Microstructure of the Pink Sheets Market

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Abstract

The Pink Sheets market is a highly unregulated trading venue that is virtually free of affirmative obligations or reporting requirements. 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 for stocks traded through the Pink Sheets. 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, and that bid-ask spreads show a consistent relation with market maker costs.

I. Introduction

The past ten years have witnessed substantial structural reform in U.S. equity markets, including the SEC Order Handling Rules, implementation of decimal pricing, and the Trade Protection Rule that emerged from Regulation NMS. The pace of regulatory activity has stirred controversy, leading some to question the current balance between rules and unfettered innovation.[1] Our goal is to determine whether familiar patterns of trade and quote activity observed on Nasdaq and the NYSE can emerge endogenously on the Pink Sheets, a lightly regulated market that is virtually free of affirmative obligations and reporting requirements.

We have been provided with all quote and trade data from the Pink Sheets Electronic Quotation and Trading System for the entire calendar year of 2004, the first year that such data are available. 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.

Until relatively recently, trade and quote data were not recorded electronically on the Pink Sheets, rendering empirical analysis infeasible. For this reason, we remain relatively ignorant about the microstructure of a market that has 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 Sheets traded companies and that there are unscrupulous individuals that will attempt to defraud investors through manipulative schemes in Pink Sheets stocks.*

[1] See "Donaldson's flawed stock exchange rule: The SEC should deregulate trading, not make it harder," Financial Times, Apr 5, 2005, p.18, and "Life after Donaldson," Wall Street Journal, Jun 6, 2005, p.A10.

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.

Angel et al. (2004) and Macy et al. (2004) also study the Pink Sheets market in the context of comparing trading costs for firms moving to either the Over-The-Counter Bulletin Board (OTCBB) or the Pink Sheets market. Both of these papers report large declines in liquidity and increases in trading costs after stocks are delisted from the NYSE or Nasdaq and trading resumes on either of these other markets. While these studies provide an important first glimpe of the differences between the Pink Sheets and the national markets, our access to a full year of intraday trade and quote data for all Pink Sheets stocks allow us to examine the microstructure of the Pink Sheets in richer detail.

The Pink Sheets market is characterized by a number of unorthodox norms. Specifically, only one market maker is needed per stock for trading to commence, issuer filings need not be current with the SEC and financial statements need not be audited, issuers have no option to determine whether their stock will be quoted and traded, and stock prices are often less than $0.01. 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. In spite of what appears to be a market of questionable quality, some of the most visible foreign companies choose the Pink Sheets as the primary foreign venue for their stocks.

Despite the impression that the Pink Sheets market is the last frontier of trading, we observe the familiar intraday patterns in trading volume and bid-ask spreads that have been documented on Nasdaq and the NYSE. This result suggests that there is an inherent commonality across markets. We also find strong 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, but permit price improvement relative to the inside spread in about 8% of all trades.

Clustering in quotes and prices likely reflects the need for market participants to reduce the 10,000 possible price increments between each dollar that are possible on the Pink Sheets. Prior research has also shown, however, that clustering can artificially widen bid-ask spreads to the detriment of investors (see Christie and Schultz (1994) and Christie, Harris and Schultz (1994)). We use a standard model of the determinants of bid-ask spreads to assess the economic forces behind Pink Sheets spreads. The model has significant explanatory power, roughly the same magnitude as that reported in studies that test for the relation between trading costs and economic determinants for stocks traded on Nasdaq or the NYSE. The main determinant of spreads in the Pink Sheets stocks is the cost of holding shares of stock in inventory. We examine the duration between trades to shed further light on this issue. We find that trading intensity varies dramatically through time for Pink Sheets stocks. Furthermore, episodes of high-volume are associated with large price swings and reversals, suggesting that the market is either inefficient in adjusting to news events or that prices fluctuate substantially with short-term trading pressure.

Our results show that minimal external oversight is necessary to support a number of empirical regularities that are associated with highly regulated and structured markets. Future research could address whether market quality might be improved with additional institutional structure. For example, the introduction of a tick size schedule or a display rule for limit orders might improve market depth. In addition, our cursory study of high volume periods suggests that the Pink Sheets market may be prone to price swings in the absence of information, consistent with "pump and dump" trading schemes.

The paper is organized as follows. Section II describes the regulatory and trading environment for Pink Sheets 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.

II. Regulatory and Trading Environment

The Pink Sheets 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.[2] A similar facility (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 Sheets issues. On June 2, 2003, Pink Sheets introduced Pink Link which offered 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 set of rules and regulations in comparison to the organized markets. At its core, 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 quoted/traded on their market. Thus, stocks on the Pink Sheets can not be thought of as ever having been "listed" or "delisted". They are quoted or not quoted.

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 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 necessary confidence 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 (independent of where their stock is traded) occurs under one of the following four situations: (a) when firms are initially quoted, (b) when

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

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 Sheets stocks through registered brokers who then route the order to a market maker quoting the particular issue. Interestingly, investors must accept 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 begin 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 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. They are also subject to the rule requiring that trades be reported within 90 seconds 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 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 Pink Sheets market (examples include Nestle, Roche Pharmaceuticals, Volkswagen, Heineken and Nintendo). These stocks generally carry much higher prices and trading volume, and far narrower percentage spreads. 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 price points per dollar 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 Sheets 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. Our comprehensive data permit us to incorporate all observations throughout the day, and to examine intraday patterns of trading and quotation behavior, as we describe in the next section.

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.[3] 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. According to the Pink Sheets website, 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.

[3] 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.

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. with 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.[4] To illustrate this, we split the observations into ADRs and non-ADRs. Figure 1B shows 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.. Since the London Stock Exchange ceases trading at 11:35 a.m. eastern, the decline is likely due to the close of the business day in London.

The pattern of bid-ask spreads in Figure 1A roughly correspond to the three distinct periods observed for 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. For comparison, McInish and Wood (1992) and Lee, Mucklow and Ready (1993) document a U-shaped pattern in the percentage inside spread during the trading day for NYSE stocks, while Chan, Christie and Schultz (1995) find that inside spreads decline during the day, and remain relatively flat for the first few hours after the open. They attribute the absence of a post-open decline in inside quoted spreads to the absence of limit orders on Nasdaq during their sample.

The distinction between ADR and non-ADR stocks is important in interpreting the intraday pattern in spreads and quotation activity. The pattern for non-ADR stocks is closer to that of Chan, Christie and Schultz (1995) since the percentage spreads decline very slowly after the open, whereas the ADR stocks behave more like those on the

[4] Moulton and Wie (2005) point out that the overlap between the NYSE and London Stock Exchange trading day is 9:30 a.m. to 11:35 a.m. EST.

organized exchanges where inside spreads decline rapidly after the open and where limit orders provide much of the liquidity. While the Pink Sheets market does not have a limit order display rule, these orders are more likely to be placed in the active ADR market rather than among the significantly less active non-ADR stocks.

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 by Lee, Mucklow and Ready (1993) and Chan, Christie and Schultz (1995). Interestingly, the most actively traded stocks are those in the $1 to $10 price range. Figure 2B presents the results for ADRs. The peak activity for these stocks occurs towards the latter part of the trading day, though there is a smaller peak just after the market opens. The crescendo in trading among ADR issues that extends from 11:35 a.m. through the close may result from information trading in the U.S. after markets close in Europe.

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, 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.[5] 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 during 2004.

Table 2 shows the summary statistics across four price categories, formed using the average quoted midpoint of each stock over 2004. Percentage spreads drop

[5] 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.

dramatically as prices increase, from 74.1% for stocks priced at or below $0.05 to 7.4% for stocks priced above $10. The high percentage spreads for low-priced Pink Sheets stocks is not caused by a binding tick size, for stocks that trade in the Pink Sheets can be quoted in increments as small as $0.0001. We study the lack of a tick size in the Pink Sheets market further in section VI. Spreads decreasing in price 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. Spreads decreasing in 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. In fact, there are over 1,000 issues whose prices is under $0.01. 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 (Qday). 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 fewer 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, 87% experience an average of between one and five quotation updates 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 are primarily ADRs.

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 (Tday).

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 computation of market quality measures such as 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.

In Panel B, 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 traded 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 0.12 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 mandated 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. 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.

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 in Panels A through C of Table 6, the spikes on the whole nickels and dimes 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 the percentage of observations between the nickels and dimes is higher for trade prices than for bid prices and quoted spreads. This is consistent with some degree of negotiation prior to a trade.

Clustering of trade prices suggests a close relation between trade prices and quotes, and therefore an absence of signficant price improvement. 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 7 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.

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, and there is a large degree of clustering. Does the clustering contribute to artificially wide spreads?

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 8 shows the results with all standard errors corrected for heteroskedasticity. 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 coefficient significant at the 10% level is the *IHP*, with a coefficient of 1.2036 and a corresponding two-sided *p*-value of 0.0023. 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*.

In unreported analysis, we regress the squared residuals from the regressions in Table 8 on the corresponding stock price. The relation is positive and highly significant prompting our use of heteroskedasticity-consistent standard errors. An alternative is to scale all variables by the inverse stock price to render the residuals homoskedastic. The disadvantage of this approach is that the intercept is transformed to inverse price, and the constant term in the regression is therefore lost. One could add a new constant to the scaled regression, but this is inconsistent with the economic model described above. For completeness, we re-run all regressions in Table 8 using the scaled variables, both with and without an additional constant term. Though the economic interpretation of the coefficients is no longer clear, the pattern of statistical significance is unchanged.

Table 8 also lists 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. To explore this further, we examine next the dynamics of trade durations.

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 9 shows summary

statistics for the 4,110 stocks with at least one trade on 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 a minimum duration of zero. 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. For all price categories, the median duration is only a small fraction of the average duration, indicating that trades for individual stocks cluster temporally.[6] This phenomenon is most pronounced for low-priced stocks. The median low-priced stock features an average duration of 12,468 seconds and a median duration of only 227 seconds.

As described by Engle and Russell (1998), 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." Trade clustering in Pink Sheets stocks could be due to informative news events, which for penny stocks could have a dramatic impact on value. Alternatively, perhaps the low-priced stocks on the Pink Sheets market are 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

[6] 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). In unreported analysis, we find that the median Pink Sheets stock features an auto-regressive parameter of 0.8233, compared to 0.9332 for IBM as reported by Engle and Russell. This result reflects the dramatic temporal variation in trading intensity for Pink Sheets stocks.

movements. 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 of the 4,110 stocks with at least one trade on 20 trading days in 2004, we find the five-day window with the maximum trading volume. Next, for each stock, we find the closing price on the closest trading day with at least one trade prior to and after the window, the maximum and minimum closing price on the trading days within the window, the trading volume in the window, the trading volume in the three trading days prior to and after the window, and the trading volume on all other days. A total of 1,375 stocks are dropped from the analysis for having no trading in a three-day window before or after the high volume window, leaving 2,735 for the analysis. Next, we compute three returns associated with each stock's high volume window. The Return is the log ratio of the closing price after the window to the closing price prior to the window. We split the stocks into two groups based on the sign of this return. For stocks with non-negative Returns, the Runup is defined as the log ratio of the maximum price that occurs within each high volume period to the closing price prior to the period. For stocks with negative Returns, the Runup is defined as the log ratio of the minimum price that occurs within each high volume period to the closing price prior to the period. Lastly, the Reversal is defined as the log ratio of the closing price after the high volume period to the relevant extreme price within the period. As a control, for each stock, we compute the Return, Runup, and Reversal in all other five-day periods outside the high-volume period. These are averaged across the available non-negative return and negative return periods for each stock. Of the 2,735 stocks in the analysis, 2,715 have a control for non-negative returns and 2,711 have a control for negative returns.

Table 10 reports the results. Note that there are roughly twice as many periods with a non-negative return than a negative return, 1,835 versus 900. Perhaps this is due to difficulty in shorting Pink Sheets stocks when prices fall. The volume characteristics are quite similar for non-negative and negative return periods. The Volume Ratio is defined as the average daily trading volume within the high volume period divided by the average trading volume outside the period. For non-negative return periods, this is 6.5 at the median, whereas for negative returns it is 6.0. The Outside Ratio is defined as the average daily trading volume in the three day periods before and after the high volume period

divided by the average trading volume on all days outside the period. The median stock has an Outside Ratio of 1.8 for non-negative returns and 1.7 for negative returns. Thus, though the trading volume is still higher than average in the few days surrounding the high volume period, it is relatively close to normal. This reflects the speed with which trading intensity changes for Pink Sheets stocks, and indicates that the five-day window used to define high volume periods captures the bulk of the activity.

The median non-negative return is 23.24% compared to –21.43% for the median negative return. These are much larger than the returns for the control periods, 12.23% and –15.12% for the non-negative and negative returns, respectively. This can be explained in two ways. Either the high volume period is reflecting a significant news event which affects stock value, or the high volume period is reflecting some form of manipulation to increase trading volume, which also moves prices. To distinguish between these two explanations, we determine whether there is some form of reversal, which reveals temporary price pressure as opposed to a permanent adjustment. The Runups are larger than the Returns, as expected, 44.18% and –39.71% at the medians for non-negative and negative returns. These are more than double the magnitude of the control periods. The subsequent reversals are dramatic. At the 25th percentile for non-negative returns, for example, the reversal is –34.83% compared to –6.47% for the control. Similarly, the reversal for negative returns at the 75th percentile is 28.77% compared to 4.69% for the control. 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 Sheets market. Our data include all quote updates and trades reported through the Pink Sheets 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 Sheets 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 Sheets 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 Sheets 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.

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Table 1. Summary Statistics of Active inside Quotes

Listed are summary statistics of active inside quotes for 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 (#Day), the average number of quote updates per day, the number of days the stock has an active inside quote (#Qday), the average number of quote updates per day the stock is quoted, and the number of unique market makers participating at least once in the inside quote (#MM). 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.

	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
#Day	190	252	252
Avg #Q/Day	0.19	0.40	1.44
#Qday	16	29	59
Avg #Q/Qday	2.18	2.85	4.49
#MM	5	8	12

	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
#Day	188	252	252
Avg #Q/Day	0.18	0.38	1.24
#Qday	15	28	54
Avg #Q/Qday	2.15	2.80	4.28
#MM	5	8	12

	ADR (N = 147)		
	25th	50th	75th
Avg Price ($)	4.79	10.76	23.16
Avg % Sprd	1.02	1.75	4.24
% Volatility	1.44	1.84	2.61
#Day	252	252	252
Avg #Q/Day	3.32	11.10	36.63
#Qday	129	227	250
Avg #Q/Qday	4.50	12.98	39.43
#MM	14	20	24

Table 2. Summary Statistics of Quotes by Midpoint

Listed are summary statistics of active inside quotes for 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 (#Day), the average number of quote updates per day, the number of days the stock has an active inside quote (#Qday), the average number of quote updates per day the stock is quoted, and the number of unique market makers participating at least once in the inside quote (#MM). Listed are the ranges for subsets formed by the average quoted midpoint price.

	$P \leq \$0.05$ (N = 1,752)			$\$1.00 < P \leq \$10.00$ (N = 624)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0026	0.0067	0.0194	1.46	2.41	4.57
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
#Day	252	252	252	108	252	252
Avg #Q/Day	0.16	0.28	0.58	0.27	0.95	3.57
#Qday	16	25	40	14	43	97
Avg #Q/Qday	2.17	2.66	3.51	2.27	3.41	6.55
#MM	4	7	10	6	10	15
	$\$0.05 < P \leq \$1.00$ (N = 1,572)			P > $10 (N = 394)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1137	0.2292	0.4391	16.41	26.35	54.59
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
#Day	133	252	252	238	252	252
Avg #Q/Day	0.24	0.60	2.10	0.08	0.38	3.59
#Qday	17	34	71	8	27	101
Avg #Q/Qday	2.29	3.11	5.09	1.75	2.61	7.24
#MM	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 number of days quoted (#Qday) and the average number of inside quote updates per day the stock is 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.

			Avg #Q/Qday			
	#Qday	#Stocks	N=1	1 < N ≤ 5	5 < N ≤ 20	N > 20
A. All Stocks	0 < N ≤ 100	3,752	146	3,111	424	71
	100 < N ≤ 250	552	0	149	321	82
	N > 250	38	0	0	3	35
	Totals	4,342	146	3,260	748	188
B. Non-ADR	0 < N ≤ 100	3,719	146	3,092	414	67
	100 < N ≤ 250	469	0	127	286	56
	N > 250	7	0	0	0	7
	Totals	4,195	146	3,219	700	130
C. ADR	0 < N ≤ 100	33	0	19	10	4
	100 < N ≤ 250	83	0	22	35	26
	N > 250	31	0	0	3	28
	Totals	147	0	41	48	58

Table 4. Summary Statistics of Trades

Listed are summary statistics of 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 share volume per trade, the average dollar volume per trade, the number of days between the first and last appearance of the stock in the database (#Day), the average number of trades per day, the number of days the stock is traded (#Tday), 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 Quotes		
	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	2,270	6,310	15,000
Avg $ Volume	487	1,327	2,552	175	753	1,928
#Day	125	252	252	184	252	252
Avg #T/Day	0.07	0.39	1.98	0.03	0.14	0.72
#Tday	5	20	72	3	11	39
Avg #T/Tday	1.60	2.50	4.53	1.50	2.25	3.58
	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	476	1,299	2,452	162	690	1,759
#Day	123	252	252	183	252	252
Avg #T/Day	0.07	0.38	1.92	0.03	0.13	0.65
#Tday	5	20	70	3	11	36
Avg #T/Tday	1.60	2.50	4.52	1.50	2.24	3.53
	ADR (N = 152)			ADR (N = 141)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	3.882	10.41	21.26	4.72	11.65	23.45
Avg SH Volume	610	1,010	1,790	600	1,010	1,640
Avg $ Volume	4,836	12,591	16,872	5,679	13,136	17,318
#Day	252	252	252	252	252	252
Avg #T/Day	0.26	1.54	4.12	0.34	1.61	4.33
#Tday	26	106	194	34	112	204
Avg #T/Tday	1.80	2.67	4.77	1.85	2.91	4.96

Table 5. Summary Statistics of Trades by Price

Listed are summary statistics of 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 share volume per trade, the average dollar volume per trade, the number of days between the first and last appearance of the stock in the database (#Day), the average number of trades per day, the number of days the stock is traded (#Tday), 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					
	$P \leq \$0.05$ (N = 2,058)			$\$1.00 < P \leq \$10.00$ (N = 1,706)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0026	0.0095	0.0244	1.468	2.24	4.00
Avg SH Volume	10,000	19,910	43,450	720	1,140	1,740
Avg $ Volume	66	179	386	1,625	2,433	3,878
#Day	172	252	252	88	230	252
Avg #T/Day	0.02	0.12	1.05	0.17	0.83	3.72
#Tday	3	8	31	8	34	106
Avg #T/Tday	1.50	2.50	4.46	1.79	2.88	5.99
	$\$0.05 < P \leq \$1.00$ (N = 3,401)			P > $10 (N = 963)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1206	0.2494	0.4946	16.38	24.04	40.50
Avg SH Volume	3,900	5,600	7,840	190	260	390
Avg $ Volume	794	1,304	1,897	4,565	6,771	11,967
#Day	109	252	252	252	252	252
Avg #T/Day	0.14	0.60	2.31	0.03	0.13	0.42
#Tday	7	29	89	4	15	42
Avg #T/Tday	1.75	2.68	4.78	1.20	1.66	2.25
	B. Trades with Inside Quote					
	$P \leq \$0.05$ (N = 1,508)			$\$1.00 < P \leq \$10.00$ (N = 578)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.0020	0.0070	0.0200	1.46	2.26	4.38
Avg SH Volume	9,140	18,640	39,670	690	1,120	1,870
Avg $ Volume	53	121	251	1,558	2,645	4,865
#Day	252	252	252	113	252	252
Avg #T/Day	0.02	0.07	0.26	0.08	0.35	1.62
#Tday	2	6	19	5	22	60
Avg #T/Tday	1.50	2.20	3.33	1.60	2.33	4.31
	$\$0.05 < P \leq \$1.00$ (N = 1,342)			P > $10 (N = 311)		
	25th	50th	75th	25th	50th	75th
Avg Price ($)	0.1066	0.2093	0.4400	15.77	24.59	48.10
Avg SH Volume	4,040	5,650	8,080	200	340	720
Avg $ Volume	680	1,117	1,735	5,580	10,919	17,000
#Day	132	252	252	251	252	252
Avg #T/Day	0.06	0.26	1.11	0.02	0.12	1.54
#Tday	6	17	50	3	11	70
Avg #T/Tday	1.57	2.31	3.83	1.29	2.00	3.49

Table 6. Trade Frequency

Listed in Panel AA is the number of Pink Sheets stocks traded using the Pink Link system in 2004, broken down by the number of days traded (#Tday) and the average number of trades per day the stock is traded. Only trades executed between 9:30 a.m. and 4:00 p.m. on non-holiday weekdays are included. Panels AB and AC 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. Panels BA, BB, and BC show results for only those trades preceded by an active inside quote on the same day.

A. All Trades

			Avg #T/Tday			
	#Tday	#Stocks	N=1	1 < N ≤ 5	5 < N ≤ 20	N>20
All Stocks	0 < N ≤ 100	6,607	992	4,822	658	135
	100 < N ≤ 250	1,486	0	537	776	173
	N > 250	35	0	0	6	29
	Totals	8,128	992	5,359	1,440	337
Non-ADR	0 < N ≤ 100	6,532	981	4,764	652	135
	100 < N ≤ 250	1,414	0	490	751	173
	N > 250	30	0	0	2	28
	Totals	7,976	981	5,254	1,405	336
ADR	0 < N ≤ 100	75	11	58	6	0
	100 < N ≤ 250	72	0	47	25	0
	N > 250	5	0	0	4	1
	Totals	152	11	105	35	1

B. Trades with Inside Quotes

			Avg #T/Tday			
	#Tday	#Stocks	N=1	1 < N ≤ 5	5 < N ≤ 20	N>20
All Stocks	0 < N ≤ 100	3,351	559	2,475	270	47
	100 < N ≤ 250	377	0	134	203	40
	N > 250	11	0	0	5	6
	Totals	3,739	559	2,609	478	93
Non-ADR	0 < N ≤ 100	3,285	551	2,422	265	47
	100 < N ≤ 250	307	0	89	178	40
	N > 250	6	0	0	1	5
	Totals	3,598	551	2,511	444	92
ADR	0 < N ≤ 100	66	8	53	5	0
	100 < N ≤ 250	70	0	45	25	0
	N > 250	5	0	0	4	1
	Totals	141	8	98	34	1

Table 7. 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 8. 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 9. 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

	$P \leq \$0.05$ (N = 671)			$\$1.00 < P \leq \$10.00$ (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
	$\$0.05 < P \leq \$1.00$ (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 10. 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. Panel A (B) shows results for the high volume periods with non-negative (negative) returns. The Volume Ratio equals the average daily trading volume in the high volume period divided by the average daily trading volume on all other days. The Outside Ratio equals the average daily trading volume in the three days before and after the high volume period divided by the average daily trading volume on all days outside the high volume period. The Return equals the log ratio of the closing price on the day after the high volume period to the closing price on the day prior to the high volume period. The Runup equals the log ratio of the maximum (minimum) trade price within the high volume period to the closing price on the day prior to the high volume period for non-negative (negative) return periods. The Reversal equals the log ratio of the closing price on the day after the high volume period to the maximum (minimum) trade price within the window for non-negative (negative) return periods. For each stock, a control is computed which equals the average Return, Runup, and Reversal for all possible 5-day periods outside the high volume period.

	A. Non-negative Returns (N = 1,835; # Control = 2,715)			B. Negative Returns (N = 900; # Control = 2,711)		
	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 (%)						
High Volume	10.05	23.24	45.20	-46.39	-21.43	-8.00
Control	7.81	12.23	18.75	-23.18	-15.12	-9.45
Runup (%)						
High Volume	22.31	44.18	78.28	-75.32	-39.71	-16.44
Control	9.98	16.13	25.08	-26.71	-17.88	-10.93
Reversal (%)						
High Volume	-34.83	-14.95	-3.82	0.00	9.88	28.77
Control	-6.47	-2.63	-0.15	-1.07	1.33	4.69

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.

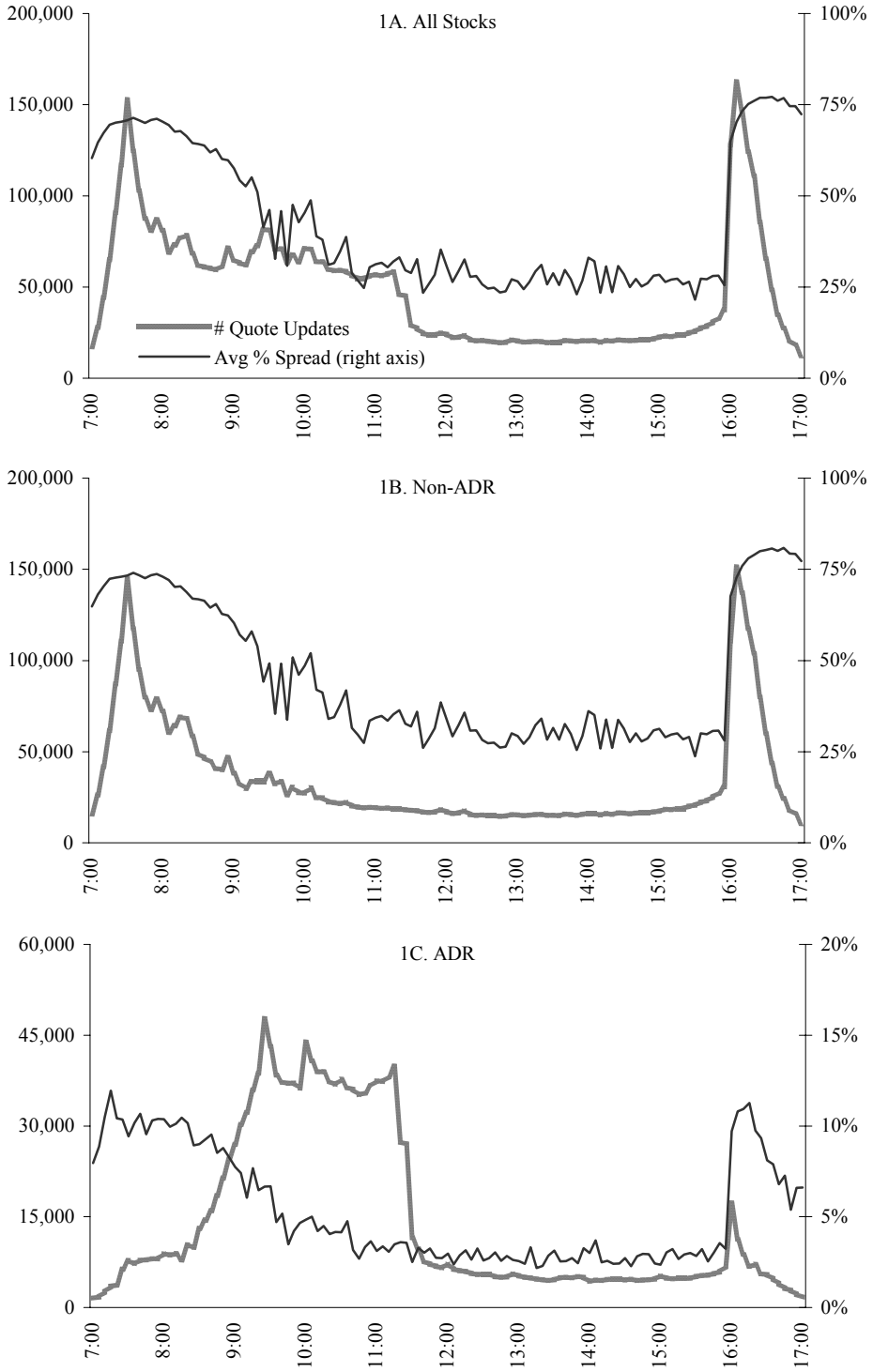
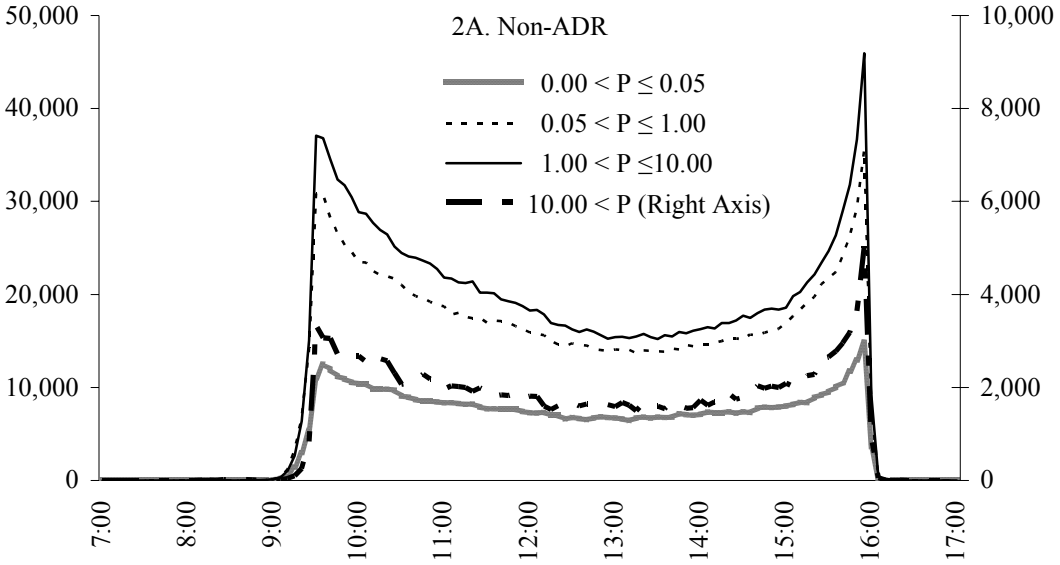


Figure 2. Trade Activity by 5-Minute Intervals

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.



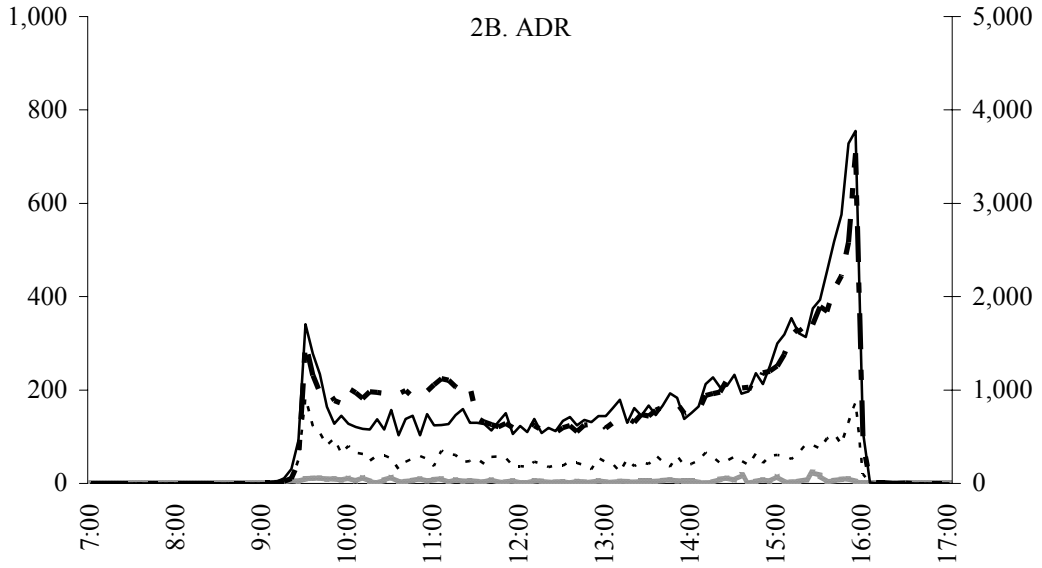
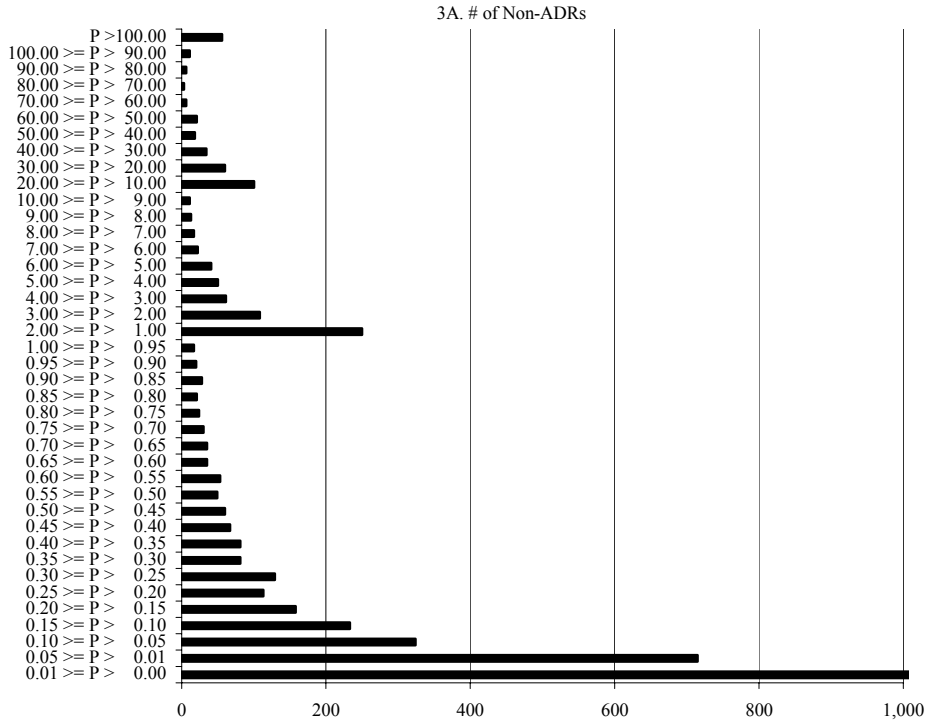


Figure 3. Number of Stocks by Midpoint

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.



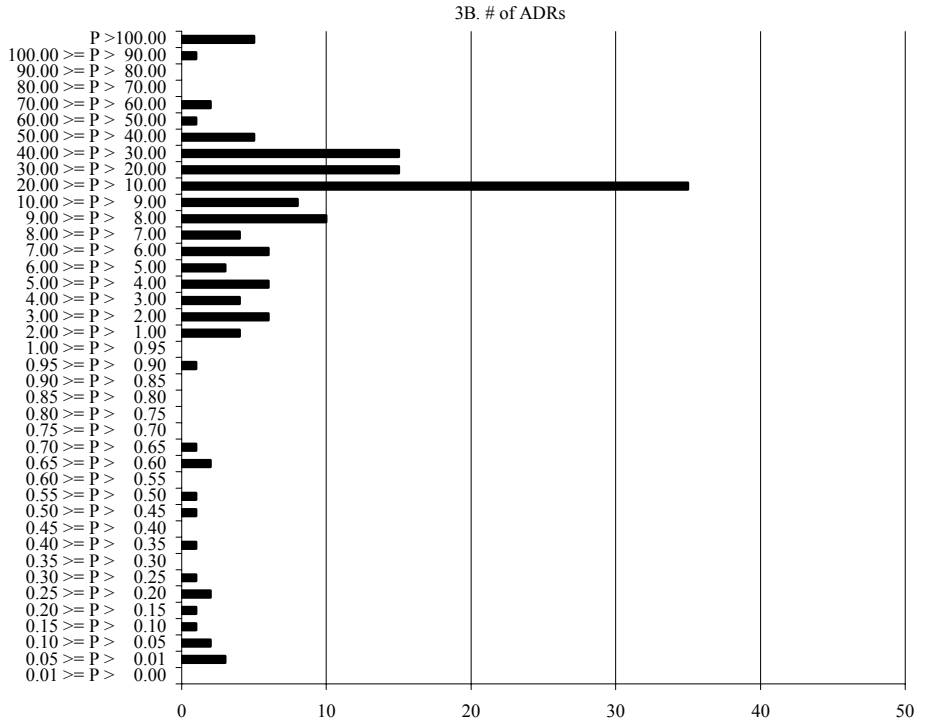
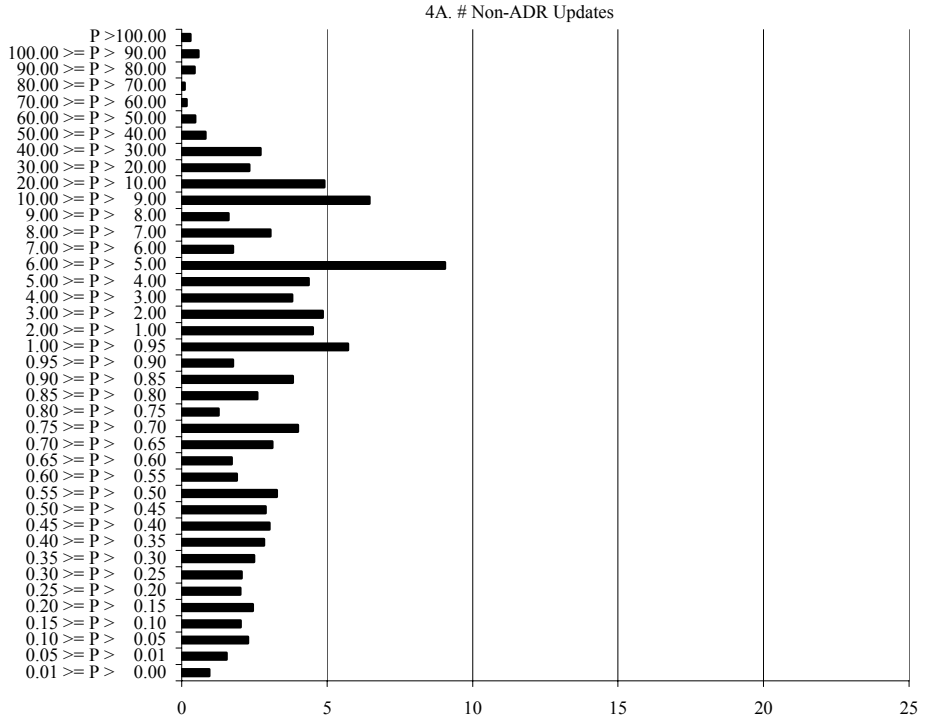


Figure 4. Number of Updates by Midpoint

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.



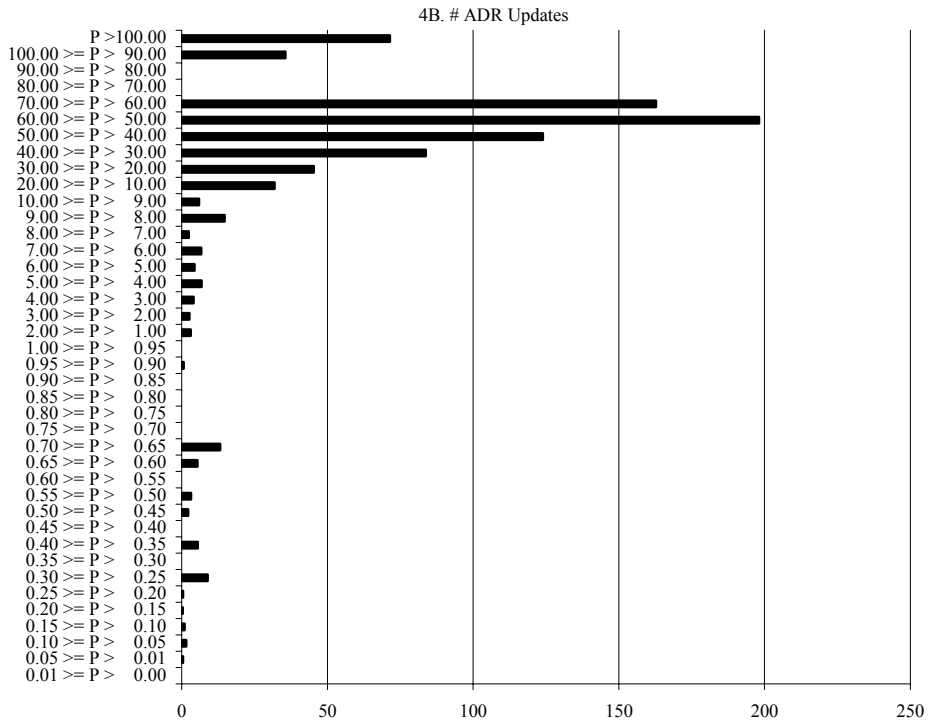


Figure 5. Histogram of Bid Quotes

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.

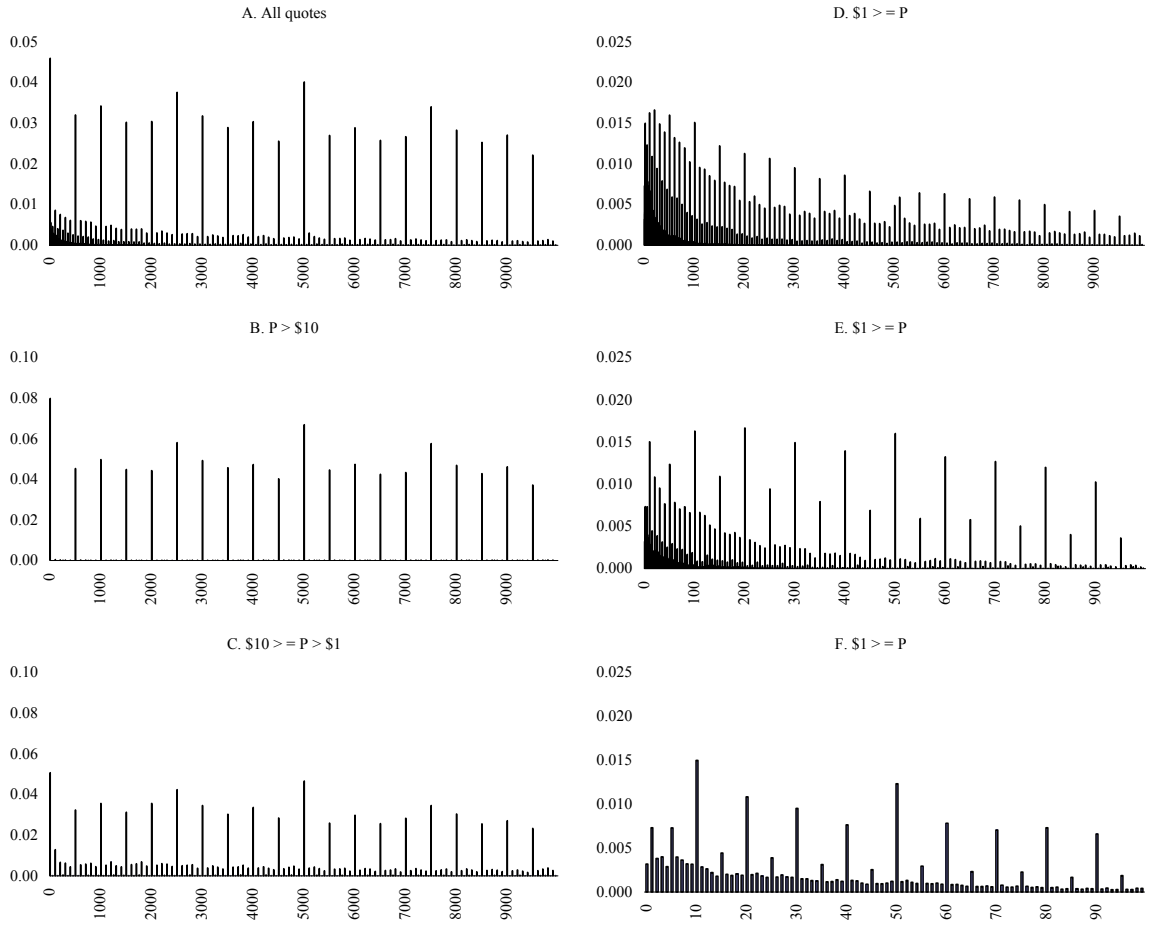


Figure 6. Histogram of quoted spreads

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.

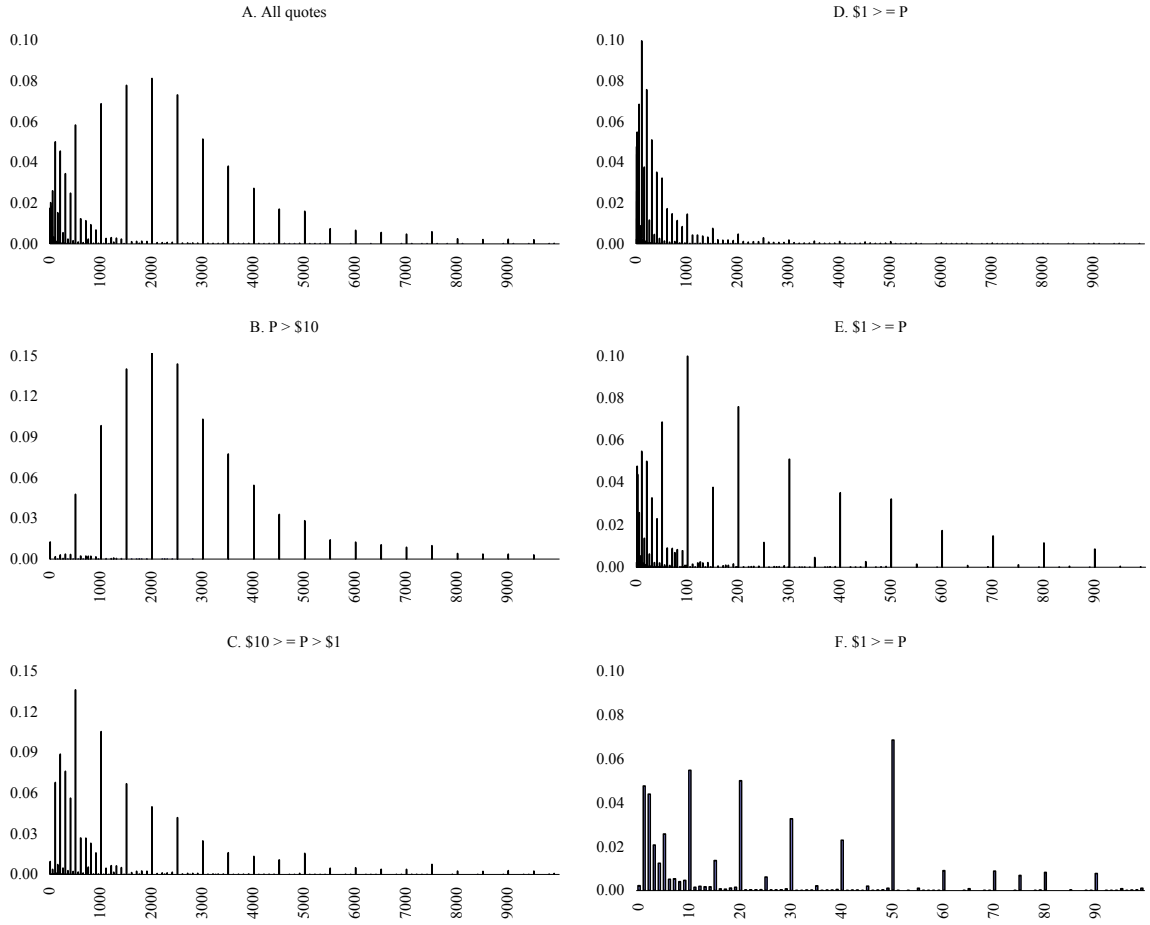


Figure 7. Histogram of trade prices

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.