Institute of Economics and Utility Regulation
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USING PANZAR-ROSSE MODEL FOR SELECTING ELECTRICITY MARKETS REGULATION TOOLS: THE CASE OF RUSSIAN WHOLESALE ELECTRICITY MARKET

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A FEW WORDS ABOUT RUSSIAN WHOLESALE ELECTRICITY MARKET

Electricity can be sold or bought at day-ahead electric energy market (DAM) for the next day or at balancing market (BM) for today by hourly intervals.

Transmission constraints call for dividing market area by free flow areas (FFAs), where there are no these constraints. The strongest restrictions are between Europe-Ural (the First Price Zone) and Siberia (the Second Price Zone), Far-Eastern and some other Russian regions are not parts of electricity market.

Companies at electricity markets operate at many FFAs (at the same time).

Our paper considers on day-ahead electricity market, as most competitive part of industry.

WHY COMPETITION LEVEL IS IMPORTANT FOR MARKET REGULATION (ECONOMIC POLICY)?

Competition level influences on market interaction and on regulatory practices.

Liberalization process continues in the electric power sector so government should oversee competition evolution of this sector.

Production and trade of electricity is partly regulated in Russia, trend to liberalization should continues,

but absence of regulation is impossible if there are no real competition on market.

Government should use different policies to develop competition on sectors with weak competitive environment and with moderate one.

The tasks of this article are:
competition level estimation at the day-ahead market (DAM) on the whole and on their parts, free flow areas (FFAs) and
to analyze price factors at FFAs with different competition levels.

COMPETITION ESTIMATIONS FOR WHOLESALE ELECTRICITY MARKET

Organization	Method's features	First Price Zone	Second Price Zone
The FAS Russia (2020)	the level of concentration (CR) in the wholesale electricity and capacity market by electricity and capacity consumption	low	moderate
	the level of concentration (CR) in the wholesale electricity and capacity market by the volume of electricity production	moderate	high
The Association "NP Market Council" (2019)	the share of the three largest companies (CR3)	55%	80%
	the Herfindahl-Hirschman index (HHI)	1298	2690
Our Results	Share of FFAs with limited competition level at Price Zone, other FFAs have weak competition	67%	40%
	DAM as a whole (H-stat)	Limited power competition (0.31-0.66)	

THE DATA

36 monthly periods for 20 FFAs (each conclude from 1 to 18 regions)

Data sources:

- Trading System Administrator of wholesale electricity market (hourly data):
  prices at DAM, market structure variables
- Russian statistical service (regional data) :
  price indexes of factors, electricity prices at retail market, production indexes, socio-economic variables

ANALYSIS METHODOLOGY (COMPETITION LEVEL ESTIMATION)

$$\log(P_{i,t}) = \beta_0 + \sum_{l=1}^{k} \beta_l * \log(x_{l.i,t}) + \sum_{j=1}^{m} \gamma_j * \log(z_{j,i,t}) + \varepsilon,$$

The resulting model for DAM can be represented as follows:

$$log\left(\frac{P_{i,t}}{P_{i,t-1}}\right) = \sum_{l=1}^{k} \beta_l * log\left(\frac{x_{l.i,t}}{x_{l,i,t-1}}\right) + \sum_{j=1}^{m} (\gamma_j * log\left(\frac{z_{j,i,t}}{z_{j,i,t-1}}\right) + \gamma_j * D_{j,i}) + \varepsilon.$$

P – consumer price,
x_l – price of factor l,
z_j, D_j – market related variable j, D is dummy variable,
β, γ – regression coefficients;
ε – random error
H-stat = $\sum_{l=1}^{k} \beta_l$

Original model for Financial Sector

$$\ln II = \beta_0 + \beta_1 * \ln AFR + \beta_2 * \ln PPE + \beta_3 * \ln PONILE + \gamma * \ln ETC + \varepsilon,$$

II – interest income;
AFR – the price of funding;
PPE – labor costs;
$PONILE$ – other expenses;
ETC – other factors, affecting the bank's interest income;
β, γ – regression coefficients;
ε – random error.

Competition level (H-stat) = $\beta_1 + \beta_2 + \beta_3$

Panzar J. C., Rosse J. N. (1987) Testing for Monopoly Equilibrium // The Journal of Industrial Economics. Vol. 35. No 4. P. 443–456

RESULTS OF PANZAR-ROSSE MODEL FOR DAM

Independent Variables	Coefficient (standard error)	Independent Variables	Coefficient (standard error)	Model Quality Data	
Non-Price part of Supply and Import	0.063*** (0.018)	Coal price	0.527** (0.166)	Prob > F (u_i=0)	0.991
Price part of Supply	0.039** (0.013)	Fuel oil price	-0.220** (0.084)	Corr (u_i;Xb)	-0.533
Demand	-0.133*** (0.036)	Rest price	0.358** (0.162)	R2 within R2 between R2 overall	0.094 0.025 0.066
Non-Price part of Demand	0.043** (0.021)				
Ratio of Demand and Supply	0.082** (0.033)	_cons	0.491 (0.470)	Prob > F (10,508)	0.000
NPP (Dummy)	-0.011* (0.006)				
HPP (Dummy)	-0.007 (0.005)				

H-stat for DAM is 0.31 or 0.66, it is higher when regional price difference is taken into account

DAM is moderately competitive

Statistically significantly different from zero based on a two-tail test:
** at the 10% level*
*** at the 5% level*
**** at the 1% level*

DESCRIPTIVE STATISTICS FOR DIFFERENT TYPES OF FFA

	Day-Ahead Market	Limited competitive zones	Weak competitive zones
	mean (minimum-maximum)		
Consumer Price	1 182.22 (550.75; 2 135.83)	1 290.16 (847.45; 2 135.83)	1 020.32 (550.75; 1 569.76)
Number of power plants, except NPP and HPP	8.50 (0; 44)	10.33 (0; 44)	5.75 (1; 19)
Share of gas-fired power plants	0.64 (0; 1)	0.78 (0.01; 1)	0.44 (0; 1)
Ratio of Demand and Supply	0.74 (0; 0.99)	0.75 (0; 0.99)	0.73 (0.00; 0.99)
Share of weak competitive zones	0.40	-	-

H-stat for particular FFA ranges from -1.00 to 0.52, which means that competitive level is higher for DAM as a whole (0.31- 0.66).

ANALYSIS METHODOLOGY (PRICE FACTORS)

$$P_t = \alpha * P_{t-1}^{\eta} * (x_t/x_{t-1})^{\beta} * (z_t/z_{t-1})^{\gamma} * \mathrm{e}^{\gamma * z_t} * P_{t-12}^{\mu} * cross_t^{\lambda} * e^{\lambda * cross_t} + \varepsilon$$

where

P – DAM-price for buyers,

Pretail – end-user price,

x – price of factors,

z – market related variables,

cross – cross-subsidization variables (depend on non-price part of demand).

$$\log(P_t) = \alpha + \eta * \log(P_{t-1}) + \beta * \log(x_t/x_{t-1}) + \gamma * \log(z_t/z_{t-1})$$
$$+\gamma * (z_t) + \mu * \log(P_{t-12}) + \lambda * \log(cross_t) + \lambda * cross_t + \varepsilon$$

$$\log(Pretail_t) = \alpha + \eta * \log(P_t) + \beta * \log(x_t/x_{t-1}) + \gamma * \log(z_t/z_{t-1})$$
$$+\gamma * (z_t) + \lambda * \log(cross_t) + \lambda * cross_t + \varepsilon$$

DAM-PRICING MODEL DIFFERENCE FOR VARIOUS FFA' TYPES

Some results	Day-Ahead Market	Limited competitive zones	Weak competitive zones
Independent Variables	**Coefficient (standard error)**		
Last month price	0,579*** (0,048)	0,498*** (0,056)	0,609*** (0,081)
Last year price	0,208* (0,106)	0,329** (0,121)	0,271 (0,190)
Index of manufactory's production	0,099** (0,047)	0,124** (0,044)	0,270** (0,122)
Cross-subsidization4	-4.449***	-4.873***	-0.609*
Coal price	-	0.024*	1.260**
Price part of Supply	0,053* (0,028)	-	0,079** (0,038)
Non-Price part of Supply and Import	0,094** (0,046)	0,035 (0,022)	-
R2 within R2 between R2 overall	0,525 0,915 0,841	0,594 0,965 0,895	0,540 0,668 0,615
Corr (u_i;Xb) Prob > F (u_i=0)	0,559 0,000	0,734 0,000	-0,065 0,044

Statistically significantly different from zero based on a two-tail test:
** at the 10% level ** at the 5% level *** at the 1% level*

RETAIL MARKET PRICING MODEL DIFFERENCE FOR FFA' TYPES

Some preliminary results	Day-Ahead Market	Limited competitive zones	Weak competitive zones
Independent Variables	**Coefficient (standard error)**		
Price-buy at DAM	0.075** (0.035)	0.116** (0.050)	0.030 (0.055)
Fuel oil price	0.146** (0.066)	0.062 (0.090)	0.222** (0.104)
Index of manufactory's production	0.056*** (0.018)	0.033 (0.020)	0.158*** (0.045)
Index of Electricity, gas, water pr.	-0.050*** (0.018)	-0.030 (0.021)	-0.091** (0.036)
Price part of Supply	-0.022** (0.009)	-0.021 (0.015)	-0.014 (0.013)
Demand	-0.030* (0.015)	-0.035** (0.017)	-0.013 (0.036)
Non-Price Part of Demand	0.026* (0.015)	0.030* (0.017)	0.009 (0.035)
rest	0.448*** (0.013)	0.363** (0.160)	0.562** (0.238)
wages	0.036 (0.024)	0.024 (0.028)	0.106** (0.052)
Cross-subsidization4	0.986*** (0.120)	0.900*** (0.152)	1.140*** (0.220)
Climate	-0.949*** (0.119)	-0.862*** (0.151)	-1.137*** (0.219)

Statistically significantly different from zero based on a two-tail test:
** at the 10% level ** at the 5% level *** at the 1% level*

CONCLUSION

1. We identified that competition on the whole DAM has limited power.
2. H-stat for DAM is 0.31 or 0.66, it is higher when regional price difference is taken into account.
3. H-stat for particular FFA ranges from -1.00 to 0.52, which means that competitive level is higher for DAM as a whole (0.31- 0.66).
4. At the First Pricing zone 10 of 15 FFA (67%) have limited competition intensity while at the Second Pricing zone in 2 of 5 FFA (40%) competition is limited. So the First Pricing zone is more competitive, then the Second One.
5. DAM pricing model differs for FFA with different competition levels, so the same market changes may influence differently for them.
6. Pricing model differs for FFA with different competition levels not only at DAM, but also at retail market too.

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Thank you for your attention

https://ur.hse.ru/

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