Zonal Pricing and Demand-Side Bidding in the Norwegian Electricity Market

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Research Questions

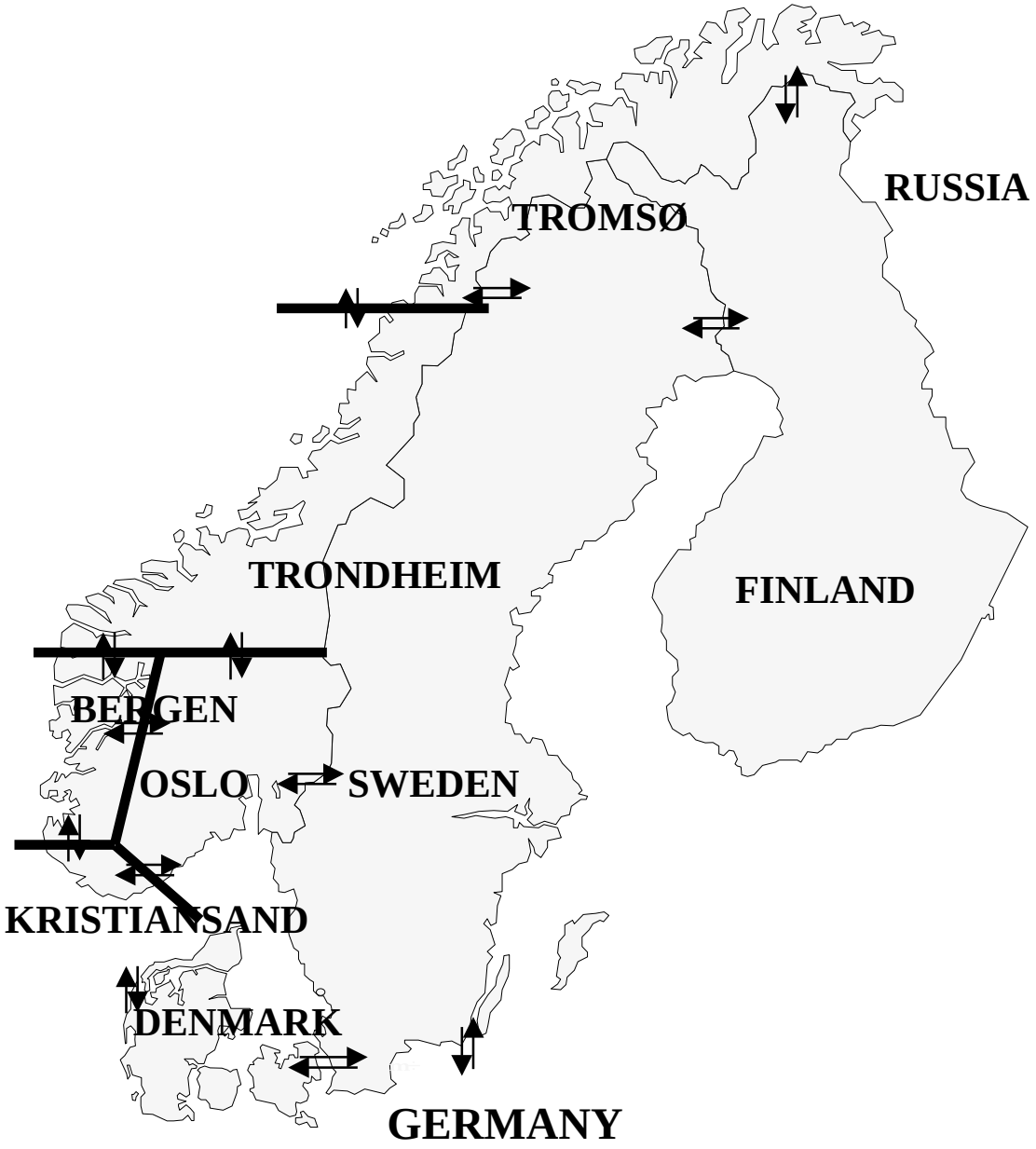
1. ***Descriptive:*** Is there evidence of market power in Norway?
2. ***Institutional:*** How do zonal pricing and demand-side bidding affect the exercise of market power?
3. ***Methodological:*** How might we assess market power without information on marginal costs?

Norwegian System - Financial

- 3 organized markets:
  Forward and futures (Eltermin)
  Day-ahead (Elspot) and
  Regulation (Regulerkraftmarkedet)
- 15-20% of energy trades through Elspot market
- Bidders supply separate bids for each hour
- Last marginal bid determines uniform price
- Elspot market clears for 24 hours at a time
- Both demand and supply-side active

Norwegian System - Physical

- >99% hydro
- CR4 = 44%, CR1 = 26% (Statkraft)
- Trade with:
  - Sweden (combined with Norwegian Pool in 1996 to form Nord Pool)
  - Finland (joined Nord Pool in 1998)
  - Denmark (joined Nord Pool in 1999)
  - Russia
- Pricing areas determined weekly by Statnett
- Transmission constraints can lead to up to 8 areas



Nord Pool

- Five areas in Norway
  - Oslo (East)
  - Kristiansand (South)
  - Bergen (West)
  - Trondheim (Mid)
  - Tromsø (North)
- Sweden (1996)
- Finland (1998)
- Denmark (1999)
- Exchanges with Germany and Russia

Market concentration is relatively low in Norway. Kristiansand is the only area where Statkraft is not one of the four largest firms.

Largest Firms and Concentration Ratios (GWh)

	West	South	East	Mid	North
Statkraft	4,339		10,461	9,843	3,185
BKK	5,958				
Norsk Hydro	2,455		7,159		
SKL	1,375				
Lyse Kraft		4,082			
Vest-Agder		2,732			
Kristiansand		2,207			
Aust-Agder		1,998			
Oslo Energi			7,714		
Hafslund			2,457		
Trondheim				3,176	
Nor-Trondelag				2,303	
Sor-Trondelag				1,582	
Tromskraft					1,338
Nordkraft					586
Finnmark					461
Others	4,147	2,732	20,051	5,934	1,382
Total	18,274	13,751	47,842	22,838	6,952
CR4	77%	80%	58%	74%	80%
CR1	33%	30%	22%	43%	46%

Source: Samkjøringen (1992)

Prices have never been set separately in all five areas, and it is rare to have four areas.

Number of Prices Areas by Year in Norway

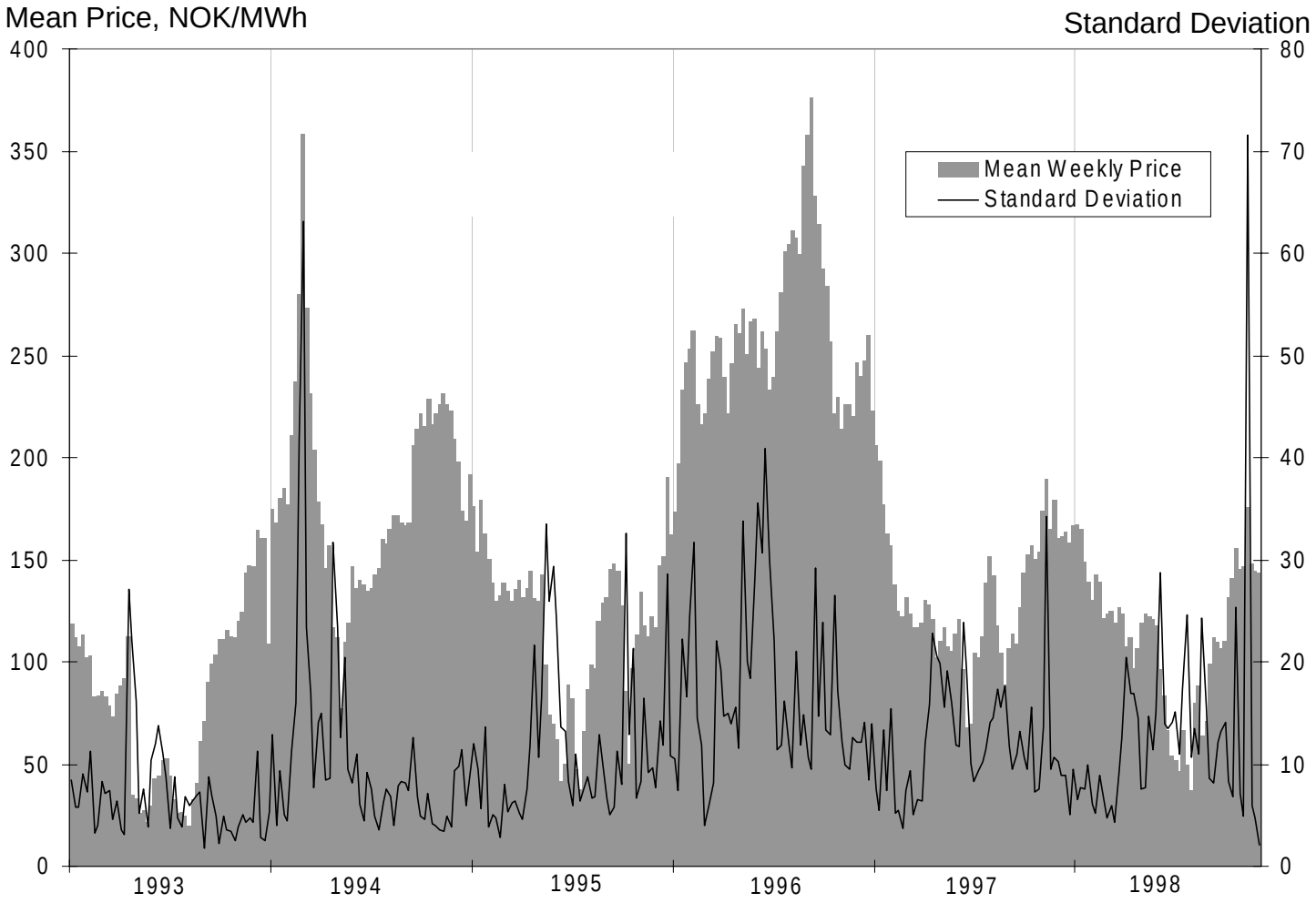
	Number of Price Areas			
Year	1	2	3	4
1996	70.6%	25.0%	4.4%	0.0%
1997	59.0%	33.1%	7.9%	0.0%
1998	46.3%	36.3%	15.0%	2.3%

Hydroelectric Costs

- Marginal costs are mainly the shadow value of water taken out of reservoir
- Shadow value of water is a function of:
  - expected future inflows
  - expected future prices
  - likelihood of draining reservoir or of spillage
- Plants with small reservoirs relative to their turbine capacity can choose to produce only when prices are high -- they have high marginal costs

Prices are usually lower in summer than winter, although unexpected shortages such as in 1996 can drive up summer prices.

Mean Weekly Price in the Elspot Market



Empirical Approach

Start with semi-reduced form pricing equation:

$p = \mu\ mc$

where μ is:

- increasing in market concentration
- decreasing in demand elasticity

Taking logs, this becomes:

$\ln(p) = \ln(mc) + \phi + \varepsilon$

for notational ease, we assume $\mu = \exp(\phi)\ \exp(\varepsilon)$

Empirical Approach (con't)

1. Compare periods when transmission constraints bind and markets are smaller to periods without transmission constraints

   $\ln(p_c)-\ln(p_u) = \ln(mc_c)-\ln(mc_u)+\phi_c-\phi_u+\varepsilon_c-\varepsilon_u$

2. Compare nights (*low elasticity*) to days (*high elasticity*)

   $[\ln(p_{n\text{-}c})- \ln(p_{n\text{-}u})]- [(\ln(p_{d\text{-}c})-\ln(p_{d\text{-}u})] = \Delta\ln(mc)_n- \Delta \ln(mc)_d$

   $+ \Delta \phi_n - \Delta \phi_d+ \Delta \varepsilon_n- \Delta \varepsilon_d$

3. Control for cost/demand shocks with prices in comparable area

   $\gamma =[\Delta\ln(p_{n\text{-}c}) - \Delta\ln(p_{n\text{-}u})] - [(\Delta\ln(p_{d\text{-}c}) - \Delta\ln(p_{d\text{-}u})]>0$

Empirical Approach - Summary

- Basic hypothesis: if transmission constraints during the night lead to higher price increases than constraints during the day (when demand is more elastic), we conclude there is evidence of market power.

- Controlling for:
  - price differences between nights and days without constraints
  - price movements in “control” area

We Find

- Norwegian market quite competitive.
- In one area, prices rise by about 15% when transmission constraints bind and demand less elastic.

→ The local market power created by transmission constraints can cause large distortions in deregulated electricity markets.

→ An active demand-side mitigates market power.

Conclusions

- Our results provide a joint test of market power and the extent to which it is constrained by the demand side
- We find some evidence of market power in Kristiansand
  - Statkraft has no presence here?
  - Financially constrained counties?