Agenda

1. Electronic Markets and the Limit Order Book

1.1 Electronic markets and how they function
1.2 Classifying Market Participants
1.3 Trading in Electronic Markets
1.4 The Limit Order Book
1.1 Electronic markets and how they function

Main financial contracts:
- Ordinary share
- Bond
- Preferred stock: hybrid of stocks and bonds

- Asset classes: Equities, bonds, cash
- More exotic ones: on electronic exchanges usually in form of funds

- Mutual fund
  - Actively managed or passively tracking of index
  - Open-end or closed-end

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<th>Voting rights</th>
<th>Guarantee of income</th>
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<tbody>
<tr>
<td>Stocks</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Bonds</td>
<td>No</td>
<td>Yes</td>
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1.1 Electronic markets and how they function

- **ETF**
  - usually index tracking
  - not obligated to purchase investor’s shares back
  - lower trading costs, good for diversification

- **Hedge-fund**
  - more aggressive strategies
  - fewer regulatory and transparency requirements
  - access limited to accredited investors

- **Other securities**: electronic trading in derivatives markets
Who trades and why?

- **Corporate managers**
  - creating some of the assets traded on exchanges
  - active participation when increasing or reducing quantity of shares

- **Financial management companies** managing funds
  - long-term (e.g. value investing) or short term (e.g. ETF) goals

- **Proprietary traders** trading on a trading advantage (real one or not)

- **Regular investors/ fundamental traders**: direct use for assets being traded

- **Governments**: manage currency, issue debt, repurchase assets, maintain market stability
1.2 Classifying Market Participants

Primary classes of traders:

1. Fundamental (or noise or liquidity) traders: driven by economic fundamentals
2. Informed traders
3. Market makers

- Arbitrageurs seen as informed traders because they anticipate price changes
- Fundamental traders could also be classified as informed traders, depending on the considered time horizon
1.3 Trading in Electronic Markets

Two types of orders:

1. Market Orders (MO)
   - Buy/ sell certain quantity at best available price
   - Seeks and (usually) results in immediate execution

2. Limit Orders (LO)
   - Buy/ sell at a given price up to certain maximum quantity
   - Passive orders
   - Price usually worse, so no direct execution, will have to wait until matching with new order or cancellation
1.3 Trading in Electronic Markets

- Orders managed by matching engine and limit order book (LOB)
  - LOB keeps track of incoming and outgoing orders
  - Matching engine uses well-defined algorithm, determines when trade can be done and selects order to be executed (time priority rules)
1.3 Trading in Electronic Markets

- MO comes in
  - Firstly matched with LOs offering best price

1. Quantity demanded < quantity offered
   - Execute LOs in order, starting with oldest, until order is fulfilled

2. Quantity demanded > quantity offered
   - Execute all orders at best price
   - Execute orders at second best price
   - Go on until order is fulfilled
1.3 Trading in Electronic Markets

- LOs with increasingly worse prices are 'deeper in the LOB'
- MOs 'walk down the book', when they are executed against LOs that are deeper in the LOB

Alternate exchange structures:
- Prorata rules used in some money markets (no time priority, execution in proportion to posted quantities)
- Priority for certain types of traders
- Auctions: initial/ closing auction, after market halt
1.3 Trading in Electronic Markets

- **Degree and cost of transparency**
  - In US: clear legal distinction between regulated exchanges and other electronic markets
  - General distinction between lit (open order book) and dark markets
  - In lit markets: differences on how and what price information is available
    - LO can be matched with subsequent events (executions/cancellations) by its identification number
    - Level-book method: only messages about events impacting the order book, no match of order and events possible
    - Lit market assumed, dark pools discussed in chapter 7
1.3 Trading in Electronic Markets

- Colocation: exchanges monetize need for speed by renting out computer/server space next to their matching engines
  - Provides uniform services by controlling the hardware, the cable and the network -> nobody is disadvantaged
  - Distinction between collocated and not collocated traders

- Fragmentation: interaction between exchanges, if better prices for MOs are available
1.3 Trading in Electronic Markets

- Extended order types:
  - **Day Orders**: for trading during regular trading, options to extend to pre- or post-market sessions
  - **Non-routable**: no re-routing to other exchanges
  - **Pegged, Hide-not-Slide**: move with midpoint or national best price
  - **Hidden**: do not display their quantity
  - **Iceberg**: partially display their quantity
  - **Immediate-or-Cancel**: as much as possible is executed at best price, rest is cancelled
  - **Fill-or-Kill**: executed at the best price in their entirety or not at all
1.3 Trading in Electronic Markets

- **Extended order types:**
  - **Good-Till-Time:** cancelled if not executed by fixed time
  - **Discretionary:** display one price but may be executed at more aggressive (hidden) prices
  - And much more -> important to be informed about all

- **Exchange fees:**
  - **Maker-taker system:** trader sending a MO pays trading fee, trader posting LO (filled by MO) pays much lower trading fee or even receives payment
  - **Taker-maker system:** inverted
1.4 The Limit Order Book

- New LO is added to LOB:
- Time priority from right to left

New buy LO at $23.9
1.4 The Limit Order Book

MO arrives: ’Sell 250 shares’

- Clear what happens to the first two „blocks“
- Remaining 50 shares: 2 cases
1.4 The Limit Order Book

Case 1: Standard market

- Executed against LOs at $23.8
1.4 The Limit Order Book

Case 2: Re-routing

- Re-route order to another exchange displaying best bid price at $23.9
- Seldom would 'come back' and walk down the book
- Depth disappears
- Order protection rules only exist in the US
1.4 The Limit Order Book

- $23.8
- $23.9
- $23.12

**Ask Side**

**Buy Side**

- Could be Immediate-or-cancel
- Remaining units are cancelled
1.4 The Limit Order Book

- LOB defined on discrete grid of prices (price levels)
- Tick: difference between two subsequent price levels
- LOB looks different for different levels of liquidity

**Figure 1.1** Snapshots of the NASDAQ LOB after the 10,000th event of the day. Blue bars represent the available sell LOs, red bars represent the available buy LOs.
1.4 The Limit Order Book

- **Quoted Spread** \( Q_t = P^a_t - P^b_t \)
  - where \( P^a_t \) is the best ask and \( P^b_t \) is the best bid price
  - Market becomes ‘locked’ if the spread is equal to 0

- **Midprice** \( M_t = \frac{1}{2}(P^a_t + P^b_t) \)
  - Used as proxy for price of asset if there were no transaction costs

Some wordings:
- Sell MO is executed against a buy LO -> ’It hits the bid’
- Buy MO is executed against a sell LO -> ’It lifts the offer’
1.4 The Limit Order Book

Microprice\(_t\) = \frac{V_t^b}{V_t^b + V_t^a} P_t^a + \frac{V_t^a}{V_t^b + V_t^a} P_t^b

- where \(V_t^b\) and \(V_t^a\) are the volumes posted at the best bid and ask prices
- Used as more subtle proxy for asset’s transaction cost-free price
- Measure direction that price has to move to as captured by number of shares posted:
  - Lots of buyers -> Microprice pushed towards ask price
  - Lots of sellers -> Microprice pushed towards bid price
- Indicates the buy (sell) pressure in the market
Thank you for your attention!