Alternative mechanisms

- The limit order book is the central starting point.
- The mechanisms discussed here either augment (assist) the book or (in some cases) serve as the sole mechanism.
  - Auctions (Ch. 5)
  - Dealers (Ch. 6)
  - Dark pools (Ch. 7)
Outline

- The need for double-sided auctions
- Auction procedures.
- Problems and manipulations
- The NASDAQ opening auction.
- Other uses of auctions.
- The Facebook IPO

Auctions in securities markets

- Generally concentrate all buying and selling interest at a single point in time.
  - Unlike (e.g.) a sequence of bilateral bargains
- As points of comparison, eBay auctions are
  - single-unit
  - seller’s auctions
  - open outcry (bidders see other bids and can make bids at any time)
Most securities auctions are
- Multiple unit
  - Many shares change hands
- Double-sided
  - Both buyers and sellers participate
  - Use modified open outcry formats
Most common use: opening and closing continuous trading sessions

Opening and closing a continuous market

- Most organized trading is not 24/7.
- Recall: liquidity is a network externality
  - Trading tends to cluster
- Many markets adopt implicit or explicit “regular trading hours”
  - Organized into one or more trading sessions
  - Example: the Tokyo Stock Exchange has a morning session (9:00am - 11:30am) and an afternoon session (12:30pm - 3:00pm)
Volume at the open and close

- At the open, volume driven by
  - Accumulated portfolio rebalancing needs.
  - Accumulated information.
- At the close, large volume pegged to closing prices.
  - Mutual funds: closing prices $\rightarrow$ net asset values $\rightarrow$ used to price customer purchases and redemptions.
  - On derivative final settlement days, closing prices used to compute settlement cash flows.

The typical opening auction procedure

- Order accumulation
  - Buyers are ranked with high bids first.
  - Sellers are ranked with low offers first.
  - Buy orders $\rightarrow$ demand curve; sell orders $\rightarrow$ supply curve.
- The market clears where the supply and demand curves cross.
Buy orders and the demand function

<table>
<thead>
<tr>
<th>Trader</th>
<th>Bid</th>
<th>Quantity</th>
<th>Cumulative demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alan</td>
<td>Market</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Beth</td>
<td>$8</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Cam</td>
<td>$6</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Dana</td>
<td>$4</td>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

Sell orders and the supply function

<table>
<thead>
<tr>
<th>Trader</th>
<th>Ask</th>
<th>Quantity</th>
<th>Cumulative Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gina</td>
<td>Market</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hari</td>
<td>4</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Ilse</td>
<td>6</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Jon</td>
<td>10</td>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>
The demand and supply curves are combined.

- At any price, $P$:
  - The matched volume is the minimum of supply and demand at $P$.
  - If (at $P$) there is excess demand, there is a buy imbalance.
  - If (at $P$) there is an excess supply, there is a sell imbalance.
  - The net imbalance is the size of the excess.

- At $\$8$, the matched volume is 10; there is sell imbalance of 2.
- At $\$6$, the matched volume is 12; there is a buy imbalance of 2.
- At $\$5$, the matched volume is $\frac{8}{6}$; there is a buy imbalance of $\frac{6}{6}$.
The clearing maximizes matched volume.

- At a price of $6, The supply, including Ilse, is 12 units.
- The demand, including Cam, is 14 units.
- The total traded quantity is the minimum (12)
- Cam only gets 2 of the 4 units he wanted.

... and the profits (surplus)

Buyers’ profits = 16 + 12 = 28
Sellers’ profits = 18 + 10 = 28
Total profits = 56

A single-price auction maximizes the total buyers and sellers profits.
Analyzing traders’ profits in auctions

Start with the following set of limit orders, ranked from most to least aggressive.

**Buyers**

- Amy
- Bill
- Cat
- Dan
- Eve

**Sellers**

- Ed
- Dora
- Bev
- Cam
- Art

The clearing price is $16:
- Amy, Bill and Cat are buyers
- Art, Bev and Cam are sellers

Profits:
- Amy: $20 - $16 = $4
- Bill: $19 - $16 = $3
- Cat: $16 - $16 = $0

Total buyers profits are $7
- Art: $16 - $14 = $2
- Bev: $16 - $15 = $1
- Cam: $16 - $16 = $0

Total sellers’ profits are $3

Total profits are $10
The single price auction achieves the highest total profits. The efficiency of alternative trading mechanisms is judged by how close they come to this maximum.

Profits:
- Amy: $20 - 16 = 4$
- Bill: $19 - 16 = 3$
- Cat: $16 - 16 = 0$

Total buyers profits are $7$
- Art: $16 - 14 = 2$
- Bev: $16 - 15 = 1$
- Cam: $16 - 16 = 0$

Total sellers' profits are $3$

Total profits are $9$

An alternative procedure: the matching market

Step 1: Pair off the most aggressive buyer (Amy) and the most aggressive seller (Art). Cross them at the midpoint of their limit prices. Amy buys from Art at $17$.
Step 2: Pair off Bill and Bev at their midpoints. Bill buys from Bev at $17$.
Step 3: Cam and Cat are paired off at $16$. Cat buys from Cam at $16$.
Dan, Eve, Dora and Ed don't trade.
Efficiency of the matching market.

Count the areas: the total profits are the same as in the single-price auction ($10). Note
• Not everyone is not trading at the same price.
• Buyers’ and sellers’ profits differ from the single-price auction.
The efficiency of the single price auction does not depend on there being one price.

An extreme alternative: the paired-off traders are always crossed at the buyer’s price.

If buyer and seller pairs are matched according to almost any pricing rule, the profits will still be $10.
What can go wrong? Suppose that the wrong people trade.

Amy and Ed are satisfied with their trade, but their max profit is $2.
Their max profit is $3.

No trade. (Cat won't pay more than $16; Dora wants at least $17.)

The max total profit is $5. This is an inefficient allocation. Trades like this can happen in an open-outcry floor market because the wrong people trade.
Economists call the “trading profits” the *surplus*.

- It represents extra value gained from trade.

It is generally true that a single-price auction where everyone truthfully reveals their buying and selling limit prices achieves the largest total surplus.

Most economists believe:

- “If you replaced the inefficient continuous trading mechanism with a single-price auction, everyone would on average be better off.”

In practice, auctions can be difficult to run.

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**Return to the original set of orders**

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gina</td>
<td>2</td>
</tr>
<tr>
<td>Hari</td>
<td>4</td>
</tr>
<tr>
<td>Ilse</td>
<td>6</td>
</tr>
<tr>
<td>Cam</td>
<td>8</td>
</tr>
<tr>
<td>Dana</td>
<td>10</td>
</tr>
<tr>
<td>Jon</td>
<td>10</td>
</tr>
</tbody>
</table>

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Manipulation

- Alan puts in two bids
  - His genuine market order for 4 shares
  - and an “artificial” bid for 10 shares, limit 9.
- The second bid discourages the other bidders (Beth, Cam, and Dana).
  - They don’t bid at all.
- At the last instant, Alan cancels his second bid.

After Alan pulls his second bid:
Deadline effects

- When should we clear the market (that is, stop accepting orders and fix a price)?
- If we set a firm time, we often encounter *deadline effects*.
  - Everyone waits until the last moment.
  - These can lead to instabilities and manipulations.
- Should we extend the deadline until outcome looks stable?
  - The Facebook IPO

Stabilization measures

- Randomization of clearing times
- Limited disclosure of demand and supply functions.
  - We don’t always show the full supply and demand curves in real time.
- Special order types
- Early submission and cancellation deadlines for certain orders ("freeze periods")
Randomization

- The auction deadline is a random time (within a narrow window)
  - The London Stock Exchange uses a 6-second window for FTSE-100 stocks
- You can’t submit/cancel “at the last moment.
- Most US exchanges do not randomize.

The NASDAQ opening auctions (“cross”)

- Timing
  - NASDAQ systems operate 4am to 8pm.
  - Trading and order entry occurs 7am to 8pm.
  - Regular trading hours are 9:30am to 4pm
  - The opening cross occurs at 9:30am
    - The opening cross operates at the same time as continuous trading.
- Orders may be marked “on open” to indicate that they are only to be executed in the opening cross.
There are two limit order books: the opening book and the regular continuous book.
- They are combined in the open procedure.

Opening orders must be received prior to 9:28am and cannot be canceled.

Starting at 9:28am, the system transmits matched volume and imbalance information every five seconds.

Between 9:28 and 9:30, the system accepts imbalance-only orders.
- Imbalance only orders are only executed if they reduce the imbalance.
- Example: if there is a buy imbalance (more buys than sells), a sell imbalance-only order would be executed.

Other financial auctions

- Periodic calls for low-activity securities.
- Initial public offerings (of debt and equity)
- Credit default swap settlements.
- High-frequency auctions
Auctions in low-activity securities

- Some stocks don’t trade frequently enough to sustain a continuous market.
- The Euronext markets (Paris, Amsterdam, Brussels, Lisbon) use twice-daily single-price call auctions to trade stocks that average fewer than 2,500 trades per year.

US Treasury Auctions

- US T-bills, notes and bonds are sold in auctions conducted at the Federal Reserve Bank of NY.
  - T-bills are auctioned most Mondays and Thursdays
  - T-notes and bonds on Wednesdays
- Two types of bids
  - Competitive bids specify a price and a quantity.
  - Non-competitive bids specify a quantity. The price is determined in the auction.
    - Like a market order.
IPO auctions

- Municipal bonds
  - Underwriting banks bid to purchase issue. They then resell to investors.
- Equity
  - Google IPO
  - WR Hambrecht’s OpenIPO (active, but lightly used)

High-frequency auctions

- Proposed as a replacement for continuous trading.
- Run a single-price call every minute.
- Proponents claim that trading once per minute would ...
  - satisfy most investors’ needs
  - remove the millisecond advantages reputedly used by high-frequency traders.
The Facebook initial public offering (IPO)

- On Friday, May 18, 2012, Facebook sold about 421 Million new shares at an offering price of $38/share.
  - In the primary market, an investment banking syndicate led by Morgan Stanley bought the shares from Facebook (at $38/share, less commission) and redistributed them to public buyers.
- Once the shares were in the hands of investors, they could be traded in the secondary market.
- Facebook chose NASDAQ as its primary listing exchange.

The NASDAQ opening cross for IPOs

- For the initial opening, orders are entered, canceled and revised during a display-only period (DOP).
- At the conclusion of the DOP, NASDAQ builds the supply and demand curves, and computes the price and quantity where supply≈demand.
- All eligible buyers and sellers are crossed at this price.
- Continuous trading commences.
What happened

- 7:56 NASDAQ announces that the DOP will run from 10:45 to 11:00.
- 10:58 Net Order Imbalance Indicator suggests an opening price of $43. Morgan requests an extension of the DOP to 11:05.
- ~11:05 NASDAQ systems construct a cross. This takes about 20 ms.
- NASDAQ systems perform a validation check.
- During the 20 ms computation time, one order had been cancelled. The validation check fails.

- NASDAQ recomputes the cross, and performs a second validation check.
- During this computation, NASDAQ receives two more cancellations, so the second validation step fails.
- NASDAQ computes the cross (a third time), but fails to register one of cancellations, so the third validation fails.
- NASDAQ computes the cross (fourth time). One more cancellation. Validation fails.
- The procedure continues to loop.
- 11:05 NASDAQ management convenes a “code blue” conference call.
The code blue call

- After a few minutes, the cross failure is attributed to the validation procedure.
- Is there a way to override the validation procedure?
- Yes. Move the cross to a duplicate system that has a few lines of code removed (the “failover” system)
- 11:25 Management approves this action.
- 11:30:09 The failover system computes the cross. 75.7 million shares trade at $42.
- 13:50 NASDAQ learns that 38,000 orders entered between 11:11 and 11:30 weren’t included in the cross.
- NASDAQ determined that it had a 3 million share short position.
  - ... which it closed (by buying shares at a lower price) at a profit of $10.8 million.

The aftermath

- NASDAQ pays a US fine of $10 million.
  - ... and $62 million to brokers.
  - “NASDAQ will make technical changes to its ... Crosses ... NASDAQ will close its order ports to new orders and cancels after the calculation of a cross is triggered [started] ...”