Electronic Commerce in the Retail Brokerage Industry: Trading Costs of Internet Versus Full Service Firms

Yannis Bakos
Henry C. Lucas, Jr.
Wonseok Oh
Sivakumar Viswanathan
Gary Simon

Stern School of Business
New York University

And

Bruce Weber

Zicklin School of Business
Baruch College,
City University of New York

November 1999

Working Paper Series
Stern #IS99-014

ELECTRONIC COMMERCE IN THE RETAIL BROKERAGE INDUSTRY: TRADING COSTS OF INTERNET VERSUS FULL SERVICE FIRMS[1]

Yannis Bakos, Henry C. Lucas, Jr., Wonseok Oh, Sivakumar Viswanathan, and Gary Simon

Stern School of Business, New York University
and

Bruce Weber

Zicklin School of Business
Baruch College, City University of New York

November 1999

Electronic brokerages on the Internet represent one of the most successful examples of electronic commerce, having captured over 20% of retail stock trades. According to economic theory, prices of commodities like securities should converge to one price in a market with the transparency of the Internet. A review of published commissions for online brokers shows that this "law of one price" does not appear to hold for the commissions charged by retail brokers. In this paper we explore one possible explanation for these differences in commissions. Specifically, we test whether the total cost of trading, including commissions and savings based on the quality of execution, obeys the law of one price. In a carefully designed experiment, we simultaneously purchased or sold 100 share lots of stock using a voice-broker, an expensive online broker and an inexpensive online broker in each trial. We found relatively few price improvements, which are a measure of execution quality. The difference among brokers in obtaining price improvements was not statistically significant. The brokers do exhibit statistically significant differences in total trading costs; at a volume of 100 shares commission costs dominate execution quality. We explore the implications of the findings for larger lot sizes, choosing a broker, and electronic commerce in the brokerage industry.

[1] The authors wish to thank Professor Ingo Walter and the Salomon Brothers Center at the Stern School for their support and willingness to underwrite the research reported in this paper.

ELECTRONIC COMMERCE IN THE RETAIL BROKERAGE INDUSTRY: TRADING COSTS OF INTERNET VERSUS FULL SERVICE FIRMS

Yannis Bakos, Henry C. Lucas, Jr., Wonseok Oh, Sivakumar Viswanathan, and Gary Simon

Stern School of Business, New York University
and

Bruce Weber

Zicklin School of Business
Baruch College, City University of New York

November 1999

Electronic commerce has the potential to revolutionize the way in which we acquire goods and services. One of the greatest successes in e-commerce has been Internet stock trading; it is estimated that nearly 20% of retail stock trades took place on-line at the end of 1998, and that on-line trades will grow to 49% by the end of 2000 (*Business Week*, 11/15/99). (Retail stock trades are those involving individual investors as opposed to trades conducted by financial institutions like mutual funds.) As of November 1999, Gomez Advisors lists 50 electronic brokers, including firms dedicated to online trading and full-service brokerage firms offering Internet trading directly or through a subsidiary (www.gomez.com).

The Internet facilitates price comparisons among different sellers (Bakos, 1997), and economic theory suggests that markets with low search costs and commodity products will move to a "Bertrand" equilibrium in which all sellers offer products at the same price (the "law of one price"). Shares of a certain type of stock are identical products regardless of the broker involved in buying or selling them. One would expect

that retail investors are aware of the availability of low commissions from electronic stock brokers, and thus full service brokers will be forced to reduce their prices to compete, leading to a convergence in the pricing structure of retail brokers. Exactly the opposite seems to be true as of late 1999: there are wide differences in advertised brokerage commissions on the Internet, and in general commissions at online brokers are significantly lower than commissions at traditional, full service brokers.

> *The purpose of this paper is to test whether pricing in the retail brokerage market is consistent with the "law of one price" characterizing a Bertrand-type of equilibrium in which all firms offer a commodity product at the same price.*

In the next section we suggest three possible explanations for why the one price law does not appear to hold in this market, and test one of them in a carefully designed experiment involving the simultaneous purchase and sale of stocks from different brokers. Specifically we test the hypothesis that the commissions advertised on the Internet differ widely because they do not represent the total cost of trading stock. In particular, the total cost of a trade includes the commission and the quality of execution of a trade (Friend, Irwin and Blume, 1973). One broker may be able to obtain a better price than another through the mechanism of a price improvement from posted bid/ask prices. This paper asks if the total cost of trading, consisting of commission and any savings based on the quality of execution, is consistent with an equilibrium characterized by the law of one price.

BACKGROUND AND THEORY

The retail brokerage industry in the U.S. has been traditionally characterized by two types of brokers: full service brokers like Merrill Lynch and Dean Witter, and discount brokers like Fidelity and Charles Schwab. Until the mid 1990s full service

brokers typically charged commissions of $150 or higher even for small trades of 100 shares, while the discount brokers often charged one half that amount or less.

The late 1990s saw the increasing popularity of online brokers like E*Trade, Datek and Accutrade, which use the Internet as the primary delivery channel for their services. These online brokers have substantially changed the competitive landscape; one of their most noticeable impacts has been the availability of deeply discounted commissions, as low as $7 per trade, which contrasts with the $100 and higher typical commission charged by full service brokers.

It can be argued that these brokers, whether full service or online, offer a commodity product: the shares purchased through any of them are for all practical purposes identical, as a share of IBM purchased through Merrill Lynch is identical to a share of IBM purchased through Datek. Economic theory predicts that in "ideal" commodity markets with several competing firms, competition will bring prices close to marginal costs (including a "fair" return on investment) (Bertrand, 1883). In the resulting "Bertrand" equilibrium all firms offer the commodity product at the same price (the "law of one price"). If a firm increases its price above this equilibrium price it would lose all of its customers as they flee to lower priced firms. If a firm were able to lower its price below the equilibrium price while still making a profit, perhaps because of superior technology compared to the other firms, it would capture the whole market, causing the exit of firms with a higher cost structure.

The variance of commission charges in the brokerage industry from under $8 to over $100 for the same 100-share trade (as of September 1999) clearly violates the law of

one price. In this paper we attempt to shed some light on this paradox. There are three broad classes of theoretical explanations for why the one-price law may not hold:

1. The current state of the retail brokerage market is not an equilibrium.

2. The law of one price does hold when differences in the quality of execution are taken into account.

3. The brokerage market is not an "ideal" commodity market as assumed in the economic model of Bertrand competition.

The first explanation asserts that the departure from the law of one price is a transient phenomenon; as customers move from high-priced brokers to low-priced brokers, the high priced brokers will either have to lower their prices or will have to exit the market. Market share data, which show a continuously increasing market share for online brokers, lend some support to this explanation.

The second possibility is that brokerage commissions are not the appropriate "prices" to study, as they do not represent the total cost to the consumer. Rational consumers care about the total cost of acquiring equities; if the quality of execution varies across brokers, then the brokers offering the best executions are able to charge higher commissions without losing customers to brokers charging lower commissions. The full service broker may be able to obtain better executions due to in-house crossing of trades, not selling order flow, access to institutional trading, better traders or better computer systems.

The third explanation asserts that the retail brokerage services market departs from the "ideal" Walrasian market postulated by economic theory. Reasons for this departure from the ideal include:

a. Products offered by different brokers, especially when comparing full service and online brokers, are not identical commodities, thus justifying a price differential (Hotelling, 1929). For example, customers may value the ability to transact with a human broker. In that case, full service brokers that offer their customers access to a human broker are able to capture some or all the additional utility they provide customers through higher commissions.

b. Customers in the retail brokerage market are not homogeneous. Their differences result in "separating" equilibria characterized by different prices (Diamond, 1987). For example, customers may differ in their value for the long history and prestige of the brand name of full service brokers, or the value they place on the services provided by full service brokers. In this case customers with high value for these services flock to the full service brokers, while customers with low (or negative) value for these services use online brokers. The commissions charged by the two types of brokers differ, reflecting the cost of the services offered by full service brokers. Notice that this example is different than the previous case, because the previous explanation assumes that *all* customers have the same preferences.

One special type of heterogeneity may be customers' ability to use an online broker, in terms of their computer literacy and the availability of reliable access to the Internet at the time they desire to place a trade. Another possibility is that price sensitive customers moved first to the lower priced online brokers, leaving only price insensitive customers behind.

c. Search costs (and resulting lack of information) may prevent customers from finding low cost sellers despite the large advertising budgets of online brokers (Pratt,

Wise and Zeckhauser, 1979; Stigler, 1961). The brokerage case is unlike the case for books, see Brynjolfsson and Smith, (1999).

d. Switching costs may prevent customers from changing their brokers. Customers often leave their securities with a broker and become accustomed to the reporting and information they receive. Moving one's securities or managing multiple brokerage accounts may act as a deterrent to switching.

In summary, commissions may be different even though the quality of execution may not differ because brokers who charge more expensive commission provide a different total service. It also may be that consumers (or at least the ones using traditional/expensive brokers) have high search costs, or face a high switching cost. Finally, customers of high commission brokers may be less price sensitive than other investors.

The experiment reported in this paper was designed to test the second explanation above. Specifically we ask whether the variance in commissions between brokers in general, and between full service and online brokers in particular, is due to differences in the quality of execution obtained by different types of brokers. Specifically, we test the hypothesis that

<total cost to consumer> = <commission> + <execution price>

obeys the law of one price across different brokers.

RESEARCH DESIGN

To test the hypothesis above, we need data on commissions and on the quality of execution. Internet brokers publish their brokerage commissions since they view them as a source of competitive advantage. Full service brokers are less open in publishing

commission schedules, though one can obtain them through a broker from one of these firms. When one executes a trade, the confirmation from the broker shows the applicable commission.

While past papers have used simulations to estimate the impact of different trading strategies (Battalio, et al., 1999), we felt that a proper test of the law of one price required actual stock trades in a controlled experimental setting. Comparing execution prices implies that one must execute identical trades at different brokers nearly simultaneously so that each broker faces the same market conditions and bid/ask spread executing the trade. Our strategy was to compare three types of brokers, full service brokers using a human intermediary, and two different types of online brokers. The experiment includes both NYSE and NASDAQ listed stocks.

The Salomon Brothers Center at the Stern School at NYU agreed to provide financing and working capital, $60,000 in total, for a controlled experiment. We opened six brokerage accounts for three different kinds of brokers: 1) two "voice brokers " who take orders the traditional way with the investor calling and speaking to a human broker, 2) two "expensive" online brokers, and 3) two "inexpensive" online brokers. In the paper, the voice brokers are designated as A and B, the expensive on-line brokers as J and K, and the inexpensive online brokers as Y and Z. Commissions for trading 100 shares were in the $50 range for the voice brokers, the $15 range for the expensive electronic brokers, and under $10 for the inexpensive electronic brokers.

The experimental design involved 64 trials, each placing three simultaneous buy or sell orders for 100 shares of the same stock, using a voice broker, a expensive online broker and an inexpensive online broker . In other words, each trial involved one of

brokers A and B, one of brokers J and K and one of brokers Y and Z. Out of the total 64 trials in the experiment, 32 were buy orders and 32 were sell orders for 32 different stocks. (Note that we did not have the ability to choose the stocks for sale; we had to sell the stocks that we had previously purchased.) The blocked design can be found in the appendix. The layout was completely balanced with respect to brokers and exchanges. For any dependent variable, such as price improvement, there are 192 values which consist of 16 buys and 16 sells for each of 6 brokers ((16+16) x 6 = 192). An analysis of variance model corresponding to the design has fixed effects for the six brokers, for the two listing exchanges and for buy versus sell. The model has random effects for the 32 individual stocks and for statistical noise.

We conducted the experiment over an eleven-day period during July and August, 1999. The experimenters worked in a room with a telephone and two computers with high-speed connections to the Internet. In the morning between 10:00 and 10:30, we selected stocks to purchase as specified in the experimental design. The selection came from the stocks in Standard and Poors Platinum and Fair Value Portfolios as listed in their newsletter, *Investor's Monthly*; the criteria for choosing a stock involved price, volume and spread. We chose securities priced under $50 so as not to exhaust our working capital at any one broker on a given day, and we selected stocks that showed active trading volume. We chose stocks with a spread of at least 1/8th, so that there was some potential for price improvement. All transactions were for a lot of 100 shares, which is one of the lot sizes retail customers frequently trade. Each trial comparing three brokers involved a different stock to remove any variation caused by the security being

purchased, and all trades were "at market." There were a total of 64 trials involving three brokers per trial for a total of 192 trades.

Each trial involved one voice broker, one expensive online broker and one inexpensive online broker. An experimenter at each computer completed the purchase screen for an online broker, pausing just before clicking on the button to submit the trade. The experimenter talking to the voice broker signaled when the broker indicated he had submitted the order, at which point the experimenters at each computer clicked to submit their trades. All three transactions were thus identical ("buy 100 shares of PRQ Corporation at the market") and were as close as humanly and electronically possible to being simultaneous (see below).

Beginning at approximately 3:30 PM in the afternoon, we simultaneously sold the stocks purchased in the morning so that we held no position longer than six hours. We recorded data identifying each broker, the bid/ask spread from the online brokers' real-time quotes and the voice broker's bid/ask spread just before the transaction. We also recorded the execution price and the commissions, which we verified when we received the printed trade confirmations.

The Bloomberg Terminal provides a detailed trace of transactions, and we copied this log for each of our trading sessions. Using this trace, it was possible to identify all three trades in 60 out of our 64 trials and to verify that they had been executed as closely together as possible. Table 1 shows the distribution of the time required for order execution for the 64 trials, each involving three brokers. Of the trades, almost 66% occurred within one minute of submission, and 87% within two minutes. There were no changes in the bid/ask quotes from the time we entered our trades until they executed,

except for two suspicious trades noted later in the paper. It appears that the experiment was successful in achieving nearly simultaneous trade execution for the three brokers in each trial.

Delay (minutes)	Count	Percentage
0 < x <= 1	42	65.6%
1 < x <= 2	14	21.9%
2 < x <= 3	2	3.1%
3 < x <= 4	1	1.6%
4 < x <= 5	1	1.6%
Unable to identify	4	6.3%

Distribution of Executions
Table 1

RESULTS

Price Improvement for Brokers

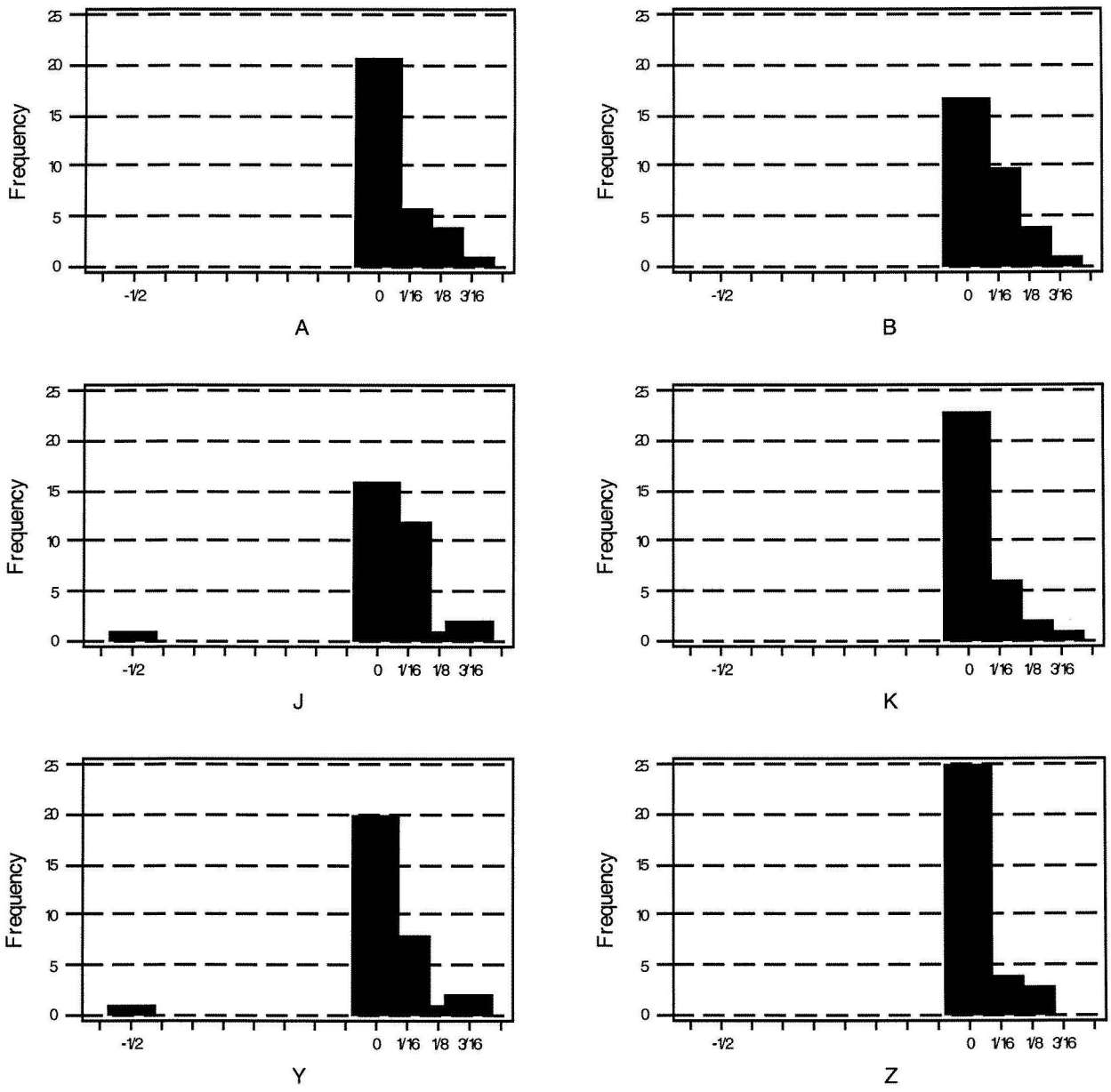
A broker obtains a price improvement when the execution price of a trade is better than the bid price for a sale or the ask price for a buy. For example, consider a stock that is quoted as $30 bid, $30 1/4 asked. This spread means that the specialist or market maker will buy shares of the stock for $30 and will sell them for $30.25 each. Assume two brokers have "buy" orders at the market price, and the first broker buys the stock at $30 1/4. The second broker is able to get a price of $30 3/16ths, and thus offers the customer a better execution. This second broker has obtained a "price improvement" of $1/16^{th}$ or 0.0625 per share. On a 100 share order, the improvement is $6.25. In this example the second broker has obtained a better execution price for the customer than the

first broker. An improvement like this occurs, for example, when a floor broker offers to sell at a better (lower) price than the specialist's ask price in order to sell stock.

Since published commissions differ across brokers, for the law of one price to hold, more expensive brokers must offer better execution than brokers with lower commissions. For the retail customer, price improvements are fundamental to better execution, and in this section we present the data on price improvements and compare them among brokers.

Figure 1 shows price improvements during trading for each of the six brokers. The most frequent improvement was none, and the most inexpensive e-broker executed at the bid or ask price for 25 of 32 trades. Note that two trades for the same stock placed through electronic brokers J and Y actually resulted in a negative improvement! In this instance, the trade executed outside of the quoted bid/ask spread as the NASDAQ market maker changed the spread as the order was received. This action was evident on the Bloomberg daily trace, and we sent letters asking for an explanation to each broker.[2] Because these prices are what an individual trading would have received, we did not adjust the data.

[2] It appeared to us that the market maker saw the orders coming and lowered the bid price for our two trades, raising it immediately afterwards. One broker did not respond to our letter and the other advised us to use limit orders rather than market orders.



Price Improvement by Broker
Figure 1

	Broker *J*	Broker *K*	Broker *Y*	Broker *Z*
Broker *A*	1/13/2 *W*=2.0	1/14/1 *W*=1.5	2/11/3 *W*=7.5	3/12/1 *W*=8.0
Broker *B*	1/14/1 *W*=2.0	5/11/0 *W*=15*	3/13/0 *W*=6.0	4/12/0 *W*=10*
Broker *J*			3/12/1 *W*=8.0	5/11/0 *W*=15*
Broker *K*			0/15/1 *W*=0.0	1/13/1 *W*=2.0

* $p \leq 0.10$

Table shows the results of 16 direct comparisons.
For figures separated by slashes:

the first figure is the number of times the broker named in the row had better price improvement

the second figure is the number of times the two brokers had equal price improvement

the third figure is the number of times the broker named in the column had better price improvement

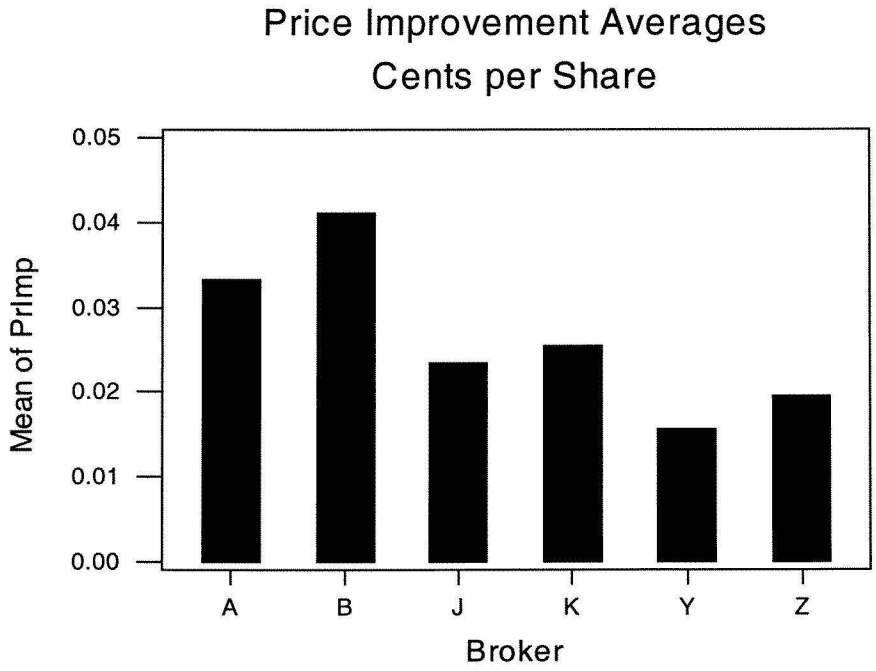
The Wilcoxon signed-rank statistic is given as *W* and is a test of the null hypothesis that the median difference between the brokers in a pair is 0.

Price Improvement Broker Comparisons
Table 2

The experimental design matches one voice broker with two online brokers (one expensive and one inexpensive) for 16 trials, 8 buys and 8 sells. While each broker is involved in 32 trials in total, we only have 16 comparisons among specific brokers, all with the same stocks, market conditions, bid/ask spreads, day and time of the week. Table 2 shows statistical comparisons based on these head-to-head pairwise comparisons of the brokers. This table has only three pairwise differences that are statistically significant, and they are significant only at the 10% level: *B* over *K*, *B* over *Z*, and *J* over *Z*.

It is also possible to compare price improvement across the 32 transactions for each broker; see Figure 2. As indicated in this figure, voice brokers on average provided the most improvement, and the inexpensive e-brokers provided the least improvement. In the context of the full experiment, the broker differences produced an *F* value of 2.24,

on (5, 123) degrees of freedom. The associated p value is 0.054. This analysis used fixed effects for the brokers and random effects for the triplets. The only interesting differences, using Tukey's pairwise method, are B over K ($p = 0.11$) and B over Y ($p = 0.07$). Our conclusion is that there is little or no difference among the brokers on price improvements.



Average Price Improvement by Broker Across all 32 Trials
Figure 2

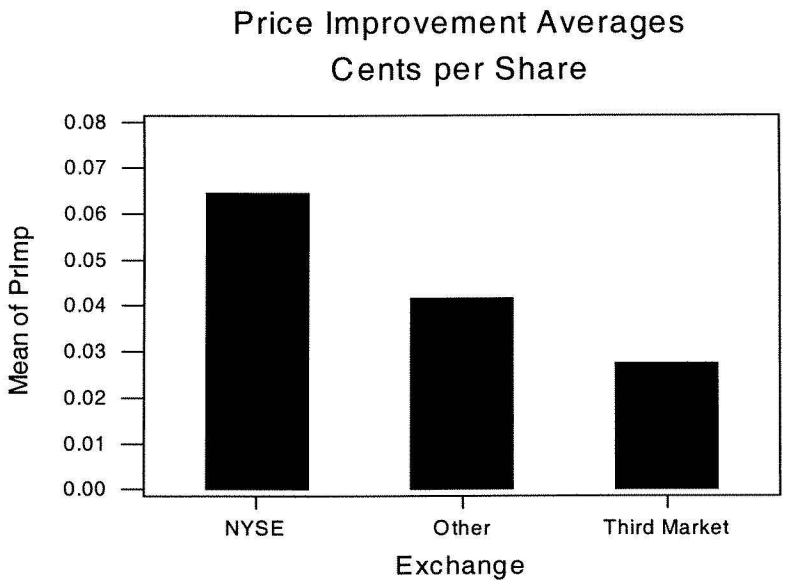
What is the power of the design? How likely are we to find a difference if one exists? We designed the experiment with a sample size that was reasonable for finding

moderate-to-large differences. With respect to price improvements, the statistical power was substantially eroded by the prevalence of tied values, meaning instances in which two brokers in a comparison had identical prices (see Table 2). With regard to total costs presented later in the paper, the experiment has more than adequate power, and indeed brokers have statistically significant and material differences in total trading costs.

Price Improvement by Market

It is interesting to ask if there is a difference in price improvement among markets. Our trades were executed on at least six different markets, which we have broken into four groups: the NYSE, the Third Market, Regional Exchanges ("Other") and the NASDAQ. Figure 3 shows the mean improvement for the non-NASDAQ market. (We did not include the NASDAQ in the table because there is only one choice of where to trade NASDAQ stocks, while shares listed on the NYSE may be traded in a number of markets. We received few price improvements on buy orders of NASDAQ stocks and no improvements on sell orders.)

The New York Stock Exchange, itself, provided the largest mean price improvement while the Third Market had the least. Table 3 shows that the differences among markets are statistically significant. In a more intricate general linear model treatment of the entire experiment, the market effect is also significant. This test included the data from NASDAQ trades. The F statistic for the exchange effect is 4.32, on (3, 182) df, and $p = 0.006$. These results suggest that the market where a trade is executed



Price Improvement by Market

Figure 3

Market	Number of Trades	Mean Price Improvement	Standard Deviation of Price Improvement
NYSE	31	0.0645	0.0522
Other	24	0.0417	0.0353
Third Market	41	0.0274	0.0371

$F = 6.83$; (2, 93) df; $p = 0.002$

This F statistic is based on the assumption that the 31 + 24 + 41 = 96 trades are statistically independent.

Price Improvement by Market
Table 3

does make a difference in the likelihood of getting a price improvement.

Total Trading Cost

Our test of the law of one price requires the computation of a total trading cost that includes both commissions and some measure of execution quality. Price improvement is the mechanism for measuring the quality of execution, but exactly how to arrive at a total trading cost given trades with and without price improvements is not immediately obvious. Following Battalio et al. (1999) and Lee (1993), we computed the total cost of a trade as the commission plus the liquidity premium. This premium is defined as the difference between the midprice of the bid/ask spread and the execution price. For a buy, the premium is the execution price - the midprice and for a sell, it is the midprice - the execution price. A price improvement moves the execution price closer to the midprice, and thus results in a lower liquidity premium and lower total trade cost.

Table 4 presents the pair-wise comparisons of costs by broker for the 16 paired trades.[3] The mean differences in the table result from subtracting the total cost of the broker in the column from the total cost of the broker in the row for the 16 trials in which the pair participated together. It is clear from the Table that there are statistically significant differences among the brokers on total trade cost. The magnitude of the

[3] Broker B provided a 10% rebate on commissions for July and August. There was no explanation of the basis for this rebate, or whether one could count on receiving it over time. As a result, we have used the actual commissions Broker B charged at the time of trade and have not subtracted the later rebate.

	J	K	Y	Z
A	-30.69 [2.77] (-44.39)***	-42.80 [2.78] (61.66)***	-51.86 [5.80] (-35.74)***	-52.08 [4.09] (-50.88)***
B	-0.82 [12.7] (-0.26)	-13.32 [3.57] (-14.91)***	-21.20 [12.65] (-6.71)***	-24.55 [3.76] (-26.09)***
J			-20.39 [5.35] (-15.24)***	-21.00 [3.00] (-28.07)***
K			-9.84 [2.65] (-14.85)***	-10.84 [3.50] (-12.40)***

* p<=.10, **p<= .05, ***p<= .01

Mean differences for 16 matched trades, [standard deviation], (t statistic)

Positive differences favor the broker in the row

Negative differences favor the broker in the column

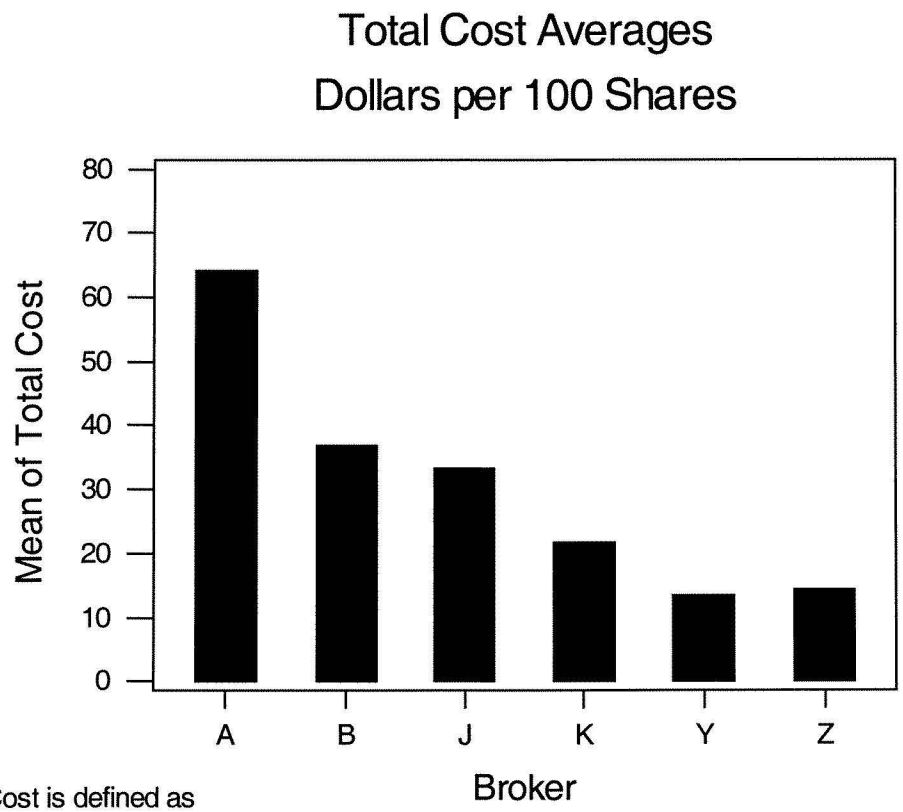
Comparison of Mean Total Trading Costs

Table 4

differences shows that the total costs of a trade for 100 shares with expensive online brokers is less than the total costs of voice brokers, except for broker B versus broker J. Total trading costs for inexpensive online brokers are significantly less than total trading costs either for the two voice brokers or the two expensive online brokers. All differences except broker B versus J are highly significant statistically.

Figure 4 is a graph of the mean trading cost for each of the 32 trades by broker. The differences are highly statistically significant using an analysis of variance (F = 67.57, p< 0.01;01, Chi-Square of 133.97, p< 0 .01), though such tests are not completely appropriate given the limitations of the research design.[4]

[4] Strictly speaking one should only compare costs within the 16 trials for each broker that involve the same stock, bid/ask spreads, etc.



Mean Trading Cost by Broker
Figure 4

The results are very clear: for 100 share lots, commission costs dominate the quality of execution because there are so few price improvements and their magnitude is so small. *For 100 share lots, the one price law is not supported; the argument that total trading costs are equal among brokers because the quality of execution balances commissions is not valid.*

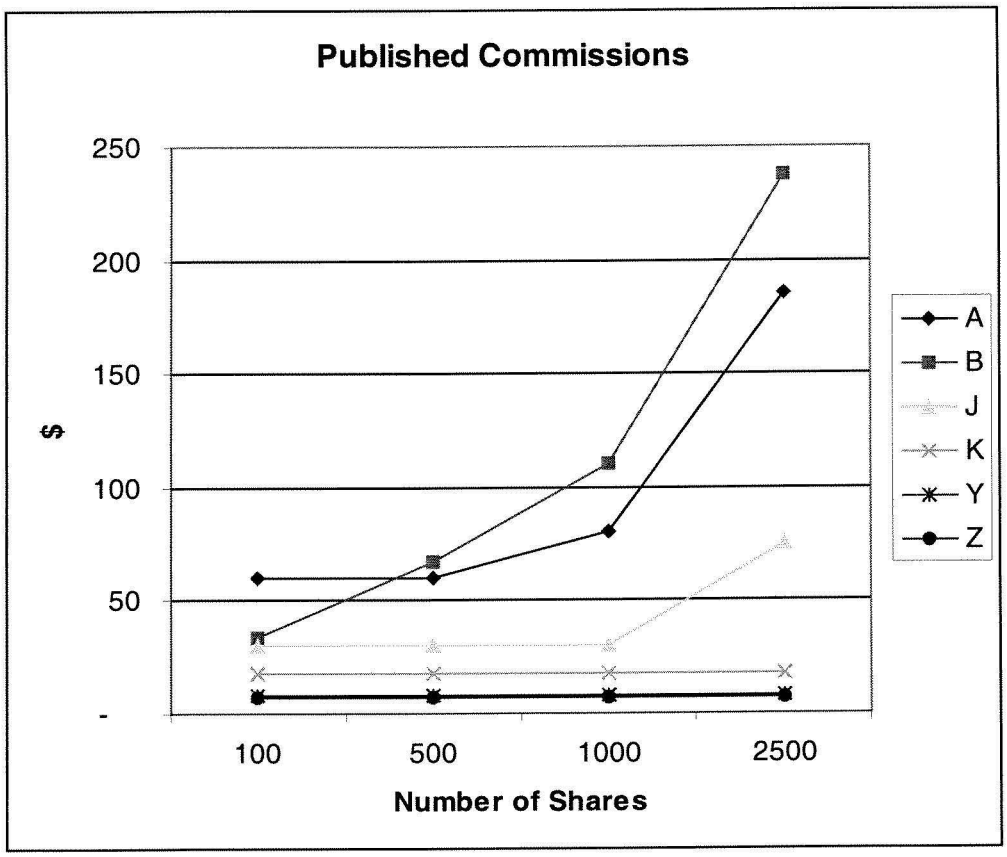
IMPLICATIONS

The results of this study show, that for 100 share lots, there is little difference in price improvement among brokers. At this volume, the commission is the dominant cost of the trade. There are significant differences in total cost among brokers, so the broker one selects matters. In general, at 100 shares, voice brokers have a higher total cost than expensive electronic brokers, who in turn have a higher total cost than inexpensive electronic brokers.

Our selection of stocks for buy orders excluded securities with spreads less than $1/8^{th}$, and thus provided an opportunity for price improvement. Where price improvement is unlikely, the results suggest that the investor will experience lower total trading costs from electronic brokers, at least for 100 share blocks.

Other Lot Sizes

Limited resources prevented us from varying the block size for trades. To what extent do our results generalize to larger blocks of stock? Figure 5 shows the commission structure for the brokers in our study by lot size. The differences in commissions raise an interesting question: what kind of price improvement would be necessary for a broker charging a higher commission to have a total trade cost less than the total cost for a broker with lower commissions? To be precise, we are interested in a differential price improvement as the lower commission broker might also provide a price



One of the brokers had separate commission structures for NYSE-listed and Nasdaq-listed stocks. As the experiment selected exactly half its stocks from each, we used the average commissions in making the calculations above.

Commissions by Trade Size
Figure 5

improvement on an order.

Figure 6 shows the price improvement needed by each of the five brokers to offset their higher commissions when compared with Broker Z, the lowest commission electronic broker in our sample (assuming Broker Z obtains no price improvement). We have chosen to extrapolate only to a block of 2500 shares as retail customers generally trade at this volume or lower, and it is not clear whether or not one could negotiate better commissions at higher volumes when dealing with voice brokers. The highest average

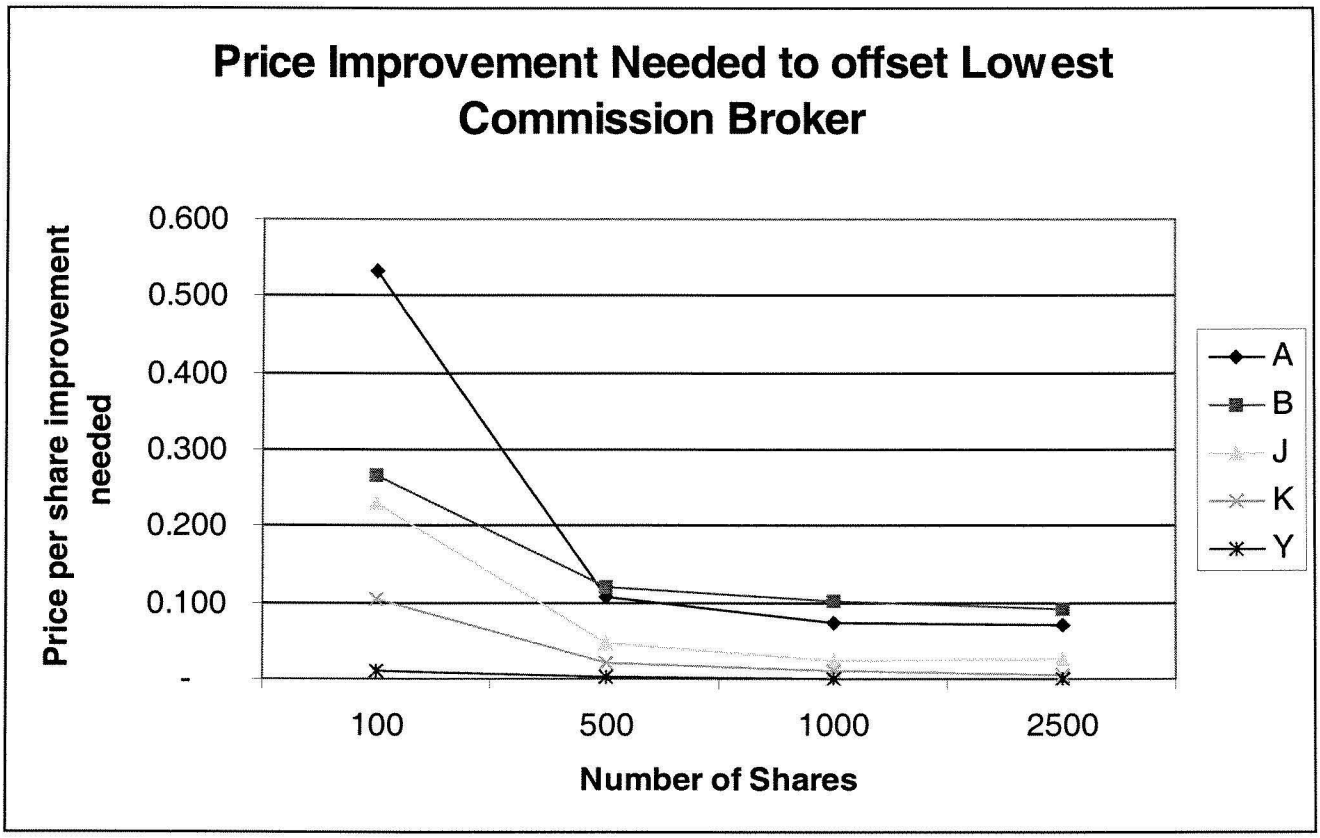


Figure 6

price improvement in our study was $ 0.041 per share for Voice Broker B. When we compare average improvements for 100 shares, only the electronic Brokers are within the range of the lowest cost electronic Broker Z in Figure 6 above. The figures indicate that, for retail trades of 100 to 1,000 shares, it will be difficult for the more costly brokers (A and B) to offset their higher commissions through price improvements.

Cost per share (in cents), based on commissions only:

	Transaction size (shares)			
Broker	**100**	**500**	**1,000**	**2,500**
A	60.25	12.05	8.025	7.41
B	33.50	13.50	11.00	9.50
J	29.95	5.99	2.995	3.00
K	17.45	3.49	1.745	0.698
Y	8.00	1.60	0.80	0.32
Z	7.00	1.40	0.70	0.28

Cost per share (in cents), commissions less average price improvement:

	Transaction size (shares)			
Broker	**100**	**500**	**1,000**	**2,500**
A	56.93	8.73	4.705	4.09
B	29.398	9.398	6.898	5.398
J	27.61	3.65	0.655	0.66
K	14.911	0.951	-0.794	-1.841
Y	6.44	0.04	-0.76	-1.24
Z	5.047	-0.553	-1.253	-1.673

One of the brokers had separate commission structures for NYSE-listed and Nasdaq-listed stocks. As the experiment selected exactly half its stocks from each, we used the average commissions in making the calculations above.

The Impact of Price Improvements
Table 5

Because the high commission brokers provided the most price improvement in our sample, commission differences alone *overstate* the total savings of using a low-cost on-line broker as shown in Table 5. The top half of the table contains each broker's commissions for four different trade sizes. The bottom half of the table subtracts the average improvement we experienced for each broker from the commission. For example, for a trade of 1000 shares, Broker A's 8.025 cents per share cost based on commission alone becomes 4.705 cents per share after adjusting for price improvements. See Table 6 for an illustration of the actual advantage of using Broker Y rather than B.

(We used the published commission schedules, and thus the commissions are correct for the four order sizes listed above. Price improvements, however, are based on transactions of 100 shares; we are projecting similar price improvements on transactions of sizes 500, 1,000, and 2,500 shares.)

	Transaction size (shares)			
Savings from Using Broker Y rather than Broker B (cents per share)	**100**	**500**	**1,000**	**2,500**
Savings from commission Costs Only	25.50	11.90	10.20	9.18
Savings Based on Total Cost	22.96	9.36	7.66	6.64

As an illustration, the savings in cents per share of using Broker Y for a 1,000 share trade rather than Broker B falls from 10.2 cents per share based on commission cost alone to 7.7 cents per share when price improvement is taken into account.

Table 6: Cost Comparison Illustration

While price improvements moderate the effects of high commissions, the projected data still strongly favors online brokers. Based on our data, it is unlikely that voice brokers will be able to make up their higher commission through price improvements, at least up to a trades under 2,500 shares.

While price improvements tend to reduce the differences among voice, expensive and inexpensive on-line brokers, price improvements do not appear sufficient to change the rankings of the brokers on total cost up to a volume of 2,500 shares. The data suggest that voice brokers will be the most expensive in terms of total trading cost followed by expensive online brokers followed by inexpensive online brokers.

Why the Law of One Price May Not Hold

Originally we suggested three possible explanations for why the variance in commissions in the brokerage model might violate the law of one price. The first of these is that brokerage markets are not in equilibrium and the third is that the brokerage

market is not an "ideal" commodity market as assumed in Bertrand competition. We believe that aspects of both explanations may account for the results of our experiment.

The equilibrium argument suggests that as customers move to low-priced brokers, higher-priced brokers will have to adjust their prices. However, the results of this research show that it is difficult for the investor to discover the total cost of trading. Electronic markets facilitate price discovery for only one part of the cost, the brokerage commission, and it is relatively easy to compare these commissions. However, it is extremely difficult to discover the "price" of the liquidity premium for electronic or voice brokers. An individual investor would have to conduct the kind of experiment reported here, which is not practical for most individuals. Price discovery in the brokerage industry is incomplete, and electronic trading has not increased its transparency sufficiently to help the customers make informed decisions that result in market equilibrium.

Another possibility is that the retail brokerage market is not a commodity market, and that different brokers offer differentiated products. Full service brokers may offer a different type of product than online brokers, for instance by encouraging interaction over the telephone with a live broker and "hand holding" the customer through the order placing process. Alternatively, it is possible that consumers are heterogeneous, with full service brokers serving retail investors who are relatively insensitive to trading costs. Finally, the high search costs involved in finding out the total cost of trading with any particular broker, combined with the substantial switching costs involved in moving an account to a new broker, may prevent some consumers from switching to the lower priced brokers

Choosing a Broker

Our results suggest that, for lot sizes of 100 shares, there are differences among voice brokers, expensive e-brokers and inexpensive e-brokers. Total trading costs occur in that order. At this volume, commissions dominate the liquidity premium. In fact, if one examines Figure 1, we received price improvements a relatively small number of times during the experiment. Trading at this volume, or trading securities with narrow bid/ask spreads so that an improvement is unlikely, favors electronic brokers.

As the size of a trade increases, the choice is less clear. If one is trading once or a small number of times, then the likelihood of a price improvement is small, and the investor can make a decision based on commission costs. If trading large blocks on a frequent basis, then the investor should be guided by expected value. Extrapolating the results of this study, the expected value of price improvements for full service brokers does not offset their commissions at higher trade sizes, and the investor appears to be better off with online brokers. It appears that the broker does matter, and the markets fail to provide sufficient information for retail investors to evaluate the total cost of trading.

SUMMARY

Our research involved a controlled experiment comparing two voice brokers, two expensive online brokers, and two inexpensive online brokers in 64 trials with simultaneous trades of 100 shares of different stocks. The results suggest that:

1. The law of one price of the Bertrand model of price competition does not hold in the retail brokerage industry today as price improvements by more expensive brokers do not offset higher commissions. Total trading costs differ across brokers, and electronic trading, by enabling extremely low commissions, has probably widened cost differences among brokers.

2. Price improvements trading NYSE-listed stocks differ by market, with the most improvement on the NYSE and the least in Third Market.

3. For 100 share orders, total costs were highest for voice brokers and lowest for inexpensive online brokers.

4. Our results suggest that most retail investors will experience the lowest total trading costs with online brokers when trading small lots. The choice of a broker is more difficult for the investor who trades large volumes and therefore may have a greater chance of price improvement.

5. Further research is needed to see if the quality of execution offsets higher commission costs for orders larger than 100 shares, as it is possible the size of a customer's order influences price improvements.

Electronic commerce is responsible for changing many markets, and Internet brokerage firms have been very successful in capturing retail market share. The Internet provides electronic brokerage firms with a lower cost structure than full service brokers, and our sample indicates that consumers are benefiting through lower trading costs. Although higher-commission brokerage firms in our sample provided a greater level of price improvement, they nevertheless imposed the highest total trading costs on their retail customers. Not surprisingly, electronic brokerages are forcing full service firms like

Morgan Stanley Dean Witter and Merrill Lynch to offer on-line trading at much lower costs than their traditional commissions (*Business Week*, 11/15/99).

Electronic commerce has increased the visibility of commissions, but it has yet to make the quality of execution obvious to the investor. This research demonstrates that electronic commerce in the brokerage market has not yet resulted in a Bertrand-type equilibrium with convergence to one price for total trading costs — retail consumers are still advised to shop for the lowest all-in trading costs consistent with their requirements for additional investment services. As full service brokers offer more low-price, on-line trading options, and as awareness grows of differential price improvements from brokers, we predict a greater degree of convergence in total trading costs.

REFERENCES

Bakos, Y., "Reducing Buyer Search Costs: Implications for Electronic Marketplaces," *Management Science*, Vol. 43, No. 12, (December 1997.), pp.

Battalio, R., J. Greene, B. Hatch and R. Jennings, "Does the Limit Order Routing Decision Matter," Unpublished Paper, Bloomington, Indiana, 1999

Bertrand, J. "Review of Theorie Mathematique de la Richesse Sociale and Researches sur les Principes Mathematicque de la Theories des Richesse," *Journal des Savants*, (1883), 499-508

Brynjolfsson, E., and Smith, M.,"Frictionless Commerce? A Comparison of Internet and Conventional Retailers," Working Paper, MIT, (1999)

Diamond, P., "Consumer Differences and Prices in a Search Model," *The Quarterly Journal of Economics*, Vol 102, Issues 2 (May., 1987), pp. 429-436

Friend, Irwin, and Marshall E. Blume, "Competitive Commissions on the New York Stock Exchange," *Journal of Finance*, 23 (September 1973), 795-819

Hotelling, J. " Stability in Competition," *Economic Journal*, 39(1929), pp. 41-47

Lee, C. M, "Market Integration and Price Execution for NYSE-Listed Securities," *Journal of Finance,* Vol. XLVIII, No. 3, (July 1993), pp. 1009-1038.

Pratt, John W.; Wise, David A.; Zechhauser, Richard. "Price Differences in Almost Competitive Markets," *The Quarterly Journal of Economics*," Vol. 93 Issue 2 (May., 1979), pp. 189-211

Stigler, G. "The Economics of Information," *Journal of Political Economy*, Vol. 69, Issue 3 (Jun., 1961), 213-225

Appendix: Experimental Design

Note that the days were not executed in order due to delays in opening accounts at several brokers. We conducted the trials indicated for each day.

DAY 1

BROKER A	BROKER J	Broker Z	NYSE
Broker B	Broker K	Broker Y	NASDAQ
BROKER A	Broker K	Broker Z	NASDAQ

DAY 2

Broker B	BROKER J	Broker Y	NYSE
BROKER A	BROKER J	Broker Y	NYSE
Broker B	Broker K	Broker Z	NASDAQ

Day 3

BROKER A	Broker K	Broker Y	NASDAQ
Broker B	BROKER J	Broker Z	NYSE
BROKER A	Broker K	Broker Y	NYSE

Day 4

Broker B	BROKER J	Broker Z	NYSE
BROKER A	BROKER J	Broker Y	NASDAQ
Broker B	BROKER J	Broker Y	NASDAQ

Day 5

BROKER A	Broker K	Broker Z	NASDAQ
Broker B	Broker K	Broker Z	NYSE
BROKER A	BROKER J	Broker Z	NYSE

Day 6

Broker B	Broker K	Broker Y	NYSE
BROKER A	Broker K	Broker Z	NYSE
Broker B	Broker K	Broker Y	NYSE

Day 7

BROKER A	BROKER J	Broker Z	NASDAQ
Broker B	BROKER J	Broker Y	NASDAQ
BROKER A	BROKER J	Broker Y	NASDAQ

Day 8

Broker B	BROKER J	Broker Z	NASDAQ
BROKER A	Broker K	Broker Y	NYSE
Broker B	Broker K	Broker Z	NASDAQ

Day 9

BROKER A	BROKER J	Broker Z	NASDAQ
Broker B	BROKER J	Broker Z	NASDAQ
BROKER A	Broker K	Broker Y	NASDAQ

Day 10

Broker B	Broker K	Broker Y	NASDAQ
BROKER A	BROKER J	Broker Y	NYSE
Broker B	BROKER J	Broker Y	NYSE

Day 11

BROKER A	Broker K	Broker Z	NYSE
Broker B	Broker K	Broker Z	NYSE