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Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

The Case of the England and Wales Electricity Market

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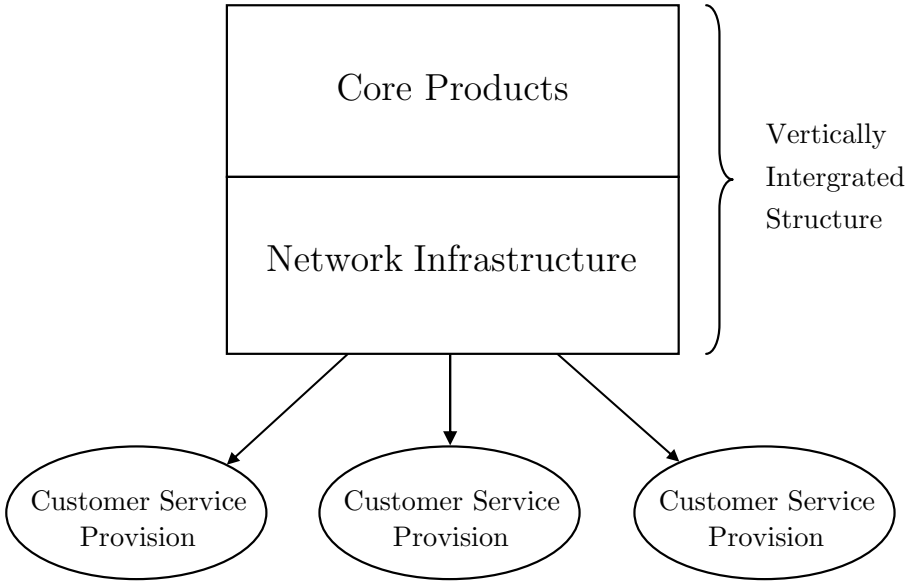
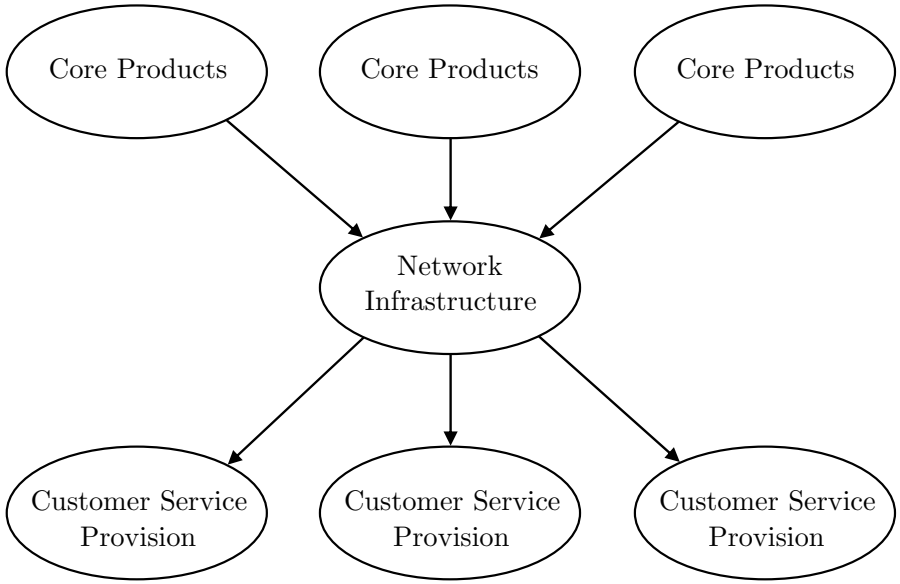
Fig. 1: *Structure of a Network Industry* **before** *and* **after** *Liberalization*

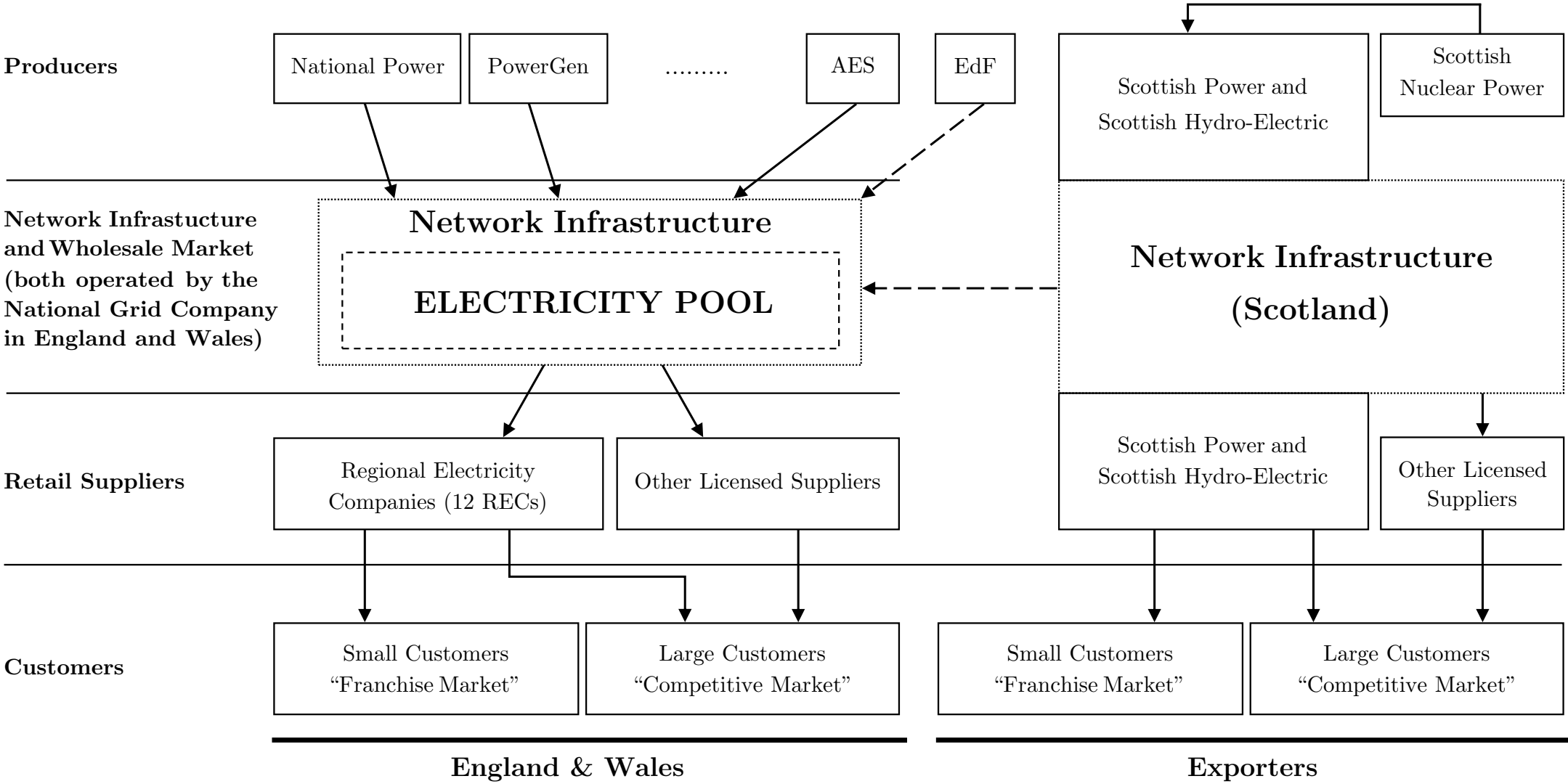


(a) Vertically Integrated Case



(b) Vertically Separated Case

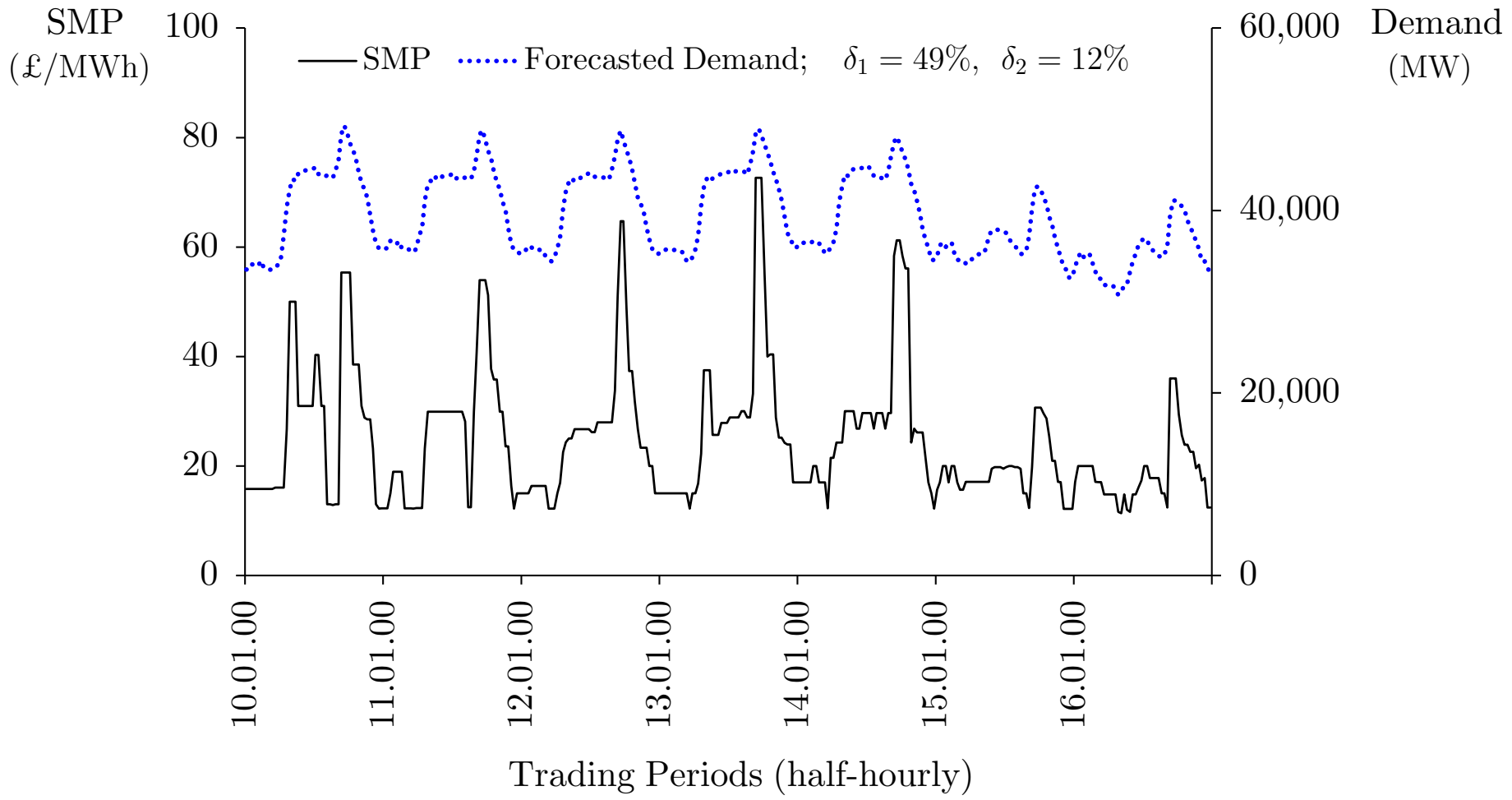
Fig. 2: *Description of the Electricity Industry in Great Britain*



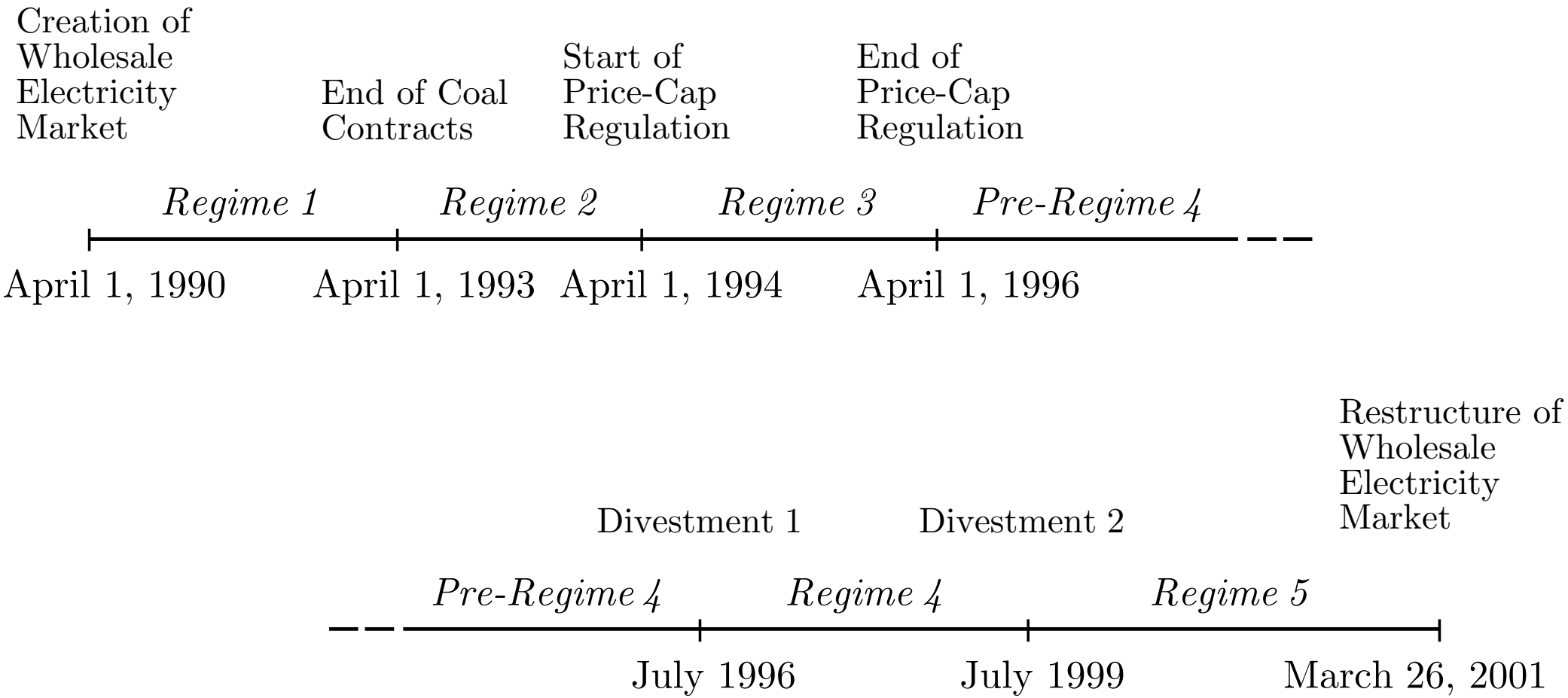
- The Key Questions to Analyze Liberalization
  - Does liberalization provide allocative efficiency?
  - Does liberalization lower prices?
- Case Study
  - Wholesale electricity market in England and Wales

- Motivation

Fig. 3: *SMP and Demand for Electricity (10.01.2000–16.01.2000)*



Institutional Changes and Regulatory Reforms



Do Producers Apply a Capacity Cutting Strategy to Increase Prices? The Case of the England and Wales Electricity Market

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Motivation

Policy Importance

- Capacity cutting:
  - necessity to operate more expensive production facilities
  - higher electricity prices for consumers

Research Question

- Were regulatory reforms successful at mitigating the noncompetitive capacity bidding?

Research Approach

- comparison of capacity bids during low- and high-demand periods
- two-stage regression model

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Literature Review

  - **Wolak and Patrick (2001)**
    Capacity bids are a more "high-powered" instrument than price bids for strategic bidding.

  - **Green (2011)**
    Increased benefits from withholding capacity usually did not exceed the costs of keeping plants open. Therefore, there is weak evidence for large-scale capacity withholding.

  - **Sweeting (2007)**
    Market power, measured based on the margins between wholesale prices and competitive benchmark prices, has increased. Furthermore, the incumbent producers could have increased profits by decreasing price bids and increasing output. The results are explained as the evidence of possible tacit collusion.

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Literature Review (*cont.*)

  - **Dechenaux and Kovenock (2007)**
    Capacity cutting could be necessary to sustain collusion in a market operated as a uniform price auction.

  - **Joskow and Kahn (2002)**
    Remaining large deviations of output prices from the competitive benchmark prices could be due to strategic capacity bidding.

  - **Fridolfsson and Tangerås (2009)**
    Producers may have an incentive to withhold base-load nuclear plants.

  - **Castro-Rodriguez *et al.* (2009)**
    Capacity bids are an alternative instrument to price bids, through which producers may affect prices.

Fig. 4: *Half-Hourly One-Sided Uniform Price Auction (Hypothetical)*

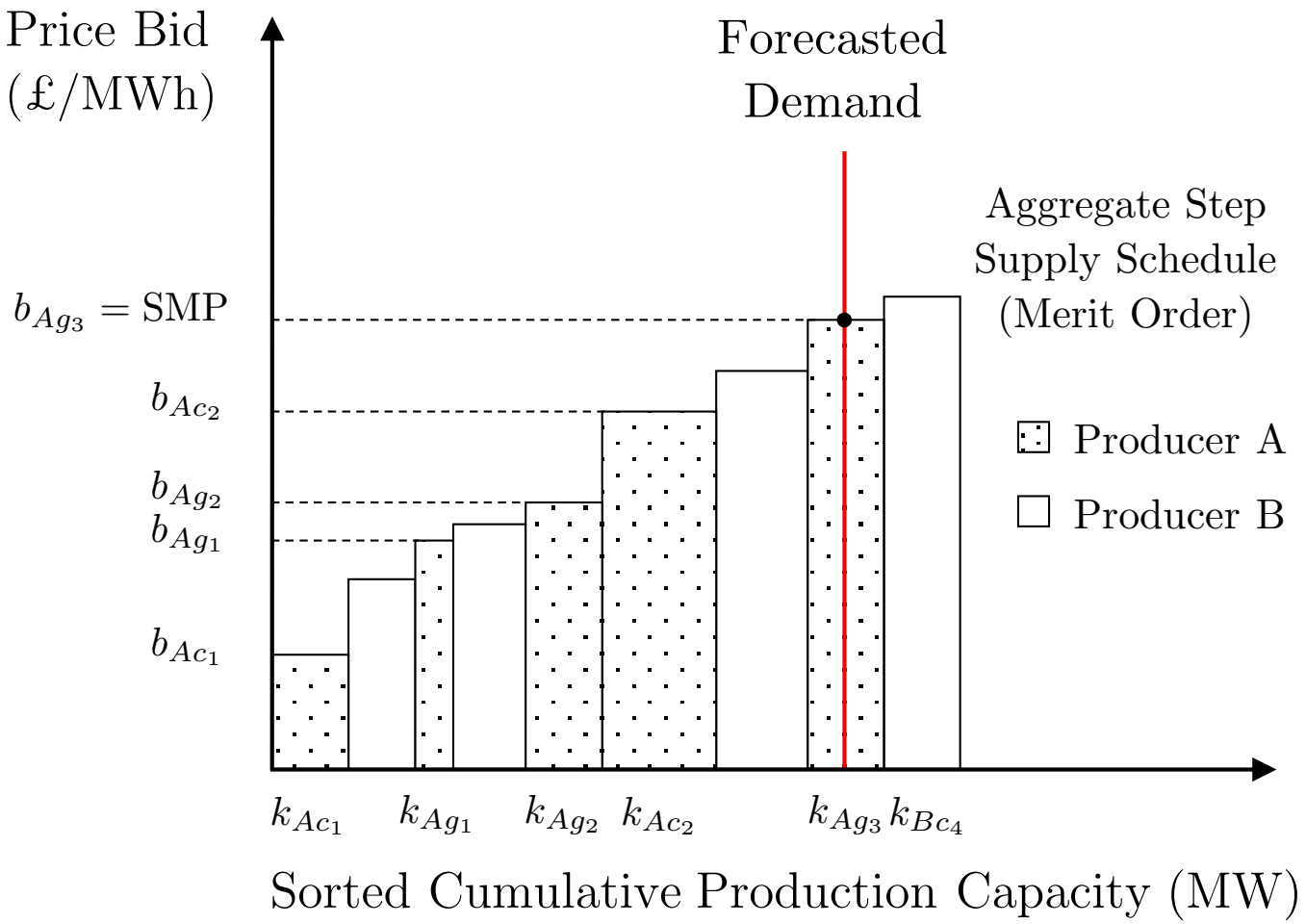
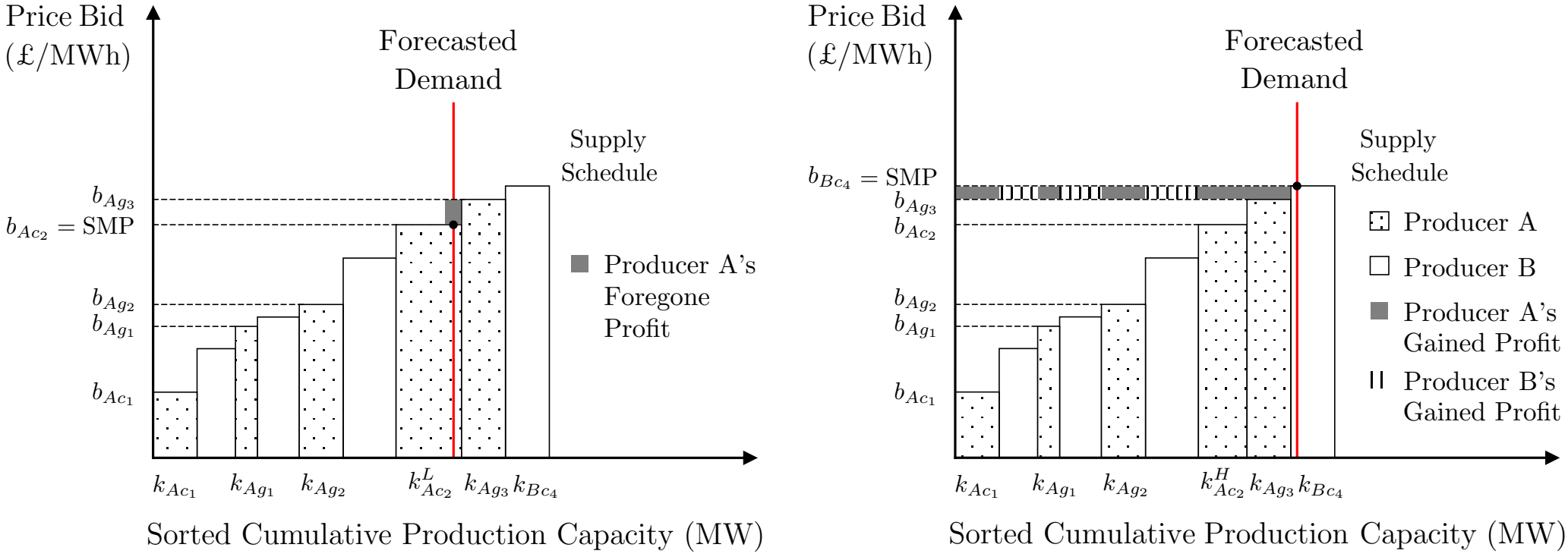


Fig. 5: *What is Capacity Cutting? No Cutting vs. Cutting*



(a) Low-Demand Trading Period

(b) High-Demand Trading Period

A wholesale price increases due to two factors:

1) a capacity bid for a coal production unit has been decreased: $k^H_{Ac_2} < k^L_{Ac_2}$;

2) demand has increased.

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Data

We compare peak- and low-demand trading periods. For this purpose we compute relative changes of variables during the peak-demand trading period compared to the same day preceding low-demand trading period.

We use two data sets covering the period January 1, 1995–September 30, 2000:

1. Market Data on forecasted demand and wholesale price for each trading period (see Tables 1 and 2)
2. Capacity Bidding Data (i.e., declared availability) for each trading period, which also includes the identity of an electricity producer, plant, production unit, and capacity (input) type (see Tables 3 and 4).

Table 5 summarizes the incidence of noncompetitive and competitive capacity bidding behaviors during January 1, 1995–September 30, 2000.

- Market Data

Table 1: *Sample of descriptive statistics for market data (1.1.2000–31.1.2000)*

	Forecasted Demand (MW)	SMP (£/MWh)
Mean	38464.60	24.39
Min	25001.00	8.00
Max	49945.00	77.89
Std Dev	5247.83	12.54
Frequency	30 min	30 min
Obs	1488	1488

Table 2: *Relative changes in market demand (MW) and SMP (£/MWh)*

$\text{Demand}_{t,(\tau-5\text{hrs})}$	$\text{Demand}_{t\tau}$	Growth in Demand_t	$\text{SMP}_{t,(\tau-5\text{hrs})}$	$\text{SMP}_{t\tau}$	Growth in SMP_t
42825	48215	0.126	55.56	77.89	0.402

Note: Subscript t is trading day (January 6, 2000) and τ is peak-demand trading period (17:30).

- Capacity Bidding Data

Table 3: *Sample of descriptive statistics for capacity bidding data (1.1.2000–31.1.2000)*

	Capacity Bid (MW)
Mean	175.41
Min	0.00
Max	989.00
Std Dev	248.12
Frequency	30 min
Obs	450336

Notes for Table 4:

k denotes capacity and Δk_{ijt} denotes a relative change in capacity. Subscript i is producer, j is capacity type, l is production unit, t is trading day (January 6, 2000), and τ is peak-demand trading period (17:30). Capacity cutting (i.e., noncompetitive capacity bidding) is defined as a reduction of capacity during the peak-demand period compared to the same day preceding low-demand period.

Table 4: *Relative change in capacity bids during January 6, 2000*

Producer	Type	$\sum_{l \in j} k_{ilt,(\tau-5\text{hrs})}$ (MW)	$\sum_{l \in j} k_{ilt,\tau}$ (MW)	Δk_{ijt}	Case consistent with strategy
NP	Large Coal	4845	4350	-0.102	noncompetitive
	Medium Coal	1306	1306	0	competitive
	Oil	1180	1180	0	competitive
	CCGT	3265	3295	0.009	competitive
	OCGT	412	412	0	competitive
PG	Large Coal	4346	4346	0	competitive
	Oil	1350	1350	0	competitive
	CCGT	2991	3032	0.014	competitive
	OCGT	191	191	0	competitive
BNFL	Nuclear	2449	2449	0	competitive
SI	Export	1514	1514	0	competitive
	CCGT	2843	2843	0	competitive
TXU	Large Coal	3792	3792	0	competitive
	Medium Coal	1774	1774	0	competitive
	CCGT	595	595	0	competitive
	OCGT	90	90	0	competitive
Ed	Large Coal	2946	2946	0	competitive
	OCGT	68	68	0	competitive
	PSB	2088	1998	-0.043	noncompetitive
BE	Nuclear	5461	5483.4	0.004	competitive
AES	Large Coal	3225	3225	0	competitive
	CCGT	250	250	0	competitive
	OCGT	215	215	0	competitive

Table 5: *Incidence of noncompetitive and competitive capacity bidding*

Case		Producer	Large Coal	Medium Coal	Small Coal	Oil	Nuclear	CCGT	OCGT	PSB	Export
Competitive bidding consistent	No (cutting)	NP	186	112	17	29	–	885	143	–	–
		PG	346	16	–	18	–	1015	67	–	–
		BNFL	–	–	–	–	198	–	–	–	–
		SI	–	–	–	–		113	–	–	80
		TXU	214	89	–	–	–	173	22	–	–
		Ed	28	–	–	–	–	–	–	41	–
		BE	5	–	–	–	122	–	–	–	–
		AES	11	–	–	–	–	25	15	–	–
	Yes (no change)	NP	1437	1705	1380	1935	–	509	1597	–	–
		PG	1174	302	–	1528	–	371	1897	–	–
		BNFL	–	–	–	–	1588	–	–	–	–
		SI	–	–	–	–		1662	–	–	1570
		TXU	601	670	–	–	–	1510	1478	–	–
		Ed	332	–	–	–	–	–	–	905	–
		BE	139	–	–	–	1138	–	–	–	–
		AES	428	–	–	–	–	694	1312	–	–
	Yes (expanding)	NP	406	180	79	64	–	633	289	–	–
		PG	509	51	–	195	–	643	65	–	–
		BNFL	–	–	–	–	243	–	–	–	–
		SI	–	–	–	–		252	–	–	374
		TXU	705	501	–	–	–	290	48	–	–
		Ed	77	–	–	–	–	–	–	1072	–
		BE	85	–	–	–	377	–	–	–	–
		AES	11	–	–	–	–	19	13	–	–

Note: Capacity cutting (i.e., noncompetitive capacity bidding) is defined as a reduction of capacity during the peak-demand period compared to the same day preceding low-demand period.

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Empirical Framework

Regression Model for Noncompetitive Capacity Bidding:

$$\Delta k_{ijt} = \alpha + \beta_{ij} \cdot \text{growth in demand}_t + \varepsilon_{ijt},$$

where

i, j, t – producer, input type, trading day

Δk_{ijt} – a relative decrease in submitted (declared) capacity

growth in demand – a relative increase in forecasted demand

Research Hypotheses:

1) $\mathbf{H_0}$: $\beta_{ij} = 0$ (no capacity cutting resulting as a response to demand increase)

2) $\mathbf{H_0}$: $\beta_{ij}^{\text{before}} = \beta_{ij}^{\text{after}}$ (no effect of reforms)

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Empirical Framework

Heckman's two-step procedure

$$\mathrm{P}(\text{Decision} = 1|\mathbf{x}) \;=\; \Phi(a + b_{ij} \cdot \text{growth in demand}_t + c_{ij} \cdot \text{growth in SMP}_t) \quad (1)$$

$$\Delta k_{ijt} \;=\; \alpha + \beta_{ij} \cdot \text{growth in demand}_t + \gamma \cdot \hat{\lambda}_{ijt} + \varepsilon_{ijt}\,, \quad (2)$$

where

i, j, t – producer, input type, trading day

Δk_{ijt} – a relative decrease in submitted (declared) capacity

growth in demand – a relative increase in forecasted demand

growth in SMP – a relative increase in the wholesale price

$\hat{\lambda}_{ijt}$ is estimated as a ratio of $\hat{\phi}(\cdot)$ and $\hat{\Phi}(\cdot)$.

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Empirical Framework

Regression Model for Noncompetitive Capacity Bidding (modified):

$$\Delta k_{ijt} \;=\; \alpha + \beta_{ij} \cdot \text{growth in demand}_t + \gamma \cdot \hat{\lambda}_{ijt} + \varepsilon_{ijt}\,,$$

where

i, j, t – producer, input type, trading day

Δk_{ijt} – a relative decrease in submitted (declared) capacity

growth in demand – a relative increase in forecasted demand

growth in SMP – a relative increase in the wholesale price

$\hat{\lambda}_{ijt}$ is estimated as a ratio of $\hat{\phi}(\cdot)$ and $\hat{\Phi}(\cdot)$.

Note: If $\hat{\gamma}$ is statistically significant, then we can conclude that there would have been a sample selection bias, had we not included $\hat{\lambda}_{ijt}$ in the amount equation.

Paper Do Producers Apply a Capacity Cutting Strategy to Increase Prices?

- Results:

Probit Selection Equation: *Strategy Choice*

Amount Equation: *Noncompetitive Capacity Bidding*

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- Findings and Conclusions

  - There is statistical evidence for noncompetitive capacity bidding during peak-demand periods.
  - Regulatory reforms to mitigate the noncompetitive capacity bidding affected differently the incumbent producers. This we explain as the possible consequence of unequal horizontal restructuring.
  - We also find statistical evidence for capacity cutting by the BE and AES producers.
  - An application of Heckman's two-step procedure is justified. In this way it has become possible to estimate the model parameters free of sample selection bias.

Thank You

- Motivation

Fig. 6: *SMP and Demand for Electricity (9.01.1995–15.01.1995)*

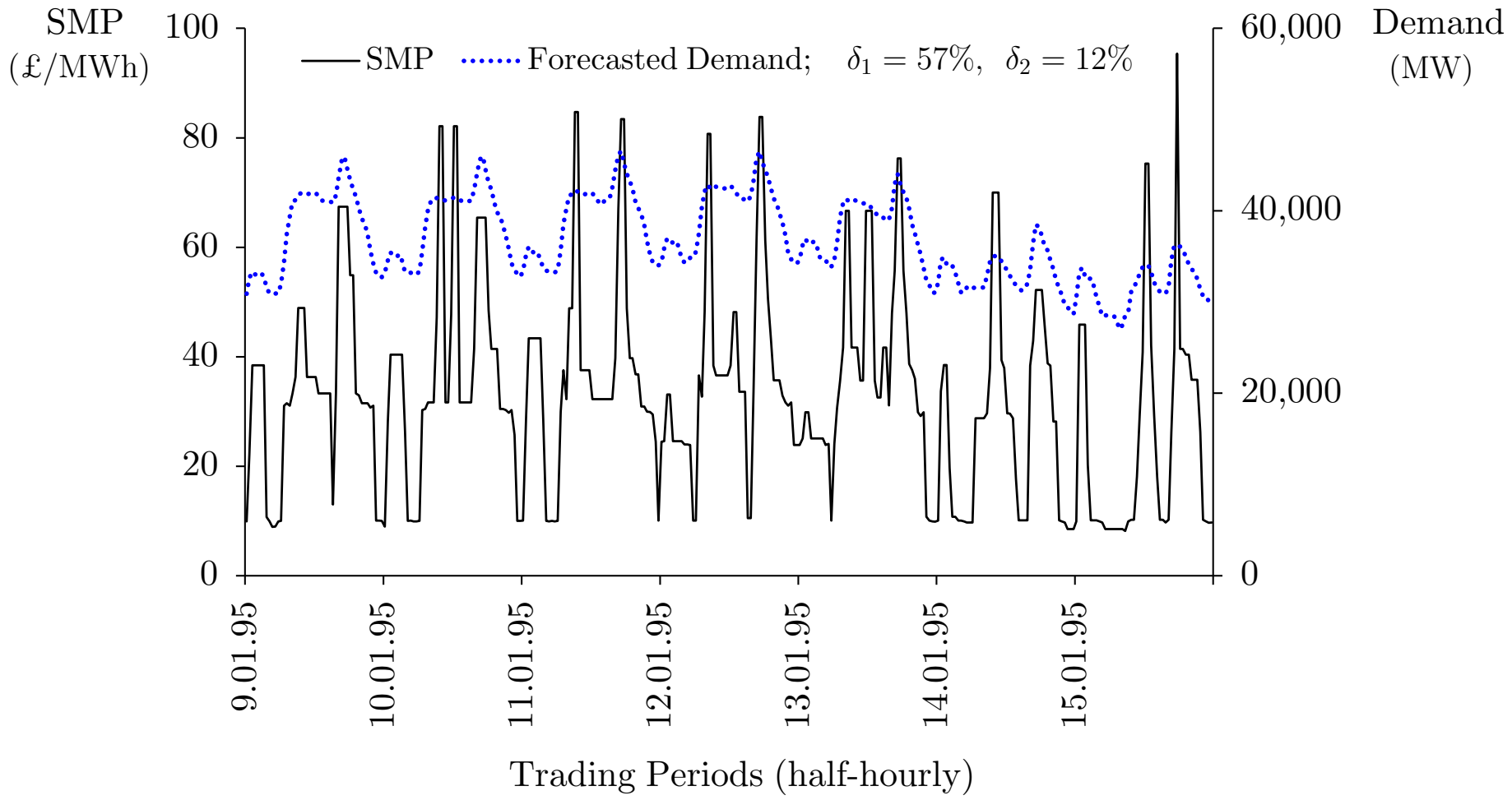

Fig. 7: *Half-Hourly One-Sided Uniform Price Auction (Real)*