Microstructure of the Pink Sheets Market

Nicolas P.B. Bollen[†]
Associate Professor of Management

and

William G. Christie
Frances Hampton Currey Professor of Management and Professor of Law

Owen Graduate School of Management
Vanderbilt University
401 21st Avenue South
Nashville, TN 37203

Current Version: October 24, 2005

Preliminary: Please do not quote without permission

[†]Research support from the Financial Markets Research Center at Vanderbilt University is gratefully acknowledged. The authors thank Carl Giangrasso from Pink Sheets for patiently answering our numerous questions about the Pink Sheets trading and quotation systems. Paul Brockman, Craig Lewis, Hans Stoll, and seminar participants at the University of Missouri provided helpful suggestions. Please address all correspondence to Nick Bollen at nick.bollen@owen.vanderbilt.edu.

Microstructure of the Pink Sheets Market

Abstract

This paper studies the trading and quotation patterns for stocks that reside in the Pink Sheets. Using all quotes and trades reported through the Pink Sheets electronic quotation service and Pink Link electronic execution service in the 2004 calendar year, we examine whether regularities that exist in highly regulated markets arise naturally in a market with few affirmative obligations or reporting requirements. We find that the market appears quite capable of creating organized rather than chaotic quotation and trading activity in an environment without a tick size, even among penny stocks. Our results suggest that although bid-ask spreads are high in this market relative to the listed exchanges or Nasdaq, they are generally consistent with estimates of market maker costs. Trading activity is characterized by short periods of high intensity, within which large price moves and subsequent reversals are common.

I. Introduction

Only recently have financial markets outside the mainstream been accessible to academic research. Two recent examples include Angel et. al. (2004) and Macy et. al. (2004), who study the impact on trading costs from the delisting of stocks from the NYSE or Nasdaq to markets such as the OTC Bulletin Board or the Pink Sheets. Both of these papers are concerned with the impact on liquidity and trading costs from moving from a national market to a market characterized by thinly traded stocks and/or stocks that are not eligible for or choose not to be listed on a national market. These studies report large declines in liquidity and increases in measures of trading costs when stocks are delisted from the national markets and trading resumes on either the Over-the-Counter Bulletin Board (OTCBB) or Pink Sheet markets.

One of the drawbacks to the existing literature is that the data available are very limited. In the case of Angel et. al. (2004) and Macy et. al. (2004), they use daily statistics such as intra-day highs and lows in their analyses. While these data are sufficient for the purposes of these papers, we remain relatively ignorant about the microstructure of markets that have been described as the remaining vestige of the "wild, wild west" of securities trading. Indeed, the Pink Sheets website (www.pinksheets.com) warns investors directly:

> *Unlike those listed on NASDAQ and New York Stock Exchange, Pink Sheets stocks are not required to meet listing standards. This means there is a wide range in the quality of issuers that are traded in the Pink Sheets, from major international conglomerates to very small companies struggling to survive. Investors must be aware that good information is simply is not available for many Pink Sheet traded companies and that there are unscrupulous individuals that will attempt to defraud investors through manipulative schemes in Pink Sheets stocks.*

The purpose of this paper is to corral the data in the Pink Sheets market and establish a number of stylized facts regarding the quotation and trading characteristics of securities that are exchanged in a highly unstructured environment. We have been provided with all of the quotation and trading data from the Pink Sheets Electronic Quotation and Trading System for the entire calendar year of 2004. This is the first paper to study the microstructure of this market in such detail, and we offer a number of insights about this important yet little known marketplace. The data permit us to study a number of market microstructure theories and test whether the economic forces shaping some of the worlds most important stock exchanges also govern one of the least understood markets in our financial system.

To highlight some of the unorthodox norms in the Pink Sheets market, consider that (1) only one market maker is needed per stock for trading to commence, (2) issuer filings need not be current with the SEC and financial statements need not be audited, (3) issuers have no option to determine whether their stock will be quoted and traded, and (4) stock prices are often less than $0.01. Interestingly, some of the most visible foreign companies choose the Pink Sheets as the primary foreign venue for their stocks. The market is, to a large extent, outside the reach of the SEC, and investors are warned very explicitly that they should only invest in Pink Sheets stocks if they are fully willing and able to lose 100% of their investment. This is a perfect case example of "buyer beware" in our financial markets.

Despite the impression that the Pink Sheets market is the last frontier of trading, we find that the market behaves in most ways like its (much) bigger cousins such as the Nasdaq or the NYSE. In our study of the intraday pattern of bid-ask spreads, we observe many of the familiar patterns that we see for listed stocks. We find evidence of clustering, despite the fact that market makers are free to choose whatever tick size fits their business model. Indeed, the market appears to have established a number of norms that limit effective tick sizes as a function of the price level of the stock. We also observe a significant clustering of trade prices that gravitate towards the quotes.

While this paper is exploratory in nature, it sheds light on a market that had previously been hidden and to some extent orphaned by academics due to a lack of data.

We hope that our results will trigger wider interest in the study of the Pink Sheets market since it remains one of the few remaining markets where trading and market activity is relatively free of regulation and government intervention. As such, it provides an interesting laboratory for conducting natural experiments for studying trade-offs between free competition and the benefits of organized rules and regulations.

The paper is organized as follows. Section II describes the regulatory and trading environment for Pink Sheet stocks. Section III provides an overview of the data. Section IV presents our results for the quotation pattern among stocks, while Section V is devoted to an analysis of the trading data. Section VI provides evidence of clustering among both quotes and trades, and also presents results on the degree of price improvement. Section VII tests whether the economic determinants of spreads identified in organized markets also plays a significant role among Pink Sheets issues. Section VIII examines temporal clustering of trades and price behavior during periods of intense trading activity. Section IX concludes the paper and offers suggestions for additional research.

II. Regulatory and Trading Environment

The Pink Sheet market originated in 1904 and can be traced to the formation of the National Quotation Bureau which was established as a quotation service for market makers in OTC securities.[1] A similar facility dubbed the yellow sheets was formed for the quotation of bonds. While paper remained the medium of communication for decades, an electronic quotation service was created in 1999 and provided real-time quotations via the Internet in both the Pink and Yellow Sheet markets. The market then became more easily accessible with the creation of the www.pinksheets.com website, which dramatically increased the visibility of Pink Sheet stocks. On June 2, 2003, Pink Sheets introduced Pink Link which offers electronic order negotiation and execution capabilities as a supplement to the routine use of telephone negotiations.

The Pink Sheets market offers issuers, market makers and investors a unique and very different set of rules and regulations in comparison to the organized markets. At its most basic level, the Pink Sheets is a forum for market makers to post quotes and execute trades. It is formally a Securities Information Processor (SIP) and an Interdealer

Quotation System. Issuers do not list their securities, and pay no fees to Pink Sheets if their stock is traded on their market. Thus, stocks on the Pink Sheets can not be thought of as ever having been "listed" or "delisted". They are simply quoted or not.

One of the key features of the market that has significant implications for both issuers and investors is that issuers do not need to register their securities with the Securities and Exchange Commission (SEC), nor are they required to even be current in their reporting requirements. In fact, financial statements need not be audited. While the Pink Sheets encourages issuers to publish current and audited statements so that investors have the confidence necessary to actively trade their stock and create a liquid market, issuers are under no obligation to do so. Stocks in all other markets, including the OTCBB which is operated by Nasdaq, must abide by the registration requirement and be current in their financial reporting obligations. The only times that issuers are required by federal law to provide adequate current information occurs under one of the following four situations: (a) when firms are initially quoted, (b) when officers or affiliates are buying or selling securities in the OTC market, (c) when issuers are actively promoting the firm that could lead to an increase in trading volume, or (d) when privately placed securities become eligible to trade in the OTC market.

Investors trade Pink Sheet stocks through registered brokers who then route the order to a market maker quoting the particular issue. Interestingly, investors must essentially sign away the liability for potential losses when trading penny stocks on the Pink Sheets market by physically signing Schedule 15G which highlights the risks of their investment and that they understand their entire capital is at risk. The inherent risk of many Pink Sheets stocks is reflected in the size of their bid-ask spreads. For most stocks on the organized exchanges, percentage spreads are typically not much larger than 1% or 2%. However, in thinly traded penny stocks, these percentage spreads may be far larger with Macey et. al. (2004) reporting percentage spreads of 51% for newly delisted companies that commence trading on the Pink Sheets. As a consequence, investors can lose a substantial fraction of their capital simply from trading costs, even if the value of a stock is unchanged between transactions!

The rules and regulations for market markers are also distinctly different in the Pink Sheets market relative to either the OTCBB or the Nasdaq market. First, unlike Nasdaq, there need only be one market maker posting quotes in order for trading to occur relative to the two market-maker rule in the other dealer markets. Market makers wishing to quote a Pink Sheets security must first qualify under NASD rules as a qualified participant. There are two primary means of satisfying this condition. The first requires that the market maker satisfy NASD rule 15c2-11 by submitting Form 211 to NASD Regulation at least three days before they wish to submit quotes in a particular issue. The form essentially certifies that the market maker has in his or her possession certain material documents regarding the firm's financial situation (such as offering circulars, latest 10k reports, or a laundry list of specific items). Certain exceptions are also available that alleviate the need to file Form 211. These exceptions include (a) issuers who are currently traded on an exchange or Nasdaq, (b) submitting an unsolicited quote that represents a customer order and not the interest of the market making firm, (c) having quoted the stock on the OTCBB for the previous 30 days or (d) the issue being piggyback qualified. This last exception permits a market maker to post quotes as long as another market maker has been posting Pink Sheets quotes for a minimum of 30 days. In addition, quotes must appear on at least 12 of these days with no more than four consecutive days without a quote. Thus, due diligence by one market maker is sufficient to allow others to post quotes as well. Finally, investors who place orders with broker/dealers should not expect to see their orders reflected in the market maker quotes since the Pink Sheets market is not subject to the Limit Order Display requirements introduced in the Order Handling Rules (see Barclay et. al. (1998)).

Market makers are, however, still subject to the requirement that they be registered with the SEC and they are subject to the same NASD rules of conduct as market makers in the OTCBB or Nasdaq market. The NASD monitors trading in the Pink Sheets and market makers are expected to abide by a number of rules that apply to stocks traded in the larger markets. For example, market makers who post open quotes must honor their prices for a normal-sized order in that security. Thus, market makers must comply with the firm-quote rule. In addition, market makers must search other markets

where the security is traded (such as the OTCBB) to ensure that the Pink Sheets price is the best available in the market at the time of execution.

Stocks appear on the Pink Sheets for several reasons. Some stocks will be quoted/traded on the Pink Sheets even if they are simultaneously quoted/traded on the OTCBB or even Nasdaq or one of the organized exchanges. However, stocks that trade almost exclusively on the Pink Sheets fall into four categories. The first include securities that are economically distressed. They will typically have been delisted from Nasdaq or an Exchange (examples include Enron and Adelphia Communications), or represent equity that has been issued by a firm after resolving a bankruptcy filing. The second represent Microcap issues that do not quality for listing in other markets and would typically fall under the penny stock umbrella. The third include large foreign issuers whose stock is listed in their home country but elect to trade via ADRs on the OTC market (examples include Nestle, Roche Pharmaceuticals, Volkswagen, Heineken and Nintendo). These stocks generally carry much higher prices, much larger trading volume, and a greater propensity for price improvement than other Pink Sheets stocks. Bypassing Nasdaq and the Exchanges allows foreign companies to avoid the expense of filing documents with the SEC and lessens their regulatory burdens (such as not preparing their financial statements according to GAAP). A number of ADRs will be of high quality and could qualify for listing on the other markets. Similarly, some issuers could potentially delist and trade on the Pink Sheets to avoid the increased compliance costs associated with Sarbanes/Oxley. The fourth includes companies that are very tightly held and trade very infrequently.

In keeping with the lack of regulatory oversight of the market, there are no prescribed tick sizes for any of the issues, independent of their share price. Since penny stocks are prevalent, trades can be executed in increments of $0.0001. There are potentially 10,000 ticks available for each issue, and it will be an empirical matter to determine if or how the market invokes the negotiation hypothesis of Harris (1991) to manage the determination of an appropriate tick size.

The Pink Sheet market follows Nasdaq and the exchanges by permitting trading between 9:30 a.m. and 4:00 p.m., and quotations are posted between 7 a.m. and 5 p.m.

The Pink Sheets market also follows Nasdaq's holiday schedule.[2] Our comprehensive data permit us to incorporate all observations throughout the day, and to examine intraday patterns of trading and quotation behavior.

III. Data

Trade and quote data from 2004 were obtained directly from Pink Sheets. The monthly quote files are a complete record of quoting activity on the Pink Sheets electronic quotation service. Quote records include ticker symbol, issuer name, time to the nearest second, and dealer identity. There are five categories of quotes indicated by Code. Code (1) indicates a dealer is updating a quote, either in price, quantity, or from inactive to active status. Only active quotes are eligible for trade. Code (2) indicates a dealer is posting a quote for a stock for which the dealer does not have an outstanding quote, i.e. it is an addition. Code (3) indicates a dealer is canceling a quote for a stock, i.e. it is a deletion. Code (4) is reserved for beginning-of-day quotes that are recycled from the prior trading day. These are indications of interest only and are not eligible for trade. Code (6) indicates that the quote is the inside quote for the market, i.e. the highest bid or lowest offer. In order for an inside quote to be recognized, there must be at least two dealers posting active quotes for a stock. Quotes are further characterized by Type. Type (A) quotes are active, and include a price and quantity. Type (U) quotes are indications of interest, and do not have prices listed. Type (OW) (offer wanted) and (BW) (bid wanted) indicate that the dealer is actively seeking a counterparty.

There are 40,155,126 records in the quote files. We eliminate 477,459 quotes with blank ticker symbols and 3,453 quotes with weekend dates. We also drop 775,456 records with Nasdaq holiday dates. A total of 15,386 unique ticker symbols are represented in the 38,898,758 remaining quote records. A subset of 6,150,895 of the quotes are Code 6 and Type A at both the bid and the ask. Of these, 10,149 quotes are dropped for having bid or ask prices less than or equal to zero, or for having ask prices less than bid prices. We examine the remaining 6,140,746 active inside quotes, representing 4,372 ticker symbols, in detail.

The monthly trade files are a complete list of transactions executed on the Pink Link electronic negotiation and trade execution system. Approximately 25% of share volume in Pink Sheets stocks is conducted using Pink Link. Trade records include ticker symbol, time to the nearest second, price, quantity, dealer identity for buyer and seller, and an indicator for whether the trade is buyer or seller initiated. There are 4,113,571 records in the 2004 trade files. Of these, 358 occur on the weekend and 10,452 occur on Nasdaq holidays, and are dropped from the analysis. An additional 1,688 trades have ticker symbols that do not match any tickers from the quote files and are removed from the analysis. A total of 8,140 unique tickers that match tickers in the quote files are represented in the 4,101,073 remaining trades. Recall that only 4,372 tickers in the quote files have at least one active inside quote for 2004, indicating that a substantial fraction of the stocks that were traded on the Pink Link system in 2004 were not actively quoted.

To investigate temporal patterns in trading and quotation activity, we compute the number of active inside quote updates and the average percentage bid-ask spread derived from these active inside quotes, as well as the number of trades, in 5-minute intervals. Figure 1 displays the results for quotes. Figure 1A uses quotes from all stocks. There appear to be three distinct periods over the course of a day for quotation activity, with peaks at approximately 7:30 a.m. and just after 4:00 p.m. and lower levels otherwise, especially between 11:30 a.m. and 4:00 p.m. The significant drop in quotation activity at 11:30 a.m. is attributable to ADRs. To illustrate this, we split the observations into ADRs and non-ADRs. Note in Figure 1B that the non-ADRS display a much smoother U-shaped pattern, whereas the ADRs in Figure 1C (on a different vertical scale) have peak activity between 9:30 a.m. and 11:30 a.m. The decline at midday may be due to the end of the business day in Europe when the London Stock Exchange ceases trading at 11:35 eastern time. In Figure 1A, there are three periods for the bid-ask spread that roughly correspond to the quotation frequencies. Bid-ask spreads are approximately 70% at the peaks of the quotation activity, and they remain at these levels after 4:00 p.m. During the 9:30 a.m. to 4:00 p.m. trading day, the average percentage bid-ask spread is approximately 30%. This suggests that the quotation activity at the spikes merely indicate presence in the marketplace.

Figure 2 displays the number of trades in 5-minute intervals partitioned by trade price. For the non-ADRs in Figure 2A, trading occurs with a U-shaped pattern that has been well documented for the NYSE and Nasdaq. Interestingly, the most actively traded stocks are those in the $1 to $10 price range. Figure 2B shows the results for ADRs. For these stocks the peak activity occurs towards the end of the trading day, though there is a smaller peak just after the market opens. Note that the scale on the right side for figures 2A and 2B apply only to the stocks priced over $10. The difference in scaling is needed to demonstrate that for non-ADRs, the trading activity for higher priced stocks is very small relative to the other price groups, while the opposite conclusion is reached for the ADR stocks. Approximately 98% of the trades are reported within the 9:30 a.m. to 4:00 p.m. trading day. Since trading is concentrated in the stated trading day, and spreads appear uninformative outside these hours, we will hereafter focus on trades and quotes that occur between 9:30 a.m. and 4:00 p.m. This reduces the number of active inside quotes substantially, from 6,140,746 to 2,687,740, representing 4,342 stocks, and the number of trades moves from 4,101,073 to 4,013,200, representing 8,128 stocks.

There are 187 unique market making firms represented in the active inside quotes for 2004. In unreported analysis we compute the number of stocks for which each of the firms is part of the active inside quote at least once in 2004. Ten firms, including well-known market makers such as Knight Securities and Schwab Capital Markets, participated in the inside at least once in over 1,000 stocks. At the other end of the spectrum, 46 firms were part of the inside for less than 10 stocks each.

IV. Quotation Results

For each of the 4,342 stocks with at least one active inside quote in 2004, we compute the average midpoint price and the average percentage spread, each equally-weighted across quotes within the 9:30 a.m. to 4:00 p.m. trading day, then averaged across days with at least one active inside quote. We also compute the daily return volatility based on close to close midpoints, the number of trading days in 2004 that the stock existed in the Pink Sheets,[3] the average number of inside quote updates per day, the number of days in 2004 on which the stock had at least one inside quote, the average number of inside quote

updates per day for those days with at least one active inside quote, and the number of unique dealers participating in the inside spread at least once. Table 1 lists the cross-sectional inter-quartile ranges of these summary statistics. For the full sample, the average price midpoint at the 25th percentile is \$0.0111, truly a penny stock. The median midpoint is \$0.1190, and the 75th percentile is \$0.8424. Thus the majority of Pink Sheets stocks are priced below one dollar. Also, the median percentage spread is over 45%, and the median day-to-day return volatility is over 13%. The median number of inside quotes per day is only 0.40, the median number of active dealers is 8, and the median number of days quoted is 29.

In Table 1 we also list the inter-quartile ranges for the subsets of non-ADR and ADR stocks, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol. The statistics for the non-ADRs are almost the same as the full sample, since they constitute such a large fraction of the total number of stocks. The characteristics of the 147 ADR stocks are much different than the non-ADRs. The median price for the ADRs is \$10.76, with a median percentage spread of just 1.75%. The median number of active dealers per ADR is 20, and the median ADR is quoted 227 trading days.

Table 2 shows the summary statistics across four price categories, formed using the average quoted midpoint of each stock over 2004. Percentage spreads drop dramatically as prices increase, from 74.1% for stocks priced at or below \$0.05 to 7.4% for stocks priced above \$10. This is consistent with the very low-priced stocks being riskier, and indeed close-to-close volatility is higher for the low-priced stocks, 17.7% versus 2.1% for the high-priced quartile. The fact that percentage spreads are decreasing in stock price is also consistent with some market making costs being fixed. We study the economic determinants of bid-ask spreads in Pink Sheets stocks further in Section VII.

Figure 3 shows the full cross-sectional distribution of the average price midpoints for non-ADRs and ADRs. Non-ADRs are dominated by stocks priced below a nickel, at least in terms of the number of stocks present in the database. Note, however, that there are also over 300 non-ADR stocks with an average price midpoint greater than \$10. ADRs are concentrated in the \$10 to \$40 range.

Figure 4 provides the average number of active inside quote updates per day for the stocks within the same price categories defined in Figure 3. Despite the fact that the largest fraction of non-ADR stocks are priced below $0.01, these are relatively inactive issues from a quotation generation perspective. Indeed, up to prices between $5 and $6, for which the average number of active inside updates per day is about 9, there is a general pattern suggesting that the higher the price of the stock, the more frequently it will be quoted. For ADRs, the average number of quotes per day peaks for stocks between $50 and $60, at around 200.

Quotation frequency is detailed further in Table 3. The data are partitioned by the number of days in which a stock is quoted. We then compute the average number of quote updates associated with these days. For the entire sample, the vast majority of the stocks are quoted on few than 100 calendar days, with only 38 stocks begin quoted daily throughout the year. For the stocks with fewer than 100 days of quotation activity, 80% experience an average of fewer than one quotation update per day. As the number of days with quotation activity increase, so does the average number of quotations per day, with 35 of the 38 stocks that are quoted daily experiencing an average of over 20 quote updates per day. Not surprisingly, these very active stocks fall under the ADR umbrella. The inactive quotation stocks are concentrated among the lower priced non-ADRs as shown in the remaining panels of the table.

V. Trade Execution Results

Of the 8,140 stocks with at least one trade during non-holiday weekdays in 2004, and for which at least one quotation record is listed in the quote files, 12 are dropped for having no trades between 9:30 a.m. and 4:00 p.m. For the 8,128 remaining stocks, and the corresponding 4,013,200 trades, we compute the average trade price, the average trade size in shares, and the average trade size in dollars, each of which is equally-weighted across trades within a day, then across days for which at least one trade occurs. We also compute the average number of trades per day, and the average number of trades per day for those days in 2004 on which the stock traded at least once.

Table 4 lists the cross-sectional inter-quartile ranges of these summary statistics. Panel A shows results for all trades, whereas Panel B restricts attention to those trades preceded on the same day by an active inside quote. This subsample is important because it permits straightforward computation of market quality measures such as effective spreads and the rate of price improvement. Panel A shows that for the full sample, the average trade price at the 25th percentile is \$0.0490, the median is \$0.3139, and the 75th percentile is \$1.7860. Thus the distribution of trade prices is shifted to the right relative to the distribution of active inside quotes. The median stock is traded less than once per day, and has at least one trade 20 days per year. ADR stocks are traded more days per year than non-ADR stocks, 106 versus 20 at their respective medians, with an average of over 1.5 trades per day versus less than 0.5. Also, the ADRs have larger dollar trade sizes than the non-ADRs, \$12,591 versus \$1,299 at their respective medians.

The results in Panel B show that the distribution of average trade prices more closely resembles the distribution of average quoted midpoints, which is as expected since we require these trades to be preceded by an active inside quote.

Table 5 lists the summary statistics in subsets of stocks organized by average trade price. As with the quote results in Table 2, the most actively trades stocks are not penny stocks, but rather those that fall in the \$1 to \$10 range, with a median intensity of almost one trade per day over 34 days per year, compared to a median of 0.1230 trades per day over 8 days per year for those stocks with average trade price less than a nickel. Trade frequency is examined further in Tables 6a (all trades) and 6b (trades with existing inside quotes). Panel A of Table 6a shows that the majority of stocks, 5,273 of 8,128, are traded less than once per day. Similar results hold conditioning on the existence of a preceding inside quote.

VI. Clustering and Price Improvement

The Pink Sheets quotation and trading systems do not have established tick sizes. The only limiting factor with regards to price points are the number of digits available in the electronic systems, which are four after the decimal in the quotation system and five after the decimal in the trading system, corresponding to hundredths and thousandths,

respectively, of a penny! Academic studies provide two relevant arguments for why the ability to price stocks in these small increments may not be optimal. First, Brown, Laux, and Schacter (1991) and Harris (1991) note that the smaller the tick size, the larger the number of possible prices at which to trade, thereby complicating negotiation and presumably decreasing the average speed of execution. Second, a smaller tick size may decrease market depth by reducing the profitability of supplying liquidity, as implied by the model of Anshuman and Kalay (1998).

To determine what tick sizes market participants actually use, we investigate the degree of clustering in quoted prices, quoted spreads, and trade prices. Table 7 lists the number of active inside quotes and trades used in the analysis, broken down by price and ADR versus non-ADR. All 2,687,740 active inside quotes filtered as above are used. Of the 4,013,200 filtered trades, 17,080 are dropped for having prices with a non-zero fifth digit after the decimal, leaving 3,996,120 for the analysis. This will allow for easier comparison to quotes which do not have a fifth digit. As listed in Panel A, the category of stocks with prices above $10 have the largest number of quotes, approximately 1.2 million at both the bid and the ask, more than double the number of quotes for the $1 to $10 category. Interestingly, however, the latter category has seven times more *trades* than the former. This puzzle is explained in Panels B and C. For the non-ADRs in Panel B, stocks in the $1 to $10 range have the most quotes and the most trades, whereas for the ADRs in Panel C it is the highest price category that dominates. For the ADRs above $10, there are about 14 inside quote updates per trade. For the non-ADRs between $1 and $10, in contrast, there are more than three trades per quote update.

Tables 8 through 10 list the percentage of bid quotes, quoted spreads, and trade prices that have decimal components in whole numbers of various increments. Table 8 shows the results for bid prices. Results for ask prices are very similar and omitted for brevity. Panel A shows that for all stocks, 92.99% of the bid quotes are on whole increments of $0.001, i.e. they have a zero in the fourth digit following the decimal. Further, when sorted by price category, for prices above $0.10, over 99 percent of the bid quotes are in whole multiples of $0.001. Thus it appears that dealers effectively eliminate 90% of the possible price points for stocks above $0.10. Panel A shows that as the increment gets larger, the percentage of quotes with whole multiples decreases, as

expected, but can still be quite high depending on the price of the stock. For stock prices above $10, for example, 97.98% of the bid quotes are on whole multiples of $0.05, and for stock prices between $1 and $10, 97.64% of the bid quotes are on whole multiples of $0.01. Tables 9 and 10 show similar results for the decimal component of the quoted spreads and trade prices.

Clustering of trade prices suggests a close relation between trade prices and quotes. To explore this further, we compare trade prices to the best available quotes. For each stock each day, we construct a time series of the best available active quotes. When an active inside quote is available, it is defined as the best available active quote. Otherwise, we take the highest active bid and lowest active ask as the best available quote. Table 11 lists the results. Only 1,126,417 trades, about 25% of all trades, are preceded by an active quote. These are evenly split between buys and sells. The vast majority of these, 87.2% and 88.0% respectively, occur at the best available quote, with 1.6% worse, and the remainder improved. When these are categorized by the code of the best available quote, large differences in price improvement are apparent. When the best available quote is a Code 1 or 2, the trade prices equal the quotes about 50% of the time, with the majority of the remainder showing price improvement. When the best available quote is a Code 4, which are beginning-of-day indications of interest, the trade prices equal the quotes only 5.1% of the time for buys and 13.3% of the time for sells. Again, the majority of the remainder shows price improvement. When the best available quote is a Code 6, an inside quote, trade prices equal quotes about 90% of the time. Thus, when more than one dealer is actively quoting a stock, quotes appear to be competitive. Otherwise, quotes are widened and trade prices are presumably determined after some negotiation.

Figures 5 through 7 illustrate the clustering graphically. Figure 5 shows the percentage of bid quotes with decimal components at each of the 10,000 possible price points. In Panel A, all stocks are included, and two features are apparent. First, there are large spikes at the whole nickels and dimes. Second, there is a right-skewed distribution with a peak at zero. This combination suggests two distributions are mixed, corresponding to clustering patterns for relatively low and high priced stocks. This is illustrated in Panels B through D. Panel B shows that for stocks above $10, there are

virtually no quotes other than the whole nickels and dimes. The largest category is at zero, i.e. approximately 8% of these quotes are on whole dollars. The next highest is $0.50, followed by $0.25 and $0.75. Panel C shows that for stocks between $1 and $10, the nickels and dimes still contain the bulk of the quotes, but other price points are visible. For stocks below $1, in Panel D, the distribution is right skewed with a peak at zero. This is due to the large number of stocks with prices close to zero. We control for this by focusing in Panel E on only those price points below $.10 and further in Panel F for those price points below $.01. When we do this, the same sort of clustering is evident, just at a different scale. In other words, regardless of the stock price, dealers cluster to eliminate price points, presumably to facilitate trade.

Excessive clustering has been linked previously to artificially widening the bid-ask spread. In the next section, we investigate spreads in the Pink Sheets market to determine whether they are economically justified.

Figure 6 displays the clustering histograms for the decimal component of quoted spreads. The patterns are quite similar to those in Figure 5. The main difference is that Panels A through C are right-skewed, whereas in Figure 5 they are symmetric. The reason for this is that the bid-ask spreads are generally below $0.50, hence there are not a lot of observations on the right side of the graphs. Figure 7 shows clustering of trade prices. The patterns noted for the bid prices and quoted spreads are evident, especially for trade prices above $10, however in all cases there is a higher percentage of observations between the nickels and dimes. This is consistent with some degree of negotiation prior to a trade.

VII. Economic Determinants of the Bid-Ask Spread

As shown previously, quoted bid-ask spreads are quite high in the Pink Sheets market, especially for low-priced stocks. To determine the degree to which the observed spreads can be explained by economic features of the market, we estimate parameters of a cross-sectional model of market maker costs. Stoll (1978) argues that these costs fall into three categories: order-processing costs, inventory-holding costs, and adverse selection costs. Order-processing costs are those associated with providing the market making service

including administrative, technological, and labor costs. Inventory-holding costs refer to the risk a market maker incurs while maintaining positions in stocks necessary for providing liquidity to investors. Adverse selection costs are generated when a market maker trades with investors that are better informed about the expected price movement of a particular stock. We incorporate these three cost components, as well as the impact of competition on spreads, using the model developed in Bollen, Smith, and Whaley (2004, hereafter "BSW").

Prior research investigating the determinants of the spread uses a variety of variables to proxy for inventory-holding costs and adverse information costs, including the volatility of stock returns, the time between trades, and market capitalization. The impact of the variables on spreads is usually estimated in a linear regression. As shown by BSW, the structural form of the regression model can have a significant impact on its explanatory power. BSW develop the "inventory holding premium" to measure the combined impact of inventory-holding costs and adverse information costs on spreads. The intuition is that the market maker charges a spread to cover the expected loss of carrying an incremental unit of inventory. BSW show that the expected loss, conditional on the stock price moving against the dealer, takes the form of an at-the-money option, and can be expressed as follows:

$$(1) \qquad IHP = S\left[2N\left(0.5\sigma E\left[\sqrt{t}\right]\right)-1\right]$$

where *IHP* is the inventory-holding premium, S is the current stock price, $N(\cdot)$ is the cumulative standard normal density function, σ is the standard deviation of security returns, and $E\left[\sqrt{t}\right]$ is the expected square root of the time until the offsetting order arrives.

To compute the *IHP* for a given stock, we compute for each trade the "trade time" defined as the number of seconds elapsed over the course of the trading day. We ignore the overnight, weekend, and Nasdaq holiday periods. Then, we compute the average square root of the time between each successive trade to proxy for $E\left[\sqrt{t}\right]$. We compute volatility σ using the sample standard deviation of close-to-close returns. If there are

trading days with no trades, we compute the close-to-close return using the next available closing price. Lastly, we use the average trade price for *S*.

In addition to the inventory holding premium, the regression model incorporates order-processing costs and the impact of competition on spreads. As is standard in the literature, we use the inverse of trading volume to proxy for order-processing costs. The larger the trading volume, the smaller should be the cost per share of stock since costs can be amortized over a larger quantity. We use the modified Herfindahl index to proxy for the level of competition for a given stock. The standard Herfindahl index is computed as:

$$(2) \qquad HI = \sum_{j=1}^{NM} \left(\frac{V_j}{TV} \right)^2$$

Where *HI* is the Hefindahl index, *NM* is the number of market makers, V_j is the number of shares traded by market maker *j*, and *TV* is the total number of shares traded by all market makers. The modified Herfindahl index *MHI* is computed as:

$$(3) \qquad MHI = \frac{HI - 1/NM}{1 - 1/NM}.$$

The advantage of the *MHI* is that it ranges from zero, for the case of perfect competition, to one, for the case of a monopolist, and so has a more natural interpretation. Taken together, our regression specification is:

$$(4) \qquad SPRD_i = \alpha + \beta_1 IHP_i + \beta_2 InvTV_i + \beta_3 MHI_i + \varepsilon_i$$

where *SPRD* is the quoted bid-ask spread, *IHP* is the inventory holding premium, *InvTV* is the inverse of trading volume, and *MHI* is the modified Herfindahl index. For each stock, we compute an equal-weighted quoted spread each day the stock is quoted in 2004. We use only the active inside quotes. Then, we record the median of these daily averages. This serves to mitigate the impact of outliers. Several stocks had extremely wide quoted spreads the first few days they appeared in the database, indicating possible data-entry error. We scale inverse trading volume by 1,000 to keep the variables' coefficient estimates in a tighter range.

Table 12 shows the results. For the full sample, 3,180 stocks have sufficient data to be included in the analysis. The adjusted R-squared is 56%. For comparison, BSW find adjusted R-squared of 54%, 72%, and 80%, respectively, for March 1996, April 1998, and December 2001 on Nasdaq. The only variable with a significant coefficient is the *IHP*, with a value of 1.2036. This result indicates that the cross-section of quoted spreads for Pink Sheets stocks can be largely explained by the inventory holding premium of market makers. If the expected square root of the time between trades we record is equal to that corresponding to an individual market maker, then we expect a coefficient of one on the *IHP*, since spreads should increase one-for-one with this cost. On the one hand, a market maker would expect a longer time between trades than we observe in the database, since we are computing the time between each trade, not the time between trades for a specific market maker. On the other hand, trades on the Pink Link system are only a subset of all trades for Pink Sheets stocks, since trades can be executed by other mechanisms. This implies a market maker would expect a shorter time between trades than we observe. The results for non-ADR stocks are virtually unchanged, which is to be expected since ADRs constitute only 137 of the 3,180 stocks in the original regression. For the ADR stocks, the adjusted R-squared rises to 61%, but the coefficient on *IHP* drops to 0.2549 and the intercept is 0.1549, both highly significant. In the BSW specification, the intercept has the interpretation as the average spread when the stock is costless to provide, and should equal the tick size in a competitive market. These results indicate some form of measurement error in the market maker costs for ADRs, perhaps due to the low number of ADR trades reported through Pink Link, which would overestimate the time between trades and hence overestimate the *IHP*.

Also listed in Table 12 are the results for regressions that use subsets of stocks organized by average trade price. For stocks with average trade prices less than or equal to $0.05, the adjusted R-squared is 27%. The coefficient on *IHP* is statistically significant, but, with a value of 0.1895, smaller than expected. Perhaps for these stocks, trade execution occurs more frequently over the telephone than via Pink Link, thereby overestimating the *IHP*. The coefficient on inverse trading volume is also significant and positive, indicating that spreads are wider for stocks with lower trading volume, consistent with order-processing costs. In this regression, the intercept is statistically

significant as well, and, with a value of $0.0047, economically large. As before, we expect the intercept to equal the tick size in a market with a minimum price increment. For Pink Sheets stocks, this is $0.0001. Thus, the quoted spreads are on average larger than expected by $0.0046 for stocks below $0.05. Similarly, for stocks with prices above $0.05 and less than or equal to $1.00, the intercept is statistically significant and economically large, at $0.0362. For this category, the coefficient on *IHP* is 0.8569 and all cost coefficients are positive and significant at the 10% level. For the next category of stocks, all three independent variables have statistically significant coefficients. And for the largest price category, only the *IHP* has a coefficient that is statistically significant. For these two last categories, the intercept is insignificantly different than zero, indicating that the level of spreads can be explained by the economic features of the market.

In summary, the quoted spreads on the Pink Sheets market conform reasonably well to their economic determinants when all stocks are included in the analysis. Stocks with average trade price below $1.00, however, which constitute a majority of the stocks quoted on the Pink Sheets, exhibit spreads that are on average wider than those predicted by a cross-sectional model of market maker costs. One explanation for this is that the model does not fully capture the risks inherent in market making for these securities, or does not accurately capture how these securities are viewed by investors or market makers.

VIII. Trade Durations

Our analysis of bid-ask spreads requires an estimate of the time between trades, or durations, as a component of the risk associated with carrying a share of a Pink Sheets stock in inventory. For each stock, we compute the average time between trades, as is standard. However, if trades cluster through time, then the average may not adequately capture a typical holding period. In this section, we investigate trade durations on the Pink Sheets market to shed further light on this issue.

For each stock, we compute the duration between each trade. As before, we ignore the overnight, weekend, and Nasdaq holiday periods. Table 13 shows summary statistics for the 4,110 stocks with at least one trade for a minimum of 20 trading days in

2004. Panel A lists results for the full sample, as well as non-ADR and ADR subsamples. For the full sample, almost all stocks have at least one instance of multiple trades occurring on the same second, as exhibited by the minimum duration. For the median stock, however, the maximum duration is 341,512 seconds, or almost three weeks. Trades obviously do not occur uniformly over the course of the year. This is also evident when comparing the average to the median duration, 15,196 versus 1,063 for the median stock, for example. The last statistic listed for the full sample is the Volume Ratio, defined as the maximum number of trades in a single day to the expected number of trades if trades occurred uniformly. For the median stock, the peak trading day has over 15 times the expected number of trades.

Panel B shows results for subsamples based on a stock's average trade price. As before, we see evidence that the stocks with price between \$1 and \$10 are the most active, with an average duration of 11,012 seconds, or about three hours, for the median stock.

To investigate the temporal clustering of trades more formally, we estimate parameters of an auto-regressive conditional duration model for each stock, following Engle and Russell (1998). Let *t* denote the time of a transaction, measured using a trading time clock that ignores overnight, weekend, and holiday periods. Define $x_i = t_i - t_{i-1}$ as the duration of the i^{th} trade. The expected duration given the prior sequence of trades is defined as:

$$(5) \qquad E\left(x_i \left| x_{i-1}, \ldots x_1 \right.\right) \equiv \psi_i ,$$

and the relation between actual and expected durations is specified as;

$$(6) \qquad x_i = \psi_i \varepsilon_i ,$$

where the disturbances ε are i.i.d. and have unit mean. The ACD(1,1) model sets the expected duration to be a function of the prior expected duration and the duration of the prior trade:

$$(7) \qquad \psi_i = \omega + \alpha x_{i-1} + \beta \psi_{i-1} .$$

This model implies a long-run unconditional expected duration of $\omega/(1-\alpha-\beta)$. Parameter estimation requires a distributional assumption for ε. The EACD(1,1) model uses an exponential distribution, resulting in a simple likelihood function that is readily estimated using MLE.

We estimate parameters in (7) for all 3,170 stocks with at least 100 trades in 2004. Table 14 shows the interquartile ranges of the parameters for the 1,508 stocks for which the ML optimizer achieved convergence. For the median stock, the α and β coefficients are 0.1487 and 0.8233, respectively. By comparison, Engle and Russell report that for IBM, over the November 1990 to January 1991 period, the α and β coefficients are 0.0631 and 0.9332, respectively. This indicates that the Pink Sheets stocks feature more intense clustering than the prototypical blue chip stock. The median ADR stock in our sample has coefficients of 0.0799 and 0.8758, implying that ADRs trade more regularly than non-ADRs. Panel B shows that the α coefficient is a decreasing function of price, indicating that the lowest priced stocks have the most intense temporal clustering of trades.

As described by Engle and Russell, bursts of trading activity "may be due to some observable event such as a news release or to an unobservable event which may best be thought of as a stochastic process." Perhaps the low-priced stocks on the Pink Sheets market are most prone to fraudulent activity such as "pump and dump" schemes in which a stock is hyped on bulletin boards to generate a spike in short-term trading activity and subsequent price movements. Alternatively, trade clustering could be due to informative news events, which for penny stocks could have a dramatic impact on value. In an attempt to distinguish between these two explanations, we study the price behavior of Pink Sheets stocks during periods of extreme activity.

For each stock with at least one trade on at least 20 days in 2004, we find the five-day window with the maximum trading volume. Then, we find the closing trade price on the days before and after the high volume window. Table 15 reports summary statistics of these high volume windows. The "Volume Ratio" is defined as the average trading volume in the window divided by the average trading volume outside the window. The "Outside Ratio" is defined as the average trading volume in the three days prior to and

after the window divided by the average trading volume over all days outside the window. In Panel A, the median stock has a volume ratio of 6.3 and an outside ratio of 1.8, indicating that the high volume period is distinct from the rest of the year, and that trading volume is only slightly elevated in the few days surrounding the five day window. The "Return" is computed as the log ratio of the closing price on the day after the high volume window to the closing price prior to the window. The median stock has a return of over 10%. To put this number in perspective, we also compute the six-day standard deviation for each stock, defined as the day-to-day volatility outside the high volume window multiplied by $\sqrt{6}$. For the median stock, the return over the high volume window is 0.8027 standard deviations, indicating that though the return seems large, it is not significantly different than expected in "normal" times.

To assess whether the spike in trading volume is due to a news event or noise, we compute the reversal in price that occurs within each high volume period. Specifically, for each stock we find the maximum and minimum trade price during the five-day window. For a stock with a positive (negative) return during the period, the reversal is defined as the log ratio of the closing price after the window to the intra-period high (low). Table 16 reports the results. Note that there are roughly twice as many periods with a positive return than a negative return. Perhaps this is due to difficulty in shorting Pink Sheets stocks when prices fall. The volume characteristics are quite similar for positive and negative periods. The median positive return is 23.24% compared to –21.43% for the median negative return. The reversals seem large, –15.12% for the positive windows and 9.82% for negative windows at the medians, and –35.67% and 28.77% at the 25^{th} and 75^{th} percentiles, respectively, for the positive and negative windows. As a control, for each stock we compute the reversals in every other five-day window during 2004. The reversals at the 25^{th} and 75^{th} percentiles for positive and negative windows, respectively, are only half as big. These results indicate that for many Pink Sheets stocks, there is the potential for substantial losses when trading during periods of high activity. This presents one explanation for the large bid-ask spreads, especially for low-priced stocks.

IX. Conclusions

This paper examines the quote and trade characteristics of stocks that reside on the Pink Sheet market. Our data include all quote updates and trades reported through the Pink Sheet market for every stock in 2004, and provide a more comprehensive understanding of this opaque market than previous studies that have access to daily summaries of a limited number of stocks for a limited length of time.

Our findings reveal a market populated with a wide array of issuers who either avoid the organized exchanges or markets or are not eligible for listing. The most important distinction among stocks in our sample is whether an issue is traded as an ADR or a non-ADR. The stocks traded as ADRs have much higher share prices, greater trading activity, and narrower percentage spreads than non-ADRs that are more heavily concentrated in the penny stock population.

Despite the ability of market makers to use up to 10,000 price points in the Pink Sheet market, we observe a remarkable uniformity in clustering as a function of share price. The market appears quite capable of organizing itself without the intervention of external regulatory agencies that dictate the nuances of trading. However, whether the market is without its inefficiencies or blemishes is not resolved in this paper.

We view potential avenues of future research in this market as critical to aid our understanding of how markets function with limited oversight or SEC regulation. Markets face a constant tradeoff between investor protection and over-regulation. In some cases, our organized markets are overburdened with rules and regulations. In the Pink Sheet market, such is not the case. While market makers are still subject to NASD rules, the Pink Sheets permit a wide range of market maker and investor flexibility. Indeed, this is one of the many avenues of future research. To what extent do investors, issuers and/or makers benefit from a loose form of regulation and oversight? Do comparable firms that are traded on the OTCBB/Nasdaq/Organized Exchanges offer greater investor protection and/or lower trading costs? If so, we can help to quantify the prices that companies (and their shareholders) are willing to pay to avoid current filings with the SEC or avoid the costs associated with regulatory oversight such as Sarbanes/Oxley.

The data may also reveal more direct evidence of trading episodes that represent fraudulent behavior on the part of either investors or market makers. So called "pump and dump" schemes are the source of much financial lore. The Pink Sheet market would seem an ideal playground for such behavior, especially given the warning by the market noted in the opening paragraph of the paper. Evidence of rapid price advances and declines in the absence of new, public information would add credence to such claims.

Our evidence also provides guidelines regarding the natural tick sizes that have emerged in the marketplace. Should Pink Sheets elect to set tick sizes as a function of price levels, we believe that our clustering results could offer reasonable cutoffs for tick size increments based on the characteristics of the issues being traded.

References

Angel, J., J. Harris, V. Panchapagesan, and I. Werner. "From Pink Slips to Pink Sheets: Liquidity and Shareholder Wealth Consequences of Nasdaq Delistings." Working paper, Georgetown University.

Anshuman, R., and A. Kalay. "Market Making with Discrete Prices." *Review of Financial Studies*, 11 (1998), 81-109.

Barclay, M, W. Christie, J. Harris, E. Kandel, and P. Schultz, 1999, Effects of Market Reform on the Trading Costs and Depths of Nasdaq Stocks, *Journal of Finance* 54, 1-34.

Bollen, N., T. Smith, and R. Whaley. "Modeling the Bid/Ask Spread: Measuring the Inventory-Holding Premium." *Journal of Financial Economics*, 72 (2004), 97-141.

Brown, S., P. Laux, and B. Schacter. "On the Existence of Optimal Tick Size." *Review of Futures Markets*, 10 (1991), 50-72.

Engle, R., and J. Russell. "Autoregressive Conditional Duration: A New Model for Irregularly Spaced Transaction Data." *Econometrica*, 66 (1998), 1127-1162.

Harris, L. "Stock Price Clustering and Discreteness." *Review of Financial Studies*, 4 (1991), 389-415.

Macy, J., M. O'Hara, and D. Pompilio. "Down and Out in the Stock Market: The Law and Finance of the Delisting Process." Working paper, Cornel University

Stoll, H. "The Pricing of Security Dealer Services: An Empirical Study of Nasdaq Stocks." *Journal of Finance*, 33 (1978), 1153-1172.

Table 1. Summary Statistics of Active inside Quotes

Listed are the inter-quartile ranges of summary statistics of active inside quotes for all Pink Sheets stocks quoted on the Pink Sheets Electronic Quotation Service in 2004. Only quotes posted between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Listed are inter-quartile ranges of the average quoted midpoint, the average percentage quoted spread, the daily volatility of percentage returns, the number of days between the first and last appearance of the stock in the database (NDay), the average number of quotes per day, the number of days the stock has an active inside quote (NQday), the average number of quotes per day the stock is quoted, and the number of unique market makers participating at least once in the inside quote. Listed are the ranges across all stocks, and for subsets of non-ADRs and ADRs, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol.

	A. All Stocks (N = 4,342)		
	25th	50th	75th
Avg Price ($)	0.0111	0.1190	0.8424
Avg % Sprd	20.40	45.19	89.90
% Volatility	5.51	13.25	22.30
NDay	190	252	252
Avg #Q/Day	0.1865	0.4008	1.4405
NQday	16	29	59
Avg #Q/QDay	2.1765	2.8500	4.4918
NMM	5	8	12

	B. Non-ADR (N = 4,195)		
	25th	50th	75th
Avg Price ($)	0.0103	0.1054	0.6724
Avg % Sprd	22.32	47.36	91.97
% Volatility	6.31	13.73	22.72
NDay	188	252	252
Avg #Q/Day	0.1786	0.3810	1.2421
NQday	15	28	54
Avg #Q/QDay	2.1539	2.8000	4.2778
NMM	5	8	12

	C. ADR (N = 147)		
	25th	50th	75th
Avg Price ($)	4.7929	10.7592	23.1583
Avg % Sprd	1.02	1.75	4.24
% Volatility	1.44	1.84	2.61
NDay	252	252	252
Avg #Q/Day	3.3175	11.0992	36.6270
NQday	129	227	250
Avg #Q/QDay	4.4961	12.9839	39.4317
NMM	14	20	24

Table 2. Summary Statistics of Quotes by Midpoint

Listed are the inter-quartile ranges of summary statistics of active inside quotes for all Pink Sheets stocks quoted on the Pink Sheets Electronic Quotation Service in 2004. Only quotes posted between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Listed are inter-quartile ranges of the average quoted midpoint, the average percentage quoted spread, the daily volatility of percentage returns, the number of days between the first and last appearance of the stock in the database (NDay), the average number of quotes per day, the number of days the stock has an active inside quote (NQday), the average number of quotes per day the stock is quoted, and the number of unique market makers participating at least once in the inside quote. Listed are the ranges for subsets formed by the average quoted midpoint price.

	A. $0.05 >= P (N = 1,752)			C. $10 >= P > $1 (N = 624)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0026	0.0067	0.0194	1.4619	2.4079	4.5667
Avg % Sprd	42.00	74.14	128.60	6.88	18.10	40.96
% Volatility	10.06	17.69	27.58	2.92	6.90	14.14
NDay	252	252	252	108	252	252
Avg #Q/Day	0.1587	0.2818	0.5828	0.2727	0.9484	3.5675
NQday	16	25	40	14	43	97
Avg #Q/QDay	2.1698	2.6552	3.5122	2.2708	3.4143	6.5536
NMM	4	7	10	6	10	15
	B. $1 >= P > $0.05 (N = 1,572)			D. P > $10 (N = 394)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1137	0.2292	0.4391	16.4107	26.3500	54.5919
Avg % Sprd	22.96	42.49	76.50	3.20	7.41	15.71
% Volatility	8.66	13.90	21.82	1.29	2.10	4.56
NDay	133	252	252	238	252	252
Avg #Q/Day	0.2389	0.6022	2.1032	0.0833	0.3810	3.5909
NQday	17	34	71	8	27	101
Avg #Q/QDay	2.2941	3.1071	5.0870	1.7500	2.6091	7.2416
NMM	6	9	14	3	6	12

Table 3. Quote Frequency

Listed in Panel A is the number of Pink Sheets stocks quoted on the Pink Sheets Electronic Quotation Service in 2004, broken down by the average number of daily inside quote updates and number of days quoted. Only quotes posted between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Panels B and C show the ranges for subsets of non-ADRs and ADRs, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol. Panels D through G show subsets based on average closing midpoint.

			Average # Daily Inside Quote Updates			
	Quote Days	# Stocks	1>=N	5>=N>1	20>=N>5	N>20
A. All Stocks	100>=N>0	3,752	3,019	546	149	38
	250>=N>100	552	5	252	233	62
	N>250	38	0	0	3	35
	Totals	4,342	3,024	798	385	135
B. Non-ADR	100>=N>0	3,719	3,004	540	139	36
	250>=N>100	469	3	226	199	41
	N>250	7	0	0	0	7
	Totals	4,195	3,007	766	338	84
C. ADR	100>=N>0	33	15	6	10	2
	250>=N>100	83	2	26	34	21
	N>250	31	0	0	3	28
	Totals	147	17	32	47	51
D. $0.05>=P	100>=N>0	1,641	1,481	128	29	3
	250>=N>100	111	0	42	60	9
	N>250	0	0	0	0	0
	Totals	1,752	1,481	170	89	12
E. $1>=P>$0.05	100>=N>0	1,342	971	278	81	12
	250>=N>100	228	0	116	97	15
	N>250	2	0	0	0	2
	Totals	1,572	971	394	178	29
F. $10>=P>$1	100>=N>0	476	318	112	31	15
	250>=N>100	142	3	70	52	17
	N>250	6	0	0	0	6
	Totals	624	321	182	83	38
G. P>$10	100>=N>0	293	249	28	8	8
	250>=N>100	71	2	24	24	21
	N>250	30	0	0	3	27
	Totals	394	251	52	35	56

Table 4. Summary Statistics of Trades

Listed are the inter-quartile ranges of summary statistics of all Pink Sheets stocks traded using the Pink Link system in 2004. Only trades executed between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Listed are inter-quartile ranges of the average trade price, the average daily share volume, the average daily dollar volume, the number of days between the first and last appearance of the stock in the database (NDay), the average number of trades per day, the number of days the stock is traded (NTday), and the average number of trades per day the stock is traded. Listed are the ranges across all stocks, and ranges for subsets of non-ADRs and ADRs, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol. Panel A shows results for all trades. Panel B shows results for only those trades preceded by an active inside quote on the same day.

	A. All Trades			B. Trades with Inside Quote		
	All Stocks (N = 8,128)			All Stocks (N = 3,739)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0490	0.3139	1.7860	0.0113	0.1106	0.8900
Avg SH Volume	1,260	5,000	9,990	2.2700	6.3100	15.0000
Avg $ Volume	486.90	1,327	2,551	174.9	753.4	1,928
Nday	125	252	252	184	252	252
Avg #T/Day	0.0714	0.3889	1.9822	0.0305	0.1429	0.7222
Ntday	5	20	72	3	11	39
Avg #T/TDay	1.6000	2.5000	4.5299	1.5000	2.2500	3.5781
	Non-ADR (N = 7,976)			Non-ADR (N = 3,598)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0469	0.3013	1.6109	0.0100	0.0980	0.6865
Avg SH Volume	1,320	5,000	10,000	2,770	6,550	15,830
Avg $ Volume	475.5	1,298.9	2,451	162.2	690.5	1,758
Nday	123	252	252	183	252	252
Avg #T/Day	0.0714	0.3810	1.9246	0.0278	0.1349	0.6508
Ntday	5	20	70	3	11	36
Avg #T/TDay	1.6000	2.5000	4.5227	1.5000	2.2353	3.5263
	ADR (N = 152)			ADR (N = 141)		
	25th	50th	75th	25th	50th	75^{th}
Avg Price ($)	3.8762	10.4076	21.2567	4.7193	11.6500	23.4500
Avg SH Volume	610.0	1,010	1,790	600.0	1,010	1,640
Avg $ Volume	4,835	12,591	16,872	5,679	13,136	17,318
NDay	252	252	252	252	252	252
Avg #T/Day	0.2619	1.5357	4.1151	0.3413	1.6071	4.3294
NTday	26	106	194	34	112	204
Avg #T/TDay	1.8036	2.6667	4.7733	1.8529	2.9057	4.9628

Table 5. Summary Statistics of Trades by Price

Listed are the inter-quartile ranges of summary statistics of all Pink Sheets stocks traded using the Pink Link system in 2004. Only trades executed between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Listed are inter-quartile ranges of the average trade price, the average daily share volume, the average daily dollar volume, the number of days between the first and last appearance of the stock in the database (NDay), the average number of trades per day, the number of days the stock is traded (NTday), and the average number of trades per day the stock is traded. Listed are the ranges across subsets based on average trade price. Panel B shows results for only those trades preceded by an active inside quote on the same day.

	A. All Trades					
	$0.05 > = P (N = 2,058)			$10 > = P > $1 (N = 1,706)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0026	0.0095	0.0244	1.4558	2.2418	4.0000
Avg SH Volume	10,000	19,910	43,450	720	1,140	1,740
Avg $ Volume	65.7	179.2	385.6	1,625	2,432.6	3,877.6
NDay	172	252	252	88	230	252
Avg #T/Day	0.0238	0.1230	1.0544	0.1746	0.8250	3.7229
NTday	3	8	31	8	34	106
Avg #T/TDay	1.5000	2.5000	4.4600	1.7931	2.8788	5.9897
	$1 > = P > $0.05 (N = 3,401)			P > $10 (N = 963)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1206	0.2494	0.4946	16.3750	24.0432	40.5000
Avg SH Volume	3,900	5,600	7,840	190	260	390
Avg $ Volume	793.8	1,303.7	1,897	4,564.7	6,771.5	11,966.7
NDay	109	252	252	252	252	252
Avg #T/Day	0.1429	0.6032	2.3135	0.0278	0.1310	0.4206
NTday	7	29	89	4	15	42
Avg #T/TDay	1.7500	2.6842	4.7830	1.2000	1.6585	2.2500
	B. Trades with Inside Quote					
	$0.05 > = P (N = 1,508)			$10 > = P > $1 (N = 578)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0020	0.0070	0.0200	1.4648	2.2617	4.3807
Avg SH Volume	9,140	18,640	39,670	690	1,120	1,870
Avg $ Volume	53.3	121.3	251.3	1,557	2,644	4,865
NDay	252	252	252	113	252	252
Avg #T/Day	0.0159	0.0675	0.2619	0.0754	0.3465	1.6230
NTday	2	6	19	5	22	60
Avg #T/TDay	1.5000	2.2000	3.3333	1.6000	2.3333	4.3067
	$1 > = P > $0.05 (N = 1,342)			P > $10 (N = 311)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1066	0.2093	0.4400	15.7735	24.5882	48.0998
Avg SH Volume	4,040	5,650	8,080	200	340	720
Avg $ Volume	680.1	1,116.6	1,734.9	5,580	10,918.6	17,000
NDay	132	252	252	251	252	252
Avg #T/Day	0.0595	0.2599	1.1111	0.0198	0.1151	1.5357
NTday	6	17	50	3	11	70
Avg #T/TDay	1.5714	2.3103	3.8278	1.2857	2.0000	3.4877

Table 6a. Trade Frequency

Listed in Panel A is the number of Pink Sheets stocks traded using the Pink Link system in 2004, broken down by the average number of daily trades and number of days traded. Only trades executed between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Panels B and C show the ranges for subsets of non-ADRs and ADRs, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol. Panels D through G show subsets based on average trade price.

			Average # Trades Daily			
	Trade Days	# Stocks	1>=N	5>=N>1	20>=N>5	N>20
A. All Stocks	100>=N>0	6,607	5,273	948	288	98
	250>=N>100	1,486	14	790	539	143
	N>250	35	0	0	6	29
	Totals	8,128	5,287	1,738	833	270
B. Non-ADR	100>=N>0	6,532	5,209	942	283	98
	250>=N>100	1,414	10	742	519	143
	N>250	30	0	0	2	28
	Totals	7,976	5,219	1,684	804	269
C. ADR	100>=N>0	75	64	6	5	0
	250>=N>100	72	4	48	20	0
	N>250	5	0	0	4	1
	Totals	152	68	54	29	1
D. $0.05>=P	100>=N>0	1,848	1,535	197	95	21
	250>=N>100	206	1	76	103	26
	N>250	4	0	0	1	3
	Totals	2,058	1,536	273	199	50
E. $1>=P>$0.05	100>=N>0	2,640	2,011	494	110	25
	250>=N>100	752	4	440	263	45
	N>250	9	0	0	0	9
	Totals	3,401	2,015	934	373	79
F. $10>=P>$1	100>=N>0	1,253	910	229	76	38
	250>=N>100	436	4	220	144	68
	N>250	17	0	0	1	16
	Totals	1,706	914	449	221	122
G. P>$10	100>=N>0	866	817	28	7	14
	250>=N>100	92	5	54	29	4
	N>250	5	0	0	4	1
	Totals	963	822	82	40	19

Table 6b. Trade Frequency for Trades with Inside Quotes

Listed in Panel A is the number of Pink Sheets stocks traded using the Pink Link system in 2004, broken down by the average number of daily trades and number of days traded. Only trades executed between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Panels B and C show the ranges for subsets of non-ADRs and ADRs, respectively. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol. Panels D through G show subsets based on average trade price.

			Average # Trades Daily			
	Trade Days	# Stocks	1>=N	5>=N>1	20>=N>5	N>20
A. All Stocks	100>=N>0	3,351	2,937	309	81	24
	250>=N>100	377	7	204	138	28
	N>250	11	0	0	5	6
	Totals	3,739	2,944	513	224	58
B. Non-ADR	100>=N>0	3,285	2,880	304	77	24
	250>=N>100	307	3	158	118	28
	N>250	6	0	0	1	5
	Totals	3,598	2,883	462	196	57
C. ADR	100>=N>0	66	57	5	4	0
	250>=N>100	70	4	46	20	0
	N>250	5	0	0	4	1
	Totals	141	61	51	28	1
D. $0.05>=P	100>=N>0	1,422	1,328	73	17	4
	250>=N>100	85	0	34	41	10
	N>250	1	0	0	1	0
	Totals	1,508	1,328	107	59	14
E. $1>=P>$0.05	100>=N>0	1,197	987	164	40	6
	250>=N>100	142	1	84	49	8
	N>250	3	0	0	0	3
	Totals	1,342	988	248	89	17
F. $10>=P>$1	100>=N>0	489	401	58	20	10
	250>=N>100	87	3	49	27	8
	N>250	2	0	0	0	2
	Totals	578	404	107	47	20
G. P>$10	100>=N>0	243	221	14	4	4
	250>=N>100	63	3	37	21	2
	N>250	5	0	0	4	1
	Totals	311	224	51	29	7

Table 7. Number of trades and quotes in clustering analysis

Listed are the numbers of trades and inside quotes used in the clustering analysis. Data include all active inside quotes on the Pink Sheets market in 2004 and all trades using the Pink Link system with trade prices containing a zero in the fifth digit after the decimal. Only trades and quotes between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol.

	A. All Stocks		
	Bid	Ask	Trade
P>10	1,197,469	1,205,743	233,321
10>=P>1	491,207	504,992	1,604,712
1>=P>.1	421,418	440,936	1,137,929
.1>=P>.001	523,284	512,706	951,081
.001>=P	54,362	23,363	69,077
Total	2,687,740	2,687,740	3,996,120

	B. Non-ADR		
	Bid	Ask	Trade
P>10	102,606	106,144	154,235
10>=P>1	411,101	429,446	1,588,601
1>=P>.1	413,580	433,099	1,133,756
.1>=P>.001	522,287	511,860	950,183
.001>=P	54,338	23,363	69,077
Total	1,503,912	1,503,912	3,895,852

	C. ADR		
	Bid	Ask	Trade
P>10	1,094,863	1,099,599	79,086
10>=P>1	80,106	75,546	16,111
1>=P>.1	7,838	7,837	4,173
.1>=P>.001	997	846	898
.001>=P	24	0	0
Total	1,183,828	1,183,828	100,268

Table 8. Percentage of bid quotes with whole fractions

Listed is the percentage of bid quotes with whole fractions. Data include all active inside quotes on the Pink Sheets market in 2004. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol.

A. All Stocks

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.9299	0.9998	0.9971	0.9883	0.7278
0.005	0.8572	0.9997	0.9949	0.9618	
0.010	0.8074	0.9966	0.9764		
0.050	0.6130	0.9798	0.6537		
0.100	0.3242	0.5208	0.3532		
0.250	0.1579	0.2624	0.1746		

B. Non-ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.8748	0.9978	0.9966	0.9882	0.7273
0.005	0.7449	0.9971	0.9940	0.9611	
0.010	0.6577	0.9764	0.9729		
0.050	0.3191	0.7993	0.5995		
0.100	0.1725	0.4986	0.3285		
0.250	0.0884	0.3938	0.1671		

C. ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.9999	1.0000	0.9999	0.9978	0.9689
0.005	0.9998	1.0000	0.9997	0.9973	
0.010	0.9975	0.9984	0.9944		
0.050	0.9865	0.9967	0.9320		
0.100	0.5169	0.5229	0.4800		
0.250	0.2461	0.2501	0.2127		

Table 9. Percentage of quoted spreads with whole fractions

Listed is the percentage of quoted dollar bid ask spreads with whole fractions. Data include all active inside quotes on the Pink Sheets market in 2004. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol.

A. All Stocks

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.91351	0.99963	0.99443	0.97784	0.62717
0.005	0.83495	0.99946	0.99120	0.93762	
0.010	0.77775	0.99397	0.95672		
0.050	0.55751	0.96920	0.52619		
0.100	0.26953	0.48428	0.23337		
0.250	0.10351	0.19526	0.07473		

B. Non-ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.84553	0.99599	0.99346	0.97751	0.62663
0.005	0.70527	0.99429	0.98968	0.93661	
0.010	0.60595	0.95877	0.95055		
0.050	0.22349	0.70740	0.45585		
0.100	0.09761	0.37087	0.19537		
0.250	0.04168	0.28052	0.06464		

C. ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.99988	0.99997	0.99970	0.99570	0.94170
0.005	0.99968	0.99995	0.99948	0.99368	
0.010	0.99600	0.99732	0.99026		
0.050	0.98185	0.99411	0.90805		
0.100	0.48793	0.49507	0.43963		
0.250	0.18204	0.18715	0.12948		

Table 10. Percentage of trade prices with whole fractions

Listed is the percentage of trade prices with whole fractions. Data include all trades on the Pink Sheets trade entry system with trade prices containing a zero in the fifth digit after the decimal. 'ADR' stocks are those identified as containing the character string 'ADR' in their name or containing a 'Y' in the fifth character of their ticker symbol.

A. All Stocks

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.91943	0.99978	0.99972	0.99637	0.72908
0.005	0.80831	0.99970	0.99828	0.92845	
0.010	0.73402	0.99670	0.98361		
0.050	0.33062	0.90844	0.49556		
0.100	0.18130	0.54244	0.27244		
0.250	0.08357	0.36231	0.12156		

B. Non-ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.91737	0.99967	0.99972	0.99635	0.72884
0.005	0.80343	0.99955	0.99827	0.92819	
0.010	0.72733	0.99540	0.98346		
0.050	0.31507	0.86408	0.49181		
0.100	0.17281	0.53818	0.27067		
0.250	0.07903	0.40090	0.12083		

C. ADR

Fraction	All quotes	P>10	10<=P<1	1>=P>.1	.1>=P>.001
0.001	0.99983	1.00000	1.00000	0.99976	0.98218
0.005	0.99800	1.00000	1.00000	0.99928	
0.010	0.99370	0.99924	0.99845		
0.050	0.93486	0.99497	0.86556		
0.100	0.51115	0.55074	0.44671		
0.250	0.25988	0.28706	0.19359		

Table 11. Trade prices relative to quotes

Listed are the number of buys and sells for which an active quote was available on the same day prior to the trade and the percentage of corresponding trade prices that were either at the inside quote, worse, or improved. "All Trades" corresponds to all buys and sells in the analysis. "Code 1" corresponds to the subset for which the best available quote was an updated dealer quote. "Code 2" corresponds to the subset for which the best available quote was a new dealer quote. "Code 4" corresponds to the subset for which the best available quote was an indication of interest at the beginning of the day. "Code 6" corresponds to the subset for which the best available quote was an inside quote, which is formed only when there are at least two active dealer quotes at the bid and ask.

	# Trades	Worse	At Quote	Improved
All Trades	1,126,417			
Buys	565,565	1.6%	87.2%	11.2%
Sells	560,852	1.6%	88.0%	10.3%
Code 1	4,529			
Buys	2,412	3.1%	46.3%	50.6%
Sells	2,117	3.0%	50.9%	46.2%
Code 2	632			
Buys	339	3.8%	57.2%	38.9%
Sells	293	4.4%	58.4%	37.2%
Code 4	32,876			
Buys	14,970	0.6%	5.1%	94.3%
Sells	17,906	0.3%	13.3%	86.5%
Code 6	1,088,380			
Buys	547,844	1.6%	89.6%	8.8%
Sells	540,536	1.7%	90.7%	7.7%

Table 12. Determinants of the Bid-Ask Spread

Listed are results of the cross-sectional regression:

$$SPRD_i = \alpha + \beta_1 IHP_i + \beta_2 InvTV_i + \beta_3 MHI_i + \varepsilon_i$$

where *SPRD* is the quoted bid-ask spread, *IHP* is the inventory holding premium, *InvTV* is the inverse of trading volume, and *MHI* is the modified Herfindahl index. For each stock quoted on the Pink Sheets Electronic Quotation Service and traded on the Pink Link trade entry system in 2004, *SPRD* is the median daily average quoted spread. IHP equals $IHP = S\left[2N\left(0.5\sigma E\left[\sqrt{t}\right]\right)-1\right]$ where S is the average trade price, σ is return volatility, and t is the time between trades. Listed are the adjusted R-squared, number of observations and OLS coefficient estimates. Below each estimate is the two-sided *p*-value using heteroskedasticity-consistent standard errors.

	R^2	N	α	β_1	β_2	β_3
Full Sample	0.5582	3,180	0.2590	1.2036	9.7291	-0.1135
			0.6508	0.0023	0.1729	0.9829
Non-ADR	0.5581	3,043	0.2851	1.2037	9.7270	-0.2032
			0.6349	0.0023	0.1730	0.9705
ADR	0.6134	137	0.1549	0.2549	10.4545	0.2614
			0.0048	0.0005	0.0171	0.7480
P <= $0.05	0.2659	1,183	0.0047	0.1895	1.3590	-0.0024
			0.0000	0.0012	0.0000	0.6045
$0.05 < P <= $1.00	0.3890	1,190	0.0362	0.8569	2.7856	0.2160
			0.0001	0.0000	0.0851	0.0084
$1.00 < P <= $10.00	0.3466	513	0.1030	0.6450	4.8848	2.0286
			0.1228	0.0000	0.0767	0.0019
$10.00 < P	0.5422	294	2.2038	1.1994	9.6145	2.5324
			0.6713	0.0026	0.1755	0.9635

Table 13. Summary Statistics of Trade Durations

Listed are summary statistics of the 4,110 stocks with at least one trade on 20 days on the Pink Link system in 2004. For each stock, the minimum, maximum, average, and median time between trades, in seconds is computed. Listed are the interquartile cross-sectional ranges of these statistics. "Volume Ratio" is the maximum number of trades on a single day as a multiple of the expected number if trades were evenly distributed across all days in 2004. Panel A shows results for the full sample, whereas panel B shows the results for subsamples based on the average trade price of each stock.

A. Full Sample

	All Stocks (N = 4,110)		
	25th	50th	75th
Min	0	0	1
Max	141,278	341,512	671,866
Average	4,811	15,196	45,124
Median	272	1,063	4,531
Volume Ratio	10.0	15.8	24.9
	Non-ADR (N = 3,991)		
	25th	50th	75th
Min	0	0	1
Max	144,230	349,344	678,328
Average	4,838	15,460	45,604
Median	264	1,020	4,491
Volume Ratio	10.2	16.0	25.2
	ADR (N = 119)		
	25th	50th	75th
Min	0	0	0
Max	71,667	166,500	367,951
Average	4,705	10,025	30,224
Median	1,030	1,913	6,564
Volume Ratio	5.8	8.7	17.0

B. Price Subsamples

	$0.05 >= P (N = 671)			$10 >= P > $1 (N = 1,044)		
	25th	50th	75th	25th	50th	75th
Min	0	0	0	0	0	1
Max	138,046	433,050	775,646	97,348	233,797	502,316
Average	3,197	12,468	40,907	3,188	11,012	31,050
Median	122	227	661	260	1,043	3,755
Volume Ratio	10.0	17.4	29.6	8.8	13.8	21.0
	$1 >= P > $0.05 (N = 1,972)			P > $10 (N = 423)		
	25th	50th	75th	25th	50th	75th
Min	0	0	1	0	2	7
Max	163,139	351,910	681,115	218,867	496,687	822,910
Average	5,840	15,753	41,348	14,025	51,809	100,889
Median	402	1,252	4,278	1,808	9,901	24,039
Volume Ratio	10.8	16.1	25.2	11.5	18.8	28.0

Table 14. Interquartile Ranges of EACD(1,1) Parameters

Listed are the interquartile ranges of parameter estimates of the EACD(1,1) model for Pink Sheets stocks in 2004. Panel A shows results for the full sample, whereas panel B shows the results for subsamples based on the average trade price of each stock.

	A. Full Sample		
	All Stocks (N =1,508)		
	25th	50th	75th
ω	61.2308	192.0301	592.4119
α	0.1002	0.1487	0.2157
β	0.7375	0.8233	0.8807
LR	4,495	9,250	18,588
	Non-ADR (N = 1,448)		
	25th	50th	75th
ω	60.8514	183.4073	600.0507
α	0.1038	0.1517	0.2173
β	0.7352	0.8204	0.8776
LR	4,566	9,483	18,836
	ADR (N = 60)		
	25th	50th	75th
ω	84.2022	231.4247	480.3557
α	0.0498	0.0799	0.1239
β	0.8079	0.8758	0.9252
LR	3,682	6,162	10,835

	B. Price Subsamples					
	$0.05 > = P (N = 273)			$10 > = P > $1 (N = 417)		
	25th	50th	75th	25th	50th	75th
ω	56.0481	139.7754	728.3112	51.8217	175.4710	542.6997
α	0.0978	0.1583	0.2350	0.1029	0.1440	0.2061
β	0.6667	0.8040	0.8764	0.7452	0.8249	0.8823
LR	3,085	7,086	15,430	3,952	8,020	16,324
	$1 > = P > $0.05 (N = 716)			P > $10 (N = 102)		
	25th	50th	75th	25th	50th	75th
ω	69.1958	213.6393	591.4521	64.7483	303.1847	808.8433
α	0.1086	0.1544	0.2164	0.0480	0.1022	0.1697
β	0.7388	0.8216	0.8753	0.7641	0.8475	0.9381
LR	5,969	11,342	20,420	3,603	6,544	20,503

Table 15. High Volume Periods

Listed are summary statistics of high volume periods for Pink Sheets stocks in 2004. The high volume period is defined as the 5-trading day window with the highest number of trades. The Volume Ratio equals the average daily trading volume in the window divided by the average daily trading volume on all days outside the window. The Outside Ratio equals the average daily trading volume in the three days before and after the window divided by the average daily trading volume on all days outside the window. The Return equals the log ratio of the closing price on the day after the window to the closing price on the day prior to the window. The Return/σ equals the Return divided by the 6-day standard deviation of returns.

A. Full Sample

	All Stocks (N = 2,735)		
	25th	50th	75th
Volume Ratio	4.4	6.3	9.6
Outside Ratio	1.2	1.8	2.9
Return	-0.0764	0.1054	0.3254
Return/σ	0.3342	0.8027	1.4786
	Non-ADR (N = 2,639)		
	25th	50th	75th
Volume Ratio	4.5	6.4	9.8
Outside Ratio	1.2	1.8	2.9
Return	-0.0822	0.1147	0.3365
Return/σ	0.3704	0.8864	1.6367
	ADR (N = 96)		
	25th	50th	75th
Volume Ratio	2.8	3.8	5.4
Outside Ratio	0.9	1.4	1.9
Return	-0.0317	0.0017	0.0363
Return/σ	0.2846	0.5848	1.3150

B. Price Subsamples

	$0.05 >= P (N = 453)			$10 >= P > $1 (N = 750)		
	25th	50th	75th	25th	50th	75th
Volume Ratio	4.4	6.6	10.6	4.1	5.7	8.4
Outside Ratio	1.0	1.7	2.7	1.2	1.7	2.7
Return	-0.2231	0.1431	0.5108	-0.0354	0.1098	0.2685
Return/σ	0.3147	0.7668	1.4919	0.4701	1.0552	1.8338
	$1 >= P > $0.05 (N = 1,339)			P > $10 (N = 193)		
	25th	50th	75th	25th	50th	75th
Volume Ratio	4.8	6.7	10.2	3.3	5.3	8.2
Outside Ratio	1.2	1.9	3.0	1.1	1.6	2.6
Return	-0.1054	0.1178	0.3640	-0.0228	0.0175	0.0842
Return/σ	0.3525	0.8591	1.5631	0.2638	0.7392	1.6079

Table 16. Reversals

Listed are summary statistics of high volume periods for Pink Sheets stocks in 2004. The high volume period is defined as the 5-trading day window with the highest number of trades. Listed are summary statistics of high volume periods for subsets of stocks formed by grouping stocks for which the high volume period featured a positive or negative return. T The Volume Ratio equals the average daily trading volume in the window divided by the average daily trading volume on all days outside the window. The Outside Ratio equals the average daily trading volume in the three days before and after the window divided by the average daily trading volume on all days outside the window. The Return equals the log ratio of the closing price on the day after the window to the closing price on the day prior to the window. The Return/σ equals the Return divided by the 6-day standard deviation of returns. Positive (Negative) reversals are defined as the log ratio of the closing price on the day after the window to the intraday high (low) during the window when the window experienced a positive (negative) return. For each stock, a control is computed which equals the average Positive and Negative reversal in periods outside the window.

	Positive Returns (N = 1,835)			Negative Returns (N = 900)		
	25th	50th	75th	25th	50th	75th
Volume Ratio	4.6	6.5	9.6	4.2	6.0	9.4
Outside Ratio	1.2	1.8	2.8	1.1	1.7	3.0
Return	0.1005	0.2324	0.4520	-0.4639	-0.2143	-0.0800
Return/σ	0.3614	0.8714	1.5618	0.2921	0.6875	1.3325
Reversal	-0.3567	-0.1512	-0.0384	0.0000	0.0982	0.2877
Control	-0.1791	-0.1002	-0.0536	0.0483	0.0860	0.1442

Figure 1. Quote Activity by 5-Minute Intervals

Displayed are the number of inside quotes and the average percentage quoted spread by 5-minute intervals on the Pink Sheets market in 2004. Quotes without ticker symbols, quotes posted on the weekend or Nasdaq holidays, quotes with ask prices less than bid prices, and quotes with bid or ask prices less than or equal to zero are excluded. There are 6,140,746 active inside quotes remaining. Spreads are averaged first across quotes for each stock within each 5-minute interval, then across stocks.

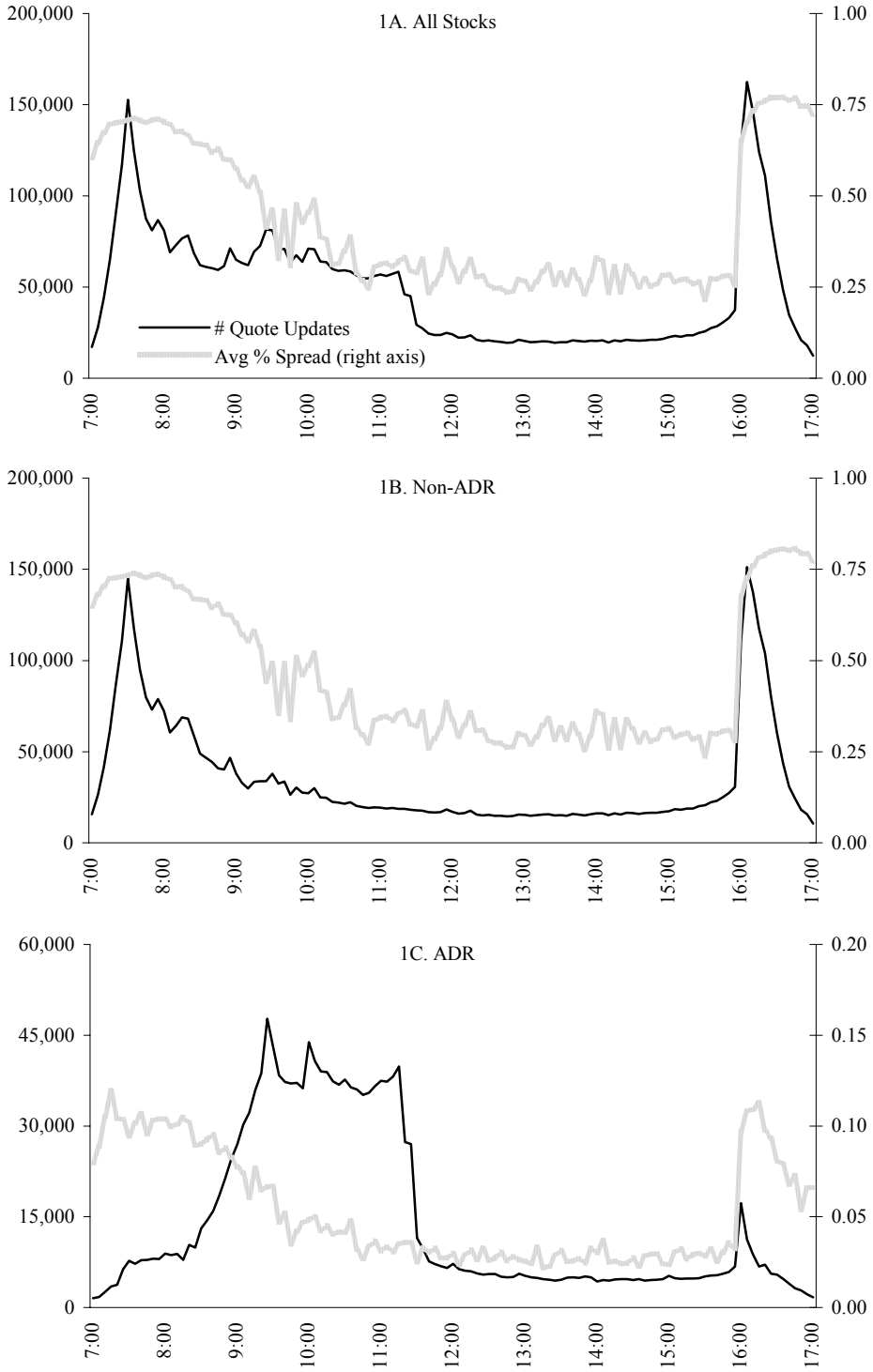
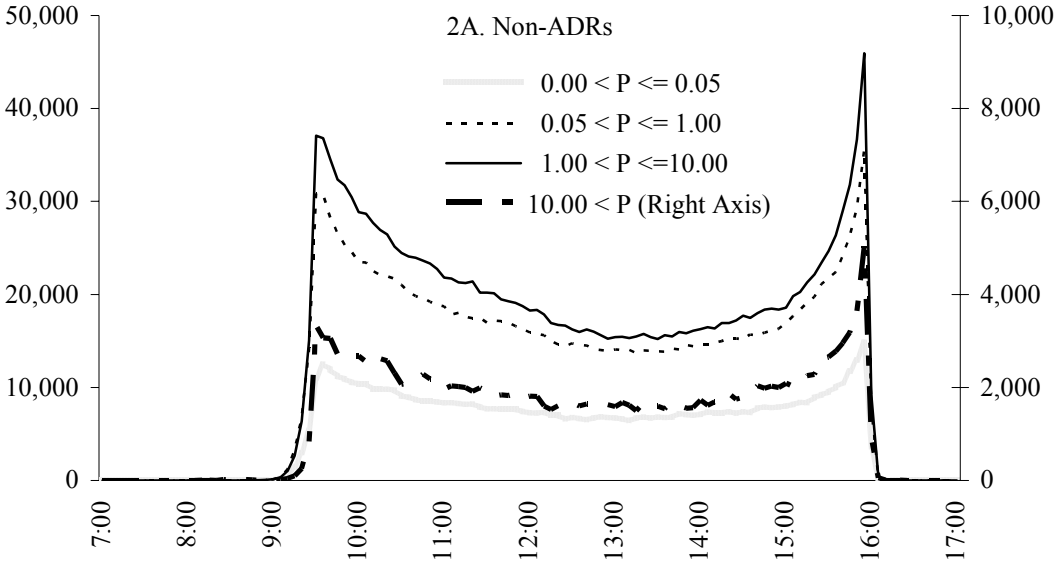


Figure 2. Trade Activity by 5-Minute Intervals

Displayed is the number of trades by 5-minute intervals for Pink Sheets stocks executed on the Pink Link trading system in 2004. Trades executed on the weekend or holidays, or for stocks not appearing in the quote file, are excluded. The remaining 4,101,073 trades are sorted into price bins based on the average trade price over all trades in 2004. Panels A and B show the number of trades for non-ADRs and ADRs, respectively.



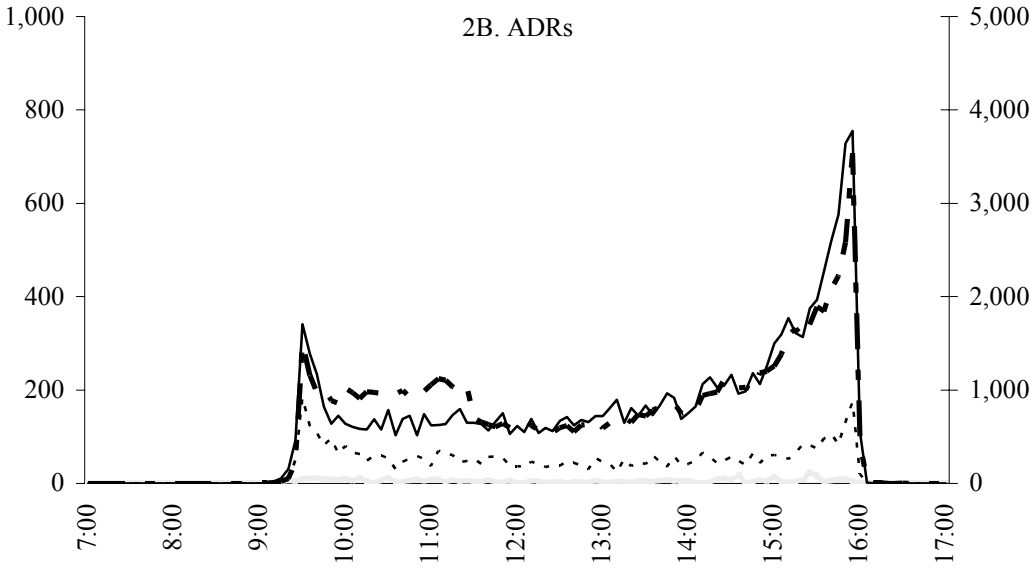
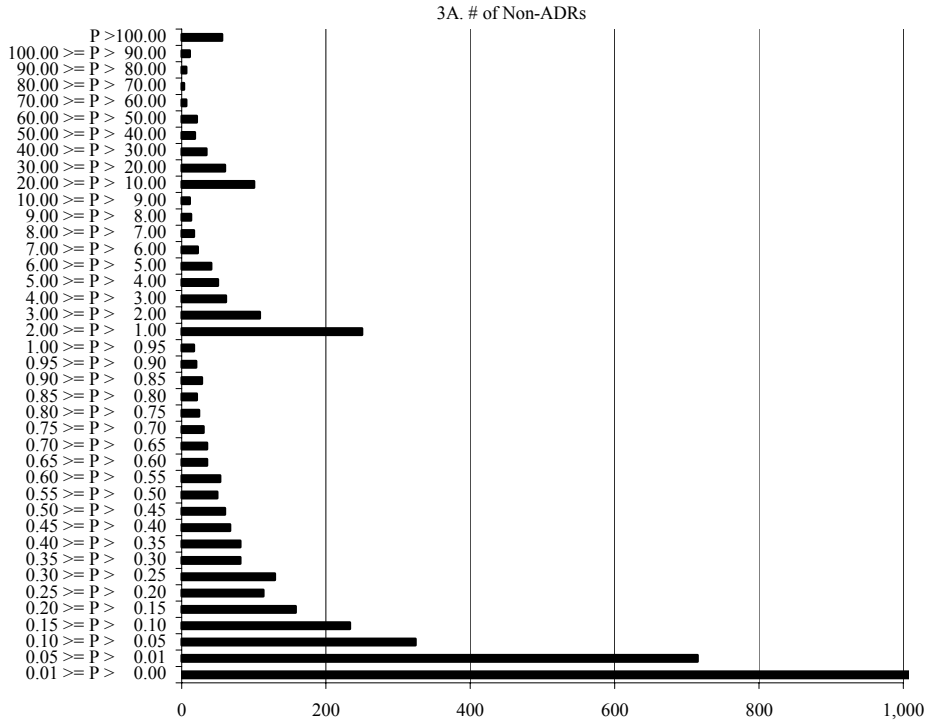


Figure 3. Number of Stocks by Midpoint

Displayed are the numbers of stocks with at least one active inside quote between 9:30 a.m. and 4:00 p.m. on the Pink Sheets electronic quotation service in 2004 as a function of the average quoted midpoint price (P). Midpoint quotes for each stock are averaged across all active inside quotes in 2004. Results are displayed for non-ADRs and ADRs separately.



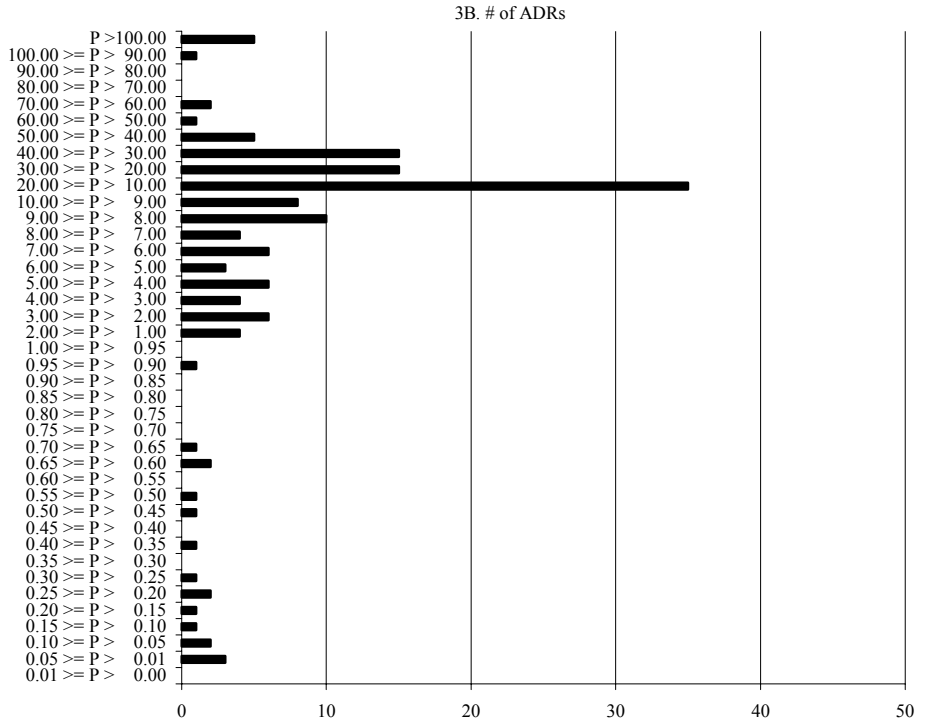


Figure 4. Number of Updates by Midpoint

Displayed are the average numbers of daily active inside quote updates between 9:30 a.m. and 4:00 p.m. on the Pink Sheets electronic quotation service in 2004 as a function of the average quoted midpoint price (P). The number of updates is averaged across days, then across stocks. Midpoint quotes for each stock are averaged across all active inside quotes in 2004. Results are displayed for non-ADRs and ADRs separately.

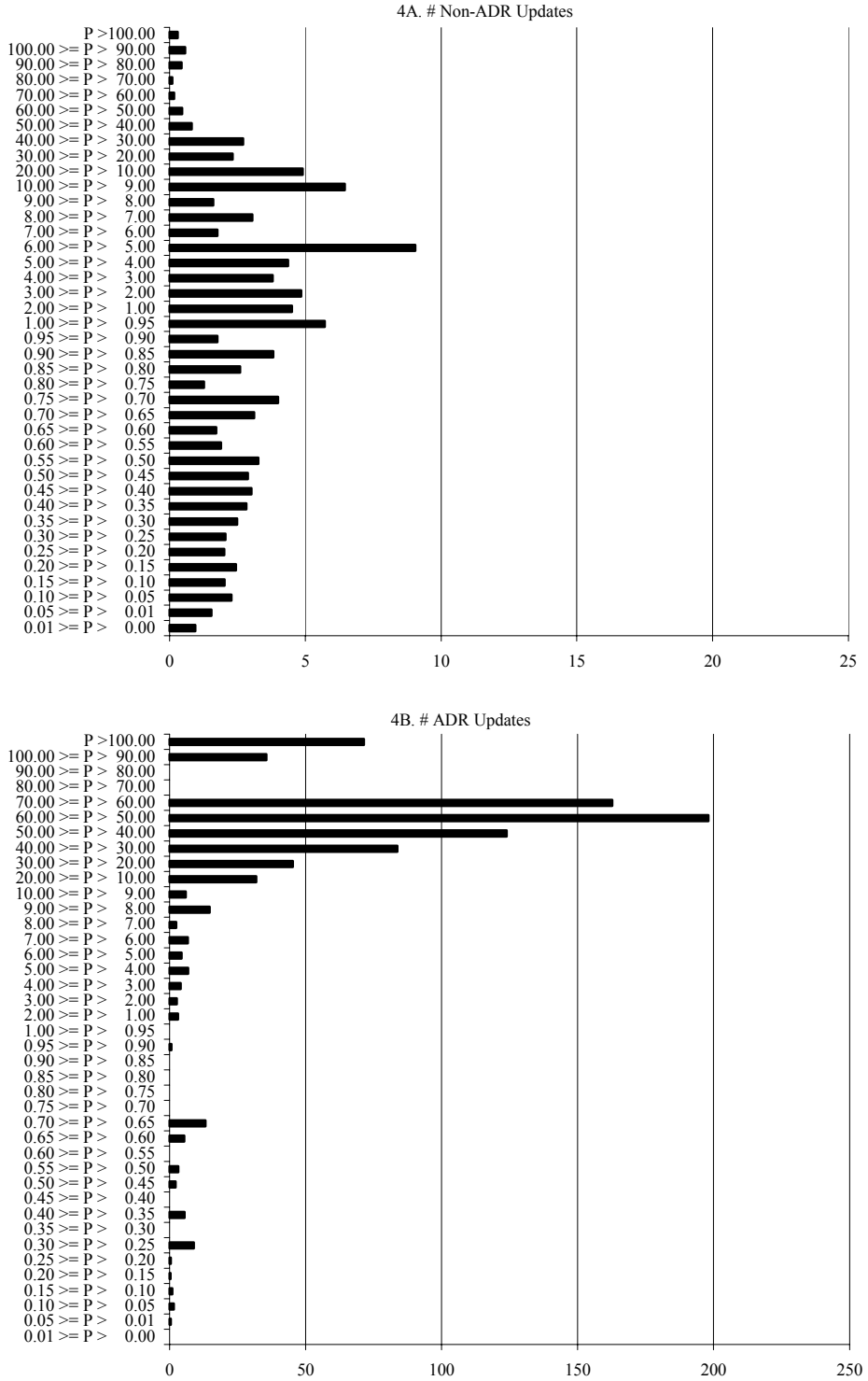


Figure 5. Histogram of Bid Quotes

Displayed are histograms of bid prices of active inside quotes posted from 9:30 a.m. to 4:00 p.m. on the Pink Sheets market in 2004. Quotes posted on Nasdaq holidays or the weekend, quotes with ask prices less than bid prices, and quotes with bid or ask prices less than or equal to zero are excluded. Panels A though D show the percentage of quotes at each of the 10,000 possible decimal increments from 0.0000 to 0.9999. Panel A shows all quotes and panels B through D show subsets based on bid price. Panels E and F show the percentage of quotes at the 1,000 possible decimal increments from 0.0000 to 0.0999, and at the 100 possible increments from 0.0000 to 0.0099, respectively, for quotes with bid price less than or equal to $1.

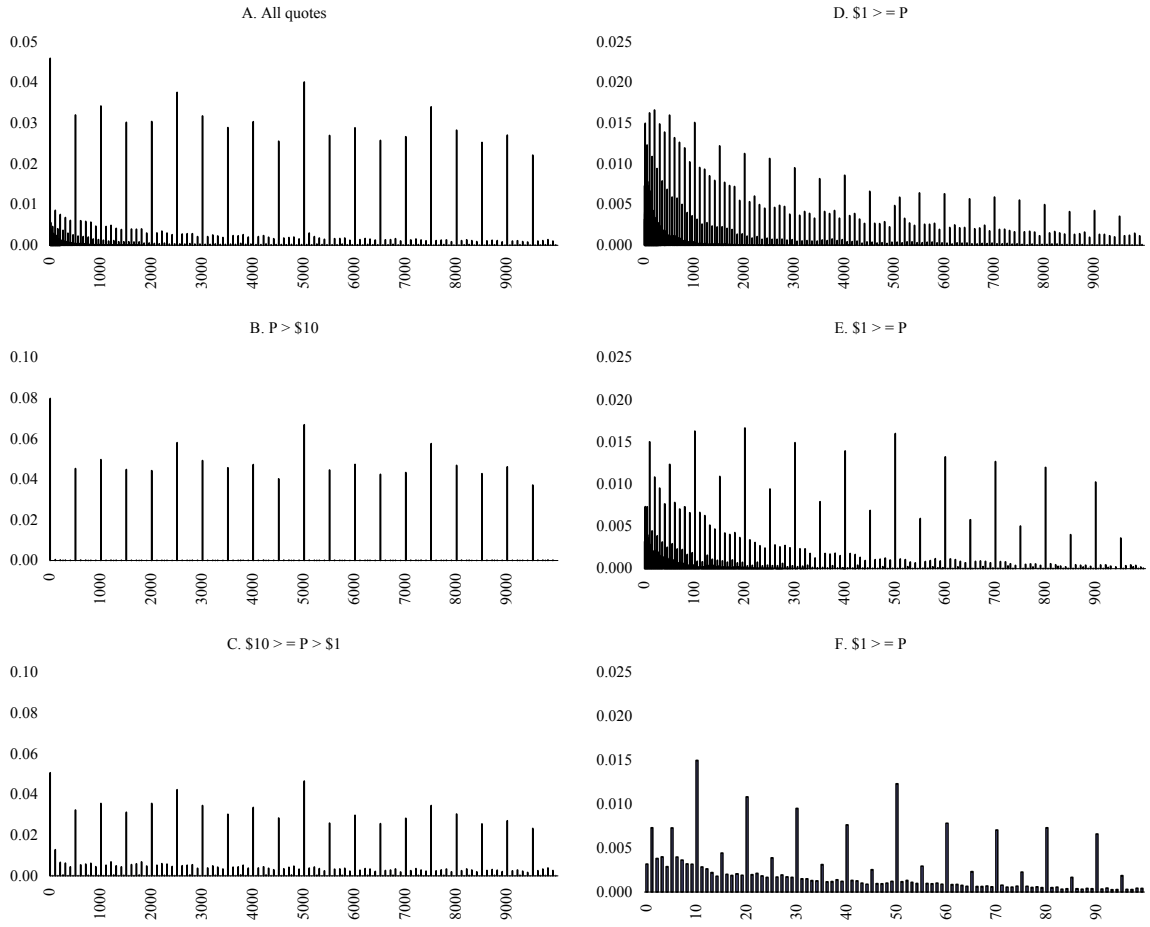


Figure 6. Histogram of quoted spreads

Displayed are histograms of quoted spreads of active inside quotes posted from 9:30 a.m. to 4:00 p.m. on the Pink Sheets market in 2004. Quotes posted on Nasdaq holidays or the weekend, quotes with ask prices less than bid prices, and quotes with bid or ask prices less than or equal to zero are excluded. Panels A though D show the percentage of quotes at each of the 10,000 possible decimal increments from 0.0000 to 0.9999. Panel A shows all quotes and panels B through D show subsets based on bid price. Panels E and F show the percentage of quotes at the 1,000 possible decimal increments from 0.0000 to 0.0999, and at the 100 possible increments from 0.0000 to 0.0099, respectively, for quotes with bid price less than or equal to $1.

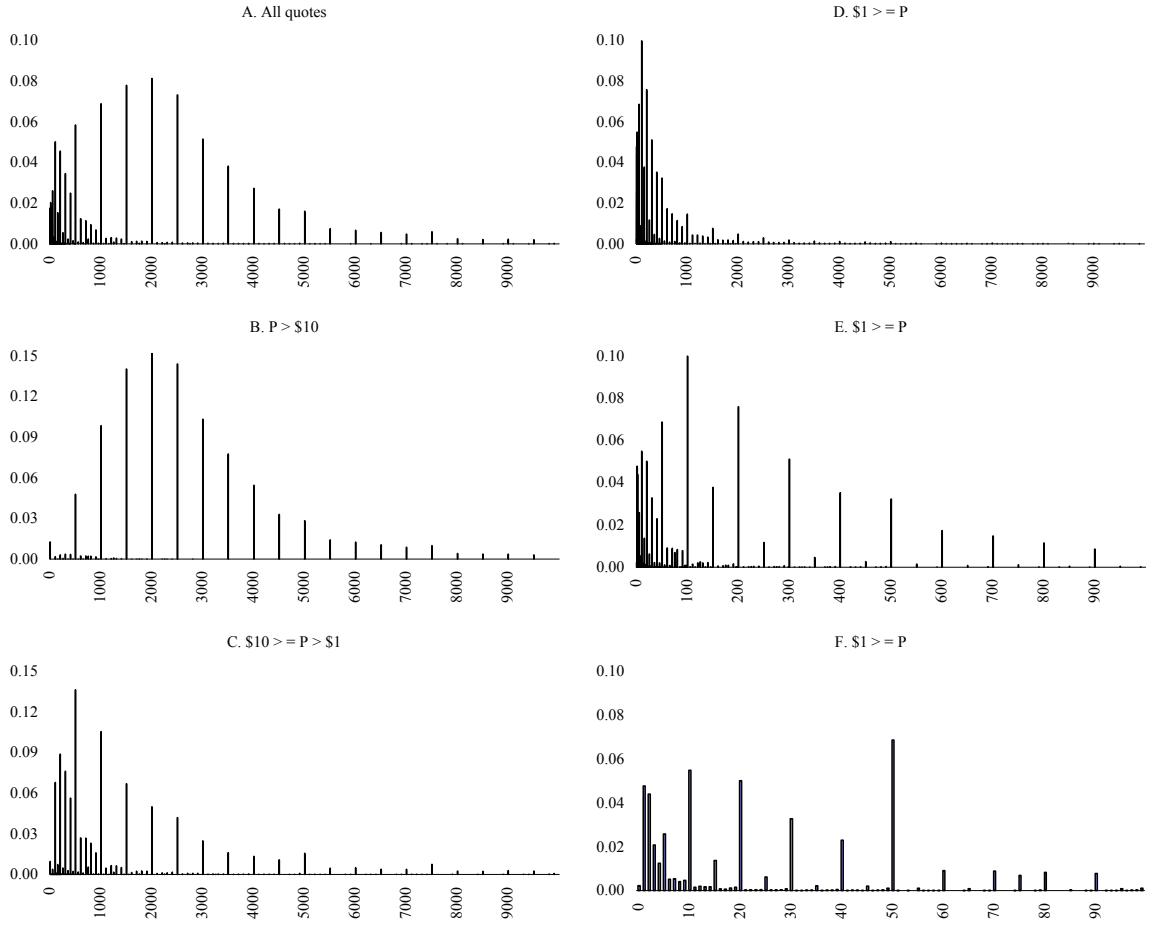
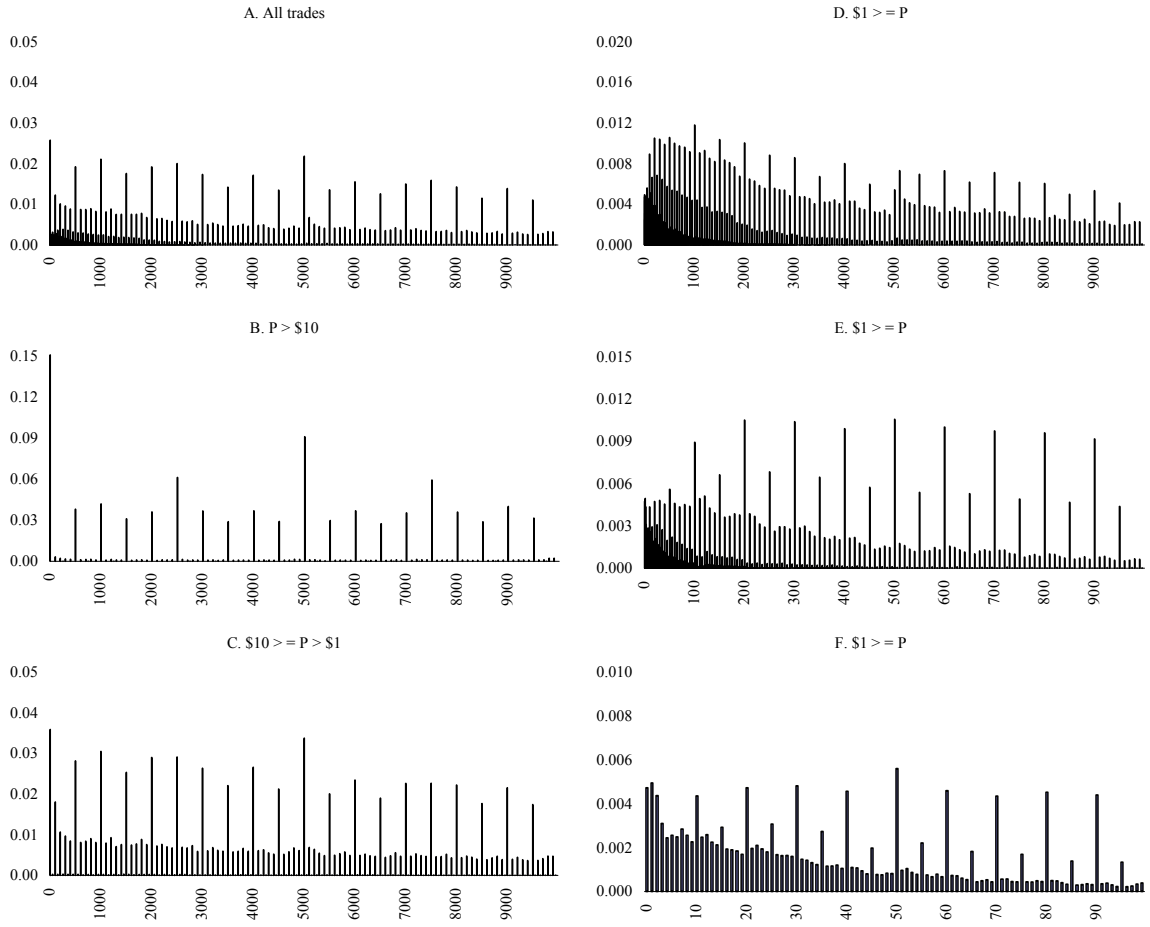


Figure 7. Histogram of trade prices

Displayed are histograms of trade prices of active inside quotes posted from 9:30 a.m. to 4:00 p.m. on the Pink Sheets market in 2004. Quotes posted on Nasdaq holidays or the weekend, quotes with ask prices less than bid prices, and quotes with bid or ask prices less than or equal to zero are excluded. Panels A though D show the percentage of quotes at each of the 10,000 possible decimal increments from 0.0000 to 0.9999. Panel A shows all quotes and panels B through D show subsets based on bid price. Panels E and F show the percentage of quotes at the 1,000 possible decimal increments from 0.0000 to 0.0999, and at the 100 possible increments from 0.0000 to 0.0099, respectively, for quotes with bid price less than or equal to $1.



Endnotes

[1] Much of the information in this section was obtained from the Pink Sheets web site www.pinksheets.com.

[2] For 2004, the Nasdaq holidays were January 1 (New Year's Day), January 19 (Martin Luther King Jr.'s Birthday), February 16 (President's Day), April 9 (Good Friday), May 31 (Memorial Day), July 5 (Independence Day), September 6 (Labor Day), November 25 (Thanksgiving), and December 24 (Christmas). In addition, Nadaq closed at 1:00 p.m. EST on November 26. Since the day after Thanksgiving traditionally has unusually light market activity, we treat the entire day as a holiday.

[3] The number of trading days that a stock existed in the Pink Sheets is defined by the first and last day in 2004 in which any type of trade or quote was observed for that stock.