12-2006

The Competitive Effects of Multiple Exchange Listed Options on the US Options Market: A Look at Market Share

Jason Kunkel
Clemson University, jkunkel@clemson.edu

THE COMPETITIVE EFFECTS OF MULTIPLE EXCHANGE LISTED OPTIONS ON THE US OPTIONS MARKET: A LOOK AT MARKET SHARE

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts
Economics

---

by
Jason Timothy Kunkel
December 2006

Accepted by:
Michael McCormick, Committee Chair
Robert Tollison
Robert McCormick

ABSTRACT

In an attempt to foster competition between financial exchanges, the Securities and Exchange Commission developed the National Market System Plan. With the exchanges competing for market share, there is potential for the loss of property rights of price quotes developed by the dominant exchange. The smaller exchanges will free ride on the dominant exchange's price quotes and "cream skim" the less risky trades. This research develops a model of CBOE (the dominant options exchange) market share to show evidence of "cream skimming." The variables in the model of market share give insight into the risk and profitability of the option contract and show that the smaller markets gain market share in less risky higher profit options. This result supports the hypothesis of "cream skimming."

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Since the termination of the allocation plan in 1989, an exchange has been free to list a qualified company's option regardless of whether or not the option has previously been listed on another exchange. This practice has been allowed and sometimes forced by the Securities and Exchange Commission (SEC) to create a National Market System that fosters competition among the financial exchanges and creates trade executions at the best price available.[1] However, in the SEC's quest to develop a National Market System, the problem of protecting some of a financial exchange's most valuable property arises. The majority of a financial exchange's assets like price quotes, bids and offers, and trade volume are intellectual property and cannot easily be guarded.[2] If an exchange cannot effectively capture the profits from creating the price quotes, they will not have incentive to create a market for options or any other financial product for that matter. The purpose of this paper is to investigate how the market has developed since the inception of multiple listed options and to create a model that uncovers evidence of "cream skimming" in the options market.

Mulherin, Netter, and Overdahl (1991) present a theory of exchanges, arguing that the main function of financial exchanges is establishing property rights to price quotes. The authors give an in depth analysis and history of the litigation related to property rights of price quotes citing an significant case entitled *Board of Trade of the City of*

---

[1] See Securities and Exchange Act, Section 11A

[2] See Mahoney, Paul. (1997) "The Exchange as Regulator." *Virginia Law Review*. Vol. 83. P1453.

Chicago v. Christie Grain and Stock Company.[3] This case was an important victory for the exchanges because the exchanges were given exclusive rights to their price quotes. The authors explain that the National Market System offsets this decision by negating the property rights of price quotes. The authors also devote a portion of their research to the option market in which they argue that multiple exchange listed options counteract property rights in price quotes by making options listing a common pool, and this absence of property rights hinders contracting between exchanges. Property rights of price quotes are a necessity, because they lead to technological and financial innovation by giving the exchanges sole rights to the profits generated by their innovation.

There have been three major developments in the options market which create a system that negates property rights to price quotes while still inducing exchanges to trade options and create innovative products. The options market utilizes a single venue known as the Options Clearing Corporation for clearing contracts, employs the Options Price Reporting Authority Plan creating a single distributor of price quotes, and uses the Intermarket Linkage Plan guaranteeing the best price for customers. These three developments are discussed in greater detail in the background of the options market.

Previous studies on the effects of multiple listed options look in particular at bid ask spreads. Neal (1987) and Mayhew (2002) show that options listed on multiple exchanges have narrower bid ask spreads then options listed on a single exchange. This smaller bid ask spread leads to an increase in investor well being by allowing them to pay a competitively induced lower prices.

With the customers in the option market benefiting from lower prices, it additionally necessary to look at the affect of multiple exchange listed options on the

[3] 198 U.S. 236 (1905)

supply side of option markets. A potential negative consequence that can occur from listing options on multiple exchanges is known as "cream skimming." With cream skimming, the dominant more liquid exchange in a security will take on the responsibility of price discovery, and the smaller exchanges then free ride on these prices and "skim" the lower risk trades from the main market. These smaller markets will realize profits from trading these products without incurring the costs and risks associated with price discovery. Battalio (1997), Easley, Kiefer, and Ohara (1996), and Amihud and Mendelson (2004) look at this phenomenon in the stock market with the New York Stock Exchange (NYSE) as the dominant market.

With strong evidence of "cream skimming" occurring in the stock market and the market structure of the options market, evidence of "cream skimming" is expected in the US options market. This paper presents empirical evidence using the market share of the Chicago Board Options Exchange (CBOE) affiliated with the Options Pricing Reporting Authority to support this claim. The CBOE is considered the dominant exchange for the listing of equity options in this research, because year after year the CBOE tends to capture the majority of the trades that occur on the options market claiming over 30% of the market share of all option products consistently. The CBOE was also the first organized exchange to list option products in 1973.

Section II of this research gives some historical context of the options market concentrating on the events leading to multiple exchange listed options and the OPRA and Intermarket Linkage Plan. A brief overview of the current market structure of the options market is also presented. Section III discusses previous literature on multiple exchange listed securities and "cream skimming." In Section IV, a model of CBOE

market share is developed for the analysis of multiple exchange listed options. Section V presents the data used to test the model. Section VI presents the regression results with a corresponding analysis and followed by a conclusion in Section VII.

OPTION MARKET BACKGROUND

From 1973 to 1976 the CBOE, American Stock Exchange (AMEX), Philadelphia Stock Exchange (PHLX), and the Pacific Stock Exchange (PCX) were created and began trading call options on stocks. From the inception of the options market the options exchanges were forced to clear all contracts through a common venue known as The Options Clearing Corporation (OCC). This requirement would lay the framework that would serve as a catalyst to competition between exchanges for the same options contract. A common clearing corporation for all exchanges makes identical options contracts traded on different exchanges interchangeable (Royal, 2000). This means that an investor can purchase a particular contract on one exchange and then sell that same contract on another exchange. In the beginning, however, options were only listed on one exchange. This would be true until February 1976 when the CBOE began to list options already listed by the PHLX.

In July of 1977, the SEC asked the options exchanges to take part in a "voluntary" moratorium on expansion until they could administer a thorough review of the effects of multiple exchange listed options. At this time there were 22 options that were listed on multiple exchanges, and the SEC had growing concerns that these options would lead to price discrepancies or "trade-throughs"[4] between the options exchanges. Following the market review, the SEC released the Options Study Report on February 15, 1979 addressing their concerns and asked the exchanges to submit a plan to remedy this

[4] A trade through is a trade that takes place at a particular price for an options contract that is inferior to the best price quoted for that particular option at the same point in time.

problem. Shortly after the Options Study Report was released, the exchanges submitted the "allocation plan," and the moratorium was lifted in March of 1980.

Under the allocation plan, an option could only be listed on one of the option exchanges and the controlling exchange could not transfer this right to any other exchange[5]. This plan was carried out using a lottery system created by the SEC, which would distribute exclusive rights to trade all new options to a single exchange. The exchanges were required to tell the SEC which options they wished to list, and the lottery would allocate the new options. The unexpected effect of this plan was an alleged draft between the exchanges. From time to time, certain members from each exchange would meet on conference calls and take turns choosing from the companies that had applied to be listed on an options exchange.

In addition to the submission of the allocation plan, the exchanges also proposed the Options Price Reporting Authority (OPRA) Plan. The OPRA Plan's purpose was to consolidate all options market information and distribute it to all of the exchanges. The plan would create a transparent and fair market, by governing services provided by venders (which included the distribution of last sale reports and price quotes) and disallowing any reporting discrimination based on the market supplying the quote.[6] On March 18, 1981, the SEC approved the OPRA Plan as a national market system plan. This allowed the exchanges to work together in planning, operating, and regulating the options market.

[5] An interesting side note of the allocation plan was that it only applied to equity options. The SEC felt that a competitive structure would best suit non-equity options and allowed multiple listings of treasury and foreign securities in October 1982, broad-based stock indexes in November 1982, narrow based indexes in August 1983, and OTC equities in May 1985.

[6] See OPRA Plan, Section VII paragraphs (b) (ii) and (iii)

The allocation plan would remain in effect until June 5, 1989 when the SEC canceled the plan by adopting Rule 19c-5[7], disallowing for all options exchanges to have any "rule, stated policy, practice, or interpretation that precludes or conditions the listing of any stock option class listed on another exchange." The SEC felt that the infrastructure resulting from the OPRA Plan that collected and distributed information to all exchanges was ample to allow for multiple exchange listed options. They felt it was necessary to apply the Display Rule[8]. The Display Rule requires the distribution of last sales reports and quotations of a certain security from every exchange trading the security and any National Association of Securities Dealer (NASD) that is acting as a market maker. The SEC understood that this rule would be sufficient to maintain competitive and transparent markets and therefore began to allow the multiple exchange listing of new options on January 20, 1990.

The allowance of existing options to be listed on multiple exchanges began gradually in 1992 and was completed in 1994. This however did not have the effect that the SEC had hoped for. None of the options that had been allocated to one exchange under the lottery system had been added to any other exchange, and only 40 percent of all options were traded on multiple exchanges. This would be the way the market would look until the end of the decade when two occurrences transpired.

The first occurrence was in 1998 when a group of large security firms announced that they were going to create the International Securities Exchange (ISE), which would list the most active options on all the other exchanges. The second involved antitrust investigation by the Department of Justice. In 1999, the Department of Justice began to

[7] See Exchange Act, 17 CFR 240.19c-5
[8] See Exchange Act Rule 11Ac1-2, 17 CFR 240.11Ac1-2

investigate apparent anticompetitive practices of the exchanges. The DOJ's antitrust investigation looked at reasons the exchanges were not listing options that had already been listed on another market, and the investigation looked at the exchanges use of the "Joint-Exchange Options Plan" which they had created. The "Joint-Exchange Options Plan" mandated that an exchange had to publicize its plans to list an option 24 hours prior to listing. All the other exchanges had to list the option on the same day as the original exchange or wait eight additional business days to list that option.

The SEC would finally see their wishes fulfilled in August 1999 when the exchanges, not wanting to go to trial and realizing the competition that the ISE would bring to the market, ended the "Joint-Exchange Options Plan" and began to list options from other exchanges. The first occurrence of this was when the AMEX and CBOE began to list options on Dell Computers, which had previously been listed on the PHLX. In response to this, the PHLX began listing many of the most actively traded options on the CBOE and the AMEX. The competition between exchanges would escalate through the beginning of 2000 with all four exchanges continuously adding options that were already listed on other exchanges, and would continue to increase when the ISE began trading options. With a common clearinghouse creating interchangeable options contracts between exchanges, market share could easily shift from one exchange to another when a new exchange listed an option. The CBOE's market share in Dell computers went from zero in July 1999 to 58% in October of 1999 (Royal, 2000).

With the now rampant listing of options on multiple exchanges, the specialist firms on each exchange began to pay for order flow. In this arrangement, specialists and market makers pay a specific amount per contract to the broker/dealers giving them

incentive to route their customer orders to a particular exchange. With the advent of exchanges paying for order flow, the AMEX and PHLX were able to steal some of the CBOE's market share. From the period of October 1999 to July 2000 the AMEX's market share grew from 26% to 29.5%, the PHLX's market share grew from 7.8% to 10.2%, while the CBOE's market share fell from 51.3% to 44.9% (Royal 2000). In response to this loss the CBOE filed a plan with the SEC in July of 2000 which would allow their market makers and specialists to pay for order flow. The SEC conducted a study on payment for order flow and concluded that it was necessary to monitor this practice.

On October 19, 1999 the SEC issued an order to the exchanges directing them to create a plan that would link the markets in receiving orders for option contracts. In response the AMEX, CBOE, ISE submitted a plan together and the PHLX and PCX submitted separated plans. The AMEX/CBOE/ISE plan or Intermarket Option Linkage Plan was chosen which linked the exchanges for either customer orders where the market maker decides not to match the best price, principal orders of eligible market makers, or orders intended to satisfy trade-throughs. In the event that an order is received by an exchange when another exchange has a better quoted price, the market maker of the receiving exchange can either match the better price filling the order itself, or the market maker can use the linkage system to send the order to the exchange with the lower price. If the order is sent to the other exchange, the receiving exchange must execute the order at the price stated as long as the price has not changed. The market maker at the receiving exchange has 15 seconds to notify the sending exchange whether or not the order was filled. If the first exchange does not receive this information in 15 seconds, it

then has the right to fill the order itself. This plan also requires a member of an exchange that follows through with a trade of an inferior price to be liable to the market maker who complains of a "trade-through."

Battalio, Hatch, and Jennings (2004) investigate the effectiveness of the Intermarket Linkage Plan by looking at similar quotes before and after the implementation of the plan and compare the average time of crossed quotes[9] in a trading day and the percent of trades executed as a trade through. They find that before the plan the average cross quote lasts 93 seconds of the day and an average of 21% of the quotes are executed during a cross. After the plan, the average cross quotes only last 14 seconds and an average of 30% of the trades execute during a cross. In addition, they find that the average trade through rate falls from 4.06% in June 2000 to 1.34% in January 2002

Currently there are six option exchanges that are members of the Options Pricing Reporting Authority (OPRA) and are connected through the Intermarket Option Linkage Plan. The AMEX, CBOE, ISE, PCX, PHLX, and the BOX all currently trade both equity and index options with the CBOE and ISE being the largest liquidity providers with each capturing around 30% of the market share of the entire US options market. All six exchanges are required to report all their real-time price information to the OPRA which in turn will sell this consolidated market information to its vendors and subscribers for a nominal fee. The CBOE has recently implemented the Hybrid trading system, in which the open outcry competitive market making system has been integrated with screen based trading to increase efficiency.

[9] A crossed quote occurs when the National Best Bid price exceeds the National Best Offer price.

PREVIOUS RESEARCH ON MULTIPLE LISTED SECURITIES

Garbade and Silber (1977) present one of the earliest studies of multiple exchange listed securities which looks at the relationship between dominant and satellite markets. This relationship arises when multiple markets list a security, with one market gaining an advantage in quoting prices, because they receive a majority of the order flow of the security. This large volume will allow for a greater amount of information to be included in their price quotes and thus the exchange will gain a comparative advantage over the markets with less volume. In order for the smaller markets to ensure investors that their quotes are based on all available information, they must adjust their prices to be in line with the dominant market's prices. Therefore, the dominant market's price quotes should lead the satellite exchanges price quotes. Garbade and Silber show that the New York Stock Exchange (NYSE) is a dominant market and its price quotes did in fact lead the smaller Pacific Stock Exchange (PSE) and Midwest Stock Exchange (MSE) quotes.

Hasbrouk (1995) finds a similar result looking at what each market that lists a particular security contributes to the price discovery process. A market's contribution to price discovery is defined as its information share as the proportion of the efficient price innovation variance that can be attributed to that market. Hasbrouk uses a cointegrated microstructure model to measure price discovery of equities and shows that the median information share of 92.7% of the price discovery occurs on the NYSE. Bessembinder (2003) additionally shows that trades that take place off the NYSE floor are more likely to be for larger more active stocks, smaller in trade size, and contain less information.

Neal (1987) looks at the effects of the allocation plan on an option's bid ask spread. At the time of Neal's study, a majority of the stocks' options were still held exclusively by an exchange under the allocation plan. However, Over-the-Counter and a select few of options that were grandfathered in were listed on multiple exchanges. Neal shows by developing a model of bid-ask spreads that options that are eligible for multiple listing have a considerably lower bid-ask spread then options listed under the allocation plan. Neal gave support for the theory of "contestable markets" and shows the effect of multiple listing is evident for a considerable amount of time after the introduction of a competitor and is evident even if a market has a majority of the market share. Mayhew (2002) also looked at the effect of competition on option bid ask spreads. Mayhew, in line with Neal, shows that options listed on multiples exchanges have narrower bid ask spreads then the options listed on a single exchange, but this discrepancy decreases as volume increases. In addition, Mayhew shows that markets with a Designated Primary Marketmaker (DPM) structure are somewhat better for low volume options, and the open outcry system is better for high volume options.

There is another line of research that looks for evidence of "cream skimming" when multiple markets list a particular security. Easley, Kiefer, and Ohara (1996) examine the role of smaller exchanges purchasing order flow to "cream skim" the smaller and potentially less information based trades. These smaller exchanges can spark order flow purchase agreements to steal the liquidity trades where they match the market price, give a discount to the brokers and still make a large profit. To test for this the authors estimate the variation of information content of trades sent to each market. The authors

show that the smaller Cincinnati Stock Exchange is less likely to have information based trades then the much larger NYSE.

Battalio (1997) also look for evidence of "cream skimming" by examining NYSE securities bid-ask spreads before and after a third market broker-dealer Madoff enters the market. Battalio shows that the bid ask spread decreases after the third market broker-dealer market enters the market. In addition, it is shown that the transaction price and midpoint of the bid ask spread do not increase. The author contends that these results together show that allowing broker-dealers to selectively execute trades may not be economically significant.

Amihud and Mendelson (2004) test whether or not the competition between the NYSE and regional and over-the-counter markets could be explained more by perfect competition or by the "cream skimming" hypothesis. This study looks at the affects of a market that is more favorable to "cream skimming" has on the NYSE market share. Under this theory the dominant exchange will lose market share to the "cream skimmers" when the market is stable and gain market share when the market is more volatile. In order to test this, Amihud and Mendelson gather a cross-sectional data-set for a set of securities that were listed on NYSE as well as other regional exchanges. They develop a model of NYSE market share in particular securities as a function of the total volume traded of that security, the price of the security, and the volatility of the securities returns. Their results showed that NYSE market share increased in stock price and volatility and decreased in the stock's trading volume. Showing that the market share increased in stock price is consistent with the "cream skimming" hypothesis, because the profit potential of a market maker has been shown to be negatively correlated with the stock

price and trades with higher profit potential will take place on the smaller exchanges. The positive correlation between market share and volatility is also consistent with the "cream-skimming" hypothesis because the smaller exchanges will prefer to trade the less risky stocks and send the more risky stocks to the dominant exchange. The negative correlation between volume and market share is both consistent with perfect competition and "cream skimming." The model developed in their analysis is the basis for the model created to test for "cream skimming" in the options market.

A MODEL OF CBOE MARKET SHARE

To develop a model of the CBOE's market share in an underlying security's option activity, it is important to understand and capture the costs and risks incurred by the market maker. A market maker is willing to supply liquidity services and execute trades to cushion imbalances of the inflow of buy and sell orders of put and call contracts. A market makers ability or inclination to assume the risks associated with trading options in a particular security will be apparent in their bid and ask prices. A market maker's bid and ask prices will determine the level of trading activity received. The costs of making markets can be separated into several components which can be controlled for in this model. Several of these variables will also give evidence of "cream skimming" in the options market. A linear model of CBOE market share as a function of volume, price, and volatility is developed with intentions of finding evidence of "cream skimming" in the options market. The CBOE's market share is the percent of market volume that is transacted on the CBOE's floor as calculated by taking the number of option contracts of an underlying security traded on the CBOE and dividing it by the total number of option contracts of the same underlying security traded on all options exchanges.

A variable that previous research shows to be necessary in a model of CBOE market share is the total volume of contracts traded in the particular option class. Tinic (1972) explains that total contract volume will control the amount of inventories a market maker must hold. In general the higher the level of trading in an option's contract, the more likely it is that the buying and selling of option's contracts will balance out. The trades of a more active market will tend to self-equate and the participation and inventory

held in terms of market making will be reduced. With low-volume options, the market maker is required to take a more active role in the option class's transactions and on average is required to hold larger positions for a longer period of time. As total volume increases, it is expected that the risk a market maker faces decreases.

This reduction in risk will be evident in the bid-ask spread of the option class. As Demsetz (1968) explains, the bid ask spread is the premium paid for immediate transactions. As trading volume increases the market maker's exposure to the option is reduced, resulting in a smaller bid ask spread. Also, as Neal (1987) describes, total volume is positively related to the number of limit orders, which automatically enter the market maker's book and take the place of a market maker's commitment. Therefore, as total volume increases, the market maker's costs are lower as reflected in the bid-ask spread. Neal also creates a model to show a non linear relationship between total volume and the bid-ask spread. The model predicts that increases in trading volume will drive the bid-ask spread to the minimum spread at a decreasing rate. Once the spread is at a minimum, evidence of the competitive effects of trading volume will be zero. The results in Mayhew (2002) give additional support to this claim.

In relation to the "cream skimming" hypothesis, Amihud and Mendelson (2004) predict a negative correlation between the total volume and the dominant market's share in trades handled. Amihud and Mendelson explain that this result has both perfect competition and "cream skimming" implications. A model of competition predicts that higher volume will lead to greater competition (which is somewhat controlled for in this model with the inclusion of the number of exchanges trading the option), where the "cream skimming" hypothesis suggests that for a given level of fixed costs, The amount

of surplus the competing market makers can capture increases with trading volume and thus a greater return on the fixed costs.

An explanatory variable to capture this predicted effect is the total volume of contracts traded in a particular security. This is calculated by summing the volumes of puts and call contracts traded in the entire options market. This value is then logged to better fit the non-linear relationship between total volume and the bid ask spread of the market maker. A negative sign is predicted on the coefficient of the logged values of total volume by the "cream skimming" hypothesis.

Another variable which previous research hypothesizes to be important in a model of CBOE market share is option price. As Demsetz predicts, the bid-ask spread per option contract will tend to increase in proportion to an increase in the price per contract to equalize the cost of transacting per dollar exchanged. If the spread did not change relative to option price, persons submitting limit orders will find it profitable to narrow spreads on those options where spread per dollar exchanged is larger. Therefore, maintaining a proportionate relationship between spread and price will result in a decrease in the commission costs per dollar exchanged as option price increases.

Both Neal and Mayhew find results that are consistent with this hypothesis. In addition, these studies show that a non-linear relationship exists with option price and bid-ask spread similar to the explanation presented for total trading volume only with an opposite relationship. As the price of an option decreases, the spread will decrease to the minimum spread at a decreasing rate. Once the bid-ask spread reaches the minimum, evidence of the competitive effects of option price can no longer be discerned.

In line with Amihud and Mendelson, the relationship between option price and CBOE market share will be positive if evidence of "cream skimming" exists. This can be concluded because, lower-priced options have a greater potential return per dollar exchanged for market makers then higher priced options, and competing markets will attempt to steal the lower priced options with higher profit potential. Therefore a positive relationship should exist between the logged values of option price and CBOE market share.

To develop an explanatory variable that will show the effects of the price or premium of an option contract, a common price effecting characteristic among option series is necessary. Although a price change in the underlying security has different effects on the price of a put and call option, there are five common factors influencing the premium on both call and put contracts. The premium is determined by the strike price of the option contract, the time until expiration of the option contract, dividends paid on the underlying stock, the risk free interest rate, and the volatility of the underlying security[10]. The risk free interest rate is not necessary in this model due to the cross-sectional nature of the dataset, and dividends paid on the underlying stock have minimal effects on the premium. Also, in the context of this model, the time until expiration of the contract and the strike price of the contract cannot be calculated due to data separated based on option class[11] rather than option series.[12] This implies that an observation in the dataset can potentially consist of contracts having different strike prices and times until expiration. This leaves volatility as the only common determinant in put and call

[10] Black and Scholes (1973) are credited with developing the model for which all option contracts are priced and gives greater detail of the contract characteristics effects on price.
[11] An option class refers to a same type, either call or put, traded on the same underlying security.
[12] An option series refers to option contracts on the same class having the same strike price and expiration month

premiums to serve as a proxy for option price. Volatility serves as a good proxy for price, because it is the main determinant in option price and is positively correlated with the price of an option. An approximation of historical volatility for the prior year serves as a price proxy in this model. The volatility for each month during the year is calculated by taking the variance of the returns of the underlying stock. The average of the twelve months was then calculated giving an average historical volatility for the previous year. The logged values of this price proxy were taken to better capture the non-linear relationship between price and the bid ask spread.

A third variable which is necessary in developing a model of CBOE market share is the volatility of the option returns. The main source of risk a market maker will be susceptible to is a potential change in the volatility of underlying stock price not already priced into the option premium that will lead to an exercising of the contract while the market maker still holds the position. As Tinic states, market makers are more likely to experience losses providing liquidity for more volatile securities. Since it is safe to assume that market maker's are risk averse, an increase in the volatility of option returns increases the bid ask spread as compensation for an increase in their exposure to risk. The "cream-skimming" hypothesis will predict that as the volatility of option returns increases the market share of CBOE should increase as well. This relationship occurs because the smaller markets will be less willing to take on additional risk and will "cream-skim" the less volatile trades.

As explained in Jameson and Wilhelm (1992), variation in the stock price causes variation in the magnitude of the option's contribution to the market maker's aggregate risk exposure to the underlying stock. This is true because an option's return volatility is

the product of the underlying stock's return volatility and the option's price elasticity with respect to the underlying stock price. Therefore, variation in the underlying stock price induces variation in an option's return volatility. With a majority of the underlying stock's volatility already priced into the premium, it is necessary to estimate a deviation above or below what is captured in the option premium. In this model, the number of standard deviations the realized volatility in the current month falls from the average historical volatility is calculated. This variable shows how far the realized volatility in the current month deviates from the average historic volatility calculated over the past twelve months. A positive value in this variable shows that the variation in the underlying stock price is above the realized variation and will thus increase the variation in the option's return. A negative value shows that the stocks variation is more tranquil then the average volatility over the last twelve months. A positive sign is expected on the variable for option return volatility.

In addition to the three key variables in the model, a variable has been included to control for the number of competitors in a security's option classes. When a new exchange begins to list an option already listed by the CBOE, market share will be transferred from the CBOE to the new competitor. The low cost of entry and exit of the market for a particular option class and a common clearing corporation makes the effect of a new competitor substantially large. The value of this variable is the number of exchanges trading options on the particular security including the CBOE and a negative coefficient is expected on this variable.

To control for the size and general interest in the underlying stock, the market capitalization of the underlying firm has been included in the model. To control for the

how the underlying stock moves in relationship to the market as a whole, the underlying stock's beta is included as a variable in the model. Two dummy variables have been included to control for any relationship between the stock market the underlying stock trades on and any of the option exchanges. The dummy variable of AMEX will take on the value of one if the stock is traded on the American Stock Exchange, and the dummy variable of NYSE will take on a value of one if the underlying stock is traded on the New York Stock Exchange. The NASDAQ is the exchange represented by both dummy variables taking on a value of zero.

An ordinary least squares regression model will be used to investigate the affects of the variables discussed previously and will take the following functional form:

$$\mathbf{CBOEShr = \beta_0 + \beta_1 ln(TotVolume) + \beta_2 ln(HisVolatility) + \beta_3 ln(DevVolatility) + \beta_4 NumExch + \beta_5 MktCap + \beta_6 Beta + \delta_1 AMEX + \delta_2 NYSE + u_i}$$

Two additional models have been included which use the CBOE market share in call options and the CBOE market share in put options. This investigates differences in the explanatory variables effect on put and call option contracts. The same signs are expected on all the variables discussed earlier in this section. The only difference in the variables used in these two models, is the use of the total number of calls for total volume in the model of the CBOE market share in calls and the total number of puts used for total volume in the model of the CBOE market share in puts.

DATA

The dataset collected to test this model is cross-sectional and consists of 1173 observations. Each observation is based on one underlying stock. The current month used in this model is January 2005 consists of 20 trading days. All option volume data is based on January 2005, as is the actual volatility which is used in the deviation of volatility calculation. Volume data used in this research represents one side of the contract. Therefore the actual number of contracts that take place are half of the volume calculation. Historical volatility is calculated using volatility values from 2004. All volume related data is collected from the Options Clearing Corporation's website.[13] The units for the volume data is in 10,000 contract sides traded. The volatility data is taken from the CBOE website.[14] The market capitalization and beta data is taken from the New York University website and is calculated by multiplying the total number of shares outstanding by the price of the companies stock.[15] Market capitalization is in billions of dollars and is the calculated at the end of 2004. The information regarding the stock exchange the companies stocks are listed on is taken from the Yahoo finance website. Below is Table 1 that gives summary statistics for each variable included in the three models.

[13] Data can be found on http://www.theocc.com/market/volume/volbyproduct_form.jsp
[14] Data can be found on http://www.cboe.com/data/HistoricalVolatility.aspx
[15] Data can be found on http://pages.stern.nyu.edu/~adamodar/pc/archives/compfirm04.xls

Table I: Summary Statistics of Data

Variable	Obs.	Mean	Std. Dev.	Min	Max
CBOEshr	1173	37.375	20.609	3.664	97.557
CBOEcallshr	1173	38.319	21.371	0	100
CBOEputshr	1173	36.515	22.859	0	100
Ln(TotVolume)	1173	1.095	1.816	-3.590	6.040
Ln(Calls)	1173	9.788	1.842	2.079	14.850
Ln(Puts)	1173	9.207	1.978	3.401	14.257
Ln(HisVolatility)	1173	3.489	.421	2.384	4.856
DevVolatility	1173	-.189	1.521	-5.672	17.360
Numexch	1173	4.557	1.173	2	6
MktCap	1173	.127	.318	.000	3.879
Beta	1173	1.189	.409	0	2.95
AMEX	1173	.009	.092	0	1
NYSE	1173	.563	.496	0	1

Underlying securities that are not listed on the CBOE exchange or are only listed on the CBOE exchange have been dropped. These data points have no element of competition and are not valuable in this model. By including market capitalization in the regression 97 observations are lost. There are also six observations that have been dropped that do not have volatility information. In addition, underlying securities in which there are less then four months in 2004 with volatility information have been dropped. This is done to have a greater number of observations in the standard deviation and average historical volatility calculation and thus more reliable results. The average market share of the CBOE in this dataset is 37% which gives a good representation of the CBOE's control of the options market. A problem of multicollinearity exists between market capitalization and total volume which is expected. These variables are highly positively correlated but both are beneficial in developing a model of CBOE market share.

To better show the effect of competition on the variables used in the regression, a table of means is included which separates the data by the number of exchanges the

securities' option is listed on. The data is partitioned into options only listed on the CBOE, options listed on the CBOE and one other exchange, and options listed on three or more exchanges (including the CBOE). Table 2 gives the means and standard errors (in parenthesis below each mean).

Table II: Table of Means

Variable	One Exchange	Two Exchanges	Three or More Exchanges
CBOEshr	100 (0)	82.580 (19.479)	26.490 (20.132)
CBOEcallshr	100 (0)	82.202 (20.373)	37.075 20.252
CBOEputshr	100 (0)	82.456 (22.816)	35.440 21.788
Ln(TotVolume)	7.248 (1.854)	9.490 (1.940)	10.932 (1.644)
Ln(Calls)	6.787 (1.801)	7.178 (1.465)	9.838 (1.787)
Ln(Puts)	5.847 (2.185)	6.133 (1.758)	9.249 (1.924)
Ln(HisVolatility)	3.392 (.526)	3.579 (.483)	3.497 (.424)
DevVolatility	-.009 (1.210)	-.166 (1.577)	-.195 (1.338)
MktCap	.215 (.589)	.115 (.145)	1.243 (3.131)
Beta	.942 (.523)	.989 (.467)	1.174 (.419)
AMEX	0 (0)	.022 (.146)	.007 (.086)
NYSE	.459 (.505)	.376 (.487)	.565 (.496)
Observations	37	93	1222

This table shows how the variables change as more competitors enter the option trading market. As expected, the CBOE's market share decreases as the number of competitors increases. When there is only one competitor of the CBOE, the CBOE controls an average of more then 80% of the order flow. This statistic shows the dominance of the

CBOE in trading options. Total volume is also higher when there are more competitors, showing that competitors will enter the market when there is a greater potential for profit with more trading activity. The deviation in volatility, representing the variability in options returns, decreases as the number of exchanges increases showing that a smaller number of exchanges will want to offer options that tend to have a higher variability in option returns. The size of the underlying company tends to be much larger for options listed on more than two exchanges showing that a greater number of exchanges will want to list the options that have a higher level of interest. The other variables do not have any noticeable relationship between the number exchanges and their average value.

RESULTS AND ANALYSIS

Table 3 gives the regression results of the model of CBOE market share. Column one gives the regression results for the CBOE market share for all contracts, column two gives the regression results of the CBOE market share in call contracts, and column three gives the results of the CBOE market share in put contracts. The logged value of total volume is represented by the total number of call contracts in the CBOE call share and the total number of put contracts in the CBOE put share. The regression is corrected for heteroskedasticity using robust standard errors. Units represent percentage points of CBOE market share.

Table III: Regression Results

Dependent Variables	**CBOEshr**	**CBOEcallshr**	**CBOEputshr**
Ln(TotVolume)	-1.070** (.457)	-1.204*** (.465)	-1.336** (.580)
Ln(HisVolatility)	10.078*** (1.439)	9.479*** (1.577)	10.954*** (1.673)
DevVolatility	.724** (.302)	.637** (.299)	.786* (.431)
Numexch	-10.637*** (.696)	-10.621*** (.709)	-10.384*** (.855)
MktCap	5.504*** (1.189)	5.523*** (.709)	6.216*** (1.384)
Beta	-.512 (1.215)	-.940 (1.291)	.048 (1.488)
AMEX	-1.338 (4.531)	-.624 (4.625)	-2.908 (5.024)
NYSE	1.528 (1.012)	.539 (1.108)	2.197* (1.200)
Intercept	51.052*** (6.267)	65.669*** (6.223)	56.011*** (6.672)
Observations **R-squared**	1173 .4954	1173 .4736	1173 .4176
***, **, and * represent significance at the 1%, 5%, and 10% levels respectively			

The results above show that the CBOE market share in total, in calls, and in puts is negatively correlated with the logged values of total volume. A regression was also run in which the volume values were not logged and the significance of the total volume coefficient decreased giving further evidence of a non-linear relationship as predicted in Neal (1987) and Mayhew (2002). The results show that as trading volume increases in an underlying security's option, a fraction of the CBOE's market share will be diverted to the other exchanges trading the option. This result is consistent with what is predicted in a perfect competition model and the "cream skimming" hypothesis.

The results also show a positive relationship between the logged values of historical volatility used as a proxy for price and the CBOE market share in total, in calls, and in puts. As with total volume, the regression was also run with the average historical volatility values not logged and the significance level decreased giving further empirical support to the non-linear relationship between price and the bid ask spread. The results show that the CBOE will have a higher market share in securities whose option classes have a higher price. All three regressions show a significance level of 1% even without controlling for other factors affecting the price of the option such as time to maturity and strike price. This shows the importance of volatility in the determining the price of all of an underlying securities' option contracts. This result is consistent with the "cream skimming" hypothesis' prediction that options with lower priced and higher profitability will be diverted from the dominant market.

The relationship between the CBOE market share and the deviation in realized volatility is positive and significant in all three regressions. These results show that underlying securities with more variability in returns then average volatility predicts will

tend to be traded on the CBOE. The CBOE's competitors will choose not to trade these securities and divert them to the CBOE to handle the greater amount of risk. This result is consistent with the "cream skimming" hypothesis which predicts that the options contracts with lower variability or risk in returns will be diverted from the CBOE.

The coefficient on firm size is highly significant and positive showing that larger firms' options will tend to trade on the CBOE. There is also no significant results on AMEX and only one significant result on NYSE showing that there is no relationship between which exchange trades the stock and which option exchange tends to dominate trading in that security's options.

The model presented explains 50%, 47%, and 42% of CBOE total market share, CBOE call share, and CBOE put share respectfully. There is also evidence of omitted variable bias which as explained earlier cannot be controlled for.

CONCLUSION

The model presented here, gives empirical support of "cream skimming" in the options markets which has already been shown to exist in the stock markets. The SEC's attempt to create a National Market System, giving customers the best possible price, has created a market in which the exchange doing a majority of the price discovery is under the attack from the smaller exchanges for the lower risk order flow.

The CBOE market share having a negative correlation with trading volume and a positive correlation with the price and variation in option returns give further empirical evidence of a loss in property rights to the option price quotes. Allowing multiple exchanges to list options on the same underlying security may be beneficial for the customer in terms of price, but it is also detrimental to the exchange doing a majority of the price discovery.

The effect of cream skimming in the options market, however, has not caused the CBOE to discontinue the development of accurate price quotes. The Intermarket Linkage Plan appears to force exchanges to reduce their concern in protecting property rights in favor of competition based on efficient market operations. It has been shown with the careful construction of the options market that exchanges will still have incentive to create markets without having exclusive rights to produce pricing information. A loss in the ability to protect intellectual property and capture its profits is predicted to negate the incentive to create and improve upon this property. In the options market, however, the oss in protection of intellectual property has forced the exchanges to innovate and become more efficient in price quote determination in order to survive.

WORKS CITED

Amihud, Y. and Mendelson, H. (2004) "Intermarket Competition and Stock Returns: Evidence from NYSE-Listed Stocks." on http://www.nyse.com/marketinfo/researchpaper/ResearchPapers.html

Battalio, Robert (1997) "Third Market Broker-Dealers: Cost Competitors or Cream Skimmers?" *The Journal of Finance* Vol. 52 P341.

Battalio, R., Hatch, B., and Jennings, R. (2004) "Toward a National Market System for U.S. Exchange-listed Equity Options." *The Journal of Finance*. Vol 59. P933.

Bessembinder, H. (2003) "Selection Biases and Cross Market Trading Cost Comparisons." on http://home.business.utah.edu/finhb/Current% 20Research/Dash5.hbessembinder.may03.pdf

Black, F. and Scholes, M. (1973) "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*. Vol 81. P637.

Demsetz, Harold. (1968) "The Cost of Transacting." *Quarterly Journal of Economics* Vol 82. P33.

Easley, D., Kiefer, N., and O'Hara M. (1996) "Cream-Skimming or Profit Sharing? The Curious Role of Purchased Order Flow." *The Journal of Finance*. Vol 51. P811.

Garbade, K. and Silber, W. (1977) "Dominant and Satellite Markets: A Study of Dually-Traded Securities." *The Review of Economics and Statistic* P455.

Hasbrouck, Joel. (1995) "One Security, Many Markets: Determining the Contributions to Price Discovery." *The Journal of Finance*. Vol. 50. P1175

Jameson, M. and Wilhelm, W. (1992) "Market Making in the Options Markets and the Costs of Discrete Hedge Rebalancing." *The Journal of Finance*. Vol 47. P765.

Mayhew, Stewart. (2002) "Competition, Market Structure, and Bid-Ask Spreads in Stock Option Markets." *The Journal of Finance*. Vol. 57. P931.

Mulherin, J., Netter, J., and Overdahl, J. (1991) "Prices are Property: The Organization of Financial Exchanges from a Transaction Cost Perspective." *Journal of Law and Economics.* Vol. 34. P591.

Neal, Robert. (1987) "Potential Competition and Actual Competition in Equity Options." *The Journal of Finance*. Vol. 42. P511.

Royal, Carl A. (2000) "Competition among Exchanges Heats up." *Futures Industry Magazine*. on www.futuresindustry.org/fimagazi-1929.asp?a=653.

Tinic, Seha. (1972) "The Economics of Liquidity Services." *Quarterly Journal of Economics*. Vol 86. P79.