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Module: High Frequency Trading

Week 1: Market Microstructure

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Electronic Markets

Market settings

- Common Stocks (Exchanges)
    - listing
    - trading
    - data
- Foreign Exchange (Dealer market)

Market Participants

- Brokers
- Traders with different motives
  - Fundamental Traders
  - Informed Traders
  - Market Makers

Orders

- Market Orders (MO)
- Limit Orders (LO)
- Limit Order Book (LOB)

Limit Order Book

HPQ on Oct 1, 2013
at 09:42:09.644
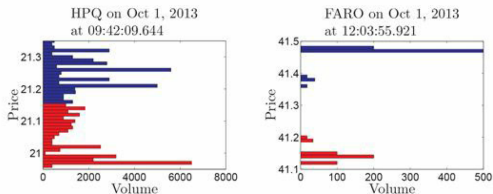
FARO on Oct 1, 2013
at 12:03:55.921

Figure 1 shows a snapshot of the limit order book (LOB) on NASDAQ after the 10,000th event of the day for two stocks, FARO and HPQ, on Oct 1. The two are quite different. The one in the left panel corresponds to HPQ, a frequently traded and liquid asset. HPQ's LOB has LOs posted at every tick out to (at least) 20 ticks away from the midprice. In the right panel, we have FARO's LOB. FARO is a seldom traded, illiquid asset. This asset has thinly posted bids and offers and irregular gaps in the LOB.
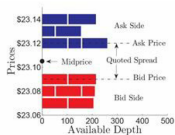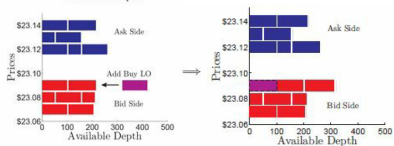
Add LO to LOB

Figure 2

In this figure, LOs are ordered in terms of time priority from right to left, so that when a new buy LO comes in at $23.09, it will be added to the line of blocks already resting at that price. This new LO joins the queue at the point closest to the y-axis, becoming the third LO waiting to be executed at $23.09.

MO Walks the LOB or Is Re-routed

A new MO (to sell) 250 shares enters this market as depicted by the sum of the green blocks in the top panel of Figure 3. The matching engine goes through the LOB, matching existing (posted) LOs (to buy on the bid side) with the entering MO following the rules in the matching algorithm. In the LOB, there are two LOs at the best bid $23.09, represented by the two red blocks, both for 100 units, totaling 200 units. These 200 units are executed at the best bid.
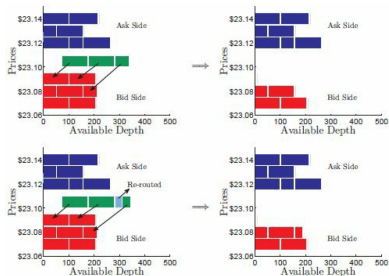
Limit order processing

Table: Bid Book by Price and Time

Price	Visibility	Time	Trader
20.06	hidden	9:35	Florio
20.05	hidden	9:30	Amy
20.05		9:33	Dmitri
20.04		9:31	Brian
20.04		9:32	Chao
20.03		9:34	Esteban

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20.05		9:33	Dmitri
20.05	hidden	9:30	Amy
20.04		9:32	Chao
20.04		9:31	Brian
20.03		9:34	Esteban

Other Order Types

Some examples of order types you might find:

- Day Orders
- IOC (Immediate-or-Cancel)
- AON (All-or-Nothing)
- Fill-or-Kill

Spread and Price

Quoted Spread:

$$\text{Quoted Spread} = P^a - P^b \tag{1}$$

Midprice:

$$\text{Midprice} = \frac{1}{2}\left(P^a + P^b\right) \tag{2}$$

Microprice

$$\text{Microprice} = \frac{V^b}{V^b + V^a}P^a + \frac{V^a}{V^b + V^a}P^b \tag{3}$$

Where:

$V^b =$ volumes posted at the best bid

$V^a =$ volumes posted at the best ask
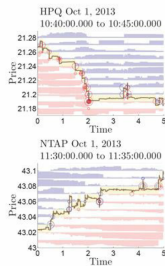
$P^b =$ bid price

$P^a =$ ask price
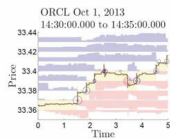
Microprice

Figure 4

Figure 4 identifies when incoming orders were executed. The red/blue circles indicate the time, price, and size (indicated by the size of the circle) of an aggressive MO which is executed against the LOs sitting in the LOB.

The brown solid line depicts a variation of the asset known as the microprice.

Market Making

- Immediacy Provided by Market Makers (MMs)
- Active Traders Who Exploit Price Movements
- Designated market maker vs. De facto market makers

Multiple Markets

Discussion: Centralized limit order book (CLOB) or fragmented market?

US Exchanges

Table 5.1. Trading volume (million shares) on Friday, September 11, 2020

Trading venue	Primary listing venue			Row totals	Row %
	NYSE	Other	Nasdaq		
TRF	1,298	560	1,724	3,583	39.94%
Nasdaq	571	249	893	1,713	19.09%
NYSE	827	60	53	939	10.47%
NYSE Arca	205	313	297	815	9.08%
Cboe EDGX	243	117	246	606	6.75%
Cboe BZX	204	152	162	518	5.77%
Cboe EDGA	62	39	52	152	1.69%
IEX	83	15	54	152	1.69%
Cboe BYX	67	41	41	150	1.67%
NYSE National	68	35	28	130	1.45%
Nasdaq BX	30	19	24	73	0.81%
Nasdaq PSX	25	23	16	63	0.71%
NYSE American	12	26	8	47	0.52%
NYSE Chicago	9	11	11	30	0.34%
LTSE	0	0	0	1	0.01%
Col totals	3,704	1,659	3,608	8,971	
Col %	41.29%	18.50%	40.22%		

Notes: TRF=Trade Reporting Facility; LTSE=Long Term Stock Exchange. "Primary listing venue" is a heading of convenience: the columns correspond to CTA Tapes A, B, and C.

Source: IEX website (https://iextrading.com/apps/market/)

Strategies

- Setting the price on the limit order book
- Spoofing and layering
  'Hound of Hounslow'
  https://www.bbc.co.uk/news/explainers-51265169

Strategies LOB 1

	Visibility	Price	Quantity	Submitted	Trader
		50.12	1,000	9:30	Cathy
		50.11	500	9:32	Bill
	Hidden	50.10	200	9:30	Gina
SELL		50.10	400	9:31	Amy
BUY		50.05	1,000	9:30	David
		50.04	500	9:32	Ellen
		50.03	400	9:31	Fred
		50.03	20,000	9:40	Stella

Strategies LOB 2

	Visibility	Price	Quantity	Submitted	Trader
		50.12	1,000	9:30	Cathy
		50.11	500	9:32	Bill
	Hidden	50.10	200	9:30	Gina
SELL		50.10	400	9:31	Amy
BUY		50.05	1,000	9:30	David
		50.04	500	9:32	Ellen
		50.03	400	9:31	Fred
		50.03	20,000	9:40	Amy