EMPIRICAL EFFECTS OF POLICY INDUCED COMPETITION IN THE ELECTRICITY INDUSTRY: THE CASE OF DISTRICT HEAT PRICING IN FINLAND 1996-2002

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ABSTRACT

The household electricity markets in Finland were opened to the competition on the 1st of November 1998. At the same time, the electricity transmission and distribution networks were regulated by special legislation (Act on Electricity Markets) and by special regulator (Electricity Market Authority). The regulation was extended to limit the unreasonable pricing and to separate financially the different business units (production, distribution and sales). However, the district heating industry does not have industry specific regulation. It is regulated through general Competition Laws. The policy induced competition in the electricity industry is expected to affect the district heating industry since both industries compete in the household heating goods markets. In addition, the district heating industry in Finland has had a regional monopoly within its distribution network. The threat of extended regulation is evident in the industry, since most of the network industries are regulated in order to facilitate access to the network and to speed up the development of competition in the market. The hypothesis of regulatory threat is studied through pricing behaviour of firms by using panel data models. The data consists of 76 district heating companies in Finland in years 1996 – 2002. The results indicate that the district heat markets are non-competitive and some evidence which supports regulatory threat hypothesis can also be found. The electricity market reform caused a slight decrease in district heating price. The results indicate also that the large and market dominant firms have been more responsive to the policy reform than small firms.

Keywords: Household energy markets, deregulation, market shares

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1. INTRODUCTION

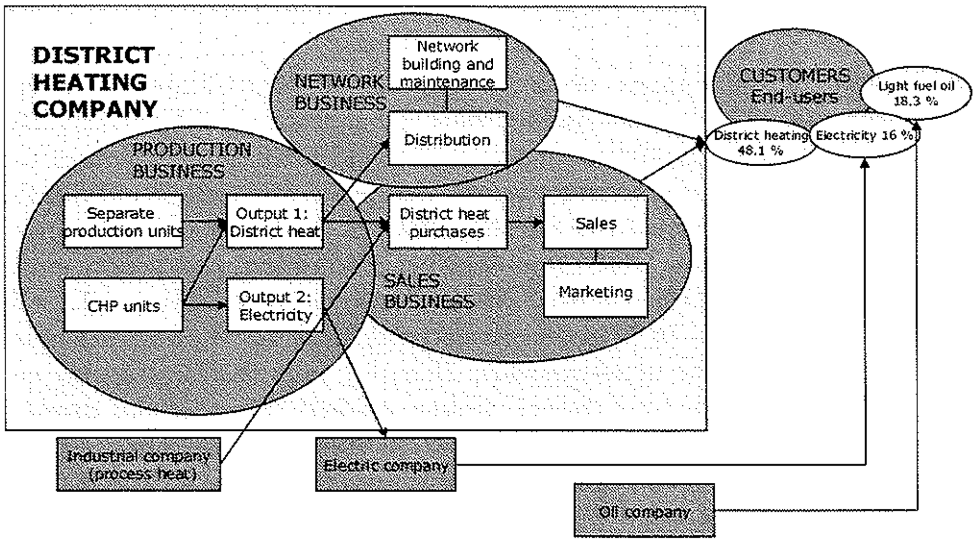
District heating is the primary heating system in 48 % of Finnish buildings. Both electricity and light fuel oil has a 17 % market share in the heating goods markets. Due to the Northern European weather conditions there is a demand for heating in houses for 7 – 10 months in a year. District heating industry can be defined as production and distribution of hot water for central heating purposes in a heating network. The production of district heating is divided to separate production, CHP (combined heat and power) production and industrial process heat production. In 2005, the total district heating production was 32.2 TWh[1]. The share of CHP production was 74 % and separate production 26 % of district heating. The district heating industry is quite heterogeneous. There are only few large energy companies participating both in electricity and district heating markets. Most of the district heating companies participate to the local heating goods markets supplying only district heat.

The Figure 1 illustrates operating of the district heating company. The district heating company can be theoretically divided to production, distribution, and sales business. In reality, most of the district heating companies are vertically integrated so all business elements belong to same company. In practice the division can be done by bookkeeping in large companies, but the division of small companies is difficult. In a small district heating company there is only few employers to take care of the production and distribution activities and the managing director handles the distribution and sales contracts. In many companies the maintenance services of the distribution network are outsourced. In some companies also the production business is separated, so that, the district heating water is produced in a industrial company, which production process produces hot water as side product, or production units are divided to an independent production companies. These independent production companies do not usually own any distribution network, because they only take care of the district heat water production.

The distribution business includes network building and maintenance and the distribution of district heating through network. The sales business includes purchases of district heating and sales and marketing of district heating services to the customer. Only the sales business has a straight contact to the customer, because customer can not buy distribution service from one company, and district heating product (hot water) from another company (straight from a producer or other seller). The company which owns the district heating network does not have obligation to distribute the district heat provided by competitive producer. There is no regulation on third party access. There is no general legal framework of the rules concerning the balance between district heat supply and demand. The owner of the network takes care of the balance between supply and demand. Therefore, the sales business is quite difficult to separate from distribution business and also the district heat purchases have to be in very close contact.

[1] TWh = terawatt hour i.e. 1 TWh = 1 000 GWh = 1 000 000 MWh

Figure 1. The District Heating Company



If we take a look at situation in Europe, the district heating is an important heating product in Sweden, Denmark, Germany and most of the Eastern European countries (www.iea.org). The aim of the EU competition policy is to develop free uniform markets for all products and services. Securing the supply of energy is also an important issue. The aim is to develop European wide electricity and gas markets. Harmonization of electricity and gas market legislation has been carried out in the EU member states. The harmonization and deregulation has caused structural changes in the national electricity and gas markets in member states. United Kingdom has led the way in a process to open up the electricity markets. Also the Northern European countries have been in the front line with NordPool, an electricity stock exchange. Since Finland became a member of European Union in 1995 it started to harmonize its energy market regulation with the EU legislation. The harmonization has caused large structural changes to the energy markets, since the prices of energy products were under state control until the end of 1980's. The price control was based on follow-up of production costs and advance notification of price increases. The price control was extended on both electricity and district heating industries. The follow-up of costs and development of pricing principles was done coordination with district heating and electricity sellers. Therefore, the pricing mechanisms of district heating and electricity were and still are quite alike. When the price control was ended in the end of 1980's there was a need to prevent excess pricing of energy products by promoting competition. The deregulation of electricity markets took place gradually. In 1995 the Electricity Market Act game to force. It was based to the EU-legislation Directive 96/92. By the Electricity Market Act, the electricity whole sale markets were opened to free competition in 1995. In the beginning of 1997 also the retail markets were opened, but in practice, the small customers could not take part because of an expensive metering.

Situation of the small customers was improved in the autumn 1998 when Electricity Market Authority introduced so called type load system by which the average consumption of an individual customer per hour was calculated. Since September 1998 small customers have not used electricity meter, which registers the consumption hourly basis, in order to buy electricity from competitive markets. In 1995 a special authority was founded to enforce the operation of the electricity markets. It was called Electricity Market Authority. Since the jurisdiction of Electricity Market Authority was extended to include natural gas markets as gas markets were also opened to the competition the name was changed to Energy Market Authority in 1st August 2000. The Energy Market Authority does not have jurisdiction concerning district heating markets. Since the district heating markets does not have special legislation its operation is under control of general competition legislation and Competition Authority. Even if district heating markets does not have special legislation or special authority to enforce its operations it still is under tight control. Following two cases are typical.

In 1999 the Competition Authority had proposed Competition Council to prohibit Helsingin Energia's abuse of dominance by unreasonable pricing and order sanctions. According to the Competition Authority the electricity and district heating pricing had been unreasonable since 1st September, 1992 for several years period. Similar proposition was given in 2000 in Kuopio Energia's case. According to the Competition Authority the electricity and the district heating price has been unreasonable at least in 1997 – 1999. In both of these cases the question was whether the companies had carried out pricing practices which can be regarded as monopoly pricing or cross subsidization. During the time of hearing in the Competition Council in 1999 – 2001 there was a real threat that the Competition Council could come up to the same result as Competition Authority. In 2001, the Competition Council gave a decision that it could not find enough evidence on abuse of dominance by unreasonable pricing.

Our target is to test how the policy induced competition in the electricity industry has affected the district heating industry in Finland. As the markets of these industries are close substitutes to each other but the heating industry does not have special regulation, the case offers us to test so called "regulatory threat hypothesis". The hypothesis is also valid as the district heating industry has typically a regional monopoly within its distribution network and the level of public ownership within the industry is high. The heterogeneity of district heating companies gives us a possibility to study several factors determining the extension of "threat" that the companies have experienced during years 1996-2002.

The article is organized as follows. Section II reviews briefly the literature on regulatory threat studies. The Section III focuses on econometric model specification. Sections IV and V give the results and Section VI concludes the study.

2. THEORETICAL BACKGROUND OF REGULATORY THREAT HYPOTHESIS

Some studies have argued that the threat of regulation causes decrease in prices. It has been argued that the monopoly company behaves more competitive manner without any regulation, when the neighbouring business has been regulated. A German study (Brunekreeft 2004) described the situation in electricity markets, in which electricity transmission and distribution were unregulated but the electricity sales was regulated. Brunekreeft found out that if the threat of regulation was real and credible, the threatened company had an incentive to limit its pricing. This led to a situation where user price ended up to a lower level than if company would have maximised its profits freely.

Driffield & Ioanniadis (2000) analysed the profit effects of different authorities' investigation and regulation to the UK petrol industry. The study evaluated empirically the effects of 1979 and 1990 Monopolies and Mergers Commissions (MMC) investigations, Trade and Industry Select Committees investigations of 1988, and the petrol price marking order of 1981. The results showed clearly that the instigation of the 1979 MMC inquiry had a significant negative effect on the profit margins of the petrol companies. All other investigations, or attempts at regulation have been ineffective at reducing profitability (Driffield & Ioannidis 2000, 369-378). Since the effect had been long-term the study concluded, that the regulatory bodies in the UK had a significant effect on consumption efficiency within the petrol industry. This was despite the fact that the industry had never been found to act against the public interest (Driffield & Ioannidis 2000, 380). These investigations were self regulative since the industry had permanently reduced its profit level.

Some studies have also paid attention to the firm specific effects when they have studied regulatory threat hypothesis. Some studies have argued that the firm specific effects matter. One of the first studies used data from oil crisis in the late 1970s by (Erfle, McMillan & Grofman 1990, 49). Indeed, Grofman was a researcher who proposed the "regulatory threat hypothesis", which states, that "when the threat of governmental price regulation is high, the larger, more visible firms in the threatened industry restrain price increases on those products where price changes are readily apparent to the public; the smaller, less visible firms do no exercised such price moderation. As the threat of governmental price regulation diminishes, the firms which had previously exhibited price restraint (and thus whose products are under priced relative to the market norm) rapidly increase prices to equalize with the industry average" (Erfle, McMillan & Grofman 1989, 136). The study used different dummy variables which described the amount of news time and reports concerning federal government's interest on oil industry. The empirical study revealed three factors that affect the threat of regulation.

1) the intensity of public opinion demanding intervention,
2) the government's capacity to react to that pressure, and
3) the availability of external scapegoats which deflect public attention from regulation.

Glazer and McMillan (1992) studied the factors affecting to company's pricing behaviour when the company is threatened with regulation (see also Block et al. 1981). A special interest was directed to the changes in pricing marginal. They stated that separation of business units is important when changes in operational environment increase the probability of regulation and decrease the effects of price increases. They followed Peltzman's (1976) idea in which the legislator prefers a monopoly product a price lower than the monopoly price, but greater than the price at zero profit level. The legislator faces different problems. First, how to design methods so, that the regulator is not under industry's control. Second, should cross-subsidisation be allowed and at what level. Third, how avoid changes in companies capital during the law is passed and it is executed (Glazer & McMillan 1992, 1089 – 1090). The study used game theory approach. They found that the increase in production costs decrease company's profits, profits of regulation, and probability to carry out regulation. The existence of other legislative initiatives increases legislators' costs and decrease probability of regulation. The monopoly's price increases fortify public pressure to decrease the prices and increase the profits from regulation. The results were as expected. The study examined also the costs of regulation more detailed. They discovered that the increase in the costs of regulation can cause both increase and decrease in companies' prices (Glazer & McMillan 1992, 1093). Threatened monopolists may try to avoid price rise if the price rise increases the probability of regulation. But if regulators allow the price rises to cover the increases in costs which the threat of regulation may cause, the threatened monopolist to absorb cost increases. Therefore, the increase in production costs diminishes probability of regulation and increases expected profits. If average costs are constant, the monopoly sets the price to a level by which it only just avoids regulation. Then the company tries to increase the price above average costs to the level in which consumer welfare diminishes to the critical level. If demand curve is convex enough the difference between the price and the average costs causes increased effect to the profits. For example when demand is inelastic, the effect in the consumer welfare equals the effect in profits and with more elastic demand the effects to the consumer welfare dominate. Then the company can earn higher profits at the same time it avoids regulation when production costs are high (Glazer & McMillan 1992, 1094 – 1095).

Linden (2004, see also Block et al 1981) proposed a model where the incidence of regulation is an increasing function of monopoly price. It was also assumed that the regulator can identify the monopoly without knowing its cost structure and regulation threat imposes an implicit or explicit competitive price that deviates from observed (monopoly) supply price. Under the credible threat of regulation the monopolist self-regulates its price on the level which is between the competitive and the monopoly price. The risk of being regulated makes the monopoly to pay price premium to the consumers. The implications of the model for practical competition policy are clear. The authorities need not run extensive and costly regulation program. Some randomly chosen regulation cases and credible regulation threat may be more effective in cost-benefit terms.

3. ECONOMETRIC MODEL, METHODS AND DATA

The empirical literature of industrial economics faces many practical problems albeit the theory of competitive and non-competitive markets is well established. However the notion that low number of producers is located in the same geographic market producing identical varieties of the same product is all that the theory concerns. The case of district heat production is a quite easily defined as a relevant market with one commodity produced by low number of producers on separate geographic area. Thus we have to concentrate on the price data with Cournot's principle: market prices should take the same level throughout with ease and rapidity. The empirical implementation focuses on the dynamics of prices and exogeneity of price setting. Thus if price adjustment is rapid then the market is regarded as competitive rather than oligopolistic (Slade 1986, Spiller & Huang 1986, Bresnahan 1989). The structure-conduct-performance (SCP) paradigm has been a much used workhorse in the empirical industrial economics (see e.g. Reid 1987, Cubbin 1988, Waterson 1984). It has been under a hard pressure for decades but still many find it as a valid starting point for empirical market share and pricing analysis (Barla 2000, Slade 2004). Basically the paradigm states that a following relationship for firm's price margin is relevant:

1) $$PC_i = \frac{p - MC_i}{p} = \frac{S_i(1+\gamma_i)}{\eta} ,$$

where p the market price of industry's output, MC_i is the i th firm's marginal costs, S_i is the firm's market share of output, γ_i is the conjecture variation term describing how other firms react to market actions made by firm i, and η is the industry price elasticity of demand.

From the econometric point of view relation described in Eq. 1) is problematic, since all variables are more or less endogenous. They all form a dynamic market process simultaneously making consistent empirical estimation difficult. In this context we will not model district heating companies' profits since we do not have direct observation for them. Instead we decompose Eq. 1) in following form

$$P_i = g(MARKET\ SHARES_i, C_i, X_i) \tag{2}$$

where P_i is the product price of district heating company, $MARKET\ SHARES_i$ contains both variables for firm's market share in *local heat markets* and output product share in *local district heat markets*, C_i is the (unit) cost for the firm, and X_i includes all other relevant variables that data allows for. In order to analyze firm's market share effect on its price setting a following dynamic empirical panel data model is suggested.

$$\begin{aligned} lnEprice_{it} &= \alpha_i + \lambda_t + \beta_1 lnEprice_{it-1} + \beta_2 DPUB_{it} + \beta_3 lnMS_{it} \\ &\quad + \beta_4 lnFUEL_{it} + \beta_5 lnSCALE_{it} + \beta_6 lnPRODS_{it} + \varepsilon_{it} \end{aligned} \tag{3}$$

where

$lnEprice$ = firm's energy tariff for the district heat.
$DPUB = 0/1$ -dummy for the local public or state ownership of the firm.
$lnMS$ = the market share of district heat among the all heat products.
$lnFUEL$ = a proxy for firm's material input unit cost.
$lnSCALE$ = firm's output capacity, i.e. how much the firm has produced energy per year (measured in GWh).
$lnPRODS$ = firm's production share of district heat.

The model captures relevant pricing factors and price dynamics in the non-competitive industry structure. The model is a two way fixed effects model that allows for controlling firm and common time effects. Thus a_i is the firm specific variable for unobserved heterogeneity. λ_t is the common time effect for all firms describing the general business conditions. The price, ownership and production variables were collected by Finnish District Heating Association (1999-2003). The market share variables were collected by Statistics Finland. The data included 76 companies during seven years. The *ln*-transformations were used to preserve the elasticity interpretation of coefficients and to normalizing the data. All prices were transformed in Euros.

It was argued that model suffer from endogeneity bias problem. Variables like $lnMS$, $lnSCALE$, and $lnPRODS$ are typically non-exogenous for firm's pricing decision. The problem can be handled with instrumental variable estimation methods (IV) since technically question is of violation of so-called orthogonality conditions, i.e. non-correlation between the explanatory variables and error term. Following variables were used as instruments: *DPUB*, *lnFUEL*, and one year lagged values of *lnFUEL*, *lnMS*, *lnSCALE*, and *lnPRODS*. For the endogenous variables regressions were run on instrument variables in addition of exogenous variables including *DPUB* dummy variable. The fitted values of these regressions were used as variables in the model 3). Thus we used the elementary 2SLS method version of the IV-estimation.

Main results from structural model estimation support the non-competitive market structure: large market shares have positive effects on energy tariff levels and price dynamics are significant (see Appendix I). Thus the results imply that strict heat markets are non-competitive. The estimation was done for three different data cases since the data contains three price variables: the energy tariff $(lnEprice)$, the total tariff for small houses $(lnEprice^{SM})$, and the total tariff for apartment houses and blocks $(lnEprice^{A})$. The total tariffs have been selected because they include all consumer taxes besides the company specific factors which affect the prices. Similarly we have three different variables for market share of district heat among heat products, i.e. $lnMS$, $lnMS^{SM}$ and $lnMS^{A}$.

However the opening of energy markets for competition in the end of 1998 is an exogenous policy event that affects firm's market conditions. Following estimation strategy is used to analyse effects of this policy change. To secure true exogeneity of policy change the residuals from above structural model estimations are analysed with different dummy-variables. Another reason for this two step estimation procedure is the problems encountered with IV-estimation containing many yearly dummies.

Table 1. Different yearly policy and shock dummies

	1997	1998	1999	2000	2001	2002
Constant	1	1	1	1	1	1
DCOM	0	0	1	1	1	1
D98	0	1	0	0	0	0
D99	0	0	1	0	0	0
D00	0	0	0	1	0	0
D01	0	0	0	0	1	0
D02	0	0	0	0	0	1

We use the dummies below for OLS estimation of residuals of above structural estimation. Constant gives the 1997 tariff level. The level is expected to zero since we analyse the residuals. Dummies *D98-D02* give the subsequent yearly exogenous (shock) effects on the tariff level. Naturally D99 is the most interesting case. Dummy DCOM analyses the case where policy change have permanent effects on the tariff pricing, i.e. has the tariff level been since 1999 at lower level than earlier due the competition. Note that the structural model contained both lagged endogenous variable and time effects variable. Thus all the trend effects are excluded from the residuals. However they can still include some non-modelled time specific firm effects. The firm's response to opening of markets for competition in year 1999 is a typical firm specific event. Depending on the firm's market position and share policy change can affect its tariff policy.

4. RESULTS OF INDUSTRY PRICING MODELS

Table 2 gives the OLS-estimations results of different time dummy models. D99 has a significant negative impact on the tariff level. However the market opening seems to be a one year shot only since the permanent effect dummy *DCOM* is not significant. However in years 2001 and 2002 we also found tariff effects. The positive tariff effect 2001 can be caused the Competition Council's acquittal. Tables 3 and 4 give the results for total tariff for small houses and apartment houses.

Table 2.Yearly time specific firm effects
OLS on residuals of structural district heating tariff model
Number of firms, N= 76. Years 1997 – 2002, T=6
(HCSE –corrected t-values in parenthesis)

	$POOLED_{IV}$				$PANEL_{IV}^{1FE}$
Constant	0.008 (1.56)	0.007 (0.82)	0.007 (0.83)	0.008 (0.77)	–
DCOM		–0.010 (-1.01)	0.002 (0.19)		
D98				-0.003 (-0.22)	–0.030 (-0.33)
D99	-0.047* (-3.83)		-0.048* (-3.69)	-0.048* (-3.11)	-0.044* (-3.79)
D00				-0.010 (-0.66)	-0.027* (-2.63)
D01				0.053* (3.42)	0.042* (3.26)
D02				-0.042* (-2.71)	-0.030* (-2.06)
R^2	0.031	0.002	0.031	0.101	0.107

*significant at 10% critical level or below

Results are similar to Table 2 but for small houses both year 1999 policy and other year effects are smaller than for apartment houses. As the fixed tax part in the total tariff is largest for the small houses the relative impact of heat tariff is smaller than for other users. General result from analysis implies that policy change in 1999 to increase competition in energy markets has decreased the tariff prices. However the estimated magnitude is only close to 2.5% decrease in tariff.

Table 3. Yearly time specific firm effects
OLS on residuals of structural district heating total tariff (small houses) model
Number of firms, N=76. Years 1997 – 2002, T= 6
(HCSE –corrected t-values in parenthesis)

	$POOLED_{IV}$				$PANEL_{IV}^{1FE}$
Constant	0.004 (1.39)	0.003 (0.72)	0.003 (0.73)	0.007 (1.07)	–
DCOM		–0.005 (-0.88)	0.001 (0.19)		
D98				-0.006 (-0.68)	–0.004 (-0.45)
D99	-0.025* (-3.41)		-0.026* (-3.29)	-0.028* (-2.98)	-0.032* (-4.22)
D00				-0.007 (-0.80)	-0.019* (-2.61)
D01				0.025* (2.72)	0.022* (3.00)
D02				-0.023* (-2.56)	-0.015* (-2.06)
R^2	0.025	0.002	0.025	0.085	0.122

*significant at 10% critical level or below

Table 4. Yearly time specific firm effects
OLS on residuals of structural district heating total tariff (apartment houses) model
Number of firms, N= 76. Years 1997– 2002, T= 6
(HCSE-corrected t-values in parenthesis)

	$POOLED_{IV}$				$PANEL_{IV}^{1FE}$
Constant	0.007* (1.86)	0.007 (1.17)	0.007 (1.25)	0.010 (1.13)	–
DCOM		-0.010 (-1.45)	-0.003 (0.03)		
D98				-0.004 (-0.37)	0.004 (0.44)
D99	-0.043* (-4.57)		-0.043* (-4.32)	-0.045* (-3.81)	-0.038* (-4.24)
D00				-0.008 (-0.67)	-0.021* (-2.37)
D01				0.028* (2.36)	0.030* (3.30)
D02				-0.027* (-2.30)	-0.014 (-1.58)
R^2	0.044	0.005	0.044	0.090	0.130

*significant at 10% critical level or below

5. TESTING FOR REGULATORY THREAT HYPOTHESIS: FIRM SPECIFIC EFFECTS OF PRICE ADJUSTMENT IN 1999

Preceding analysis showed that the firms reacted to opening of energy markets for competition in 1999. The effect of reform was decrease - albeit small - in tariffs. Next we analyse in details what are the firm specific determinants of year 1999 tariff cut. The analysis is conducted with the random coefficient model (RCM) estimation of panel data. RCM approach is used as it gives the firm specific impact coefficient of year 1999 tariff cut for each firm separately. Panel data allows for firm level price variability both in cross-section and time series dimensions. RCM estimation uses efficiently these dimensions in deriving firm specific reactions.

We analyse once again the residuals $(\hat{\varepsilon}_{it})$ from structural model estimation (see Appendix I). Now we use only year 1999 dummy for RCM approach for observations in $t = 1997,......,2002$

$$\hat{\varepsilon}_{it} = \alpha + \beta_i D99 + \mu_{it} \quad ,$$

$$E[\mu_{it}] = 0, \quad VAR[\boldsymbol{\mu}_i] = \sigma_i^2 \boldsymbol{I}$$

where $i = 1,...,76$ and

$$\beta_i = \beta + v_i \quad \text{with } E[v_i] = 0 \text{ and } VAR[\boldsymbol{v}_i] = \boldsymbol{\Omega}.$$

Thus we have a model like

$$\hat{\varepsilon}_{it} = \alpha + \beta D99 + (\mu_{it} + D99 v_{it}) = \alpha + \beta D99 + w_{it},$$

where

$$E[w_{it}] = 0, \quad VAR[\boldsymbol{w}_i] = \sigma_i^2 \boldsymbol{I} + D99\boldsymbol{\Omega}D99.$$

This is a linear regression model where we allow for firm specific heteroskedasticity and correlation across the firms i. β_i for each firm is a random draw from a distribution with overall mean β. RCM enables us to estimate a two component reaction parameter for policy change in 1999. Parameter β_i includes a common component for all firms β and a firm specific components v_i. Once we have obtained firm specific components β_i $(i = 1, 2, ..., 76)$ we can analyse their distribution and dependence on different firm characteristics in year 1999.

The results from RCM estimation was following (HCSE t-values in parenthesis)

$$\underset{(1.52)}{\hat{\varepsilon}_{it} = 0.0087} - \underset{(-3.76^*)}{0.052D99}, \quad R^2 = 0.03, \quad \chi^2(150) = 1533.73,$$

where $\hat{\beta} = -0.052$ is the common reaction. The Chi-square test is for homogeneity $\beta_i = \beta_j$ for $i \neq j$. Clearly the firm specific components $\hat{\beta}_i$ are not equal. Figure 2 gives the distribution of $\hat{\beta}_i$'s. It is skewed to the left. This implies that some firms react quite strongly to policy change in 1999. Their tariff cut is more than on the average.

Figure 2. The firm specific components $\beta_i = \beta + v_i$

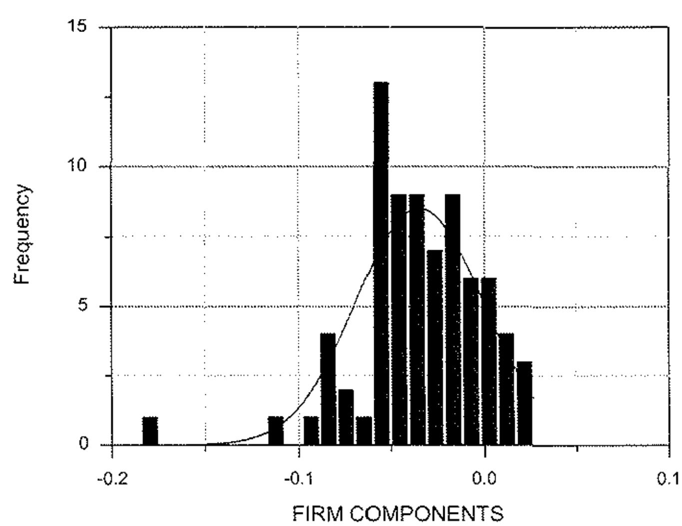


Table 5 gives regression result on $\hat{\beta}_i$'s with suitable firm characteristics. Note that we have used scaling $ln(\hat{\beta}_i + 10)$ to preserve the logarithmic variables.

Table 5. Firm specific RCM components and firm characteristics in 1999
OLS estimation
(BP: Breusch & Pagan test for residual heteroskedasticity)
N= 76 (HCSE-corrected t-values in parenthesis)

Constant	*DJOINT*	*DPUB*	*DCOMPANY*	ln*FUEL*	*lnSCALE*	ln*PRODS*
2.313*	0.0028*	−0.0008	−0.0026*	−0.0041*	−0.0038	−0.0012*
(13.12)	(2.44)	(−1.01)	(−3.61)	(−2.42)	(−1.07)	(−2.33)
$R^2 = 0.248$	$BP = 14.67$*					

*significant at 10% critical level or below

The results are surprising and interesting albeit only indicative. However they do not conflict with the regulatory threat hypothesis. Only when the firm produces both electricity and heat *(DJoint)* the tariff decreasing effect of policy change in 1999 is attenuated. When the firm is a part of larger company ($DCOMPANY = 1$, 0 otherwise) then the decreasing effects are also confirmed. Similarly at the firm level large input costs *(lnFUEL)* and dominant market share *(lnPRODS)* are connected with larger than average tariff cuts. Input costs had (as expected) on average positive effect on tariff prices (see Appendix 1) but for year 1999 policy response the large fuel costs means lower tariff. Thus at the firm level large and market dominant firms are more reactive to policy changes. However the state ownership *(DPUB)* and scale of energy production *(lnSCALE)* are non-significance for tariff reduction. Some firm specific heterogeneity is still present in residuals. Note also that we are only able to derive some qualitative implications from Table 5, not quantitative, as analysis is based on dummy variables, estimated coefficients, and residuals from estimated models.

Generally the results imply that large and market dominant firms have been more responsive to year 1999 energy market reform. Their tariff cuts have been larger than average tariff reduction. The results with total tariff for small houses and apartment houses were similar to above (not reported).

6. CONCLUSIONS

The results obtained from different estimations indicate that competitive case is not the prevailing one in the Finnish district heat production in years 1996-2002. Point estimates for parameter for market share, cost, and scale variables in pricing models together revealed features that are typical for non-competitive markets. The results imply also that the opening of electricity market for competition had decreasing effects on district heating prices. The Competition Councils decision had an opposite effect to the district heating pricing. This was obvious since the decision was positive, no abuse of dominance through unreasonable pricing can be found.

The most interesting results were found when the firm specific components were analysed for year 1999 incidence. The large companies were found to be more responsive to the policy changes. This supports the "regulatory threat hypothesis". Also the joint production companies reacted to the policy change. The companies with large input costs were also responsive. This is opposite to Glazer and McMillan (1992) view that regulatory threat is less probable if production costs are high. However the market share variable correlated with the company size variable and had a positive tariff level effect.

From the regulators and companies point of view the results are encouraging since the related industries regulation and competition authorities decision making have direct effects to the district heating pricing. The regulatory effects can be achieved without costly. The effects are quite strong since the 10 largest district heating companies sell about 50 % the total district heating sales.

Until the end of 2004 the electricity and natural gas market regulation has not had specific rules on limiting the amount of profits from network business. It will be interesting to carry out a follow up study to find out whether this new profit level fixing will have effects also on district heating pricing.

APPENDIX 1A

IV (2SLS) estimation results for district heat energy tariff in Finland ($lnEprice$)
Number of firms $N = 76$. Years 1997- 2002, $T = 6$.
(HCSE -corrected t-values in parenthesis)

	$POOLED_{IV}$	$PANEL_{IV}^{2FE}$
$Constant$	-9.293 (-1.63)	0.125 (0.188)
$TIME$	0.005* (1.76)	-
$lnEprice_{-1}$	0.701* (15.71)	0.212* (3.13)
$DPUB$	0.012 (0.127)	0.138* (2.74)
$lnMS$	-0.013 (-1.02)	0.094 (0.94)
$lnFUEL$	0.101* (3.52)	0.105* (2.64)
$lnSCALE$	-0.005 (-0.23)	0.380* (2.92)
$lnPRODS$	0.017 (1.28)	0.038 (0.82)
R^2	0.697	0.813
DW / AC	2.16/-0.08	2.08/-0.05
$Hausman$	1.12	2.73

*significant at 10% critical level or below

$POOLED_{IV}$: Instrumental variables (IV) estimation. Instruments: all exogenous variables (TIMEr, DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables
(lnMS, lnSCALE, lnPRODS).

$PANEL_{IV}^{2FE}$: 2-way fixed effect (2FE) panel data instrumental variable estimation (IV).

Instruments: (DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables (lnMS, lnSCALE, lnPRODS).

DW/AC: Durbin-Watson test statistics and estimated residual 1[st] order autocorrelation

Hausman: Orthogonality test for valid instruments (H_0: $Corr(X_{IV}, \varepsilon) = 0$)

APPENDIX IB

IV (2SLS) estimation results for district heat energy total tariff in Finland
(Small houses, $lnEprice^{SM}$)
Number of firms $N = 76$. Years 1997-2002, $T = 6$.
(HCSE -corrected t-values in parenthesis)

	$POOLED_{IV}$	$PANEL_{IV}^{2FE}$
Constant	-5.314 (-1.48)	1.769 (4.63)
TIME	0.003* (1.63)	-
$lnEprice_{-1}^{SM}$	0.816* (19.23)	0.242* (4.42)
DPUB	0.031 (0.424)	0.017* (0.57)
$lnMS^{SM}$	-0.002 (-0.69)	-0.029 (-0.67)
lnFUEL	0.059* (2.85)	0.071* (3.05)
lnSCALE	-0.002 (-0.12)	0.195* (2.44)
lnPRODS	0.006 (0.67)	0.050* (1.76)
R^2	0.798	0.881
DW / AC	2.27/-0.14	2.12/-0.07
Hausman	0.78	2.83

*significant at 10% critical level or below

$POOLED_{IV}$: Instrumental variables (IV) estimation. Instruments: all exogenous variables (TIME, DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables
($lnMS^{SM}$, lnSCALE, lnPRODS).

$PANEL_{IV}^{2FE}$: 2-way fixed effect (2FE) panel data instrumental variable estimation (IV).

Instruments: (DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables
($lnMS^{SM}$, lnSCALE, lnPRODS).

DW/AC: Durbin-Watson test statistics and estimated residual 1st order autocorrelation

Hausman: Orthogonality test for valid instruments (H_0: $Corr(X_{IV}, \varepsilon) = 0$)

Appendix Ic

IV (2SLS) estimation results for district heat energy total tariff in Finland
(Apartment houses, $lnEprice^A$)
Number of firms $N = 76$. Years 1997-2002, $T = 6$.
(HCSE -corrected t-values in parenthesis)

	$POOLED_{IV}$	$PANEL_{IV}^{2FE}$
Constant	-10.179* (-2.21)	2.140 (3.17)
TIME	0.005* (2.34)	-
$lnEprice_{-1}^A$	0.750* (10.81)	0.175* (3.32)
DPUB	-0.085 (-1.07)	0.041 (1.19)
$lnMS^A$	0.001 (0.11)	-0.142 (-0.95)
lnFUEL	0.049* (2.01)	0.086* (3.11)
lnSCALE	0.014 (0.71)	0.229* (2.55)
lnPRODS	0.024* (2.68)	0.058* (1.77)
R^2	0.691	0.838
DW / AC	2.17/-0.09	2.09/-0.06
Hausman	2.76	3.70

*significant at 10% critical level or below

$POOLED_{IV}$: Instrumental variables (IV) estimation. Instruments: all exogenous variables (TIME, DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables
($lnMS^A$, lnSCALE, lnPRODS).

$PANEL_{IV}^{2FE}$: 2-way fixed effect (2FE) panel data instrumental variable estimation (IV).

Instruments: (DPUB, lnFUEL) and one year lagged values of lnFUEL and endogenous variables ($lnMS^A$, lnSCALE, lnPRODS).

DW/AC: Durbin-Watson test statistics and estimated residual 1st order autocorrelation

Hausman: Orthogonality test for valid instruments (H_0: $Corr(X_{IV}, \varepsilon) = 0$)

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