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. Stocks of grain available in May, although not necessarily plentiful, are relatively easy to predict late in the crop year. This factor may moderate the riskiness of trading in the May contract during the expiration period.

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) is 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 for TWM, VOL and DVAR for each observation period 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 month representing the number of days of trading in the contract analyzed.

A comparison of the means from each of the months 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. The correlation between mean values of TWM and VOL is -.56 for Chicago contracts and -.74 for 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, with a correlation of .99 in Chicago and a correlation of .53 in Kansas City. Mean values of DVAR are also negatively correlated with mean values of VOL, with a correlation of -.53 in Chicago and -.39 in Kansas City indicating that increases in price variability are associated with thinness in a futures contract.

The relationships between volume, price variability, and the exchange on which the contracts are traded suggested by the summary statistics will be further investigated through regression analysis.

## REGRESSION ANALYSIS

The regression analysis uses data from the Chicago and Kansas City wheat futures markets. A data set was created that includes the daily TWM from both markets, the daily VOL from both markets, the daily DVAR from both markets, an intercept dummy variable representing the exchange with Chicago=0 and Kansas City=1 (KC) and an expiration month intercept dummy variable with March and May=1 and all other months=0 (EXPIR).

The first regression analyzed for this study regressed the daily values of LOGLM (TWM in natural logs) for both Chicago and Kansas City on LOGVOL (the natural log of volume of trading) and DVAR (the first difference of the variance of prices in levels). Ordinary Least Squares (OLS) analysis was used. The estimated coefficients from this regression were significant at the 5% level. The relationship between volume and liquidity costs was negative while the relationship between price variability and liquidity costs was positive. However, the Breusch-Pagan test (BP test) indicated significant heteroskedasticity in this regression. Heteroskedasticity is a problem that often occurs in cross-sectional data. If it is present, the OLS coefficients remain unbiased, but estimates of the variance and the standard errors of the coefficients are biased. Thus, heteroskedasticity invalidates any hypothesis tests which use the OLS estimates, so it must be corrected.

In the next regression, the exchange dummy variable was added to analyze whether the exchange effect could be causing the significant heteroskedasticity. In addition to the exchange dummy variable, interaction terms between KC and LOGVOL and KC and DVAR were also included in the regression equation. OLS was again used for this regression. The estimated coefficients were all significant at the 5% level. But significant heteroskedasticity remained as indicated by the BP test.

In a third regression, the expiration month dummy variable (EXPIR) was added to the set of regressors as well as interaction terms between EXPIR and LOGVOL and EXPIR and DVAR. This regression still yielded a very significant BP measure. Heteroskedasticity became more significant with each regression performed. Therefore, the heteroskedasticity could not be explained by differences in the relationship between LOGLM, DVAR, and LOGVOL across exchanges or between expiration and non-expiration months.

It was then hypothesized that the variance is constant within an observation month at each exchange, but varies from month to month and between exchanges. The data set was divided into the fourteen different observation months, representing the seven observation 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 was constant within months but changed from month to month, no heteroskedasticity should appear in the regressions which considered each month separately. None of the BP tests performed for the fourteen monthly regressions was significant. Thus, our hypothesis that the variance is constant within months and that the heteroskedasticity found in the earlier regressions is attributable to the change in the error variance between months was supported.

Due to the finding that mean liquidity costs in Chicago contracts are so close to minimum values for all except expiration contracts, further regression analysis concentrated on only 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 were included in further regression 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 LOGLM, DVAR, and LOGVOL. Slope and intercept shifters involving both KC and a dummy variable representing the March contract (MAR) are also included, with KCLV representing the interaction of KC and LOGVOL, KCDVAR representing the interaction of KC and DVAR, MARLV representing the interaction of MAR and LOGVOL, and MARDVAR representing the interaction of MAR and DVAR.

To correct for the non-constant error variance in this final regression, maximum likelihood estimates of sigma squared 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 = 10.552 with 8 degrees of freedom; the critical value is 15.507).

The results of the final regression indicate that 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 insignificance of KC, KCLV, and KCDVAR, and of the joint insignificance of MAR, MARLV and MARDVAR to determine if the coefficients are different between exchanges and expiration months. Both hypotheses are rejected at the 5% level according the Wald test (Wald statistic = 13.337 with 3 degrees of freedom for the first test, and Wald statistic = 29.127 with 3 degrees of freedom for the second test). Thus, the relationship between LOGLM, LOGVOL and DVAR differs significantly across exchanges and expiration months. 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 has a negative impact on liquidity.

To further analyze these relationships, a regression was specified relating TWM to VOL and DVAR. Initial estimation revealed severe heteroskedasticity in the errors. The changing error variance was shown to be caused by switching of contract expiration and observation periods, that is, for a given contract and month the variance was constant, but it changed from month to month. This led to concentration on the two expiration months at each exchange and 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 generally lower volume of trading 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 significantly larger intercept for Kansas City. While, on average, liquidity costs are lower in March than in May, this difference is ameliorated by the increased sensitivity of liquidity costs 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, in particular the effects associated with the March contract in the regression analysis. A possible future extension of this work would expand the time period and number of contracts considered.

TABLE 1 OBSERVATION MONTH, CONTRACT, AND MONTHS TO EXPIRATION

| | Periods of Observation | | | | | |
|---|---|---|---|---|---|---|
| Contract | 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**

Summary Statistics for Chicago Wheat Futures
1985 March wheat contract observed in January 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 March wheat contract observed in January 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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**

Summary Statistics for Chicago Wheat Futures
1985 September wheat contract observed in February 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 September wheat contract observed in February 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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

Summary Statistics for Chicago Wheat Futures
1985 March wheat contract observed in March 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 March wheat contract observed in March 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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

Summary Statistics for Chicago Wheat Futures
1985 July wheat contract observed in March 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 July wheat contract observed in March 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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**

Summary Statistics for Chicago Wheat Futures
1985 July wheat contract observed in April 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 July wheat contract observed in April 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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**

Summary Statistics for Chicago Wheat Futures
1985 May wheat contract observed in May 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 May wheat contract observed in May 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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

Summary Statistics for Chicago Wheat Futures
1985 July wheat contract observed in June 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Summary Statistics for Kansas City Wheat Futures
1985 July wheat contract observed in June 1985

| Variables | N | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| 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 |

Durbin-Watson Statistic = 2.014
R-squared = 0.794
Breusch-Pagan Statistic = 10.552 with 8 degrees of freedom

* Indicates significance at the 0.05 level.

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