AN ANALYSIS OF COMPETITION IN THE SECURITIES INDUSTRY: THE MARKET FOR DUALLY-LISTED NYSE STOCKS

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ABSTRACT

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Prior empirical research regarding competition within the securities industry established two apparently conflicting results: the presence of statistically and economically significant price differentials based on trade location in an environment that appears to be characterized by effective competition. This paper attempts to reconcile these results. Recent data are used to replicate earlier studies, shorten time frames used in earlier studies and test a local market hypothesis. In addition, this paper uses a liquidity premium measure, as opposed to the spread, as the price of liquidity services and examines the impact of competition across all exchanges, not just the NYSE. The paper concludes with regressions that explain price differentials across exchanges. Evidence of selective market making or cream skimming behavior is found on the part of non-NYSE exchanges. Non-NYSE exchanges tend to offer superior execution when the NYSE is active (in terms of the total number of trades) and in smaller trades. Compared to activity measures, the typical competition measure used in earlier research has relatively weak explanatory power regarding price differentials when time frames are reduced to allow for the shifting competitive position of non-NYSE exchanges.

Dedicated to my Mother and Father, in appreciation of their love, kindness and patience.

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INTRODUCTION

Over the past decade, the securities industry has been the focus of considerable academic research. A predominant issue has been the nature of competitive relationships that exist on and between stock exchanges that trade the same asset. Recent allegations leveled against the Nasdaq demonstrate the timeliness of this issue. The Securities and Exchange Commission (SEC) alleged in a draft complaint (summer 1996) that the NASD failed to force dealers to report promptly stock trades and failed to discipline some dealers from "backing away," or refusing to honor investors' orders for stock at favorable prices.[1] Prior to these allegations, controversy over competitive practices still existed due to the relatively recent practice of payment for order flow (which began in earnest in 1988), particularly by Nasdaq dealers.[2]

These allegations are troublesome given efforts by the securities industry to ensure a high degree of integration between exchanges. Improved technology has been used to reduce information lags and search costs, theoretically allowing exchanges to be "in the same

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[1]"SEC Seeks Settlement With NASD," *The Wall Street Journal*, June 18, 1996, Section C, p. 1. Under the settlement of the draft complaint, the NASD agreed to be censured, but not fined.

[2]The Cincinnati exchange has also come under recent scrutiny to end a practice known as "preferencing." Under the Cincinnati exchange's rules, a broker can also act as a specialist, selling his own shares for a mark-up at very low risk. NYSE supporters contend that the investor loses a one-in-four chance to get a better price on the NYSE when a dealer does business on the Cincinnati.

market" more often. That is, the price (for liquidity services) on one exchange should competitively constrain prices on competing exchanges. The allegations made by the SEC seem to contradict this line of reasoning. Do financial exchanges effectively compete? This is the central question this analysis attempts to address.

CHAPTER 1

AN OVERVIEW OF COMPETITION IN THE SECURITIES INDUSTRY

Frequently, trading in NYSE-listed stocks takes place simultaneously (or within a relatively short period of time) on two different exchanges. Stocks that trade on more than one exchange are known as dually-listed stocks. Possible trade locations include the NYSE, Nasdaq, Boston, Cincinnati, Midwest (Chicago), Pacific and Philadelphia exchanges; the latter five known generally as regional exchanges.[3] [4] All exchanges that trade NYSE-listed stocks are linked by the Intermarket Trading System (ITS), which displays current quotes and recent trade information. The ITS allows traders to route quickly a trade to the dealer offering the best possible price. For 1993, the ITS encompassed more than 2,000 dually-listed NYSE stocks that traded on the regional and Nasdaq exchanges.[5]

A broker trading stock on behalf of the public has a fiduciary responsibility to obtain execution at the best bid or offer (BBO) displayed by the ITS. However, as noted by Cohen et al., the existence of the ITS does not ensure that this fiduciary responsibility is always fulfilled: the "ITS as it currently exists is far from perfectly operating and it is unlikely soon

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[3]Trades in NYSE-listed stocks may also take place on computer-based trading systems such as the Instinet, Posit, Lattice or Arizona stock exchange. These smaller exchanges are not included in the analysis.

[4]Most trading on the regional exchanges (at times more than 95 percent) is in NYSE-listed stocks; the remainder are local stocks. Engel and Hecht (1994), p. 144.

[5]Engel and Hecht (1994), p. 107. Throughout the remainder of this analysis, non-NYSE (including Nasdaq) exchanges are referred to generally as regional exchanges.

to be. Therefore, price priority rules are sometimes violated."[6] In essence, the ITS is simply a quotation display device, not an execution system. A trader that normally deals on the NYSE may see a better regional quote and attempt to secure it but fail to because the trade was "hit" before he or she could secure the trade, because the quote was "stale" (old) or the quote pertained to a smaller trade. If the trader then returns to the NYSE, the market may have turned against him and a worse price will be obtained compared to if he had simply submitted the order to the NYSE. Thus (especially when trade activity is hectic) "traders do ignore seemingly better quotes available elsewhere, and execute orders at their most convenient and reliable market . . . . Clearly this results in violations of price priority.[7]

It is important to note that the fiduciary responsibility of the broker *does not* mean that all exchanges offer the same price. Specialists not offering the BBO are not obligated to trade at these prices. In addition, discounting (trading inside the best bid or ask) is fairly common. Blume and Goldstein (1992) found that 12 to 31 percent of trades in their sample occurred inside the BBO while Petersen and Fialkowski (1993) found price improvement for 35 percent of trades in their sample. Petersen and Fialkowski also found that 19 percent of orders in their sample were sent to an exchange offering inferior quotes.

Previous research used two terms to describe the trading of dually-listed stocks: the fragmentation of order flow and competition between exchanges. Fragmentation occurs any time the same stock trades on two different exchanges. Conceptually, the terms competition and fragmentation may be used interchangeably because they refer to the same phenomenon: the splitting of order flow between two or more exchanges. However, using a more strict

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[6]Cohen et al. (1982), p. 133.

[7]Ibid.

interpretation, these two terms have different implications. Competition refers to the positive aspects arising from the splitting of order flow while fragmentation refers to negative effects.

While earlier research recognized both positive and negative effects associated with the splitting of order flow, competition has implicitly remained the focus. The SEC started this trend two decades ago by implementing a number of rule changes with the stated purpose of fostering competition; negative aspects were largely ignored. A consensus has yet to be reached regarding the net effect of the rule changes. A brief consideration of these changes follows in order to provide some background regarding the controversy over efforts to enhance competition within the securities industry.

A. Attempts to Introduce Competition: Increasing Order Flow Fragmentation

Ever since the U.S. Congress first passed the Security Amendments Act of 1975, the chief objectives of the SEC have been (1) to increase competition in the securities industry and (2) the achievement of a National Market System (NMS). The goal of the NMS was to promote the efficient execution of transactions, encourage fair competition between brokers/dealers and markets and to make readily available information regarding quotes and transactions.[8] Hamilton (1987) noted the effect of linking the exchanges as follows: "The ITS is the cornerstone of the NMS . . . . The survival of so much off-board (non-NYSE) trading is the keystone of the NMS . . . . The NMS has increased competition and, as intended, has pushed the NYSE to improve its performance somewhat in order to prevent the off-board market from capturing greater market share."[9]

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[8]Cohen and Conroy (1990), p. 278.

[9]Hamilton (1987), pp. 1,335 and 1,334.

Rule changes have advanced the SEC's first objective. Originally, due to NYSE Rule 390, NYSE members could not trade as third market (Nasdaq) dealers. That is, NYSE members had to trade shares on the exchange floor. However, Rule 19c-3 (effective July 18, 1980) permitted NYSE members to make off-board trades. This enabled brokers to act as dealers (market makers) by allowing them to match buy and sell orders in-house without sending each order directly to the floor of the exchange.[10] Essentially, Rule 19c-3 was an attempt to increase market making competition in the hopes of reducing spreads and attracting more order flow.

NYSE Rules 97 and 127 may also have contributed to off-board trading. These rules allowed smaller orders, limit orders and the NYSE specialist for a particular stock to take precedence over some part of block trades (greater than 10,000 shares). In order not to disrupt a pre-arranged block trade, a market maker may cross the trade on a regional exchange.[11]

However, the net effect of these rule changes, particularly Rule 19c-3, has been, and continues to be, the subject of much controversy. The initial effect of 19c-3 was favorable as large brokerage houses began to trade in-house. Yet, by mid-1983, most large NYSE firms had ceased trading off-board. Some market analysts attributed this to coercion by exchange specialists.[12] The SEC noted that inefficiencies and frustration with the ITS combined with a general dissatisfaction of the Rule 19c-3 environment may have contributed

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[10]Cohen and Conroy (1990), p. 278. Due to the uncertainty of the effects, the SEC restricted off-board trading to only those issues newly listed on the exchange after April 26, 1979.

[11]Hamilton (1987), p. 1,333.

[12]Cohen and Conroy (1990), p. 278.

to this outcome.[13]

In a report issued in 1981, the SEC stated that it was "not possible at this time to reach any conclusions regarding effects of an active OTC (over-the-counter or Nasdaq) market in Rule 19c-3 common stocks."[14] More recently, Cohen and Conroy (1990) noted that "no consensus on the results of the 19c-3 experiment has yet emerged" and that "our empirical results reflect the basic problems associated with increased competition in a manner that also results in increased market fragmentation."[15] On the one hand, greater competition decreased percentage spreads while on the other, higher return variances seemed to result from the fragmentation of order flow. Hence, the debate over the net effect of increased competition (fragmentation) continues.

Yet, most market analysts agree that attempts to enhance competition have indeed increased the attractiveness of off-board trading for many traders. Off-board transactions can differ from NYSE transactions for a number of reasons. Often, off-board trades can be executed more readily or information the trade may contain can temporarily be kept secret.[16] In a more recent development, dealers on non-NYSE exchanges (particularly Nasdaq) have started to pay for order flow, typically one cent per share. In addition, the NYSE auction market may be ill-suited for block trades. Marketability of block trades depends on the

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[13]SEC, Request for Comment on Off-Board Trading Pursuant to Rule 19c-3, Release No. 20074, 6 (1983).

[14]SEC, A Monitoring Report on the Operation and Effects of Rule 19c-3 under the Securities and Exchange Act of 1934, Release No. 18062 (1981). These results were criticized by the NYSE. As with many other studies on the topic, the NYSE felt that the report did not address the possible adverse effects associated with Rule 19c-3.

[15]Cohen and Conroy (1990), pp. 279 and 304.

[16]Hamilton (1987), p. 1,333.

broker actively searching among known large investors as NYSE specialists are precluded from searching for offsetting block trade by NYSE Rule 113. "Upstairs marketmakers" may negotiate these block transactions. Some are not NYSE members and may go off-board to complete the trade.[17]

When combined, the improved technology linking exchanges, rule changes and other factors such as payment for order flow have translated into an increasing percentage of trades involving NYSE-listed securities taking place off-board. While most studies have found that the positive effects associated with this competition dominate negative effects from fragmentation, undesirable effects do exist. They will tend to increase the cost to transact and/or decrease execution quality. These effects are considered briefly now.

1. Costs of Fragmentation

While the fragmentation of order flow may result in poorer execution for both dealers/traders and investors for a variety of reasons, there are essentially two underlying causes. First, a market clearing price must now be reached on several exchanges instead of just one. Assuming that information is not perfect and information time lags exist, prices may not be the same at a given instance on two exchanges due to different supply or demand conditions or information asymmetry. The price on one of the larger exchanges (NYSE) may represent (or more closely approximate) the true market clearing price while a stock that trades on a regional exchange may suffer from information adjustment lags or may be more susceptible to local demand or supply shocks.

Second, fragmentation will tend to reduce the general "thickness" of the market. As a result, investors may forego possible price improvement as the order is not exposed to all

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[17]Ibid.

possible offsetting trades. In addition, traders will most likely have to wait at least as long to execute a trade compared to fully consolidated order flow. Fragmentation implies that trades are exposed to fewer possible matching trades on any given exchanges. This means that dealers must search and this involves costs. To offset search costs, dealers/brokers may increase their price for liquidity services to offset the longer waiting time to trade (particularly if they hold an undesirable inventory position).

Third, the uncertainty surrounding the equilibrium price of an asset (particularly for the smaller exchanges) may have two effects compared to the case of consolidated order flow. First, market makers or specialists may increase their bid/ask spread for protection against price uncertainty. This is referred to generally as satellite or price risk cost: prices on regional exchanges tend to depend heavily on prior NYSE prices. As noted by Hamilton "(i)f investors and marketmakers are risk averse the probability of deviating from the price in the dominant (NYSE) marketplace is a cost of off-board trading."[18] Second, transaction prices will become more volatile as new information reaches the exchanges and prices adjust. Less stable transaction prices increase the price variance of an asset and serve to strengthen the first effect of wider bid\ask spreads.

Externality considerations may also be used to argue against the fragmentation of order flow. Some exchanges (regionals) may free ride from others (NYSE) who regulate to ensure that their exchange operates in a smooth and timely manner. Campbell et al. noted that "by listing a new contract, an exchange also provides a central place where integrated traders meet, making it possible to trade off-floor at minimal search cost and to free ride on available competitive price information to lower negotiation cost. Hence, off-floor trades

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[18]Ibid, p. 1,334.

based on the bid/ask spread may be cost-efficient for certain traders who compliment each other through reputation or block-trading frequency."[19] This externality argument is strengthened if economies of scale for regulatory activities exist.

Finally, increased fragmentation may lead to in-house markets for stocks (19c-3 stocks) creating submarkets that do not interact across fragments. Submarkets are created because brokers are allowed to act as dealers, matching buy and sell orders in-house without sending each order directly to the floor of the exchange. This leads to violations in price priority rules, inferior execution prices (due to unexposed orders), more public orders executing against dealers instead of other public orders and violations of secondary priority rules.[20] As before, the net effect is to reduce the quality of the market.

To sum up, the pooling of orders onto one exchange should serve to increase the effective thickness of the market (the number of traders willing to buy/sell at any given price). In turn, a thicker market should lead to lower price variances, a shorter waiting time to transact, shorter price adjustment delays and lower spreads.[21]

2. Benefits of Competition

Competition, as used in this analysis, refers to competitive pressures faced by the NYSE specialist, the dominant player in the market for NYSE-listed stocks. Competition may originate from other specialists on the regional exchanges, private crossing networks, Nasdaq marketmakers or floor traders on the NYSE. Given guaranteed execution at the BBO, specialists tend to compete by offering greater price improvement to the broker (and

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[19]Campbell et al. (1991), p. 497.

[20]Cohen and Conroy (1990), p. 281.

[21]Cohen et al. (1982), p. 119.

ultimately the customer).[22] Different transaction rules which affect the brokers choice of an exchange may also affect competition.[23] In addition, exchanges may offer inducements such as payment for order flow.

Generally, there are two main benefits to competition between exchanges. First, competition may serve to reduce the power of a monopolist specialist, lowering the cost to transact by reducing bid/ask spreads.[24] Competition eliminates any excess profitability and results in lower spreads because the specialist (or other party) is forced to accept more risk for a given trade. Second, dually-listing stocks allows diverse markets to exist simultaneously (e.g. specialist and competitive broker). Different markets may serve the diverse needs of heterogeneous traders and allow order flow to migrate to the most efficient market structure for that type of financial asset.

3. Caveats

When the NYSE and OTC markets trade the same security, different market structures compete. Each type of structure has its own advantages. Though an interesting question, this paper does not explore the implications of this fact. Instead, its primary focus is the measurement and effect of competition on the price of liquidity services. To simplify this task, this analysis views exchanges as entities that compete against one another for order flow based on the price execution they offer for trades. In reality, the separate exchanges merely offer alternative locations to complete a transaction; the specialists (NYSE and regionals) or competing market makers (Nasdaq) are really the parties quoting stocks and

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[22]Neal and Reiffen (1994), p. 4.

[23]Ibid.

[24]Demsetz (1968), p. 43.

competing for order flow.

While it is true that parties trading NYSE-listed stocks can choose among the different exchanges, certain parties may tend to deal only with a particular exchange, possibly resulting in inefficiencies. If this "preferred" exchange is a non-NYSE exchange, then the investor forgoes the opportunity of exposing their trade to the open outcry system on the NYSE, where the market for the stock is typically most active. As a result, traders may forego possible price improvement. However, by completing the trade off-board, brokerage firms can often bypass an accumulation of orders on the NYSE specialist's book. Therefore, the exchanges are able to offer different types of execution quality, which may or may not benefit the investor. The convention of competing exchanges is thought to capture these differences and allows the analysis to simplify the institutional details of the industry in order to focus on the measurement and effect of competition between exchanges.

Following the convention established by Lee (1993), this analysis assumes that all trades are initiated by outside public traders who pay for liquidity, because the identity of the trade initiator is not known. The analysis uses the price of liquidity services as the measure of execution quality. However, this is only one aspect of trade quality. The speed of execution, the amount of guaranteed depth and the reliability of trade settlement also affect execution quality.[25] Therefore, the price of liquidity services is only one criterion that should be used in the evaluation of exchange performance. This is particularly relevant if trades migrate off-board to avoid queuing on the NYSE. In this instance, broker's may obtain

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[25]Lee (1993), p. 1,012.

"better" execution for their client, though at a higher price.[26]

B. Statement of Purpose and Layout of Paper

The purpose of this paper is to provide insight regarding the competitive relationship between stock exchanges and in the process help to resolve the controversy surrounding attempts to foster a more competitive exchange environment. Prior research on the topic of competition between stock exchanges has demonstrated that competitive effects seem to dominate fragmentation effects, reducing spreads on the NYSE. These results were statistically significant and appeared to demonstrate that competition was indeed effective in reducing NYSE liquidity prices.

However, more recent research demonstrated that there appears to be non-trivial price differences for a given stock based on trade location. These results seem to contradict one another. If competition is effective, price differences should theoretically not exist because the transaction costs in this industry are most likely negligible, even for the smallest trades (100 shares). Given these empirical results, a number of pertinent questions arise. Do both results continue to hold using more recent data? Are the competition measures capturing effective competition or some other phenomenon? Finally, is it possible to reconcile these two results? These are the questions that this analysis attempts to address.

The paper proceeds in the following manner. Chapter 2 considers a number of economic and measurement issues that may cause earlier studies to miss the true nature and

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[26]Using the trade price as the sole criterion of trade quality may be misleading if regional exchanges tend to offer worse execution when the market for the stock is very active and the queuing of order flow becomes a relevant factor in determining trade quality. However, this analysis finds that non-NYSE exchanges are able to offer relatively better execution at these times. Therefore, it is assumed that tradeoffs between price and speed of execution factors do not significantly alter the interpretation of the results.

effect of competition. Issues include (1) the definition of the competition variable, (2) the use of a spread instead of a liquidity premium measure, (3) the use of daily aggregated measures (across time frames and trade size classes) and (4) unobservable variables.

Chapter 3 presents the formal literature review. Included are studies using regression analysis to quantify competitive effects and two studies comparing transaction prices across exchanges. These studies serve as a foundation for the analysis in Chapter 4.

Chapter 4 introduces the formal methodology of this paper. It is based on a simple dominant exchange model where the NYSE dominates other exchanges due to informational advantages. It then replicates the methodologies used in earlier studies to examine whether more recent data confirm their results. Once the results are replicated, the analysis shortens the time frames used to derive variables used in the analysis. This may affect the interpretation of certain key variables, particularly volume and competition. In addition, competitive effects are measured on all exchanges, not just the NYSE.

Chapter 5 investigates the price dispersion phenomenon and presents a discussion of the Law of One Price and the characteristics needed for it to hold in a particular market. An analysis is performed to test whether or not the regional exchanges are local markets. If they are local markets, the Law of One Price need not take effect, thus price differentials may exist between the exchanges.

Chapter 6 completes the analysis. It attempts to explain price differentials between the NYSE and regional exchanges and the conditions under which the regional exchanges compete. In order to examine the possibility that the regional exchanges cream skim (i.e., offer selective market making) and do not offer effective competition all of the time, explanatory variables are derived that characterize the trading environment. A cream skimming explanation permits the existence of an effective competition measure in an environment characterized by non-trivial price differences. This analysis finds evidence of this behavior. Regional trade activity and relevant price execution are found to be a function of NYSE activity. Regional exchanges tend to trade or "compete" when the trading environment is active (thus free-riding on the NYSE price discovery process, minimizing price risk costs and inventory adjustment costs) and tend to target smaller trades (thus avoiding information traders).

CHAPTER 2

ECONOMIC AND MEASUREMENT ISSUES

Numerous studies have examined the effect competition has on the price of NYSE liquidity services. Typically, studies have used regression analysis to determine whether competition, as measured by volume dispersion or the number of exchanges actively trading a particular stock, significantly reduced NYSE spreads. The theories underlying most regressions were based on one of two models: (1) a transaction or inventory cost model where the spread compensates the dealer or specialist for providing services of immediacy or (2) an adverse selection model where the spread serves as compensation for the existence of individuals who have superior information regarding a trade (information traders).[27]

In both models, the NYSE spread is typically modelled as a function of least five independent variables: trade activity, price volatility, price, information and competition. Trade activity is measured using daily trade (total) volume or the number of transactions throughout the day. The more active a market, the shorter the waiting time to execute a particular transaction. This should reduce spreads as it reduces the risk associated with carrying a particular inventory. In general, dealers participate in trading activities to the extent required by temporary imbalances in the inflow of orders. Other things being equal, the probability that there is an imbalance varies inversely with the time rate of transactions.[28]

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[27]Mann and Seijas (1991), p. 54.

[28]Tinic and West (1972), p. 1,709.

The price volatility of a stock is measured using a price variance measure over the trade day. Higher price variances increase uncertainty and risk and therefore increase spreads. The stock's price also increases spreads because "the price directly affects the total borrowing costs or the opportunity cost of capital tied up when the specialist takes a position in an issue."[29] Information has been measured using the volume or percentage of large or block trades over the trade day. Block trades originate from institutional investors who may have superior information. Spreads will increase as a form of protection against information traders. Competition has typically been measured using a Herfindahl-Hirschman Index (HHI) calculated using exchange-specific trade volumes over the trade day or a measure representing the number of exchanges that were active during the day. If competitive effects dominate fragmentation effects, then both measures should reduce the quoted spread.

Typically, all five independent variables have been found to have significant explanatory power and had the hypothesized effect on NYSE spreads. However, while earlier research seems to have reached a consensus regarding the effect of these variables, they may also contain similar flaws. Certain economic and measurement issues may not have been addressed due to the nature of the data. In most analyses (except the most recent), daily average measures have been used because transaction data were not available. The use of a transactions database allows for improved specification. While this holds true for all of the variables mentioned, only economic and measurement issues affecting the competition and volume variables are considered as they are the focus of this analysis.

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[29]Tinic (1972), p. 80.

A. Competition Measures

Although two competition measures have been used with success in the past, the specification of this variable is important because while the measures are similar, they are not equivalent. Two distinct issues arise regarding this variable. First, which competition measure is more accurate? Second, does either measure effectively represent the competitive environment?

1. The Measurement of Competition

Because both competition variables were found to have the hypothesized effect on the price of NYSE liquidity services, this analysis utilizes both measures. It will investigate the robustness of each measure on both NYSE and regional liquidity prices moving from daily to hourly time frames. It is possible that the two measures capture different phenomena and therefore have disparate impacts on regional and NYSE liquidity prices. If true, competition coefficients may differ markedly depending on the exchange and the measure used in the regression. For example, the overall dispersion of volume (between the NYSE and other exchanges) may be irrelevant to the smaller (regional) exchanges. However, a variable representing the number of exchanges that are active during a particular time frame may be relevant for these exchanges because if one regional exchange finds conditions suitable for trading, most likely the conditions are suitable for others to "compete" as well. In addition, relatively small increases in regional trade volume will not greatly affect the HHI variable, but will affect the number of exchanges that are active.

Conversely, for a large exchange such as the NYSE, the dispersion of total volume (NYSE versus off-board volume) may be more important. Hamilton noted that "the division of off-NYSE trading between regional exchanges and the third market may have no discernable effect on NYSE spreads; perhaps only the total off-board trading matters."[30] In this case, the location of volume would not matter so much as the fact that trading took place on an exchange other than the NYSE.

2. Effectiveness of Competition Measures

The second issue regarding the competition variable is whether either measure truly represents the presence of effective competition. Prior research also raised this concern. Demsetz (1968) questioned the accuracy of an activity competition measure. Using the number of exchanges trading a particular stock as a competition variable, Demsetz noted that "an enumeration of the forces of competition is not, by itself, convincing evidence of competition."[31] In reference to Demsetz's paper, Tinic (1972) echoed this concern: "(e)specially in the case of issues experiencing heavily concentrated trading activity in the NYSE, the mere presence of external markets (as measured by the number of multiple listings) need not indicate the degree of effective competitive pressure on the specialist."[32]

Having noted this weakness, Tinic used an HHI measure in his analysis. This measure was not without acknowledged shortcomings. This occurs because the index might simply act as a proxy for long-run trading activity; lower HHI values may simply reflect the influence of heavy trading volume. Mulherin (1996) noted that the reported association between a Herfindahl index and spreads may be driven in whole or in part by the incidence of limit orders and heated floor trading activity on the NYSE. Heated floor competition keeps specialists "honest" by forcing them to maintain narrow spreads. This internal

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[30]Hamilton (1979), p. 180.

[31]Demsetz (1968), p. 44.

[32]Tinic (1972), p. 88.

competition measure may be correlated with an HHI measure.

Therefore, both measures may not represent effective inter-exchange competition. Essentially, the issue is the exogeniety of the competition variable: competition, as it has been measured in the past, may simply be a function of market activity (volume) or even the spread of an asset.[33] If competition is merely a function of trading activity, then the inclusion of volume and competition variables in a regression not only reduces the explanatory power of both, but may also spuriously credit the competition variable with reducing spreads.

Given this relationship, improved specification may result by reducing the correlation between volume and competition. This is particularly important if non-NYSE exchanges engage in cream skimming activity because these exchanges may become active or "compete" only under certain conditions. Coffee (1996) noted that these exchanges typically pay for order flow (nonprice competition) only in active NYSE stocks, trade disproportionately in smaller trades (avoiding information traders) and often match quotes on the NYSE and free-ride on the NYSE price discovery process (which is easier when volume is heavier). McInish and Wood (1992) found that regionals and Nasdaq free-ride at least 90 percent of the time on trading in NYSE-listed securities. By isolating trading environments that are more conducive to cream skimming and reducing the correlation between volume and competition, this analysis can more accurately measure competitive effects relative to other market characteristics.

To test the robustness of the competition measure, this paper utilizes three approaches. First, three time frames are used to quantify competition's impact on the cost

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[33]McInish and Wood (1992) noted that the direction of causality for the inverse relationship between NYSE spreads and regional trading volume is uncertain. Tight NYSE spreads may result in greater regional trading.

to transact: daily, half-day and hourly. It is postulated that this breakdown will increase the size and significance of the volume and competition coefficients because shorter time frames are able to separate volume effects from competitive effects more accurately; there should be less correlation in the variables using shorter average time frames. This is particularly true for non-NYSE exchanges where trading may be sporadic.

Second, the analysis in the final section of this paper uses competition measures (in addition to other variables) to explain price differentials between the regional exchanges and the NYSE. To be truly effective, competition should not only reduce the spread or price on the NYSE, but it should also reduce price differentials between exchanges.

Finally, the competition variable measuring the number of exchanges that are actively trading a stock is modified to include a threshold value. This measure does not recognize an exchange as "active" unless a certain threshold of trades were executed on the exchange during the relevant time frame.[34] In many instances, only one or two trades occur on an exchange during the time frame. It is questionable whether these exchanges should truly be considered "active" and included in the competition variable.

B. The Price of Liquidity Services: Spread or Liquidity Premium?

Earlier studies used the NYSE spread as a measure of the price for liquidity services. The spread is defined as the difference between the bid and ask price a dealer or specialist quotes. The bid is the price at which the dealer or specialist is willing to accept a trade while the ask is the price at which the dealer is willing to trade stock. However, more recent literature has noted that using the spread as the dependent variable is inappropriate because

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[34]Analyses were also performed without the threshold, but threshold values greatly increased the explanatory power of this variable. This is attributed to a reduction in correlation between the volume and competition variables.

transactions often occur "inside" the quoted spread. To trade inside the spread means price improvement for the investor (a transaction price greater than the bid or less than the ask). Blume and Goldstein (1992) found that between 12 to 31 percent of the trades in their sample occurred inside the quoted spread.

Transactions may occur inside the quoted spread for a number of reasons. Discounts may be offered due to competitive pressures. Alternatively, dealers or specialists may offer selected discounts for particular trades in order to balance inventory or because of temporary information advantages. Transactions may also occur inside the spread if specialists do not display the best limit orders or if market orders are matched.[35] As a result, using the posted spread as a price measure will overstate the cost to transact.

Recent literature supports this contention. Reiss and Werner (1996) and Peterson and Fialkowski (1994) noted that researchers should not use average spreads to measure the efficiency of a market: "(e)mpirical tests of the sources of the spread must use the spread actually paid by investors."[36] Peterson and Fialkowski went on to state that using the spread as a price measure may not be a problem if spreads serve as a proxy for actual transaction prices. However, in their analysis the authors found that "(t)he effective spread faced by investors in our samples is significantly smaller than the posted spread."[37] The possible

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[35]Specialists need only post quotes that are "representative" of orders in the limit order book. In particular, limit orders which are better than the current quote are not automatically posted as new quotes. McInish and Wood (1995) refer to undisplayed limit orders that are at better prices than those of limit orders actually displayed as the "hidden limit order book." Fictitious price improvement may occur if market orders execute against hidden limit orders. The authors feel that if true spreads were revealed by the NYSE, the spreads would be matched by the regionals and the illusory price improvement would disappear.

[36]Peterson and Fialkowski (1994), p. 290.

[37]Ibid, p. 270.

misspecification is compounded if the two measures are not highly correlated. The authors derived this result: "(n)ot only do we find the size of the posted spread and the effective spread differ in magnitude, but their correlation is also small."[38]

A more appropriate measure of the cost to transact is the liquidity premium. The liquidity premium is defined as the difference between the transaction price and the equilibrium price of a transaction. Although the true equilibrium price is not known with certainty, it is assumed to equal the mid-point of the spread. This is a strong assumption. However, it is maintained that the liquidity premium is a superior measure to the spread because it captures the essential elements of the transaction: the spread and the actual transaction price.

As a simple example of how the liquidity premium is calculated, assume a bid equal to 45.0 and an ask equal to 45.5. Given a transaction at the ask, the equilibrium price would then be calculated as (45.0 + 45.5)/2 or 45.25 and the liquidity premium would equal .25 (45.5 - 45.25). The strength of this approach is that the liquidity premium measure allows an analysis to use observable information that is pertinent (transaction price) and captures discounts.

In order to calculate liquidity premiums, this analysis uses the midpoint of NYSE spreads as an estimate of the equilibrium price of a stock. Regional quotes are not used because they are unreliable; often they are not meaningful. Petersen and Fialkowski noted that "price improvement relative to an exchange's own quote can be deceiving."[39] That is, regional quotes may be irrelevant; however, while their quotes may be inferior, they tend to

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[38]Ibid, p. 271.

[39]Petersen and Fialkowski (1994), p. 275.

match best quotes even if they do not display them.[40]

C. Aggregation Across Trade Size Classes

Because prior research did not control for the size of trades, regressions treated trades of different sizes as homogeneous products. However, it is questionable whether a trade of 5,000 shares should be considered the same product as a trade of 100 shares. Trades that are not the same size may be heterogeneous products because the information content of the trades differ, non-NYSE exchanges are less willing to deal (compete) in larger trades (as they have a greater impact on inventory and are often informationally motivated) and often larger trades benefit from discounting. Reiss and Werner noted this discounting behavior: "(o)ur estimates reveal that medium to large trades on average receive discounts from the touch (inside) spread."[41]

Recent literature has demonstrated the need to control for the composition of volume. McInish and Wood (1992) found that trade size had significant explanatory regarding relative bid/ask spreads in their analysis. Lin, Sanger and Booth (1995) also confirmed the importance of trade size. The authors noted that "(t)he average effective spread is found to increase with trade size. . . . The increase in the effective spread associated with trade size is largely the result of an increase in adverse information revealed from large trades."[42]

To control for volume composition, this analysis separates trades into five size categories when comparing liquidity premiums across exchanges. Individual size classes

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[40]Ibid, p. 289.

[41]Reiss and Werner (1996), p. 161. This result pertains to trades on the London Stock Exchange's electronic quotation system, known as SEAQ.

[42]Lin, Sanger and Booth (1995), p. 1,180.

include trades between 100 and 400 shares, 500 and 900, 1,000 and 1,900, 2,000 and 4,900 and trades greater than 5,000 shares. This breakdown follows the convention established by Lee (1993), which is summarized in the literature review. In addition, regressions that are used to explain liquidity premiums on specific exchanges include a size variable to capture any effects attributable to the size of the trade.

D. Unobservable Variables

The final issue is the possible bias resulting from relevant unobservable variables. While these variables are observable to the market participant, they are not observable to the econometrician viewing the data set. There are three general categories of unobservable variables: (1) the queuing of order flow on the NYSE specialist's book (after price, orders are handled based on the time they are placed); (2) the payment for order flow; and (3) a trader's taste for a particular non-NYSE exchange, more generally described as a principal-agent phenomenon. Principal-agent problems may arise in the industry as brokers and traders forego their fiduciary responsibility to seek best execution for investors. The search for best execution may be costly to the brokers and traders not only in terms of time commitment, but also because "gentlemen's agreements" exist. In addition, certain brokers may limit their trading to a particular exchange.

All unobservable variables may be regarded as "non-price" competition variables. They are methods by which the regional exchanges compete for order flow with the NYSE. Non-price factors increase regional volume at the expense of the NYSE, making competition look relatively more active. In particular, the queuing of order flow on the NYSE may cause trades to migrate off-board for reasons not related to the price of the stock. This may bias the competition coefficient.

The direction of the bias hinges upon (1) the effect non-price competition factors (omitted) have on liquidity premiums (dependent variable) and (2) the correlation between the omitted variables and the variables included in the analysis. For example, let X_1 represent a "typical" competition variable, X_2 an unobserved non-price competition variable and Y the average liquidity premium. If the real regression is:

(1) $$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

and the estimated equation is

(2) $$Y = \alpha + \beta_1 X_1 + \varepsilon$$

then the expected value of the competition coefficient becomes

(3) $$E(\beta_1 | X_1) = \beta_1 + \beta_2 * f(r_{12})$$

where $f(r_{12})$ is the simple correlation coefficient between X_1 and X_2. A bias will exist as long as the true β_2 does not equal zero (i.e., X_2 is relevant) or the simple correlation coefficient does not equal zero.

As an example of potential bias, consider the HHI competition variable. We would expect the HHI coefficient to have a positive impact on liquidity premiums; greater volume dispersion (lower HHI) represents greater competition (lower liquidity premiums). Therefore, β_1 should be positive. The correlation between omitted non-price competition factors and the HHI variable should be negative. When the regional exchanges compete using non-price factors, volume dispersion increases, ceterius paribus, reducing the value of the HHI variable. Therefore $f(r_{12})$ is negative.

This relationship is well-grounded in empirical research. Harris noted that it may become profitable to supply liquidity when volume is high and spreads equal their minimum price variation (a spread of 1/8): "supplying liquidity will be highly . . . perhaps excessively . . . profitable."[43] In general, the OTC and regional exchanges will find it more attractive to "compete" at higher volume levels. McInish and Wood stated that "competition will vary with volume . . .the crowd is more active as volume levels rise."[44] Coffee (1996) noted that traders tend to pay for order flow only in stocks that are active. Because regionals cannot compete on price terms at minimum spreads, they may compete using non-price factors.

Hence, the direction of the bias (if any), depends on the sign of β_2, the effect of non-price factors on the dependent variable. If it is equal to zero, no bias will exist. However, if β_2 is positive, then the HHI competition coefficient will be biased downward (less positive), moving the coefficient away from its hypothesized value. Most likely, if dealers had to resort to discounting (and were able to discount, given the spread) or reducing the outstanding spread to attract order flow, they would have, assuming it was profitable. Therefore, it is asserted that non-price competition factors cause liquidity premiums to remain at higher levels or increase because traders are willing to accept higher costs to transact (which are passed on to the investor) in exchange for speedier transactions, payment for order flow or the maintenance of certain trade relationships. This biases an HHI competition coefficient downward (less positive) and an activity competition coefficient upward (less negative), reducing both of their true impact on liquidity premiums. This occurs because volume leaves the NYSE for non-price reasons.

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[43]Harris (1992), p. 14.

[44]McInish and Wood (1992), p. 754.

Unfortunately, given the data, there exists no acceptable method to control for this type of bias. This remains a challenge for future research. However, if a bias does exist, shortening time frames used to measure variables should limit any bias to fewer observations, hopefully allowing the competition measure to be modelled more accurately.

CHAPTER 3

LITERATURE REVIEW

The literature reviewed in this chapter is separated into two general categories. The first group of analyses use regressions to quantify competition's effect on NYSE spreads and liquidity premiums. The second group compares the price of liquidity premiums and effective spreads across exchanges that trade dually-listed NYSE stocks. Both methodologies are replicated in Chapter 4.

A. The Effect of Competition on NYSE Spreads and Liquidity Premiums

Demsetz (1968) published the first recognized paper analyzing the effect of competition on NYSE spreads. The analysis used a random sample of 192 stocks over two days in 1965; only competitive effects from regional exchanges were considered. Two simple regressions demonstrated that while the competition coefficient (the number of exchanges that listed the stock) had the expected sign, the results were not statistically significant. Demsetz attributed the weak explanatory power of the competition variable to measurement difficulties.

Tinic (1972) improved Demsetz's specification through the use of an HHI variable to measure competition and the inclusion of a number of other relevant explanatory variables. Data were averaged over nineteen trading days in 1969 for 80 stocks. Tinic found that competition had a statistically significant effect on the average NYSE spread. Other coefficients included in the regression were also found to have a statistically significant effect on NYSE spreads.

Tinic and West (1972) used the average number of dealers quoting spreads as a competition variable to measure the effect on Nasdaq spreads. Two regressions using separate data sets were performed. The first regression used data on 68 stocks for a single day in 1962; in this instance competition was found to have poor explanatory power. The authors attributed this result to the fact that a single day of data was used. In addition, the authors noted that the "low t-ratios with V (volume) and N_q (competition) result in part from the high intercorrelation between the two variables."[45] This intercorrelation "makes the partitioning of explanatory power between the two variables virtually impossible."[46]

The second regression used 1971 data for 300 Nasdaq stocks averaged over the first five days in November. The authors felt that the five day averaging procedure would make the data more stable. Using this data set, Tinic and West found significant competitive and volume effects. However, though they found significant competitive effects, the authors noted that "(t)rading activity still remains a dominant factor in determining the number of dealers to participate in the market-making process."[47] Tinic and West attributed the significance of their results (compared to Demsetz's analysis) to their different measurement of competition and the different markets (NYSE versus Nasdaq). The authors termed the regional competition used in Demsetz's analysis as "possibly irrelevant."

Branch and Freed (1977) reconfirmed the statistically negative effect competition has on the average NYSE spread. The authors used data from 1,732 stocks over one day in 1974.

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[45]Tinic and West (1972), p.1,713.

[46]Ibid, p. 1,714.

[47]Ibid, p. 1,720.

Competition was measured using the number of different exchanges on which the security traded (including the third market); it was found to significantly reduce spreads, though the effect was small.

Hamilton (1979) analyzed the determinants of the NYSE spread using cross-sectional data on 315 NYSE-listed stocks from 1975. Variables were derived by averaging over four trading days. Using the number of marketmakers that provide quotes for a stock as a competition measure, Hamilton found that off-exchange trading of NYSE-listed stocks can result in smaller and less volatile spreads if effects attributable to increased competition dominate fragmentation effects.

Cohen and Conroy (1990) examined whether Rule 19(c)-3 led to (1) higher levels of market making activity, (2) increased competition among market makers, and (3) increased return variance. Rule 19(c)-3's objective was to introduce competition by allowing NYSE members to act as third market dealers for a limited group of stocks. Using residual analysis, Cohen and Conroy found that 19(c)-3 stocks benefited from the attempt to increase competition: "Overall, it is apparent that, on an ex post basis, the OTC market making activity of exchange members did have a favorable effect on bid/ask spreads, at least for some groups of stocks."[48]

McInish and Wood (1992) used a linear regression model to identify time-of-day effects for NYSE spreads. The data covered all quotes for by NYSE specialists for the first six months of 1989. The authors constructed a minute-by-minute time series of time weighted percentage NYSE bid/ask spreads (BAS) over the trading day. Competition was defined as the square root of volume traded off-board divided by NYSE volume. It was

[48]Cohen and Conroy (1990), p. 294.

found to have a (highly) statistically significant effect on the BAS.

Harris (1992) found unusual results in his analysis. Using data from the first and second quarter of 1989, Harris found that less volume dispersion (as measured by the log of the ratio of NYSE volume over total volume) decreased the average relative spread. He attributed this result to the fact that trades migrate to the primary exchange (NYSE) when spreads are tight: "(t)he (competition) variable coefficient is negative. If large (NYSE) market share is a proxy for lack of competition among dealers, this result would be surprising. Note, however, that if spreads in the primary market are tight, order flow will migrate to the primary market and primary market share will be large, which is consistent with the observed result."[49]

Using a linear programming model, McInish and Wood (1994) found that competitive effects dominate fragmentation effects. The analysis used data from 1988-1990 and separated stocks into 5 portfolio classes, which maximized the degree of fragmentation between them but minimized differences in other explanatory variables. Both the spread and liquidity premium were found to decrease with fragmentation.

B. Does Trade Location Affect Price Execution?

Lee (1993) attempted to measure the degree of integration between the NYSE and Nasdaq/regional exchanges by comparing liquidity premiums of similar orders across exchanges. He found that the price execution (using liquidity premiums) of trades differed systematically based on trade location. These intermarket differences were found to be a function of trade size, with the smallest and largest trades exhibiting the greatest liquidity premium differences.

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[49]Harris (1992), p. 11.

Lee's hypothesis was that the ITS linking the exchanges did not effectively communicate intermarket liquidity differences. If it did, then identical orders would have equal opportunity for best price execution regardless of their initial routing location. Lee noted that even though dealers and traders are required to use the best ITS quote to satisfy their fiduciary responsibility, price differences based on the location of execution can still exist due to hidden liquidity that is not reflected by these quotes. As noted, many trades take place inside these quotes.

Lee's analysis was performed in the following manner. Trades on the NYSE were matched to regional trades based on the size of the trade and a two minute time interval.[50] Liquidity premiums were then calculated for all matched trades. If there was more than one NYSE trade to match, then the liquidity premiums on the NYSE were averaged for all matched trades. The "excess cost" of the trade on the regional exchange was then defined as the difference between the liquidity premium on the regional exchange minus the liquidity premium on the NYSE, which may be positive or negative.[51]

All trading days in 1988 and 1989, except October 25, 1989, were used in the analysis. Tables 1a and 1b list liquidity premium differences calculated by Lee for 1988 and 1989 (a positive value indicates that execution costs were higher on the regional/Nasdaq exchange):

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[50]This time frame was changed to intervals of one, five and ten minutes, with no appreciable change in the results.

[51]It was noted that a comparison of intermarket average liquidity premiums for a given size may not be accurate. Regional dealers may "skim the cream" by making markets only in more liquid stocks, meaning that they would have lower liquidity premiums than the NYSE. In addition, effective spreads are known to display pronounced intraday patterns.

Table 1a
Average Excess Liquidity Premium Paid for 1988 Off-Board Trades in Time Matched Sample
Charles Lee (1993)

Trade Size (Shares)

Exchange	100 - 400	500 - 900	1000 - 1900	2000 - 4900	5000 - 9900
Boston	1.4*	0.71	0.67*	-0.03*	2.11
Cincinnati	1.36*	-1.21*	-1.36*	-0.020	0.73
Midwest	0.68*	-0.70*	-0.95*	-0.9*	-0.28*
Pacific	1.10*	-0.23*	-0.18*	-0.5*	-0.71*
Philadelphia	1.56*	0.5*	-0.5	-0.41	0.32
Nasdaq	1.51*	0.76*	0.59*	0.21*	2.61*
All	1.07*	-0.22*	-0.42*	-0.49*	0.31
*Denotes statistical significance at the one-percent level.					

Table 1b
Average Excess Liquidity Premium Paid for 1989 Off-Board Trades in Time Matched Sample
Charles Lee (1993)

Trade Size (Shares)

Exchange	100 - 400	500 - 900	1000 - 1900	2000 - 4900	5000 - 9900
Boston	1.04*	0.55*	0.33	0.35	0.88
Cincinnati	2.65*	0.44	-0.44*	1.49	1.32
Midwest	0.87*	-0.03*	-0.27*	-0.32*	-0.06
Pacific	1.19*	0.38	0.23	-0.02*	-0.42
Philadelphia	1.82*	1.21*	0.89*	0.46	1.26
Nasdaq	1.58*	1.23*	0.89*	1.13*	2.26*
All	1.22*	0.45*	0.14	0.22*	0.51
*Denotes statistical significance at the one-percent level.					

For the smallest trades (100 - 400 shares), the NYSE was found to offer better execution. The Midwest and occasionally the Cincinnati and Pacific exchanges offered superior price execution for midsize trades (500 - 4900). For large trades, the results were mixed. However, a consistent result was that "(o)nly the Nasdaq performs consistently worse than the NYSE in all size categories."[52]

Petersen and Fialkowski (1994) preformed a similar analysis. The authors found that there was significantly less price improvement for orders sent to regional exchanges. On average, orders routed to regional exchanges received 3.1 cents less price improvement compared to the NYSE. This result was not attributable to worse regional quotes. Regionals tended to match the best quote when they executed an order even if they were not currently displaying it. The authors attributed price differences due to liquidity that was not displayed, particularly on the NYSE.

C. Summary

Prior empirical research appears to have settled a number of issues regarding the determinants of NYSE bid-ask spreads. All studies found that volume significantly reduces spreads. There was a positive and significant relation between spreads and the price and price volatility of an asset. The effect of information appears to depend on the measure one uses, though in most cases it proved to have significant explanatory power. McInish and Wood (1992) demonstrated that the variables listed above have a similar impact on liquidity premiums and that trade size has significant explanatory power regarding liquidity premiums. Regarding the competition variable, research demonstrated that competition reduces spreads, and in one study, reduces liquidity premiums, no matter the competition

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[52]Lee (1993), p. 1,011.

measure used in the analysis.

However, many researchers have also commented on the inherent difficulty of measuring competition accurately due to the high correlation between volume and competition. As a result, a number of authors noted that the competition measure may capture effects that are more properly attributed to volume. Some papers even called into question the direction of causality: Does volume reduce spreads thereby attracting dealers to the more active market or does greater competition force down spreads? The implicit assumption in prior research was that competition caused spreads to fall. This need not be the case. What appears to be a more competitive environment may simply be a by-product of higher volume that reduces spreads.

The two final studies in the literature review demonstrated that price execution for similar adjacent trades can differ systematically depending on the location of the trade. Lee (1993) found that non-NYSE exchanges offered worse execution on average between one and one and one-half cents for the smallest trades (100 - 400) while Peterson and Fialkowski (1994) found that regionals offer significantly less price improvement. As noted, these price differences are most likely the result of hidden liquidity (i.e., traders willing to execute a trade at better terms for the investor) that is not reflected by intermarket (ITS) quotes: many trades take place inside these quotes.

1. Do Empirical Results Conflict?

The fact that (1) prices can differ systematically based on trade location while (2) competition appears to reduce both NYSE spreads and liquidity premiums may be troubling. It seems to imply that the securities industry is not typically characterized by a competitive environment. That is, competition or volume dispersion may indeed be associated with lower spreads and prices, but this condition is not prevalent enough to force price differentials between exchanges down to their transaction cost, which in this case should not differ significantly from zero. Do statistically significant price differentials imply that this industry is non-competitive the majority of the time?

It may not if there is no causal relationship between these two results. However, it is asserted that a competitive environment which reduces prices on individual exchanges should also serve to reduce price differentials between exchanges. This follows because an active trade environment (as measured by volume or the number of trades) also tends to improve the competitive position of non-NYSE exchanges. When trading activity increases (in most cases competition will as well), there is less room for price differences to exist because non-NYSE exchanges know true prices with greater certainty, information and cost heterogeneity between exchanges declines and price discreetness makes it costly to discount when spreads are low (spreads tend to decrease in active trading environments). In addition, if the market is active and spreads are reduced to their minimum level of 1/8 (a liquidity premium of 6.25, assuming a transaction at the bid or ask), then NYSE specialists cannot hide liquidity and price differences cannot exist because discounting is no longer an option.

Another explanation for the coexistence of these two results is that competition has a different effect on regional exchanges compared to the NYSE. However, as will be shown in the next chapter, competition not only has the same negative impact on regional liquidity premiums, but the effect is similar in magnitude as well (based on the sign and size of the competition coefficient). Hence, this explanation is dismissed.

2. Possible Explanations for Empirical Results

There are three possible explanations for the coexistence of the apparently conflicting empirical results found in the literature:

1. The competition results derived from regressions may not be directly comparable to price difference calculations. While most regressions used data aggregated over the trade day, Lee used two-minute time frames to derive price differences. Regressions may simply capture a general relation between average daily volume dispersion and average spreads/liquidity premiums: this may not hold at shorter time frames. The broader time frame may also allow the competition measure to capture volume effects inadvertently or introduce a bias from unobserved non-price variables.

2. The individual exchanges are not completely integrated, but retain some local power over price. Hence, it may be improper to pool price data across exchanges. The exchanges may not be completely integrated due to information lags or because certain dealers or traders prefer a particular regional exchange, foregoing possible price improvement resulting from hidden liquidity on the NYSE.

3. The two results do not conflict, but the competition measure is flawed because it captures cream skimming activity.[53] Evidence suggests that trades take place on non-NYSE exchanges when trades are relatively small (thus avoiding information traders) and when trade volume is relatively heavy (thus free-riding on NYSE price discovery and minimizing price risk and inventory carrying costs). Cream skimming activity can potentially make competition look effective while simultaneously allowing price differences to exist.

The remainder of this paper is devoted to exploring these explanations in greater depth.

[53]Cream skimming refers generally to selective market making by regionals dealers or selective trade location decisions by traders.

CHAPTER 4

COMPETITION AND PRICE DIFFERENCES

The simple model outlined in this chapter provides a general framework for viewing the securities industry. The model also provides motivation for price difference calculations between the NYSE and non-NYSE exchanges, time frame breakdowns and trade size breakdowns used later in the analysis. Earlier empirical studies are then replicated to ensure that their results were not driven by specific data sets and that structural changes have not occurred within the industry which may alter their general conclusions.

A. The Simple Model: The NYSE as the Dominant Exchange

Although many exchanges can trade dually-listed NYSE securities, trading is unquestionably dominated by the NYSE, particularly when trades are large. In 1993, 90 percent of NYSE-listed stocks were traded on at least one other exchange.[54] Of these dually-listed stocks, the largest regional exchange (Midwest or Chicago) traded only 4 percent of the total volume, while Nasdaq traded only 7 percent.[55] Market shares were similar in this analysis. Table 2 lists each exchange's share of total volume for stocks included in the sample:

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[54]Engel and Hecht (1994), p. 107.

[55]Ibid.

Table 2

Exchange Volume for 1992 Sample

Exchange	Total Volume	Percent of Total Volume
Boston	79,395,500	1.54%
Cincinnati	84,669,000	1.64%
Midwest	170,312,600	3.30%
NYSE	4,416,448,900	85.46%
Nasdaq	233,409,700	4.52%
Pacific	116,339,600	2.25%
Philadelphia	67,405,800	1.30%
Total	**5,167,981,100**	**100.00%**

Given the large NYSE market share, the market for NYSE-listed securities is modeled as being dominated or led by the NYSE, while smaller exchanges follow by forming a competitive fringe. The NYSE leads or dominates because its large market share gives dealers and specialists on the NYSE a virtual monopoly on the price discovery process. Due to their position, NYSE specialists have access to highly significant information: the number of shares and prices at which orders are awaiting execution. In other words, they know the supply and demand for a particular stock and to some degree, can predict the direction in which the price is headed.[56] As a result, NYSE dealers and specialists know the true state of the market with greater certainty and therefore suffer less from price risk and inventory carrying costs. The presence of hidden limit orders on the NYSE serves to strengthen this information advantage. Specialists need not reveal these orders because they

[56]The New York Institute of Finance (1992), p. 82.

do not necessarily have to display their best quote, but only a representative quote.[57]

Non-NYSE exchanges are modeled as a fringe competitor because their small market share places them at an information disadvantage, making them price takers the majority of the time. As noted, they will often free-ride from the NYSE price discovery process.[58] Regionals are occasionally forced to submit orders to the NYSE to discover true prices. In addition, the fringe also competes on non-price terms, occasionally paying for order flow or providing quicker execution if the NYSE is active.[59]

Within the context of this model, the magnitude of NYSE information and location advantages change throughout the day based on the volume of trading. As volume increases and more information becomes available, parties that choose to transact on the fringe reduce their price risk because heavier volume reduces the time between trade observations. Specialists on the fringe also reduce their inventory carrying costs as market volume increases.[60] Finally, queuing on the NYSE may increase the attractiveness of fringe trading

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[57]McInish and Wood (1995) found that NYSE specialists failed to display about one-half of all limit orders that were inside existing quotes for a sample of 118 NYSE-listed stocks.

[58]Garbade and Silber (1979) were the first to characterize the NYSE as a dominant competitor, with the regional and Nasdaq dealers offering satellite competition. They found that the satellites provided price leadership only 10-20 percent of the time. McInish and Wood (1992) found that the satellites did not meaningfully contribute to price discovery. Lee (1993) noted that NYSE specialists may widen spreads (and increase inside-the-spread trading on the floor) for strategic reasons; to deter nonprimary exchanges from free riding on the NYSE price discovery mechanism.

[59]For this analysis, it is assumed that all non-NYSE exchanges operate under similar information disadvantages. Hence, prices are only compared between exchanges in the two information states.

[60]Inventory considerations such as these are not trivial. Most models specify inventory carrying and asymmetric information costs as the two major determinants of the spread. Mann and Seijas (1991) noted that "(d)ealers argue that it is not the cost of carrying inventory, but the risk of carrying it" that determines spreads. They seemed to worry almost exclusively about losing money by a markdown in the value of their portfolios.

because it potentially improves the quality (speed) of these trades. Therefore, when trading is relatively heavy, the fringe marginal cost/supply curve shifts down as information and other general advantages of the dominant exchange are diminished. This causes the market share of the dominant exchange to decline as competition increases. Conversely, at lower volume levels, both price risk and inventory carrying cost risk increase, shifting the fringe supply curve up and increasing the market share of the dominant exchange.

Because the level of trade activity changes over the trading day, the fringe marginal cost/supply curve will also not remain constant: it will shift depending on the trade volume.[61] This simple modeling points to a weakness of the daily variables used in earlier studies: a daily competition measure cannot isolate shifts in the competitive position of the fringe that occur throughout the day. To capture the changing competitive position of the fringe given the volume of trading, this paper reduces time frames used in liquidity premium regressions from daily to half-day to hourly. Assuming competition has a negative effect on liquidity premiums, the improved measurement resulting from smaller time frames should strengthen this effect.

A similar argument is made regarding the size of trades. The fringe is in a better position to compete for smaller trades because these trades tend to contain less information and have a smaller impact on inventories. Because trades of different magnitude cannot be considered a homogeneous product, they are separated into five size classes when comparing liquidity premiums across exchanges.

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[61]It is assumed that there is a positive, though decreasing, relationship between trade volume and price information.

B. Data

Data used in this analysis are from the Institute for the Study of Securities Markets (ISSM) for the entire 1992 calendar year. Each trade and quote that appears in the transaction database is time stamped to the nearest second with the originating exchange identified. In addition, each trade entry specifies the transaction price and the size of the trade. Due to the immense size of the transaction database, a sample of forty-two stocks was selected. This sample was not selected at random. Given the relatively small size of the sample, a random sample may have resulted in too many "small" or "large" stocks, based on volume and overall price levels. Stocks were purposely selected to represent a broad spectrum of prices, daily volume levels and industry classifications, though there is certainly no reason to suspect that industry type would have meaningful implications for this analysis.

Table 3 lists the stocks included in the sample (along with a number of other pertinent statistics) from smallest to largest based on the number of trades for the year. It also provides some insight regarding the size of the individual stock databases. As shown, there is a wide range of values. The second column of Table 3 lists the total number of trades and quotes for the entire year for each stock on all exchanges. The third column lists the number of "clean" trades that remained after quotes and cancelled or problem trades were removed. Cancelled trades are flagged in the original transaction database with a "-9999" in the price field while problem trades (inaccurate price transmitted) are flagged with a "0." The fourth column lists the number of cancelled or problem trades. Except for Reebok, these records comprise a relatively small portion of the total number of records in the database.

Table 2

1992 Sample

	Stock	Total Number of Trades and Quotes	Number of Clean Trades	Number of Deleted Records
1	Honda	10,666	5,298	12
2	Nashua	11,077	5,393	14
3	Geico	10,599	5,817	23
4	Ionics	14,198	7,722	9
5	Bradlees	15,406	8,735	18
6	KLM	25,459	9,015	96
7	ChrisCraft	17,247	9,299	8
8	Quik & Reily	20,502	10,024	29
9	MGM	20,943	11,392	14
10	Johnson	37,266	18,982	20
11	Goodrich	53,415	24,757	27
12	Skyway	54,502	31,000	650
13	Safeway	54,502	31,000	650
14	Mattel	73,237	38,336	814
15	Kroger	75,982	45,031	822
16	LA Gear	92,729	46,609	3,865
17	Office Depot	84,847	47,313	869
18	Rockwell	91,577	48,034	744
19	Dayton	101,515	48,675	922
20	Xerox	125,818	52,920	1,321
21	Quaker Oats	97,981	53,705	1,094
22	Ameritech	96,942	61,863	2,959
23	Nynex	103,293	63,151	2,283
24	Caterpillar	123,207	65,363	1,022
25	Kellogg	132,315	65,683	809
26	General Mills	124,807	69,069	1,746
27	Wendy's	128,553	82,501	1,681
28	Reebok	133,255	98,842	17,729
29	Gillette	196,330	110,466	1,725
30	Amoco	222,791	113,599	2,102
31	Toys R Us	219,993	129,996	2,527
32	Dupont	279,486	144,489	1,660
33	Sears	244,066	146,135	1,458
34	McDonald's	251,502	156,800	1,741
35	KMart	260,622	168,065	2,316
36	General Electric	443,797	260,507	2,308
37	Ford	461,909	295,940	2,292
38	Homedepot	454,334	307,704	4,944
39	Walmart	449,961	322,350	2,003
40	GTE	452,280	333,948	1,599
41	Disney	433,471	337,206	3,371
42	General Motors	512,138	392,668	2,544
	Total	**6,814,520**	**4,285,402**	**72,840**

Occasionally, data entry errors will occur in the database; these are unavoidable. The ISSM runs a number of screening procedures to catch these errors by comparing suspect trades to trades in the immediate time vicinity. Yet, even these procedures cannot identify all errors. Because some errors remained, additional checks were performed when calculating price differences. Liquidity premium differences greater than \$0.75 were individually checked by comparing the price for that trade to comparable surrounding trades. If convincing evidence of a data entry error or stale quote existed, the observation was removed.[62] In addition, the program which calculated liquidity premium differences automatically removed individual liquidity premium differences greater than \$2. It is argued that differences this large cannot exist and need not be checked.[63]

Prior to the presentation of results, it is instructive to describe how the original data were manipulated in order to derive price differentials and data sets used in regressions. This allows the reader to conceptualize the final data sets used in the analysis. Figure 1 illustrates how each of the 42 separate stock data sets were split for liquidity premium difference calculations. The data set for General Motors is used as an example. For 1992, there were 512, 138 total trades and quotes for this stock. After removing cancelled and problem trades and regional quotes, a field was created representing the continuously updated outstanding quote on the NYSE. The total data set was then split between the six non-NYSE exchanges.

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[62]Perhaps the most commonplace error (though not directly attributable to data entry error) was the existence of "stale" quotes in the data set. If fresh quotes are not immediately listed for a new day, then the program calculates liquidity premiums using the previous day's quote if a trade is matched. If the bid and ask, and hence the transaction price change, then the liquidity premium will be miscalculated: it will appear larger than it really is. The screening procedure was able to remove these instances.

[63]Lee also included a \$2 filter.

For example, the split for the Boston exchange contains all Boston and NYSE trades and the outstanding NYSE quote field.

Next, for each of the six smaller exchange data sets, the data were separated again into five size classes, which contain all regional and NYSE trades for that size category and the outstanding NYSE quote field. This results in 30 mini-data sets for each stock. At this point, regional trades were matched to NYSE trades using the appropriate time frame. Liquidity premiums were then calculated for the NYSE or regional trades and a difference was taken. This resulted in a total of 1,260 possible data sets (30 times 42) of price differences for the entire sample. Finally, these data sets were then aggregated across the 42 stocks based on size class and exchange so that 30 data sets remained. A similar process was used for regression data sets, although one less step was required because there was no breakdown based on size class.

C. Replication of Empirical Results: Liquidity Premium Difference Calculations

To analyze liquidity premium differentials between exchanges, regional trades were matched to their NYSE counterparts (i.e., the same size class) if the NYSE trade occurred one minute before or one minute after the regional trade.[64] Liquidity premiums were then derived for these matched trades. Liquidity premium differences were calculated as the difference between the regional and NYSE liquidity premiums. If more than one NYSE trade was matched to a regional trade, then an average was taken in order to derive the liquidity premium on the NYSE.

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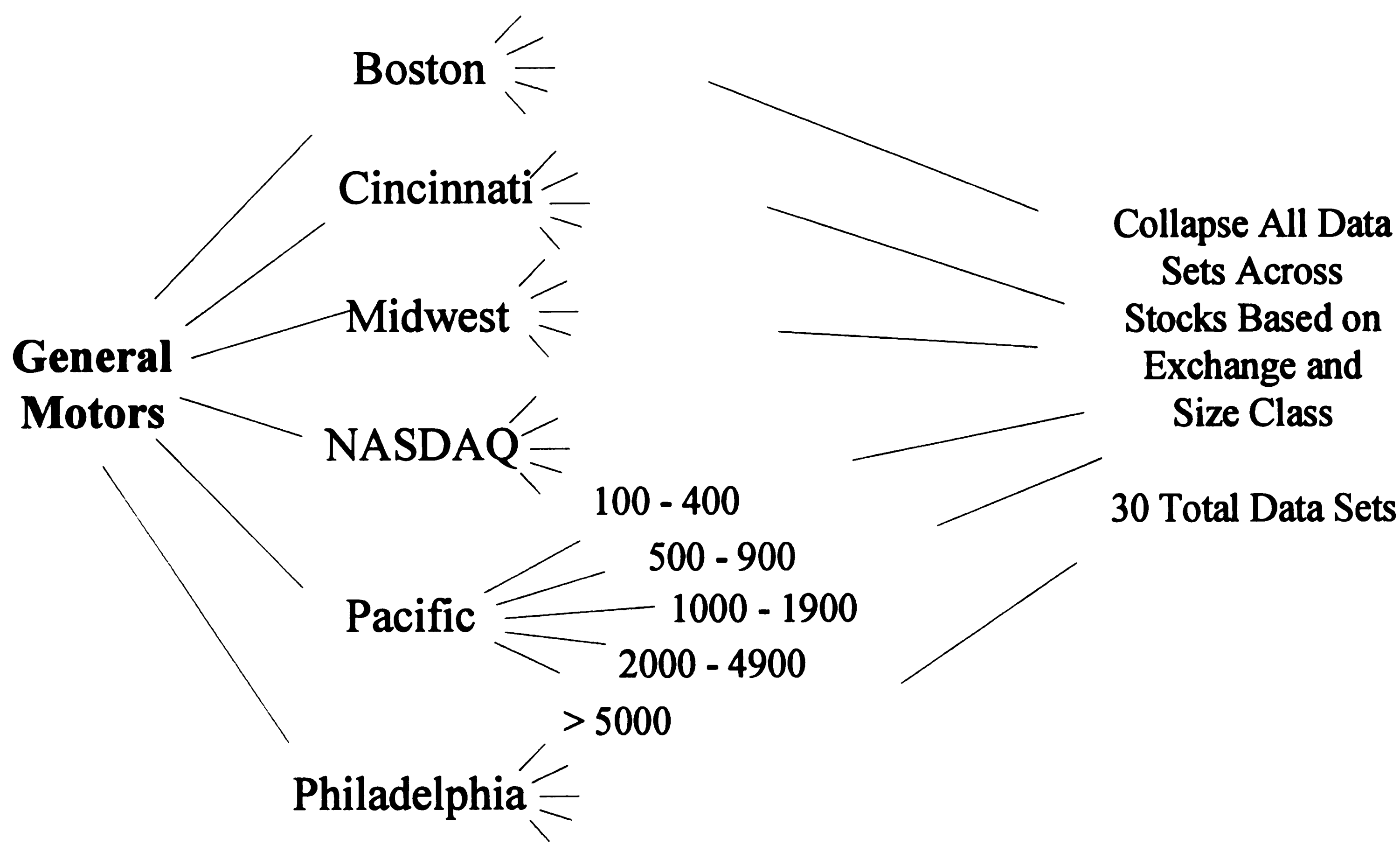
[64]Five minute and one minute time frames were also used: this did not alter the general results and generally increased or decreased the number of matched trades. This is consistent with Lee (1993).

Figure 1
Data Manipulation



As an illustration, consider Figure 2. Assume that a trade occurs on a regional exchange at 9:31 at the ask price with an outstanding quote of $30 and $30.25. The regional trade (R1) would be matched to NYSE trades N1, N2 and N3. The liquidity premium difference (regional - NYSE) would equal (12.5 - (12.5 + 0 + 12.5)/3) or 12.5 - 8.33 for a difference of 4.166 cents per share in favor of the NYSE. Assume further that the outstanding quote shifts a short time later at 9:32:30 to $30.375 and $30.125. The second regional trade (R2) would be matched to NYSE trades N4 and N5. The liquidity premium difference would be calculated as (0 - (12.5 +12.5)/2) or -12.5 cents per share, which favors the regional exchange. NYSE trade N6 would not be matched.[65]

Table 4 reports annual average liquidity premium differences for time matched trades in 1992. Positive (negative) values indicate that the regional exchange paid a higher (lower) average liquidity premium for that trade size class. All values are expressed in cents per share. An asterisk denotes statistical significance using a one-percent confidence interval (i.e., it rejects the null hypothesis that the mean liquidity premium differential is equal to zero) while two asterisks denote statistical significance using a five-percent confidence interval.[66]

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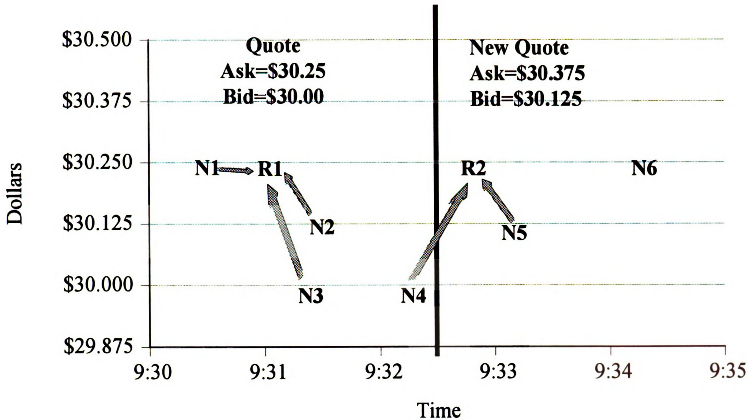
[65]Liquidity premiums for all exchanges use the outstanding mid-spread on the NYSE as the equilibrium price because regional quotes are often unreliable. In addition, if regional/Nasdaq spreads had been used, it may have produced inaccurate results because the midpoint of the spread may not represent the true equilibrium price.

[66]Most of the price differences found in Table 4 were found to be significant. However, this result may be driven by the large number of observations used in the analysis.

Figure 2
Liquidity Premium Difference Calculation



Using Table 4, a number of trends become apparent. First, matched regional trades occurred disproportionately in the smallest trade size class. Execution results for this group were mixed: three exchanges offered worse average execution while the other three offered better average execution compared to the NYSE. Moving from the smallest to largest trade size class, liquidity premium differences tend to exhibit a U-shape, decreasing at first from their original value and increasing when the 1,000 - 1,900 size class is reached: this holds for all exchanges. Except for the Philadelphia exchange, all non-NYSE exchanges offered better average execution for trades between 500 - 900 and 1,000 - 1,900 shares. Only in the largest trade size class did all non-NYSE exchanges offer noticeably poorer execution than the NYSE.

In order to understand the economic significance of these statistics, consider the price difference for trades on the Pacific exchange for the 100 - 400 size class. The average calculated price difference is 0.61 cents in favor of the NYSE. For this sample of stocks, 160,969 Pacific trades were matched to at least one similar NYSE trade. If the average volume of these matched trades is approximately 200 shares (more trades occur at the smallest size of 100 shares), then the total trade volume on the Pacific for these matched trades is equal to 32,193,800 shares. Given the average liquidity premium difference, similar trades that occurred on the Pacific exchange for this sample in 1992 paid a total of $19.6 million (32.1 million shares times 0.61 cents) in excess liquidity premiums compared to similar NYSE trades. For 1992, approximately 2,400 stocks were listed on the NYSE, most (approximately 90 percent) were dually listed on the non-NYSE exchanges as well. If stocks not included in the sample are similar to those included in the sample, then the total cost to execute off-board for this size class is much greater.

Table 4

Average Liquidity Premium Differences
Time Matched Trades by Size Class, 1992

	Size Class									
	100 - 400		500-900		1000-1900		2000-4900		>5000	
Exchange	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference
Boston	93,622	-1.4867 *	9,976	-1.923 *	6,841	-1.436 *	2,641	-0.4656 *	926	1.5105 *
Cincinnati	79,174	-0.0190	14,723	-2.5777 *	11,622	-2.4376 *	2,488	-0.3126 **	1,316	3.2979 *
Midwest	174,118	0.1362 *	17,803	-1.7293 *	14,069	-1.4533 *	5,460	-0.254 **	2,175	1.4148 *
Pacific	160,969	0.6100 *	21,210	-0.9367 *	13,288	-0.1851 **	3,594	0.462 *	771	0.7796 *
Nasdaq	318,166	-0.1167 *	30,443	-0.7618 *	20,730	-0.125 **	7,236	0.6011 *	1,761	2.1179 *
Philadelphi	88,489	0.7166 *	7,616	0.089	4,716	0.5869 *	1,621	1.1251 *	981	2.9487 *

* Denotes statistical significance using a one-percent confidence interval.
** Denotes statistical significance using a five-percent confidence interval.

D. Replication of Empirical Results: The Effect of Competition on Average Daily Spreads and Liquidity Premiums

To test competition's effect on the price of liquidity services, simple ordinary least squares regressions were performed using the NYSE spread or average liquidity premium for a given exchange as the dependent variable. Competition was proxied using two variables. The first is the HHI measure reviewed earlier. It is equal to the sum of the daily NYSE market share (of total volume) squared plus the daily non-NYSE share squared.[67] The second competition variable (ACTIVE2) is a simple count of the number of exchanges that were active during the trading day. In order to be considered active, an exchange had to trade at least 1,000 shares of the given stock during the trading day.

Five additional explanatory variables were also used. These include:

1. The log of the average price on a given exchange
2. The log of the average size trade on a given exchange
3. The log of daily trade volume executed on a given exchange
4. Price volatility on a given exchange ((maximum price - minimum price) / average price)
5. Block volume (trades greater than 10,000 shares) on a given exchange

Log transformations were used because the explanatory variables were hypothesized to have a decreasing impact on the dependent variable as they increase in value. The volatility and block volume (information) variables did not use a log transformation.[68]

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[67]Regressions were also performed using (1) the sum of each individual exchange's market share squared and (2) the sum of NYSE, Nasdaq and regional exchange shares squared. These alternative measures did not alter the general results.

[68]Typically, the volume variable used a log transformation in earlier studies while the average price variable occasionally used a log transformation. McInish and Wood (1992) used a square root transformation for the average size variable. Most studies did not transform the volatility or information variable (block trading). Regional regressions using log transformations of these variables did not alter the general results, although NYSE regressions (using the liquidity premium as the dependent variable) had a noticeably better fit.

Separate regressions were performed using each competition measure (ACTIVE2 and HHI) with the same set of explanatory variables. For both sets of regressions, the general results for the non-competition explanatory variables were quite similar. Therefore, in order to conserve space, complete results are detailed only for the *unshaded* competition variable in Table 5. The unshaded competition variable represents the "preferred" competition measure for a given exchange (the coefficient had the expected sign and attained greater statistical significance). Non-competition coefficients, R-squared and Durbin-Watson statistics associated with the regressions using the shaded competition variable are not listed.

The dependent variable for the first regression in Table 5 is the log of the average daily NYSE spread (measured in cents). Regressions that follow use the log of the average daily liquidity premium on the NYSE or regional exchange as the dependent variable. Coefficient values are listed while t-statistics appear in parenthesis below the coefficient values.

Results using the average NYSE spread as the dependent variable were very comparable to earlier studies. All coefficients had the expected sign and were statistically significant using a one-percent confidence interval. Average price, average size, price volatility, and the number of large trades (information) increased average spreads. The volume coefficient was negative and highly significant: both competition coefficients had considerable significance and the expected sign.

The results changed somewhat using an average liquidity premium measure as the dependent variable. In particular, the average price and volume coefficients, though maintaining their significance, lost much of it. The average size coefficient became negative. Presumably, larger trades were able to benefit from discounting, which was captured when

Table 5

Daily Time Frame Regressions

Dependent Variable	Log Avg. Price	Log Avg. Size	Log Exchange Volume	Price Volatility	Block Volume	HHI	ACTIVE2	Durbin-Watson	Adjusted R-Square
Avg. NYSE Spread	0.2838 (68.72)	0.0732 (11.92)	-0.1513 (-64.34)	0.0006 (4.015)	8E-05 (11.92)	0.3143 (15.01)	-0.0379 (-19.18)	0.901	0.5647
Avg. NYSE Liq. Premium	0.1703 (26.23)	-0.1203 (-12.49)	-0.0424 (-11.48)	0.0054 (24.39)	2E-05 (17.39)	0.2771 (8.439)	-0.0455 (-14.65)	1.4	0.2241
Avg. Boston Liq. Premium	0.1381 (14.98)	0.0565 (7.763)	-0.0668 (-14.59)	0.0169 (28.58)	0.0002 (2.917)	-0.1351 (-2.534)	-0.0385 (-9.983)	1.87	0.168
Avg. Cincinnati Liq. Premium	0.0153 (1.331)	-0.0789 (-7.646)	-0.0039 (-0.622)	0.0004 (0.789)	0.0004 (8.627)	-0.1955 (-2.597)	-0.0777 (-9.132)	1.51	0.046
Avg. Midwest Liq. Premium	0.2553 (31.37)	-0.0469 (-3.855)	-0.0553 (-7.376)	0.0002 (0.879)	1E-05 (9.542)	-0.1974 (-4.673)	-0.0494 (-12.00)	1.66	0.209
Avg. Nasdaq Liq. Premium	0.1349 (23.10)	0.0369 (6.216)	-0.0504 (-13.46)	0.1349 (2.655)	5E-05 (2.831)	-0.2654 (-7.397)	-0.0377 (-10.84)	1.74	0.1597
Avg. Pacific Liq. Premium	0.2524 (32.53)	-0.1121 (-11.66)	0.0361 (7.574)	0.0118 (7.363)	0.0002 (3.315)	-0.2196 (-4.975)	-0.0592 (-16.19)	1.79	0.1594
Avg. Philadelphia Liq. Premium	0.2088 (25.46)	-0.0086 (-1.17)	-0.0076 (-1.69)	0.0006 (1.466)	6E-05 (1.378)	0.0025 (0.051)	-0.058 (-15.20)	1.79	0.1253

Note: Regressions using shaded competition variable were run separately.

the liquidity premium measure was used. Both competition coefficients maintained their appropriate signs, though their significance was reduced slightly.

Moving to the regional regressions, the equations generally had greater difficulty explaining average liquidity premiums (as measured by the R-squared statistic), particularly the Cincinnati exchange. One interesting result was the superior explanatory power of the ACTIVE2 competition measure compared to HHI. For all non-NYSE exchanges, the ACTIVE2 coefficient had the anticipated sign and was highly significant. Conversely, five of the regional regressions derived an unanticipated sign for the HHI coefficient.[69]

Except for the Pacific exchange, the regional volume coefficient always had the anticipated sign and in three of the regressions, it was statistically significant using a one-percent confidence interval. Regional price volatility, average price and block volume coefficients always had the anticipated sign and were usually significant. The results for the regional average size variable were mixed.

E. Summary of Replication Results

Based on results in this chapter, it appears that data from 1992 confirm results from earlier studies. Statistically significant price differences were still present. In general, the results were quite comparable to Lee, though many average liquidity premium differences were larger in this study. This may be attributable to the smaller size of the sample. The

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[69]Additional regressions were performed using both competition measures simultaneously. This did not alter the general results; the regional competition coefficients were very similar to regressions using the measures separately. However, an F-test revealed that five of the six regional regressions had a statistically better fit using both competition variables in the regressions, compared to using only the ACTIVE2 variable. This result appears to be driven by the large number of observations; the differences in the sum of squared error terms was negligible. However, there was a much larger difference between these two terms comparing regressions using only HHI to those using both competition variables.

major difference between the two sets of results was that (1) data from 1992 did not find worse average execution for all non-NYSE exchanges for the smallest trade size class and (2) all non-NYSE exchanges paid much higher liquidity premiums for large trades.

Competition was found to significantly reduce NYSE liquidity prices, whether they were measured using a spread or liquidity premium measure. In general, most regression coefficients had the expected signs. However, regressions had a considerably more difficult time explaining average liquidity premiums, presumably due to unpredictable discounting behavior as the liquidity premium measure should essentially equal half the spread unless discounting was involved. Regional regressions were similar to the NYSE regression, though generally the variables had less explanatory power.

Using the average daily spread as the dependent variable, NYSE volume and competition elasticities were quite similar to earlier studies. The NYSE volume elasticity was equal to -.1513 while the HHI competition elasticity was equal to .41 (using the average value of .77) and the ACTIVE2 elasticity was equal to approximately -.01 (average value of 5.02). A ten percent increase in the HHI measure will increase the dependent variable by 4.1 percent, or 0.87 cents, given the average NYSE spread of 21.2 cents. If two less exchanges are active on average, it will increase the dependent variable by .4 percent, or .08 cents.[70] For the regional regressions, the elasticity of ACTIVE2 was approximately equal to -.01.

The dominant exchange and fringe competitors seem to have different views of competition based on the superior explanatory power of the ACTIVE2 competition measure

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[70]These results are consistent with Hamilton (1979). Hamilton, using the number of marketmakers trading the stock as a measure of competition, derived net competition elasticities between -.02 and -.04 and a volume elasticity of -.07. Branch and Freed (1977), derived a competition elasticity of -.17 (using the number of exchanges that trade the stock) and a volume elasticity of -.02 using the relative spread as a dependent variable.

in the fringe regressions. Apparently, NYSE market share or overall volume dispersion does not matter to the regionals, only that some or most of them are active. The two measures most likely capture different phenomena. Compared to ACTIVE2, the HHI variable may not capture the queuing and free-riding process that occurs when the market for a stock is active, which serves to increase non-NYSE activity and "competition." Queuing and free-riding are most likely associated with tight spreads and lower liquidity premiums, hence the significance of the ACTIVE2 coefficient on reducing local liquidity premiums. This finding is consistent with the view of these exchanges as a competitive fringe. Presumably, if one or two regional exchanges finds it attractive to compete, free-ride or benefit from queuing on the NYSE, most do.

The volume variable had noticeably less explanatory power in the regional regressions compared to the NYSE. It is possible that sporadic regional trade activity increases the correlation between the volume and competition measures, reducing the explanatory power of both variables. This possibility is examined in the next chapter.

CHAPTER 5

PRICE DISPERSION IN THE SECURITIES INDUSTRY

Chapter 4 established a number of results regarding the determinants of spreads and/or liquidity premiums in the securities industry. One of the stronger results was that competition had a similar and significant impact on liquidity premiums across all exchanges (as measured by the sign, significance and size of the ACTIVE2 competition coefficient). Most other explanatory variables also had similar impacts on liquidity premiums across exchanges. This result is noteworthy given the large disparity in trade volume between the exchanges. In general, it seems to imply that the exchanges are integrated to a substantial degree.

Yet, this implication contradicts another result from Chapter 4: statistically and economically significant price differences. As noted in Chapter 3, in an environment where competition seems to constrain or reduce prices on individual exchanges; competition should also serve to reduce price differentials between exchanges. In the case of the securities industry, price differences should in fact approach zero because technology largely eliminates transaction or transport costs between exchanges.

Chapter 5 continues to examine the coexistence of these two results now that the empirics from earlier studies have been confirmed. The relevant issue now becomes the proper interpretation of the empirical results. Should price dispersion be interpreted as an indictment of the Law of One Price, or is another explanation responsible, such as a failure to define the market properly?[71] Using this framework, the nature of competition within the securities industry is explored.

A. The Law of One Price

Researchers often use two standard assumptions to characterize industry conduct and performance: competitive markets and the Law of One Price. In most cases, these assumptions are not unrealistic and simplify the task of studying industry dynamics. The competitive market assumption states that individual firms (exchanges) do not have power over price, but must take the market price as given. The Law of One Price states that for any product, there can exist only one market price at any point in time. Although the two assumptions are technically independent, it is assumed for the purposes of this analysis that a competitive market is a sufficient condition for the Law of One Price to hold in the securities industry. That is, price dispersion can exist only if the industry is not competitive.[72]

The structure of an industry determines whether or not it is competitive and can be characterized as a single market. Specifically, four structural characteristics are necessary to allow competition to exist: (1) a homogeneous product; (2) low transaction costs; (3) many buyers and sellers; and (4) complete information. If the industry encompasses these four structural characteristics, then the conditions within the industry are such that it should be competitive and the Law of One Price can take effect. Conversely, if any one structural

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[71]For the analysis in this chapter, it is implicitly assumed that the individual exchanges comprise a single market. Following Stigler and Sherwin (1985), the market for the good is defined as "the area within which the price of a good tends to uniformity, allowance being made for transportation costs."

[72]In the context of this analysis, competition implies that activity on other exchanges effectively reduces liquidity premiums and liquidity premium differentials between exchanges.

characteristic does not hold, then the industry need not be competitive, and price dispersion may result.

The first two structural characteristics are assumed to hold in this analysis. The quality of matched trades was held constant using a two-minute time frame and size breakdowns. Transaction (and transportation, assumed negligible) costs are more troublesome because they are unobservable. There may be costs associated with the decision to transact on exchanges or with other parties with whom the broker does not normally deal, more generally a principal-agent phenomenon. Dealers or brokers may have reciprocal relationships with counterparts on a particular exchange, hence they may not actively search for best execution.

Unfortunately, there is no acceptable method to measure or address these costs, assuming they exist in some meaningful form. However, if these costs do exist, they are more likely to have a greater impact on smaller exchanges: these exchanges have thinner markets, tend to deal primarily in smaller trades (hence the cost of paying higher liquidity premiums due to transaction costs for any one trade is smaller) and most likely transact on behalf of less sophisticated parties compared to the NYSE. Based on the empirical results from the previous section, it does not appear that these costs systematically affect smaller off-board trades. Therefore, transaction costs are regarded as negligible and price differences should approach zero if competition is effective in this industry.

B. Structural Characteristics Three and Four: Complete Information and Many Buyers and Sellers; The Local Market Hypothesis

The simple model used earlier depicted the securities industry as being led by a dominant exchange (NYSE) followed by fringe competitors. Clearly, complete information does not exist within the context of this model. Given this information asymmetry, a pertinent question is how much asymmetry exists. Is there enough information asymmetry, or enough of an information lag between exchanges, that non-NYSE exchanges can be characterized as separate local markets? Alternatively, does the ITS ensure adequate integration?

The local market hypothesis proceeds in two separate, but related steps. The first step uses regressions to explain average liquidity premiums on the individual exchanges. Time frames are shortened from daily to half-day to hourly averages. The purpose of these regressions is to (1) establish the effect that shorter time frames have on coefficient values, (2) provide a benchmark for local market regressions and (3) provide a more consistent basis (in terms of time frames) for comparisons between price difference results and the effect competition has on individual exchange liquidity premiums. It is hypothesized that reducing time frames will increase the explanatory power of the volume and competition variables, particularly for the regional exchanges. This should occur because shorter time frames (1) reduce the correlation between these two variables, (2) allow the analysis to more accurately identify when activity actually occurs on non-NYSE exchanges (their competitive position may change during the day based on market activity) and (3) limit any bias in the competition coefficient attributable to non-price competition from non-NYSE exchanges.

The second step tests the formal local market hypothesis. Regressions are used once more to explain average exchange liquidity premiums, but now a set of fringe and dominant exchange explanatory variables are included simultaneously. Given the modeling of the NYSE as a dominant exchange, prices on the fringe should be responsive to information and activity at this market center. If they are not, then this provides evidence that these exchanges are more properly viewed as local markets.[73]

A few notes regarding the methodology are in order. The competition measure (ACTIVE2) again includes threshold values. For the daily time frame, an exchange had to trade at least 1,000 shares in a given stock to be considered active. For the half-day time frame the threshold was 400 shares; for hourly it was 200 shares.[74] In the first set of regressions which establish trends in coefficients moving to smaller time frames, competition coefficients appear shaded or unshaded following the convention used in the previous chapter.

For local market regressions using two sets of explanatory variables, only the average price on the regional was included due to the high correlation between average prices on regional exchanges and the NYSE (a correlation of one was not uncommon). Also, these regressions include only the ACTIVE2 competition measure because this measure seems to have superior explanatory value (compared to the HHI measure) regarding regional liquidity premiums. Finally, due to space constraints, Durbin-Watson statistics were not included for either set of regressions: values typically ranged between 1.8 and 1.9.[75]

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[73]Unfortunately, the local market hypothesis cannot be tested rigorously. Claiming that regional conditions have a greater impact on local liquidity premiums involves a certain amount of discretion. This is true for any analysis that attempts to measure the extent of a market. Regarding the definition of a single market, Stigler and Sherwin (1985, p. 562) noted that "no unique criterion exists. . . . (m)arkets can show every level of interdependence from absolute homogeneity to complete independence." Therefore, the classification of the separate exchanges as a single market necessarily involves the use of some discretionary judgement.

[74]The smallest possible trade is equal to 100 shares. For an exchange to be considered "active," threshold values force exchanges to trade at an average hourly rate slightly greater than the smallest trade. Hence, the daily threshold level, which encompasses seven hourly time periods, is set at 1,000 and the half-day threshold level, which encompasses three to four hourly time periods, is set at 400.

[75]It is possible that reducing time frames will introduce serial correlation, in turn reducing the significance of coefficients. This may occur if large or small values of a particular

1. The Effect of Shorter Time Frames

Tables 6a-g list results from the first set of regressions. (Daily results are listed again for comparative purposes.) T-statistics appear in parenthesis below coefficient values. Table 6a lists results for NYSE regressions using both an average spread and liquidity premium measure as the dependent variable. In general, all coefficients had the expected signs and most did not change appreciably moving to smaller time frames: all coefficients were statistically significant using a one-percent confidence interval no matter the time frame used. However, both competition coefficients tended to increase in size and significance moving to an hourly time frame when the NYSE liquidity premium was used as a dependent variable.

Tables 6b-g lists results for regional regressions. Many of the regional regression results were similar to the NYSE. Again, most coefficients had the expected signs. Most regional average price, price volatility and block trade coefficients remained positive and statistically significant moving to smaller time frames.

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variable (e.g., volume) are not independent of values in time periods that precede or follow it. This analysis did not find a problem with serial correlation moving to smaller time frames.

Table 6a

NYSE OLS Regression Results

Dependent Variable	Log Avg. NYSE Price	Log Avg. NYSE Size	Log NYSE Volume	Avg. NYSE Volatility	NYSE Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Daily Time Frame								
Log of Spread	0.2838 (68.72)	0.0733 (11.92)	-0.1513 (-64.33)	0.0006 (4.015)	0.0001 (11.92)	0.3143 (15.01)	-0.0379 (-19.18)	0.5647
Log of Average Liquidity Prem.	0.1703 (26.23)	-0.1203 (-12.49)	-0.0424 (-11.47)	0.0054 (24.39)	2E-05 (17.39)	0.2771 (8.439)	-0.0455 (-14.65)	0.2241
Half-Day Time Frame								
Log of Spread	0.2997 (90.04)	0.0937 (21.55)	-0.1448 (-80.36)	0.0009 (5.54)	1E-06 (13.43)	0.2691 (18.48)	-0.0427 (-28.22)	0.4807
Log of Average Liquidity Prem.	0.1761 (31.64)	-0.0904 (-12.49)	-0.0450 (-14.91)	0.0014 (5.348)	3E-05 (22.16)	0.2468 (10.18)	-0.0422 (-16.68)	0.1298
Hourly Time Frame								
Log of Spread	0.2679 (122.59)	0.0750 (33.35)	-0.1112 (-93.33)	0.0017 (8.206)	3E-05 (18.28)	0.1785 (21.13)	-0.0356 (-36.48)	0.2810
Log of Average Liquidity Prem.	0.0865 (23.03)	-0.1287 (-32.93)	-0.0130 (-6.37)	0.0334 (9.391)	0.0001 (32.18)	0.3567 (24.45)	-0.1258 (-14.98)	0.0660

Note: Regressions using shaded competition variable were run separately.

Table 6b

Boston OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1381 (14.98)	0.0565 (7.763)	-0.0668 (-14.59)	0.0169 (28.58)	0.0002 (2.917)	-0.1351 (-2.534)	-0.0385 (-9.982)	0.168

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1235 (16.67)	0.0617 (0.062)	-0.0729 (-19.60)	0.0018 (3.161)	0.0003 (4.032)	-0.1809 (-4.723)	-0.0466 (-14.81)	0.103

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.0868 (16.10)	0.0952 (23.54)	-0.103 (-35.09)	0.0016 (3.49)	0.0005 (6.261)	-0.0387 (-1.795)	-0.0388 (-20.27)	0.1122

Note: Regressions using shaded competition variable were run separately.

Exhibit 6c

Cincinnati OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.0153	-0.0789	-0.0039	0.0004	0.0004	-0.1955	-0.0777	0.047
Liquidity Prem.	(1.331)	(-7.646)	(-0.622)	(0.789)	(8.627)	(-2.597)	(-9.132)	

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.0098	-0.0483	-0.0329	0.0002	0.0006	-0.1729	-0.0644	0.0559
Liquidity Prem.	(1.13)	(-6.257)	(-6.869)	(1.348)	(10.51)	(-3.446)	(-10.56)	

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.027	0.0211	-0.0723	5E-05	0.0006	-0.0943	-0.044	0.084
Liquidity Prem.	(4.831)	(4.254)	(-19.61)	(0.392)	(10.54)	(-3.88)	(-17.42)	

Note: Regressions using shaded competition variable were run separately.

Table 6d

Midwest OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.2726 (36.43)	-0.006 (-0.761)	-0.0499 (-9.802)	0.0469 (14.29)	0.0001 (4.488)	-0.1975 (-4.673)	-0.0622 (-19.49)	0.209

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.2405 (39.32)	-0.0138 (-2.218)	-0.0497 (-12.12)	0.0635 (16.84)	0.0002 (7.117)	-0.1286 (-4.06)	-0.0709 (-28.04)	0.1649

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1754 (43.96)	0.0175 (4.265)	-0.0697 (-22.15)	0.0845 (19.50)	0.0003 (9.60)	-0.0759 (-4.434)	-0.0545 (-33.51)	0.114

Note: Regressions using shaded competition variable were run separately.

Table 6e

Nasdaq OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1349 (23.10)	0.0369 (6.216)	-0.0504 (-13.45)	0.1349 (2.655)	5E-05 (2.831)	-0.2654 (-7.397)	-0.0377 (-10.84)	0.1603

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1219 (25.36)	0.0401 (8.108)	-0.0477 (-15.71)	0.0019 (4.269)	6E-05 (2.991)	-0.1439 (-5.360)	-0.0325 (-11.82)	0.0935

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.0801 (25.13)	0.0532 (15.92)	-0.0559 (-24.06)	0.0015 (4.738)	4E-05 (1.699)	-0.0917 (-6.336)	-0.0137 (-8.734)	0.045

Note: Regressions using shaded competition variable were run separately.

Exhibit 6f

Pacific OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.2524 (32.53)	-0.1121 (-11.65)	0.0362 (7.574)	0.0118 (7.363)	0.0002 (3.315)	-0.2196 (-4.975)	-0.0592 (-16.19)	0.1599

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.2406 (38.22)	-0.0843 (-11.49)	0.0157 (4.026)	0.0163 (9.148)	0.0002 (3.320)	-0.1354 (-4.145)	-0.0548 (-18.36)	0.1233

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average Liquidity Prem.	0.1866 (45.73)	-0.0111 (-2.239)	-0.0369 (-11.51)	0.0875 (24.78)	0.0002 (4.23)	0.075 (4.224)	-0.0443 (-25.68)	0.089

Note: Regressions using shaded competition variable were run separately.

Exhibit 6g

Philadelphia OLS Regression Results

Daily Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.2088	-0.0086	-0.0076	0.0006	6E-05	0.0025	-0.058	0.1259
Liquidity Prem.	(25.46)	(-1.17)	(-1.692)	(1.466)	(1.378)	(0.051)	(-15.19)	

Half-Day Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.1782	0.0054	-0.0185	0.0007	0.00011	0.0904	-0.0457	0.077
Liquidity Prem.	(26.709)	(0.896)	(-4.967)	(1.58)	(2.234)	(2.433)	(-11.47)	

Hourly Time Frame

Dependent Variable	Log Avg. Reg. Price	Log Avg. Reg. Size	Log Reg. Volume	Avg. Reg. Volatility	Reg. Block Trades	HHI	ACTIVE2	Adjusted R-Squared
Log Average	0.1545	0.0317	-0.0368	0.0013	0.0001	0.0991	-0.0414	0.0715
Liquidity Prem.	(32.28)	(7.082)	(-12.055)	(2.357)	(2.133)	(4.88)	(-21.99)	

Note: Regressions using shaded competition variable were run separately.

However, there were also some noticeable differences between the NYSE and regional regressions. While the NYSE average trade size coefficient was negative and significant at all time frames, most regional average trade size coefficients were positive and significant (except the Pacific), particularly at smaller time frames. This result may occur because larger trades are able to benefit from discounting on the NYSE, but must pay a premium on the smaller exchanges where traders prefer to deal in smaller-sized trades that contain less information. The shorter time frames are able to capture this discounting behavior. This result in consistent with the price difference calculations from Table 4.

Perhaps most interesting was the behavior of the volume and competition coefficients. For all regional exchanges, the volume coefficient became noticeably more significant and (slightly) larger at shorter time frames (regardless of the competition measure used), whereas the significance of the NYSE volume coefficient did not change appreciably (using liquidity premiums as the dependent variable). The ACTIVE2 competition measure maintained its superiority compared to an HHI measure moving to an hourly time frame. In four of six regional regressions, the HHI coefficient did not attain the expected sign using an hourly time frame. Conversely, both competition variables had significant explanatory power and the expected sign in the NYSE regressions, no matter the time frame.[76]

2. Summary of Regressions Using Shorter Time Frames

Reducing time frames to explain average liquidity premiums does not seem to affect greatly NYSE coefficients. In particular, the volume coefficient did not change appreciably,

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[76]Regressions were also performed using both competition measures simultaneously. The competition coefficients did not change appreciably compared to the regressions where they were used separately. F-tests revealed similar findings to those performed for the daily regressions in Table 5.

although both competition coefficients gained size and significance (using the liquidity premium as the dependent variable). However, for the regional regressions, shorter time frames had a much stronger impact, especially for the volume and average trade size coefficients. For all regional exchanges, the volume coefficient became much more significant using shorter time frames (except Nasdaq), while the average trade size coefficient tended to become positive and more significant. The superiority of the ACTIVE2 competition measure also became clear using hourly averages.

Given these expected results, it is argued that hourly time frames improve the accuracy of coefficient estimates, particularly competition, regional trade volume (due to sporadic trade activity) and regional average trade size coefficients. Though R^2 statistics are generally lower using hourly time frames, only at these time frames do coefficients have similar impacts on liquidity premiums across regional exchanges.

Based on these results, the first explanation for statistically significant price differences in a competitive industry environment is dismissed. When time frames were shortened from daily to hourly values, the competition coefficient gained significance. Hence, the coexistence of these two empirical results is not attributable to the different time frames used to derive these results.

3. The Local Market Hypothesis

The local market hypothesis tests whether observed price dispersion can be attributed to the pooling of data across several local markets. To test this hypothesis, two assumptions are made. First, it is assumed that the dominance of the NYSE is great enough so that NYSE cost and demand conditions can serve as a proxy for the entire industry.[77] Second, it is assumed that dealers on individual exchanges face downward sloping demand curves and will adjust prices to reflect them.

To test the local market hypothesis, a set of regional and NYSE explanatory variables are included simultaneously in regressions using local average liquidity premiums as the dependent variable. The local market hypothesis will not be rejected if fringe coefficients are statistically superior compared to their NYSE counterparts when explaining local liquidity premiums. For this analysis, the sign, significance and size (in order of importance) of the respective coefficients are used as the primary criteria to determine the extent of the market. Conversely, the local market hypothesis will be rejected if NYSE explanatory variables are as good or better predictors of local liquidity premiums. Tables 7a-f present results from local market regressions. The discussion that follows is limited to hourly time frame results as these are considered to be the most pertinent.

The first two variables in Tables 7a-f are average regional price and competition. Both coefficients had the expected sign and were statistically significant for all exchanges using hourly time frames. The average trade size coefficients were positive and statistically significant for the regional (except for the Pacific exchange) variables; the NYSE average trade size coefficient was negative and significant. The regional volume coefficients were negative and highly significant for all exchanges; the NYSE volume coefficient was negative and significant in only one of the six regressions (Midwest).

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[77]Obviously, this assumption may not hold in many instances. However, though conditions may differ across exchanges, all that is required is that the differences are not great enough to force a particular regional exchange to adjust its price. Given the discrete nature of prices in this industry, this is not unrealistic.

Table 7a

Regional Market Test, Boston

Daily Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size Regional	Log Average Trade Size NYSE	Log Volume Regional	Log Volume NYSE	Average Volatility Regional	Average Volatility NYSE	Block Trades Regional	Block Trades NYSE	Adjusted R-Squared
Log Avg. Daily Liq. Prem.	-0.0315 (-5.669)	0.111 (10.21)	0.0645 (8.705)	-0.1183 (-7.495)	-0.0752 (-15.32)	0.0084 (0.853)	0.0165 (27.93)	0.0004 (1.063)	0.0001 (1.81)	8E-06 (5.064)	0.1768

Half-Day Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size Regional	Log Average Trade Size NYSE	Log Volume Regional	Log Volume NYSE	Average Volatility Regional	Average Volatility NYSE	Block Trades Regional	Block Trades NYSE	Adjusted R-Squared
Log Avg. Half-Day Liq. Prem.	-0.0388 (-9.028)	0.1089 (12.72)	0.073 (11.51)	-0.0886 (-7.591)	-0.082 (-19.71)	0.0008 (0.112)	0.0013 (2.346)	0.0003 (1.105)	0.0002 (2.97)	2E-05 (6.964)	0.111

Hourly Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size Regional	Log Average Trade Size NYSE	Log Volume Regional	Log Volume NYSE	Average Volatility Regional	Average Volatility NYSE	Block Trades Regional	Block Trades NYSE	Adjusted R-Squared
Log Avg. Hourly Liq. Prem.	-0.0349 (-14.14)	0.0874 (14.88)	0.0988 (23.76)	-0.0339 (-5.160)	-0.1067 (-34.69)	-0.0073 (-1.669)	0.0016 (3.471)	0.0003 (0.894)	0.0004 (5.70)	2E-05 (8.546)	0.1155

Figure 7b

Regional Market Test, Cincinatti

Daily Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Daily Liq. Prem.	-0.0863 (-9.59)	-0.0338 (-2.505)	-0.0379 (-3.357)	-0.2017 (-8.629)	-0.0416 (-5.146)	0.0624 (3.981)	0.0002 (0.495)	0.0002 (0.871)	0.0004 (7.773)	1E-05 (5.027)	0.0593

Half-Day Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Half-Day Liq. Prem.	-0.0683 (-10.42)	-0.0132 (-1.328)	-0.0189 (-2.223)	-0.1248 (-7.814)	-0.059 (-9.512)	0.0229 (2.074)	0.0001 (0.942)	-0.0001 (-0.424)	0.0005 (9.354)	2E-05 (7.812)	0.0644

Hourly Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Hourly Liq. Prem.	-0.0432 (-14.80)	0.0288 (4.735)	0.0283 (5.396)	-0.0203 (-2.665)	-0.0793 (-19.56)	-0.006 (-1.123)	4E-05 (0.399)	0.0002 (0.629)	0.0005 (9.533)	2E-05 (8.773)	0.0868

Table 7c

Regional Market Test, Midwest

Daily Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Daily Liq. Prem.	-0.0373 (-8.955)	0.2731 (31.07)	0.006 (0.704)	-0.0515 (-3.863)	-0.0478 (-8.036)	-0.0479 (-5.552)	0.0487 (14.88)	-6E-06 (-0.026)	4E-05 (1.664)	1E-05 (9.997)	0.2231

Half-Day Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Half-Day Liq. Prem.	-0.0531 (-16.02)	0.2378 (33.75)	8E-05 (0.013)	-0.0586 (-6.013)	-0.0554 (-11.91)	-0.0285 (-4.39)	0.0657 (17.41)	0.0002 (0.852)	0.0001 (4.181)	2E-05 (12.52)	0.1758

Hourly Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Hourly Liq. Prem.	-0.046 (-22.99)	0.1754 (39.40)	0.0293 (6.95)	-0.0544 (-10.57)	-0.0773 (-23.81)	-0.0121 (-3.489)	0.0872 (20.05)	4E-05 (0.117)	0.0002 (7.020)	4E-05 (16.37)	0.1233

Table 7d

Regional Market Test, Nasdaq

Daily Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Daily Liq. Prem.	-0.0292	0.1036	0.0722	-0.1282	-0.0773	0.0307	0.0009	0.0003	1E-05	1E-05	0.1804
	(-7.834)	(14.77)	(10.72)	(-11.51)	(-15.85)	(3.918)	(2.276)	(1.767)	(0.713)	(9.509)	

Half-Day Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Half-Day Liq. Prem.	-0.0297	0.0947	0.0729	-0.1108	-0.0756	0.035	0.0017	0.0004	2E-05	2E-05	0.1077
	(-10.08)	(16.75)	(13.06)	(-13.04)	(-18.97)	(5.746)	(4.038)	(1.839)	(1.064)	(10.55)	

Hourly Time Frame

Dependent		Log Average	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted
Variable	ACTIVE2	Reg. Price	Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	R-Squared
Log Avg. Hourly Liq. Prem.	-0.0115	0.0805	0.0595	-0.0275	-0.0608	-0.0044	0.0014	0.0004	3E-06	2E-05	0.0486
	(-6.789)	(22.57)	(16.50)	(-6.189)	(-22.91)	(-1.414)	(4.769)	(1.447)	(0.135)	(12.07)	

Figure 7e

Regional Market Test, Pacific

Daily Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Daily Liq. Prem.	-0.0433 (-9.535)	0.2394 (25.12)	-0.1037 (-10.25)	-0.0739 (-5.348)	0.0356 (6.228)	-0.0189 (-2.133)	0.0123 (7.68)	0.0003 (1.245)	0.0001 (2.694)	5E-06 (4.016)	0.1678

Half-Day Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Half-Day Liq. Prem.	-0.0491 (-13.39)	0.2173 (28.92)	-0.0681 (-8.815)	-0.0917 (-8.856)	0.0041 (0.904)	0.0075 (1.103)	0.0164 (9.297)	0.0005 (1.852)	0.0001 (2.396)	1E-05 (6.682)	0.1304

Hourly Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Hourly Liq. Prem.	-0.0498 (-23.95)	0.1654 (35.66)	0.0067 (1.401)	-0.0848 (-15.92)	-0.0509 (-15.11)	0.0228 (6.273)	0.0865 (24.52)	0.0007 (2.126)	0.0001 (2.577)	3E-05 (13.37)	0.0944

Figure 7f

Regional Market Test, Philadelphia

Daily Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Daily Liq. Prem.	-0.0381 (-7.604)	0.2072 (21.66)	0.0006 (0.077)	-0.0622 (-4.206)	-0.0172 (-3.253)	-0.029 (-3.125)	0.0006 (1.423)	0.0004 (1.619)	2E-05 (0.464)	1E-05 (7.842)	0.1352

Half-Day Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Half-Day Liq. Prem.	-0.0473 (-10.40)	0.1725 (22.52)	0.0172 (2.639)	-0.0414 (-3.656)	-0.0304 (-6.951)	0.0068 (0.902)	0.0006 (1.363)	0.0004 (1.591)	5E-05 (1.188)	1E-05 (5.993)	0.0804

Hourly Time Frame

Dependent Variable	ACTIVE2	Log Average Reg. Price	Log Average Trade Size		Log Volume		Average Volatility		Block Trades		Adjusted R-Squared
			Regional	NYSE	Regional	NYSE	Regional	NYSE	Regional	NYSE	
Log Avg. Hourly Liq. Prem.	-0.0434 (-18.61)	0.1562 (30.08)	0.0386 (8.316)	-0.016 (-2.592)	-0.044 (-13.54)	0.0011 (0.278)	0.0012 (2.107)	0.0012 (2.951)	6E-05 (0.919)	2E-05 (9.992)	0.0748

The regional average volatility coefficients were positive and significant in five out of six regressions; the NYSE average volatility coefficient was positive and significant in only two (Pacific and Philadelphia) of the regressions. In these instances, the regional average volatility coefficient was slightly larger. The regional block trade coefficients were positive and significant in four of the six regressions; the NYSE block trade coefficient was positive and significant in all regressions. In the regressions where both coefficients obtained the expected sign and were significant, the coefficient values were roughly equal in magnitude. However, because the average NYSE block trades value is much larger, its elasticity will tend to be smaller given the semi-log specification.

4. Summary of Local Market Hypothesis

These results do not provide strong support for the local market hypothesis: only the behavior of the regional volume coefficient suggests strongly that local conditions are superior predictors of local prices.[78] However, this result may be a simple manifestation of cream skimming behavior (selective market making) and queuing on the NYSE. Non-NYSE exchanges tend to become more active only when conditions are favorable: in active markets, lower spreads and in smaller trades. Because they pick up relatively more volume when inventory carrying and price risk costs are minimized, it is not surprising that regional volume is strongly associated with lower liquidity premiums.

Still, it would seem that NYSE volume should have more of an impact on regional liquidity premiums because it characterizes whether or not the industry is generally active.

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[78]Regressions were also performed using regional and NYSE explanatory variables separately to explain local average liquidity premiums. An F-test revealed that regressions using both sets of variables had significantly better explanatory power compared to regressions using either set of variables alone. However, this result appears to be driven by the large number of observations.

When the industry is more active, price information is disseminated, shrinking the NYSE information advantage and reducing price risk and inventory carrying costs for those who trade on the regionals. However, NYSE volume may not capture the type of activity that reduces these costs because heavy volume may be comprised of a few large trades on the NYSE. Heavy volume comprised of many smaller trades would help the competitive position of the fringe more because they can benefit from price information, queuing on the NYSE and avoid information traders. Therefore, a more accurate measure of trade activity and its corresponding effect on the regional exchanges may be the number of transactions that take place within a time frame for a given size class. This is consistent with Hamilton (1979).

CHAPTER 6

CREAM SKIMMING BEHAVIOR

This chapter explores the third explanation for statistically significant price differences in what appears to be a competitive industry environment. This explanation holds that competition measures are inherently flawed because they capture cream skimming or selective market making activity. These terms describe the phenomenon where regional trading activity *and* price performance relative to the NYSE are systematically dependent on the activity of the trade environment. To examine the cream skimming hypothesis, this analysis uses two variables (and a competition variable) to capture the conduciveness of the trade environment to cream skimming behavior. These variables are then used to explain hourly average price differences in order to quantify their impact given that one exchange offers better or worse average execution (i.e., there exists a non-zero average price difference).

A. Capturing Trade Activity: New Calculation of Liquidity Premium Differentials

In order to derive liquidity premium differentials, this paper used a scheme that matched similar-sized regional trades to NYSE trades occurring one minute before or after the regional trade. While this matching technique provides useful information, it has several drawbacks, particularly when used in an analysis of cream skimming behavior. The two main drawbacks are as follows.

First, in order to derive a single average liquidity premium difference for a given size class, two averaging calculations were required. If more than one NYSE trade was matched to a regional trade, then the NYSE liquidity premiums were averaged to derive a single liquidity premium difference. These individual liquidity premium differences were then averaged again to obtain yearly averages. The weakness of this approach is that it does not capture the intensity of trading surrounding a regional trade. That is, the matching scheme treats a regional trade matched to one NYSE trade the same as a regional trade matched to ten NYSE trades. Clearly, the two scenarios may reflect different trading environments.

Second, the older matching scheme derived only one average liquidity premium difference between two exchanges. Yet, one liquidity premium difference may not accurately reflect execution quality on both exchanges simultaneously. For example, an average liquidity premium difference of one cent indicates that on average, regional execution is one cent higher than the NYSE. However, average regional execution that is one cent higher than average NYSE execution need *not* imply that the average NYSE trade also receives one cent better execution. This may occur if regional execution (relative to the NYSE) is dependent upon whether the trade environment is active or slow, as measured by the number of matched NYSE trades. The example below illustrates how this result may occur.

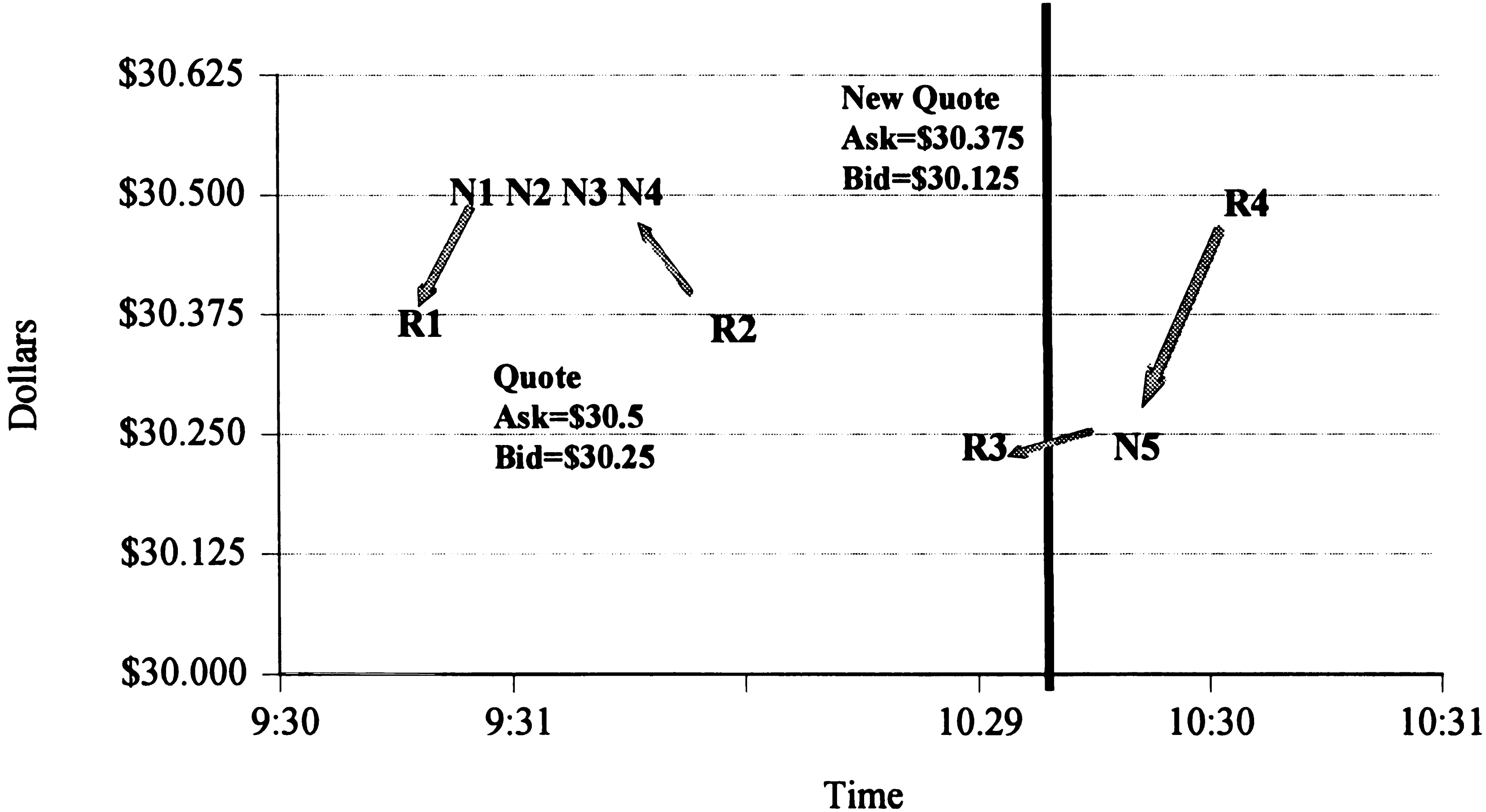
To counter these drawbacks, a new matching scheme is employed in this chapter. The most important feature of this new technique is that it does *not* average matched NYSE trades. As a result, if regional execution (relative to the NYSE) is dependent upon trade activity, then the price difference calculation will be weighted in the appropriate direction to reflect this. In addition, the derivation of a price difference for trades occurring on each exchange allows the analysis to identify the exchange that benefits or suffers from this new weighting of trades.

An example illustrates the new matching technique and how it differs from the technique used earlier. In this example, regional execution improves when many NYSE trades surround a regional trade (constructed purposely to mimic the data). Figure 3 shows a hypothetical situation where trading occurs at 9:30 and 10:30. For simplicity, regional (R) trades are assumed to occur on the same regional exchange and all trades are assumed to be in the same size class. Arrows indicate the trade that is used for matching purposes.

Assume a regional trade occurs at 9:30:10 (R1) at the midspread of $30.375. The matching scheme records the price conditions (transaction price and midspread) on the regional but does not consider this trade "matched" because the outstanding price conditions on the NYSE are unknown.

The regional price conditions are then extended out one minute. If a NYSE trade occurs within the minute, then the matching scheme records one matched trade that occurred on the NYSE (assuming it is within the same size class). If a NYSE trade does not occur within one minute, then the regional price conditions are discarded and the program again looks to identify price conditions on both exchanges.

Figure 3
Liquidity Premiums Differences Using Trading Intensity



Returning to Figure 3, assume four trades occur on the NYSE at 9:30:30 at $30.50. The price conditions on both exchanges are now known and the program registers four matched trades that occurred on the NYSE that paid an excess liquidity premium of 12.5 cents each compared to the most recent regional price conditions. A regional trade at 9:31 (R2) is also matched and the regional price conditions are updated. This trade received 12.5 cents superior execution compared to the most recent NYSE price conditions.

At 10:30, another regional trade occurs (R3). Again, the regional price conditions are recorded, but the trade is not considered matched. The NYSE trade at 10:30:40 at the new midspread is matched and receives 12.5 cents superior execution compared to the most recent regional price conditions (which used the older quote). The regional trade at 10:31 (R4) is also matched (50 cents worse than the NYSE).

A calculation of the average liquidity premium difference using the two matching schemes demonstrates the difference between them. Using the old matching scheme (where NYSE trades before *and* after regional trades are matched and an average is taken if more than one NYSE trade is matched), the average liquidity premium difference (regional minus NYSE liquidity premium) would be calculated as:

Old Technique $[(-12.5) + (-12.5) + (12.5) + (25)]/4 = 12.5/4 = 3.125$ cents

This result *does not* recognize the fact that superior regional execution took place in a more active trading environment because it averages the four matched NYSE trades. In addition, the result implies that *all* NYSE trades received 3.125 cents superior execution, when only a representative trade did.

Using the new matching scheme, an average difference can be calculated for matched trades that actually occurred on both exchanges:

Matched Trades on Regional [(-12.5) + (25)]/2 = 12.5/2 = 6.25 cents

Matched Trades on NYSE [4(-12.5) + (12.5)]/5 = -37.5/5 = -7.5 cents

This is a more accurate representation of the price differences for all matched trades that *actually* took place on the respective exchanges. The new matching technique captures the fact that superior regional execution takes place in a more active trade environment and adjusts the NYSE average price difference to reflect this. That is why we derive the unusual result that both exchanges seem to offer worse average execution.

To sum up, a matching scheme that does not average matched NYSE trades is necessary to examine cream skimming behavior of fringe competitors because execution quality on the regional exchanges may depend on NYSE trading intensities. Price difference calculations must be allowed to reflect this. If this behavior is present, it will manifest itself by making average NYSE execution look much worse. A matching scheme that derives a single liquidity premium difference and does not identify where a trade occurred is not helpful because worse average execution on one exchange automatically implies superior average execution on the other exchange of an equal magnitude.

B. Comparison of Different Matching Techniques

Table 8 depicts average liquidity premium differences for 1992 using the new matching scheme. The first column of Table 8 lists the matched pair of exchanges, with the first exchange representing the location of the matched trade. For example, the first pair of figures in the upper left-hand corner of Table 8 are listed as 45,130 and -1.6819. This indicates that 45,130 trades that occurred on the Boston exchange were matched to a NYSE trade in the 100 - 400 size class.

On average, these trades received 1.6819 cents better execution compared to trades on the NYSE using the most recent price conditions and a one minute time frame. Directly below are trades that actually occurred on the NYSE and were matched to a similar Boston trade. As shown, 67,281 trades occurred on the NYSE that had a match on the Boston exchange. These trades paid 4.998 more on average. Table 9 displays earlier results using the older matching technique for comparative purposes.

Comparing the matching techniques, two results become apparent. These results provide strong evidence that regionals improve their relative execution when many similar NYSE trades (in the same trade size category) surround regional trading:

1. Using the newer matching technique (Table 8), matched trades that actually occurred on the regionals are fairly close to the values using the old matching scheme in Table 9. Allowing for trading intensity by counting all matched NYSE trades within the time frame did not change relative execution for trades occurring on the regional/Nasdaq exchanges.

2. Using the newer matching technique, matched trades that actually occurred on the NYSE are much worse than the differences calculated using the old scheme. When trading intensity was allowed and all matched NYSE trades were counted, average NYSE execution suffered compared to average regional/Nasdaq execution. This result mimics the above example. Only for the largest size class does this result not hold; regional execution was still much worse.

Table 8

Average Liquidity Premium Differences, Trading Intensity Allowed
Time Matched Trades by Size Class, 1992

	Size Class									
	100 - 400		500-900		1000-1900		2000-4900		>5000	
Exchange	Number of Trades	Average Difference	Number of Trades	Average Difference	Number of Trades	Average Difference	Number of Trades	Average Difference	Number of Trades	Average Difference
Boston-NYSE	45,130	-1.6819 *	3,967	-2.4814 *	2,948	-1.4392 *	1,161	-0.9528 *	379	1.1708 *
NYSE-Boston	67,281	-4.9984 *	5,171	-4.7069 *	3,881	-4.8769 *	1,344	-1.13 *	460	2.8804 *
Cincinnati-NYSE	39,677	-0.02	5,629	-2.4005 *	5,064	-2.5657 *	1,044	-0.4969	483	3.3721 *
NYSE-Cincinnati	73,421	-3.179 *	7,982	-4.6945 *	7,154	-4.2678 *	1,606	-3.1055 *	680	1.6177 *
Midwest-NYSE	81,217	-0.1344 *	6,546	-2.0881 *	5,726	-1.1735 *	2,311	-0.5842 *	833	1.328 *
NYSE-Midwest	129,153	-3.1506 *	8,748	-3.3898 *	7,419	-2.9307 *	2,702	-1.6122 *	954	-0.3407
Pacific-NYSE	79,277	0.8113 *	7,932	-0.8092 *	5,231	-0.0048	1,439	0.4647 **	393	-0.0795
NYSE-Pacific	121,203	-2.6885 *	10,585	-2.722 *	7,596	-1.9089 *	1,851	-0.9995 *	333	0.7883
Nasdaq-NYSE	154,678	-0.1564 *	10,288	-1.123 *	8,209	-0.3944 *	2,852	0.4101 *	758	1.5089 *
NYSE-Nasdaq	228,181	-2.8208 *	15,395	-3.1021 *	11,445	-1.1721 *	3,751	-0.6282 *	791	1.6988 *
Philadelphia-NYSE	41,597	0.5561 *	2,821	0.2304	1,843	0.6581 *	677	1.6433 *	387	3.2946 *
NYSE-Philadelphia	79,426	-1.9849 *	4,171	-1.3291 *	2,786	-1.2579 *	847	-0.3318	443	3.5694 *

* Denotes statistical significance using a one-percent confidence interval.
** Denotes statistical significance using a five-percent confidence interval.

Table 9

Average Liquidity Premium Differences
Time Matched Trades by Size Class, 1992

	Size Class									
	100 - 400		500-900		1000-1900		2000-4900		>5000	
Exchange	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference	Matched Regional Trades	Average Difference
Boston	93,622	-1.4867 *	9,976	-1.923 *	6,841	-1.436 *	2,641	-0.4656 *	926	1.5105 *
Cincinnati	79,174	-0.0190	14,723	-2.5777 *	11,622	-2.4376 *	2,488	-0.3126 **	1,316	3.2979 *
Midwest	174,118	0.1362 *	17,803	-1.7293 *	14,069	-1.4533 *	5,460	-0.254 **	2,175	1.4148 *
Pacific	160,969	0.6100 *	21,210	-0.9367 *	13,288	-0.1851 **	3,594	0.462 *	771	0.7796 *
Nasdaq	318,166	-0.1167 *	30,443	-0.7618 *	20,730	-0.125 **	7,236	0.6011 *	1,761	2.1179 *
Philadelphi	88,489	0.7166 *	7,616	0.089	4,716	0.5869 *	1,621	1.1251 *	981	2.9487 *

* Denotes statistical significance using a one-percent confidence interval.
** Denotes statistical significance using a five-percent confidence interval.

Although some of the liquidity premium differences in Tables 8 and 9 differ significantly, the only real difference between the two matching schemes is the weighting of matched NYSE observations and the fact that the second technique uses a matching time frame half as long. However, price differences calculated using the older matching technique were invariant between a one-minute, two-minute and five-minute time frame: different time frames only changed the total number of matched trades. Therefore, the different results are solely attributable to the equal weighting of all matched NYSE trades and using most recent price conditions.

The results in Tables 8 and 9 demonstrate that regional exchanges tend to offer better execution in an environment characterized by active NYSE trading activity. When all matched NYSE trades were counted (Table 8), the average liquidity premium difference for trades occurring on the NYSE grew noticeably worse, while the average liquidity premium differences for trades occurring on the regional exchanges did not change appreciably. These results strongly suggest some type of cream skimming behavior: the regional exchanges not only choose to "compete" in active markets, but also tend to offer better execution at these times. This behavior makes it possible for statistically significant liquidity premium differences to exist between exchanges because the fringe offers competition or better execution only some of the time.

C. The Cream Skimming Hypothesis

To examine cream skimming activity, two variables are used to explain average hourly liquidity premium differentials.[79] These variables capture (1) market activity, (2) the

[79]Half-hour averages were also analyzed, but they did not change the general conclusions.

ability of non-NYSE exchanges to free-ride from price information, (3) any benefit arising from the queuing of order flow on the NYSE and (4) the lower spreads and risk associated with active markets. They are as follows:

TRADES sum of number of matched NYSE trades during the hour (per stock)

TOTVOL sum of all trade volume on all exchanges, need not be matched (per stock)[80]

The TRADES variable captures specific activity on the NYSE exchange based on the number of matched transactions that occurred there. It is anticipated that the TRADES coefficient will be negative in most cases, reducing price differentials, no matter the exchange offering better execution. As the number of TRADES grows large, the market becomes very active, forcing spreads and liquidity premiums to their minimum values and liquidity premium differentials to zero.

The TOTVOL variable captures all general trade activity over the time frame that can be used for price information or inventory adjustment purposes. This measure includes volume on *all* exchanges and in *all* size classes. It is hypothesized that the TOTVOL measure will also have a negative impact on price differentials, particularly when regionals can use this information to reduce information asymmetry. A competition measure (ACTIVE2) is included to test the explanatory power of this measure relative to cream skimming variables.[81] The dependent variable is equal to the log of the average liquidity premium difference (regional minus NYSE liquidity premium).

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[80]This modeling assumes that these variables are exogenous. It is possible that smaller liquidity premiums (and smaller liquidity premium differentials, potentially equalling zero if spreads are at their minimum level) attract more trading. However, this analysis omits zero liquidity premium differentials where this possibility may be most problematic.

[81]Regressions were also performed using the HHI competition variable. The results were very similar to those using the ACTIVE2 competition measure.

1. Splitting of Data

Based on the results from Table 8, cream skimming by regional exchanges manifests itself through poorer average NYSE execution: average liquidity premium differences for trades occurring on the regionals were not affected greatly. Because regionals appear to offer better execution in more active markets and the effects manifest themselves through worse average execution for trades occurring on the NYSE, the complete price difference data set for each exchange and size class was split into two smaller data sets: (1) matched trades occurring on the NYSE that received better average execution and (2) matched trades occurring on the NYSE that received worse average execution. This split allows the three explanatory variables to have different impacts on the dependent variable depending on the exchange offering better execution over the time frame.[82]

This split ignores observations where the average liquidity premium difference equaled zero. While this will most likely result in omission of some useful information, it is recognized that the data set is quite limited in its ability to characterize an environment as conducive to cream skimming behavior. As a result, it is not rich enough to incorporate zero liquidity premium differences in the analysis; there may be some relevant variables that were omitted. In addition, the discrete nature of pricing in the industry causes a fairly wide range of explanatory variables to be associated with zero liquidity premiums differences. Therefore, the results that follow are conditional on non-zero liquidity premium differences.

When the data sets were split in this fashion, one of the data sets contained negative liquidity premium differentials (when the NYSE gave worse average execution). To ease

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[82]The data sets were also split in a similar manner for trades occurring on the regional exchanges. Regressions using these data also tend to support the contention that regional trading and execution is dependent on overall NYSE activity, though results are generally weaker.

the interpretation of the regression coefficients, these differences were converted into positive values. Using this conversion, all coefficients may be interpreted in a similar manner; in both regressions, a negative coefficient reduces price differentials (given that one exchange offered better average execution).

Tables 10a-f list average values for variables of interest. As shown, when the NYSE offers worse average execution, the average liquidity premium difference tends to be much larger, as are the TRADES and TOTVOL variables. (P-values indicate the probability that these variables are *not* larger when the NYSE offer worse average execution.) The greater number of matched NYSE TRADES that take place during time frames when the NYSE offers worse average execution weighs down the average NYSE execution, as in the previous example. This is especially true for the smallest trade size class, where the number of TRADES is very different depending on the exchange offering better average execution. However, even though the TRADES and TOTVOL variables tend to be larger on average when the regionals offer better execution, a pertinent question is whether their effects are statistically different depending on the exchange offering better execution.

Table 10a

Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Boston

			Average Hourly Liquidity Premium Difference		Hourly TRADES		Hourly TOTVOL (000s)	
Execution	**Size Class**	**Number of Observations**	**Average**	**p-value**	**Average**	**p-value**	**Average**	**p-value**
NYSE Worse Execution*	100 - 400	5,113	7.9	0.001	10.0	0.001	2,860.5	0.001
NYSE Better Execution		2,161	6.3		5.5		1,860.4	
NYSE Worse Execution*	500 - 900	430	13.7	0.001	3.8	0.001	4,620.4	0.001
NYSE Better Execution		287	8.5		1.9		2,870.5	
NYSE Worse Execution*	1000 - 1900	363	13.6	0.001	3.5	0.001	4,772.4	0.001
NYSE Better Execution		272	8.4		1.9		3,307.1	
NYSE Worse Execution*	2000 - 4900	127	12.9	0.001	2.2	0.029	4,529.7	0.034
NYSE Better Execution		159	8.7		1.7		3,754.9	
NYSE Worse Execution*	>5000	28	10.0	0.409	2.1	0.221	4,744.1	NA
NYSE Better Execution		107	9.6		1.8		5,186.0	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesis is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse execution.

Table 10b

Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Cincinnati

			Average Hourly Liquidity Premium Difference		Hourly TRADES		Hourly TOTVOL (000s)	
Execution	Size Class	Number of Observations	Average	p-value	Average	p-value	Average	p-value
NYSE Worse Execution*	100 - 400	1,939	8.0	0.001	13.1	0.001	3,402.2	0.001
NYSE Better Execution		2,287	5.9		7.2		2,286.8	
NYSE Worse Execution*	500 - 900	1,245	9.6	0.001	2.7	0.001	2,733.7	0.456
NYSE Better Execution		545	8.1		1.9		2,717.7	
NYSE Worse Execution*	1000 - 1900	1,036	10.9	0.001	3.0	0.001	4,163.6	0.001
NYSE Better Execution		467	7.2		1.9		3,005.2	
NYSE Worse Execution*	2000 - 4900	167	11.8	0.001	2.9	0.001	5,336.7	0.001
NYSE Better Execution		211	9.1		1.5		3,754.2	
NYSE Worse Execution*	>5000	37	9.4	0.436	3.1	0.001	8,107.0	0.001
NYSE Better Execution		168	9.2		1.6		4,166.4	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesis is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse execution.

Table 10c

Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Midwest

Execution	Size Class	Number of Observations	Average Hourly Liquidity Premium Difference: Average	Average Hourly Liquidity Premium Difference: p-value	Hourly TRADES: Average	Hourly TRADES: p-value	Hourly TOTVOL (000s): Average	Hourly TOTVOL (000s): p-value
NYSE Worse Execution*	100 - 400	3,783	8.1	0.001	13.3	0.001	2,670.8	0.001
NYSE Better Execution		5,477	6.7		7.4		1,768.7	
NYSE Worse Execution*	500 - 900	1,150	12.6	0.001	2.7	0.001	3,358.8	0.001
NYSE Better Execution		788	9.6		1.9		2,827.6	
NYSE Worse Execution*	1000 - 1900	847	11.0	0.001	2.8	0.001	3,356.5	0.001
NYSE Better Execution		598	9.1		1.9		2,678.5	
NYSE Worse Execution*	2000 - 4900	326	10.5	0.129	2.5	0.001	4,508.9	0.018
NYSE Better Execution		340	9.8		1.7		3,756.8	
NYSE Worse Execution*	>5000	72	11.5	0.348	1.9	0.007	5,968.5	0.001
NYSE Better Execution		200	11.0		1.4		1,067.5	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesis is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse execution.

Table 10d

Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Nasdaq

			Average Hourly Liquidity Premium Difference		Hourly TRADES		Hourly TOTVOL (000s)	
Execution	**Size Class**	**Number of Observations**	**Average**	**p-value**	**Average**	**p-value**	**Average**	**p-value**
NYSE Worse Execution*	100 - 400	5,633	7.0	0.001	16.8	0.001	2,470.7	0.001
NYSE Better Execution		7,676	5.2		9.8		1,672.4	
NYSE Worse Execution*	500 - 900	1,367	11.9	0.001	3.8	0.001	3,421.4	0.001
NYSE Better Execution		1,368	9.0		2.3		2,537.1	
NYSE Worse Execution*	1000 - 1900	951	10.8	0.001	3.6	0.001	3,774.4	0.001
NYSE Better Execution		1,158	8.9		2.3		2,814.1	
NYSE Worse Execution*	2000 - 4900	306	12.2	0.001	2.8	0.001	4,728.6	0.001
NYSE Better Execution		567	9.3		1.8		3,753.7	
NYSE Worse Execution*	>5000	57	12.2	0.356	1.9	0.029	5,169.3	0.288
NYSE Better Execution		170	11.7		1.5		4,640.1	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesis is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse execution.

Table 10e

Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Pacific

			Average Hourly Liquidity Premium Differen		Hourly TRADES		Hourly TOTVOL (000s)	
Execution	Size Class	Number of Observations	Average	p-value	Average	p-value	Average	p-value
NYSE Worse Execution*	100 - 400	2,678	8.0	0.001	12.6	0.001	2,678.3	0.001
NYSE Better Execution		5,384	6.9		7.0		1,895.9	
NYSE Worse Execution*	500 - 900	1,316	12.2	0.001	2.7	0.001	3,156.6	0.054
NYSE Better Execution		960	10.5		2.2		2,949.3	
NYSE Worse Execution*	1000 - 1900	760	11.4	0.044	3.1	0.001	3,906.6	0.001
NYSE Better Execution		777	10.5		2.3		3,334.8	
NYSE Worse Execution*	2000 - 4900	191	12.8	0.161	2.3	0.013	5,268.7	0.001
NYSE Better Execution		249	11.6		1.8		3,998.6	
NYSE Worse Execution*	>5000	28	10.2	NA	2.0	0.159	4,916.2	NA
NYSE Better Execution		53	11.9		1.5		5,546.2	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesi is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse executio

Table 10f

**Average Values for Liquidity Premium Difference Regressions
Trades Occuring on NYSE with Matches on Philadelphia**

Execution	Size Class	Number of Observations	Average Hourly Liquidity Premium Differen: Average	Average Hourly Liquidity Premium Differen: p-value	Hourly TRADES: Average	Hourly TRADES: p-value	Hourly TOTVOL (000s): Average	Hourly TOTVOL (000s): p-value
NYSE Worse Execution*	100 - 400	2,137	8.6	0.001	12.9	0.001	3,140.2	0.001
NYSE Better Execution		4,459	7.4		5.8		1,974.8	
NYSE Worse Execution*	500 - 900	388	13.7	0.001	2.8	0.001	4,021.3	0.001
NYSE Better Execution		499	10.5		2.0		3,144.2	
NYSE Worse Execution*	1000 - 1900	243	12.4		3.0	0.001	5,236.1	0.001
NYSE Better Execution		361	11.6		1.8		3,623.6	
NYSE Worse Execution*	2000 - 4900	83	12.5	0.371	2.4	0.001	5,174.8	0.382
NYSE Better Execution		153	12.0		1.5		4,927.9	
NYSE Worse Execution*	>5000	18	10.8	NA	1.4	NA	5,321.1	0.440
NYSE Better Execution		128	10.9		1.5		5,145.0	

* Average liquidity premium difference (regional - NYSE) measure converted into positive value. P-values indicate the probability that the null hypothesis is rejected. The null hypothesis states that the TRADES, TOTVOL and average liquidity premium difference are larger when NYSE offers worse execution

2. Cream Skimming Regressions

The term cream skimming, as it is used in this analysis, describes the phenomenon where regional execution relative to the NYSE improves in an environment characterized by active trading. In other words, the quality of regional execution is directly dependent on NYSE activity. Given this definition, the following hypotheses are tested:

Hypothesis 1 *The number of TRADES reduces price differentials to a greater extent when the NYSE offers better average execution.*

> This result reflects the different impact that increased NYSE activity has on regional exchanges. If the NYSE is able to offer superior execution (due to information advantages or hidden liquidity), increasing NYSE activity significantly reduces this advantage. However, if for some reason the regional is already competitive with the NYSE, increased NYSE trades disseminate little new information that is helpful. In either case, the TRADES coefficient will be negative simply because many TRADES force liquidity premiums to their minimum level and price differentials down to zero.

Hypothesis 2 *TOTVOL increases price differences in favor of regional exchanges, no matter the exchange offering superior average execution.*

> This variable may provide less information, but the information can be used nonetheless. TOTVOL includes all volume in the stock during the hour, no matter the size of the trade or the exchange. Given that TRADES is held constant, the fact that TOTVOL actually improves regional execution relative to the NYSE is not that surprising, especially for the smallest size class.

Hypothesis 3 *The number of matched NYSE TRADES has the greatest impact on reducing price differentials for the smallest sized trades.*

> Regional exchanges prefer to deal in smaller trades because these trades are less likely to have originated from information traders, thereby lowering the traders risk and costs to trade. In addition, smaller trades have less potential impact on inventories.

Tables 11a-f list the results for the cream skimming regressions. As an example of how to interpret the results, consider Table 11a. The first entry is for the data set that contains observations for trades matched between the Boston and NYSE exchanges where the Boston exchange gave better execution (column 1). This data set includes observations that actually occurred on the NYSE (column 2) for trades in the 100 - 400 size class (column 3). Columns that follow list coefficient and t-statistic values for the TRADES, TOTVOL and ACTIVE2 variables (the TRADES, TOTVOL and dependent variables are log transformations). Adjusted-R^2 statistics are listed as well. Due to space constraints, Durbin-Watson statistics were omitted; values typically ranged between 1.6 and 1.9.

To test the three hypotheses, simple one-sided t-tests were used. These tests are meant only to demonstrate that the variables of interest have a significantly different effect depending on the exchange offering better average execution. The hypotheses simply compare regressions either within a particular trade size class (Hypotheses 1 and 2) or across trade size classes (Hypothesis 3). Table 12 lists the results of the tests. A value of "1" indicates that the first hypothesis was confirmed for that size class while a value of "2" or "3" denotes that the second or third hypothesis held. (The third hypothesis only compares regressions in which the NYSE offered better average execution across size classes.)

Table 11a

Liquidity Premium Difference Regressions, Boston Matches Between Boston and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Boston	NYSE	100 to 400	-0.3581 (-27.13)	0.2842 (14.82)	-0.2499 (-13.93)	0.161
NYSE	NYSE		-0.738 (-50.08)	-0.0527 (-3.281)	-0.032 (-2.746)	0.592
Boston	NYSE	500 to 900	-0.032 (-2.388)	0.0708 (1.181)	-0.1381 (-2.264)	0.021
NYSE	NYSE		-0.685 (-12.44)	0.0410 (0.985)	-0.11 (2.69)	0.402
Boston	NYSE	1000 to 1900	-0.085 (-1.417)	0.0637 (1.063)	-0.038 (-0.583)	-0.002
NYSE	NYSE		-0.5615 (-9.249)	-0.0410 (-0.903)	0.0686 (1.417)	0.267
Boston	NYSE	2000 to 4900	-0.3028 (-3.019)	0.1963 (2.088)	-0.1242 (-1.133)	0.0574
NYSE	NYSE		-0.5088 (-5.667)	0.0758 (1.316)	-0.0029 (-0.044)	0.1563
Boston	NYSE	5000 and greater	-0.4072 (-1.545)	0.1203 (0.559)	-0.058 (-0.305)	0.002
NYSE	NYSE		-0.4065 (-3.374)	0.1523 (1.757)	-0.1318 (-1.516)	0.0797

Table 11b

Liquidity Premium Difference Regressions, Cincinnati
Matches Between Cincinatti and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Cincinnati	NYSE	100	-0.4168	0.307	-0.1225	0.144
		to	(-17.69)	(8.82)	(-3.197)	
		400				
NYSE	NYSE		-0.7165	-0.0069	-0.0057	0.546
			(-49.68)	(-0.346)	(-0.305)	
Cincinnati	NYSE	500	-0.1438	0.0787	-0.055	0.017
		to	(-4.506)	(2.810)	(-1.98)	
		900				
NYSE	NYSE		-0.5861	0.0739	-0.0219	0.293
			(-14.947)	(2.562)	(-0.777)	
Cincinnati	NYSE	1000	-0.1402	0.0093	0.0115	0.016
		to	(-4.035)	(0.264)	(0.276)	
		1900				
NYSE	NYSE		-0.6977	0.0827	-0.0359	0.365
			(-16.21)	(2.434)	(-0.90)	
Cincinnati	NYSE	2000	-0.1008	0.0489	0.1235	0.006
		to	(-1.19)	(0.566)	(1.269)	
		4900				
NYSE	NYSE		-0.5121	0.0558	0.0764	0.189
			(-6.99)	(1.252)	(1.591)	
Cincinnati	NYSE	5000	-0.1171	-0.0381	0.3037	-0.003
		and	(-0.839)	(-0.268)	(1.425)	
		greater				
NYSE	NYSE		-0.5199	-0.0145	0.011	0.186
			(-5.809)	(-0.229)	(0.165)	

Table 11c

Liquidity Premium Difference Regressions, Midwest
Matches Between Midwest and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Midwest	NYSE	100	-0.286	0.2122	-0.2418	0.128
		to	(-16.96)	(9.001)	(-11.82)	
		400				
NYSE	NYSE		-0.6032	-0.0687	-0.0464	0.531
			(-61.46)	(-5.658)	(-4.56)	
Midwest	NYSE	500	-0.1246	0.0689	-0.0799	0.017
		to	(-3.731)	(2.252)	(-2.913)	
		900				
NYSE	NYSE		-0.5967	0.0249	-0.0617	0.278
			(-15.829)	(0.924)	(-2.464)	
Midwest	NYSE	1000	-0.1834	0.0846	-0.0697	0.031
		to	(-4.966)	(2.326)	(-2.174)	
		1900				
NYSE	NYSE		-0.5411	0.0324	-0.0576	0.213
			(-11.969)	(0.917)	(-1.795)	
Midwest	NYSE	2000	-0.0395	0.0111	-0.0038	-0.008
		to	(-0.622)	(0.194)	(-0.067)	
		4900				
NYSE	NYSE		-0.5738	0.0895	-0.0496	0.177
			(-8.483)	(2.143)	(-1.207)	
Midwest	NYSE	5000	-0.1517	0.0287	-0.0127	-0.029
		and	(-0.977)	(0.229)	(-0.088)	
		greater				
NYSE	NYSE		-0.3231	-0.0191	-0.0233	0.038
			(-2.922)	(-0.284)	(-0.415)	

Table 11d

Liquidity Premium Difference Regressions, Nasdaq
Matches Between Nasdaq and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Nasdaq	NYSE	100	-0.3275	0.2945	-0.2402	0.131
		to	(-21.26)	(13.42)	(-13.46)	
		400				
NYSE	NYSE		-0.666	-0.041	-0.0323	0.553
			(-73.97)	(-3.426)	(-3.486)	
Nasdaq	NYSE	500	-0.2479	0.158	-0.1128	0.049
		to	(-7.87)	(4.683)	(-3.611)	
		900				
NYSE	NYSE		-0.6243	0.0041	-0.0078	0.343
			(-24.28)	(0.186)	(-0.423)	
Nasdaq	NYSE	1000	-0.2091	0.0427	-0.0324	0.042
		to	(-5.945)	(1.093)	(-0.958)	
		1900				
NYSE	NYSE		-0.5319	0.0159	-0.0466	0.275
			(-17.93)	(0.634)	(-2.246)	
Nasdaq	NYSE	2000	-0.2419	0.1119	-0.0488	0.035
		to	(-3.648)	(1.742)	(-0.739)	
		4900				
NYSE	NYSE		-0.465	0.0666	-0.0273	0.148
			(-9.647)	(1.864)	(-0.852)	
Nasdaq	NYSE	5000	-0.2644	0.0987	-0.195	0.012
		and	(-1.267)	(0.720)	(-1.28)	
		greater				
NYSE	NYSE		-0.3666	-0.0089	-0.0639	0.081
			(-3.189)	(-0.135)	(-1.019)	

Table 11e

Liquidity Premium Difference Regressions, Pacific
Matches Between Pacific and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Pacific	NYSE	100	-0.3216	0.2004	-0.1824	0.121
		to	(-18.51)	(7.909)	(-8.532)	
		400				
NYSE	NYSE		-0.6591	0.0392	-0.0669	0.489
			(-61.82)	(2.808)	(-5.912)	
Pacific	NYSE	500	-0.175	0.0291	-0.0097	0.025
		to	(-5.786)	(1.081)	(-0.372)	
		900				
NYSE	NYSE		-0.562	0.073	-0.039	0.219
			(-15.87)	(2.547)	(-1.48)	
Pacific	NYSE	1000	-0.1967	0.0737	-0.0023	0.028
		to	(-4.911)	(1.801)	(-0.60)	
		1900				
NYSE	NYSE		-0.431	0.1278	-0.1026	0.150
			(-11.22)	(3.65)	(-3.211)	
Pacific	NYSE	2000	-0.0553	-0.0454	0.0635	-0.009
		to	(-0.616)	(-0.571)	(0.728)	
		4900				
NYSE	NYSE		-0.5128	0.1609	0.0914	0.170
			(-6.795)	(2.965)	(1.466)	
Pacific	NYSE	5000	0.1361	-0.3131	0.0492	-0.024
		and	(0.593)	(-1.40)	(0.304)	
		greater				
NYSE	NYSE		-0.6502	0.1436	0.0252	0.111
			(-3.075)	(1.265)	(0.238)	

Table 11f

Liquidity Premium Difference Regressions, Philadelphia Matches Between Philadelphia and NYSE Exchanges
Log of Average Hourly Liquidity Premium Difference as Dependent Variable

Exchange Giving Better Execution	Location of Matched Trades	Size Class	TRADES	TOTVOL	ACTIVE2	Adjusted R-squared
Philadelphia	NYSE	100 to 400	-0.2428 (-10.92)	0.1591 (5.081)	-0.1733 (-5.516)	0.073
NYSE	NYSE		-0.5769 (-50.54)	-0.0333 (-2.412)	-0.0402 (-3.344)	0.456
Philadelphia	NYSE	500 to 900	-0.1101 (-2.163)	-0.0206 (-1.425)	0.0222 (0.424)	0.013
NYSE	NYSE		-0.4263 (-9.528)	0.0062 (0.434)	-0.004 (-0.132)	0.155
Philadelphia	NYSE	1000 to 1900	-0.1667 (-2.305)	0.1113 (1.572)	-0.0452 (-0.612)	0.010
NYSE	NYSE		-0.5874 (-9.669)	0.1282 (2.929)	-0.0437 (-0.868)	0.202
Philadelphia	NYSE	2000 to 4900	-0.0153 (-0.139)	0.2551 (2.366)	-0.1378 (-1.152)	0.040
NYSE	NYSE		-0.4006 (-3.49)	0.0894 (1.40)	-0.1192 (-1.742)	0.069
Philadelphia	NYSE	5000 and greater	0.3952 (1.034)	-0.1098 (-0.526)	0.2299 (0.933)	-0.046
NYSE	NYSE		-0.3904 (-3.293)	-0.0176 (-0.221)	0.0611 (0.683)	0.076

Table 12

Summary of Cream Skimming Regressions

Exchange	**100 - 400**			**500 - 900**			**1000 - 1900**			**2000 - 4900**			**≥5000**		
Boston	1	2	na	1	2	3	1	2	3	1	2	3			3
Cincinnati	1	2	na	1	2	3	1		3	1		3	1		3
Midwest	1	2	na	1	2		1	2	3	1		3	1	2	3
Nasdaq	1	2	na	1	2	3	1	2	3	1	2	3	1	2	3
Pacific	1	2	na	1		3	1		3	1		3	1		
Philadelphi	1	2	na	1		3	1			1	2	3	1		3

Table 12 shows that 29 out of 30 pairs of regressions supported the first hypothesis while 18 out of 30 supported the second hypothesis and 21 out of 24 supported the third hypothesis. Based on these results, it appears that increased NYSE activity has different effects depending on the competitive position of the fringe and the size of the trade. Greater NYSE matched trades quickly erode price differences in favor of the NYSE while increases in TOTVOL actually increase price differences in favor of the regionals, given that the number of TRADES is held constant. These results tend to be strongest for the smallest trades. These results seem to confirm the general hypothesis that relative regional execution is dependent on the activity of the trading environment, as measured by the number of matched trades and total volume.

No formal hypothesis regarding the behavior of the competition measure was included in this analysis. However, based on the results in Tables 11a-f, its impact is quite small (particularly when compared to the TRADES coefficient) and trails off very quickly after regressions for the smallest size class.

D. Conclusions

This paper examined why statistically significant price differences exist in an industry where competition, as measured by an HHI variable or the number of exchanges that actively trade a given stock, appears competitive. Along the way, some interesting results were established. First, data from 1992 confirmed the general results of earlier studies: both competition measures still appear to effectively reduce NYSE spreads and liquidity premiums. Second, when a liquidity premium measure was used in place of the spread as a dependent variable, it did not change the general impact of the explanatory variables. Third, explanatory variables appear to have similar impacts on prices across all exchanges, except for the average trade size variable. Fourth, when time frames were shortened, the explanatory power of the regional volume and average trade size variables grew markedly while the NYSE volume and average trade size coefficients were not affected. In addition, the activity competition measure became superior to the alternative HHI measure. This finding was consistent with the view of non-NYSE exchanges as a single fringe competitor.

Statistically significant price differentials were also found to exist. This analysis rejected a local market explanation for this phenomenon: except for the regional volume variable, regional explanatory variables were not systematically superior to NYSE explanatory variables when explaining local liquidity premiums. To explain the price differentials, a new matching technique was used. This technique captured NYSE trade activity surrounding regional trades and established that superior regional execution occurs in a more active trade environment. This result suggests that regionals free-ride from NYSE activity and benefit from the queuing of order flow when the market is active.

This result led to an examination of cream skimming in these markets. Regressions demonstrated that regional exchanges use specific NYSE trade activity (TRADES) and general trade activity (TOTVOL) to improve their execution relative to the NYSE: their relative execution systematically depends on market activity. This cream skimming or selective market making behavior allows price differentials to exist while simultaneously permitting competition variables to appear effective in reducing prices.

Finally, this analysis also found that competition measures have relatively weak explanatory power compared to an activity measure, such as the number of trades that are occurring on the NYSE, when explaining price differences. This result calls into question the traditional method of measuring competition within the securities industry. Regional exchanges tend to trade or "compete" only in smaller trades or when the market for the stock is active.

Given this behavior, it is questionable whether or not the positive effects attributed to competition between exchanges is accurate, at least in terms of price measures. It is conceivable that order flow need not be fragmented to obtain the positive impacts attributed to competition between exchanges; volume effects and competition on the NYSE itself (from floor traders) may be enough to reduce the price of liquidity services to a magnitude similar to when order flow is fragmented. Evidence suggests that competition does not cause prices to fall, but rather regionals tend to trade when the market is active and spreads are tight. By trading on the regional exchanges in this environment, traders eliminate the possibility that they may benefit from hidden liquidity on the NYSE, which appears to be the one of the driving forces behind superior NYSE execution. If this observation is correct, then the costs and benefits associated with the fragmentation of order flow should be reexamined or reconsidered.

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