31C01300/31E01310
Energy & Environmental Economics

Lecture 1: Perfect competition

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Spring 2022

This week

First lecture

- Of markets, economics, and efficiency

Second lecture

- Electricity markets

Benchmark: Perfect competition

The first fundamental theorem of welfare economics:

THEOREM

A competitive equilibrium allocation is Pareto efficient*.

Or, in other words, perfect competition maximizes social efficiency.
But what does that mean?

*) It impossible to reallocate goods so that no one can be made better off without making someone else worse off.

Example: Perfect competition in a market for a single good

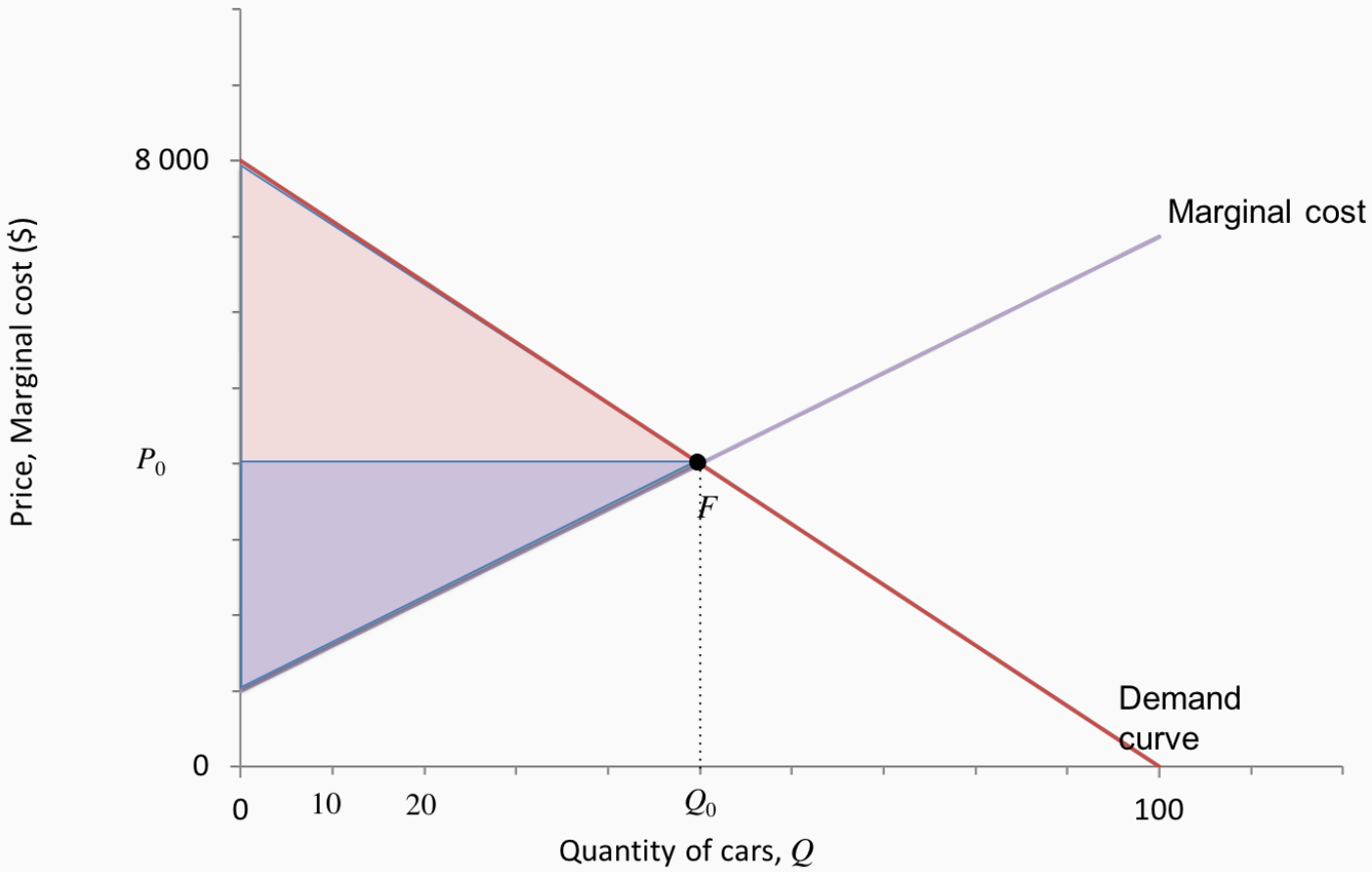

Figure 1: Demand and supply bids.

Source: CORE.

In-class exercise: Market allocation

Take note of two things:

1. Do you want to buy or sell
   - You are a buyer, if you are not an Aalto econ major
   - You are a seller, if you are an Aalto econ major
2. Your private value for the item, i.e. the maximum price you are willing to pay or the minimum price you are willing to sell the item
   - Take the alphabet ordinal number of the first letter of your first name (A = 1, B = 2, ...), use a proxy if needed.

As an example, Ilvo gets you B and 9 from the first two points.

And now let's organize a market.

Example: Market with uniform auction

Demand

- Assume that we have a group of individuals interested in buying a good. Label these individuals with $i = 1, 2, \ldots, n_i$.
- Each of the buyers can submit a one bid to buy the good.
- A bid consists of the maximum price buyer i is willing to pay, p_i, and the maximum quantity she is willing to purchase, q_i.

Supply

- Similarly, take a group of sellers, $j = 1, 2, \ldots, n_j$.
- A sales bid consists of the minimum price seller j must get to sell the good, p_j, and the maximum quantity she is willing to sell, q_j.

Example: Market with uniform auction

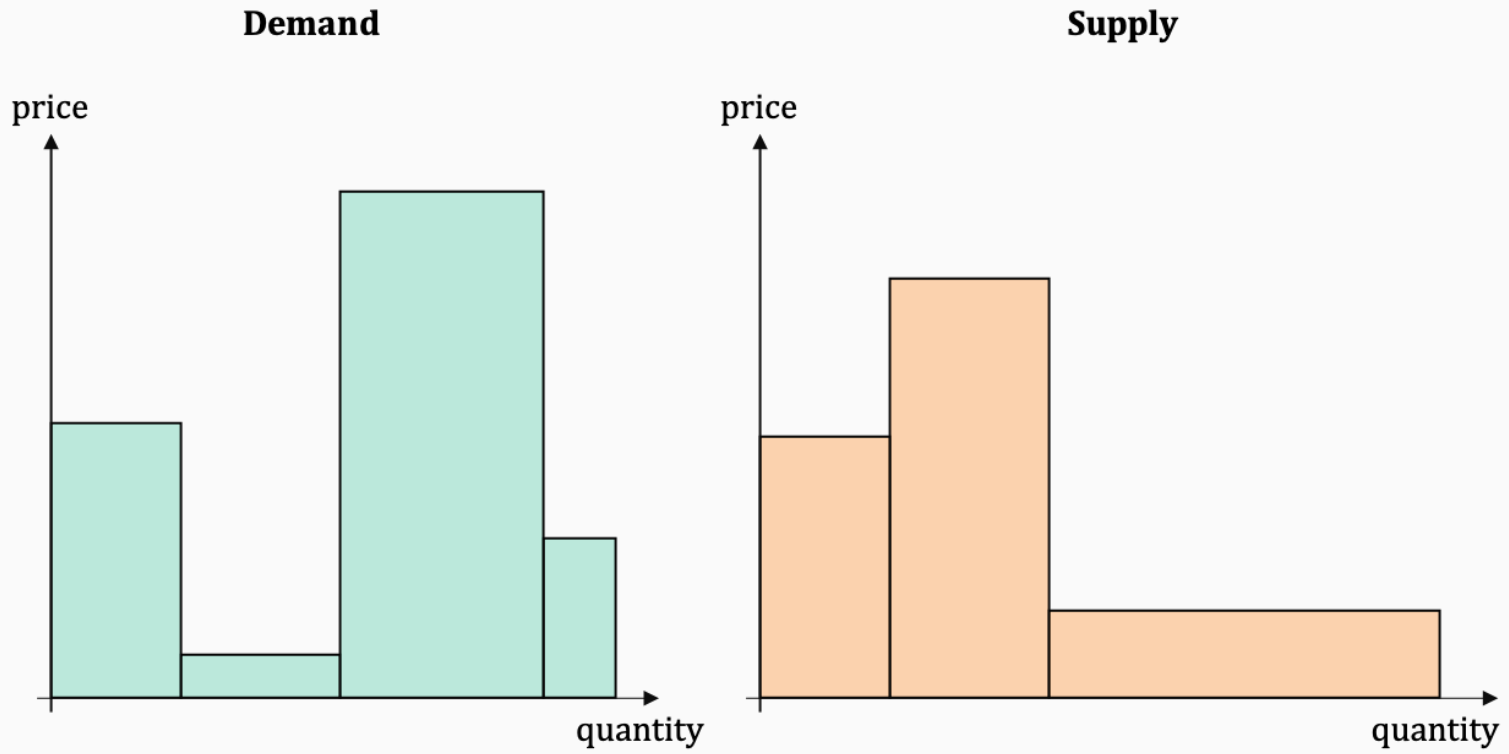

Figure 2: Demand and supply bids.

Example: Market with uniform auction

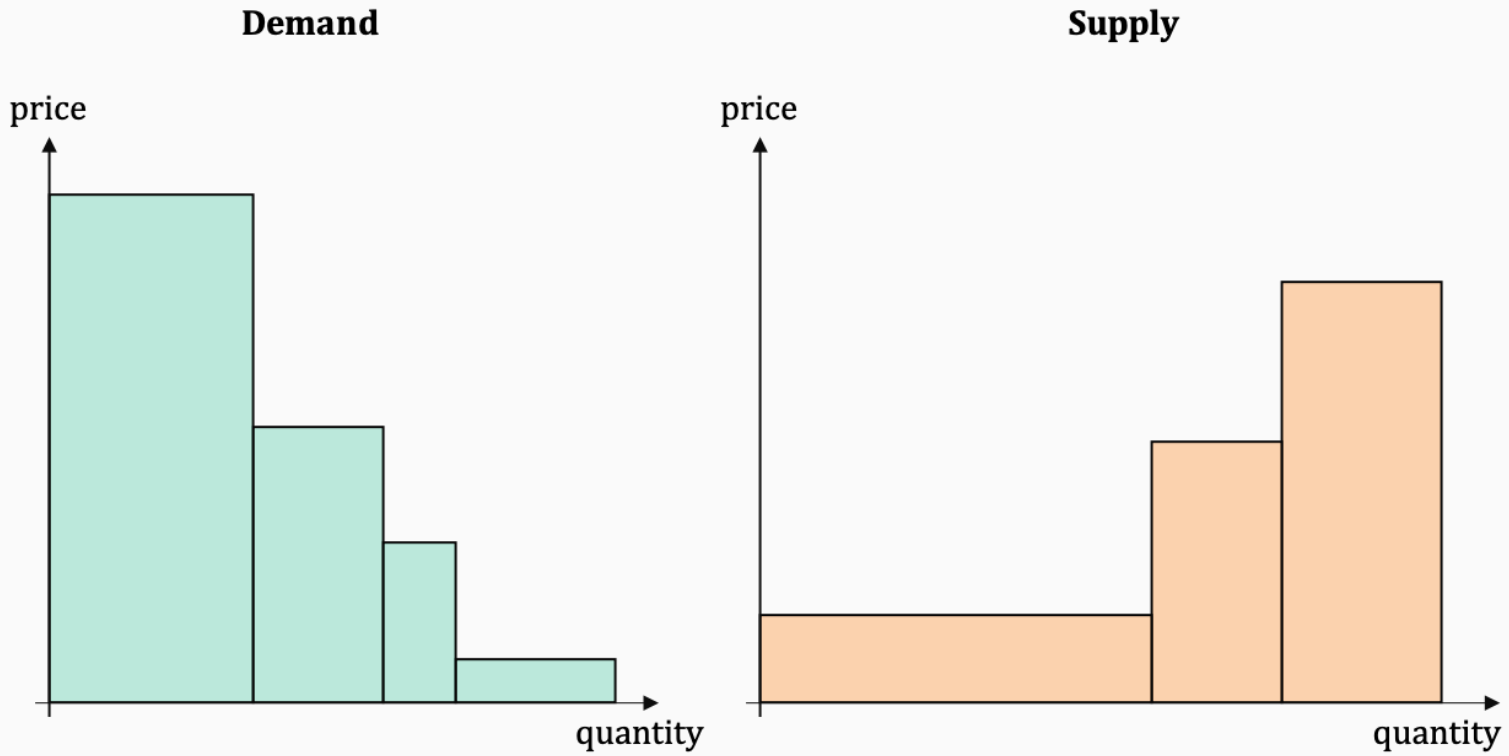

Figure 3: Demand and supply bids arranged by price.

Example: Market with uniform auction

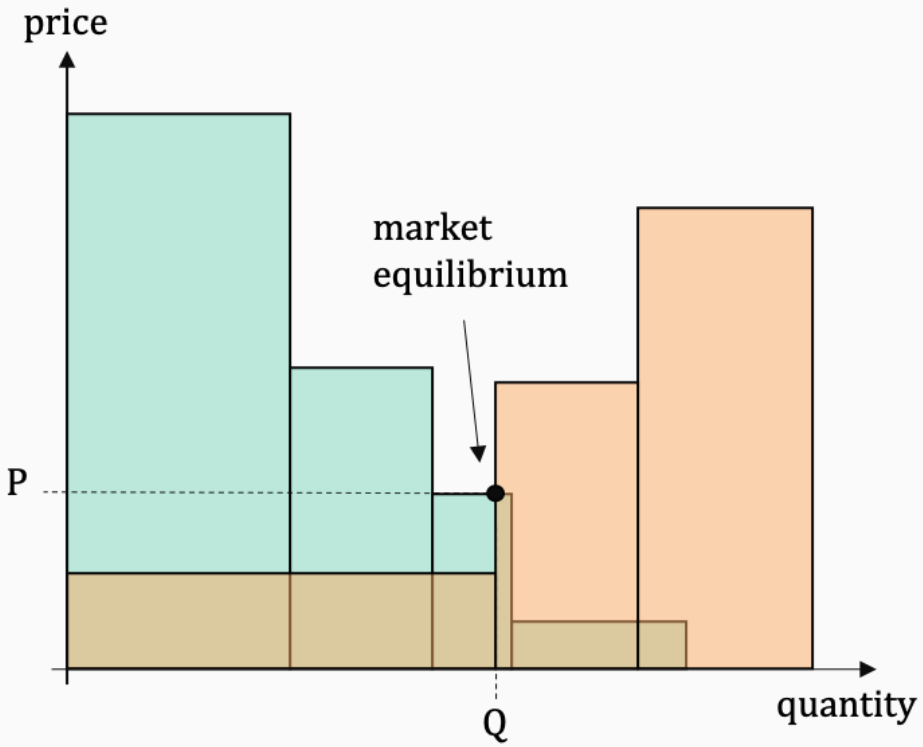

Figure 4: Demand and supply curves.

Example: Market place with uniform auction

Solving the market equilibrium

Given demand bids $(p_i, q_i)_{i \in \mathcal{D}}$ and supply bids $(p_j, q_j)_{j \in \mathcal{S}}$ for a single time period t, we solve:

$$\begin{aligned} \max_{d_i, s_j} & \sum_i p_i d_i - \sum_j p_j s_j \\ \text{s.t.} \quad & d_t = \sum_i d_i, \quad 0 \leq d_i \leq q_i, \ \forall i, \\ & s_t = \sum_j s_j, \quad 0 \leq s_j \leq q_j, \ \forall j, \\ & d_t - s_t = 0. \end{aligned}$$

The shadow price of the balance constraint $d_t - s_t = 0$ at the maximum give the equilibrium price P^* and quantity Q^*.

Example: Market with uniform auction

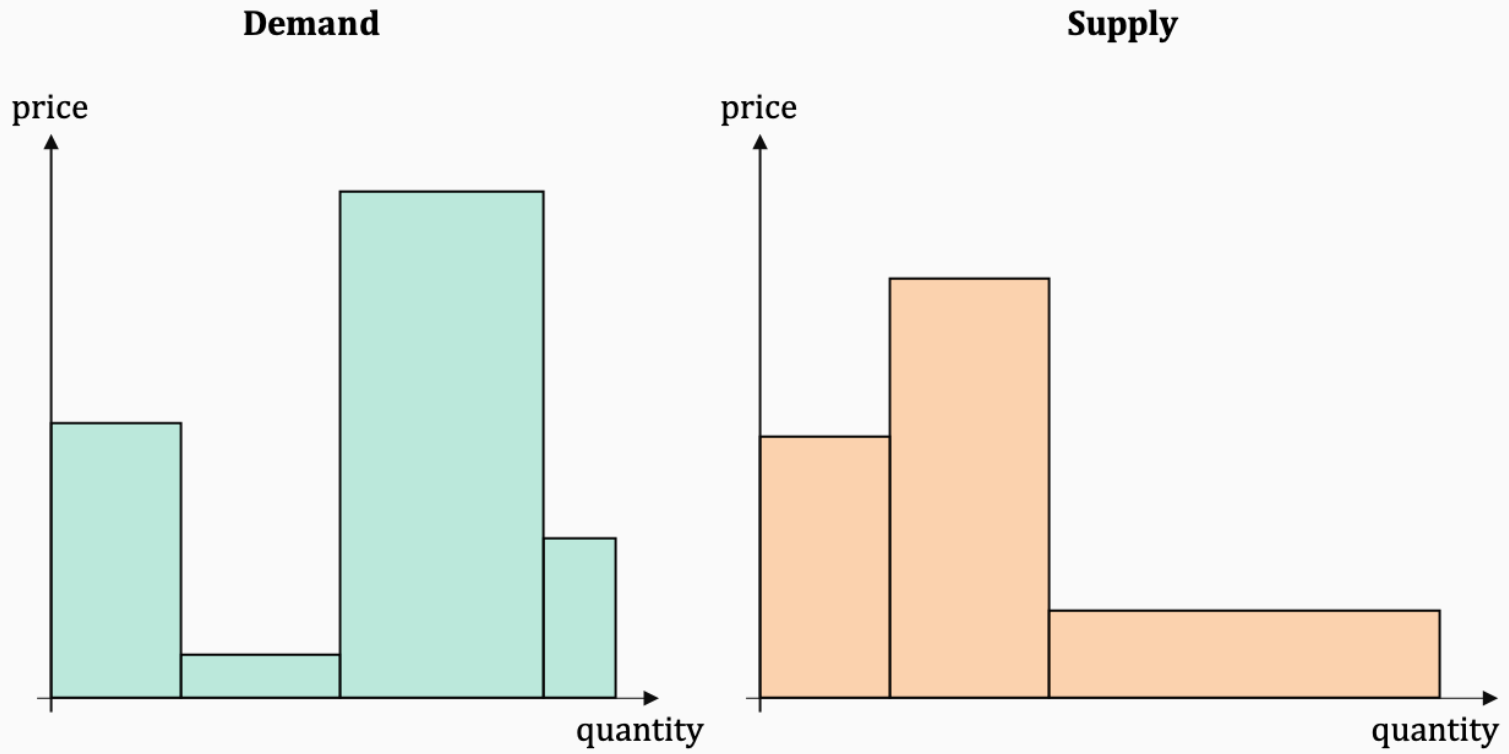

Figure 5: Balancing the market.

Example: Market place with uniform auction

Alternative interpretation

If market price is P^*, we can reformulate

$$\begin{aligned}
&\max_{d_i, s_j} \sum_i p_i d_i - \sum_j p_j s_j \\
\Leftrightarrow &\max_{d_i, s_j} \sum_i p_i d_i - P^* d_t + P^* s_t - \sum_j p_j s_j \\
\Leftrightarrow &\max_{d_i, s_j} \sum_i p_i d_i - \sum_i P^* d_i + \sum_i P^* s_j - \sum_j p_j s_j \\
\Leftrightarrow &\max_{d_i, s_j} \sum_i (p_i - P^*) d_i + \sum_j (P^* - p_j) s_j
\end{aligned}$$

But this is equivalent to the surplus maximization! The market outcome is efficient in this precise sense.

Example: Perfect competition in a market for a single good

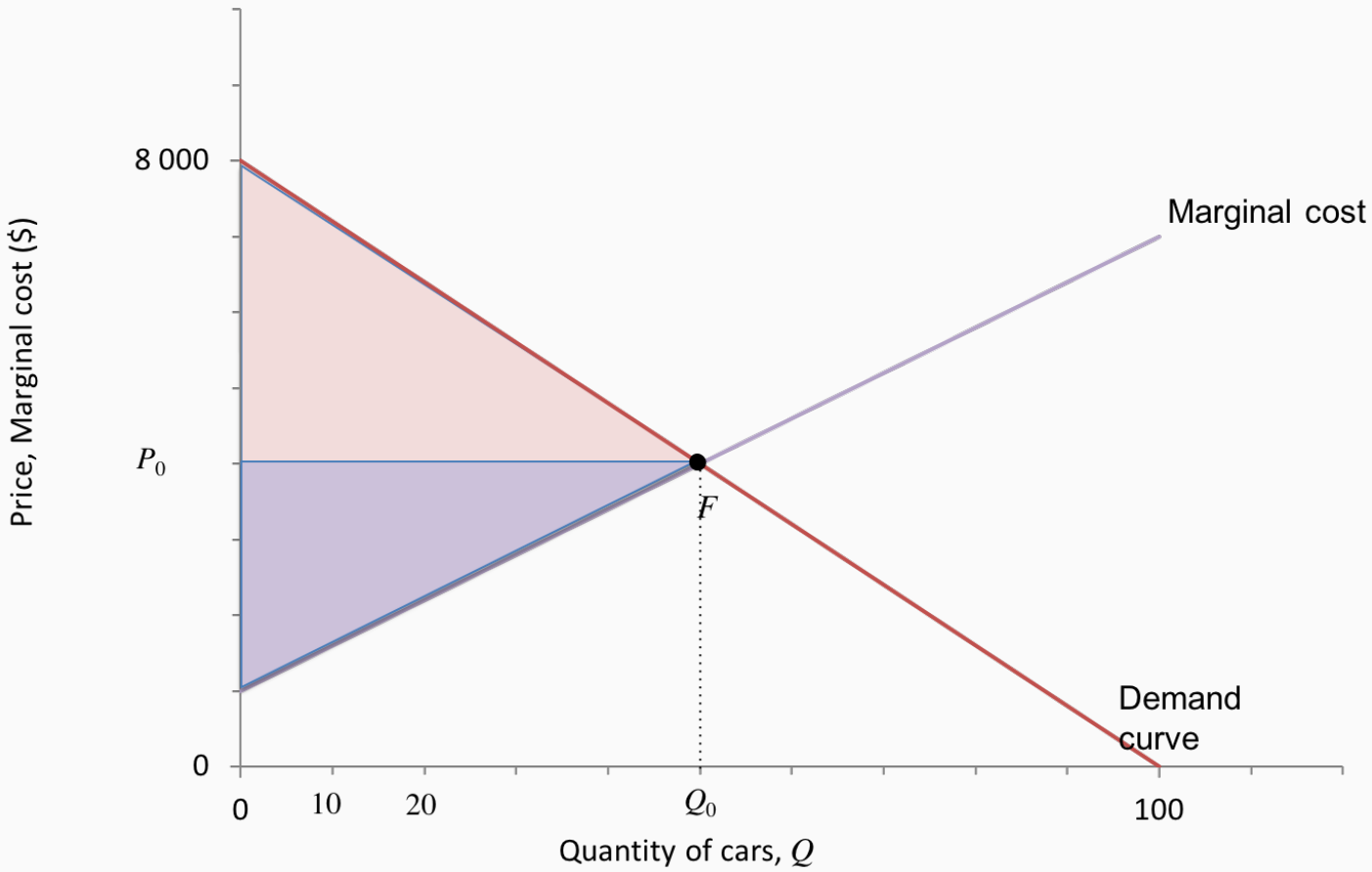

Figure 6: Demand and supply bids.

Source: CORE.

Example: Demand

bid.id	date.time	type	P	Q
1	2015-01-15 11:00:00	D	0.011	144.215
2	2015-01-15 11:00:00	D	0.029	79.928
3	2015-01-15 11:00:00	D	0.042	63.523
...	...	...	...	...
79	2015-01-15 11:00:00	D	25	0.035
80	2015-01-15 11:00:00	D	25.010	0.464
81	2015-01-15 11:00:00	D	25.145	0.881
...	...	...	...	...
165	2015-01-15 11:00:00	D	120.900	30
166	2015-01-15 11:00:00	D	123.203	25.400
167	2015-01-15 11:00:00	D	126.257	45

Table 1: Demand bids in the Nordic electricity market.

Example: Supply

bid.id	date.time	type	P	Q
1	2015-01-15 11:00:00	S	0.011	146.371
2	2015-01-15 11:00:00	S	0.029	272.917
3	2015-01-15 11:00:00	S	0.042	205.597
...	...	...	...	...
116	2015-01-15 11:00:00	S	20.007	4.999
117	2015-01-15 11:00:00	S	20.100	64.486
118	2015-01-15 11:00:00	S	20.200	32.611
...	...	...	...	...
583	2015-01-15 11:00:00	S	100.100	5.107
584	2015-01-15 11:00:00	S	108	0.569
585	2015-01-15 11:00:00	S	110	4.689

Table 2: Supply bids in the Nordic electricity market.

Illustration: demand and supply curves in practice

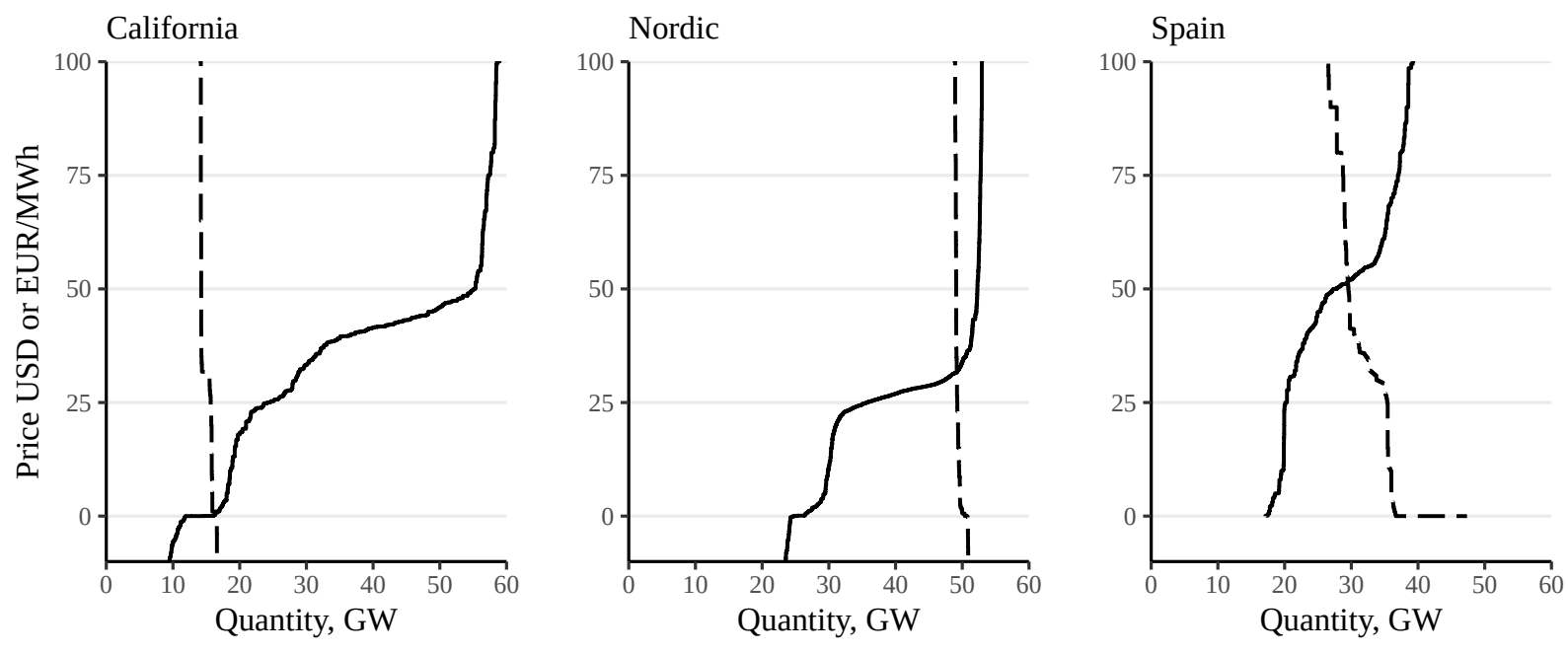

Figure 7: Demand and supply bid curves for noon 3 Apr 2017.

- We will continue with the electricity markets in the next lecture