

Lecture 7

Trading on an LOM Exchange

We raised several areas worth attending to in our discussion of a single limit order market (the trade off between immediacy and lower price, picking off risk, and insider information). These issues are magnified when trading in a multi-market setting. This session is devoted to giving you some experience in trading simultaneously on an exchange with several markets.

Trading Exchanges

- ◆ Day traders typically buy and sell on more than one security at a time.
- ◆ One list of the World's 10 most famous traders of all time reads: George Soros, Jim Rogers, Richard Dennis, Paul Tudor Jones, John Paulson, Steven Cohen, **David Tepper**, Nick Leeson (caused the collapse of Barings Bank).
- ◆ Typically day traders fold their position at the end of each “trading day” to avoid exposure overnight to adverse movements in their portfolio.
- ◆ This is a very competitive business, and novices run the extreme risk of losing money and sleep.
- ◆ Disciplined retirees enjoy the challenge, have the time, and sometimes quite well suited to this occupation.

Recycling

- ◆ Imagine you are one of about 40 firms in the recycling business.
- ◆ There are four product markets
 1. Plastics
 2. Metals
 3. Glass
 4. Paper
- ◆ Your upstream collectors have endowed you with 10 units of each product. You also have \$400 of liquid assets (cash) for trading in these four product markets.

Valuations

- ◆ You have also developed a network of clients that will buy all your stock at the end of the garbage collection/disposal period, say a week.
- ◆ At the end of the week you dispose of all your recycled material a unit (product specific) price or value that is given to you at the beginning of the game.
- ◆ Let's call the unit value of plastic units $V(\text{Plastic})$, and so on for the others. You sell each unit of plastic you own at $V(\text{Plastic})$ at the end of the week, and so on.
- ◆ Your values are independently drawn from a uniform distribution with support $[0,10]$.
- ◆ For example, if you draw $V(\text{Plastic}) = 9$ but $V(\text{Metal}) = 1$, then acquiring plastic is much more valuable than acquiring metal.

Value of the firm

- ◆ The initial value of your firm is:

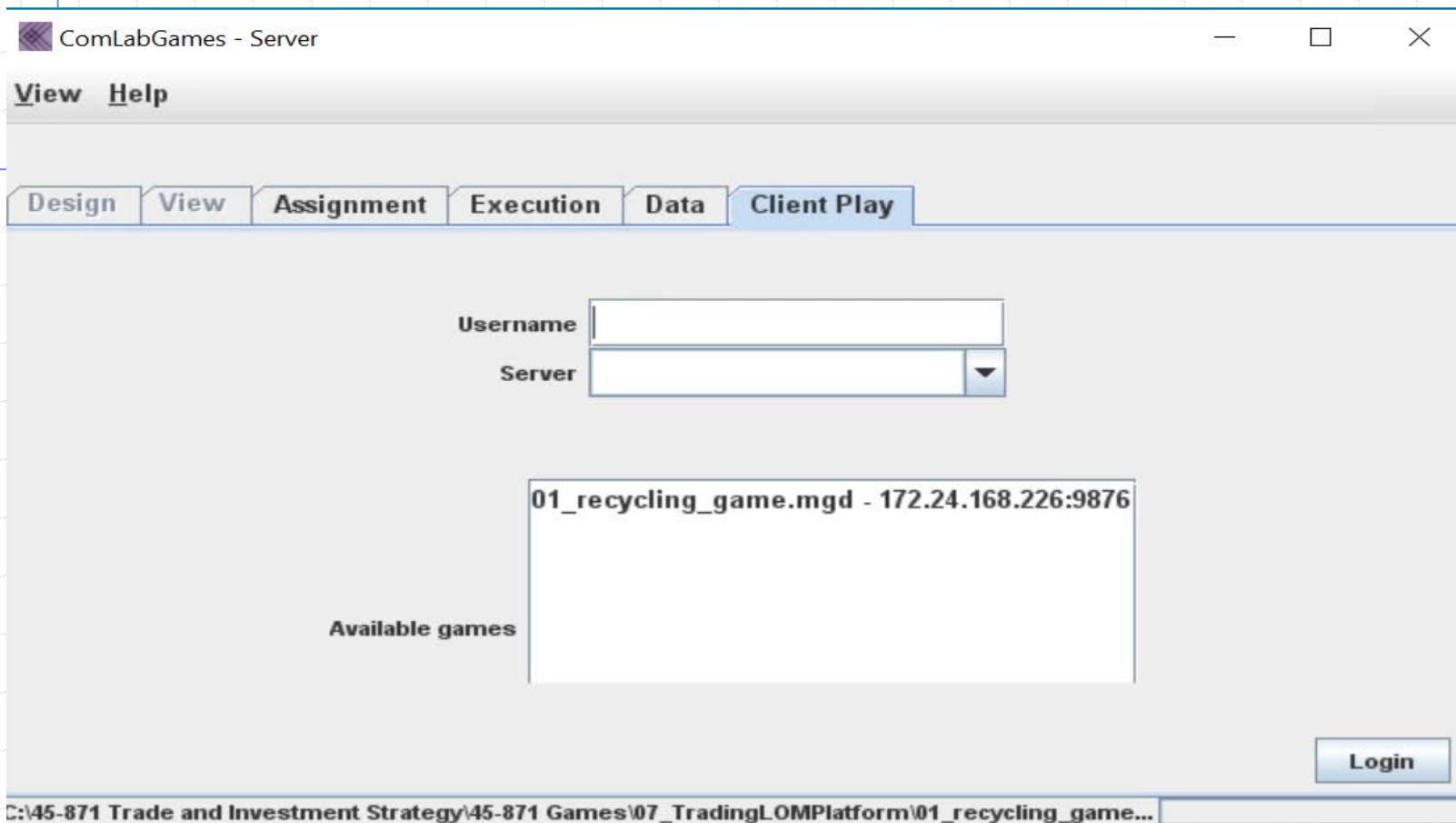
$$\text{Cash} + 10^* [V(\text{Plastic}) + V(\text{Metal}) + V(\text{Glass}) + V(\text{Paper})]$$

- ◆ Your aim is to maximize the value of your firm at the end of the collection/disposal week.
- ◆ Let's call the units of plastic you have at the end of the game $Q(\text{Plastic})$. The value of your firm at the end of the collection/disposal period is:


$$\text{Cash} + V(\text{Plastic}) Q(\text{Plastic}) + V(\text{Metal}) Q(\text{Metal}) + V(\text{Glass}) Q(\text{Glass}) + V(\text{Paper}) Q(\text{Paper})$$

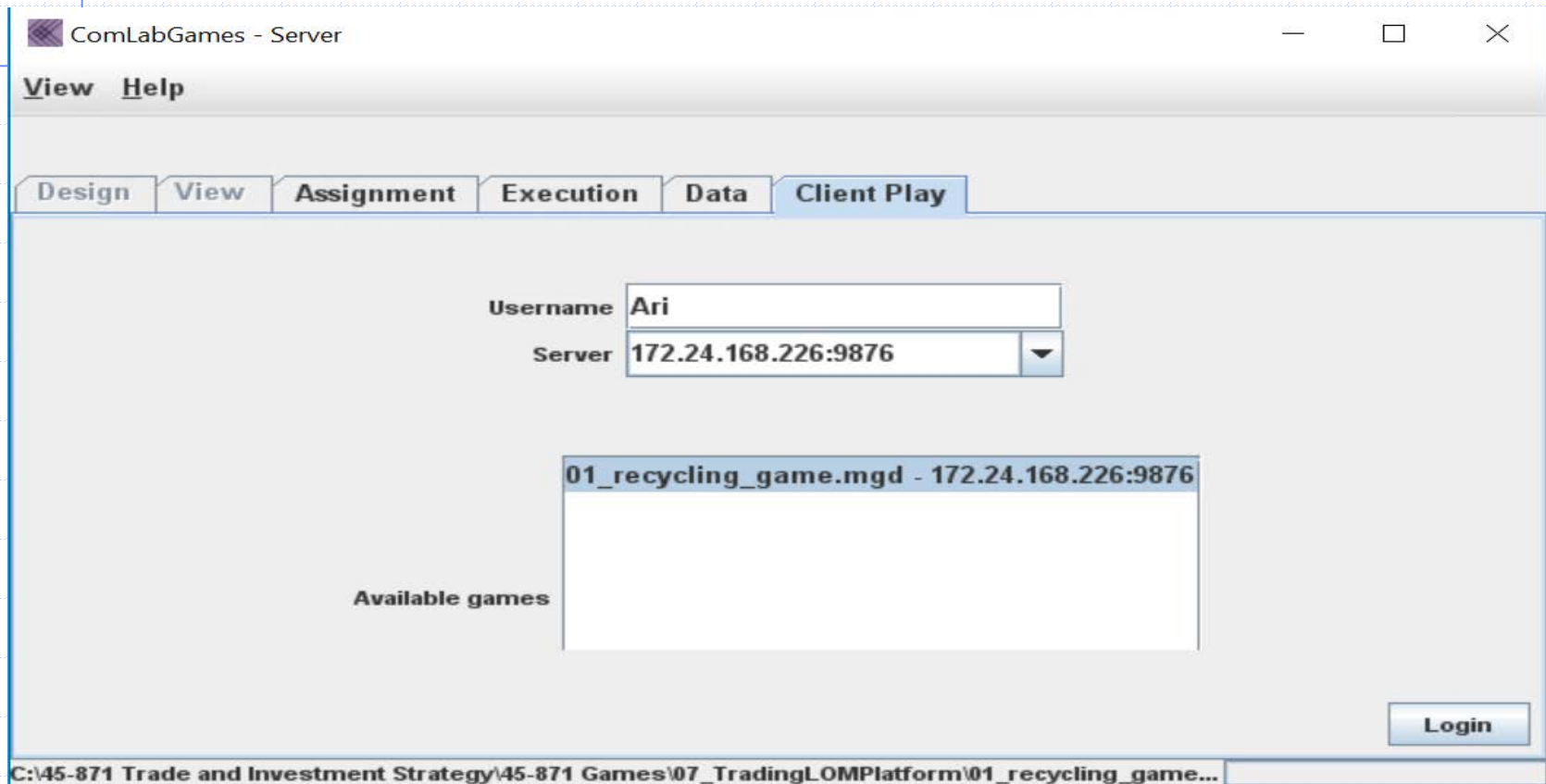
Login Instructions

1. Click on Client Play
2. Click on Available games: "01_recycling_game.mgd"



Continuing Login Instructions

1. Server address: 172.24.168.226 will appear automatically after selecting "01_recycling_game". If not type 172.24.168.226 in  .
2. Write a username.
3. Click on "Login".



Trading window before all subjects login

1. In each session sixteen subjects must login before any of them see a trading window.
2. Information about the number of subjects waiting to start the game is shown at the bottom left corner.

ComLabGames

Username: Ari Id: 12 Identity:

History

Name

View more history

Limit order book

Price	Quantity	Cumulative	Player id	Player type
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Cash

Duration: 600 Price: 0 Quantity: 1 Sell Buy

Summary data

Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
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Subject's own limit orders

Price	Quantity	Revenue\Cost	Duration
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Transaction history

Price	Quantity	Buyer ID	Buyer Type	Seller ID	Seller Type	Time
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Waiting 15 of 16 subjects to start a session!

Round:

Trading window

1. To trade in a specific market like "Paper", click on that market (i.e. Paper).
2. The selected market is highlighted in blue in "Summary data".

ComLabGames
Username: Clara Id: 19 Identity: 3

Plastics

History	Name	19:20:19 (27)	19:20:18 (28)
Total Asset Value		718.61	0
Difference		0	0
Plastics		9.16	9.16

You know that you are trading in Plastic market if $V(\text{Plastics})$ appears in History and matches the Plastics valuation in summary.

Summary data	Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	9.16	10						
Metals	8.21	10						
Glass	9.14	10						
Paper	5.35	10						

Plastic market is selected.

Player type:Firm (3)

Round: 1

ComLabGames
Username: Clara Id: 19 Identity: 3

Paper

History	Name	19:20:19 (152)	19:20:18 (153)
Total Asset Value		718.61	0
Difference		0	0
Paper		5.35	5.35



$V(\text{Paper}) = 5.35$ in History matches $V(\text{Paper})$ in summary

Summary data	Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	9.16	10						
Metals	8.21	10						
Glass	9.14	10						
Paper	5.35	10						

Paper market was selected.

Player type:Firm (3)

Submit a price/quantity in a specific market

1. Select the market you want to trade in.
2. Type a price and quantity, and then click  to sell and  to buy.
3. The limit order book shows outstanding limit orders for a specific market.

ComLabGames

Username: Ar Id: 18 Identity: 2

Plastics



History

Name	19:20:19 (2...	19:20:18 (2...
Total Asset Value	663.36	0
Difference	0	0
Plastics	2.53	2.53

Limit order book

Price	Quantity	Cumulative	Player id	Player type
5	2	0	18	Firm (2)

Submitted sell order in Plastics market

Cash 400 Duration 600 Price 5 Quantity 2  

Summary data

Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	2.53	8	2 (10)			5 (2)	
Metals	6.93	10					
Glass	7.57	10					
Paper	9.31	10					

Subject's own limit orders

Price	Quantity	Revenue/Cost	Duration	
5	2	10	582	X

Transaction history

Price	Quantity	Buyer ID	Buyer Ty...	Seller ID	Seller Ty...	Time
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Player type: Firm (2)

Round: 1

ComLabGames

Username: Clara Id: 19 Identity: 3

Paper



History

Name	19:20:19 (24...	19:20:18 (24...
Total Asset Value	718.61	0
Difference	0	0
Paper	5.35	5.35

Limit order book

Price	Quantity	Cumulative	Player id	Player type
6	3	0	19	Firm

Submitted buy order in Paper market

Cash 382 Duration 600 Price 6 Quantity 3  

Summary data

Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	9.16	10	0 (0)			5 (2)	
Metals	8.21	10					
Glass	9.14	10					
Paper	5.35	10	3 (18)	6 (3)			

Subject's own limit orders

Price	Quantity	Revenue/Cost	Duration	
6	3	18	584	X

Transaction history

Price	Quantity	Buyer ID	Buyer Type	Seller ID	Seller Type	Time
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Player type: Firm (3)

Round: 1

Trading window description

1. Limit order book shows all outstanding sell orders in red and all outstanding buy orders in green.
2. Summary data shows the bid (ask) in green (red).

ComLabGames
 Username: Manuel Id: 17 Identity: 1

All valuation drawn from U(0,10) in each market

History	Name	19:20:19 (7...)	19:20:18 (7...)
Total Asset Value	519.38	0	
Difference	0	0	
Paper	0.52	0.52	

Limit order book	Price	Quantity	Cumulative	Player id	Player type
	7.2	2	0	17	Firm (1)
	7	3	2	19	Firm (3)
	6.1	4	5	17	Firm (1)
	5	3	0	18	Firm
	3.6	1	3	18	Firm
	0.3	2	4	17	Firm

Sell orders show total outstanding quantity submitted by a subject and in the brackets, total value of all subject's (Manuel's) sell orders. There are six sell orders for \$38.8.

Buy orders show total outstanding buy orders, which is 2 for. Total value of all submitted buy orders is \$0.6 and is written in brackets.

Summary data	Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
	Plastics	0.78	10					5 (2)
	Metals	1.72	10					
	Glass	8.92	10					
	Paper	0.52	4	6 (38.8)	2 (0.6)	5 (3)	6.1 (4)	

Subject's own limit orders	Price	Quantity	Revenue/Cost	Duration	
	7.2	2	14.4	577	x
	6.1	4	24.4	560	x
	0.3	2	0.6	588	x

To delete an order click on "x". In our example sell limit order for 6.1 and q=4 was deleted

Player type: Firm (1)

ComLabGames
 Username: Manuel Id: 17 Identity: 1

Difference = updated asset value after a trade - previous total asset value

History	Name	19:20:19 (7...)	19:20:18 (7...)
Total Asset Value	519.38	0	
Difference	0	0	
Paper	0.52	0.52	

Limit order book	Price	Quantity	Cumulative	Player id	Player type
	7.2	2	0	17	Firm (1)
	7	3	2	19	Firm (3)
	5	3	0	18	Firm
	3.6	1	3	18	Firm
	0.3	2	4	17	Firm

Summary data	Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
	Plastics	0.78	10					5 (2)
	Metals	1.72	10					
	Glass	8.92	10					
	Paper	0.52	4	8	2 (0.6)	5 (3)	7 (3)	

Subject's own limit orders	Price	Quantity	Revenue/Cost	Duration	
	7.2	2	14.4	499	x
	0.3	2	0.6	511	x

Player type: Firm (1)

Trading

1. To buy/sell directly select the best order by clicking on the price of the order and click **Buy** / **Sell**.
2. Summary data and Transaction history show the executed order.

Price \$7 was selected and by clicking on **Buy**, the price at which buy order is executed is \$7 (i.e. the highest outstanding sell limit order price)

History				Limit order book				
Name	20:27:27 (1..)	19:20:18 (1..)	19:20:18 (1..)	Price	Quantity	Cumulative	Player id	Player type
Total Asset Val...	668.3	663.36	0	7	3	0	19	Firm (3)
Difference	4.94	0	0	5	3	0	18	Firm
Paper	9.31	9.31	9.31	3.6	1	3	18	Firm

Summary data							
Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	2.53	8					5 (2)
Metals	6.93	10					
Glass	7.57	10					
Paper	9.31	10	0 (0)	4 (18.6)	5 (3)	7 (3)	

Subject's own limit orders				Transaction history						
Price	Quantity	Revenue\Cost	Duration	Price	Quantity	Buyer ID	Buyer Ty..	Seller ID	Seller Ty..	Time
5	3	15	787842	x						
3.6	1	3.6	787863	x						

Player type:Firm (2)

Round: 1

Price \$7 was selected and by clicking on **Sell**, the price at which sell order is executed is \$7 (i.e. the highest outstanding buy limit order price)

History				Limit order book				
Name	00:29:17 (7)	20:27:27 (1..)	19:20:19 (1..)	Price	Quantity	Cumulative	Player id	Player type
Total Asset Val...	675.23	668.3	663.36	5	3	0	18	Firm
Difference	11.86	4.94	0	3.6	1	3	18	Firm
Paper	9.31	9.31	9.31					

Summary data							
Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	2.53	8					5 (2)
Metals	6.93	10					
Glass	7.57	10					
Paper	9.31	13		4 (18.6)	5 (3)	7 (3)	

Subject's own limit orders				Transaction history							
Price	Quantity	Revenue\Cost	Duration	Price	Quantity	Buyer ID	Buyer Ty..	Seller ID	Seller Ty..	Time	
5	3	15	787801	x	7	3	18	Firm (2)	19	Firm (3)	00:29:16
3.6	1	3.6	787823	x							

Player type:Firm (2)

Round: 1

Trading in a different market

1. Summary data shows last trading price(quantity) for each market.
2. Transaction history shows all transactions for the selected market (in our example it shows "Glass" market)

ComLabGames
Username: Clara Id: 19 Identity: 3

Glass

History

Name	08:37:56 (25)	00:29:17 (29...)	20:27:27 (43...)
Total Asset Value	750.73	737.03	732.09
Difference	32.13	18.43	13.49
Glass	9.14	9.14	9.14

View more history

Limit order book

Price	Quantity	Cumulative	Player id	Player type
7.3	1	0	20	Firm (4)
6	2	0	17	Firm
5	6	2	19	Firm
4.1	3	8	18	Firm

Cash 345 Duration 80,000 Price 6.4 Quantity 5 Sell Buy

Summary data

Asset name	Valuation	Endowment	Sell orders	Buy orders	Bid (Quantity)	Ask (Quantity)	Trading price (Quantity)
Plastics	9.16	13					5 (2)
Metals	8.21	10					
Glass	9.14	15	0 (0)	6 (30)	6 (2)	7.3 (1)	6.4 (5)
Paper	5.35	7		0 (0)	5 (3)		7 (3)

Subject's own limit orders

Price	Quantity	Revenue/Cost	Duration	
5	6	30	79634	x

Transaction history

Price	Quantity	Buyer ID	Buyer Type	Seller ID	Seller Type	Time
6.4	5	19	Firm (3)	20	Firm (4)	08:37:56

Player type:Firm (3)

Round: 1

Price \$6.4 and quantity 5 was selected and by clicking on **Buy**, buyer (id = 19) bought glass from seller id = 20. Her cash decreased to \$345. Her current total asset value is $\$750.73 = 370 + 9.16 \cdot 13 + 8.21 \cdot 10 + 9.14 \cdot 15 + 7 \cdot 5.35$.

Summary page for trading game

ComLabGames - Client

Username: Simone Id: 20 Identity: 4

Player ID	Final Total Asset Value	Initial Total Asset Value	Difference	Q(Plastics)	Q(Metal)	Q(Glass)	Q(Paper)
17	519.38	519.38	0	10	10	10	10
18	675.23	663.36	11.86	8	10	10	13
19	752.57	718.61	33.97	13	10	16	7
20	611.62	599.47	12.15	9	10	4	10

Market Stage time limit: unlimited Round: 1 Continue

Player type: Firm (4)

Game is over!

The challenge of optimal trading on a limit order market exchange

- ◆ The previous lecture described trading those strategies that **fully insure** traders against loss:
 - Straddle your valuation with your personal quote (*most attractive buy and sell limit order*).
 - Place market buy order if your valuation exceeds the ask price (*cheapest limit sell order in the book*).
 - Place market sell order if your valuation is less than the bid price (*most expensive limit buy order in the book*).
- ◆ These guidelines to trading are incomplete; they do not prescribe:
 - how tightly to straddle your valuation; *tighter quotes increase the number of transactions but reduce the net gain on any given trade*.
 - how often to place market orders; *placing more market orders increases the trading volume but the lower the net gain on each transaction*.
- ◆ The guidelines are also based on the premise that trading strategies entailing even a small prospect of loss are unacceptable.

What is the basis for measuring exposure to loss?

- ◆ Lacking any information about future prices, how does one adjust for risk?
- ◆ Such information might come from about the histories of:
 - bid and ask prices.
 - potentially the whole order book.
 - factors that might influence the book.
- ◆ Imperfect information can be represented as a probability distribution about the bid and ask, roughly approximated by guessing around it.

Using information about a future spread

◆ Suppose you are a trader and:

- ❑ the current ask is A' and the current bid is B' .
- ❑ at some **time in the future** (for example at the end of the trading day), if you behave optimally,
 - the ask will be A .
 - the bid will be B .
- ❑ you will **close your position** (meaning your net acquisition of each security is zero) at this future time with market orders.

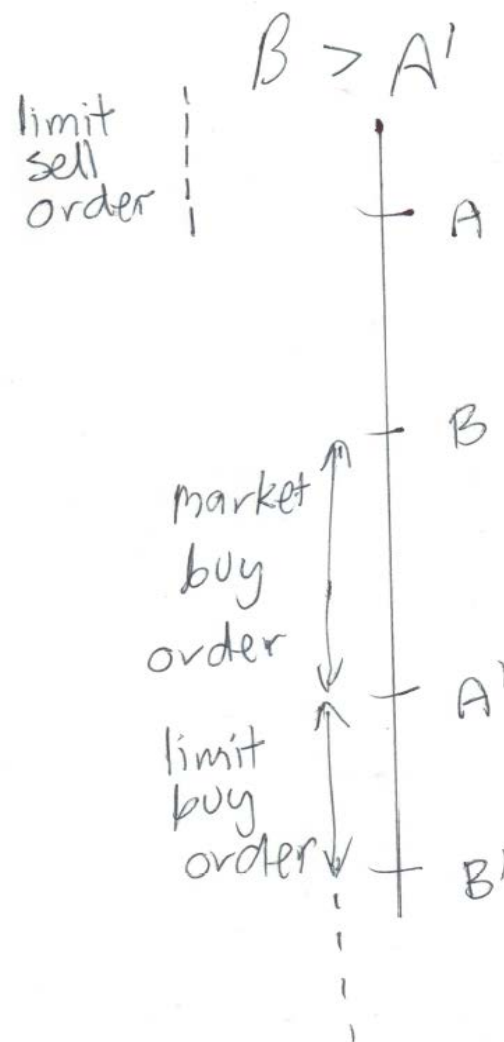
◆ There are 6 cases to consider:

1. $B > A'$ (*The future bid exceeds the current ask.*)
2. $B' > A$ (*The current bid exceeds the future ask.*)
3. $A > A' > B' > B$ (*The future spread contains the current spread.*)
4. $A' > A > B > B'$ (*The current spread contains the future spread.*)
5. $A' > A > B' > B$ (*The current spread overlaps the future spread from above.*)
6. $A > A' > B > B'$ (*The current spread overlaps the future spread from below.*)

◆ It is instructive to briefly consider each case separately.

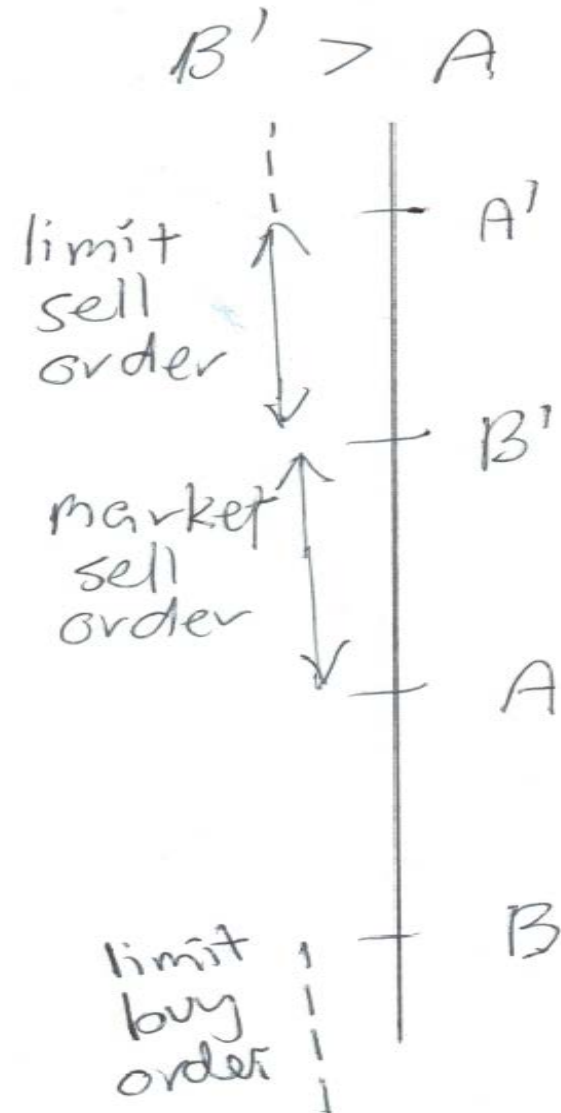
1. Future bid exceeds current ask

- ◆ Suppose $[B', A']$ and $[B, A]$ don't overlap and $A' < B$.
- ◆ Then buying the security now (with a market buy order) and selling it later (with a market sell) is profitable.
- ◆ In the diagram opposite the dashed line indicates limit orders outside the current spread. For example, placing a:
 - a limit sell order above A puts it a long way above A' , the current ask.
 - a limit buy order below B' implies it is below the current bid, by definition.



2. Current bid exceeds future ask

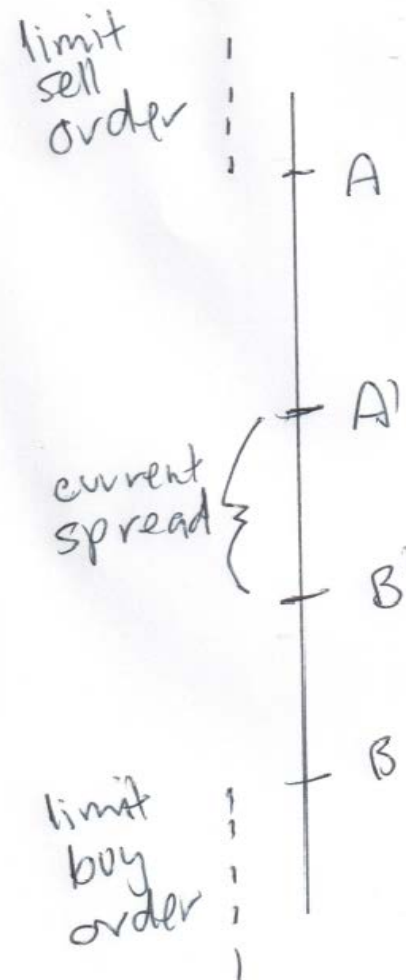
- ◆ Suppose: $[B', A']$ and $[B, A]$ don't overlap, and $A < B'$.
- ◆ Then selling the security now (with a market sell order) and buying it later (with a market buy) is profitable.
- ◆ In the diagram opposite the dashed line indicates limit orders outside the current spread. For example, placing a:
 - a limit buy order below B puts it a long way below B' , the current bid.
 - a limit sell order above A' implies it is below the current ask, by definition.



3. Future spread contains current spread

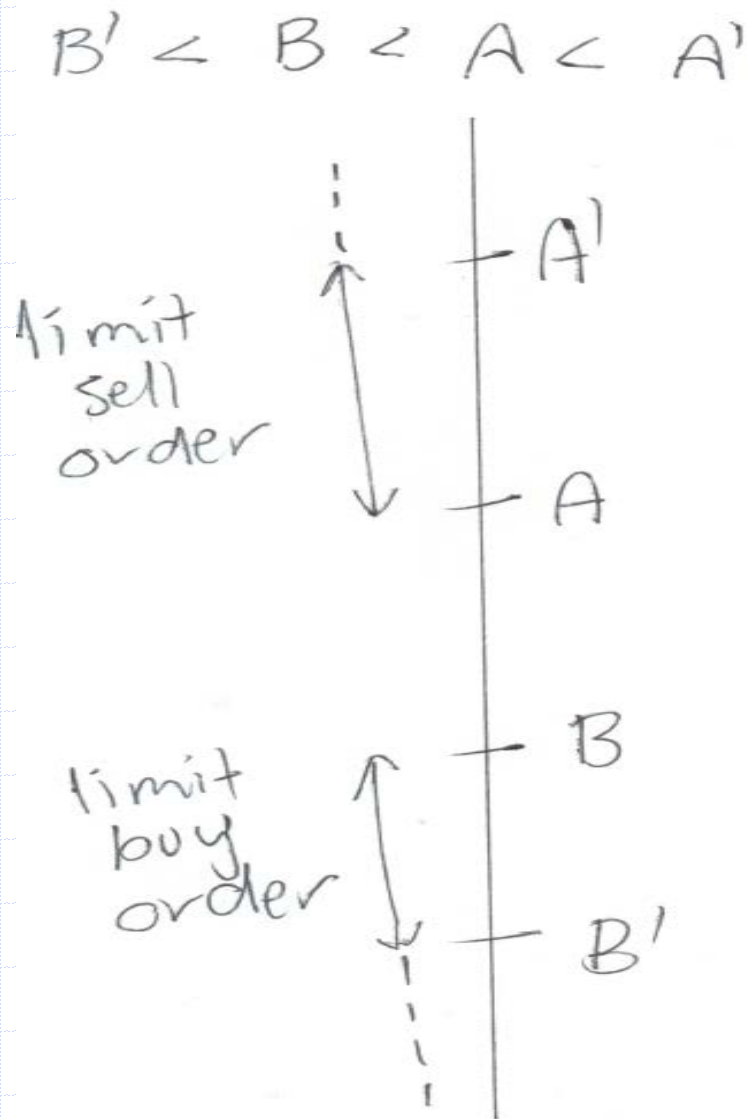
- ◆ Suppose $B < B'$ but $A' < A$.
- ◆ In words, the spread will enlarge, perhaps due to increased volatility, but currently traders hold similar opinions about the uncertainty ahead.
- ◆ Here there are no profitable:
 - market orders.
 - limit orders inside the spread.
- ◆ Only limit orders behind the spread are protected against loss, namely:
 - Limit buy orders below the future bid.
 - Limit sell orders above the future ask.

$$B < B' < A' < A$$



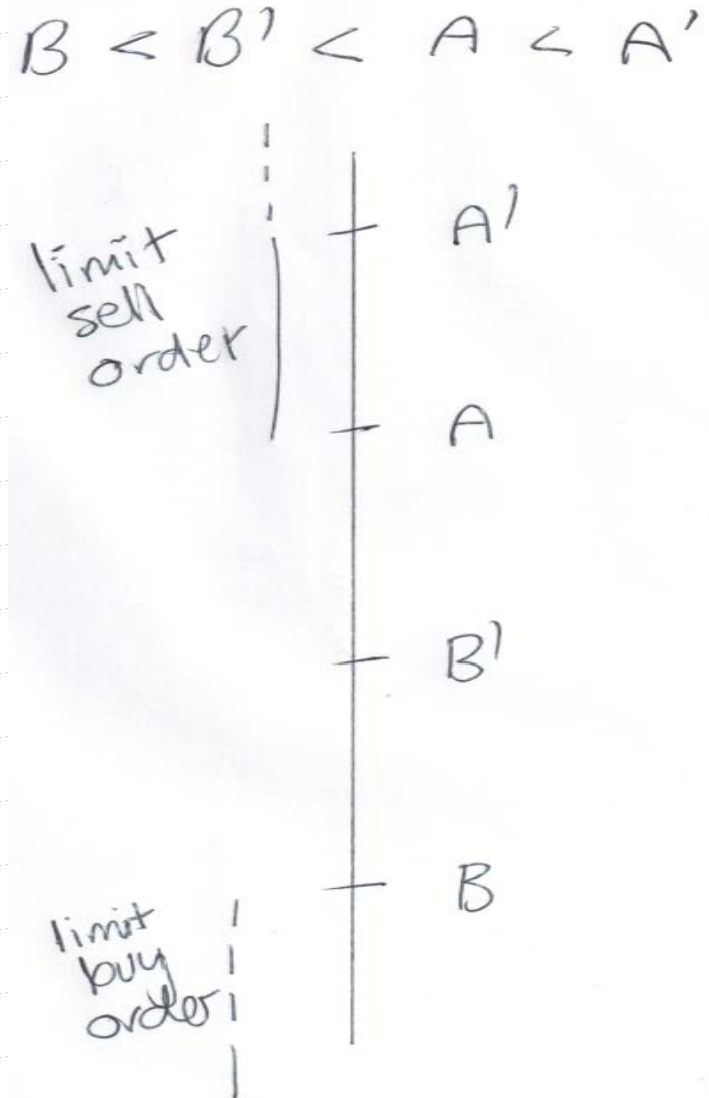
4. Current spread contains future spread

- ◆ Suppose $B < B'$ but $A' < A$.
- ◆ In words, the spread will contract, perhaps due to decreased volatility that resolves some current differences in opinion about value.
- ◆ There are no profitable pairs of market orders (that guarantee transactions and profits).
- ◆ There are, however, profitable limit orders that shrink the spread, namely:
 - limit buy orders from B' up to B
 - limit sell orders for A' down to A .



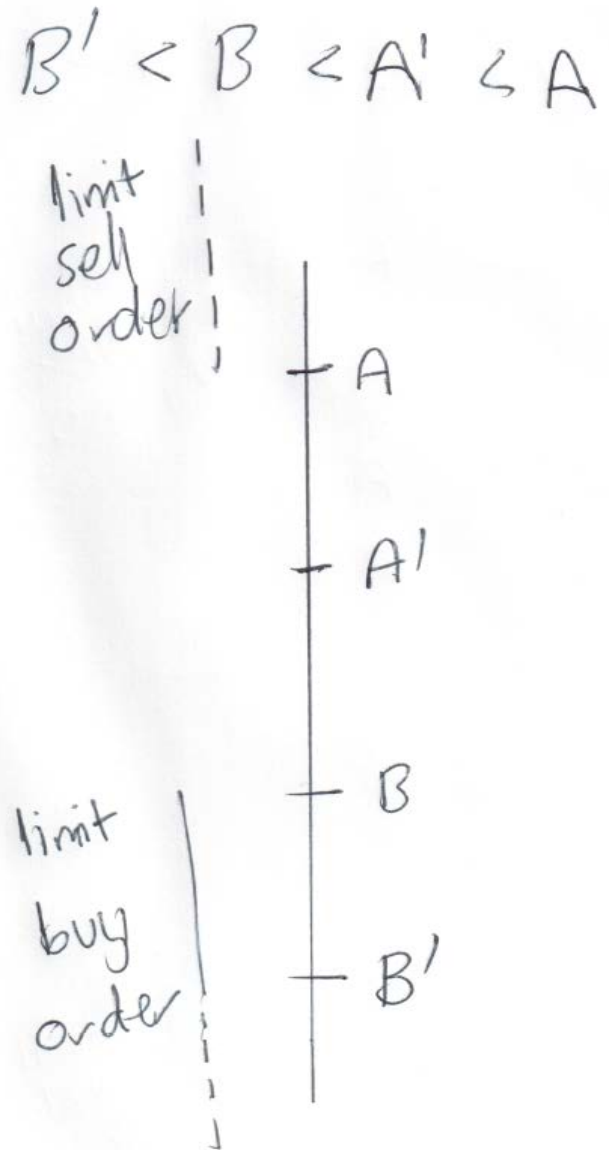
5. Current spread overlaps future spread from above

- ◆ Suppose $B < B' < A < A'$.
- ◆ There is a downward shift in the spread but it is not very pronounced.
- ◆ There are no profitable pairs of market orders (that guarantee transactions and profits).
- ◆ Placing a limit sell order inside the spread, between A' and A is, however, profitable.
- ◆ The only other profitable limit orders are outside the spread.



6. Current spread overlaps future spread from below

- ◆ Suppose $B' < B < A' < A$.
- ◆ There is an upward shift in the spread, but it is not very pronounced.
- ◆ There are no profitable pairs of market orders (guaranteeing both transactions and profits).
- ◆ Placing a limit buy order inside the spread, between B' and B is, however, profitable.
- ◆ The only other profitable limit orders are outside the spread.



How do investors differ from traders?

◆ Suppose the investor:

- has a valuation of V for the security or stock.
- would increase or decrease his holdings by one unit, or maintain the same inventory, depending on which is the most profitable course of action.
- knows the bid-ask spread will be $[B, A]$ and the current spread is $[B', A']$.

◆ The investor wishes to adjust the number of securities he holds by:

- increasing his holdings if his valuation is high enough.
- decreasing his holdings if his valuation is low enough.

◆ In addition to the buy/sell question, there is also a question of timing.

Does he trade at:

- the current time?
- after the bid-ask spread changes?

◆ Again, there are six scenarios, complicated by the fact that the optimal course of action depends on where the valuation lies in relation to both bid-ask spreads. This is a question for Assignment 4.