Intraday-trade: Economics refresher

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Understanding Society

Why do we need an intra-day market?

- By trading intra-day firms can adjust their production schedule and reduce their reliance on the balancing market
- Drivers for the intra-day market
  - Wind producers can make accurate predictions about their production 4 to 6 hours before actual production
  - Network operators make a conservative estimate for day-ahead transmission capacity, but with additional information on day-ahead production plans they can increase intra-day capacity
  - Balancing regimes differ across countries. By trading intra-day firms can affect where they buy balancing energy

Refreshing: basic economics

- Network operators offer a lot of services which have characteristics of public goods

  voltage stability can be enjoyed by all network users

- However, transmission capacity is a private good

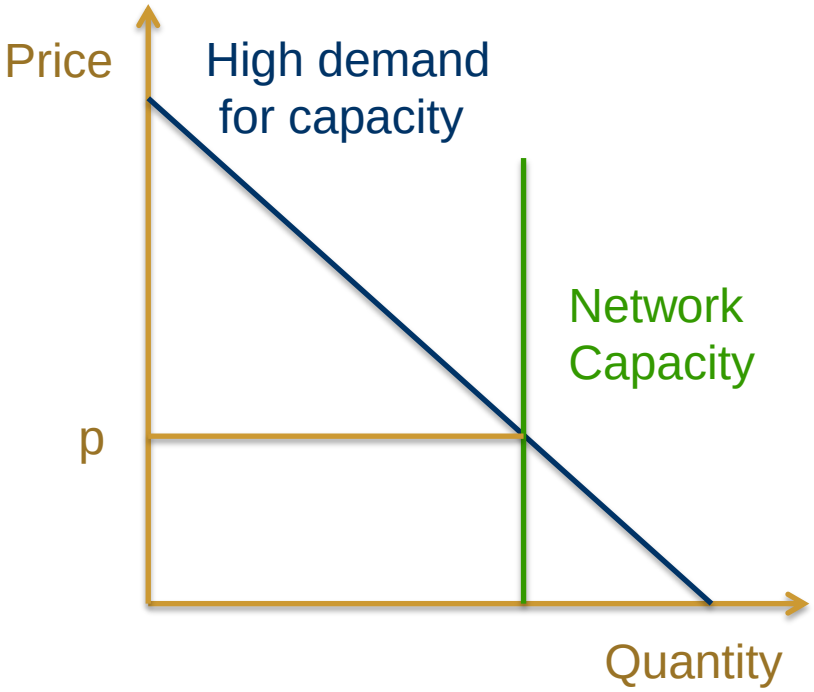
  1 MW of capacity can be used by one firm at once

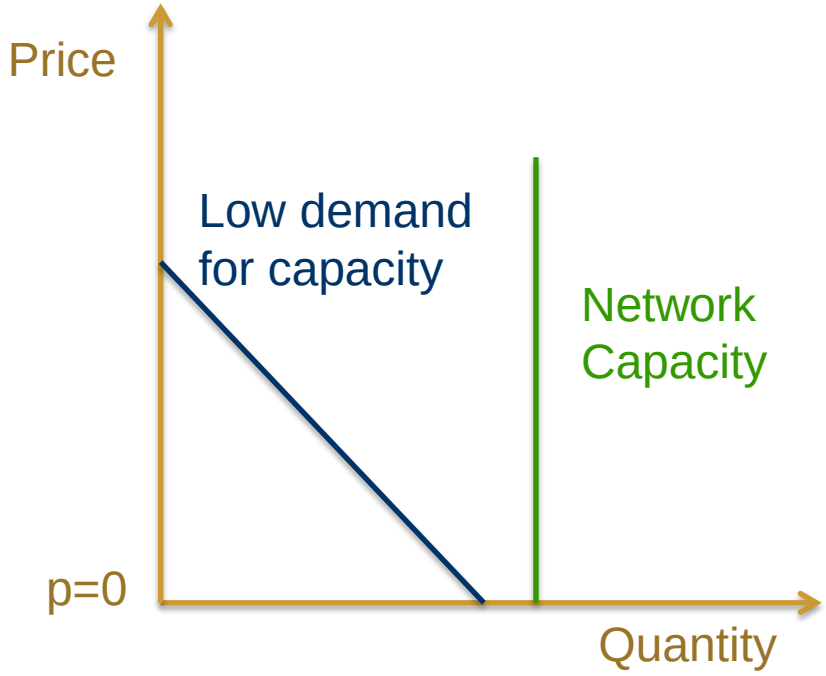
- We can therefore rely on a market mechanism to allocate capacity
- Efficiency requires that capacity is allocated to firms with the highest valuation
- Firms need to pay for capacity as otherwise they will not report their true valuation

  talk is cheap

- It is likely that *day-ahead price ≠ intra-day price* as demand and supply conditions change

Refreshing: market equilibrium





The price is sufficiently high to select only firms with a high valuation…

.. but can be zero if demand is small

Refreshing: optimal price

- In the optimum

  price = opportunity cost

  = the value of capacity for an alternative user

- If there is unused capacity left, then this opportunity costs is zero
- If there is scarcity then price = opportunity cost > MC = 0

- Two mechanisms can be used to ensure that the price equals the opportunity cost
  - Collect information of all users (batch auction or continuous trade)
  - Set a minimal price for capacity (advanced clock auction)

Which auction should we use?

1. Batch auction

- Similar to the day-ahead auction
- Auctioneer accepts all bids until a certain period of time
- One clearing price is calculated
- Operates several times per day

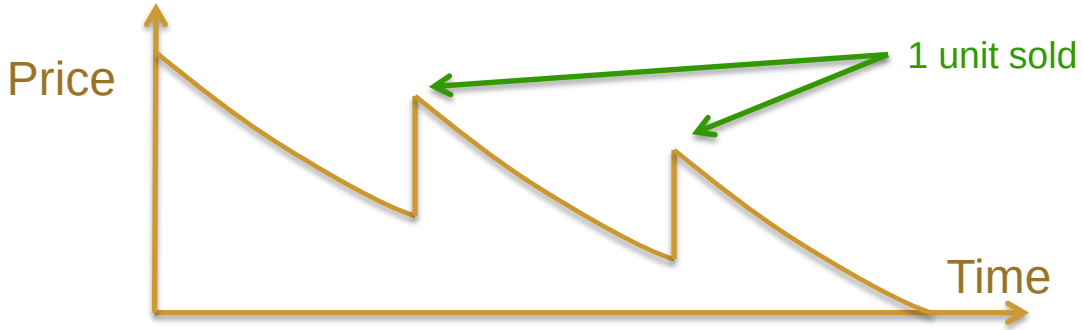
2. Continuous auction *(automated limit-order book)*

- Firms can continuously submit, adjust and remove orders in a central order book
- Orders that can be cleared given network constraints are cleared
- At market-opening a batch auction is run to help price discovery → day-ahead market
- Day-ahead bids that do not clear, move to the intra-day order book

Which auction should we use?

3. Advanced clock auction

- Used for allocating seats in an airplane (*yield management*)
- Buyers randomly arrive to buy a unit of capacity, buyers are never present simultaneously
- If capacity is sold now, it can not be sold in the future
  This is an opportunity cost
- Price = Function [time remaining (-) , capacity available (-)]



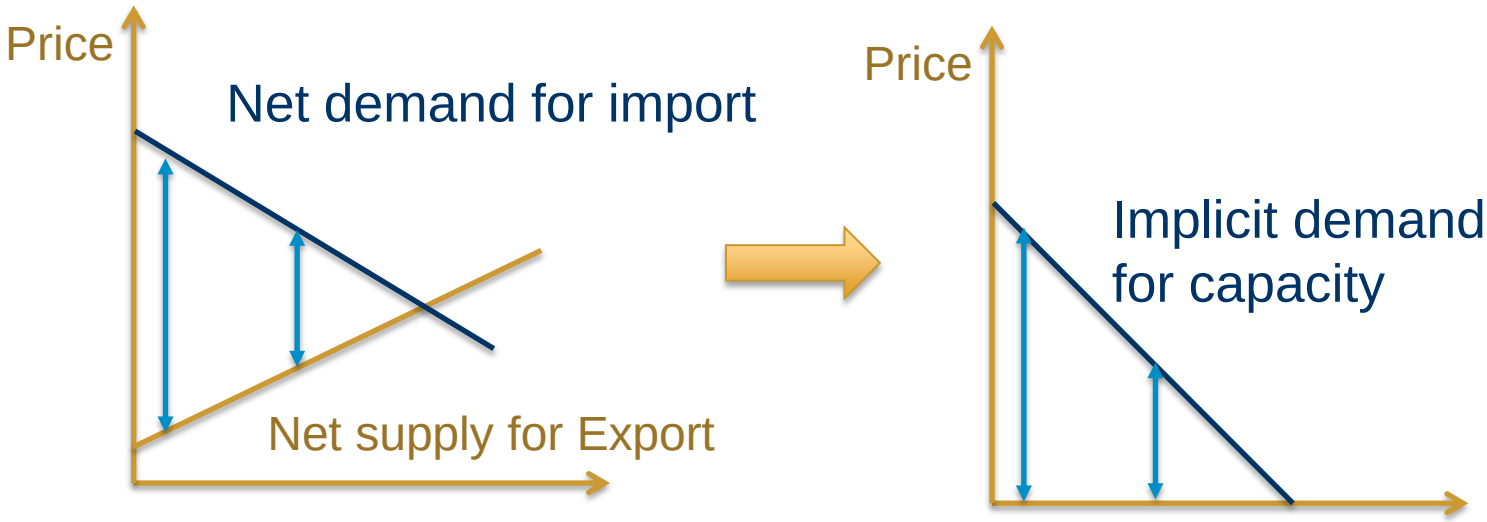
- Price depends on stochastic process + distribution of valuations

Which auction should we use?

- **Batch trading** is preferred to **continuous trading** if assets are illiquid
  - Liquidity cut-off at Euronext: 10 trades / trading day / asset
  - With an hourly capacity market: 240 trades / day / border
  - We might need a higher cut-off, as we need information about alternative trades to determine the opportunity cost
- **Advanced clock auction**
  - It **delays allocation**. This is unfortunate, as it is optimal in electricity markets to obtain capacity early (ramping constraints, start-up times etc…)
  - It solves the **initial allocation** of new capacity. In the airline industry this is important as there is no secondary market for seats
  - **Additional markets** may be necessary: a continuous market for *energy* trading, a secondary market for *capacity*

Demand for capacity

- Demand for network capacity = a derived demand
  It depends on the regional price differences for electrical energy
- To derive the implicit demand for capacity
  - Collect information on demand and supply of energy in different regions
  - Subtract “net import demand” vertically from “net export supply”



- Principle behind market coupling / market splitting

Implicit capacity trading

- Collect energy bids and offers in each location, clear bids subject to network constraints
- Allocations can be determined by solving an optimization problem, also under continuous trade

  [no block bids etc..]

At each moment:
Maximize *Value of cleared energy bids & offers (from order book)*

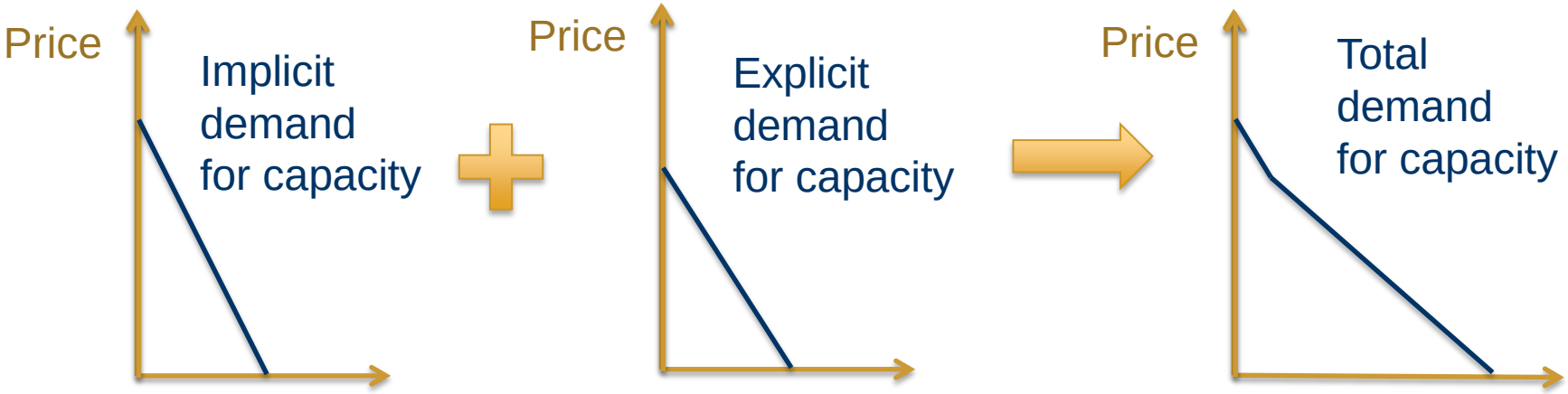
Subject to *Network Constraints*

- Over time, the network presentation can be improved from cross-border ATC values to a DC-load flow approximation
- Close to real time, such a centrally coordinated market is likely to be optimal

  [*Wilson, Econometrica, 2002*]

Explicit demand for capacity

- If exchanges are illiquid we may auction capacity explicitly
  i.e. firms buy a transportation right
- However, for efficiency and liquidity reasons, capacity should not be earmarked for explicit auctioning
- Instead explicit and implicit demand should compete for capacity
- Total demand = implicit demand + explicit demand



Implicit and explicit capacity trading

- Implicit and explicit allocations can be determined by solving one optimization problem

  [as in *O'Neill et al., 2002, IEEE*]

At each moment:
Maximize *Value of cleared energy bids (from order book)*
+ *Value of cleared capacity bids (from order book)*

Subject to *Network Constraints*

- **Advantages**
  - Description of network constraints can improve over time
  - Firms can resell explicit capacity to the implicit market