ECONOMICS DEPARTMENT
Uppsala University
Master Thesis
Author: Johanna Hansson
Supervisor: Bengt Assarsson
Fall Semester 2009

The Swedish District Heating Market

Firm Ownership and Variations in Price, Costs of Production and Profitability

Abstract

The purpose of this investigation is to further the current discussion of how the Swedish market for district heating can be made more competitive and effective. This is done by investigating how price, costs of production and profitability of district heating varies with ownership, a variable frequently held accountable for financial performance variations in natural monopoly markets. The investigation is based on financial and technical performance data from 203 firms from 2007 and 2008, compiled by the Swedish Energy Market Inspectorate. The results strongly indicate that private firms are more profitable than firms owned, fully or partly, by local government. Furthermore, the results find that higher profitability tends to be positively correlated with prices, rather than negatively with costs of production. The results speak in favor of private ownership under regulation, rather than the current mixture of public and unregulated private ownership.

Key words: District heating, natural monopoly, ownership

Contents

An Empirical Investigation of Ownership in the Swedish District Heating Market

1 Introduction

In Sweden, the price of district heating varies significantly between different counties and different firms. The highest price is more than twice as high as the lowest price (Avgiftsgruppen 2008). At the same time, some firms are making considerable profits while others are making losses. This has caused allegations in both media and other forums about overpricing and inefficiencies, and of course begs the question: What causes these significant differences?

District heating is a ‘natural monopoly’. This is because the required investments in infrastructure are so large that it is cheaper for one firm than for several to produce a certain amount of output. Therefore, it is economically inefficient to have several firms in the same geographic market (Depoorter 1999). However, if production is limited to only one firm, this firm is likely to have significant market power. This is also associated with inefficiencies, according to monopoly theory (Gravelle & Rees 2004). In response to this inherent conflict of interests, most natural monopoly firms are either publicly owned or regulated. The Swedish district heating market however, is unregulated and characterized only partly by public ownership. Of the over 200 regional natural monopolies in the district heating market, about 25 percent are owned either partly or fully by private interests, providing just below 50 percent of total delivered heat.

Economic theory predicts that private ownership of a natural monopoly firm will lead to higher prices and lower costs of production (and thereby higher profitability) than public ownership. This is because the primary objective of a privately owned firm is to maximize profits for its owners. This is not necessarily the case for publicly owned firms. For public firms the owners (the tax payers) are also the consumers and the inhabitants in the local community, and may therefore have other goals, perhaps of a non-financial or distributional nature, such as public interest prices or standards. There may also be less pressure to minimize costs in public firms, with no profit claiming residual owners.

The purpose of this investigation is to further the current discussion of how the Swedish market for district heating can be made more competitive and effective. This will be done by investigating a variable frequently held accountable, both in theory and in practice, for variations in financial performance in natural monopoly markets: Ownership. The purpose will be achieved by answering the question: How does price, cost of production and profitability of district heating vary with type of ownership?

1.1 Scope and Limitations of the Investigation

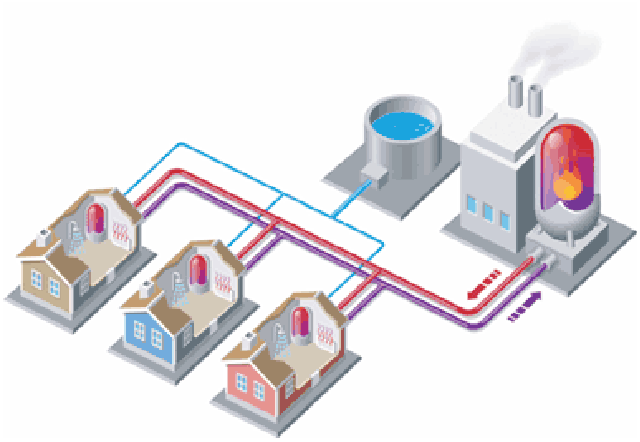
It has been acknowledged in previous empirical investigations that district heating financial performance in general, and price in particular, is dependent on a number of factors. For example size, market share, method of heat production, raw materials or carbon dioxide emissions. Some of these factors will be considered to a certain extent when exploring costs. Despite this, considering ownership in isolation is an oversimplification of reality. The extent to which other characteristics may influence the results will be explored in the discussion.

2 The Swedish District Heating Market

District heating is an efficient and environmentally friendly way of heating residential, industrial and commercial buildings. This is because, instead of every building having their own means of heating, heat is produced using advanced methods and environmentally friendly materials in a centralized location. District heating currently has a market share of over 50 percent of heating in Sweden. In the heating market for apartment buildings, the market share is closer to 75 percent. (Svensk Fjärrvärme 2009)

With district heating, hot water is transported through isolated pipelines from a heating central to surrounding buildings. The water is at a temperature of between 70 and 120 degrees centigrade and is used to heat for example radiators and water pipes in the building. When the water cools, it is transported back to the heating central. District heating is therefore a closed system (see figure 1). The processes which are used to produce heat in the heating central can vary between different firms. In the 1950s, many heating centrals used oil to heat water. However, since the 1980s many heating centrals use more environmentally friendly materials. Most of the fuels used today are resources which would otherwise have been disposed of in some other way, for example residual heat from industries such as forestry or waste management facilities. Producing district heat using environmentally friendly materials has reduced carbon dioxide emissions by 50 percent. (Svensk Fjärrvärme 2009)

Figure 1: *The District Heating Network*



(Göteborg Energi 2009)

2.1 Competition in the Market

District heating can be divided into two parts: Distribution and production. Distribution of district heating is generally considered to have a sub-additive cost function. This means that the costs for one firm to produce a given amount of output are lower than for two or more firms to produce the same amount. This is because the required investments in infrastructure are very large. Therefore, it is economically inefficient to have two distribution networks parallel to one another. This makes distribution of district heating a 'natural monopoly'. Production of district heating is not necessarily a natural monopoly. However, in Sweden, distribution and production are vertically integrated into the same firm. Therefore, district heating as a whole is most appropriately considered a natural monopoly. (EI 2009:11 p. 13; EMIR 2007:03 p. 39-41; Fastighetsägarna Stockholm 2008 p. 10-11; SOU 2004:136 p. 49)

This does not necessarily mean that district heating firms have monopoly power. The competitive situation depends on how the “relevant market” is defined[1]. Despite the availability of alternative forms of heating, the majority of reports depart from the assumption that district heating is its own relevant market. This is because, in reality, customers have very limited options to switch away from district heating. This is particularly true for apartment houses in urban areas, where installing an alternative form of heating can be practically very difficult. There can also be substantial costs associated with switching from district heating to an alternative. The practical difficulties and the costs together create an involuntary “lock-in” effect for the end customer (Hellmer 2008 p. 10). It can be argued that the relevant market for district heating is different before and after the customer has chosen district heating. For customers who already have district heating, there are limited competitive pressures from alternatives. However, prior to choosing district heating, there is arguably more pressure from alternatives. (EI 2009:11 p. 13; EMIR 2007:03 p. 39-41; Fastighetsägarna Stockholm 2008 p. 10-11) SOU 2004:136 p. 49)

One way in which the level of competition in the market could be increased is through so called ‘third party access’ (TPA). Under the current system, the owner is not required to let any other party have access to the distribution network. Therefore, to compete, a new firm would have to build an entirely new network (which they are unlikely to do as the costs are sub-additive). Third party access is currently under investigation by the Swedish government and a first report is due in April 2010. (Ministry of Enterprise, Energy and Communications 2009)

2.2 Variations in Price

The price of district heating varies largely between different firms and different geographic areas. This has been reported most notably in the Nils Holgersson reports[2]. Many investigations have speculated in the reasons for the large variations in price. To some extent, the variations in price are explained by the use of different production methods or raw materials. However, also factors like the size of the distribution network, market share, heating central age and carbon dioxide emissions can have an influence. No completely successful attempt has been made in modeling the price of district heating. The closest attempt can be attributed to Andersson & Werner (2003 & 2005). Andersson & Werner have modeled price using multiple regressions based on data from 2001 and 2003. The 2001 model explains 58 percent of the price variations, and the 2003 model 43 percent. Price for each firm is estimated based on the Nils Holgersson reports. The 2001 model includes ten variables which are significant at the 5 percent level. The implications of this model are discussed below.

The model predicts that an increase in size, market share and the amount of bio fuels or residual heat from either industry or waste management facilities causes the price of district heating to fall. Specifically, the model predicts that the price of district heating falls with 28 Kr/MWh for every ten-fold

[1] The “relevant market” has both a product and a geographic dimension. The product dimension considers the products which can be defined as close substitutes. A product can for example be considered a close substitute if a customer switches products in response to a hypothetical price increase of 5-10 percent ceteris paribus. The geographic dimension considers for example the area in which the given firms provide the product under similar competitive conditions. Defining the relevant market can be very difficult in practice. (SOU 2004:136)

[2] The Nils Holgersson reports have compared the costs for garbage collection, water and sewage, electricity and heating for different counties for the last fourteen years. Costs are compared for different counties by moving around a standardized house and recording list prices. (Nils Holgersson 2009)

increase of delivered heat (MWh). An increase in market share by 10 percent reduces the price with 3.4 Kr/MWh. The price also falls by 1.6 Kr/MWh with every 10 percent of total delivered heat that consists of bio fuels. The use of residual heat from industry or waste management facilities reduces the price with 4 Kr/MWh. The model further predicts that an increase in carbon dioxide emissions, distribution capital, use of power heat, real rate of return and a move from public to private ownership will increase price. Specifically, the model predicts that the price will increase with 0.47 Kr/MWh for every additional kilo carbon dioxide emissions. The price will increase with 1.7 percent of distribution capital. The use of power heat increases the price with 21 Kr/MWh. A non-public owner increases the price with 3.4 percent. One percentage point higher real rate of return increases the price with 8.2 Kr/MWh. It should however be noted that the model only explains 58 percent of the price variations. That is, 42 percent of price variations remain unexplained in this model. (Andersson & Werner 2003)

2.3 The Role of Ownership[3]

Prior to 1996, all the district heating firms were owned by local government and operated according to a self-cost principle. In 1996 the market was reformed, and district heating firms could be privatized and operated according to profit-maximizing principle (EI R2009:136). The reform was followed by a wave of privatization (Andersson & Werner 2003 p. 25). The reform has led to a very heterogeneous market in terms of ownership. There are over 200 regional monopoly firms in the Swedish district heating market. In 2008, about 75 percent of firms were under local government ownership, delivering just over 50 percent of all district heat. Most firms deliver heat only in their local county; however there are some examples of firms delivering heat to several counties. Despite the 1996 deregulation, firms operated by local government are still subject to legal restrictions (Kommunallagen 1991:100 and Fjärrvärmelagen 2008:163). This means they are required to operate in a 'business like' way (that is, not according to a self-cost principle), but profit-maximization cannot be the primary objective of the operations (SOU 2004:136).

Around ten percent of firms are owned by a combination of local government and other private interests. Most of these firms are small, with the exception of AB Fortum Värme samägt med Stockholm stad (Fortum), which delivers just below 20 percent of all district heat in Sweden. The remaining combined owned firms together deliver just below ten percent of all district heat in Sweden[4]. There are also firms owned entirely by private interests. Again, most of these firms are small – the exception being E.ON, which delivers between 10 and 15 percent of all district heat in Sweden. The remaining privately owned firms account for less than 2 percent of total delivered heat. One firm is owned by the Swedish state, Vattenfall, and accounts for about 5 percent of total delivered heat. (Energy Market Inspectorate 2009)

Andersson & Werner (2001, 2003, 2005 & 2009) have conducted an analysis on how ownership is related to price and profitability for the years 1999, 2001, 2003 and 2007. Their reports have divided firms into seven categories based on ownership. These include local government operations,

[3] The percentages of total delivered heat referred to in this section are based on own calculations from data compiled by the Swedish Energy Market Inspectorate for 2008. The data is presented and discussed in more detail in chapter four.

[4] For the most part, the private owner for combination firms is either Fortum, E.ON or Vattenfall.

local government firms, “other” local government firms, Fortum, E.ON, Vattenfall and “other firms”. The authors find that the price and profitability of district heating for firms operated by local government and Vattenfall are slightly lower, and has increased less over time, than for the remaining categories. Fortum has consistent had the highest price and profitability of any category. E.ON has had very variable results over time. The reports also investigate profitability as a function of price. For all years, the results show a positive correlation between profitability and price, indicating that different ownership categories have “normal” prices relative to their required rate of return. In 1999, 2001 and 2003 price is estimated from the Nils Holgersson reports and profitability from financial reports. In 2007, both price and profitability is estimated from data compiled by the Energy Market Inspectorate (EI).

To this author’s knowledge, no other reports have in as much detail questioned the relevance of ownership as the reports by Andersson & Werner. A report conducted by the Swedish Energy Agency in 2000 did however investigate ownership, using a simple regression with a dummy variable to indicate public or private ownership. Their calculations indicate a weak, but significant, positive relationship between private ownership and price: Privately owned firms have an average price which is about 5 percent higher than publicly owned firms (Swedish Energy Agency 2000 p. 59).

2.4 Increasing Transparency

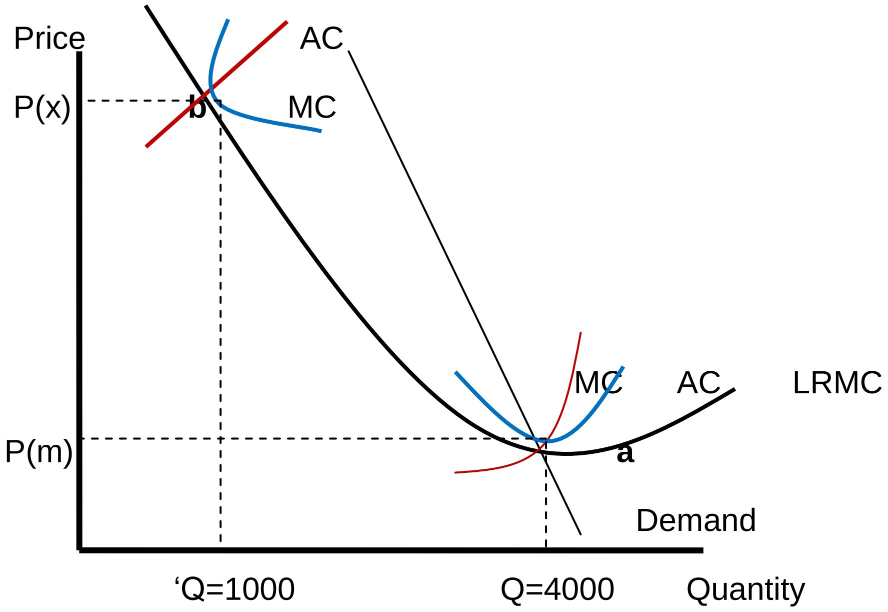
As is evident in the above review, previous investigations, with the exception of Andersson (2009), have departed from external sources for estimates of price and financial reports relating to all the business areas of district heating firms for estimates of costs and profitability (over 75 percent of district heating firms are involved in other business areas, for example broadband or waste management). This is because district heating firms have in the past not been required to report financial data separately for the district heating arm of the business. In 2007, the Swedish Energy Market Inspectorate enforced new regulations, requiring separate reporting. This measure was taken to increase transparency and reduce the risk of price discrimination and cross-subsidization (EI 2009:11).

In October of 2009 new district heating specific data was made available to the public for 2008. Therefore, district heating specific data is currently available for two years, 2007 and 2008. This data allows for a more accurate investigation of variations in financial performance to be undertaken; motivating this new study to complement empirical investigations conducted in the past.

3 Theoretical Framework

As discussed in the previous chapter, district heating is most appropriately considered a 'natural monopoly' market. This means that one firm is able to produce the same amount to a lower per unit price than several firms. A natural monopoly exists when the long run average cost curve declines at the point when the curve intersects market demand. This is illustrated in figure 2. A monopolist would supply the market at point a, with a price P (m) and quantity of 4000. Suppose instead that market consist of four firms. Each firm would supply the market at point b, with a price P (x) and a quantity of 1000. The total amount produced is the same as in the situation with one firm, but the unit price is higher. Having several firms supply the market is therefore a sub-optimal solution. (Depoorter 1999 p. 500)

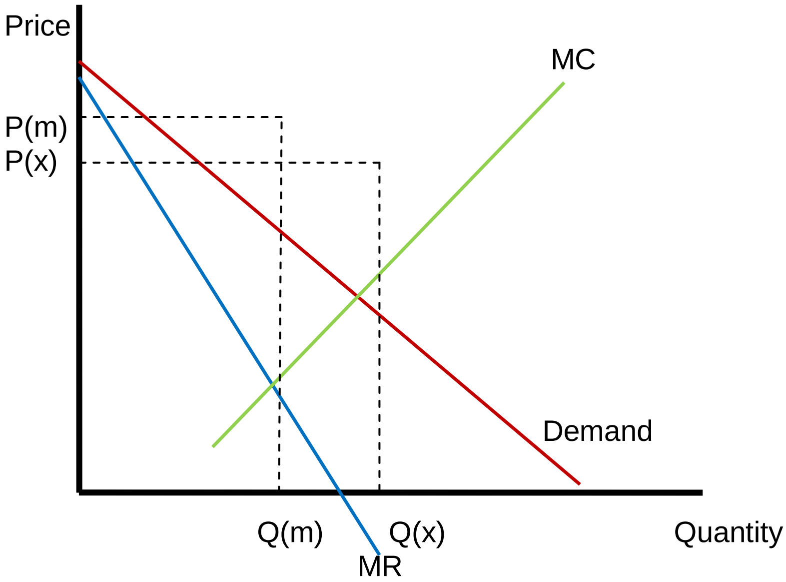
Figure 2: *Natural Monopoly*



(Depoorter 1999 p. 500)

The natural monopoly market results in an implicit conflict of interests: It is economically more efficient if one firm serves the market, but this gives the single firm monopoly power. If the single firm aims to profit-maximize, this will also lead to a sub-optimal solution. This is illustrated in figure 3. In a perfectly competitive market, a firm will produce where demand equals the marginal cost of production. This results in quantity Q (x) being produced to the price P (x). A monopolist on the other hand, will produce when marginal revenue equals marginal cost. This results in quantity Q (m) being produced a price P (m). In the monopolist situation, the quantity produced is lower, and the price higher, than in the competitive situation. The monopolist situation is therefore a suboptimal solution. (Besanko & Braeutigam 2005 p. 407, 434)

Figure 3: *Monopoly versus Perfect Competition*



(Besanko & Braeutigam 2005 p. 407)

3.1 Public versus Private Ownership

About fifty years ago, public ownership was thought to be the key solution to the inherent conflict of interest caused by natural monopolies. However, in the last two or three decades, a renewed faith in free markets has resulted in waves of privatization. There are many benefits associated with public ownership. The absence of an explicit profit incentive allows for 'responsible attention' to be directed to non-financial or distributional goals, such as public interest prices and standards. Therefore, under public ownership, price can be set at average or marginal cost of production (depending on desired distribution of resources), and thereby monopoly profits can be avoided. (Depoorter 1999 p. 514)

However, with public ownership, the lack of profit-claiming residual shareholders could negatively impact economic efficiency. This is because the incentives to reduce costs, try to improve quality or innovate are arguably weaker in public enterprises, as the manager receives poor returns as a non-owner. The interests of the tax payers are therefore likely to succumb to the interests of for example suppliers, consumers or employees. Economic efficiency could also suffer because vague goals relating to for example the environment or social welfare, which are hard to measure, are set in favor of profit maximizing. It is also not certain that a lack of profit maximization incentives necessarily result in an absence of monopoly pricing: Just because the firm is required to keep profits low or reasonable, this does not implicitly keep the firm from revenue or cost maximizing. Finally, it has been argued that public ownership fails to foster technological innovation, which can have significant impact on cost structures, especially in natural monopoly markets. (Depoorter 1999 p. 514-515)

It is also possible to have natural monopoly firms in private ownership. This basically means that the firm's owner is free to set price to maximize profits, without any consideration for other (non-financial) goals. The theoretical implications of this are best explained in a monopoly model of price and quantity determination (also see figure 3 above) (Gravelle & Rees 2004).

A monopoly firm faces a downward sloping demand curve. The slope of the demand curve reflects the elasticity of demand for the good. The demand function for a monopoly can be expressed as,

$$p = D(q) \qquad \frac{dp}{dq} < 0, \tag{1}$$

where p is price, q is output and D is the demand function. The first derivative of the demand function is negative. The firm's total cost function can be expressed as

$$C = C(q) \qquad C^{'}(q) > 0, \tag{2}$$

where C is the total cost. The marginal cost pf production is always positive. The profit function for a monopoly can be expressed as

$$\pi(q) = pq - C(q), \tag{3}$$

where π is the profit and the profit-maximizing output q* is positive. The first and second order conditions of the profit function can be expressed as

$$\pi^{'}(q) = p + \frac{qdp}{dq} - C^{'}(q) = 0 \tag{4}$$

$$\pi^{''}(q) = \frac{2dp}{dq} + \frac{qd^2p}{dq^2} - C^{''}(q) < 0. \tag{5}$$

The term $p + qdp/dq$ is the derivative of total revenue with respect to quantity; the marginal revenue. The first order condition shows that under monopoly marginal revenue will equal marginal cost. The term $2dp/dq + qd^2p/dq^2$ is the derivative of marginal revenue with respect to output. The second order condition shows that the slope of the marginal cost curve must exceed the slope of the marginal revenue curve at the optimal point. Therefore, marginal cost increases with output when marginal revenue decrease,

$$C^{''}(q) > 0 > \frac{2dp}{dq} + \frac{qd^2p}{dq^2} \quad . \tag{6}$$

We can rewrite the first order condition of the profit function with respect to marginal revenue

$$MR = p(1 + \left(\frac{q}{p}\right)\left(\frac{dp}{dq}\right)). \tag{7}$$

If we define elasticity of demand as

$$e = p\frac{\left(\frac{dq}{dp}\right)}{q} < 0, \tag{8}$$

then the relationship between marginal revenue and demand elasticity can be expressed as

$$MR = p(1 + \frac{1}{e}). \tag{9}$$

This equation, in combination with the first order condition of the profit function gives the condition for optimal output, which can be expressed as

$$p\left(1+\frac{1}{e}\right)=C'(q)=MC. \qquad (10)$$

This result implies that the price a monopolist charges will always exceed marginal cost since the price elasticity is infinite. Also, optimal output will always be at the point on the demand curve where $e < -1$ (given that $C'(q) > 0$). This implies that a (natural) monopolist left to its own devices maximizes profits by setting price where marginal revenue equals marginal cost, and reducing costs of production. The price level depends on the elasticity of demand. For a product with few close substitutes, elasticity of demand is likely to be quite low. Therefore, both the price and the subsequent profits enjoyed by the monopolist will be higher, and quantity produced will be lower, than socially optimal. (Gravelle & Rees, 2004, p. 191-192)

3.2 Regulation

It is also possible to use regulation with respect to price or revenue in response to a natural monopoly market. Regulation features in many natural monopoly markets, both in Sweden and around the world. The Swedish district heating market, however, is unregulated. This is in contrast to other energy markets such as the electricity and the natural gas markets, which are currently regulated ex-post. From 2012, the electricity and natural gas markets will be regulated ex-ante with respect to revenue (Energy Market Inspectorate 2009).

With regulation, firms are generally privately owned but limited in the price they can charge, or in the profits which they can extract from their operations. Ideally, regulation should create an incentive for the privately owned firm to profit maximize through minimizing costs rather than maximizing price (Netz 1999 p. 401). In theory, regulation can achieve the social optimum solution, where demand equals either average or marginal cost or of production (depending on desired distribution of resources). However, in practice, achieving the social optimum is difficult because the regulator has imperfect information (Armstrong et al 1995 p. 14, 28).

The regulator cannot know exactly the cost and production functions of the natural monopoly firm. Rather, the regulated firm is likely to know more about its cost and production functions than the regulator (Armstrong et al 1995 p. 14, 28). Given the assumption of asymmetric information, the regulator can choose between two broad regulation principles: Rate of return regulation or incentive regulation. Each will have different implications for price, costs of production and profitability. Rate of return regulation has featured particularly in the United States, and incentive regulation in Europe (Netz 1999 p. 401). In Sweden, the Energy Market Inspectorate will implement a revenue cap regulation from 2012, which is a form of incentive regulation (Energy Market Inspectorate 2009).

4 Data

To investigate how price, cost of production and profitability of district heating vary with type of ownership, this investigation departs from data made available by the Swedish Energy Market Inspectorate (EI) in October of 2009. The data contains financial and technical data from 203 district heating firms from 2007 and 2008. The original data is available on http://www.ei.se/For-Energiforetag/Fjarrvarme/Inrapporterade-data/.

The original dataset is not complete for all 203 district heating firms. About 5 percent of the firms have no recorded data at all[5]. These firms have been excluded from the investigation all together. There are also some firms for which only certain values are missing. For example, there are some firms which have reported zero revenue from district heating, meaning that price could not be calculated. Observations for the variable under investigation could not be calculated due to missing values have been excluded.

4.1 Ownership

The firms in the EI dataset are divided into six categories based on ownership: Public, combination, private, Vattenfall, Fortum and E.ON. Public firms are firms owned and operated by the local government. Combination firms are owned by a combination of local government and private interests. Private firms are owned by private interests only. Firms are categorized as public, combination or private based on information in annual reports (or, where not available, websites). A complete list of the firms in each of the first three categories is presented in Appendix A. Vattenfall, Fortum and E.ON are considered individually. This is because they are the largest firms in the market based on total delivered heat. A similar division is also made in the investigations by Andersson & Werner (2001, 2003, 2005 & 2009), enabling comparison.

4.2 Price, Costs of Production and Profits

The price of district heating is appreciated by dividing total income from district heating by total delivered heat. Although a rough estimate, it is arguably the best available proxy[6]. Total cost of production is extracted directly from the EI data, and is appreciated on a per unit basis by dividing by total delivered heat. In the EI data, total costs of production is divided into eight different components: (i) Raw materials (ii) merchandise (iii) other external costs (iv) personnel costs (v) write offs and write downs of material and immaterial infrastructure assets (vi) write downs of extraordinary operating assets (vii) comparison disturbing values (viii) other operating costs.

Profits are appreciated as the discrepancy between price and marginal cost of production. In line with economic theory regarding natural monopoly firms, the marginal cost of production is specified as the long run (when all factors of production are variable) average costs attributable to producing one additional increment of district heating (long run average incremental costs) (Noumba Um 2004 et al. p. 14-18). It can be rather subjective to define exactly which costs are directly attributable to the production of district heating in the

[5] Most of these firms have no recorded data either because they have a financial year starting in the middle of the calendar year or because data had not been reported to or entered by the EI.

[6] An alternative source of price of district heating is the Nils Holgersson reports. In the Nils Holgersson reports a standardized apartment house is ‘moved around’ different counties and the list price recorded. Although the Nils Holgersson data arguably provides a more accurate estimate, it does not appreciate costs or profitability.

long run[7]. Therefore profits based on a maximum, 'best estimate' and minimum of long run average incremental costs are calculated as below

$$\Pi(max) = P - [C(i) + C(ii)] \qquad (11)$$

$$\Pi(estimate) = P - [C(i) + C(ii) + 0{,}5C(iii) + 0{,}5C(iv) + 0{,}5C(v)] \qquad (12)$$

$$\Pi(min) = P - \begin{bmatrix} C(i) + C(ii) + C(iii) + C(iv) + \\ C(v) + C(vi) + C(vii) + C(viii) \end{bmatrix} \qquad (13)$$

where Π is profit, P is price and C is cost for the given component as defined under cost of production on the previous page. The maximum estimate of profits (equation 11) is based on a definition of long run average incremental costs which includes only costs for raw materials & necessities and merchandise. Costs for raw materials are most definitely variable with producing an additional increment of district heating. The minimum estimate (equation 13) of profits is based on a LRAIC definition which includes all cost components.

The 'best' estimate includes raw materials, merchandise and 50 percent of other external costs, personnel costs and write offs and write downs of material and immaterial assets (equation 12). The motivation for this estimate is as follows: Other external costs include for example costs for office and production facilities and energy costs. Especially energy costs would be considered a variable cost and should be included. Personnel costs include costs for both personnel in administration and production. Personnel costs associated with production should be included, but not necessarily administration. Write offs for material and immaterial assets is included because it is necessary to extend the distribution network to reach new customers. However assets in production may not need to be extended to produce an additional increment of district heating. Write downs should however not necessarily be included.

4.3 Key Financial Indicators

For comparison, profitability is also appreciated using key financial indicators, including rate of return on equity (ROE), rate of return on capital employed (ROCE) and rate of return on total assets (ROA). 22 firms in 2008 and 13 firms in 2007 have reported negative stockholder's equity. As a rate of return of equity based on a negative equity value has little economic significance, these observations have been excluded for the purpose of comparison between ownership categories. The formulae on which the financial indicators are based are defined below,

$$ROE = Net\ Income / [(0{,}72 * Untaxed\ Reserves) + Stockholder's\ Equity] \qquad (14)$$

$$ROCE = [Net\ Income + Interest\ Expenses] / Employed\ Capital \qquad (15)$$

$$ROA = [Net\ Income + Interest\ Expenses] / Total\ Assets\ . \qquad (16)$$

[7] It is not always justified to conduct an analysis of profitability based on the costs which indicated in the financial report. This is because all or part of the distribution networks can be written off already. The Swedish Energy Market Inspectorate does not plan to depart from reported costs in the price regulation of the electricity or natural gas network, and they argue that reported costs do not give a representative picture of the long run costs of production (EI 2009:11 p. 25). However, given that reported costs are publicly available, they are arguably the best estimate for this investigation.

4.4 Reliability

Some criticism can be directed towards the reliability of the data compiled by the Energy Market Inspectorate. For example, several district heating firms have zero revenue from district heating, which is unlikely to be correct. Also, district heating firms have only been required to report financial results for the district heating arm of the business separately since 2007. As over 75 percent of firms are involved in multiple business areas, it is difficult to insure than the separation is done in the same way in all instances, despite guidelines from the Energy Market Inspectorate.

5 Results

Price, costs of production and profitability has been appreciated for each ownership category for the years 2007 and 2008. Note that for the purpose of comparison the median rather than the mean are used for the categories public, combination and private. This is because the distribution is generally skewed and prone to outliers. Summary statistics for public, combination and private firms are presented in Appendix B.

5.1 Price, Costs of Production and Profits

The appreciated price of district heating ranges from 525 Kr/MWh to 623 Kr/MWh in 2007 and from 532 Kr/MWh to 588 Kr/MWh in 2008. In both years, public or combination firms have the lowest average price, and Fortum has the highest average price. E.ON also has a notably low average price in 2008, at 538 Kr/MWh. The price for all ownership categories and both years are presented in table 1. Orange indicates a minimum and blue indicates a maximum (also in tables 2, 3 and 4 to follow).

Table 1: *Price per Ownership Category (Kr/MWh)*

		Public	Combined	Private	Vattenfall	Fortum	E.ON
Price	07	525	525	561	512	623	571
	08	547	532	578	576	588	538

The total costs of production range from 474 Kr/MWh to 752 Kr/MWh in 2007 and from 491 Kr/MWh to 850 Kr/MWh in 2008. For both years, combined firms have the lowest total costs of production and Vattenfall the highest total costs of production. The differences in total costs can be attributable to differences in the costs components. Particularly the cost components, other external costs (iii), personnel costs (iv) and write offs and write downs of material and immaterial infrastructure assets (v), vary largely between different ownership categories. The total costs and the cost components for all ownership categories for both years are presented in table 2.

Table 2: *Cost of Production Components per Ownership Category (Kr/MWh)*

		Public	Combined	Private	Vattenfall	Fortum	E.ON
C(i)	07	277	266	286	246	265	297
	08	264	261	257	402	280	290
C(ii)	07	0	0	0	0	0	0
	08	0	0	0	0	0	0
C(iii)	07	111	105	89	227	138	96
	08	108	95	120	147	138	90
C(iv)	07	58	0	1	108	51	66
	08	54	2	13	120	53	68
C(v)	07	89	82	85	111	92	76
	08	102	81	82	153	87	68
C(vi)	07	0	0	0	0	0	0
	08	0	0	0	0	0	0
C(vii)	07	0	0	0	0	0	0
	08	0	0	0	0	0	0
C(viii)	07	0	0	0	60	0	50
	08	0	0	0	27	0	4
Total Cost	**07**	**545**	**474**	**509**	**752**	**546**	**585**
	08	**582**	**491**	**517**	**850**	**558**	**520**

Note: Cost components are defined in section 4.2. Values refer to median values, and therefore the components do not necessarily add up to the total cost.

The three measures of profit depend on which cost components are taken into account. It can be observed the three estimates of profits internally rank the ownership categories in different orders. This is because the largest differences in costs stem from components (iii), (iv) and (v) as discussed above. Despite this, the highest profits are attributable to Fortum for all estimates for both years with only one exception, minimum profits in 2008. Also the lowest profits (or the losses) are attributable to one firm, Vattenfall, for all estimates for both years also, with only the exception of maximum profits in 2007.

Table 3: *Profits per Ownership Category (Kr/MWh)*

		Public	Combined	Private	Vattenfall	Fortum	E.ON
Profit I	07	265	244	322	266	358	274
	08	266	273	270	147	309	247
Profit II	07	125	140	182	43	218	155
	08	131	151	159	-36	169	134
Profit III	07	-2	26	61	-250	77	-14
	08	-13	32	86	-274	30	18

The price, costs of production and three estimates of profits are illustrated in diagram form in Appendix C.

5.2 Key Financial Indicators

As a point of comparison for profitability, three key financial indicators have been calculated for the six ownership categories. The indicators include rate of return on equity (ROE), rate of return on capital employed (ROCE) and rate of return on total assets (ROA), and the results for each are presented in table 4.

Table 4: *Rate of Return per Ownership Category (%)*

		Public	Combined	Private	Vattenfall	Fortum	E.ON
ROE	07	9	11	17	14	11	10
	08	7	8	15	6	10	20
ROCE	07	5	5	8	7	11	5
	08	4	5	7	3	10	11
ROA	07	3	7	7	8	8	8
	08	5	5	7	6	8	15

District heating is a capital intensive industry. To a certain extent, this influences which measures of profitability are more appropriate, although all should preferably be considered together. For example, for capital intensive industries, it is important that a firm uses its capital in an effective way. It is also likely that a capital intensive firm is borrowing more heavily than a less capital intensive firm.

ROE measures how much a firm has earned for each dollar or stockholder investment. ROE is generally used to assess the effectiveness of the firm's overall business strategy. ROA measures how well the management has invested total capital, provided by both debt holders and stockholders. This is the broadest measure of profitability, regardless of financial strategy. The difference between ROE and ROA is therefore a question of financial liability. All six ownership categories systematically have a higher ROE than ROA.
ROCE measures the rate of return from capital employed. ROCE is particularly important for capital intensive industries which require large

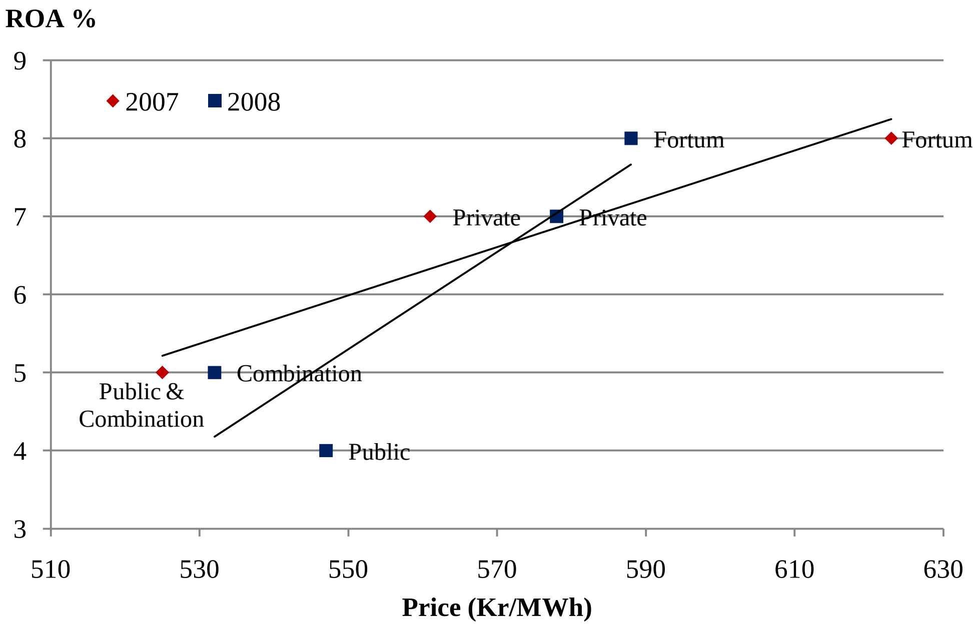
investments in infrastructure, such as district heating, telecommunications, oil and natural gas. (Libby, Libby & Short 2001 p. 265, 660)

All the key financial indicators underscore the results in the previous section: Public and combination firms have on average lower profitability than private firms and Fortum. The results for Vattenfall and E.ON are very variable across the two years. The measures for rate of return are illustrated in diagram form in Appendix D.

5.3 Profitability as a Function of Price and Total Costs

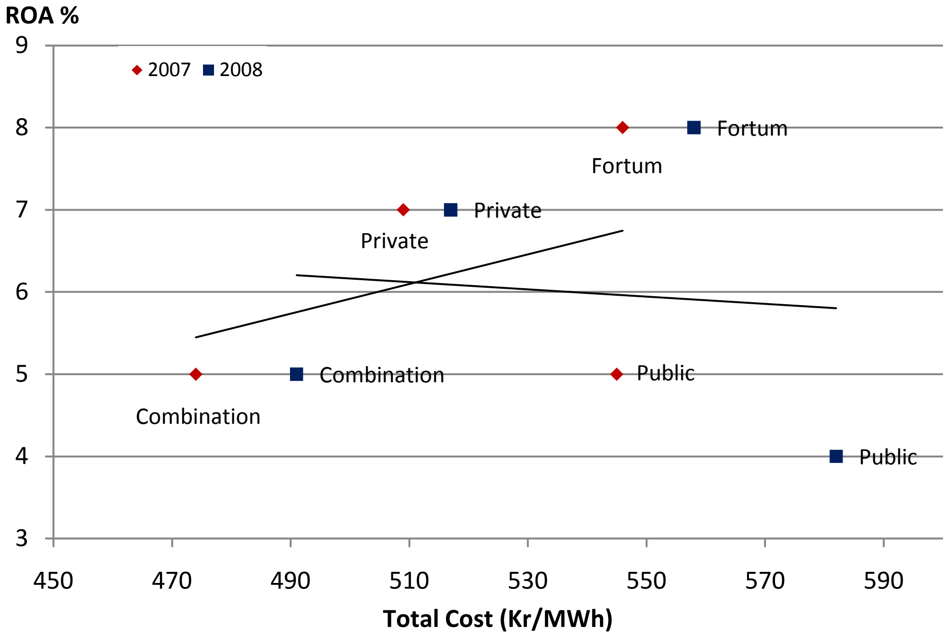
ROA, as a measure of the effectiveness of the firm's overall business strategy, has been used to investigate profitability as a function of price and total costs. The variable results of Vattenfall and E.ON across the two years (tables 1, 2 and 4) significantly change the trend lines. Therefore, for the purpose of this exercise, they have been excluded[8]. A positive relationship between ROA and price can be observed in both 2007 and 2008 (figure 4). A positive relationship can also be observed between ROA and total costs of production in 2007. However, the relationship is negative in 2008 (figure 5). Versions of figures 4 and 5 including E.ON and Vattenfall are presented in Appendix E.

Figure 4: *ROA as a Function of Price*



[8] The possible reasons for the large discrepancies between the two years for Vattenfall and E.ON is explored further in the next chapter.

Figure 5: *ROA as a Function of Total Costs*



6 Discussion

The results indicate that private firms are more profitable than firms owned, fully or partly, by local government. Furthermore, the results indicate that a high level of profitability is positively correlated with a higher price for the end consumer, rather than negatively correlated with lower costs of production for the firm. Some of the results are very variable between the two years, making their interpretation more difficult.

6.1 Public Ownership

Public firms have lower prices, higher costs of production and lower profitability than other ownership categories. This result is aligned with the economic theory regarding public ownership of natural monopoly firms. The results are also aligned with previous studies, such as the studies conducted by Andersson & Werner. The lower prices and lower rates of return indicate that public ownership is successful in bringing 'responsible attention' to non-financial goals, which Depoorter (1999) advocated as an important benefit. The lower rate of returns is however also heavily influenced by the laws which govern public firms. The law states that, in simplified terms, operations have to be run in a business like way, but profit-maximizing cannot be the primary objective. That is: Public firms are by law required to maintain a "reasonable" rate of return.

The benefit of 'responsible attention' to non-financial goals does however appear to come at the expense of higher costs, possibly caused by economic inefficiency. The cost components which are relatively higher include costs for personnel, other external costs (including rent and energy costs) and write offs and write downs of material and immaterial infrastructure assets. Especially costs for personnel and other external costs could be linked with economic inefficiency, and attributed to ownership. There may however also be influence of other factors. This will be discussed further in section 6.4.

Vattenfall has had very variable results for price, costs of production and profitability across 2007 and 2008. It is therefore hard to compare the performance of Vattenfall, which is owned by the Swedish State, with economic theory. The large discrepancy in price and costs of production mostly stem from a smaller quantity of district heating being reported as sold in 2008 than in 2007, making both price and costs of production lower on a per unit basis in 2007.

The large discrepancy in the rate of return figures appears to be derived from differences in net income between the two years. In 2007, net income was 183,784 MKR, and in 2008 it was 68,062 MKR. That is a 63 percent decrease in net income. This difference in turn stems mostly from a much larger income from shares in other businesses in 2007 (that is, income that is not directly related to district heating). Which year that is more representative for Vattenfall's performance over time is difficult to comment on based on the EI data. It can be observed however, that very few firms have any income at all from shares in other businesses (only E.ON in 2008). Previous studies have found that Vattenfall's financial performance is closer aligned with that of public firms. However, Vattenfall have a price setting policy and a required rate of return which is in line with private firms (Vattenfall 2009).

6.2 Combination Ownership

Combination owned firms have lower prices, lower costs and lower profitability than other ownership categories. Price and profitability are in line with public firms. The total costs are however much lower than for public firms, in fact, the lowest costs out of all ownership categories is appreciated for combination firms. According to economic theory, this could be motivated by the private owner attempting to profit-maximize. This does however not explain why costs are significantly lower than that for privately owned firms. A possible reason for the very low costs of production could be that, given the public owners' 'responsible attention' to lower prices for consumers, lower costs of production are the only way for private owners to extract reasonable profits. It should be observed that the division of ownership varies between the different firms. The majority of firms have a division at, or close to, fifty-fifty. However, there are examples of firms where local government owns as little as 5 percent or as much as 80 percent (see Appendix A). Which owner is in majority is likely to affect the extent to which social welfare or profit maximizing is prioritized.

Fortum has the highest prices, high costs and high profitability compared to other ownership categories. Fortum is partly owned by Stockholm City, making it a combination firm. However, unlike for other combination firms, price and profitability are both very high. This observation is surprising, considering that Fortum's board is made up to 50 percent by representatives from the public owner, Stockholm City (Fortum 2009). It may be the case, given that Fortum is a very large international corporation, headquartered in Finland, that it is difficult for individual board members to exercise significant influence over decisions. The board members representing the part owners Stockholm City should ideally be advocating the consumers' interests (through for example lower prices) more strongly. Fortum's costs of production are on par with that of publicly owned firms. It is possible that the ability to raise prices to such high levels reduces the pressure to decrease costs of production. The high prices and high profitability of Fortum is also observed in previous investigations.

6.3 Private Ownership

Private firms have higher prices, lower costs and higher profitability than other ownership categories. The high price and high profitability is to be expected in accordance with economic theory; profit maximizing is the primary objective for the owners of a private firm. The total costs are notably lower than for public firms, but not quite as low as for combination owned firms. This is possibly because it is easier for private firms than for combination firms to extract profits by raising the price. The difference in total costs appears to stem from lower external costs, personnel costs and write offs and write downs of infrastructure assets. This could point to greater cost efficiency, as is predicted by economic theory. However costs are not as low as for combination firms, indicating that private firms could still have some room to improve efficiency.

Similar tendencies can potentially be observed for E.ON, which is privately owned. However, the results recorded for 2007 and 2008 are very variable, making them hard to interpret without further investigating the components which make up the dependent variables. As with Vattenfall, the discrepancy in price and costs stems mostly from differences in the reported quantity of district heating sold. The amount sold is about 10 percent higher in 2008 than in 2007.

The difference in rates of return, however, seems to stem from a variety of components. As with Vattenfall, there is a considerable income reported from shares in other businesses in 2008, making the net income about 260 percent higher than in 2007. However, there is also a very large discrepancy in the net interest expense, shareholder's equity, capital employed and total assets. It is therefore impossible to say which year is more representative for E.ON based solely on the EI data. What can be said is that the rates of return values are notably low in 2007, and notably high in 2008. E.ON has, in previous investigations, also showed very variable results over time.

6.4 Putting Financial Performance in Perspective

It has been argued by privately owned firms that it is unfair to compare their prices and level of profitability with that of public firms, because public firms have an unreasonably low level of profitability. There is no established benchmark for normal profitability for the district heating market (EI 2009:11). A possible comparison for profitability in the district heating market could be the weighted average cost of capital (WACC) for the electricity industry[9], which is estimated at 6.5-7.1 percent in 2007 and 6.7-7.4 percent in 2008 (Icecapital 2007 & 2008).

As a very rough estimate of excess profits, the discrepancy between WACC and the rate of return on capital employed (ROCE) can be appreciated (Libby, Libby & Short 2001). Although many similarities exist between electricity and district heating, there are still some characteristic differences. This could influence the results. Public firms have a ROCE lower than the WACC. Combination firms, Vattenfall and possibly private firms have ROCE values in relatively close proximity to the WACC. E.ON and notably Fortum have a ROCE above the WACC[10]. This indicates that the public firms have an exceptionally low rate of return, and, at the same time, there could be reason to suspect that E.ON and Fortum are achieving higher than normal profits through overpricing.

6.5 Influence of Other Factors

There are a number of other factors, beyond ownership, which are possibly affecting the results. Previous investigations have highlighted for example size, portion of bio fuels in the production, market share, residual heat, carbon dioxide emissions, distribution capital and required rate of return. The investigation shows that most of the difference in cost stems from thee cost components; costs for personnel, other external costs and write offs and write downs of material and immaterial infrastructure assets. The differences in these cost components are determined to some extent by ownership. However, other factors are also likely to have a role to play.

It is difficult to generalize the characteristics of the six ownership categories. Two observations can be made based on the data from the Energy Market Inspectorate: Private firms tend to be both smaller and newer than public firms. This could affect costs. As a natural monopoly, district heating is likely to be associated with returns to scale (Depoorter 1999). This has also been shown for district heating in the regressions by Andersson & Werner (2001 & 2003). Large returns to scale would mean that larger firms should have a lower per unit cost than smaller firms. However, as public firms have

[9] Appreciated by ICECAPITAL on behalf of the Energy Market Inspectorate

[10] ROCE is 3 and 5 percent for public firms in 2007 and 2008, 5 and 7 percent for combination firms, 8 and 7 percent for private firms, 10 and 11 percent for Fortum, 8 and 15 percent for E.ON and 8 and 6 percent for Vattenfall.

higher costs than private firms, returns to scale may not change the results. Age of distribution network could theoretically also affect costs. In Andersson & Werner's reports, age was shown to be insignificant in determining price. Private firms tend to be newer than public firms. This could affect costs of production through write offs and write downs of material and immaterial infrastructure assets. The lower write offs associated with private firms could therefore be caused by newer networks, not efficiencies created through private ownership.

7 Concluding Remarks

The purpose of this investigation was to further the current discussion of how the Swedish market for district heating can be made more competitive and effective. This has been done by investigating a variable frequently held accountable, both in theory and in practice, for variations in financial performance in natural monopoly markets: Ownership. The purpose has been achieved by investigating specifically how price, costs of production and profitability of district heating varies with type of ownership.

Some clear trends have been observed. The results strongly indicate that private firms are more profitable than firms owned, fully or partly, by local government. Furthermore, the results indicate that a high level of profitability is correlated positively with high prices for the end consumer, rather than negatively with low costs of production of the firm.

Neither public nor private firms appear to have sufficient pressure to minimize costs, as neither is close to the much lower costs associated with combination firms. For private firms this is mostly likely motivated by the relative ease with which price can be increased. For public firms, the objectives are primarily low prices and reasonable profitability, rather than low costs. As such, neither public nor private firms are arguably achieving a socially optimal outcome. Combination firms; where the public owner acts as a kind of price control for the private, profit-maximizing owner, seems to come closer to a socially desirable outcome that public or private firms. This observation speaks in favor of private ownership under regulation rather than the current mixture of public and unregulated private ownership.

It can be concluded that the results are relatively closely aligned with both theory and previous empirical results. However, as discussed in the introduction, considering ownership in isolation is an oversimplification of reality as combinations of factors are in interplay. In a future investigation, ownership should ideally be considered in conjunction with other factors which could influence financial performance.

Reference List

Andersson, S, 2009 *Fjärrvärme i Sverige 2007 – En Analys av Priser och Lönsamhet i Svenska Fjärrvärmeföretag,* Svensk Fjärrvärme AB, viewed 15 November 2009. Available from: <http://svenskfjärrvärme.se/download_biblo/1292/FVB_FV_SV_2007-20090217.pdf>

Andersson, S, Werner, S S 2001 *Svensk fjärrvärme – ägare priser och lönsamhet,* Chalmers Technical University, viewed 15 November 2009. Available from: <http://mk.quicknet.se/13062/upload/dokument/rpt_sv_fv.pdf>

Andersson, S, Werner, S 2003 *Fjärrvärme i Sverige 2001 – En analys av ägande, jämställdhet, priser och lösamhet i svenska fjärrvärmeföretag med vissa internationella utblickar,* FVB Sverige AB, viewed 15 November 2009. Available from: <http://mk.quicknet.se/13062/upload/dokument/rpt_fv_sverige_2001.pdf>

Andersson, S, Werner, S 2005 *Fjärrvärme i Sverige 2003 - En analys av råvarukostnader, ägande, jämställdhet, priser och lönsamhet i svenska fjärrvärmeföretag*, FVB Sverige AB, viewed 15 November 2009. Available from:<http://mk.quicknet.se/13062/upload/dokument/rpt_fv_sverige_2003.pdf>

Armstrong, M, Cowan, S & Vickers, J 1995 *Regulatory reform - Economic analysis and the British experience,* MIT Press, Cambridge, Massachusetts

Avgiftsgruppen 2009 *Fastigheten Nils Holgerssons underbara resa genom Sverige – en avgiftsstudie för 2008,* Stockholm, viewed 5th November 2009. Available from: http://www.nilsholgersson.nu/Avgiftrapport/2008/AvgiftsrapportNH2008_m_bilagor.pdf

Besanko, D & Braeutigam, R 2005 *Microeconomics* 2nd Ed, John Wiley & Sons, New Jersey

Depoorter, B 1999 *Regulation of Natural Monopoly*, University of Ghent, viewed 15 December 2009. Available from: <http://encyclo.findlaw.com/5400book.pdf>

Fortum, 2009, *Fortum,* Espoo, viewed 9th January 2010. Available from: <http://fortum.com>

Göteborg Energi AB, 2009, *Göteborg Energi AB,* Göteborg, viewed 28 December 2009. Available from: <http://www.goteborgenergi.se/>

Gravelle, H, Rees, R 2004, *Microeconomics,* 3rd Edition, Prentice Hall, Essex, England

Hellmer, S, 2008 *Un-cashed Switching Benefits – Loyalty or Lock-ins? The Case of District Heating in Sweden,* Blekinge Institute of Technology, viewed 18 December 2009. Available from: <http://cni.tu.berlin.de/fileadmin/documents/infraday/2008/papers/_13d_hellmer_paper.pdf>

Ice Capital 2009, *WACC 2008,* report on behalf of the Swedish Energy Market Inspectorate, Ice Capital, viewed 4th January 2010

Ice Capital 2008, *WACC 2007,* report on behalf of the Swedish Energy Market Inspectorate, Ice Capital, viewed 4th January 2010

Ministry of Energy, Enterprise and Communications 2009 *Utredning om tredjepartstillträde till fjärrvärmenäten.* Press release (online) issued 22 January 2009, viewed 19th December 2009. Available from:
<http://www.riksdagen.se/Webbnav/index.aspx?nid=10&dok_id=DIR2009:5>

Netz, J 1999 *Price Regulation: A (Non Technical) Overview,* Purdue University, viewed 15 December 2009. Available from:
<http://encyclo.findlaw.com/5200book.pdf>

Noumba Um, P et al. 2004 *A Model for Calculating Interconnection Costs in Telecommunications,* World Bank, Washington DC, United States.

Libby, R, Libby, P & Short, D 2001 *Financial Accounting,* 3rd Edition, McGraw Hill, New York

Swedish Energy Market Inspectorate, 2009 *EI R2009:11 Särredovisning av fjärrvärmeverksamhet – Är nuvarande reglering tillräcklig för att hantera riskerna av för korssubventionering och prissubventionering?,* Swedish Energy Market Inspectorate, viewed 3 November 2009. Available from:
<http://ei.se/upload/Rapporter/EI20R200911_Sarredovisning_av_fjarrvarmeverksamhet.pdf>

Swedish Energy Market Inspectorate, 2009, *The Swedish Energy Market Inspectorate*, Eskilstuna, viewed 1 November 2009. Available from:
<hppt://ei.se>

Swedish Energy Market Inspectorate, 2009, *District Heating Firms Reported Data,* Eskilstuna, viewed 1 November 2009. Available from:
>http://www.ei.se/For-Energiforetag/Fjarrvarme/Inrapporterade-data/>

Swedish Energy Market Inspectorate, 2004 *EMIR 2007:03 Uppvärmning i Sverige 2007*, Swedish Energy Market Inspectorate, viewed 5 November 2009. Available from:
<http://energimarknadsinspektionen.se/upload/Rapporter/Uppv%C3%A4rmning%20Sverige%202007_utan%20bilagor.pdf>

Statens Offentliga Utredningar, 2004 *SOU 2004:136 Skäligt Pris på Fjärrvärme,* Statens Offentliga Utredningar, viewed 3 November 2009. Avaliable from: <http://regeringen.se/content/1/c6/03/79/76/555a25d9.pdf>

Svensk Fjärrvärme AB, 2009 *Svensk Fjärrvärme AB,* Stockholm, viewed 2 November 2009. Avaliable from: <http://svenskfjarrvarme.se/>

Vattenfall, 2009, *Vattenfall,* Stockholm, viewed 9th of January. Available from: <hppt://vattenfall.se>

Websites or financial reports from all district heating firms in Appendix A

Appendix A Ownership Classification

Publicly Owned Firms: AB Borlänge Energi, Affärsverken Karlskrona, Ale Fjärrvärme AB, Alingsås Energinät AB, Alvesta Energi AB, Aneby Miljö och Vatten AB, Arboga Energi AB, Arjeblogs Kommun, Arvidsjaurs Energi AB, Bengtfors Kommun, Bionär Närvärme AB, Bodens Energi AB, Bollnäs Energi AB, Borgholm Energi AB, Borås Energi och Miljö, Bromölla Fjärrvärme AB, Bräcke Kommun, Eksta Bostads AB, Emmaboda Energi AB, ENA Energi AB, Eskilstuna Energi AB, Falbygdens Energi AB, Falkenberg Energi AB, Falu Energi & Vatten AB, Farmaenergi i Ed AB, Finspång Tekniska Verk AB, Fjärrvärme i Osby AB, Gislaved Energi AB, Gällivare Värmeverk AB, Gävle Energi AB, Göteborg Energi AB, Götene Vatten & Värme AB, Habo Energi AB, Hagfors Energi AB, Halmstad Energi AB, Hammarö Energi AB, Hedemora Energi AB, Herrljunga Elektriska AB, Hjo Energi AB, Hyltebostäder, Härnösand Energi AB, Hässleholm Mijö AB, Jokkmokks Värmeverk AB, Jämtlands Värme AB, Jönköping Energi AB, Karlshamn Energi AB, Karlstad Energi AB, Katrineholm Energi AB, Kils Energi AB, Kristinehämns Fjärrvärme AB, Kungälv Energi, Köpings Kommun, Landskrona Kommun, Lerum Fjärrvärme AB, LEVA i Lysekil AB, Lidköpings Värmeverk AB, Linde Energi AB, Ljusdal Energi AB, Malung-Sälens Kommun, Mariestad-Töreboda Energi AB, Mark Kraftvärme AB, Mjölby-Svartådalen Energi AB, Mullsjö Energi & Miljö AB, Mälarenergi AB, Mölndal Energi AB, Mörbylånga Kommun, Nordanstigs Bostäder, Nordanstigs Kommun, Norrenergi AB, Norrenergi AB, Nybro Energi AB, Nässjö Affärsverk AB, Olofströms Kraft AB, Oxelö Energi AB, Pajala Värmeverk AB, Partille Energi AB, Ronneby Mijö & Teknik AB, Rättviks Teknik AB, Sala-Heby Energi AB, Sandviken Energi AB, Sevab Strängnäs Energi AB, Skara Energi AB, Skellefteå Kraft AB, Skövde Värmeverk AB, Smedjebacken Energi AB, Sollentuna Energi AB, Sorsele Värmeverk AB, Stenungsund Energi & Miljö Ab, Uddevalla Energi AB, Ulricehamn Energi AB, Umeå Energi AB, Vaggeryds Energi AB, Vara Värme AB, Varberg Energi AB, Vetlanda Energi & Teknik AB, Vimmerby Energi AB, Västervik Miljö & Energi AB, Växsjö Energi AB, Ydre Kommun, Ystad Energi AB, Ånge Energi AB, Åsele Energiverk AB, Åtvidabergs Fjärrvärme AB, Älvkarleby Fjärrvärme AB, Älvsbyns Energi AB, Öresundskraft Ängelholm AB, Örkelljunga Fjärrvärme AB, Österlens Kraft AB, Övik Energi AB

Combination Owned Firms: AB PiteEnergi (50/50), Arvika Fjärrvärme (40/60), Haparanda Värmeverk AB, (50/50), Hofors Energi AB (40/60), Hällefors Värme AB (5/95), Jämtkraft AB (80/20), Kalmar Energi AB (50/50), Karlsborgs Energi AB (50/50), Karlskoga Värmeverk AB (51/49), Laxåvärme AB, Lilla Edets Fjärrvärme (50/50), Luleå Energi AB (70/30), Munkfors Värmeverk AB (60/40), Nossebro Energi AB, Oskarshamn Energi AB (50/50), Perstorps Fjärrvärme AB (50/50), Svenljunga Energi AB, Säffle Fjärrvärme (49/51), Sävsjö Energi AB (50/50), Vattenfall Kalix Fjärrvärme AB, Värnamo Energi AB (45/55), Västerbergsslagens Energi AB, Åre Fjärrvärme AB (80/20), Överkalix Värmeverk AB (50/50), Övertorneå Värmeverk AB (50/50)

Privately Owned Firms: Agrovärme Enköping, Elektra Värme AB, Filipstads Värme AB, Fortum Värme Nynäshamn, Gotlands Närvärme AB, Grästorps Energi AB, Lantmännen Agrovärme AB, Lenhovda Energi AB, Molkom Biovärme AB, Neova AB, Pålsboda Bioenergi AB, Rindi Energi AB, Skurups Fjärrvärme AB, Vårgårda Värmecentral AB

Appendix B Summary Statistics

Price

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	534	560	532	560	513	532	580	572
SE	7	8	8	10	14	14	24	13
Median	**527**	**554**	**525**	**547**	**524**	**532**	**561**	**578**
Standard Deviation	87	103	88	114	73	73	97	64
Skewness	0	3	0	3	0	-1	0	1
Range	593	1136	593	1136	349	343	300	348
Minimum	232	244	232	244	325	325	425	419
Maximum	824	1380	824	1380	674	668	725	767
Count	177	182	129	128	29	27	19	24

Total Costs (Kr/MWh)

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	549	549	565	611	478	530	530	514
SE	10	12	12	15	17	35	24	19
Median	**531**	**561**	**545**	**582**	**474**	**491**	**509**	**517**
SD	127	168	132	170	93	183	97	89
Skewness	2	2	2	2	-1	3	0	0
Range	813	1203	771	1184	365	1015	350	302
Minimum	292	289	334	308	292	289	367	388
Maximum	1105	1492	1105	1492	657	1304	717	690
Count	178	182	130	127	29	28	16	23

Profits I (Kr/MWh)

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	255	264	248	261	255	255	308	289
SE	9	9	11	13	14	11	21	13
Median	**266**	**269**	**265**	**266**	**244**	**273**	**322**	**270**
Skewness	-1	0	-1	0	0	0	0	1
SD	118	128	129	147	76	61	83	62
Range	1005	1033	1005	1033	329	255	281	229
Minimum	-322	-207	-322	-207	109	143	174	210
Maximum	783	826	783	826	438	398	456	439
Count	178	182	130	127	29	28	16	23

Profits II (Kr/MWh)

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	125	123	113	111	147	130	185	176
SE	7	8	9	11	13	21	16	11
Median	**133**	**139**	**125**	**131**	**140**	**151**	**182**	**159**
SD	99	112	104	118	71	109	65	52
Skewness	-2	-2	-2	-1	0	-3	0	0
Range	829	693	829	693	315	574	259	21
Minimum	-419	-336	-419	-336	-26	-315	48	62
Maximum	410	357	410	357	289	259	304	277
Count	178	182	129	130	29	28	16	22

Profits III (Kr/MWh)

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	-14	-28	-33	-50	32	-2	59	65
SE	9	11	11	13	17	34	16	18
Median	**10**	**5**	**-2**	**-13**	**26**	**32**	**61**	**86**
SD	121	149	126	144	92	180	65	84
Skewness	-2	-2	-2	-1	-1	-4	0	-1
Range	790	968	740	626	449	935	243	289
Minimum	-579	-795	-579	-488	-238	-795	-78	-116
Maximum	210	173	161	138	210	140	165	173
Count	178	127	130	127	29	28	16	23

Rate of Return on Equity (%)

	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	2	-26	-3	-39	9	-1	24	11
SE	6	17	8	24	7	8	8	5
Median	**10**	**9**	**9**	**7**	**11**	**8**	**17**	**15**
SD	80	213	92	255	35	41	33	23
Skewness	-8	-9	-8	-8	-3	-2	3	-2
Range	1005	2449	1005	2449	213	219	151	101
Minimum	-845	-2361	-845	-2361	-142	-143	-14	-62
Maximum	160	88	160	88	71	76	137	38
Count	165	161	118	111	28	27	17	21

Rate of Return of Capital Employed (%)

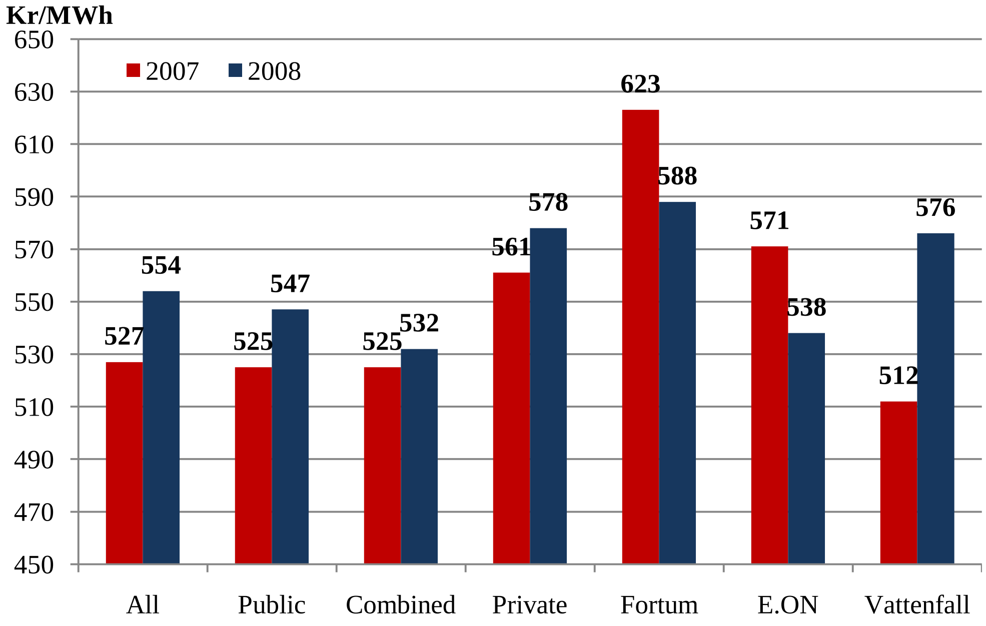
	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	9	7	5	5	11	5	13	17
SE	1	1	1	1	3	6	3	5
Median	**6**	**6**	**3**	**5**	**7**	**5**	**8**	**7**
SD	12	18	10	12	16	32	14	23
Skewness	3	-2	3	-3	2	-3	2	3
Range	101	238	100	151	88	219	51	116
Minimum	-26	-138	-26	-86	-14	-138	1	-16
Maximum	74	100	73	65	74	80	52	100
Count	176	177	170	125	30	28	18	21

Rate of Return on Total Assets (%)

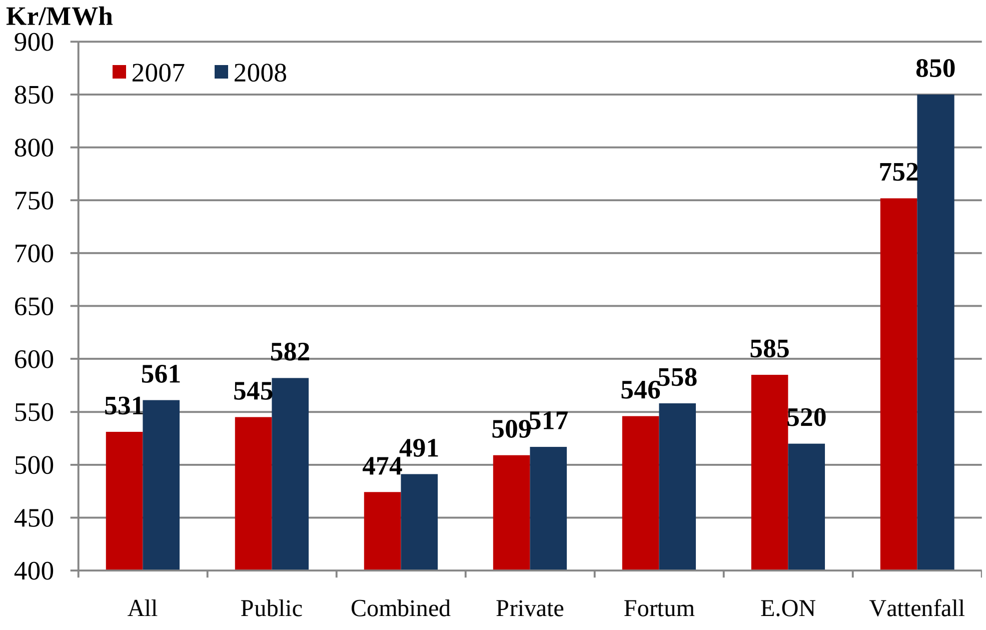
	All		Public		Combination		Private	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*	*2007*	*2008*
Mean	5	4	4	4	7	4	7	6
SE	0	1	0	0	1	3	1	1
Median	**5**	**4**	**5**	**4**	**5**	**5**	**7**	**7**
SD	5	8	5	5	7	16	3	5
Skewness	0	-5	-1	-2	1	-4	-1	-2
Range	43	90	43	39	30	90	10	21
Minimum	-21	-70	-21	-22	-8	-70	1	-8
Maximum	23	20	22	17	23	20	11	12
Count	178	181	130	127	31	27	17	22

Appendix C Price, Costs of Production and Profits

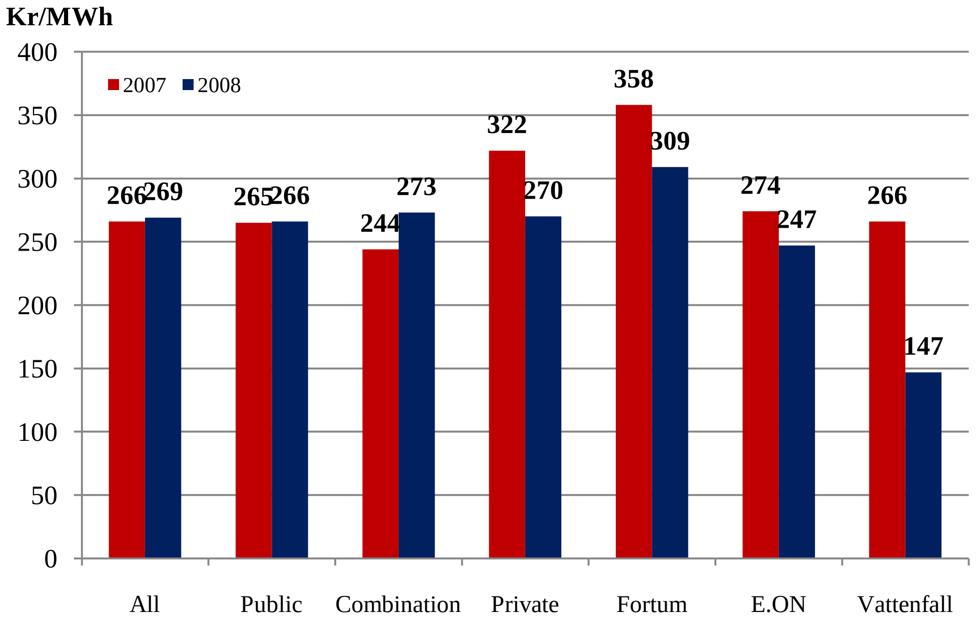
Price per Ownership Category



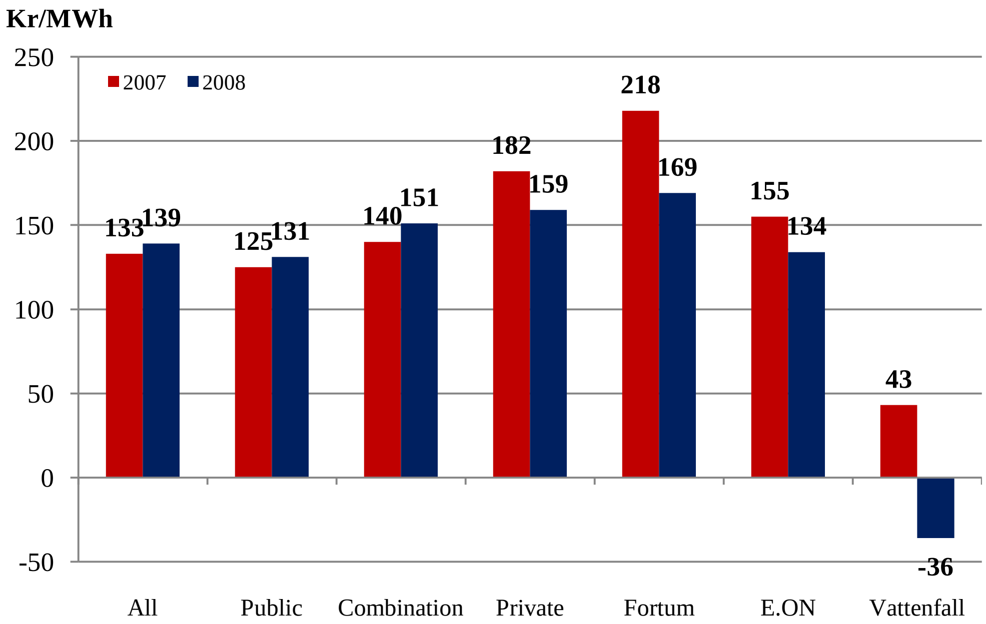
Total Cost per Ownership Category



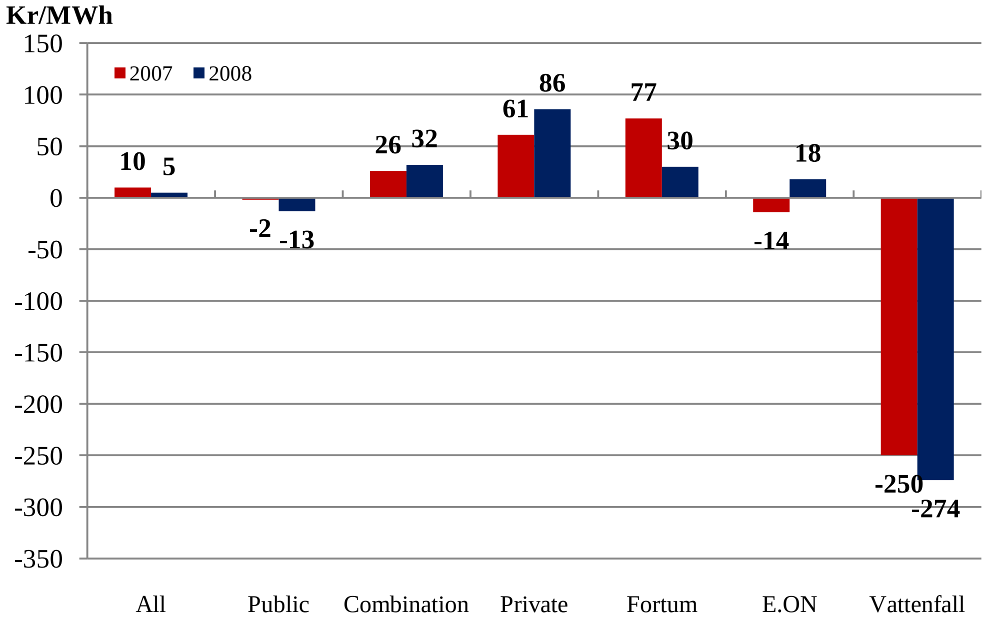
Maximum Profits per Ownership Category



'Best Estimate' Profits per Ownership Category

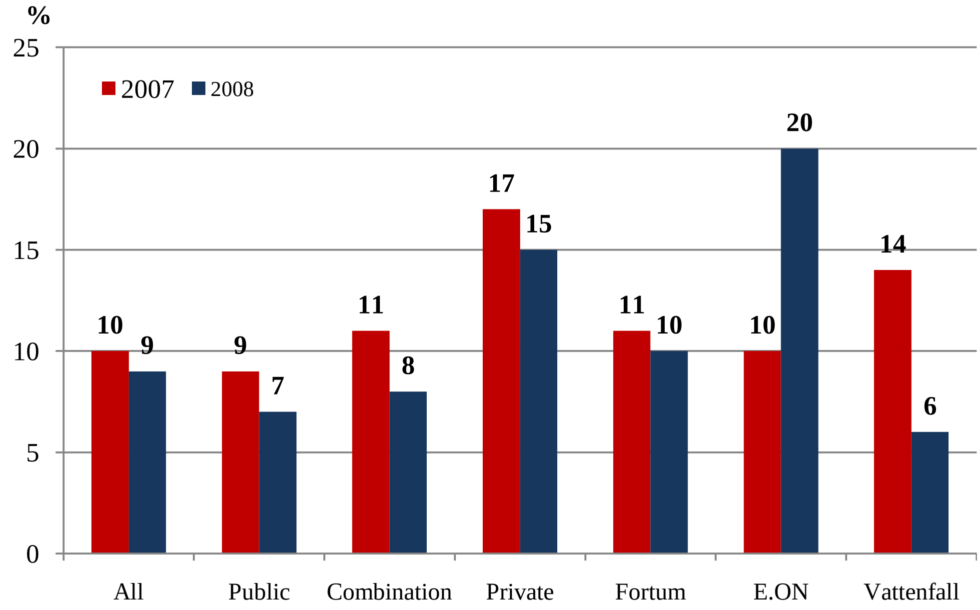


Minimum Profits per Ownership Category

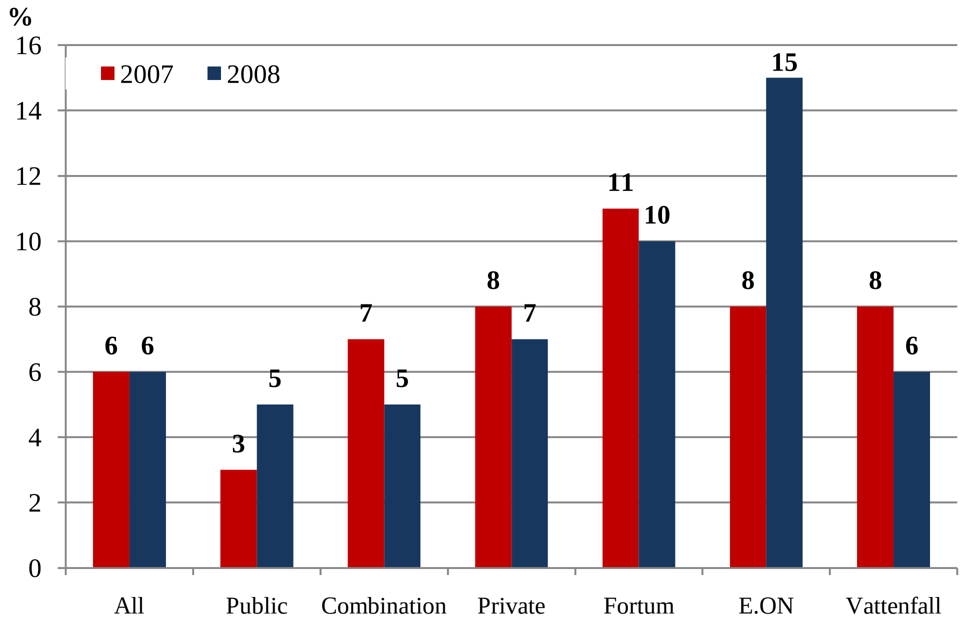


Appendix D Key Financial Indicators

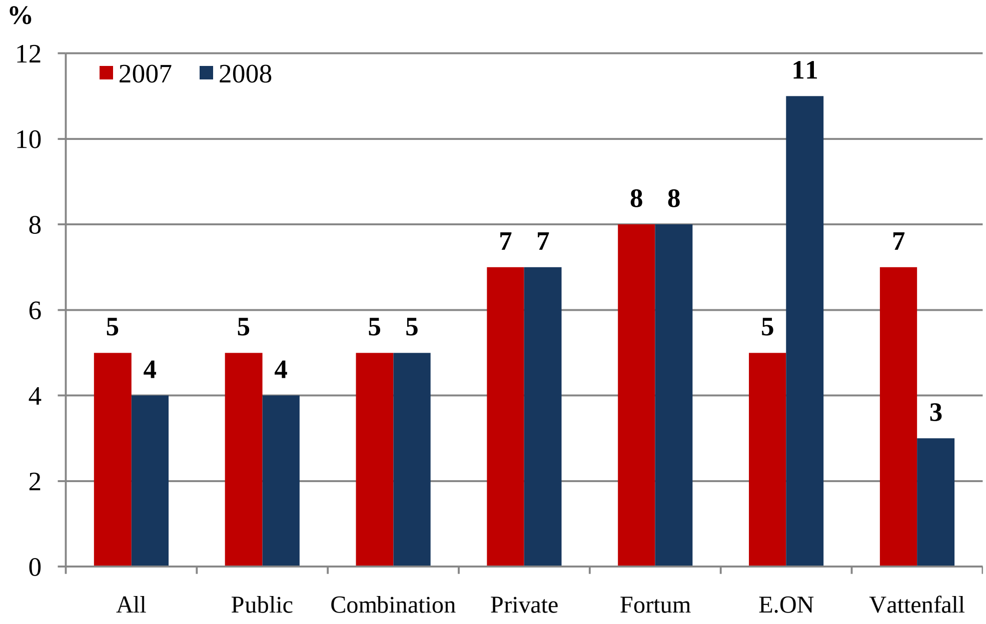
ROE per Ownership Category



ROCE per Ownership Category



ROA per Ownership Category



Appendix E ROA as a Function of Price and Total Costs of Production