

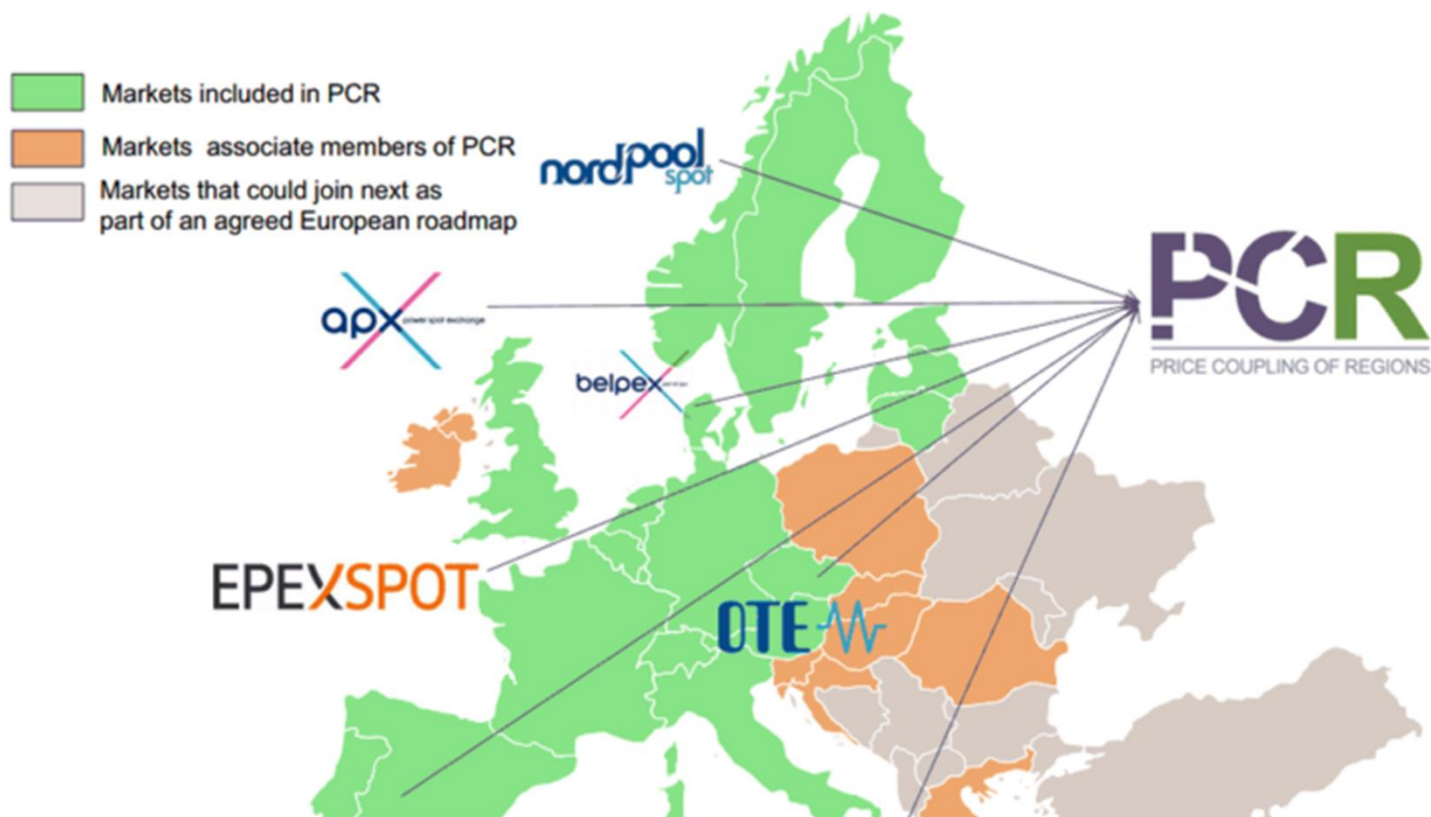
Comparing auction designs where suppliers have uncertain costs and uncertain pivotal status

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Transparency in EU electricity markets

- Disclosure of availability (REMIT)
- Disclosure of production in each plant.



Uncertain production costs

Suppliers have asymmetric information and costs are interdependent:

- In spot market, owner has **private** information about its own production costs and is less informed about competitors' costs.
- In forward markets, future electricity price is a **common** uncertainty. Similar for hydro-dominated markets.

We believe that cost uncertainty is largest in hydro-dominated markets during extreme system conditions when water is scarce. Partly because probability of regulatory intervention is high.

Pivotal suppliers

Production capacities are important for competition in electricity markets.

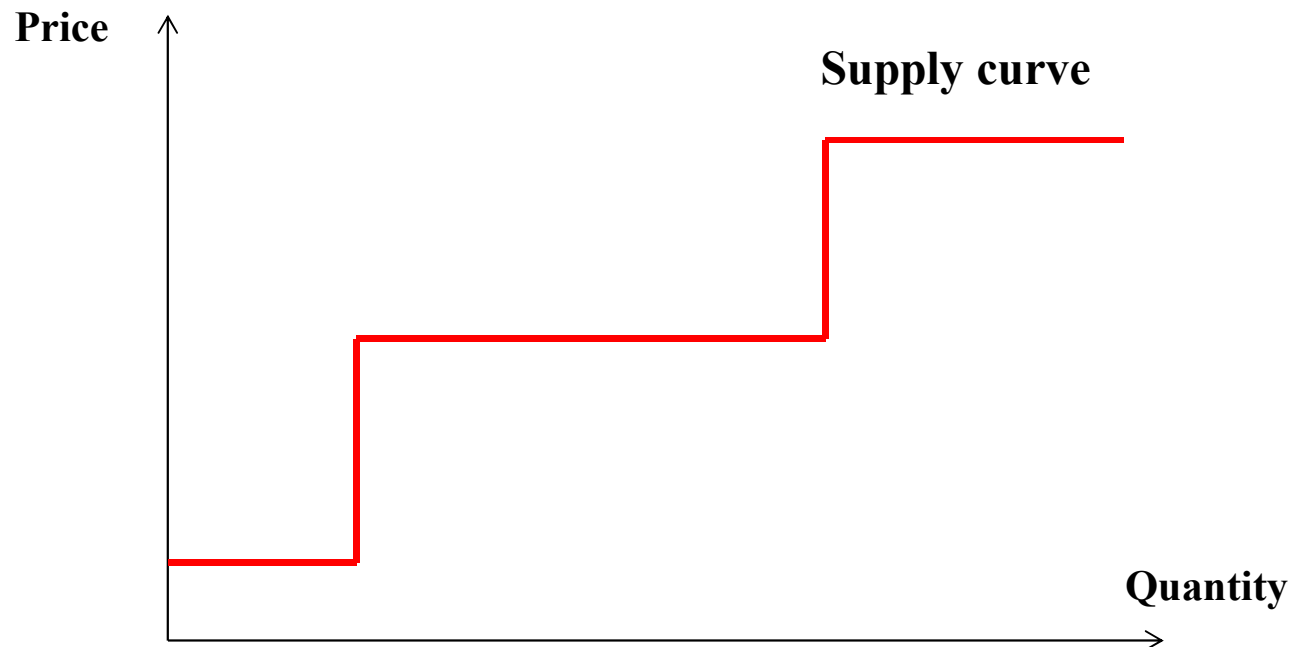
A supplier is pivotal if total capacity of rivals is less than demand => significant market power.

In our model, pivotal status of producer is uncertain due to demand shocks and intermittent output (renewables).

Multi-unit auctions

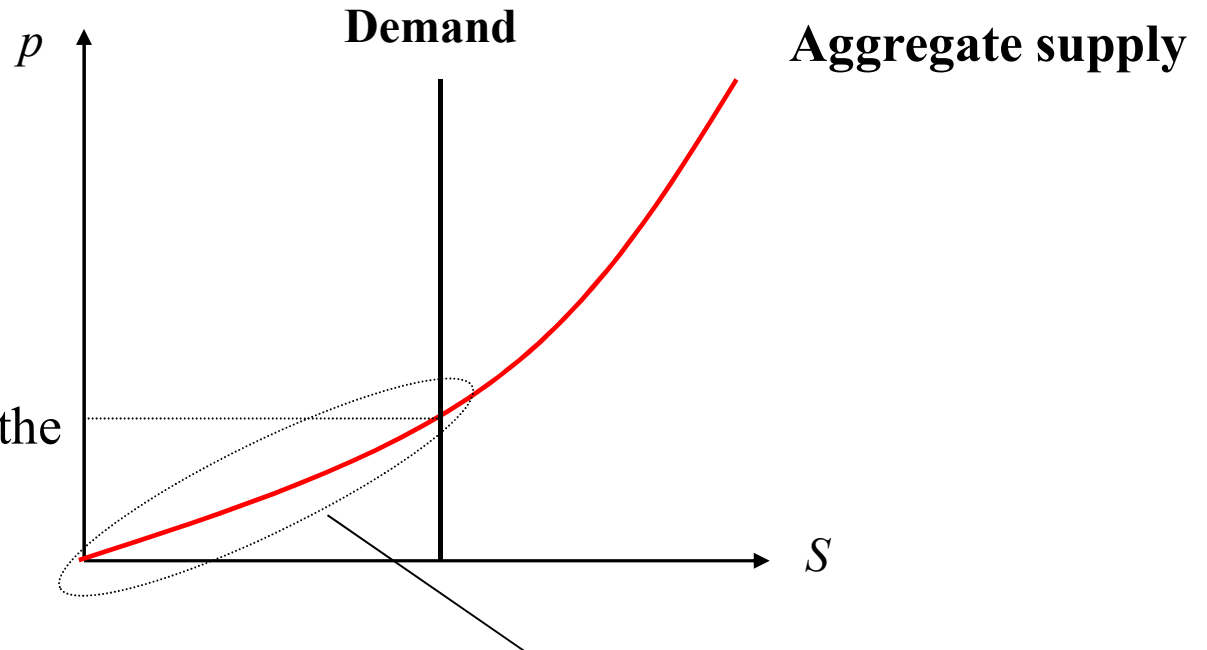
Each year multi-unit auctions trade divisible-goods worth trillions of dollars, e.g. in electricity markets, treasury auctions and auctions of emission permits.

We consider a procurement auction, where each producer submits a supply curve.



Uniform and discriminatory pricing

Uniform-price: All accepted bids are paid the price of marginal bid.

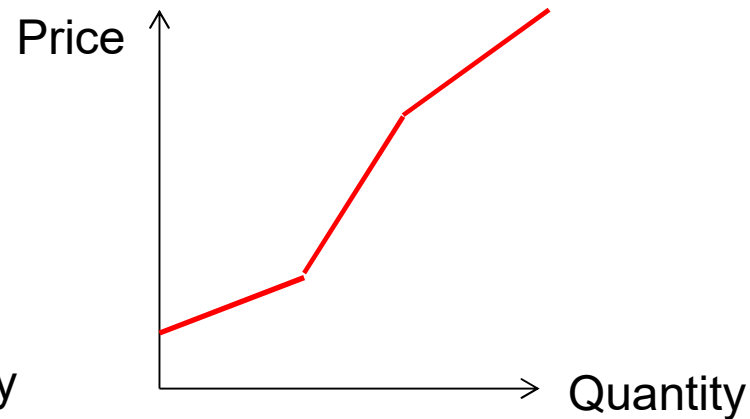
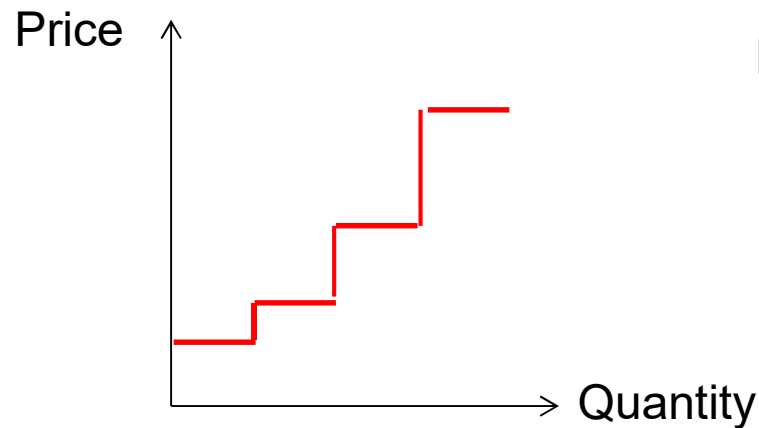


Pay-as-bid: Accepted bids are paid their bid.

Most electricity markets use uniform-pricing, but most treasury auctions use discriminatory pricing.

Market design: Bidding format

Shape of supply schedule is restricted by bidding format.
Bids are often submitted per plant.



=> Bidding format influences to what extent suppliers can condition output on competitor's information. Influence on market performance?

Contributions

- First to analyse multi-unit auction with asymmetric information and pivotal suppliers. Relevant for improved transparency in electricity markets.
- First to compare market designs for asymmetric information and unique equilibria.
- First to identify situations where restrictions in the bidding format improves welfare.

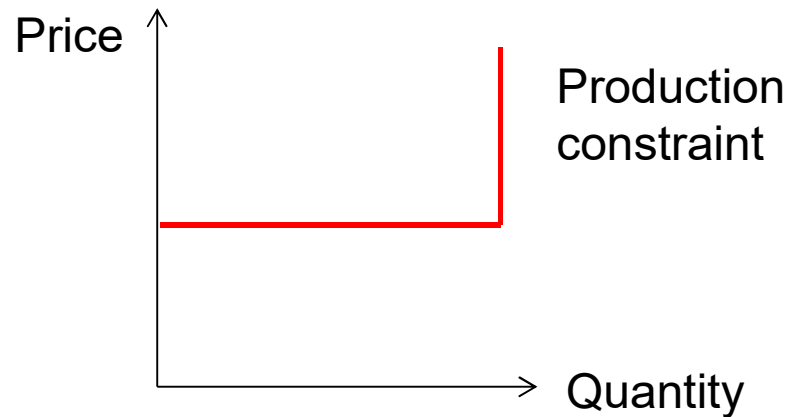
Model and timing

One shot game of duopoly market:

- 1) Producers receive asymmetric information (signals) about costs.
- 2) Producers submit offers.
- 3) Market is cleared.

Bidding format in our model

We use von der Fehr and Harbord's (1993) bidding format. Each producer has only one production plant and must offer all of its output at a single unit price.



Model of marginal cost

Signals drawn from a bivariate probability distribution.

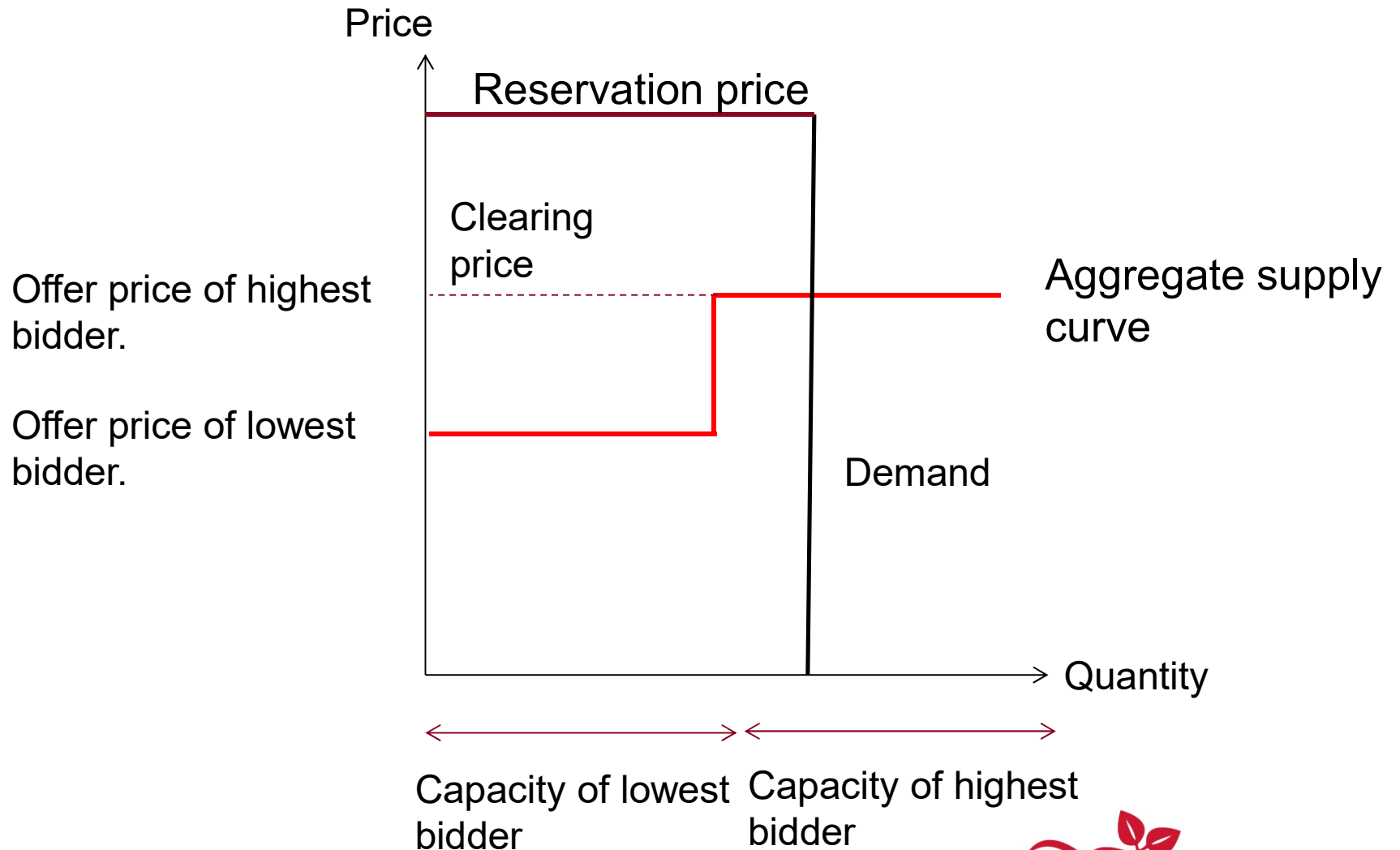
Both signals informative of firm's marginal cost, $c_1(s_1, s_2)$.

Private cost: firm's cost independent of rival's signal.

Common uncertainty: both signals equally informative.

Similar to Milgrom and Weber's (1982) model of single object auction.

Market clearing: pivotal case



Market clearing: non-pivotal case



Method

We solve for Bayesian Nash equilibrium; each firm chooses an offer that maximizes its expected profit given its private information.

Result: Uniqueness

- Price cap, capacity constraint and uncertain pivotal status \Rightarrow Unique Bayesian NE, which is symmetric.
- * An arbitrarily small uncertainty about the pivotal status is sufficient to give uniqueness.

Closed form expression

$$p(s) = c(s, s) + \int_s^{\bar{s}} \frac{dc(v, v)}{dv} e^{-\int_s^v H(u) du} dv.$$

$H(u)$ depends on information structure and market design. It is proportional to the quantity effect and inversely proportional to the price effect.

Does not matter much whether costs are private or a common uncertainty.

Result: Bidding format

- Flat marginal costs => Welfare is maximized if offers are restricted to be flat. (Related to Ausubel et al. (2014)).
- Relevant for forward markets, hydro-dominated electricity markets, security auctions and auctions of emission permits. Especially for uniform-price auctions with common uncertainties.

Result: Transparency

- Mark-ups are reduced if producers receive more similar information (level playing field).
- Related results: Less noise reduces mark-ups (Vives, 2011). Disclosure of information reduces mark-ups in single object auction (Milgrom and Weber, 1982).

But:

- Milgrom and Weber's (1982) disclosure result not always true in multi-unit auctions (Perry and Reny, 1999).
- More transparency facilitates tacit collusion in repeated game (von der Fehr, 2013).

Result: Payment mechanism

- Uniform and discriminatory pricing are equivalent when producers' signals are independent and pivotal status is uncertain.
- Ranking of auctions depend on correlation of signals.
- Advantages and disadvantages with uniform pricing tend to be amplified if producers are pivotal with a higher probability.

Result: Sensitivity to demand and capacity shocks

- Equilibrium offers depend on expected sales of lowest and highest bidder.
- Variance in sales for highest and lowest bidder do not influence equilibrium offers for discriminatory pricing. Somewhat more influence on offers in a uniform-price auction.

Conclusions

- Level playing field => lower prices.
- It does not matter much whether costs are private or a common uncertainty.
- Restrictions in the bidding format can improve welfare.
- It does not matter much whether the market uses uniform or discriminatory pricing.
- Market performance of discriminatory auction not influenced by demand variance. Uniform-price auction is more sensitive.
- To avoid monopoly outcomes in uniform-price auctions, there should be some uncertainty about pivotal status.

How to improve cost transparency?

- Transparent offers.
- Forward/futures markets
- Public information on fuel price indexes, reservoir levels and prices for emission permits
- Reduce regulatory risk in hydro-dominated markets: Contingency plans for intervention in case of extreme system conditions