The Effects of Multiple Listing on Bid-Ask Spreads for Equity Options

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(ABSTRACT)

The purpose of this thesis was to test the hypothesis that multiple-listing of equity options leads to lower bid-ask spreads because of increased competition. This competition can come in two forms, actual or potential, both of which are theorized to have the same effect on spreads.

A model of the determinants of the bid-ask spread was formulated. Separate tests were conducted on 1985 and on 1992 CBOE data. The first test arose from the fact that in 1985, only a certain number of options were multiple-listed, or eligible to be multiple-listed. Spreads for multiple-listed options were conjectured to be below spreads for single-listed options across low levels of volume, and equal to single-listed option spreads at higher levels of volume. The evidence for this was mixed based on several regressions with different functional forms. The second test arose from the fact that in 1992, because of an SEC rule change, all options were eligible to be multiple-listed but still only a few were. Spreads for multiple-listed options were conjectured to be equal to spreads for single-listed options because the single-listed options had the potential to become multiple-listed. Again, the evidence for this was mixed. It appears that the actual and potential competitive effects from multiple-listing had yet to come to fruition as of 1992. Further testing revealed that, on an option-by-option basis, spreads generally rose from 1985 to 1992.

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CHAPTER 1. BACKGROUND

Stock options were first traded on the Chicago Board of Exchange (CBOE) on April 26, 1973. At that time, only calls on 16 underlying stocks were traded.[1] In 1975, the American Stock Exchange (AMEX) and Philadelphia Stock Exchange (PHLX) began equity option trading, as did the Midwest Stock Exchange the following year. In February 1976, the CBOE began trading certain options which were already being traded on the PHLX. This was the first instance of multiple-listing, or the trading of an option on more than one exchange. This was followed by further instances of multiple-listing, as well as rapid growth in the trading of equity derivatives. These events caused the Securities and Exchange Commission (SEC), the regulatory body charged with monitoring these markets, to ask the exchanges to voluntarily suspend the listing of any new options in mid-1977 until option markets could be studied in more detail. This moratorium ended in 1980 when the SEC decided not to allow further multiple-listing of options because of concerns about market fragmentation.[2] They were especially concerned about the potential for trade-throughs, or transactions taking place on one exchange while more favorable prices were available on another exchange. Instead, the individual exchanges devised an "Allocation Plan." This plan, approved by the SEC in 1980, allowed individual exchanges to have a monopoly over the trading of new options. Options which were already multiple-listed prior to the moratorium were allowed to continue to be traded on more than one exchange.[3] In addition, options on OTC stocks were allowed to be multiple-listed.

The SEC again reviewed the issue of multiple trading in 1986. Robert Neal, under the auspices of the Office of the Chief Economist, was the author of one of two studies put forth by the SEC which attempted to quantify the effect that multiple-listing was having on bid-ask spreads in equity options.[4,5] In his study, later published in *The Journal of Finance*, he concluded that

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[1] A call gives the purchaser the right, but not the obligation, to buy a particular underlying instrument (in this case, a stock) for a certain price within a certain time frame.
[2] See [¶ 84,417] Multiple Trading of Standardized Options, p. 80,121.
[3] In reality, though, trading in multiple-listed options becomes dominated by one exchange, the "primary market."
[4] The other study, conducted by the Directorate of Economic and Policy Analysis, was very similar in construct to Neal's and made essentially the same conclusion.

spreads for options listed on multiple exchanges were significantly lower than spreads for options listed on only one exchange.[6] This was true in spite of the fact that trading in multiple-listed options generally becomes dominated by one exchange, or the so-called "primary market." Thus, actual competition was seemingly not a factor in these markets. Neal attributes this result to the forces of potential competition. Because secondary exchanges stand ready to enter the market and become actual competitors in the presence of supracompetitive profits, the primary exchanges charge competitive spreads. Thus, the contestable markets hypothesis was found to hold in the case of market-making in equity options.[7]

Based on its review of Neal's study and other evidence, the SEC voted to allow the multiple trading of options in May 1989.[8] Effective in 1990, options can be listed on more than one exchange.[9] The purpose of this paper is to evaluate what, if any, effect the multiple-listing of options has had on the bid-ask spread of CBOE options, both in 1985 when it affected few options and in 1992 when it affected all options.

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[5] The bid-ask spread is the difference between the price at which the market-maker is willing to buy an option (the bid) and the price at which the market-maker is willing to sell an option (the ask). This is the market-maker's profit on a roundturn trade.

[6] Neal, 1987.

[7] See Baumol *et al*.

[8] See [¶ 84,417] Multiple Trading of Standardized Options.

[9] The original effective date for the rule was January 22, 1990. One week before the implementation date, the SEC "asked the exchanges to voluntarily limit their multiple-listings to new options while maintaining the exclusivity of listings for existing options" until June in order to develop an electronic link among exchanges. See *SEC Delay to Limit New Option Listings*.

CHAPTER 2. A REVIEW OF NEAL'S STUDY

Neal develops an econometric model of the determinants of the bid-ask spread and tests for the effect of multiple-listing by adding a multiple-listing dummy variable. He conjectures that the spread is a function of volume, price, volatility, and the existence of multiple-listing. The inclusion of each of these variables is well supported by the existing literature for the determinants of the bid-ask spread for securities. A summary of the rationale for these variables is provided here.

Volume is theorized to be negatively related to the bid-ask spread. That is, as the volume traded in an option increases, the spread paid to a market-maker should decline. In Demsetz's seminal work on bid-ask spreads and market-making, he defined the spread as "the markup that is paid for predictable immediacy of exchange in organized markets."[10] In other words, it is the premium that must be paid by the trading public to compensate the market-maker for the supply of immediacy of transactions. It follows from this argument that options which have higher volume will have smaller spreads because the market-maker will not need to be compensated as highly. To quote Demsetz again: "Waiting costs are relatively important costs for trading in organized markets, and would seem to dominate the determination of spread."[11] Obviously, with higher volume waiting time is reduced. For this reason, volume is included as a relevant variable in the determination of the bid-ask spread.

The spread is not an always decreasing function of volume, however. There exists a lower bound to the bid-ask spread because of the unique quotation system of options traded on exchanges, equal to 1/16 or 6.25 cents. The spread can never be lower than this bound. After a certain level of volume (V* in Figure 1), the spread will simply equal the minimum spread regardless of the effects of single versus multiple-listing. The effect of volume on spread, holding all else equal except the multiple-listing dummy, is shown in the following figure:

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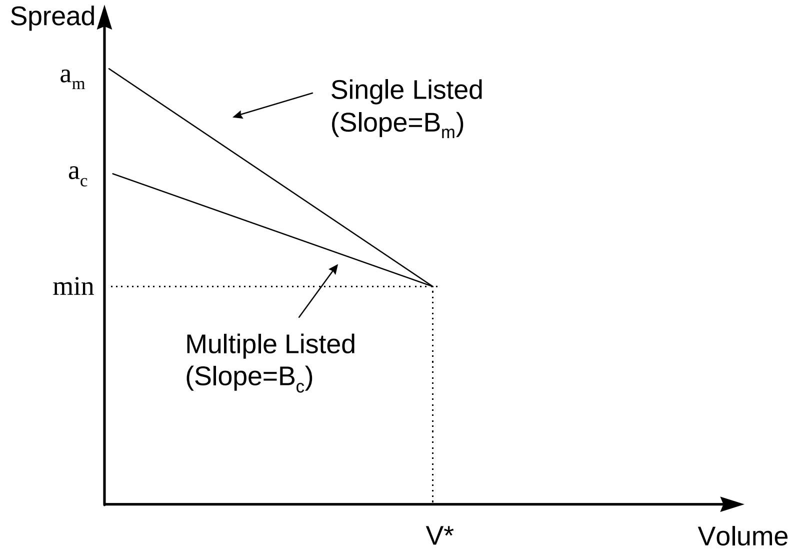
[10] Demsetz, pp. 35-36.
[11] Demsetz, p. 41.

Figure 1. The Effect of Volume on Spread



Source: Adapted from Neal, p. 516.

This relationship can also be expressed by the following equations, where the *m* subscript denotes the monopolist, or single-listed situation and the *c* subscript denotes the competitive, or multiple-listed situation.

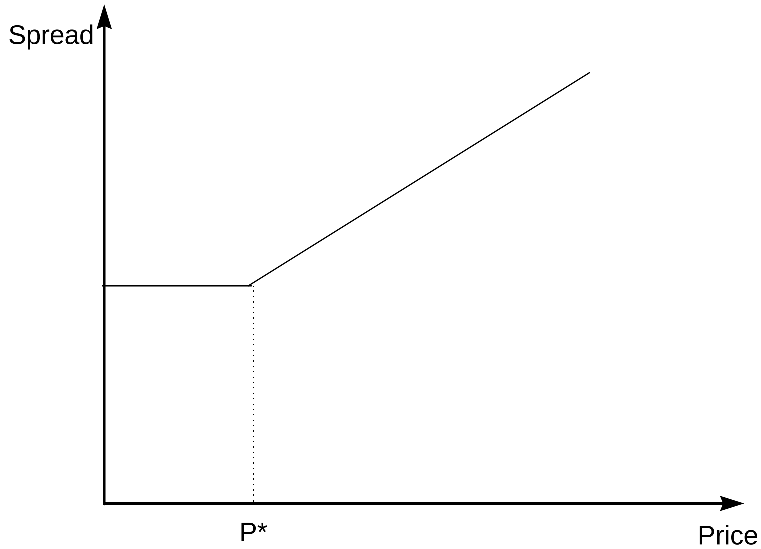
$S_m = a_m - B_m V$	if V < V*	where	$a_m > 0$, $B_m > 0$
S_m=minimum spread	if V >= V*		
$S_c = a_c - B_c V$	if V < V*	where	$a_c > 0$, $B_c > 0$
S_c=minimum spread	if V >= V*		

As shown in Figure 1, a_m would be greater than a_c, denoting the higher intercept for single-listed options and the absolute value of B_m would be greater than the absolute value of B_c, denoting the steeper slope for single-listed options.

The price of an option is conjectured to be positively related to the bid-ask spread. As the price increases, so should the spread such that the compensation to the market-maker per dollar traded is equivalent across options. In this way, the relative spread, defined as the spread as a percent of the price of the option, will be equal across all options. Yet, as was shown in the case of volume, there is also a lower bound on the spread. Below a certain price (price P* in Figure

2), the spread will be equal to the minimum, all else equal. As the price crosses the threshold, the spread will be an increasing function of price. This is shown in the following diagram.

Figure 2. The Effect of Price on Spread



Source: Neal, p. 517.

The price of the option can be considered the value of the transaction. As the value of the transaction increases, so must the compensation to the market-maker. For example, the commission to be paid to the seller of a $40,000 Lexus will differ in magnitude from the commission paid to the seller of a $1,000 used car. This could be because of a number of different factors, such as increased holding costs or differences in the potential losses associated with an equivalent percentage change in price. Even the CBOE recognizes this positive relationship between price and spread. In its 1992 Constitution, the CBOE lists maximum spreads that market-makers are allowed to charge for certain products. These maximum spreads are defined over various levels of transaction prices as an increasing function. For example, for contracts with a bid less than \$2, the maximum spread is \$0.25, while for options with a bid between \$10 and \$20, the maximum spread is \$0.75.[12]

Volatility is hypothesized to be positively related to spread in this model. The volatility of an option measures the risk to the market-maker of holding the option. The standard deviation is the usual measure of volatility of options. If the risk increases in a given option, the market-maker will require a larger return, in the form of a larger bid-ask spread. As Ho and Stoll observed, this risk can come in two forms: risk on the rate of return to be earned by the market-maker and uncertainty about the timing of future transactions.[13] On the other hand, it can also be argued that volatility is not relevant to the determination of the spread. This is because market-makers hedge against inventory risk and are thus not influenced by option volatility. For his model, Neal includes the implied volatility of the options from the Black-Scholes Option Pricing Model as a determinant of the bid-ask spread.[14]

The last variable included in Neal's model is a dummy variable for multiple-listing. The variable is zero if the option is listed on a single exchange and one otherwise. This is the main variable of interest in the equation and the sign of its coefficient is theorized to be negative. That is, all else equal, the spread for a single-listed option will be higher than the spread for a multiple-listed option.

SAMPLE DESIGN

Neal's study uses a specific sample design in order to obtain a robust set of observations and to minimize certain effects. First, he chooses only near-term options with one week to expiration. For example, he uses data from September 9-13, 1985 for options with a September 21 expiration. As options near expiration, trading activity increases and therefore a more robust set of data is available. Second, Neal chooses only at-the-money calls. He does this in order to minimize the effect of price, which tends to be much larger than the effect from multiple-listing.

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[12] See CBOE *Constitution and Rules*, ¶2277.
[13] Ho and Stoll (1981), p. 47. See also Jameson and Wilhelm and O'Hara and Oldfield for additional evidence of risk as a determinant of the bid-ask spread.
[14] He uses the formula SD(option return)=stock price/call price * option delta * implied stock return standard deviation. See page 518.

By using at-the-money calls, the amount of variation in price is reduced, thus allowing better volatility and multiple-listing effects estimates.

Neal's study focused on two sets of options traded on AMEX in 1985-86. The first set included 27 single-listed options. The second set included 16 multiple-listed options, of which 9 were options on OTC stocks and 7 were "old" multiple-listed options (i.e., multiple-listed before the moratorium by the SEC in 1977). He ran regressions using four different functional forms of volume. The equation using a linear, non-log functional form is:

$$\text{Spread} = \beta_o + \beta_1 \text{volume} + \beta_2 \text{volume} \cdot \text{DML} + \beta_3 \text{price} + \beta_4 \text{price} \cdot \text{DLP} + \beta_5 \text{volatility} + \beta_6 \text{DML}$$

$$\begin{aligned}
\text{where Spread} &= \text{ask price - bid price} \\
\text{Volume} &= \text{daily trading volume} \\
\text{DML} &= \text{0 if single listed and 1 if multiple listed} \\
\text{Price} &= \text{mean of bid and ask prices} \\
\text{DLP} &= \text{0 if option price is greater than \$0.50 and 1 if less than \$0.50} \\
\text{Volatility} &= \text{implied standard deviation of the option return}
\end{aligned}$$

This equation was regressed using four different functional forms for volume: linear level of volume, log of volume, log of volume and log of volume squared, and square root of volume.

MULTIPLE-LISTING EFFECT

In order to calculate the effect of multiple-listing on the bid-ask spreads, the coefficient on the dummy variable for multiple-listing must be considered as well as the interaction variable of volume and the dummy variable for multiple-listing. The coefficient estimates for the multiple-listing dummy variable and associated t-statistics are reproduced below.

Table 1. Coefficient Estimates for Dummy Variable for Multiple Listing

Functional form	*September*	*January*	*April*	*Combined*
Volume	-0.059304 (-3.7)	-0.030006 (-4.7)	-0.039425 (-6.5)	-0.042204 (-9.7)
Ln Volume	-0.034884 (-1.6)	-0.015868 (-1.0)	-0.049699 (-2.7)	-0.016314 (-1.4)
Ln Volume and ln Volume squared	-0.034162 (-1.6)	-0.043528 (-2.6)	-0.073504 (-3.9)	-0.035705 (-3.1)
Sq. Root of Volume	-0.052526 (-3.1)	-0.036166 (-4.5)	-0.043908 (-5.1)	-0.043542 (-7.7)

Note: t-statistics are in parentheses.
Source: Neal, pp. 522-524.

At a 95% confidence level, Neal rejects the hypothesis that the multiple-listing dummy variable is equal to zero in most cases. The coefficient is always negative, as expected. The interaction variable is used to test the hypothesis that as volume increases, the spreads for single and multiple-listed options converge. Figure 1 illustrated the negation of the differences between single and multiple-listing options' spreads once volume reached a sufficiently high level and the spread was forced to the minimum. An illustration of the combined effect of multiple-listing for various levels of volume is shown in Appendix Table A-1. Neal estimates that the combined effect of multiple-listing is approximately a 20% reduction in spreads.[15]

[15] See page 524.

Chapter 3. Critiques of Neal's Study

In response to the proposed SEC rule change concerning the multiple-listing of options and the associated studies by Neal and the Directorate of Economic and Policy Analysis, separate critiques were put forward by three of the exchanges: one by Hans Stoll for the CBOE, one by Seymour Smidt for the Philadelphia Stock Exchange (PHLX), and one by Gregory Conner for the Pacific Stock Exchange (PSE). The salient criticisms in their studies include purported flaws in the following areas: regression model design, data used, and regression model theory.

Flaws in Regression Model Design

The first critique leveled against the study concerns the construction of Neal's regression equations. As noted earlier, Neal's study has two distinct classes of data represented: multiple-listed options (composed of OTC stocks and "old" options) and single- listed options. He tests for the effect of multiple-listing by adding a dummy variable. Yet, there is a selection bias in this if there are any missing variables which are "class-specific." For example, if the spread for single-listed options, and not multiple-listed options, was also a function of another variable, *Z*, then this would affect the multiple-listing dummy variable. Conner notes in his study that volume and equity capitalization differ among the classes of options.

Flaws in Data

There were a number of criticisms related to the quality of the data used. These types of issues are important given that regression results are only as good as the underlying data source. One problem noted by both Stoll and Conner is that the number of observations is overstated. There are multiple quotes per option on any given day. Stoll argues that each different quote may not give additional information. In other words, each quote may not be an independent observation that adds unique information to the dataset. Therefore, it is argued that the true number of observations is overstated. This may lead to errors in the statistical tests.

Another data problem concerns the difference between the quoted and the realized spread. The data used in the study was for a quoted spread, yet the actual spread the market-maker realizes may be different. For example, a market-maker may offer to buy an option at a bid price of $10 and sell an option at an ask price of $12, resulting in a spread of $2. Yet if the market-maker is unable to buy any options at that price, he may be forced to pay $11 for the option in the next transaction. This would lead to a realized spread of $1, which is quite different than the quoted spread of $2.

Another critique concerning the data used is related to the process by which the spread is set. As Stoll points out, a market-maker sets a bid-ask spread based on expectations of certain facts, such as the expected volume and volatility. Yet the actual values of these variables may differ. For example, suppose a market-maker sets a spread of $10 in anticipation of a volume equal to 500 contracts and a volatility of 10%. Yet suppose actual volatility is in the 15-20% range. The market-maker is obligated to stand by the quoted spread of $10, yet had he known volatility would have been at a higher level, he may have quoted a spread of $15. This leads to an "errors-in-the-variables" problem, or measurement error. This type of error occurs when an independent variable cannot be measured with accuracy and can lead to biased estimators.

FLAWS IN REGRESSION MODEL THEORY

Neal was apparently the first researcher to attempt to quantify the determinants of the bid-ask spread for equity options. As a theoretical basis, he used the existing literature for the determinants of the spread for stocks. Yet Smidt and Stoll raise concerns that, because of the unique nature of options as derivative securities, some measure of the market for the underlying equity should be included in the regression. They suggest some account should be made of this fact, although they do not give any concrete examples.

The last major criticism of Neal's study argues that market-making is not a contestable market. Contestable market theory depends upon the proposition that the cost of entry into the market for potential competitors is small. Stoll argues that there is a prohibitively high cost of entry into the market for potential market-makers if costs include the cost to customers of channeling orders to a different exchange. If this is true, then potential market-makers will not act as a competitive force since the threat of entry by new exchanges is low since customers will not use a different exchange. Potential competition will therefore not have a discernible effect on bid-ask spreads and market-making in options is not a contestable market.

CHAPTER 4. RESPONSES TO CRITICISMS

Although each critique raised by the studies commissioned by the exchanges has some merit, they do not carry enough weight to nullify the hypothesis of Neal's study that multiple-listed options have lower bid-ask spreads than single-listed options. Yet, they do point out areas for further refinement of the model.

REGRESSION MODEL DESIGN/DATA

The "errors-in-the-variables" problem and quality of data problems addressed by the critiques are not easily corrected. There is a limitation on the type (and quality) of data which can be collected by the exchanges in the course of options trading. Use of a random coefficient estimator may provide a better estimate when data is measured with error or functional forms are unknown, and should be considered in future research.[16]

REGRESSION MODEL THEORY

Some measure of the underlying stock market should be included as a refinement to the model of bid-ask spreads. Because of the unique characteristic of options as derivative securities, this could be an important additional explanatory variable. This potential omission does not, however, have an important impact on Neal's study. Because the study was designed to compare the spread between two different groups of options, this omitted variable problem would depend on the underlying markets for single-listed options and multiple-listed options being fundamentally different. But, there is no evidence that these markets are fundamentally different.

The backbone of the criticism arguing that market-making in options is not a contestable market is that the costs to customers of redirecting trades to other exchanges is prohibitively high. If this is true and there is no threat of customers using secondary exchanges for option trading, primary exchanges will not be "reined in" by potential competitors because these potential competitors will not be a realistic threat. However, the evidence from customers suggests that the cost of redirecting trades is not prohibitively high. In a letter to the SEC from the president of

[16] See Swamy and Tavlas.

Merrill Lynch, a large customer, the process by which a primary market is designated in a multiple-listing environment is described. Although it is noted that the costs to small firms from designating a primary market for many options may be large, additional disclosure from exchanges, as proposed in the letter, would alleviate this burden. In other words, Merrill Lynch is saying that (with some additional disclosure from exchanges) it is not prohibitively expensive to designate a primary market from among several exchanges and thus trade options in a multiple-listed environment. Therefore, Stoll's argument that costs to customers of trading on more than one exchange is prohibitively high does not appear to hold much merit.

CHAPTER 5. AN ALTERNATIVE APPROACH

The present study was designed to test the hypothesis that the rule allowing the multiple-listing of options has decreased bid-ask spreads for equity options. Even though very few options that were once solely listed on the CBOE are now listed on multiple exchanges, potential competitors are hypothesized to have had the same effect that actual competitors would have. Because Neal's study was done in 1986, he could only compare the bid-ask spread between the few options eligible to be traded on multiple exchanges and the rest that can only be traded on a single exchange. Post-1990, all options were eligible for multiple-listing. Thus, comparisons of spreads between options that were actually multiple-listed and options that were eligible for multiple-listing but not actually listed on more than one exchange are possible. In this way, it is possible to test if potential competition acts as actual competition.

DATA DESCRIPTION

Neal used data on options traded on AMEX in his study. Because of data constraints, data on options traded on the CBOE in 1985 and in 1992 were used.[17] The first group of options considered consisted of options traded on only the CBOE in 1985 and 1992. This is comparable to Neal's single exchange group of options. The second group of options considered were those listed on the CBOE and on some other exchange in 1985 and in 1992. This is comparable to Neal's group of options that were traded on multiple exchanges. The underlying companies included in the sample are shown in the table below.

[17] Data is from the Berkeley Options Data Base.

Table 2. Underlying Companies Sampled

Listed only on CBOE in 1985 and 1992		*Listed on CBOE and Other Exchange in 1985 and 1992*		
Symbol	Company	Symbol	Company	Other Exchange
AAL	Alexander & Alexander Services	AXP	American Express	AMEX
AEP	American Electric Power Co.	DEC	Digital Equipment	AMEX
T	AT&T	DIS	Disney (Walt) Productions	AMEX
BS	Bethlehem Steel Corp.	DD	DuPont (EI) De Nemours	AMEX
CCB	Capital Cities Communications	MER	Merrill Lynch & Co.	AMEX
C	Chysler Corp.	TAN	Tandy	AMEX
CSC	Computer Science Corp.	XRX	Xerox	PSE
DAL	Delta Airlines	CGP	Coastal Corporation	AMEX
AGE	Edwards, A.G. & Sons, Inc.			
FLR	Fluor Corp.			
HRS	Harris Corp.			

The companies in the first group, those listed on only the CBOE in both sample years, were randomly chosen from among dozens in that category. The second group, those listed on the CBOE and on some other exchange in both sample years, is a complete universe of such companies.

HYPOTHESES

Two outcomes were predicted to occur. First, in 1985, spreads on options listed only on the CBOE were expected to be larger than spreads on options listed on the CBOE and some other exchange. Only a limited number of options were eligible for multiple-listing in 1985. Spreads should be lower on multiple-listed options as a result of actual competition.[18] Second, in 1992, spreads on options listed only on the CBOE were expected to be the same as spreads on options listed on the CBOE and some other exchange. This is because all options were eligible to be listed on multiple exchanges in 1992. The forces of potential competition (on options not listed on multiple exchanges) and actual competition (on options listed on multiple exchanges subject to the caveat in footnote 18) are expected to have the same effect on spreads and, thus, there should be no difference between spreads for single- and multiple-listed options.

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[18] Potential competition is also at work here because of the fact that trading in options becomes dominated by one exchange and thus there is not much actual competition between exchanges for multiple-listed options.

CHAPTER 6. TEST ON 1985 DATA

Following Neal's design, this sample consisted of quotes from three independent one-week time periods: January 7-11, April 8-12, and September 9-13, 1985. Again following Neal's design, near-term calls which were at-the-money or near-the-money for each time period were used. For example, calls expiring in January 1985 for the January sample, calls expiring in April 1985 for the April sample, etc. were used. Quotes with a zero bid price were excluded from the sample, as were obvious data entry errors. Also excluded were a few options with ex-dividend dates before expiration because of complications in calculating implied volatility for options with yields. The underlying stocks included and number of observations by week for each stock are detailed below.

Table 3. Number of Observations By Underlying Company

	Single Listed Options				*Multiple Listed Options*		
	Jan-85	Apr-85	Sep-85		Jan-85	Apr-85	Sep-85
BS	49	16	0	AXP	39	39	0
C	0	0	318	CGP	0	0	17
CSC	0	0	108	DD	37	32	14
DAL	307	373	94	DEC	50	20	42
FLR	32	119	0	DIS	33	39	11
T	123	189	0	MER	42	33	28
				TAN	29	51	0
				XRX	149	193	46
Total	511	697	520	Total	201	214	158

OLS estimates of Neal's model described in the previous section were estimated for each week and for the three weeks combined. This model conjectures the bid-ask spread as a function of volume, price of the option, volatility, and the multiple-listing dummy (plus some interaction variables). Volume is equal to the total number of call contracts traded on the CBOE for a given underlying on a certain day. Thus, the volume variable will be the same for all the quotes for the same underlying on the same day. The price of the option is set equal to the ask price. The volatility of the option is calculated as the implied volatility for American style options using the

Cox-Rubinstein binomial model.[19] The implied volatility was calculated using FinancialCad® software. The inputs into the calculation include the underlying price, exercise price, expiry date, value date, price, and interest rate, all of which are available in the Berkeley Options Data Base except for the interest rate. For this variable, the 3-month Treasury bill interest rate was used on each day.[20] Neal's model used estimates of implied volatility for European style options from the Black-Scholes model. Use of the Cox-Rubinstein binomial model is an improvement over the use of the Black-Scholes model because it accounts for the unique features that go into the pricing of American style options.

EMPIRICAL RESULTS

The coefficient estimates and associated t-statistics of the regressions for each functional form for volume are summarized below. Several observations had daily volume equal to zero. Because of this, volume was replaced with volume plus two for functional forms involving logarithms.

[19] American style options can be exercised at any point before the expiration date; European style options can only be exercised on the expiration date. All options traded on the CBOE are American style.
[20] From Federal Reserve Statistical Release H.15.

Table 4a. The Effect of Multiple Listing Using Volume Levels

	January	*April*	*September*	*Combined*
Intercept	0.1022752	0.113944	0.155093	0.078383
	(14.5)	(13.5)	(9.8)	(16.1)
Volume (-)	-0.0000015	-0.000020	-0.000128	-0.000004
	(-1.9)	(-5.1)	(-13.4)	(-4.5)
Volume * DML (-)	-0.0000157	-0.000014	0.000121	-0.000026
	(-3.8)	(-2.5)	(3.5)	(-7.6)
Price (+)	0.0257320	0.052014	0.035607	0.040454
	(11.3)	(27.7)	(5.6)	(25.0)
Price * DLP (-)	-0.0397964	0.002148	-0.012504	-0.007124
	(-6.1)	(0.3)	(-0.8)	(-1.5)
Volatility (+)	0.0705727	-0.054934	0.129161	0.044800
	(5.3)	(-3.6)	(3.3)	(3.9)
DML (-)	0.0220511	0.012868	-0.007585	0.039547
	(3.9)	(1.8)	(-0.6)	(9.1)
Sample size	890	1104	678	2672
Adj. R-sqrd	0.498	0.574	0.419	0.406

Note: The expected sign is listed after the variable. T-statistics are in parenthesis.

Table 4b. The Effect of Multiple Listing Using Log of Volume

	January	*April*	*September*	*Combined*
Intercept	0.179413	0.199777	0.506091	0.280609
	(8.6)	(6.5)	(13.9)	(17.8)
Log of Volume (-)	-0.010732	-0.015829	-0.068627	-0.028810
	(-4.1)	(-3.8)	(-14.0)	(-13.9)
Log of Volume * DML (-)	0.005546	0.002864	0.065718	0.019628
	(2.0)	(0.7)	(11.6)	(8.8)
Price (+)	0.027016	0.054757	0.030897	0.041980
	(11.9)	(29.7)	(5.0)	(26.6)
Price * DLP (-)	-0.037336	0.007306	-0.027077	-0.007581
	(-5.8)	(1.1)	(-1.8)	(-1.6)
Volatility (+)	0.052547	-0.072989	0.102206	0.002862
	(3.8)	(-4.7)	(2.6)	(0.3)
DML (-)	-0.044927	-0.047512	-0.334502	-0.137202
	(-2.3)	(-1.6)	(-9.9)	(-9.2)
Sample size	890	1104	678	2672
Adj. R-sqrd	0.508	0.584	0.429	0.443

Note: The expected sign is listed after the variable. T-statistics are in parenthesis. Volume has been replaced by volume + 2.

Table 4c. The Effect of Multiple Listing Using Log of Volume and Log Volume Squared

	January	*April*	*September*	*Combined*
Intercept	0.234934	0.137390	0.576557	0.354920
	(4.5)	(2.6)	(4.6)	(10.2)
Log Volume (-)	-0.026475	0.003897	-0.093239	-0.051422
	(-1.9)	(0.3)	(-2.2)	(-5.3)
Log Volume^2 (-)	0.001098	-0.001524	0.002086	0.001690
	(1.2)	(-1.4)	(0.6)	(2.4)
Log Volume * DML (-)	0.012496	-0.004735	0.076223	0.028932
	(1.9)	(-0.7)	(4.1)	(6.5)
Price (+)	0.027149	0.054438	0.030358	0.042155
	(11.9)	(29.3)	(4.9)	(26.7)
Price * DLP (-)	-0.038066	0.006889	-0.028155	-0.008953
	(-5.9)	(1.0)	(-1.9)	(-1.9)
Volatility (+)	0.050839	-0.072371	0.104432	0.001496
	(3.7)	(-4.6)	(2.7)	(0.1)
DML (-)	-0.093710	0.006664	-0.395242	-0.201494
	(-2.0)	(0.1)	(-3.6)	(-6.6)
Sample size	890	1104	678	2672
Adj. R-sqrd	0.508	0.584	0.429	0.444

Note: The expected sign is listed after the variable. T-statistics are in parenthesis. Volume has been replaced by volume + 2.

Table 4d. The Effect of Multiple Listing Using the Square Root of Volume

	January	*April*	*September*	*Combined*
Intercept	0.113818	0.135546	0.233905	0.112261
	(13.2)	(11.2)	(12.1)	(17.6)
Root Volume (-)	-0.000321	-0.001319	-0.006501	-0.001020
	(-2.9)	(-4.8)	(-14.0)	(-9.1)
Root Volume * DML (-)	-0.000502	-0.000660	0.006005	-0.000516
	(-2.4)	(-2.0)	(6.7)	(-2.8)
Price (+)	0.026306	0.053354	0.034542	0.041253
	(11.6)	(28.7)	(5.5)	(25.7)
Price * DLP (-)	-0.038210	0.004293	-0.017896	-0.004842
	(-5.9)	(0.6)	(-1.2)	(-1.0)
Volatility (+)	0.062810	-0.068104	0.106163	0.024679
	(4.6)	(-4.4)	(2.7)	(2.2)
DML (-)	0.013765	0.003652	-0.075051	0.015620
	(1.9)	(0.4)	(-4.5)	(2.7)
Sample size	890	1104	678	2672
Adj. R-sqrd	0.503	0.583	0.430	0.422

Note: The expected sign is listed after the variable. T-statistics are in parenthesis.

Exclusive of the effects of multiple-listing, the signs on the coefficient estimates generally are as predicted by theory. Volume was hypothesized to have a negative effect on the bid-ask spread. For most datasets and for most functional forms, the coefficient estimate for volume is negative and significant at a 95% confidence level. Price was conjectured to be positively related to the bid-ask spread, and each coefficient estimate supports this theory. All of the coefficient estimates for price were positive and highly significant. For the interaction variable for price, the results were mixed. Some coefficient estimates were negative and significant, as anticipated, while others were positive. For the most part, the model is supported by the regression estimates.

A common problem associated with time series data is serial correlation. This occurs when the residual terms are correlated with one another over time. As a first test for this condition, the residuals for each dataset were examined to look for any common patterns. Visual inspection of the residuals does not suggest obvious autocorrelation. As a further test for serial correlation, Durbin-Watson *d* statistics were calculated for each model. These statistics are detailed below.

Table 5. Durbin-Watson Test for Autocorrelation

Functional Form	d statistic by dataset Jan-85	Apr-85	Sep-85	All Data	No. of explanatory variables (a)	d test statistic d_L	d_U	$4\text{-}d_L$	$4\text{-}d_U$
Volume	**1.857**	*1.779*	**1.826**	*1.596*	6	1.55	1.80	2.45	2.20
Log Volume	**1.846**	*1.765*	**1.849**	*1.703*	6	1.55	1.80	2.45	2.20
Log Volume and Log vol sq	**1.845**	*1.774*	**1.851**	*1.706*	7	1.53	1.83	2.47	2.17
Root Volume	**1.852**	*1.653*	**1.851**	*1.620*	6	1.55	1.80	2.45	2.20

(a) Excluding constant.
Note: Bolded numbers represent instances where we fail to reject the null hypothesis of no autocorrelation; italized numbers represent inconclusive test statistics.

A two-tailed distribution was used to test for both positive and negative serial correlation. Based on the above calculations, in eight of the sixteen instances it is possible to fail to reject the null hypothesis that there is no serial correlation. Furthermore, eight statistics are inconclusive, and in no instances is it possible to reject the null hypothesis that there is no autocorrelation. Based on these two tests, visual inspection and the Durbin-Watson test, a correction for serial correlation is not warranted.

MULTIPLE-LISTING EFFECT

In order to fully account for the effects of multiple-listing, the multiple-listing dummy variable and the interaction variable with volume must be considered.[21] Appendix Table A-2 shows the combined effects of multiple-listing across different levels of volume for each functional

[21] See discussion on pages 3-4 of this paper.

form by dataset.[22] The results using the level of volume, the log of volume, and the square root of volume lend weak support to the hypothesis that multiple-listing decreases spreads.

The result appears to be that, for most of the datasets and functional forms, multiple-listing does not make any difference in the spread. Using the log of volume, multiple-listed options appear to have higher spreads than single-listed options. Appendix Table A-1 shows the combined effects for Neal's study on AMEX data. Using the functional form of the log of volume gave inconsistent results for him as well, while the other forms supported his hypothesis. The contradictory results from AMEX and CBOE may be caused by differences in competition resulting from the dissimilar organization of trading on these two exchanges.[23] The CBOE uses a system of competing market-makers, while AMEX uses a specialist system like the New York Stock Exchange. While market-makers and specialists fill the same role at each of the exchanges, they differ in the amount of competition inherent in their structure. There is only one specialist dealing in an option on AMEX, while there are several market-makers dealing in each option on CBOE. The competitive nature of the CBOE system may result in the spreads for single-listed options being as competitive as multiple-listed options. A comparison of CBOE and AMEX spreads for a contemporaneous period may provide evidence of this and would be an interesting point for further research.

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[22] The scales on the graphs in Appendix Tables A-2 and A-3 are identical.
[23] See Junkus, pp. 62-63 for a description of the various ways trading can be organized on options exchanges.

CHAPTER 7. TEST ON 1992 DATA

The same methodology as had been used for sampling the 1985 data was utilized to sample the 1992 data. Quotes from three one-week time periods, January 6-10, April 6-10, and September 8-11, 1992 were obtained.[24] Near-term calls at-the-money or near-the-money were sampled. Quotes with zero bid prices were again excluded, as were obvious outliers and options with ex-dividend dates before expiration. The underlying stocks and number of observations in these datasets are detailed below.

Table 6. Number of Observations By Underlying Company

	Single Listed Options				*Multiple Listed Options*		
	Jan-92	Apr-92	Sep-92		Jan-92	Apr-92	Sep-92
AAL	88	0	118	AXP	757	511	96
AEP	69	34	39	CGP	56	40	19
AGE	59	82	95	DD	305	267	41
BS	219	192	58	DEC	859	875	361
C	198	281	228	DIS	1,200	1,576	496
CCB	167	267	168	MER	756	801	259
CSC	140	80	48	TAN	47	86	48
DAL	589	370	305	XRX	233	257	62
FLR	321	216	249				
HRS	113	33	59				
T	475	307	40				
Total	2,438	1,862	1,407	Total	3,980	4,413	1,382

As you can see from a comparison of Tables 3 and 6, the volume of quotes increased overall, and the volume of quotes for multiple-listed options increased by quite a large amount. For example, quotes on DIS increased by almost 4000% in January and April 1992 compared to January and April of 1985, respectively.

[24] Monday, September 7th was a holiday and thus the CBOE was closed.

EMPIRICAL RESULTS

OLS estimates of the model were obtained for each dataset using the four different functional forms for volume. The coefficient estimates and associated t-statistics are summarized below.

Table 7a. The Effect of Multiple Listing Using Volume Levels

	January	*April*	*September*	*Combined*
Intercept	0.1649283	0.2665022	0.1908204	0.2058086
	(25.2)	(41.7)	(16.7)	(46.2)
Volume (-)	-0.0000274	-0.0000816	-0.0001353	-0.0000418
	(-17.8)	(-24.9)	(-14.9)	(-29.1)
Volume * DML (no effect)	0.0001396	0.0001095	0.0000693	0.0000673
	(3.5)	(4.4)	(0.7)	(2.9)
Price (+)	0.0916112	0.0909590	0.1739380	0.1030381
	(72.7)	(81.5)	(66.6)	(118.9)
Price * DLP (-)	0.0711157	0.0391369	0.1816463	0.0764131
	(10.5)	(5.4)	(14.6)	(15.5)
Volatility (+)	-0.0947836	-0.1644676	-0.4487207	-0.1763660
	(-11.9)	(-19.0)	(-25.3)	(-29.4)
DML (no effect)	-0.1240652	-0.1908799	-0.1668884	-0.1555414
	(-28.5)	(-43.3)	(-19.1)	(-51.5)
Sample size	6694	6275	2759	15728
Adj. R-sqrd	0.557	0.632	0.705	0.582

Note: The expected sign is listed after the variable. T-statistics are in parenthesis.

Table 7b. The Effect of Multiple Listing Using Log of Volume

	January	*April*	*September*	*Combined*
Intercept	0.3459524	0.5103950	0.3169087	0.4174978
	(30.8)	(46.9)	(21.2)	(59.9)
Log of Volume (-)	-0.0371772	-0.0585338	-0.0383967	-0.0467431
	(-24.9)	(-33.7)	(-18.0)	(-46.5)
Log of Volume * DML (no effect)	0.0457741	0.0561731	0.0326476	0.0460388
	(18.6)	(26.1)	(7.8)	(31.1)
Price (+)	0.0889600	0.0884359	0.1698222	0.0994193
	(72.0)	(81.5)	(65.4)	(118.7)
Price * DLP (-)	0.0648095	0.0449649	0.1718183	0.0719285
	(9.8)	(6.4)	(13.9)	(15.2)
Volatility (+)	-0.0838557	-0.1394572	-0.4457596	-0.1557059
	(-11.0)	(-16.9)	(-25.6)	(-27.3)
DML (no effect)	-0.3107981	-0.4346302	-0.2778254	-0.3655992
	(-31.9)	(-43.9)	(-20.0)	(-59.3)
Sample size	6694	6275	2759	15728
Adj. R-sqrd	0.576	0.658	0.715	0.613

Note: The expected sign is listed after the variable. T-statistics are in parenthesis. Volume has been replaced by volume + 2.

Table 7c. The Effect of Multiple Listing Using Log of Volume and Log Volume Squared

	January	*April*	*September*	*Combined*
Intercept	0.2961593	0.4784240	0.2432127	0.3905246
	(18.1)	(27.5)	(12.5)	(40.8)
Log Volume (-)	-0.0122638	-0.0429471	0.0130783	-0.0316866
	(-2.0)	(-6.3)	(1.4)	(-8.3)
Log Volume^2 (-)	-0.0023721	-0.0015513	-0.0062326	-0.0015518
	(-4.2)	(-2.3)	(-5.8)	(-4.1)
Log Volume * DML (no effect)	0.0346685	0.0492937	0.0104160	0.0395686
	(9.6)	(13.6)	(1.8)	(18.3)
Price (+)	0.0882452	0.0883226	0.1703019	0.0991667
	(70.8)	(81.3)	(65.9)	(118.1)
Price * DLP (-)	0.0635053	0.0445977	0.1743376	0.0714746
	(9.6)	(6.3)	(14.2)	(15.1)
Volatility (+)	-0.0919107	-0.1436532	-0.4435946	-0.1602423
	(-11.7)	(-17.0)	(-25.6)	(-27.5)
DML (no effect)	-0.2653169	-0.4064403	-0.2252821	-0.3419600
	(-18.2)	(-26.1)	(-13.7)	(-40.5)
Sample size	6694	6275	2759	15728
Adj. R-sqrd	0.577	0.658	0.718	0.613

Note: The expected sign is listed after the variable. T-statistics are in parenthesis. Volume has been replaced by volume + 2.

Table 7d. The Effect of Multiple Listing Using the Square Root of Volume

	January	*April*	*September*	*Combined*
Intercept	0.3459524	0.3268937	0.2374054	0.2674863
	(28.6)	(46.2)	(19.5)	(54.1)
Root Volume (-)	-0.0028266	-0.0058127	-0.0062244	-0.0041647
	(-22.0)	(-30.4)	(-17.6)	(-39.4)
Root Volume * DML (no effect)	0.0051546	0.0053689	0.0042782	0.0040855
	(8.1)	(11.7)	(2.9)	(10.6)
Price (+)	0.0892946	0.0892494	0.1714746	0.1003164
	(71.1)	(81.2)	(66.3)	(117.4)
Price * DLP (-)	0.0663756	0.0411551	0.1758094	0.0721373
	(9.9)	(5.8)	(14.2)	(14.9)
Volatility (+)	-0.0971438	-0.1603702	-0.4457329	-0.1758421
	(-12.5)	(-19.0)	(-25.5)	(-30.1)
DML (no effect)	-0.3107981	-0.4346302	-0.2778254	-0.2104615
	(-31.9)	(-43.9)	(-20.0)	(-58.3)
Sample size	6694	6275	2759	15728
Adj. R-sqrd	0.576	0.658	0.715	0.599

Note: The expected sign is listed after the variable. T-statistics are in parenthesis.

The signs on the coefficient estimates are consistent with the theory for volume and price, but not for volatility. In all instances except one, the coefficient on volume is negative, as predicted. In each instance, the coefficient on price is positive, as predicted. Yet on volatility, the coefficient in each instance has a negative sign. This may be explained by the fact that market-makers hold balanced, limited risk positions (i.e., conversions or reverse conversions) or are hedging a position and are thus not concerned about the volatility of the option.

Two tests were again performed for serial correlation. The residuals of each regression were examined over time without a finding of any obvious serial correlation. As an additional test, Durbin-Watson statistics were calculated. The results are detailed in the table below.

Table 8. Durbin-Watson Test for Autocorrelation

Functional Form	d statistic by dataset				No. of explanatory variables (a)	d test statistic			
	Jan-92	Apr-92	Sep-92	All Data		d_L	d_U	$4\text{-}d_L$	$4\text{-}d_U$
Volume	*1.784*	*1.751*	*1.706*	*1.749*	6	1.55	1.80	2.45	2.20
Log Volume	*1.791*	*1.761*	*1.704*	*1.767*	6	1.55	1.80	2.45	2.20
Log Volume and Log vol sq	*1.786*	*1.758*	*1.701*	*1.764*	7	1.53	1.83	2.47	2.17
Root Volume	*1.782*	*1.746*	*1.705*	*1.749*	6	1.55	1.80	2.45	2.20

(a) Excluding constant.
Note: Bolded numbers represent instances where we fail to reject the null hypothesis of no autocorrelation; italized numbers represent inconclusive test statistics.

Based on these two pieces of evidence, it does not appear there needs to be a correction for serial correlation.

MULTIPLE-LISTING EFFECT

It was hypothesized that options which were multiple-listed in 1985 would have lower spreads than single-listed options. The forces of actual (and potential) competition were held to be responsible for acting as a suppressant on the spreads of multiple-listed options. After the implementation of the rule change allowing multiple-listing, the forces of potential competition should apply to all options, whether or not they are actually listed on another exchange. The fact that single-listed options could be relatively easily listed on another exchange should keep spreads at a competitive level. Therefore, one would expect to see no difference between the spreads on multiple-listed options and the spreads on single-listed options in 1992. The combined effects of multiple-listing are shown in Appendix Table A-3. For most functional forms and for most datasets, there appears to be a large difference between the spreads for single-listed and the spreads for multiple-listed options. In fact, in 1992 spreads for single-listed options are higher than multiple-listed options. This is the effect that was predicted for 1985. These results are also very similar to Neal's results for 1985-86 AMEX data, depicted in Appendix Table A-1.

The difference between spreads on single- and multiple-listed options in 1992 may be due to the fact that the effect of potential competition has not yet been realized. As of the end of

1992, there were no options that had been listed on only the CBOE pre-1990 that were now listed on another exchange. The actual effect of the rule change as of the end of 1992 had been that options being listed for the first time post-implementation of the rule change were being listed on more than one exchange. But, options that had already been listed on one exchange were still being traded on just one exchange. If market-makers do not believe that there is a credible threat from other exchanges on options that are already single-listed, spreads on these options will not reach the levels of spreads on multiple-listed options. This would lead to a result such as the one obtained from this test.

CHAPTER 8. TESTS COMPARING 1985 AND 1992

TEST FOR EVIDENCE OF STRUCTURAL CHANGE FROM 1985 TO 1992

It is hypothesized that there was a structural change in the determination of the spread from 1985 to 1992 because of the different regulations regarding multiple-listing. An F-test was constructed in order to test this. For each functional form, the data from 1985 and 1992 were pooled by dataset. That is, January data from 1985 and 1992 were pooled, April data from 1985 and 1992 were pooled, and September data from 1985 and 1992 were pooled. The model for the determination of the spread was estimated via OLS for each of these constrained datasets. The F-statistics are given below.

Table 9. F-statistic by Functional Form and Dataset

		Dataset	
Functional Form	Jan	Apr	Sep
Using Volume Levels	77.3	110.4	52.2
Using Log of Volume	47.5	51.9	54.6
Using Log of Volume and Log of Volume Squared	40.5	45.0	43.7
Using Root Volume	62.7	257.4	48.4

The F-statistic is significant at the 95% level, thus supporting the hypothesis that there was a structural change from 1985 to 1992. This lends support to the overall hypothesis that there were different forces acting upon the determination of the spread in the two sample years. As hypothesized here, the difference is the rule change allowing multiple-listing of all options effective in 1990.

TEST FOR EFFECT OF TIME ON SPREADS

An additional test was run to estimate the effect of time on spreads from 1985 to 1992. As stated earlier, spreads for single-listed options were hypothesized to have declined from 1985 to 1992, and spreads for multiple-listed options were hypothesized to have remained the same from 1985 to 1992. The equation for the determinants of the bid-ask spread was estimated separately for eight different underlyings. These options, four each single- and multiple-listed, were chosen because they were well-represented in both sample years. A dummy variable equal to 1 in 1992 and 0 in 1985 was included. The results using the level of volume are presented below.

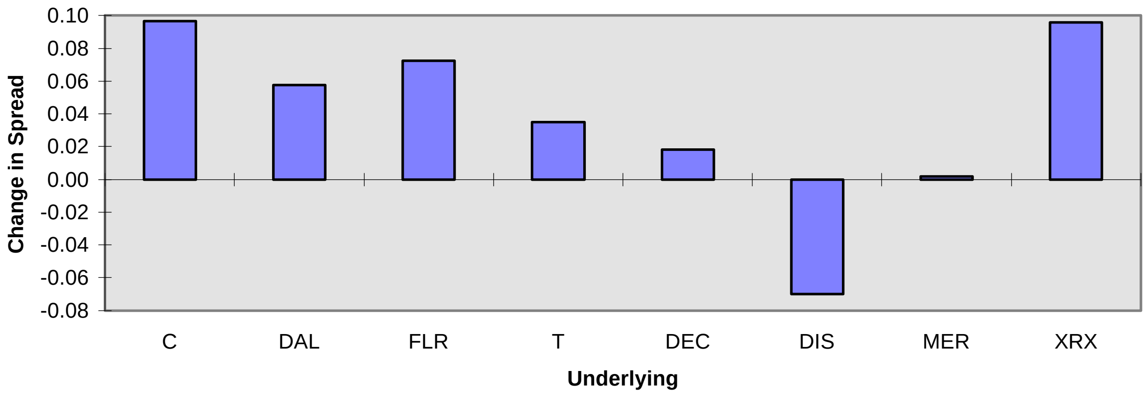
Table 10. The Effect of Time on Spreads of Single-Listed and Multiple-Listed Options

Underlying	Constant	Price	Price*DLP	Volume	Volatility	Dummy (1992=1)	No. of obs.	Adj. R-sqrd.
Single-Listed Options								
C	0.024970	-0.000018	0.030843	-0.145258	0.114290	0.096774	1038	0.513
	(2.6)	(-3.8)	(8.2)	(-4.0)	(8.1)	(10.3)		
DAL	0.147699	0.045602	-0.022203	-0.000033	-0.054812	0.057541	2038	0.583
	(15.4)	(36.8)	(-1.2)	(-7.7)	(-2.1)	(14.2)		
FLR	0.128050	-0.000040	0.038483	-0.101783	0.018273	0.072318	937	0.629
	(9.5)	(-7.2)	(19.7)	(-3.7)	(1.0)	(8.1)		
T	0.077767	-0.000004	0.044715	0.086565	-0.063592	0.034823	1134	0.335
	(10.5)	(-6.4)	(13.4)	(3.8)	(-2.3)	(7.6)		
Multiple-Listed Options								
DEC	0.120886	0.000694	0.047249	-0.089062	-0.034995	0.018343	2207	0.577
	(15.5)	(3.7)	(45.4)	(-6.4)	(-1.9)	(2.6)		
DIS	0.207769	0.000078	0.042392	-0.176485	-0.161049	-0.069798	3355	0.408
	(20.2)	(2.1)	(46.4)	(-4.4)	(-5.9)	(-9.0)		
MER	0.143950	-0.000387	0.038617	-0.092597	-0.046211	0.001914	1919	0.374
	(13.1)	(-1.5)	(25.8)	(-5.1)	(-2.5)	(0.3)		
XRX	0.166507	-0.000023	0.039936	-0.026492	-0.185540	0.095934	940	0.718
	(16.6)	(-6.4)	(22.4)	(-1.1)	(-5.7)	(16.9)		

Note: T-statistics are in parenthesis under the coefficient estimate.

These results show that, all else equal, spreads *increased* for all options except DIS from 1985 to 1992. This result is contrary to the expectation of declining spreads as a result of increased competition. Figure 3 illustrates the magnitudes of the change in spreads from 1985 to 1992, holding all else equal.

Figure 3. Change in Spreads from 1985 to 1992 Holding All Else Equal, by Underlying



Nominal spreads have increased in seven of eight options tested from 1985 to 1992. Both actual and potential competition has increased, and one would expect this to result in decreased spreads. On a real basis, the spreads have not increased as dramatically. The GDP Implicit Price Deflator has increased from 78.4 in 1985 to 100.0 in 1992, the base year. Therefore, part of the increase in spreads could simply be attributed to inflation.

Interestingly, the cost for a seat on the CBOE has also increased by a large amount from the early 1980s through the end of 1992. In 1981, the price for a seat was $180,000. By the end of 1991, the price had increased to $239,500 and by the end of 1992, the price had increased to $258,333, an increase of 7.9% in one year alone.[25] The price of a seat on the exchange is in some sense a measure of the profitability of market-making. Thus, it could be argued that the profits associated with making a market in options has increased over this time period. This could be due to increased volume of trading on the exchange, and it could also be due to higher spreads and less competition. Thus, while some explanation for the increase in spreads from 1985 to 1992 is due to inflation, another part may be due to increased profit-taking on the part of market-makers.

[25] Figures for 1981 and 1992 from "Exchanges: Growth and change the ongoing story," p. 56. Figure for 1992 is an average of the three prices considered the 'last sale' of 1992 and was quoted by CBOE Member Services. Data for 1985 was not available.

CHAPTER 9. CONCLUSION

This paper examined whether multiple-listing, or simply the availability of the choice to multiple-list, of equity options and the resulting competition, either actual or potential, resulted in lower bid-ask spreads. Two separate tests were conducted on data from the CBOE. The first test arose from the fact that in 1985, only a certain number of options were multiple-listed, or eligible to be multiple-listed. A model of the determinants of the bid-ask spread was formulated and to that was added a multiple-listing dummy variable and an interaction variable with volume and the dummy variable. Spreads for multiple-listed options were conjectured to be below spreads for single-listed options across low levels of volume, and equal to single-listed option spreads at higher levels of volume. The evidence for this was mixed based on several regressions with different functional forms. The second test arose from the fact that in 1992, because of an SEC rule change, all options were eligible to be multiple-listed but still only a few were. Spreads for multiple-listed options were conjectured to be equal to spreads for single-listed options because the single-listed options had the potential to become multiple-listed. Again, the evidence for this was mixed. It appears that the actual and potential competitive effects from multiple-listing had yet to come to fruition as of 1992. Further testing revealed that there was indeed a structural change in the determination of the spread from 1985 to 1992. Also, it was discovered that, on an option-by-option basis, nominal spreads generally rose from 1985 to 1992. Anecdotal evidence in the popular press suggests that competition is increasing in multiple-listed options, and further research into this issue using more recent data may lead to stronger results of decreased spreads.

BIBLIOGRAPHY

Baumol, William J., John C. Panzar, and Robert D. Willig. *Contestable Markets and The Theory of Industry Structure*, Harcourt Brace Jovanovich, Inc., 1982.

Chicago Board of Exchange. *Constitution and Rules*, January 16, 1992.

Chicago Board of Exchange. “Options Listing History as of Wednesday, January 24, 1996.”

Conner, Gregory. *Competitivity of Options Trading Under the Options Allocation Plan*.

Davis, Jeffry and Lois Lightfoot. “DEPA’s Response to CBOE and PHLX Criticisms of the Study ‘The Effects of Multiple Trading on the Market for OTC Options.’”

Demsetz, Harold. “The Cost of Transacting.” *Quarterly Journal of Economics*, 1968, pp. 33-45.

“Exchanges: Growth and change the ongoing story.” *Futures*, March 1992, pp. 52-57.

Grossman, Sanford J. and Merton H. Miller. “Liquidity and Market Structure.” *The Journal of Finance*, July 1988, pp. 617-637.

Ho, Thomas and Hans R. Stoll. “Optimal Dealer Pricing Under Transactions and Return Uncertainty.” *Journal of Financial Economics*, March 1981, pp. 47-73.

Jameson, Mel and William Wilhelm. “Market Making in the Options Markets and the Costs of Discrete Hedge Rebalancing.” *The Journal of Finance*, June 1992, pp. 765-779.

Junkus, Joan, “U.S. Options Exchanges.” *The Handbook of Equity Derivatives* edited by Jack Clark Francis, William W. Toy, and J. Gregg Whittaker, 1995, p. 51-71.

Neal, Robert. “Potential and Actual Competition in Equity Options.” *The Journal of Finance*, July 1987, pp. 511-531.

O’Hara, Maureen and George S. Oldfield. “The Microeconomics of Market Making.” *Journal of Financial and Quantitative Analysis*, December 1986, pp. 361-376.

“SEC Asks Exchanges to Delay the Multiple Listing of Options.” *Chicago Tribune*, January 14, 1990.

“SEC Delay to Limit New Option Listings.” *Chicago Tribune*, January 22, 1990.

Securities and Exchange Commission, Directorate of Economic and Policy Analysis. “The Effects of Multiple Trading on the Market for OTC Options,” November 1986.

Securities and Exchange Commission. “[¶ 84,417] Final Rules on Multiple Trading of Standardized Options.” *Federal Securities Law Reports*, 1989, pp. 80,120-80,153.

Securities and Exchange Commission. “Report of the Special Study of the Options Markets,” 1979, pp. 800-869.

Smidt, Seymour. Memo to Nicholas A. Giordano regarding SEC Staff Studies of Multiple Trading in Options, February 9, 1987.

Sher, Allan L., Executive Vice President of Merrill Lynch Pierce Fenner & Smith Inc. Letter to Mr. George Fitzsimmons, Secretary of Securities and Exchange Commission, March 15, 1977.

Stoll, Hans R. "Comment on SEC Staff Studies of Multiple Trading of Options." February 5, 1987.

Swamy, P.A.V.B. and George S. Tavlas. "Random Coefficient Models: Theory and Applications," *Journal of Economic Surveys*, Vol. 9, No. 2, pp. 165-196.

Tully, Daniel P., President and Chief Operating Officer Letter to Johnathan G. Katz, Secretary of Securities and Exchange Commission, September 10, 1987.

Wilson, Neil. "Amex adapts OM system." *Futures & Options World*, October 1996, p. 41.