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The Pool and the Puddle Archipelago

Why the NYSE handles volume
with less volatility than NASDAQ

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A stone dropped in a pool makes a smaller splash than in a puddle

The NYSE and NASDAQ trade billions of shares a day in starkly different ways. The NYSE specialist system channels liquidity primarily into one large pool. NASDAQ is a network of market makers, in effect an archipelago of smaller puddles of liquidity.

Trading in a NYSE stock centers on a small group consisting of the specialist and several floor brokers active in the stock. The great majority of shares trade within immediate physical proximity of this small group, transacted through the specialist's order book. The depth of the order book, the entire range of bids and offers, is visible to this group and to brokers and a minority of investors at large who pay to receive the data. In effect, all trading in a NYSE stock benefits from a transparent, centralized view of all the orders currently active.

Trading in a NASDAQ stock occurs independently across a number of market makers, each with a small fraction of the overall liquidity. Each maintains its own order book, small in comparison to the NYSE specialist's order book for a comparable stock. These market makers are connected in the sense that their individual quotes and the overall best bid and offer are broadcast. Their order books, each much smaller than the specialist's for an equivalent stock on the NYSE, are not communicated to others. The dynamics between investors and market makers plays out primarily in the local context of each market maker's order book, with investors wholly unaware of the depth of bids and offers behind the best quoted bid and offer. As such, each investor experiences the effects of a single puddle of liquidity, rather than interacting with the overall pool of all orders.

These details of the NYSE and NASDAQ operations are often referred to as "market microstructure" differences. They reveal a clear distinction between the environments in which individual trades occur. These microstructure differences sensibly lead to differences in very short-term measures of volatility for individual trades. It is well known, for example, that quote spreads on the NYSE are lower than NASDAQ, even controlling for differences in the stocks comprising the two markets.

We find that market microstructure differences also lead to a difference in volatility between the two markets over a full day. Differences in the short-term operations actually cause a difference in the long-term volatility. Trading beyond the current quotes necessarily makes use of the depth of orders behind the best bid and offer. Awareness of the depth of the order book can significantly affect trading tactics. The centralized visibility of the depth of orders on the NYSE allows for better informed trading decisions, which can have a significant effect on observed price movement. For a given single day's trading volume, a stock on the NYSE experiences less price movement than one

on NASDAQ. Channeling all the traded volume into a single pool of liquidity results in less trading-induced volatility than channeling it through many separate, smaller puddles. Noting that volatility in response to trading volume is a measure of overall trading cost to investors, this implies that overall trading costs are lower on the NYSE than on NASDAQ.

Volatility and Traded Volume

We seek to find the price volatility produced in response to traded volume. A simple measure of volatility for a single day is the range of price from low to high relative to the middle price,

Volatility = (high price – low price) / (mid price).

The traded volume for the same day can be expressed as a fraction of the shares outstanding, allowing apples-to-apples comparisons between stocks of greatly different liquidity. The idea being that turning over 1% of the shares of an illiquid stock should have roughly the same impact on its price as 1% of the shares of a liquid stock. This is conveniently expressed as an annualized turnover using the typical number of trading days in a year:

Turnover = 252 * (single day's volume) / (shares outstanding).

We calculated turnover and volatility in this way for each stock on each available day from June 1998 through March 2005. This is almost 7 years of observations on a group of 1100 stocks for which there is ample intraday data available from TickData Inc., amounting to a total of 1.65 million single-day observations. The stocks are the most liquid on each market, with roughly two-thirds from the NYSE and one-third from NASDAQ.

We hypothesize that turnover will produce a measurable impact on price volatility, growing in proportion to the square root of the turnover. This could be explored by plotting the square of the volatility (variance) against the turnover, looking for a straight line. Figure 1 shows a scatter plot of variance versus turnover for 2000 points selected from the full 1.65 million observations, which evidently reveals no clear relationship. In the lingo of time series analysis, there is more noise than signal.

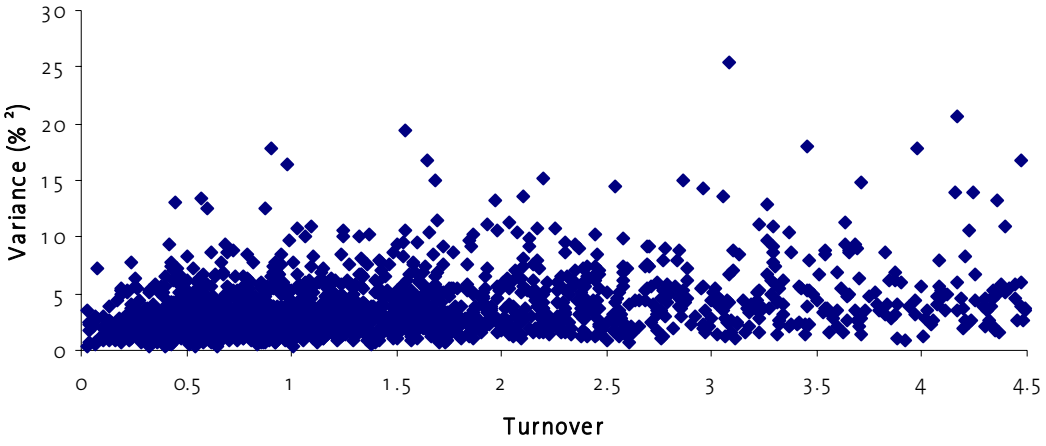

Figure 1. Scatter plot of selected raw data
2000 representative points from original 1.65 million

To identify a relationship more precisely, we use binned statistics. We arrange the points in 20 bins, each representing 5% of the data, sorted by turnover. The first bin has the points in which turnover is in the lowest 5% of all turnover values, the second bin has the points in which turnover is in the second lowest 5%, and so on. Each bin has 5% of the 1.65 million points, or 82,746 points. We recover from each bin the median turnover and the median variance for all the points in that bin. This characterizes the typical volatility for each level of turnover, viewing turnover as a parameter. A plot of just these median (turnover,variance) pairs in Figure 2 shows a clear linear relationship.

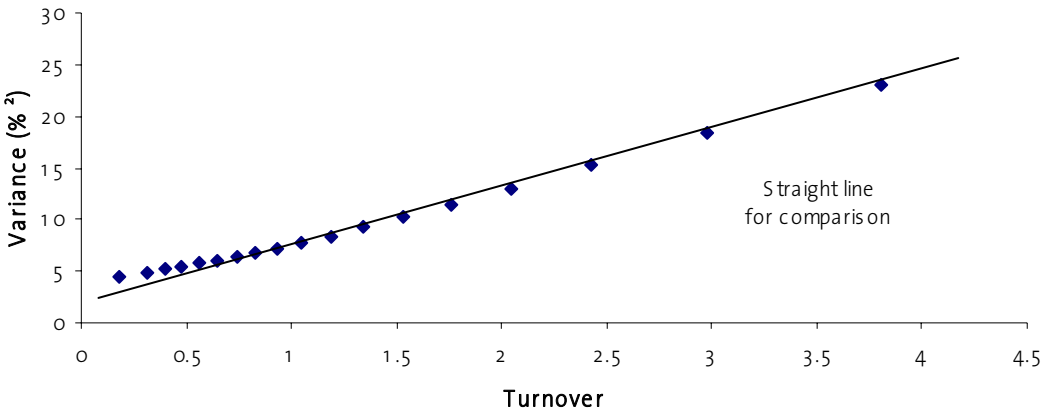

Figure 2. Median bin plot
5% of data per bin, ordered by turnover.
Median variance and median turnover for each bin.
Two points lie outside the plot boundaries.

Market Efficiency

So, in this statistical sense, we are able to deduce the linear relationship between turnover and variance that was postulated above. For a given level of turnover in a stock, there is a predictable median expected price variance for that stock on that day, and this variance rises linearly with turnover. It quantifies the expected range of stock price movement in response to a given level of volume. In so doing, it provides a measure of the trading efficiency in the marketplace. The range of price movement during a single day is a measure of the profits available to market makers and short-term speculators and of the cost borne by long-term investors. The more efficient market is the one in which speculator profits and investor costs are minimized.

The efficiency of trading on the NYSE and NASDAQ can be compared in this way. Figure 3 shows a direct comparison between listed stocks, almost all of which are traded primarily on the NYSE, and over-the-counter (OTC) stocks traded on NASDAQ. For a given level of turnover, OTC stocks exhibit roughly twice as much price variance as NYSE stocks (or about 40% to 50% more price movement low-to-high – remember volatility is the square root of variance). On this basis, NASDAQ stocks exhibit higher trading cost than comparable NYSE stocks.

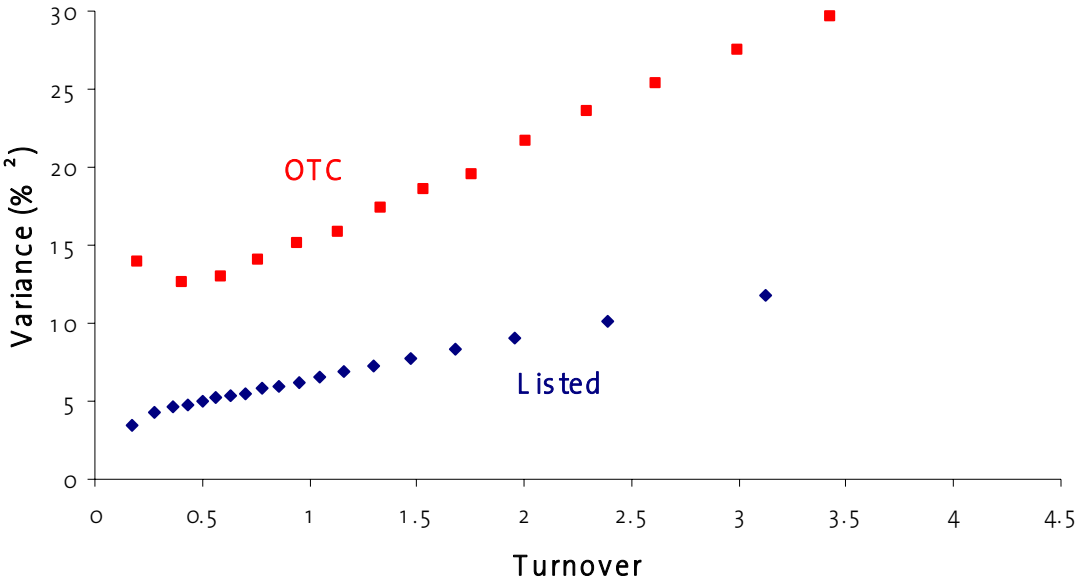

Figure 3. Comparison of Listed and OTC Stocks
Median Statistics for each 5% bucket, ordered by Turnover

A Look at Other Factors

This result is not attributable to the different character of the stock universes between the NYSE and NASDAQ. NASDAQ is more heavily weighted toward technology stocks, for example, and this could account for the higher volatility in Figure 3. If this were the case, the volatility response within each sector would be the same for the NYSE and NASDAQ. We have applied the same comparison at a sector level for four major sectors where both the NYSE and NASDAQ have a significant number of comparable stocks, shown in Figure 4. For consumer and financial stocks NASDAQ is only slightly more volatile, but in industrial and technology stocks it is significantly more volatile than comparable stocks on the NYSE. This indicates that sector weighting differences are not the cause of higher volatility for NASDAQ stocks, since NASDAQ stocks are more volatile than NYSE stocks within each comparable sector.

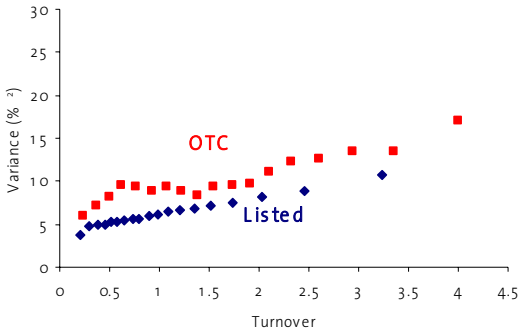

Figure 4a. Consumer Stocks

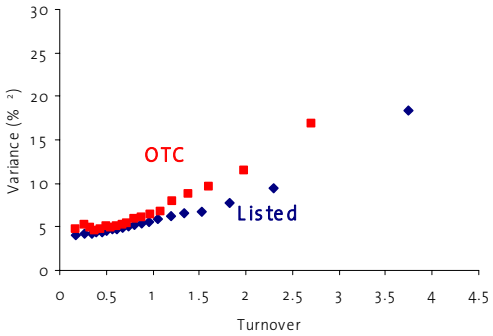

Figure 4b. Financial Stocks

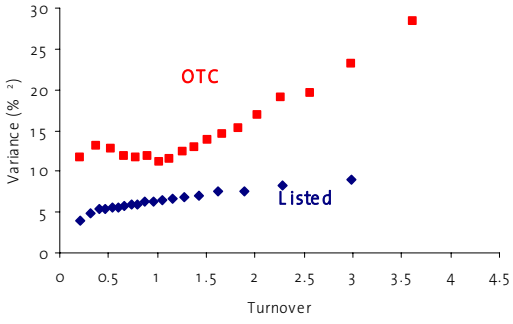

Figure 4c. Industrial Stocks

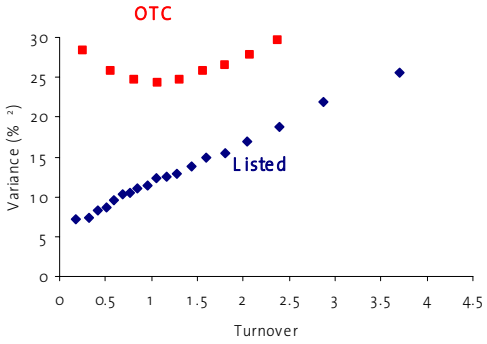

Figure 4d. Technology Stocks

Figure 4. Comparisons for 4 Sectors

The same is true for the other major factors that distinguish NASDAQ and the NYSE. Figure 5 compares results for different market capitalization ranges and shows that NASDAQ stocks are again more volatile for each cap range. We separated high and low cap by dividing stocks on either side of $3 billion in market cap, roughly the median of our stock sample.

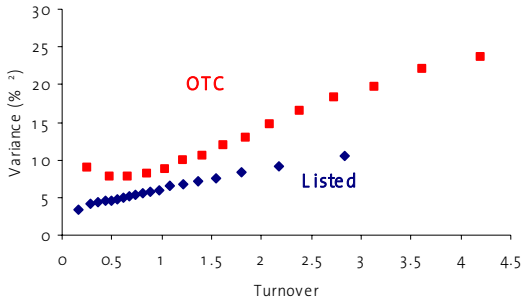

Figure 5a. High Cap Comparison
Listed and OTC stocks over $3B

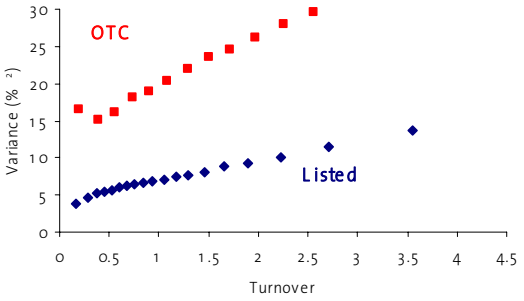

Figure 5b. Low Cap Comparison
Listed and OTC stocks under $3B

Figure 5. Comparisons for Different Market Caps

Figure 6 compares results for high and low volatilities, dividing stocks above and below 50% average annual realized volatility. Even controlling for stocks with similar levels of average realized volatility, a measure influenced heavily by the company's performance, NASDAQ stocks exhibit higher single-day price response to trading turnover, a measure influenced heavily by that day's trading activity.

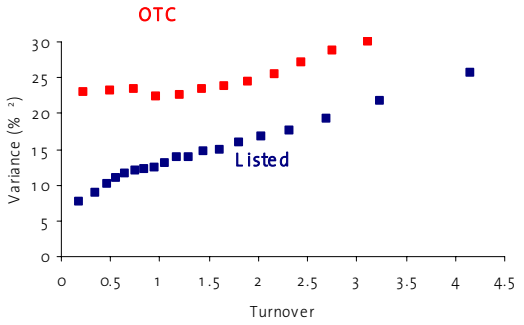

Figure 6a. High Volatility Comparison
Listed and OTC stocks over 50% volatility

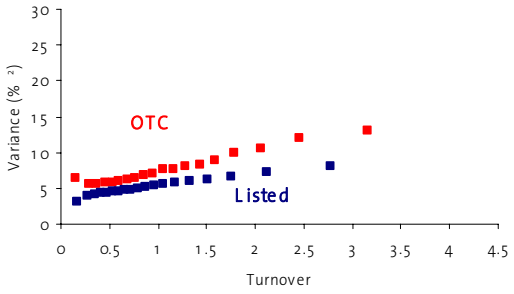

Figure 6b. Low Volatility Comparison
Listed and OTC stocks under 50% volatility

Figure 6. Comparisons for Different Market Volatilities

Figure 7 shows similar results when stocks are arranged by share price, dividing high and low price stocks at $30 per share. NASDAQ stocks exhibit a more sensitive price response to a given level of turnover when compared to NYSE stocks, regardless of major differences in the stocks on the two markets, such as sector weighting, market cap, volatility or share price.

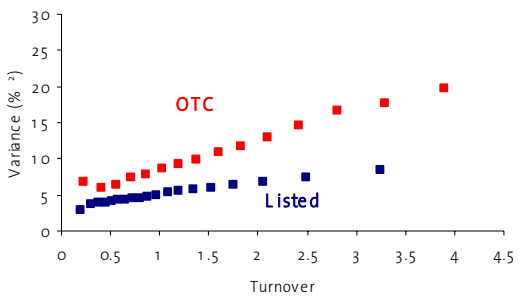

Figure 7a. High Price Comparison
Listed and OTC stocks over $30 per share

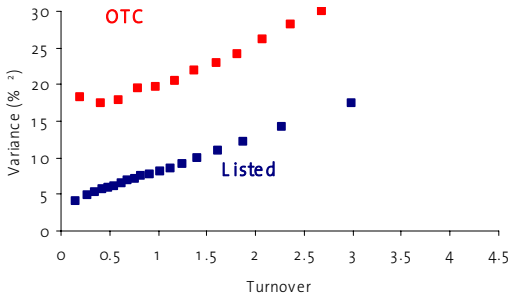

Figure 7b. Low Price Comparison
Listed and OTC stocks under $30 per share

Figure 7. Comparisons for Different Share Prices

Decimalization

A surprising result is the method's power to discern the difference in volatility before and after decimalization in early 2001. Figure 8 shows results for NASDAQ (OTC) and NYSE (listed) stocks before and after decimalization. The apparent reduction in trading costs, as measured by this volume-induced volatility, ushered in by decimalization is remarkable. Similar results have been found by others who have studied quote spreads for these periods.

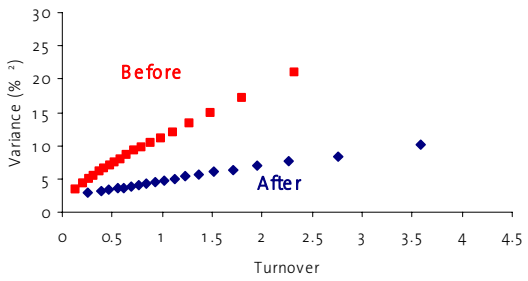

Figure 8a. Decimalization Effect
for Listed Stocks

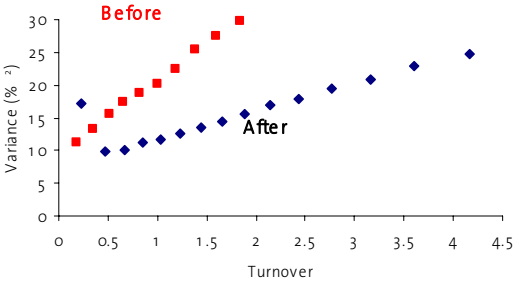

Figure 8b. Decimalization Effect
for OTC Stocks

Figure 8. Decimalization Effect

Super Liquid Stocks

While the NYSE appears to be more efficient for the majority of stocks, it is interesting to note that this result does not hold for super liquid stocks. Figure 9 shows results for the top 20 stocks on each market, ranked by average daily dollar volume over the whole time period for this study. Restricting the focus to just these super liquid stocks, NASDAQ is slightly more efficient than the NYSE.

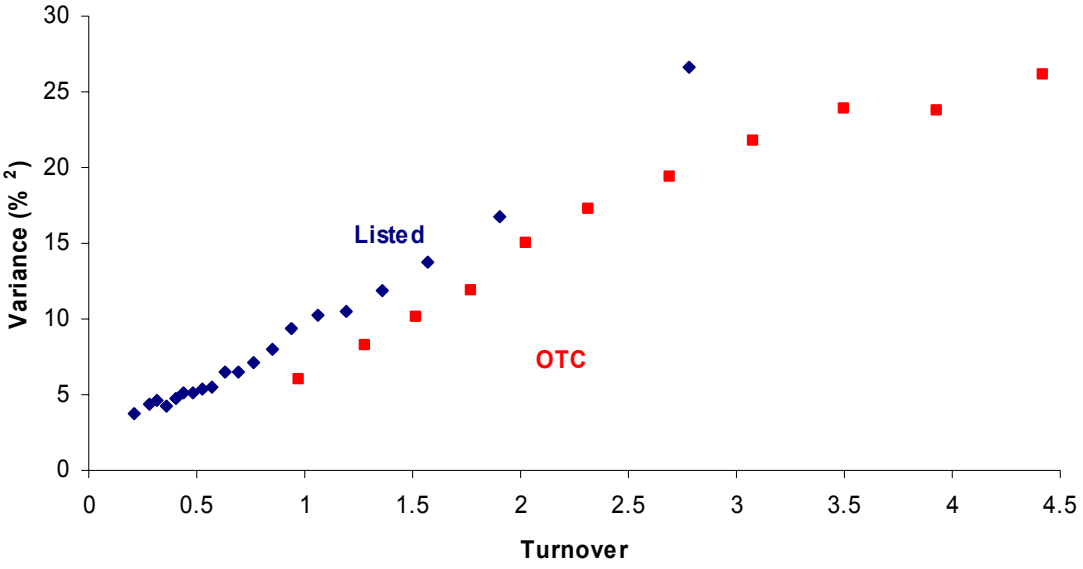

Figure 9. Super Liquid Stocks

Conclusions

The NYSE and NASDAQ execute individual trades in very different ways. The NYSE is a centralized system akin to a large pool of liquidity. NASDAQ is made up of many market makers comprising a network of smaller puddles of liquidity. We have given evidence that these market microstructure differences, the centralized visibility of the depth of orders on the NYSE in particular, lead to differences in volatility and trading costs over a long time frame. We use a novel approach to quantify the impact of traded volume on intraday price volatility, using binned statistics to characterize the median price range at each level of turnover for a single day's trading. The price range in a single day produced in response to different levels of turnover is significantly higher for NASDAQ than for the NYSE. This result holds even after accounting for differences in the stock universes between the two markets, such as sector weighting, market cap, volatility and share price. The arguments are similar to those employed by those who have shown that quote spreads are higher on NASDAQ than on the NYSE. However, we focus on the longer-term measure of price movement to indicate the larger effects of the microstructure differences. The intraday volatility of a stock in response to traded volume is a simple measure of the cost faced by investors and that cost is lower for NYSE stocks than NASDAQ stocks.

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