10th session

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The Microstructure of Financial Markets

↳ Harris;

- Definition
  - Mark Garman (1976)

- **Market microstructure** is the study of the process and outcomes of exchanging assets under explicit trading rules**.**" (Maureen O'Hara, a former president of the American Finance Association)

- Market Microstructure fits in Financial Economics and studies "the **black box**":

  - Price formation and price discovery;
  - Market structure and the way specific trading mechanisms affect the results, including the price
  - Frictions, imperfect information, assimetries.

Market structures

- Rules that regulate trading: who can trade, what can be traded, the location and the timing of the trades, the information that is revealed.

- Trades take place during *trading sessions*
  Continuous Markets *vs* call markets

  - advantage of continuous markets: flexibility – traders may try to trade at any time while the market is open; information may be incorporated fast in prices.

  - advantage of call markets: increases liquidity at the same time and place; lower volatility.

- Execution systems (how buyers are matched with sellers)

  Quote-driven (dealers) *vs* order-driven (order precedence rules).

  - **Quote-driven markets**

  Continuous markets.

  In pure *quote-driven* markets, dealers participate in every trade.

  Geographically dispersed markets, electronically linked. No consolidation of trading: no "floor".

  Dealers trade among themselves.

- **Order-driven markets**

Buy and sell orders are matched without intermediaries, (except maybe brokers) based on order precedence rules.

The traders issue orders to the exchange (continuous markets or call markets).

Basic types of orders: limit orders and market orders.

- Sometimes dealers trade in *order-driven* markets. In this case they trade with who accepts the order.

- **Hybrid markets**

E.g.: Dealer-specialists markets: they are *order-driven* but the specialist must provide liquidity under some circumstances.

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- <u>Orders-</u> trade instructions. They always specify:
  - what traders want to trade,
  - how much they want to trade,
  - whether to buy or to sell.

  They can specify other aspects. Examples:
  - for how long the order is valid,
  - when the order should be executed,
  - whether it can be partially executed.

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- The best _bid_: the highest bid price in the market.

- The best _ask (offer)_: the lowest offer price in the market.

- The difference between the best ask and the best bid is the market _bid/ask spread_ .

- **MARKET ORDER**

Oferta "ao mercado"

– Instruction to trade at the best price available in the market.

– The trader is sure to trade. He is not sure of the price.

– Small market orders are generally executed immediately without much effect on prices.

- Suppose the best bid of an asset is 100 and the best ask is 102. Without further information, our best estimate of the value of the asset is the average: 101.
The buyer pays 102: pays 1 more unit than the estimated value (half the *spread*). Price of liquidity. The seller receives 100: receives 1 unit less than the estimated value of the asset (half the *spread*). Price of liquidity .

- Large market orders are harder to execute. It may be hard to find traders willing to take the other side, either because they are not interested in the asset or because they are afraid to be trading with someone with superior information. To attract a counterpart, the sellers may have to sell cheaper and the buyers may have to accept to pay more. PRICE IMPACT.

- In illiquid markets, with few participants, the price impact is larger than in liquid markets.

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- **LIMIT ORDER**

  Oferta "limitada"

  – Instruction to trade at the best price, as long as it is not worse than the specified limit price.

  - A limit buy order specifies the maximum price that he/she is willing to pay.

  - A limit sell order specifies the minimum price that he/she is willing to accept.

  - Standing limit orders are placed in a file called the <u>limit order book</u> *(livro de ofertas central).*

  - A limit order may not be executed.

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- *Marketable* limit order: it may be immediately executed. It is equivalent to a market order.

- Buy orders that are not immediately executed may be *in the market* or *behind the market*.
  - A limit buy order with a limit price less than the best bid is *behind the market*.
  - A limit sell order with a limit price above the best offer is *behind the market*.

  - A limit order is *in the market* if limit price is between the best offer and the best bid.

  - Traders who submit standing limit orders, <u>offer liquidity</u> – they give the other traders the option to trade when they want.

  - Traders who submit market orders <u>take liquidity</u> - they want to trade quickly and accept the conditions that other traders have made.

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- Buy limit orders are *put options.* They give other traders the opportunity to sell when they want to sell.

- Sell limit orders are *call options*. They give other traders the opportunity to buy when they want to buy.

- Standing limit orders are different from option contracts because no one sells the option, it is freely granted to the market. Any one may use the limit order option by submitting a market order.

- The option value of a limit order is the value of the order to other *traders*.
  - Limit price- If it is far behind the market it has little value. Traders prefer to trade first, with better prices. If it is marketable, traders who want to trade immediately value the option to trade.
  - How long the order stands - Orders that remain available for a long time allow traders to defer the trader decision, possibly to see the price changes. The probability that prices change is larger in longer intervals. Therefore, the option is more valuable.

- Volatility- When prices change fast, it increases the probability of executing a profitable trade. There are higher chances of profiting from taking the limit order before traders cancel it.

- Using limit orders with a *broker* allows attending to other businesses without a permanent surveillance of the market.

- **STOP ORDER** – It is used to stop losses when prices move against the position. Traders buy after price rises to the stop price and sell when price falls to the stop price.

  - A stop order may be executed at a price different from the stop price, if prices move quickly.

- Stop orders add *momentum* to the market. They are sell orders when prices are falling and buy orders when prices are rising. Accelerate price changes →destabilizing effect

- **MARKET-IF-TOUCHED ORDER (very rare)** – Order to buy when prices fall to the *touch price* or to sell when prices rise to the *touch price* . →stabilizing effect

- Contrary to a limit order, it fills at the best available price.

- Revealed Information – **Transparency**
  - Capability of market participants to obtain information about the trading process.
    - The forecast of the evolution of prices depends on the revealed information.
    - The information may be about the time of execution of the order and may allow the assessment of the performance of a broker.
    - Sold information may be a significant part of the revenue.

- Markets with electronic trading systems facilitate the registration of information.

- A market is said to be <u>transparent</u> when the public has complete information.

- Markets that show only the best bid and the best ask show "the top of the book".

- Markets that show the standing orders at each price are "open book" markets.

- Transparency is of particular interest to those that do not possess private information.

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- Comparison of Quote-driven and Order-driven markets with respect to Transparency
  - Quote-driven markets tend to be more fragmented, different dealers may quote different prices and these are not necessarily made public.
  - Order-driven markets with a limit order book tend to be less fragmented. However, the limit order book is not necessarily open.

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- **The informed traders and market efficiency**

  - <u>Market Value</u>: price at which you trade.

  - <u>Fundamental Value</u>: "true" value, intrinsic value, fundamental value. Expected present value of all present and future benefits and costs associated with holding a financial asset.

  - Different from perfect foresight values. Fundamental values depend only on information that is currently available.

  - Prices are perfectly informative if they equal fundamental values. The difference between fundamental value and market value is <u>noise</u>.

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- Efficient markets - very informative prices.

- Fundamental value is not observable $\Rightarrow$ not evident if prices are informative or noisy.

- Fundamental values reflect all the available information $\Rightarrow$ only change with the arrival of new information $\Rightarrow$ unpredictable

- When price changes cannot be predicted $\rightarrow$ random walk.

- INFORMED TADERS use information
  - Public
  - Private

- They buy when they think the asset is undervalued and sell when they think it is overvalued. Expectation of profit.

- Lose money if:
  - Their fundamental value estimates are wrong.
  - The price moves away from the fundamental value (short run).

- By trading, they influence the price .
  - Buy ⇨ ↗P.   If buy when P < V, P tends to V.
  - Sell ⇨ ↘P.   If sell when P > V, P tends to V.

- Their fundamental value estimates may be different, the price reflects an average of their estimates.

- The price is usually more informative than the individual estimates.

- $E_i(V) = V + e_i$ $E(e_i) = 0$ (unbiased expectations).

- $D_i = a.[E_i(V)-P]$

- $\sum_i D_i = 0 \iff \sum_i a.[E_i(V)-P] = 0 \iff a.\sum_i E_i(V) - NaP = 0$

$P = \sum_i E_i(V) / N$

- $P = \sum_i (V + e_i)/N = V + \sum_i e_i/N$

- If forecast errors are independent from each other, the law of large numbers implies that the market forecast error should tend to zero (expected value) as N gets large.

- In the LR those with the best estimates make the largest profits. → Trade aggressively → influence more the market.

- More liquid markets → smaller effect of trades on prices → informed traders may profit more from the differences relative to fundamental values.

- To minimize the price impacts of their trades, they may define strategies.

- If their private information is short-lived or if it is shared by other informed traders, they should trade aggressively.

- If they believe their informative advantage will last some time, they should dissimulate.

- Informed traders do not profit systematically if they trade only with each other. Uninformed traders.

- Uninformed traders prefer not to trade with the informed. asymmetric information.

- Markets with many uninformed participants – even if in aggregate they lose a lot, individually they do not lose a lot. The informed traders may profit much, they compete to obtain information. Informative prices.

- Informative prices ⇨ profit opportunities?

- Creation of opportunity:
  - News. Fundamental values change.
  - Uninformed make prices change.

- Difficult to find if P changed because new information arrived and the informed traders reacted or because the uninformed are on the same side of the market.

- The information incorporated in prices depends on the acquisition costs and on the profit potential.

- <u>Weak-form Efficiency:</u> the actual prices reflect all the information in past prices. Prices follow a random walk.

- <u>Semistrong-form Efficiency:</u> the actual prices reflect all the public information (past prices, volumes and news).

- <u>Strong-form Efficiency</u>: the actual prices reflect all public and private information.

- Efficiency in a microestrutural perspective : prices reflect all the information that traders can acquire and profitably trade upon.

- Trade-off between the interest of the informed traders and of the uninformed:
  - More informative prices lead to more efficient allocation decisions.
  - The utilitarian purposes of the uninformed traders are also important to the economy: move money through time, hedge…

- Measures like the publication of information reduces the potential for profit by the informed traders without reducing the information content of prices.

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- Dealers ⮩ Harris: chap.13

- Obtain a profit by selling high and buying low.

- They supply liquidity. They are passive *traders*: they trade when other traders want to trade.

- They can speculate, trying to predict future price changes looking at the order flow they get.

- Not commissions, *spread*.

- Directly or through brokers.

- Directly: the *bid* and the *ask* are requested before one reveals on which side one is.

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- Dealers quote a bid and an ask but they usually prefer one of the sides. For example, if they prefer to buy, they raise prices (both the bid and the sell).

- Inventories rise when dealers buy more than they sell and fall when they sell more than they buy. (*Inventories* are positions that dealers have on the security they trade.)

- Target Inventories: positions they want to hold.

- Inventory imbalance: difference between the actual level and the target inventory.

- cost of having an inventory: lose when prices move against the position –<u>Inventory Risk</u>

- The inventory risk is lower if the dealer is able to rebalance inventory quickly.
  - Buy quickly after selling
  - Sell quickly after buying

  $\Big\}$ Round-trip transactions

Inventory control

- Inventory level too low:
  - Raise the *bid.*
  - Raise the *ask.*
  - Take another dealer's *ask* . Fast. Costly.
- Inverse.
- Price discovery process– Search for prices that ensure a balance between Demand and Supply.

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- Types of inventory risk:
  - <u>Diversifiable inventory risk</u> - Uncorrelated with the inventory imbalance .Changes in P that cannot be predicted, zero on average. Dealers gain and lose with equal probabilities.

  - <u>Adverse selection risk</u> - informed traders. ↘P after the *dealers* buy and ↗P after the *dealers* sell.

- Trading with the informed traders (on only one side of the market) causes divergence from the inventory target.

- Setting the quotes close to the fundamental values allows to avoid informed traders. In practice, dealers worry about the price discovery process. Fundamental values are a by-product.

- When the *dealer* suspects he traded with an informed *trader*
  - adjusts quotes to avoid keep on offering profit opportunities.
  - If has sold: raises quotes. Discourages a new sale. Encourages purchases that rebalance inventory.
  - If has bought: lowers quotes. Discourages a new purchase. Encourages new sales that rebalance inventory.
- When the *dealer* wants to avoid trading with an informed *trader*
  - He tries to determine what informed traders are doing. If he suspects that informed traders are buying, he raises his quotes. If he suspects that informed traders are selling, he lowers his quotes. – prices reflect information.

- Informed traders prefer to trade anonymously, using brokers to arrange their trades.

- *Dealers* form an opinion. Large orders, impatient traders. However, all are suspect.

- If the next buyer is an informed trader, the *ask* should be higher.

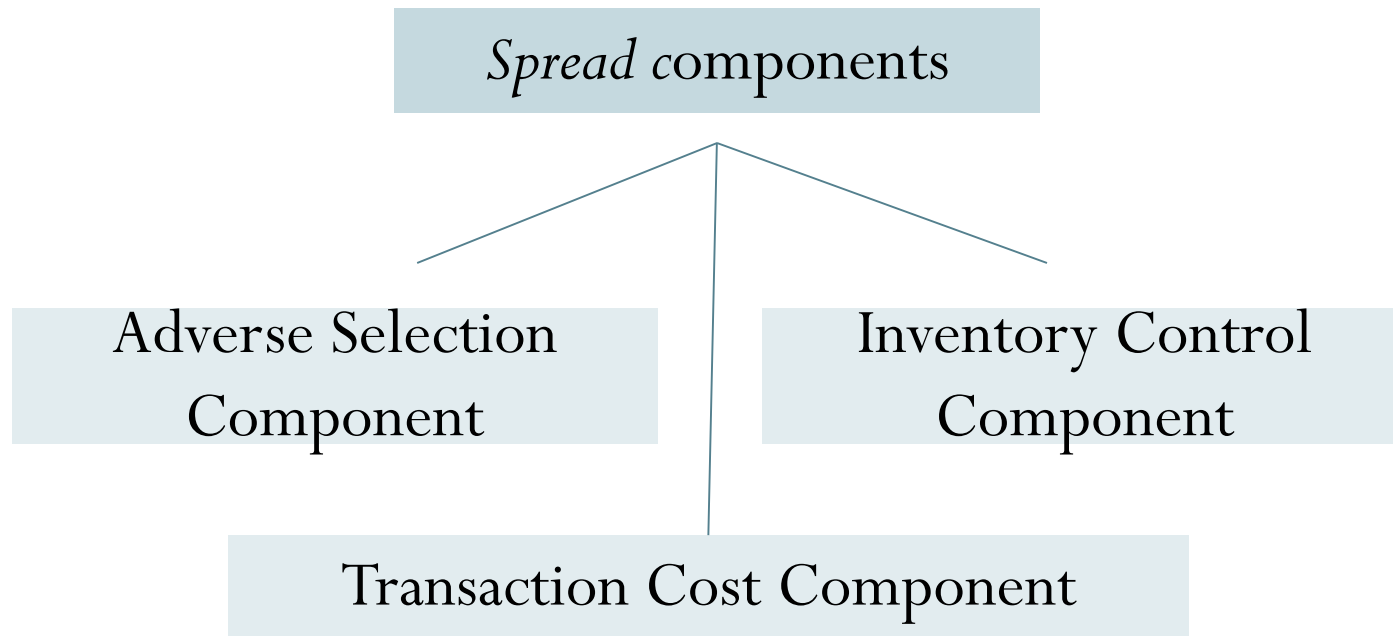 If the next seller is an informed trader, the *bid* should be lower.

- *Ask* as the expected value of the fundamental value given the probability that the next t*rader* is a buyer. Conditional expected value .

  Bid as the expected value of the fundamental value given the probability that the next t*rader* is a seller. Conditional expected value .

- If dealers suspect the next trader is informed, they increase the *spread*. **Adverse selection component**.

- Larger *spreads* for larger orders

- Pricing mistakes:

  - Adjust the quotes too much, giving excessive weight to the probability of trading with an informed trader. They may move prices away from fundamental values and create profitable opportunities for well-informed traders.

  - Fail to adjust the quotes enough after trading with informed traders, losing when prices move against the inventory.

- Trade deliberately with well-informed traders: lose by trading on the wrong side of the market but obtain valuable information. Adjust prices quickly to avoid keep on losing.

- *Spread*   ⇩ Harris: chap.14

- cost of immediacy and compensation for supplying liquidity.

- When the *spread* is large, there is less incentive to place market orders and more incentive to place limit orders.

- Low competition: possibility of setting the *spreads* in order to maximize profits.

- More elastic demand: smaller *spreads*.
- In competitive dealer markets, *spreads* adjust until dealers earn "normal profits".

Spread components

Adverse Selection Component

Inventory Control Component

Transaction Cost Component

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Transaction Cost Component

- operation costs (wages, space costs, accounting…).
- Demsetz (1968)

Inventory Risk Component

- Dealers are not passive providers of immediacy, they actively adjust the spread in response to fluctuations in inventory levels. Risk-averse, demand compensation for the costs of building up positions to accomodate order flow.
- Stoll (1978), Ho & Stoll (1981, 1983), Amihud & Mendelson (1980)

Adverse Selection Component

- Copeland e Galai (1983), Glosten & Milgrom (1985), and Easley & O'Hara (1987).

- If the *spread* was set so that only transaction costs and inventory risk are covered, trading with informed traders would drive dealers out of the market. S*pread* is widened to cover the adverse selection risk.

- Information Perspective: It is the difference between the expected fundamental value conditional on the next trader being a buyer and the expected fundamental value conditional on the next trader being a seller.

- Accounting Perspective: it is the part of the *spread* that compensates the dealer for what they expect to lose by trading with the informed traders.

- Glosten-Milgrom theorem: the two perspectives are equivalent.

- <u>1st perspective</u> (information)

  - Unconditional Value : *V*.

  - The probability that the next order is a buy order is equal to the probability that the next order is a sell order.

  - Probability that the next *trader* has superior information : *P*.

  - If the informed *trader* wants to buy: value $=$ V+E.

    If the informed *trader* wants to sell: value $=$ V-E.

- *Spread:* the difference between the expected fundamental value conditional on the next trader being a buyer and the expected fundamental value conditional on the next trader being a seller.

- Expected fundamental value conditional on the next trader being a buyer $= P.(V+E) + (1-P).V = V + E.P$

- Expected fundamental value conditional on the next trader being a seller $= P.(V-E) + (1-P).V = V - E.P$

> *Spread* (adverse selection) according to the 1st perspective $= 2E.P$

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- ## 2nd perspective (accounting)

  - *Spread:* value that compensates the expected loss for trading with the informed traders

  - If the next order is a sell, the *dealer* buys at B.

    - If the trader is uninformed, the dealer gets $V - B$.
    - If the trader is informed, the dealer gets $(V - E) - B$.

  - If the next order is a buy, the *dealer* sells at A.

    - If the trader is uninformed, the dealer gets $A - V$.
    - If the trader is informed, the dealer gets $A - (V + E)$.

  - The *dealer* will not lose on average if :

    - $(1-P) \cdot (V - B) + P \cdot [(V - E) - B] + (1-P) \cdot (A - V) + P \cdot [A - (V + E)] = 0 \quad \Leftrightarrow$

$$A - B = 2P.E$$

- Determinants of the size of the *spread*
  - Asymmetric information
  - Volatility
  - Utilitarian trading interest.

- The only one that is easily measurable is volatility.

- Asymmetric information (already seen)

- Volatility

  - Assets with high volatility should have wide *spreads*. Inventory risks are higher because possible losses are larger. Risk-averse dealers charge a risk premium.

  - It is more difficult to be fully informed about the value of very volatile assets, so the information asymmetry problems are greater.

- Utilitarian trading interest
  - When utilitarian trading interest is strong, the markets are very active. Active markets tend to have narrow *spreads*.
    - When utilitarian trading interest is strong, the adverse selection component of the *spread* is smaller because information is more diluted in the order flow.
    - Dealers that trade actively can spread their fixed costs over more volume- small transaction costs component.
    - The inventory risk is smaller, because it is easier to lay off inventory imbalances
    - Those who place limit orders prefer to do it in more active markets because the probability that they are quickly executed is higher. That narrows *spreads* in these markets (competition between *dealers* and limit orders).

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Liquidity

- The ability to trade when one wants. The ability to trade large size quickly, at low cost. 3 dimensions

- Impatient *traders* take liquidity.

- *Dealers,* limit order traders offer liquidity.

- Brokers and exchanges organize liquidity.

- Liquidity is the object of a bilateral search, in which buyers look for sellers and sellers look for buyers . When they are matched under acceptable conditions they have found liquidity.

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Change	Hold constant	Implication
Spend more time searching	1)Size of trade. 2)Price willing to pay or receive.	Expect to find: 1)better price. 2) more size.
Increase size of desired trade	1)Time spent searching. 2) Price.	Expect to find: 1)worse price. 2) more time searching.
Offer a better price	1)Size of trade. 2)Time spent searching.	Expect to find: 1)less time searching. 2)more size

Harris 2003, p.398

- Liquidity dimensions:
  - Immediacy – how quickly trades of a given size can be arranged at a given cost.
  - Width– cost of doing a trade of a given size *(spread*, commissions).
  - Depth – size of a trade that can be arranged at a given cost.

- Width and Depth are duals to each other: To minimize the cost given the size is similar to maximize the size given the cost.
- Impatient *Traders* – immediacy.
- Patient *Traders* – width
- Large *Traders*– depth.