MA668: Algorithmic and High Frequency Trading
Lecture 03

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A Snippet

1. As depth disappears (for instance, as observed during the Flash Crash of 6th May, 2013), an MO at the end of the sequence, may be executed against very poor prices, or in the worst case, matched with "stub prices".
2. "stub prices" are LO's at such absurdly low prices that clearly suggests that they are not expected to be executed (such trades were observed during the Flash Crash).
3. Thus LOB serves to keep track of LO's and supply the algorithm that matches incoming orders to existing LO's.

More on LOB (Characteristics)

1. LOB is defined on a fixed discrete grid of prices (price levels).
2. Size of the step (difference between one price level and the next) is called the "tick".
3. In the US, the minimum tick size is 1 cent, for all stocks with a price above \$1.
4. Other markets may have other ticks (Paris Bourse or Blosa de Madrid: €0.001 to €0.05, contingent on the price at which the stock is trading at).

Spread

1. Difference between ask and bid price is defined as:

$$\text{Quoted Spread}_t = P_t^a - P_t^b,$$

   where P_t^a is the best ask-price and P_t^b is the best bid-price.

2. In this case the best sell price is \$21.16 and the best buy price is \$21.15. Therefore:

$$\text{Quoted Spread}_t = \$0.01.$$

3. In some cases, when the bid and the ask are equal and the spread becomes zero, then the market is said to be locked.
4. But such events are short-lived.
5. However, in case of extremely liquid assets, it is becoming an increasingly more frequent event.

Mid-Price

1. Another common object used when describing the LOB is the mid-price.
2. The mid-price is the arithmetic average of the bid and the ask:

$$\text{Mid-Price}_t = \frac{1}{2}\left(P_t^a + P_t^b\right).$$

3. This is often used as the proxy for the time underlying price of the asset: the price for the asset, if there were no explicit/implicit costs.

HPQ

1. Frequently traded and is a liquid asset.
2. HPQ's LOB has LO's posted at every tick out to (at least) 20 ticks away from the mid-price.
3. Spread is 1 tick.
4. 10000-th event at 9:42 AM.
5. More than 1000 units posted for sum of depth at the best two price levels in bid and ask.

FARO

1. Seldomly traded and is an illiquid asset.
2. It has thinly posted bids.
3. Spread is 20 ticks (20 cents) on a (approximately) \$41 price asset.
4. 10000-th event at 12:40 PM.
5. Less than 100 units posted for sum of depth at the best two price levels in bid and ask.

Figure 1.4

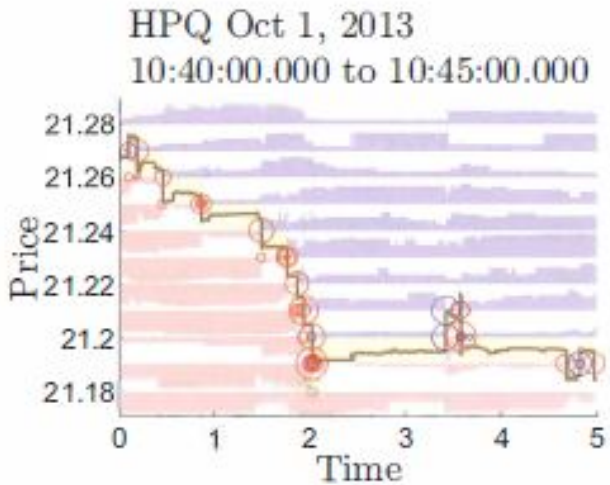
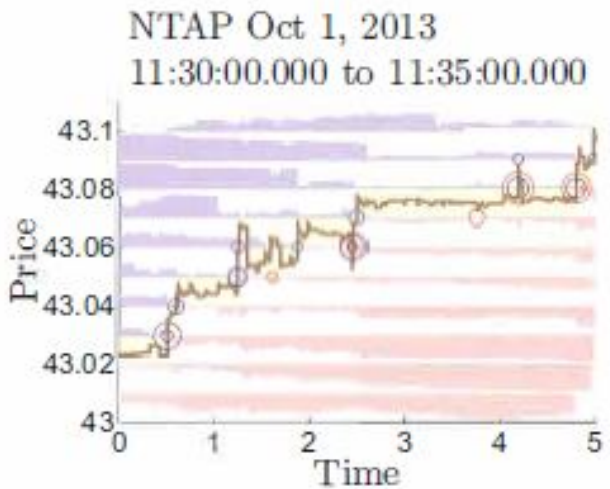


Figure 1.4 Time series of the changes in the LOB for the three assets HPQ, NTAP, and ORCL.



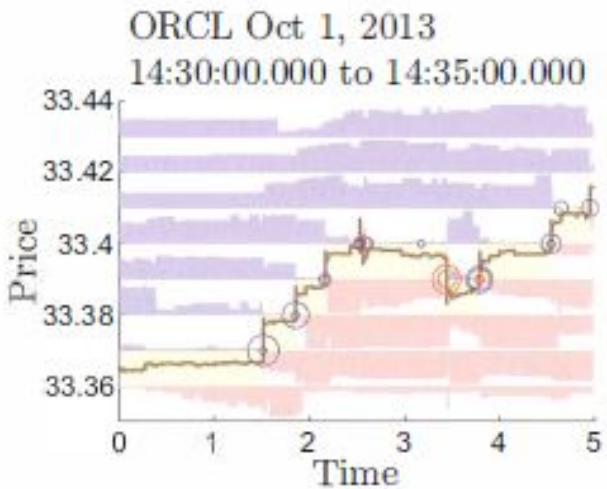


Figure: Figure 1.4

Dynamic Version of Three Assets

1. Evolution of LOB over time (5 minutes) for HPQ, NTAP and ORCL.
2. The static picture of captured by the shaded blue and red regions.
3. Best prices (bid and ask) are identified by the edges of the intermediate light shaded region, which identifies the bid-ask spread.
4. Also identifies when incoming orders are executed.
5. Red/blue circles indicate the time, price and size of an aggressive MO executed against the LO's sitting in the LOB.
6. Hit the bid: Sell MO executes against a buy LO.
7. Lift the offer: Buy MO executes against a sell LO.

Dynamic Version of Three Assets (Contd ...)

1. Brown solid line depicts a variation of the asset price known as the "microprice" defined as:

$$\text{Microprice}_t = \frac{V_t^b}{V_t^b + V_t^a} \times P_t^a + \frac{V_t^a}{V_t^b + V_t^a} \times P_t^b,$$

where:

   A. V_t^b: Volume posted at the best bid.
   B. V_t^a: Volume posted at the best ask.
   C. P_t^b: Bid price.
   D. P_t^b: Ask price.

2. The "microprice" is used as a more subtle proxy for the assets' transaction cost-free price, as it measures the tendency that the price has to move either towards the bid or the ask side as captured by the number of shares posted, and hence indicates the buy/sell pressure on the market.

A Prelude

1. Aspects of design and implementation of trading strategies: Requires consideration of economics that drives these trading strategies.
2. Focus on:
   - (A) Basic market making models.
   - (B) Trading from the point of view of better informed trader.
   - (C) Trading form perspective of less informed market maker.
3. Market microstructure:
   - (A) Studies of the process of exchanging assets.
   - (B) Trading strategies and their outcomes.
   - (C) Asset prices, volumes, risk transfers etc.
   - (D) Information which affects trading outcomes (including asset prices): Key dimension of trading and price setting process.
   - (E) Microstructure studies is DIFFERENT from general asset pricing studies.
   - (F) Liquidity and price discovery $\rightarrow$ Key drivers pertinent to effective algorithmic and high frequency trading.
4. While trading can take place in a number of possible ways, our focus is on trading and trading algorithms that take place in large electronic markets: Both open exchanges and electronic private exchanges.

Market Making

Market participants:

(A) Passive market maker (MM): Facilitates trade, makes profit from the spread and execution skills, and must be quick at adapting to changing market conditions.

(B) Active trader: Those who exploit their ability to anticipate price movements and must identify the optimal timing for their market intervention.

(C) Considering our focus on active exchanges, it is natural that there are many MM's in competition.

Market Making (Contd ...)

MM's play a crucial role in markets where they are responsible for providing market liquidity to market participants:

(A) A key dimension of liquidity as provided by an MM is immediacy.

(B) By quoting buy and sell prices (or posting Limit Orders (LOs) on both sides of the book) the MM is willing to provide liquidity to the market.

(C) Obviously: To make this a sustainable business, the MM quotes a buy price lower than the quoted sell price.

(D) By posting LO's, the MM is providing liquidity to other traders who may be looking to execute a trade quickly, e.g., by entering a MO.

(E) Dichotomy that separates MM's as liquidity providers, from other traders, considered as liquidity takers.