Lecture 1. Trading Mechanisms

1. Liquidity

A market is called *liquid* if it is *deep*, *broad*, and *resilient*. In a deep market, there is a large incremental quantity available for sale (or purchase) little above (or below) the current market price; as a result, demand and supply shocks do not result in a large price change. In a broad market, there are many participants, none of whom possesses dominant market power; as a result, trading cost is low. In a resilient market, the price changes that are related with to the trading process (not a change in fundamental value) are small and die out quickly; as a result, transaction over a short horizon does not cost significantly more than the trade over a longer horizon.

- Liquidity demanders on the buy side of the market are *active* in that they accept the terms offered by *passive* liquidity suppliers on the sell side. That is, the passive side (e.g., brokers, dealers, and specialists) "makes" the market and the active side "takes" it.

Remark 1.1. The *liquidity externality* is a network externality, which favors *market consolidation*, the concentration of trading activity in a single mechanism or venue. However, market segmentation is still appealing due to differences in market participants (e.g., retail versus institutional investors) and innovations by market designers.

Remark 1.2. In a *transparent* market, market participants are endowed with equal access to information about the trading process (e.g., bids, asks, execution). Electronic markets are transparent, while dealer markets are opaque.

2. Trading Mechanisms

2.1. Limit and Market Orders in Limit Order Markets

A *limit order* is an order that specifies a direction, quantity, and acceptable price; e.g., buy 200 shares at $30 per share. In a limit order market where orders arrive randomly in time, the price of a newly arrived order is compared with those of orders already in the system to ascertain if there is a match. If there is a match, the trade occurs at the price set by the first order.

- The priority rules govern the sequence in which order are executed. Price priority is basic. Time is the secondary priority; specifically, at a given price level, orders are executed first-in, first-out.

Remark 2.1. Unexecuted limit orders held by the system constitute the "book" which is visible to market participants. Limit orders can be canceled or modified at any time, so the book is dynamic. When all trading for a security occurs through a single book, the market is called to have a *consolidated limit order book* (CLOB). A CLOB is used for actively traded stocks in most Asian and European markets.

Example 2.2. Suppose there already exists the limit order to sell 300 shares at $30.00 in the system. The newly arrived order to buy 200 shares at $25.50 is not matched. A subsequent order to buy 100 shares at $32.00 is matched and an execution takes place for 100 shares at $30.00.

A *market order* is executed at the best available price. If the order quantity is larger than the quantity available at the best price on book, the market order will be "partially" executed at progressively worse prices until the order is filled.

Example 2.3. (Limit order execution) An execution takes place for 200 shares at KRW 10,300 (i.e., (1)-(3)).

Ask	Price	Bid
	10,600	
	10,500	
(2) 200	10,400	
	10,300	(1) 200
(3) 200	10,200	
	10,100	
	10,000	
	9,900	
	9,800	

Example 2.4. (Limit order execution) The first execution takes place for 200 shares at KRW 10,600 (i.e., (1)-(3)). The second execution takes place for 200 shares at KRW 10,600 (i.e., (1)-(4)).

Ask	Price	Bid
	10,600	(1) 500
	10,500	
	10,400	
	10,300	
(4) 200	10,200	
	10,100	(2) 200
	10,000	
(3) 200	9,900	
	9,800	

Example 2.5. (Limit order execution) The first execution takes place for 100 shares at KRW 10,600 (i.e., (1)-(3)). The second execution takes place for 200 shares at KRW 10,100 (i.e., (2)-(4)). The third execution takes place for 100 shares at KRW 10,200 (i.e., (3)-(5)).

Ask	Price	Bid
	10,600	(1) 100
	10,500	
	10,400	(5) 300
	10,300	
(3) 200	10,200	
	10,100	(2) 200
	10,000	
(4) 200	9,900	
	9,800	

Example 2.6. (Market order execution) A market order to buy 400 shares is executed for 100 shares at KRW 10,300, 200 shares at KRW 10,400, and 100 shares at KRW 10,500.

<Before>				<After>		
Ask	Price	Bid		Ask	Price	Bid
200	10,600			200	10,600	
150	10,500			50	10,500	
200	10,400				10,400	
100	10,300		$\Rightarrow$		10,300	
	10,200				10,200	
	10,100	100			10,100	100
	10,000	200			10,000	200
	9,900	100			9,900	100
	9,800	200			9,800	200

2.2. Floor Markets

In a floor market, numerous buyers and sellers are represented by a smaller number of brokers, often called *members*, who negotiate and strike bilateral deals face to face. The members act either as "agents," representing the customer orders to others, or as "principals," taking the other side of customer orders. The combination of these two functions may suffer from a conflict of interest; i.e., a principal-agent problem may occur. Thus, so-called dual trading is either forbidden or strongly regulated.

- In recent years, most floor-based trading has gone electronic and floor markets had largely evaporated. The current largest floor markets are the U.S. commodity future markets: the Chicago Board of Trade, the New York Mercantile Exchange, and Chicago Mercantile Exchange.

Remark 2.7. Coval and Shumway (2002) investigate the information content of the ambient noise level in the Chicago Board of Trade trading pit, and find that the sound level conveys information which is economically and statistically significant. Following a rise in the sound level, prices become more volatile, depth declines, and information asymmetry increases.

2.3. Dealer Markets

A *dealer* is an intermediary who acts as a counter-party for the trades of his customers. A trade starts with a customer calling a dealer. The dealer quotes bid and ask prices, whereupon the customer may buy at the dealer's ask, sell at the dealer's bid, or do nothing. This process presumes that the dealer and customer have a preexisting relationship.

- Dealer markets include foreign exchange (FX), corporate bond, and swap markets. Since dealers provide price quotes only in response to customer inquiries and these are not publicly visible, dealer markets are characterized by low transparency.

Remark 2.8. In addition to dealer-customer relationship, inter-dealer relationship is also important. This is because dealers often have undesired long and short positions and in this case they attempt to sell or buy in the inter-dealer market.

Remark 2.9. Dealers make markets work where they might otherwise fail. In the NYSE, for instance, a *specialist* is designated as a dealer who provides continuous liquidity by maintaining a two-sided market when there is nothing on the limit order book and no one else on the floor bidding or offering. In limit order markets with no designated dealers, liquidity is supplied by customers since it derives from the unexecuted customer orders in the book. As a result, limit order markets have difficulty with sustaining continuous trading of small stocks for which trading interest is insufficient.

Remark 2.10. Dealers can facilitate large trades in the block market (a.k.a. the upstairs market) by acting as principal (i.e., taking the other side of the order), trying to locate a counter-party, working the order over time, or some combination of these.

2.4. Auctions

In a *single-price double-sided* auction, supply and demand curves are constructed by ranking bids and asks. Prices and quantities are determined by maximizing the feasible trading volume. The double-sided auction is widely used at the open/close of continuous trading sessions. For securities with low trading interest, most trade occurs using periodic auctions (called *fixings*).

Example 2.11. Trading is made in such way that the highest bid price for buying and the lowest ask price for selling are concluded in regular sequence, and the principle of time priority is also applied to the same price of KRW15,250 for trading to be concluded (U: unexecuted, P: partially executed, E: executed).

Selling quantity	Price	Buying quantity
	15,400	E 1,000
U U	15,350	E 300
U U	15,300	E 200
U 2,000 U 1,000 P 500 E 100	15,250	E 200 E 300
E 150	15,200	U U
E 150 E 500	15,150	U
E 500	15,100	U U U
E 150	15,050	

2.5. Crossing Networks

In *crossing networks* (e.g., POSIT, Instinet), the buyers and sellers are paired for an agreed-on quantity. The trade is later priced by reference to a price determined in and derived from other listing markets.

- The pricing in crossing markets is described as derivative, in the sense that a derivative mechanism is a device for executing trades in a security based on a price determined for the same security in another market.

3. U.S. Equity Markets

3.1. Overview

The principal market venues are (a) the exchanges (e.g., the NYSE, the AMEX, the regional stock exchanges), (b) the NASDAQ, and (c) electronic communication systems (ECNs, e.g., Inet, Archipelago) and crossing networks. Inter-market linkage systems connect the trading venues. The Securities and Exchange Commission (SEC) is the primary regulator of trading.

3.2. The NYSE

NYSE trading protocols are complex because the NYSE is a hybrid market that features an open outcry system, a dealer market, and an electronic limit order book. There is one specialist per stock. The specialist has the sole authority and responsibility for the quotes. To maintain a fair and orderly market, the specialist should fulfill the affirmative (i.e., what he should do) and negative (i.e., what he should avoid) obligations. The limit order book is maintained by the specialist. The opening and closing procedures resemble a single-price call auction.

3.3. The NASDAQ

The NASDAQ is an electronic system linking geographically dispersed dealers and displaying their bid and ask quotes. The display and trading protocols are similar to those found in an electronic limit order market, except that customers are not permitted direct access to the system. Since the NASDAQ allows some practices like *preferencing*, the actual trading protocols are complex.

4. Korea Stock Exchanges

- There are two major stock exchanges in Korea, both of which are operated and monitored by the Korea Exchange (KRX), a demutualized organization established in January 2005. The KOSPI was opened in 1956 and has listed global corporations such as Hyundai Motor, LG Electronics, POSCO, Samsung Electronics, etc. Similar to the U.S. NASDAQ, the KOSDAQ, launched in 1996, provides an external funding opportunity for technology-oriented startup companies.

- The Korea stock markets operate from Monday to Friday, except for holidays. Before July 31, 2016, a normal trading session was from 9:00 to 15:00 and since then the closing time has been extended to 15:30.

- During the normal trading session, prices are determined by a continuous auction in which price-contingent limit orders are entered to constitute the limit order book and then are matched on the basis of priority rules when liquidity demanders submit market or marketable limit orders. All transactions are conducted automatically without human intervention; put differently, there is no designated dealer (like a specialist in the NYSE market) who is supposed to maintain liquidity and continuous trading.

- Opening price is determined by a single-price call auction conducted from 8:00 to 9:00.

- Before June 12, 2015, daily prices were confined to move within a 15% boundary, centering on previous closing prices. Since June 15, 2015, the price limit rule has been relaxed to allow a 30% boundary.

- The minimum number of shares applied to an order is set at one share.

- The tick size depends on price levels. The tick sizes are KRW 1 for prices below KRW 1,000; KRW 5 for prices between KRW 1,000 and KRW 5,000; KRW 10 for prices between KRW 5,000 and KRW 10,000; KRW 50 for prices between KRW 10,000 and KRW 50,000; KRW 100 for prices between KRW 50,000 and KRW 100,000; KRW 500 for prices between KRW 100,000 and KRW 500,000; and KRW 1,000 for prices above KRW 500,000.

- The most common order types are limit orders and market orders. Investors can also place more complicated orders such as limit-to-market-on-close orders (i.e., a limit order with the condition to convert to a market order before the market closing call auction), immediately executable limit orders (i.e., a limit order setting the price equal to the best price on the opposite side of the book), best limit orders (i.e., a limit order setting the price equal to the best price on the same side of the book), target price orders (i.e., an order specifying the intention to trade at a target price which is determined later), and auction-based block trading orders (i.e., an order having the price matched at volume weighted average price of the day).