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Liquidity Costs in Futures Options Markets

The major finding is that liquidity costs in futures options market are two to three times higher than liquidity costs in the futures market. Liquidity cost is one potential factor to consider when choosing between hedging with a futures contract or with an option contract. While there is considerable research that estimates liquidity costs of futures trading, there is little comparable research about options markets. This study, for the first time, attempts to determine and compare liquidity costs in options and futures markets. The study uses July 2007 wheat futures and options contracts traded on Kansas City Board of Trade. Two measures of liquidity costs were used for both options and futures markets. One measure of liquidity costs in options markets is the average bid-ask spread that is calculated from the available bid-ask quotes. A new measure of liquidity costs in options markets is derived based on the Black model and it uses trade prices instead of observed bid-ask quotes. The liquidity costs in the options market was estimated to be 1.60 cents per bushel using observed bid-ask spreads and it was 1.37 cents per bushel when the new measure was used. Liquidity costs in the futures markets are estimated using Roll's measure and average absolute price changes. The estimates were 0.45 and 0.49 cents per bushel, respectively for futures contracts. A positive relation was found between option liquidity costs and moneyness of the option. Days to expiration of the contracts was not statistically significant in explaining the liquidity cost of the option.

Key words: Bid-ask spread, Black model, KCBT, liquidity costs, options

Introduction

Futures and options contracts traded on futures exchanges are important price risk management tools for grain producers and merchandisers. Agricultural producers typically dislike the margin calls associated with futures contracts so they have sometimes been encouraged to consider options as an alternative. One possibly important consideration in choosing between hedging with futures or options contracts is the relative liquidity costs. Transaction cost is one of several aspects that hedgers should consider while choosing between hedging with a futures contract or an option contract. On any standardized exchange two elements comprise almost all of the transaction cost – brokerage fees and bid-ask spreads. Under competitive conditions the bid-ask spread measures the cost of making transactions without delay. A person who desires to immediately sell or buy a contract will, on the average, suffer a markdown equal to half of the bid-ask spread. The difference in price paid by an urgent buyer and received by an urgent seller is the liquidity cost. Since brokerage commissions do not vary with the time taken to complete a transaction, differences in bid-ask spread indicate differences in the liquidity cost (Demsestz 1986). Hedgers can choose to hedge in futures or options market. Thus, there is a need to answer the question of how much are liquidity costs in options markets?

The answer to this question is important because knowledge of liquidity costs help hedgers and speculators in choosing between futures and options markets. All speculators and hedgers, who transact through floor brokers, should know the size of liquidity costs to compare and evaluate available exchanges. Futures exchanges need to know liquidity costs to evaluate new alternatives such as electronic trading. Moreover, knowing liquidity costs can help researchers to account for them while simulating hedging strategies or speculative trading.

While there is considerable research that estimates liquidity costs of futures trading (Brorsen 1989; Hasbrouck and Schwartz 1988; Locke and Venkatesh 1997; Roll 1984;

Thompson, Eales and Seibold 1993; Thompson and Waller 1986; Wang, Yau, and Baptiste 1997), there is little comparable research about options markets. Baesel, Shows, and Thorp (1983) estimated overall cost of liquidity services in listed stock options using trade data of a diversified portfolio of an options hedge fund. Their study provides a limited idea about liquidity costs as it considers a single portfolio hedge fund, which might have been traded differently than a typical options trade. For example, Greer, Brorsen, and Liu (1992) found that a large technical trader incurred liquidity costs about double those estimated for all transactions. Considering liquidity costs is an important criterion in choosing between futures and options markets and so far no research has attempted to estimate and compare liquidity costs in both market simultaneously. The purpose of this article is to estimate and compare liquidity costs in options and futures markets. The article uses bid-ask spread as a measure of liquidity costs in the wheat options market and also proposes a new alternative measure of liquidity costs in options markets. The study also determines the factors affecting size of liquidity costs in option markets.

Theory

In open-outcry commodity futures markets, liquidity is primarily provided by floor traders who readily bid and offer a price for a specific contract. Since the floor traders must make a profit for providing their services the price at which a trade occurs is different from the equilibrium price and in a direction adverse to the hedgers and speculators. Since all trades occur at the bid or ask price of floor traders, the bid-ask spread gives the size of liquidity costs in the market. The bid-ask spread is an accepted measure of liquidity cost in security and futures markets. Unfortunately, the exchanges do not record the bid and ask price at which trades occur. Moreover, the available measures of liquidity costs based on intraday price movement i.e. Roll's measure and average absolute price deviations are not appropriate for options markets as commodity options markets are very thin which leads to an insufficient number of observations. Thus, we require other measure of liquidity costs for options markets.

Black (1975) proposed a valuation model for futures options. The Black model assumes a lognormal distribution for futures price and gives predicted option premiums at equilibrium based on futures price, strike price, days to maturity, interest rate, and volatility of the underlying asset. If a market is efficient and devoid of arbitrage opportunities any deviation of observed premium from predicted premium can be seen as a result of floor traders' participation. Since, observed premium is either at bid or ask price of the option, the absolute difference between observed and predicted premium comprises half of the liquidity costs. Hence, $2 \cdot E[|\pi - \hat{\pi}|]$ gives a new measure of liquidity costs in options market where, π is the observed option premium and $\hat{\pi}$ is predicted option premium using the Black model.

Previous work on liquidity in futures markets found that liquidity costs and trading volume are negatively correlated, while liquidity costs and price variability are positively related (Demsestz 1986; Hasbrouck and Schwartz 1988; Thompson, Eales and Seibold 1993). This is because in a high volume market, traders trade with little price effect from their transactions. However, in thin markets, the transactions of individual traders may have significant price effects and may therefore result in higher liquidity costs. Trading volumes for the same commodity in options markets are considerably lower than those in futures markets. For instance, 4,318,007 wheat futures contracts were traded at KCBT during 2007 as compared to 352,948 wheat options contracts (KCBT 2007). The options markets are also expected to be less liquid than the futures markets because the option market is segmented by puts, calls and varying strike prices in addition to date of maturity. Moreover, options contracts require higher skill for trading as it is more complex in terms of understanding and execution which more or less restrict their use to specialized traders and firms. Liquidity costs in the options market are therefore expected to be higher than those in the underlying futures market.

Data

The intraday prices used in this study were the Time and Sales data from the Kansas City Board of Trade (KCBT) for the options on July 2007 wheat futures contract. The data base contains a record of each bid, ask, and trade price. Kansas City Board of Trade employees overlook the trading pits from an area called "the pulpit." As trading occurs, a "pit reporter" listens intently for prices shouted out by traders in the trading pit and relays them via a headset to a computer terminal operator known as the "data entry operator." The operator enters the prices into a computer. The data set contain 3,767 bid and ask price observations along with the underlying futures contract price, out of which 2,129 were for call options and 1,683 for put options. There is a possibility of selectivity bias in using the bid-ask quotes since bid-ask quotes are only reported when no trade occurs. If a trade is less likely to happen given a wide bid-ask spread, bid-ask spreads would overestimate liquidity costs. Bid and ask prices observed before the market opens were not included in the data set. There were 3,472 bid-ask spreads calculated for wheat July 2007 option contract with different strike prices at Kansas City Board of Trade exchange. Two outlying observations showing negative liquidity costs, which were presumably due to a data entry error were discarded. The data set contains 3,724 options transactions and 40,417 futures transactions.

Procedures

Liquidity cost in options markets was estimated using bid-ask quotes and a new measure which uses trade price of options. Bid-ask spread is the difference between ask price and bid price observed at the same time. Liquidity cost can be measured as

(1) $$liquidity\ cost_t = ask_t - bid_t.$$

Second measure of liquidity cost uses transaction data instead of the bid-ask quotes and is

(2) $$liquidity\ cost_t = 2\left|\overline{\pi_t - \hat{\pi}_t}\right|$$

where, π_t is observed option premium and $\hat{\pi}_t$ is expected premium obtained by Black's formula. For put and call options, the expected option premium can be obtained as

(3) $$\hat{\pi} = e^{(-r\cdot t)}[FP \cdot \mathrm{cdfN}(x_1) - SP \cdot cdfN(x_2)]$$

(4) $$\hat{\pi} = e^{(-r\cdot t)}[FP \cdot \mathrm{cdfN}(-x_1) - SP \cdot cdfN(-x_2)],$$

respectively. Where,

$$x_1 = [\ln(FP/SP) + (\hat{v}^2 \cdot t)/2]/(\hat{v} \cdot \sqrt{t})$$

$$x_2 = [\ln(FP/SP) - (\hat{v}^2 \cdot t)/2]/(\hat{v} \cdot \sqrt{t})$$

and

$\mathrm{cdfN}(\cdot) =$ standard normal cumulative density function

$FP =$ price of underlying futures contract

$SP =$ option strike price

$\hat{v} =$ predicted implied volatility (%)

$t =$ time to expiration (days/365)

$r =$ risk-free interest rate (%).

All the parameters in the above model other than the volatility measure — the time to maturity, the strike price, the risk-free rate, and the current underlying price — are observable. The predicted implied volatilities were calculated by estimating

(5) $$v_t = \beta_0 + \beta_1 M_t + \beta_2 |M_t| + \beta_3 D_t + \sum_{i=3}^{T} \beta_i T_{it} + e_t$$

where, v_t is implied volatility at time t obtained by substituting observed option premium and other parameters in the Black formula and solving the formula for volatility. M_t is moneyness of the option at time t which is difference between strike price and underlying futures price, T_{it} are dummy variables for day, D_t is a dummy variable for type of option which takes value of 1 if it is a call option or 0 if it is a put option, The underlying futures prices used in the Black model were the most recent underlying futures price. Hence, the value of option premium is indirectly affected by staleness of the nearest underlying futures price and thus it affects the measure of liquidity cost. The effect of this staleness is removed by estimating the following regression:

(6) $$\ln(|\pi_t - \hat{\pi}_t|) = \alpha_0 + \alpha_1 S_t + \epsilon_t$$

where S_t is length of time between the observed option transaction and the most recent underlying futures price. The parameter estimates of the above regression are presented in Table 3. If staleness of the futures price is zero e^{α_0} represents the absolute difference between observed and predicted option premium. Thus, the liquidity costs can be calculated as two times the expected value of (6) given S_t is zero:

(7) $$\text{liquidity cost} = 2 \cdot e^{\alpha_0}$$

As bid-ask quotes for the futures market are not recorded by the exchange, two proxies of bid-ask spread were used to measure the liquidity costs in futures market: the Roll's measure and average absolute value of price changes. According to Roll (1983) if markets are informationally efficient, the covariance between price changes is negative and directly related to the bid-ask spread. Roll's measure (RM) was calculated as

(8) $$RM = 2\sqrt{-\mathrm{cov}(\Delta F_t, \Delta F_{t-1})}$$

where, ΔF_t is change in wheat price at time *t*. The other accepted proxy for the bid-ask spread was proposed by Thompson and Waller (1988), who suggested the average absolute value of price changes as a direct measure of the average execution cost of trading in a contract. The average absolute price changes is calculated as

(9) $$\text{Average absolute price change} = \frac{\sum_{t=2}^{T}|\Delta F_t|}{T-2}.$$

To test hypotheses about the factors influencing liquidity costs, the following regression equation was estimated by ordinary least squares:

(10) $$y_t = \beta_0 + \beta_1 M_t + \beta_2 T_t + \beta_3 D_t + e_t$$

where, y_t is difference between ask price and bid price, M_t is moneyness of the option, T_t is time to maturity of contracts in days, D_t is a dummy variable which takes the value 1 if it is call option and 0 if it is put option.

Results

Summary statistics of observed bid-ask spread are presented in Table 1. The results show that average liquidity cost was 1.60 cents per bushel ($ 80 per 5,000 bushel contract). Mean value of moneyness was – 16.29 cents which indicates that on average the options were out of the money. The data set contained 56 per cent call option transactions.

The estimated regression using bid-ask spread as the dependent variable is presented in Table 2. Moneyness of the option had a positive and significant effect on liquidity cost. The coefficient of moneyness indicates that as it increases by 1 cent liquidity cost increases by around 0.006 cents. The coefficient of days to expiration was not significant. The call options had around 0.08 cents higher liquidity cost than did put options. The result might be due to the proportion of call options being higher in the data set as compared to the put options, which might make it more costly to develop a delta-neutral hedge.

The other measure of liquidity costs in the options market uses traded option premiums. Here the predicted option premiums were calculated using the Black formula for options on futures. The results are presented in Table 3. The average absolute deviation of observed premium from the predicted premium was estimated to be 1.37 cents.

Roll’s measure and average absolute price deviation were used to estimate liquidity costs in the futures market. Both measures were calculated for each trading day and then averaged over the sample period. The estimates of these two measures along with the measures of liquidity costs in options market are presented in Table 4. Average Roll’s measure and average absolute price changes were 0.45 and 0.49 cents per bushel, respectively. These results are consistent with the results of the study conducted by Thompson, Eales and Seibold (1993) for the same exchange and commodity. They estimated Roll’s measure for July 1985 wheat futures contract as 0.41 cents per bushel.

The liquidity costs of options are clearly higher than the liquidity costs of the futures market. These costs are still considerably lower than the cost of forward contracting that have been found for hard red winter wheat (Brorsen, Coombs, and Anderson 1995; Townsend and Brorsen 2000), so producers who want to avoid margin calls should still consider options a viable alternative to forward contracting. Also, most producers purchase out-of-the-money puts and so most of their puts will expire worthless. Therefore, the option liquidity cost will only be incurred one time, while the futures liquidity cost will be incurred twice. The bid-ask spread reflects the liquidity cost from a round turn so one option transaction would only incur half of the estimated liquidity cost. Another practical implication is that producers may want to use limit orders in options markets to reduce their higher liquidity cost.

Summary and Conclusion

The objective of this study was to estimate and compare liquidity costs in options and futures markets and determine the factors affecting these liquidity costs. To meet the objectives, intraday prices of wheat futures and options contracts traded on Kansas City Board of Trade exchange were used. Bid-ask spread was used as a measure of liquidity cost in the options market and Roll’s measure and average absolute price deviations were used to estimate liquidity costs in the futures market. A new measure of liquidity cost in options markets was proposed which uses trade prices of option contracts. The average bid-ask spread for wheat option contracts was 1.60 cents per bushel. The proposed new measure estimated liquidity costs in wheat option contracts to be 1.37 cents per bushel. Both the estimates of liquidity costs in the options market were considerably higher than estimated liquidity costs in the futures market, which were 0.45 and 0.49 cents per bushel, using Roll’s measure and average absolute price deviation respectively. Further, to test the hypothesis about effects of moneyness, days to maturity of the contracts and type of option on liquidity costs, a multiple linear regression was used. The regression results suggest that there is a positive relationship between moneyness and liquidity cost. Days to maturity have no impact on liquidity costs. On average, liquidity costs of call options were higher than those of put options.

The study confirms that it costs more to trade in futures option markets as compared to futures markets. The implication of this result to the hedger is that transacting in options is more expensive than transacting in futures. The hedger should consider this fact when choosing between futures and options.

Table 1. Summary Statistics of Variables Calculated for Options Contracts Traded at KCBT

Variable	Mean	SD	Minimum	Maximum
Liquidity cost (cents/bu.)	1.60	0.81	0.00	6.00
Moneyness (cents/bu.)	-16.29	37.22	–167.00	168.00
Days to expiration	62.41	42.39	1.00	169.00
Calls (%)	0.57	0.50	0.00	1.00

Table 2. Estimated Parameters of Factors Affecting Liquidity Costs (cents/bu.) in Wheat Option Contracts at KCBT with Average Bid-Ask Spread as Dependent Variable

Variable	Parameter Estimate	Standard Error
Intercept	1.6154	0.0439
Moneyness (cents/bu.)	0.0059	0.0003
Days to expiration	0.0005	0.0005
Calls	0.0758	0.0263

Note: R-squared = 0.2136

Table 3. Regression Model of Log of Absolute Difference between Observed and Predicted Option Premium

Variable	Parameter Estimate	Standard Error
Intercept	–0.3843	0.0200
Staleness (seconds)	–0.0002	0.0001

Table 4. Measures of Liquidity Costs in Wheat Futures and Options Contracts at KCBT

	Options Market		Futures Market	
	New Measure	Average Bid-Ask Spread	Roll's Measure	Average Absolute Price Change
Mean (cents/bushel)	1.37	1.60	0.45	0.49
Standard error	0.0007	0.8137	0.5063	0.3290

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