MA668: Algorithmic and High Frequency Trading
Lecture 15

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Price Patterns: Figure 4.5

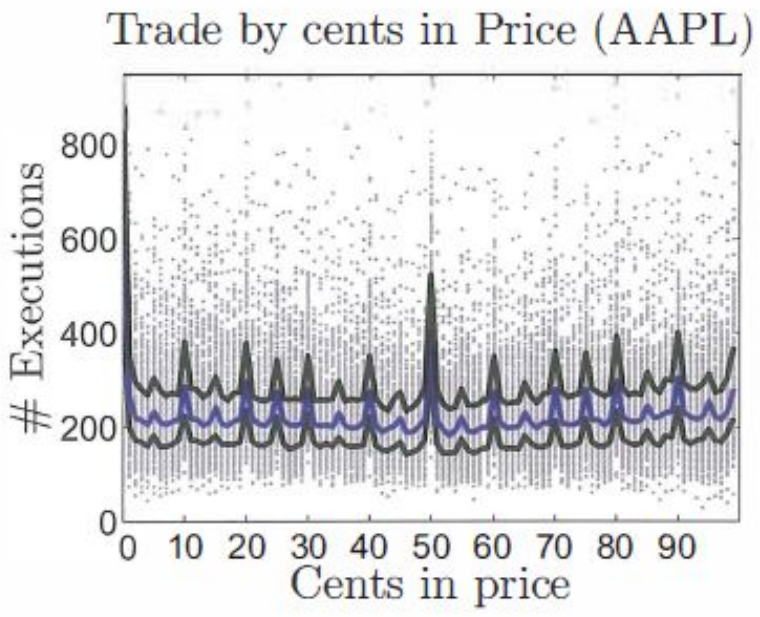

Figure 4.5 Price pattern: frequency of executions by number of cents in the price.

Figure: Figure 4.5

Price Patterns: Figure 4.5 (Contd ...)

1. Standard Practice: Look at volume patterns, but not price patterns.
2. Question: Whether execution at prices that end in multiples of 5 cents (round values) are different from those that are not.
3. No strong fundamental reason as to why the price of an asset should have a round value such as \$450.25 or \$21.00.
4. However, if we look at the frequency with which we observe transactions taking place at different prices grouped by the number of cents in the price, we find the pattern displayed in Figure 4.5.
5. Figure 4.5 also shows the quartiles Q1, median and Q3 as solid lines.

Price Patterns: Figure 4.5 (Contd ...)

1. The pattern is quite evident.
2. (A) Very large accumulation of transactions whose prices end in exact dollar-valued prices.
   (B) Large number of transactions with prices that end in 50 cents.
   (C) Spikes of larger than usual numbers of transactions at prices that end in units of 10 cents and even 5 cents.
3. Straightforward interpretation for this phenomenon: For some reason (rational or not) there is a preference for providing liquidity at prices that end in round cent values.
4. The term "`preference for providing liquidity`" may be viewed in the context of transaction prices being (mostly) determined by an aggressive MO filling a standing posted LO.
5. So it is liquidity providers who decide to accept a large number of executions at a particular price level.

Price Patterns: Figure 4.5 (Contd ...)

1. Question: Why would agents provide liquidity in this way?
2. Hypothesis: There are a number of stop-loss orders and momentum orders programmed to execute as MOs at round prices.
3. These could be latent having been programmed by agents who decide to enter/exit when the price moves beyond a certain barrier, which is psychologically or conveniently set at a whole number.
4. If this line of reasoning is correct, then the accumulation of executions at those prices may be triggered by psychologically-based demand for liquidity which is then happily provided by agents who do not have such psychological inclinations and expect the unusual demand for liquidity at these prices to be unjustified by economic/market microstructure fundamentals (and hence, a source of profit).

Trading and Market Quality

1. Financial markets play a key role in helping a market economy to allocate resources over time and uncertainty.
2. Financial markets provide a forum for firms to raise capital and facilitate investor participation in the general economic progress of the economy.
3. In this context: The stock market provides a forum where equity holders can convert their equity into cash (and vice-versa) quickly and at a reasonable price.
4. Goal: Look at different ways of measuring the market's effectiveness in this role under the generic heading of "`market quality`".
5. Recall the two basic arguments to explain intraday patterns:
   A. New information increases trading volume.
   B. An increased desire to trade (e.g., due to increased trader urgency) interacts with the quality of the market which feeds back to motivate further trading.

Trading and Market Quality (Contd ...)

1. Market quality enters directly into the second argument: `An expected increase in volume generates expectations of better market quality`, that is of improved effectiveness of the market in facilitating the trade via:
   - (A) lower execution costs (spreads).
   - (B) greater price efficiency (less mean-reversion in price levels or lower transitory volatility) etc.
   - (C) which induces greater volume.
2. In the first argument: Market quality enters indirectly, as it modulates the relationship between the exogenous forces of new information and traders' desire to execute trades.
3. Either way: If the quality of the market varies, trading activity will also vary with it.

Trading and Market Quality (Contd ...)

1. Question:
   - A. What determines market quality?
   - B. What determines the effectiveness of the market in facilitating trade?
2. Naturally: The direct cost of trading matters:
   - A. How much does one pay for shares one wishes to buy?
   - B. What is the price that one pays relative to one's opinion of its market value?
   - C. How much does one value the information obtained from the market?
   - D. How easy is it to complete a transaction?
3. Dimensions along which to evaluate the quality of a market (from an agent's perspective) are:
   - A. Having sufficient information to identify the true market value of the asset.
   - B. Being able to buy (or sell) any quantity at prices sufficiently close to the asset's value.
   - C. Having the confidence that deals are honored.

Trading and Market Quality (Contd ...)

1. While there is (obviously) qualms about the existence of "true market price" of an asset, nevertheless it is a useful concept to work with and is the basis of much of the literature.
2. From the short list of aspects of market quality, the last one, namely, honoring of deals is usually taken for granted.
3. The other two aspects are captured by measures of market quality, such as spreads, price impact, volatility, resilience, depth, probability of informed trading (PIN) etc.

Trading and Market Quality (Contd ...)

1. Spread measures the immediate cost of execution.
2. Price impact measures the cost of executing larger trades via their impact of trading in prices.
3. Volatility measures the effectiveness of the price in transmitting information about the market value of an asset.
4. Resilience is related to market impact and measures the market's ability to return to equilibrium after a trade.
5. Depth measures the amount of visible liquidity in the market.
6. PIN measures the degree of information asymmetry in the market.

Spreads

1. Spreads measure the execution costs of small transactions by measuring how close the price of a trade is to the market price.
2. The first problem, naturally, is to determine what is the "true market price".
3. The simplest and the most common approach, is to use the mid-price,

$$S_t = \frac{1}{2}\left(a_t + b_t\right), \tag{1}$$

   which is the simple average of the bid (b_t) and the ask (a_t) price.
4. This is based on the economic concept that the market price is the equilibrium price, the price at which demand equals supply, and in a market with frictions that generate a gap between the best buy price (the ask) and the best sell price (the bid), the equilibrium should be somewhere in between.
5. An alternative estimate of the market price, already seen earlier, is the microprice.

Spreads (Contd ...)

1. The two most common spread measures are the "quoted" and the "effective" spread, both of which use the mid-price as the market price.
2. The quoted spread QS, is the difference between the ask and the bid price,

$$QS_t = a_t - b_t,$$

   and represents the potential cost of immediacy: The difference in price between posting an LO at the best price and aggressively executing an MO, at any point in time.
3. It also reflects the distance from the market price if one takes the midpoint as a reference.
4. (A) Direct trading cost of a market sell order is $S_t - b_t = \frac{QS_t}{2}$.

   (B) Direct trading cost of a market buy order is $a_t - S_t = \frac{QS_t}{2}$.
5. The effective spread (ES) for a market buy order is $ES_t = a_t - S_t$ and for a market sell order is $ES_t = S_t - b_t$.

Spreads (Contd ...)

1. For an MO executed in full, on an exchange, against a visible LO, the effective spread is equal to the quoted half-spread (if it does not walk the LOB).
2. Sometimes it will be greater, if it does walk the LOB, or smaller, if it is matched with a "hidden order" inside the spread: It could even be negative, if the hidden order [a] was aggressively posted.
3. A negative effective spread reflects that one is buying at a price "below" or selling at a price "above" the "market price" (represented by the mid-price).
4. In empirical analysis, these spreads are usually normalized and expressed in bps relative to the mid-price.

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[a] A hidden order is an LO that is posted in the LOB, but is not visible to market participants

Table 4.2

Asset	Mean	StdDev	P01	Q1	Median	Q3	P99
ISNS	33.2	270.8	2.0	11.0	22.0	40.0	129.2
FARO	23.9	192.0	2.4	8.9	12.0	16.6	71.0
MENT	3.5	27.4	1.0	1.0	1.1	2.0	13.9
AAPL	13.6	54.7	5.4	11.0	13.8	16.9	29.3

Table 4.2 Time-average Quoted Spread (in cents).

Figure: Table 4.2

Table 4.2 (Contd ...)

1. Table 4.2: Quoted spread for the four assets during 2013 (ordered from least to most traded).
2. For each asset, we compute the time weighted average quoted spread, tQS, for each minute of the day.
3. Calculated as follows: For each minute of the day $t = 1 : 390$ while the market is open (from 09:30–16:00),

$$tQS_t = \sum_{i=1}^{n-1} (\tau_{i+1} - \tau_i)\, QS_{\tau_i},$$

   where $i \in \{1, 2, \ldots, n\}$ indices the time τ_i (in minutes) at which the quoted spread changes during minute t.
4. Table 4.2: Described the statistics for the minutes of every day in 2013 (252 trading days), for each asset.

Table 4.2 (Contd ...)

1. Table 4.2: Descriptive statistics.
2. More frequently traded assets trade at lower spreads.
3. This positive relationship between volume and market quality can work both ways: Volume attracts liquidity and improves market quality or higher market quality facilitates trade and generates greater volume.
4. However: AAPL seems to have an enormous spread.
5. Explanation: The large spread for AAPL is an illusion as we have not adjusted for the relative tick size.
6. The average mid-prices (at the end of each minute) for the assets are: ISNS ($5.25), FARO ($40.62), MENT ($19.93) and AAPL ($473.00).
7. Implication: Median (relative) quoted spreads are: ISNS (419 bps), FARO (29.5 bps), MENT (5.5 bps) and AAPL (2.9 bps).
8. Using relative spreads $\Rightarrow$ Expected relationship between quoted spreads and volume.

Table 4.2 (Contd ...)

1. From Table 4.2: More frequently traded assets tend to have less volatile quoted spread: ISNS (1.32 bps), FARO (0.64 bps), MENT (0.91 bps) and (0.42 bps).
2. MENT Example: Illustrates another aspect of importance of tick-sizes, especially from a regulatory perspective.
3. In the US (for assets with prices greater than \$1), the minimum tick size is legally fixed at one cent [a].
4. The imposition of a minimum tick size of one cent may affect trading for some assets, such as MENT, in whose case, for almost 50% of all minutes, the one cent minimum is constraining MENT's quoted spread at that level (one cent).
5. This translates to a possibly significantly large relative minimum quotes spread (around 5 bps for MENT) and may be limiting the market quality for this asset.

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[a] There are ways to trade in fractions of a cent, but the one cent minimum is binding in most cases

Table 4.2 (Contd ...)

1. The numbers in Table 4.2 are contaminated resulting from trading stops, particularly the trading halt on August 22, 2013.
2. However, the corrected table is not included here, since it is not significantly different.
3. Nevertheless, the point to be taken note of is the importance of knowing the details of the dataset.
4. In the ITCH database, all messages are recorded and timestamped, "even when the market is halted and there is no trading".
5. On August 22, 2013, even though NASDAQ halted trading for three hours, yet during this time period, messages kept coming into the exchange and were time-stamped.
6. In particular, many orders were "cancelled" and the "ask" and "bid" moved dramatically.
7. Consequently: There were huge and also negative artificial spreads.
8. CAUTION: In case of analysis being used in (designing of/trading using) algorithms, especially involving unsupervised/deep learning, the unified data could generate significant distortions.