Exit and cross-ownership

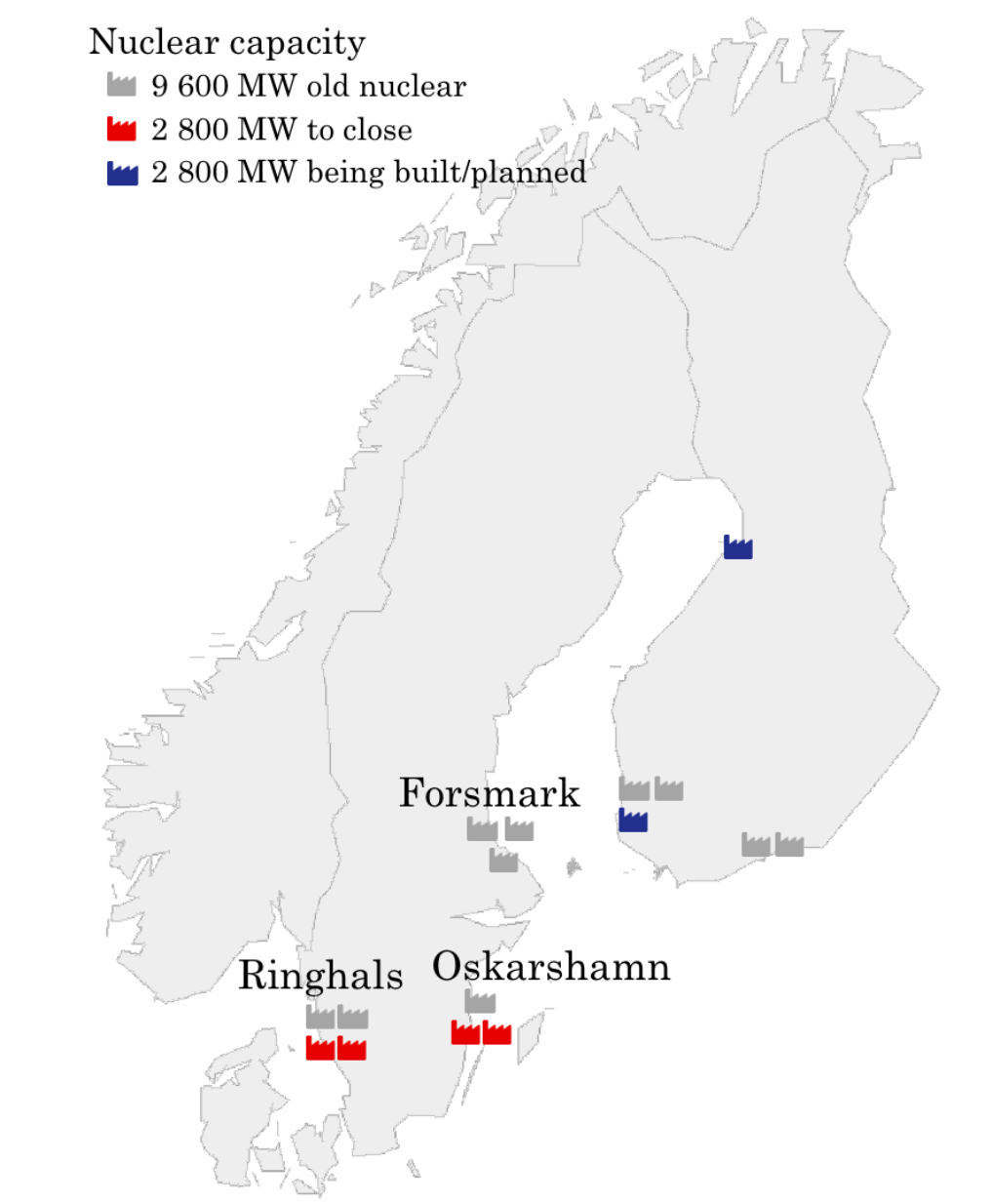
Matti LISKI
Iivo VEHVILÄINEN

Present Energy Transitions, Oslo Workshop
24 Apr 2018

Aalto University

We have received funding from the Academy of Finland program "New Energy".

Nordic nuclear industry – ca. 25% of supply



Main results

- We show that cross-ownership allows firms to achieve noncompetitive capacity phase-out.
- We quantify effects for the Nordic nuclear industry facing a declining market due to subsidized entry of renewable power.
- In our computation, cross-ownership induced closures:
  1. Add consumer costs by 5+ billion euro/year (75 %).
  2. Increase annual emissions by 30+ MtnCO_2 per year.

Connection to the energy transition

Climate and energy policies

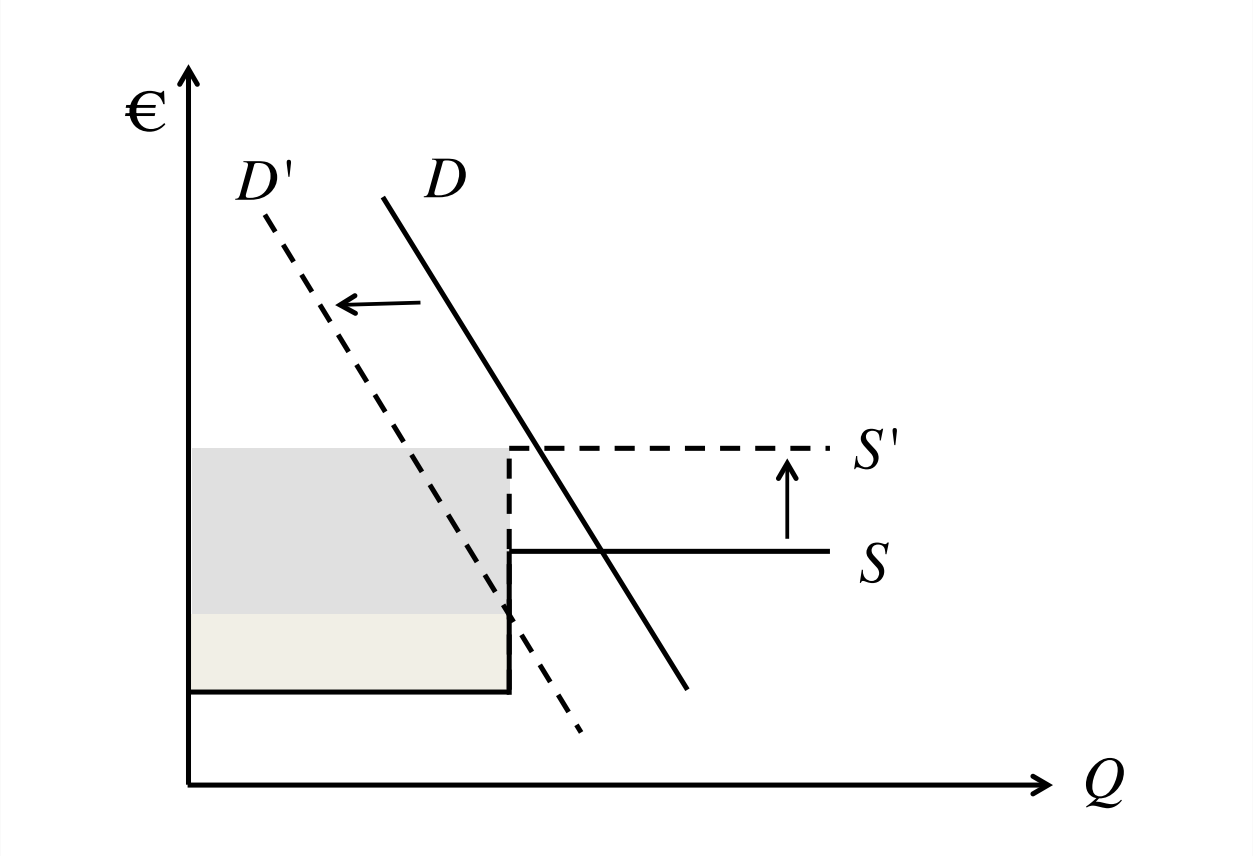
$\rightarrow$ *a growing market* for renewable energy technologies

- The world is investing a quarter of trillion euros annually in renewable energy technologies (IEA, 2015)

$\rightarrow$ *a declining market* for the incumbent technologies

- Must adjust their capacity utilization
- Ultimately exit the market

Policy choices impact the incidence of costs



- Ideally: taxes or other penalties on old technologies
- Less-than-ideally: subsidies to new technologies

Incumbents' equilibrium response: exit

The phase-out of nuclear in the Nordics

- Few large players in the market: there is no reason for them to take the policy-driven decline in the demand as given.
- By retiring some capacity early, the industry can influence the demand left for the capacity remaining in the market.

Declining market leads to a war of attrition

Exit in oligopoly

- Declining demand
- Lumpy closures of capacity: price jumps at closure times
- In equilibrium:
  - Firms exit in the size order, largest first
  - At exit time of firm i: $p_t = mc_i$

Simple model – first without cross-ownerships

Case of a duopoly

- Two firms, i and j, own plants K and k, $K > k$.
- Inverse demand function $p_t(Q)$.
- Marginal cost of production c.
- Payoffs defined with:

$$\pi_t(K, k) = (p_t(K + k) - c)K$$

Illustration of the equilibrium argument

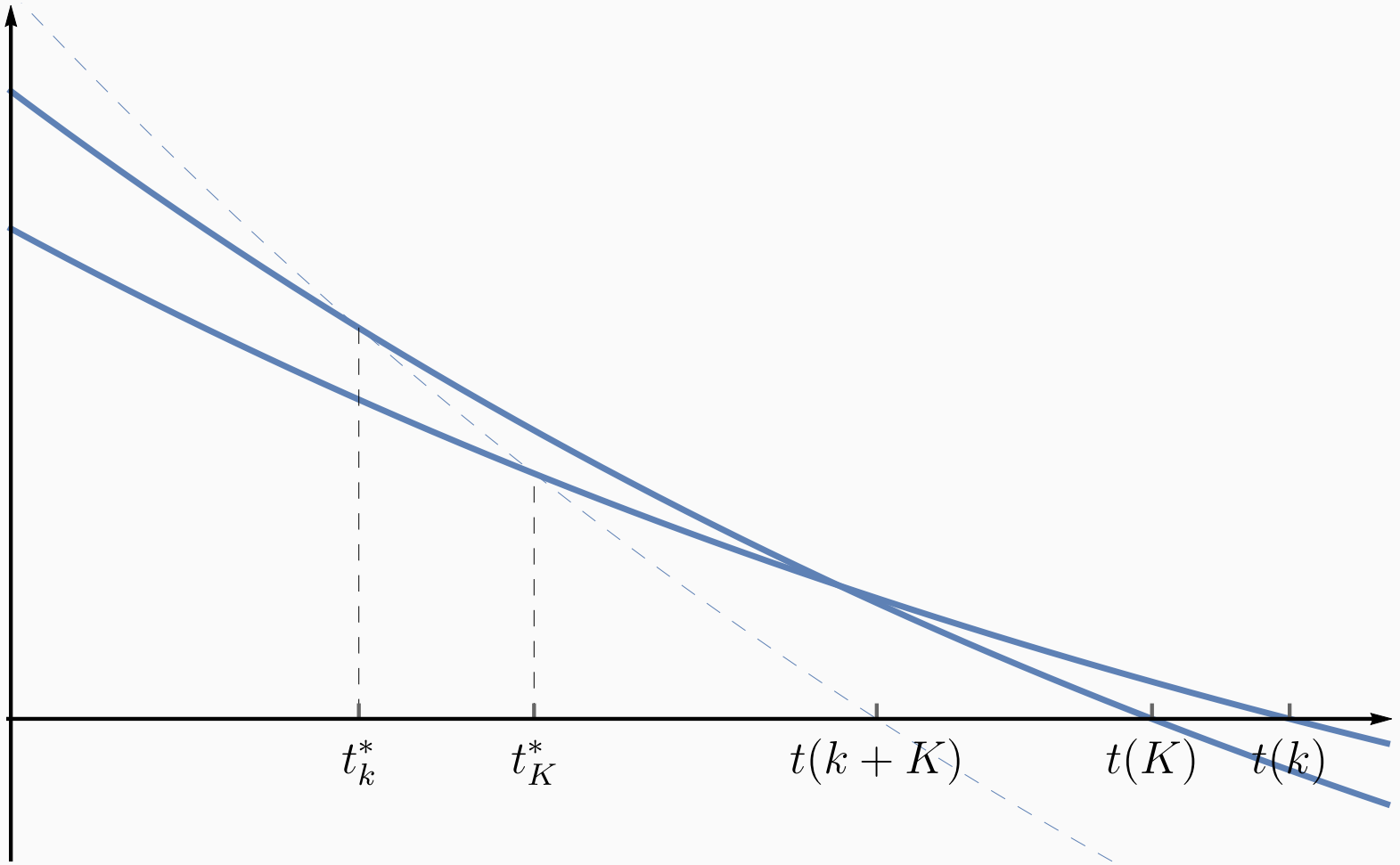


Figure 1: Flow profits over time. Sizes of the plants determine latest closing times, $t(k)$ and $t(K)$, which in turn determine the order of closure in equilibrium.

Impact of the ownership structure to exit

Cross-ownership changes the nature of the game

- The very same firms own assets that benefit from closures: e.g. shares in remaining assets run by other firms or other own production assets.
- Allows firms to internalize the closure externalities.

Simple model – with cross-ownerships

- Larger firm i owns a share α of j.
- Smaller firm j owns a share β of i.
- Payoffs are

$$\begin{aligned} \pi_t^i &= (1-\beta)\pi_t(K,k) + \alpha\pi_t(k,K) \\ \pi_t^j &= \beta\pi_t(K,k) + (1-\alpha)\pi_t(k,K) \end{aligned}$$

- When $K > k$ and market large enough to start with we show:
  - No $\alpha < 1$ that reverses order of closure.
  - There is $\beta^* \in (0,1)$, s.t. $\forall \beta > \beta^*$ order of closure is reversed.
  - Any $\alpha + \beta = 1$ results in fully collusive outcomes.

Application: The case of nuclear phase out in Sweden

1. Impact of renewables to supply–demand balance
2. Prices from an estimate for the thermal supply curve
3. Model game as above, two cases:
    - Cross-ownerships within the nuclear industry only
    - Cross-ownerships including hydro assets
4. Simulate with backward induction

Renewable entry lowers prices

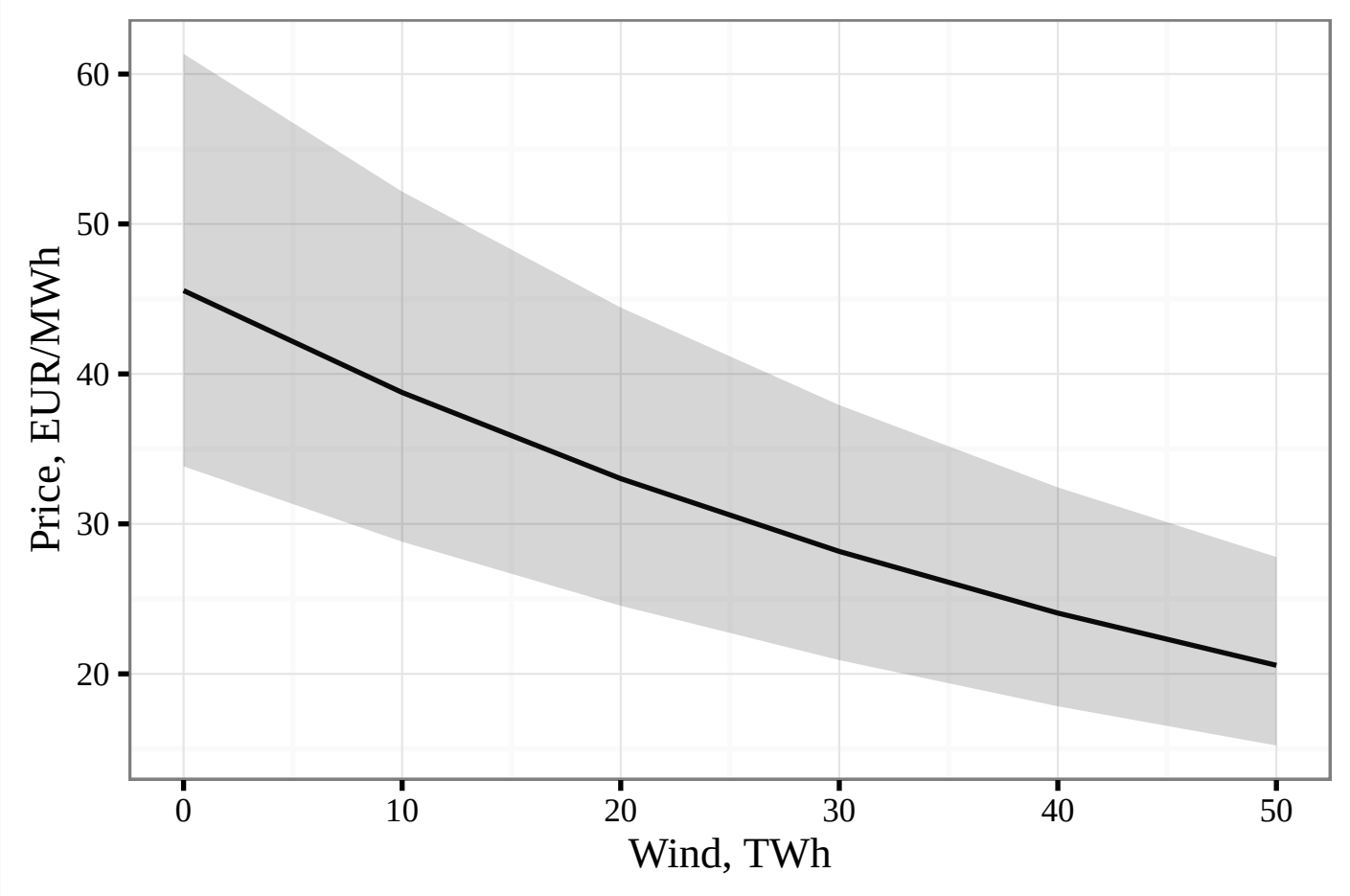


Figure 2: Annual mean price in the Nordics with increasing wind.

Source: Liski and Vehviläinen (2017)

Ownership structure of the Swedish nuclear industry

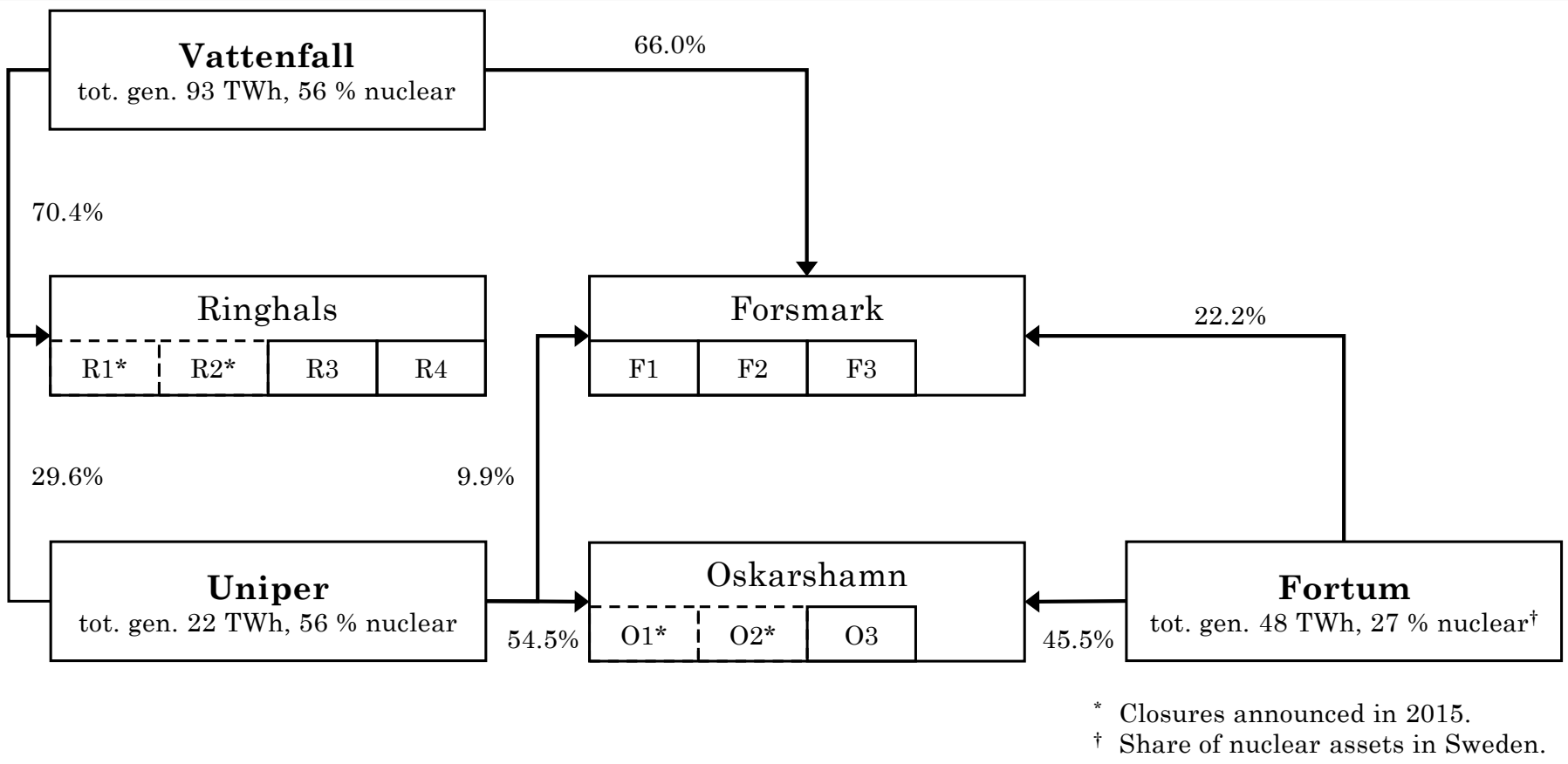
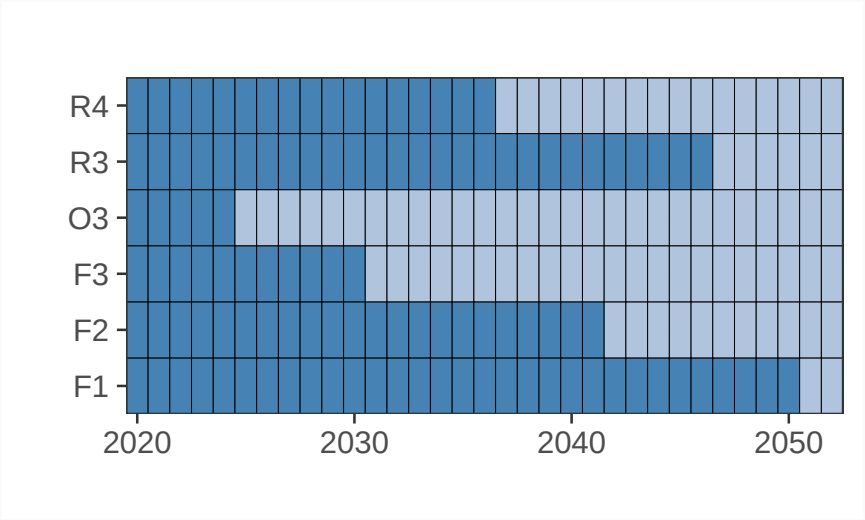


Figure 3: Three plant sites, ten reactor units, three main owners.

Ownership structure makes phase-out path non-competitive

(a) Competitive equilibrium



(b) Cross-ownerships (nuclear only)

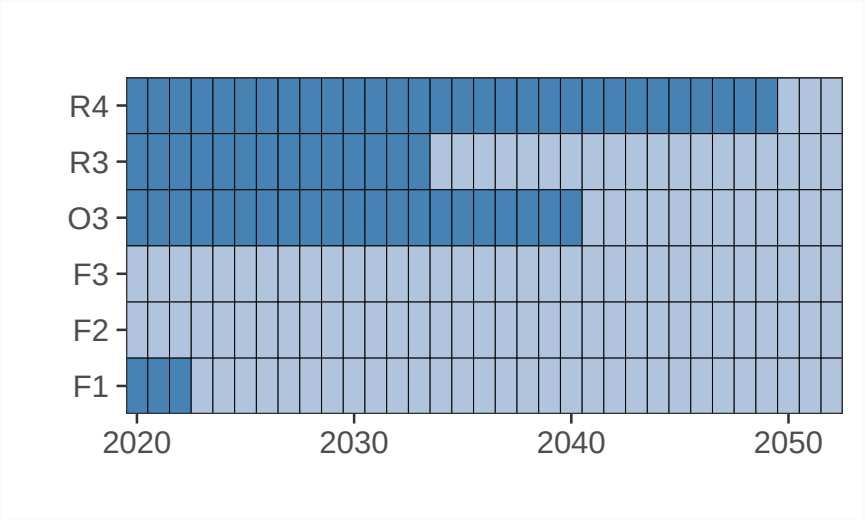


Figure 4: Impact of ownership to closure decisions. Dark blue = running, light blue = closed.

Ownership structure leads to higher prices

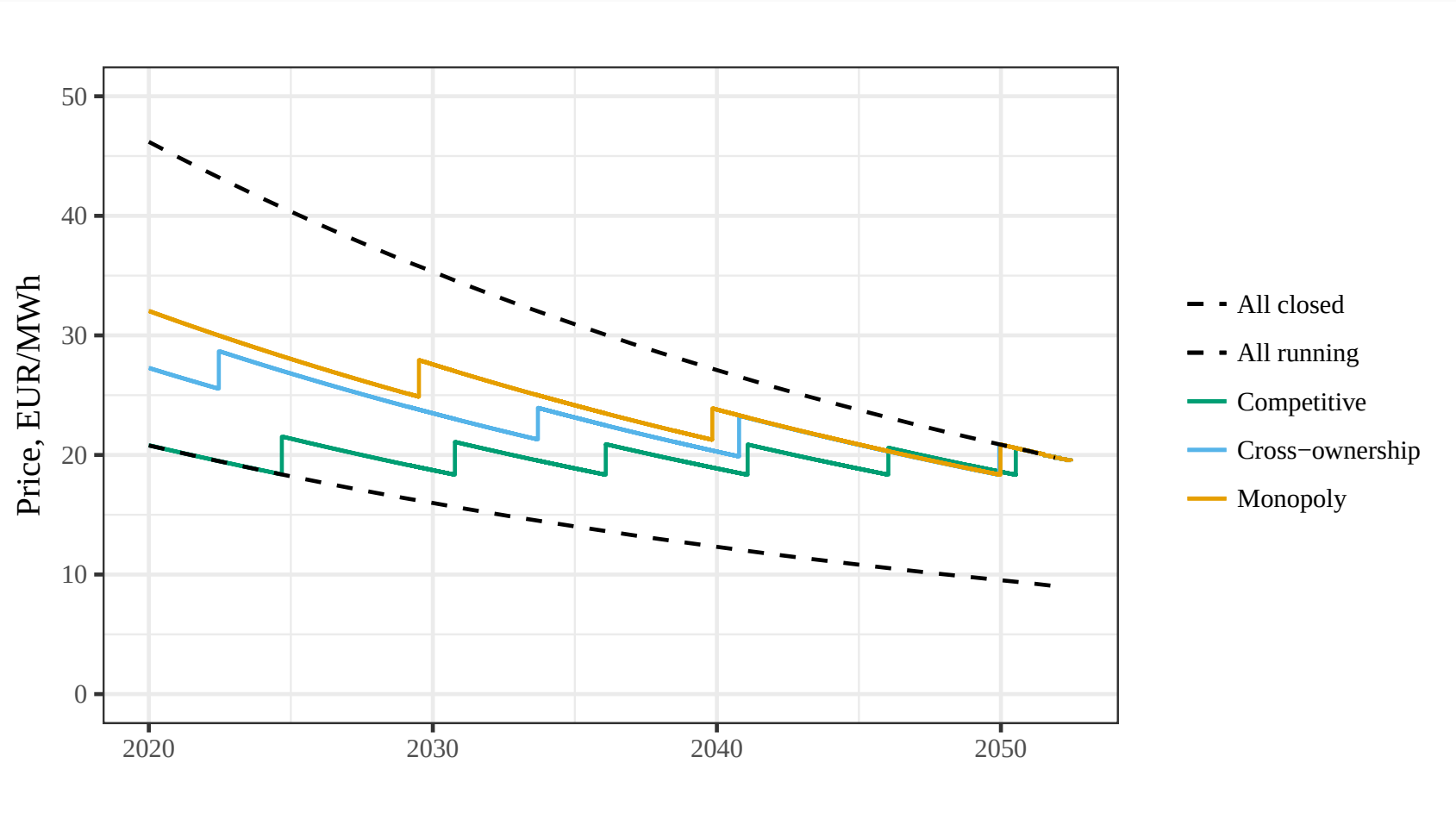


Figure 5: Price paths in equilibrium outcomes (with nuclear industry only).

Early closures lead to higher consumer cost and emissions

Table 1: Summary with nuclear assets only, mean values for 2020–2029.

Case	Price EUR/MWh	Industry MEUR/a	Market MEUR/a	Nuclear TWh/a	Emissions MtCO2/a
All running	18.3	-2	6,909	49.5	0
Competitive	19.8	64	7,490	44.3	4.9
Cross-ownership	26.1	212	9,861	27.2	21.1
Monopoly	28.3	219	10,683	22.3	25.7
All closed	40.6	0	15,311	0	46.8

- Small gains to industry create large shifts in surplus.
- Reduction of nuclear increases emissions.

Even larger impacts with full portfolio of assets included

Table 2: Summary with hydro assets, mean values for 2020–2029.

Case	Price EUR/MWh	Industry MEUR/a	Market MEUR/a	Nuclear TWh/a	Emissions MtCO2/a
All running	18.3	837	6,909	49.5	0
Competitive	19.8	1,001	7,490	44.3	4.9
Cross-ownership	34.5	2,025	13,042	9.9	37.4
Monopoly	40.6	2,244	15,311	0	46.8
All closed	40.6	2,244	15,311	0	46.8

- Cross-ownerships with hydro assets: only one unit stays.
- Even higher environmental impacts: about half of the total emissions in any single Nordic country.

Conclusions

- Cross-ownership arrangements can eliminate free-riding incentives and achieve collusive exit decisions from the market.
- In the Swedish nuclear case, the incumbents are strongly incentivized to reorganize their assets:
  - Renewable subsidies impact prices, and expectations.
  - Intricate cross-ownership structure to start with.
  - Closures announced already for 4/10 units.
- Climate and energy policy implications, in addition to the clear antitrust interest.