Securities Trading: Principles and Protocols

> Chapter 3 Limit order markets

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Assignments

□ STPP, Chapter 3.

- Problems and exercises 1-16. In separate STTP Problems and Exercises notes (on line)
- □ STPP, Chapter 4. *Skip section 4.5*
 - Text problems 4.1
 - Embedded problem on NBBO calculation in these overheads.

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The (electronic) limit order market

- The dominant trading mechanism for equities, exchangetraded futures contracts and options.
- In foreign exchange (FX), bonds, and swaps, *dealer markets* dominate.

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The basics

- Orders specify direction (buy or sell), quantity and limit price.
 - "Buy 100 MSFT, limit 27"
 - \Leftrightarrow "Buy 100 shares of Microsoft, up to \$27 per share."
- Orders that can't be matched (executed) on arrival are added to the book.
 - The book is the collection of unexecuted ("resting") orders.
- □ An arriving order is compared to the book.
- □ If there's a compatible counterparty order, we have a match.

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The terms of the match

- The quantity is the smaller of the quantities in the two orders.
- □ The match price is the limit price of the resting order.

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What happens?

- Suppose that there is one bid in the book: "Buy 200 ABC, limit 20"
- What happens with an arriving order ...
 - Sell 200 ABC, limit 19?
 - Sell 50 ABC, limit 21?
 - Sell 50 ABC, limit 20?
 - Sell 500 ABC, limit 18?

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Priority

- Suppose that the buy side of the book has ten bids for XYZ with limit prices at least \$10.
- □ An order arrives: "Sell 39 *XYZ*, limit \$10." Who gets filled?
- □ In most markets, the priorities are:
 - Price
 - More aggressive prices (higher bids, lower asks) have priority.
 - Visibility
 - Displayed orders have priority over hidden orders.
 - Time
 - orders entered earlier have priority.

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Other in	te	raction	IS		
		Price	Quantity	Submitted	Trader
		50.12	1,000	9:30	Cathy
		50.11	500	9:32	Bill
	Η	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
	<i>H</i> :	hidden		Copyright 2015, J	oel Hasbrouck, All r

Hari sends in ...

- □ Buy 200, limit 50.10
- □ Sell 1,200, limit 50.04
- □ Sell 1,200, limit 50.05
- □ Buy 500, limit 50.11

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Order modifiers and qualifications

- □ Immediate or Cancel (IOC)
 - Do it now or not at all.
 - Partial fill is okay, but cancel the remainder.
- □ All or None (AON)
 - Don't give me a partial fill.
 - Order held unexecuted until it can be filled in its entirety
- □ Fill or Kill (FOK) = IOC + AON
 - Execute the entire order right now. Otherwise, cancel.
- □ Notes:
 - IOC is very common; AON less common.
 - In some markets AON defaults to FOK.

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		Price	Quantity	Submitted	Trader
		50.12	1,000	9:30	Cathy
		50.11	500	9:32	Bill
	Н	50.10	200	9:30	Gina
		50.10	400	9:31	Amy
SELL	Η	50.09	100	9:29	Marte
BUY		50.05	1,000	9:30	David
	<i>H</i> :	hidden			



Live limit order book

- Most exchanges make their books available in real time for a fee.
- BATS Global Markets provides real time books with no charge (batstrading.com)
 - In the Book Viewer panel (lower right), the book in SPY (the S&P 500 ETF) is continually updated.
 - SPY is an extremely active security. For contrast, try PRK.

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Securities Trading: Principles and Protocols

> Chapter 4 Multiple markets

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<section-header> Description of the second s

Trading and listing of US equities

- The "home" for trading a stock is the issue's primary listing exchange.
 - The exchange provides trading facilities/procedures for the stock.
- □ The listing exchange does not have monopoly trading rights.
- Trading occurs in many venues, through many mechanisms.

sday, January 17, 2012											
		Listing ve	nue								
Trading venue	NYSE	NASDAQ	Amex	Arca							
New York (NYSE)	811										
Chicago	10	4	0	11							
CBOE	3	1	0	2							
NYSE Arca	383	205	9	212							
Nasdaq	530	466	11	166							
NASD ADF	1,230	636	37	284							
PSX	28	24	0	19							
NYSE Amex		9	13								
Boston	94	47	1	21							
National Exch	17	10	2	2							
BATS (and BATS Y)	386	222	7	153							
Edge (A and X)	374	187	8	75							
Composite Total	3,865	1.810 com		945							

A partial key

- CBOE: Chicago Board Options Exchange, which can also trade stocks
- NASD ADF Alternate Display Facility
 - Reporting channel for "dark" trades
- PSX (Nasdaq-owned former Phildadelphia Stock Exchange)
- BATS ("Best alternative trading system")

Holding things together

- □ A fragmented market is difficult to use.
 - Buyers and sellers must search for the best terms of trade.
- To simplify the process, there are linking systems and procedures that aim to create ...
 - Virtual consolidation: the nodes in a fragmented market are linked to approximate the appearance of a consolidated market.
- Some systems are mandated by regulation
- Others have arisen in competitive response to perceived needs.

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Market information systems

- Transmit trade reports, bid and ask quotes, etc. from the market centers to the users.
 - They are one-way: they don't allow users to transmit orders to the market.
- The market information systems also consolidate information.
- The most important piece is the highest bid across all market centers and the lowest offer.

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Determination of the NBB

- Market centers generate quote updates through time.
- Maintain a list of what each center is bidding.
- □ The NBB is the max price in this list.
- Next: example

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The quote				Bids					Calculation
data stream	Time E	'x Bid	Offer	Α	В	С	NBB	AtBBid	the NBB.
uata stream.	9:31 A	A 10.01	10.04	10.01			10.01	Α	
	9:32 I	3 10.03	10.07	10.01	10.03		10.03	В	
	9:33 (C 10.00	10.04	10.01	10.03	10.00	10.03	В	
	9:34 A	A 10.02	10.03	10.02	10.03	10.00	10.03	В	
	9:35 A	A 10.01	10.07	10.01	10.03	10.00	10.03	В	
	9:36 H	3 10.00	10.04	10.01	10.00	10.00	10.01	Α	
	9:37 (2 10.01	10.09	10.01	10.00	10.01	10.01	AC	
	9:38 H	3 10.01	10.06	10.01	10.01	10.01	10.01	ABC	
	9:39 I	3 10.01	10.05	10.01	10.01	10.01	10.01	ABC	
	9:40 0	2 10.04	10.08	10.01	10.01	10.04	10.04	С	
	9:41 H	3 10.03	10.07	10.01	10.03	10.04	10.04	С	
	9:42 A	A 10.04	10.05	10.04	10.03	10.04	10.04	AC	
	9:43 (2 10.01	10.03	10.04	10.03	10.01	10.04	Α	
	9:44 A	A 10.05	10.07	10.05	10.03	10.01	10.05	Α	
	9:45 (2 10.06	10.10	10.05	10.03	10.06	10.06	С	
	9:46 A	A 10.06	10.12	10.06	10.03	10.06	10.06	AC	
	9:47 I	3 10.04	10.11	10.06	10.04	10.06	10.06	AC	
	9:48 H	3 10.06	10.09	10.06	10.06	10.06	10.06	ABC	

					Offers				
alculation of the NBO	Time	Ex	Bid	Offer	Α	В	С	NBO	AtBOfr
	9:31	А	10.01	10.04	10.04			10.04	A
	9:32	В	10.03	10.07	10.04	10.07		10.04	Α
Same process only	9:33	С	10.00	10.04	10.04	10.07	10.04	10.04	AC
we use the min	9:34	Α	10.02	10.03	10.03	10.07	10.04	10.03	Α
we use the min	9:35	Α	10.01	10.07	10.07	10.07	10.04	10.04	С
across exchanges.	9:36	В	10.00	10.04	10.07	10.04	10.04	10.04	ВС
	9:37	С	10.01	10.09	10.07	10.04	10.09	10.04	В
	9:38	В	10.01	10.06	10.07	10.06	10.09	10.06	В
	9:39	В	10.01	10.05	10.07	10.05	10.09	10.05	В
	9:40	С	10.04	10.08	10.07	10.05	10.08	10.05	В
	9:41	В	10.03	10.07	10.07	10.07	10.08	10.07	AB
	9:42	Α	10.04	10.05	10.05	10.07	10.08	10.05	Α
	9:43	С	10.01	10.03	10.05	10.07	10.03	10.03	С
	9:44	А	10.05	10.07	10.07	10.07	10.03	10.03	С
Novt overhead, the	9:45	С	10.06	10.10	10.07	10.07	10.10	10.07	AB
NDDO anno a	9:46	А	10.06	10.12	10.12	10.07	10.10	10.07	В
NBBO spread.	9:47	В	10.04	10.11	10.12	10.11	10.10	10.10	С
	9:48	В	10.06	10.09	copyright	10 .09	10.10 Hasbro	10,09 uck, All r	B ights rese

				Bids					Offers						
Time	Ex	Bid	Offer	Α	В	С	NBB	AtBBid	Α	В	С	NBO	AtB0fr	Spread	
9:31	А	10.01	10.04	10.01			10.01	Α	10.04			10.04	Α	0.03	
9:32	В	10.03	10.07	10.01	10.03		10.03	В	10.04	10.07		10.04	Α	0.01	
9:33	С	10.00	10.04	10.01	10.03	10.00	10.03	В	10.04	10.07	10.04	10.04	AC	0.01	
9:34	А	10.02	10.03	10.02	10.03	10.00	10.03	В	10.03	10.07	10.04	10.03	Α	0.00	Locked
9:35	А	10.01	10.07	10.01	10.03	10.00	10.03	В	10.07	10.07	10.04	10.04	С	0.01	
9:36	В	10.00	10.04	10.01	10.00	10.00	10.01	Α	10.07	10.04	10.04	10.04	ВС	0.03	
9:37	С	10.01	10.09	10.01	10.00	10.01	10.01	AC	10.07	10.04	10.09	10.04	В	0.03	
9:38	В	10.01	10.06	10.01	10.01	10.01	10.01	ABC	10.07	10.06	10.09	10.06	В	0.05	
9:39	В	10.01	10.05	10.01	10.01	10.01	10.01	ABC	10.07	10.05	10.09	10.05	В	0.04	
9:40	С	10.04	10.08	10.01	10.01	10.04	10.04	С	10.07	10.05	10.08	10.05	В	0.01	
9:41	В	10.03	10.07	10.01	10.03	10.04	10.04	С	10.07	10.07	10.08	10.07	AB	0.03	
9:42	А	10.04	10.05	10.04	10.03	10.04	10.04	AC	10.05	10.07	10.08	10.05	Α	0.01	
9:43	С	10.01	10.03	10.04	10.03	10.01	10.04	Α	10.05	10.07	10.03	10.03	С	-0.01	Crossed
9:44	А	10.05	10.07	10.05	10.03	10.01	10.05	Α	10.07	10.07	10.03	10.03	С	-0.02	Crossed
9:45	С	10.06	10.10	10.05	10.03	10.06	10.06	С	10.07	10.07	10.10	10.07	AB	0.01	
9:46	A	10.06	10.12	10.06	10.03	10.06	10.06	AC	10.12	10.07	10.10	10.07	В	0.01	
9:47	В	10.04	10.11	10.06	10.04	10.06	10.06	AC	10.12	10.11	10.10	10.10	С	0.04	
9:48	В	10.06	10.09	10.06	10.06	10.06	10.06	ABC	10.12	10.09	10.10	10.09	В	0.03	

NBBO notes

- □ The exchange(s) at the NBB may differ from those at the NBO.
- The NBBO spread is spread = NBO NBB.
- When *spread* = 0, the market is said to be *locked*.
 - In principle, a trade could occur.
- □ When *spread* < 0, the market is *crossed*.
 - In principle, there's an arbitrage.
- Locked and crossed markets only arise across different exchanges. Within any single exchange, locks and crosses don't occur.
- Next overhead: Embedded *practice* problem. Compute the NBBO and the spread. (Answers will be posted to web site.)

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			Bids					Offers					
'ime Ex	Bid	Offer	Α	В	С	NBB	AtBBid	Α	В	С	NBO	AtB0fr	Spread
1:03C	20.10	20.20											
1:04A	20.09	20.18											
l1:05B	20.11	20.20											
l1:06B	20.10	20.11											
l1:07A	20.08	20.10											
l1:08B	20.07	20.09											
L1:09B	20.08	20.20											
1:10A	20.03	20.12											
l1:11B	20.04	20.11											
l1:12C	20.04	20.18											
l1:13C	20.05	20.11											
1:14A	20.06	20.11											
l1:15C	20.04	20.13											
l1:16B	20.03	20.10											
l1:17A	20.02	20.09											
1:18C	20.07	20.11											
l1:19B	20.08	20.09											
L1:20B	20.02	20.08											

Steps

□ For the bid:

- 1. Enter the bid for the exchange that just updated.
- 2. Propagate the bids downwards for each exchange.
- 3. Take the max to get the NBB
- □ Repeat for the NBO
- Compute the spread

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				Rids				
Step 1. Copy the bid for the	Time E	Ex Bid	Offer	A	В	С	NBB	AtBBid
undating exchange	11:030	20.10	20.20			20.10		
apadeing exchange.	11:04 <i>A</i>	A 20.09	20.18	20.09				
	11:05 E	3 20.11	20.20		20.11			
	11:06 E	3 20.10	20.11		20.10			
	11:07 <i>A</i>	A 20.08	20.10	20.08				
				Bids				
Stan 2 Propagate the hids that	Time E	Ex Bid	Offer	Α	В	С	NBB	AtBBid
bayon't changed	11:030	20.10	20.20			20.10		
naven i changeu.	11:04 <i>A</i>	A 20.09	20.18	20.09		20.10		
	11:05 E	3 20.11	20.20	20.09	20.11	20.10		
	11:06 E	3 20.10	20.11	20.09	20.10	20.10		
	11:07 <i>A</i>	A 20.08	20.10	20.08	20.10	20.10		
				Bids				
	Time E	Ex Bid	Offer	Α	В	С	NBB	AtBBid
Step 3. Take the max; see who	11:030	20.10	20.20			20.10	20.10	С
matches the max.	11:04 <i>A</i>	A 20.09	20.18	20.09		20.10	20.10	С
	11:05 E	3 20.11	20.20	20.09	20.11	20.10	20.11	В
	11:06E	3 20.10	20.11	20.09	20.10	20.10	20.10	BC
	11:07 <i>A</i>	A 20.08	20.10	20.08	20.10	20.10	20.10	BC

Latency in market information systems

- Most traders obtain data through consolidated feeds.
- Many market centers allow users ("subscribers") to obtain direct lines, which are faster.
- Next: two data paths

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Priority in a fragmented market
Within a single book, orders are usually prioritized by price, visibility, time.
When there are two orders on different books, any and all of these priorities may be violated.

Trade-throughs

A trade-through is a violation of price priority

- Example
 - Trader *A* bids 100,
 - Trader *B* bids 99
 - Trader C sells to B at 99 ("C traded though A's bid.")
 - The disadvantaged parties are A and C
 or, if A and C are brokers, their customers

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Why do trade-throughs occur?

- □ Ignorance (*C* may not be aware of *A*'s bid)
- □ *C* may desire a rapid execution.
- □ *C* may doubt the firmness of *A*'s bid.
- □ Violations of a broker's agency responsibility to the client.

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Order protection and Reg NMS

- Before a market center executes an order, it must check to ensure that the execution would not cause a trade-through.
 - Check the bids and offers at the top of every other market's books.
- If the execution would cause a trade-through, the market center must either
 - Return the order unexecuted.
 - Route the order to a market where it could be executed.
- □ Note: there is an alternative procedure, the *intermarket sweep order* (*ISO*), which will be discussed later.

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