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ELECTRICITY RETAILING IN NORWAY

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ROBERT SCHUMAN CENTRE FOR ADVANCED STUDIES

LOYOLA DE PALACIO PROGRAMME ON ENERGY POLICY

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EUI Working Paper **RSCAS** 2009/04

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Abstract

We analyse retailer and household behaviour on the Norwegian electricity market, based on detailed information on prices and other market characteristics. We find that there exists a competitive market segment where a number of retailers compete fiercely for customers, with small margins on all products. However, we also find evidence of monopolistic behaviour, whereby retailers exploit the passivity of some of their customers. We discuss explanations for these results, as well as means to improve market performance.

Keywords

Introduction[*]

The opening up of electricity retail markets to competition has been controversial. From a theoretical perspective, it has been argued that various market imperfections, such as switching costs, complexity and informational requirements, creates obstacles to the functioning of electricity retail markets, at least at the household end.[1] From an empirical perspective, it has been demonstrated that the opening of retail markets has not always lead to lower prices, and may indeed have resulted in higher prices for some consumers.[2]

From this perspective, the Norwegian experience may be of particular interest. Unlike the rest of the world, here market opening did not happen gradually but was introduced simultaneously at all levels with the Energy Act of 1990. However, competition for small consumers, including households, did not become effective until a range of regulatory measures had been put in place. After 1999, the market has become consistently more competitive and is now broadly considered to work quite well. The Norwegian retail market therefore represents a unique case, both with regard to its long history and to its apparent success.

The Norwegian retail market has been analysed by a number of authors, including Bye (2003), von der Fehr *et al* (2005), Amundsen *et al* (2006), Amundsen and Bergman (2006), Littlechild (2006), Olsen *et al* (2006), Amundsen and Bergman (2007) and Johnsen and Olsen (2008). These authors discuss the institutional set up of the Norwegian market, often in a comparative perspective, and present evidence on market performance, based on aggregate data.

In this paper, we aim to extend these analyses with the help of much more comprehensive and detailed sets of data than have been used previously. This includes weekly price offers on a variety of contracts for individual retailers, as well as data from the wholesale market, covering both spot and long-term contracts. In addition, we have data on retailer market shares, consumer switching and consumer perceptions of the market. Combining these data sets, we are able to cast new light on the performance of the Norwegian retail market, to some extent confirming, but also challenging prevailing views.

While we agree with previous analyses that overall the Norwegian retail market performs quite well, we demonstrate that the picture is nuanced. It is true that a large segment of the market may be characterised as fully competitive, with a broad range of products to choose from and with prices that closely reflect costs. However, in other segments consumers are paying prices that exceed costs by non-negligible amounts under (default) contracts that they are unlikely to find ideal.

More specifically, we find considerable heterogeneity in market behaviour. Consumers basically fall into one of two groups: active and passive. Active consumers have at some point made a switch of retailer and, even though they may not switch continually, they have moved into the more competitive market segment. Passive consumers have never switched and therefore take power under default contracts and sometimes pay prices well in excess of best available offers. We discuss reasons why, so long after market opening and with the considerable public interest in the electricity market in general and electricity prices in particular, a substantial number of consumers fail to take advantage of market

1   See for instance Waterson (2003), Wilson and Price (2005) and Brennan (2007).

2   See for instance Giulietti *et al.* (2005) and Giulietti *et al.* (2007) on the UK and Littlechild (2006), Olsen *et al* (2006) and Johnsen and Olsen (2008) on the Nordic countries.

opportunities, and we present evidence to suggest that many consumers remain essentially ignorant about the market.

On the supplier side, we find that retailers also fall into two distinct groups. The first group consists of retailers who are not confined to a specific regional market but compete actively for customers from other regions also; this group is dominated by retailers with essentially a nationwide business. The second group consists of retailers who do not operate outside of their own regional market (i.e. the distribution area of the associated distributor). Among the latter retailers there is a number of small companies who offer electricity at what is effectively subsidised prices; backed by an abundance of cheap hydro, the local-government owners have decided to transfer the surplus from the electricity business to their local constituency in the form of low electricity prices. However, the majority within the group of regional retailers charge prices around or above the level seen in the competitive end of the market; indeed, there is evidence that some of these retailers exploit market power towards their passive customers.

Interestingly, and in contrast to earlier studies, we find no great differences in the pricing of products within market segments. In particular, in the competitive end of the market all types of products are offered at cost-reflective prices; correspondingly, where retailers exploit market power they do so for all types of products. The apparent differences in prices across types of contracts would therefore seem to follow from aggregation; seen across different market segments, it would appear that some products perform worse than others, but once we distinguish between retailers in different segments we find they behave differently, but consistently.

We also challenge the view that the competitiveness of the Norwegian retail market is due to the very fragmented industry structure. It is true that there are many retailers, but only a limited number operate in the competitive market segment. However, unlike in the wholesale market – where behaviour may be characterised as capacity-constrained price competition and where market structure is likely to be of the utmost importance – in the competitive retail-market segment we have something that resembles textbook Bertrand price competition and, as is well known, such competition is fierce and lead to cost-reflective prices even with a small number of competitors. The well-functioning of the retail market is therefore due to a combination of structural and institutional features that have created an open and transparent market place with small costs associated both with entry and exit of retailers and with consumer switching between retailers.

The rest of the paper is organised as follows. In the next section, we present the developments of the Norwegian retail market from market opening in 1991, including descriptions of institutional features, regulatory framework, market structure and products. In subsequent sections, we analyse prices of the three major categories of products, "variable price", "fixed price" and "spot price". The penultimate section contains a discussion of consumer behaviour, while the final section contains our concluding remarks.

The Norwegian Electricity Retail Market[3]

In this section, we present an outline of the Norwegian electricity retail market. We describe the regulatory framework, participants and products traded, thereby providing background information for the analysis in subsequent sections.

Regulation

Before 1991, Norway was in effect divided into a series of regional electricity markets, in each of which a single utility had both the right and the obligation to supply all consumers who requested

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3   An overview of the Norwegian electricity industry is provided in OED (2006); see also Bye and Hope (2005).

connection to its network; in 1990, there were 380 such utilities. The 1990 Energy Act, which took effect on January 1, 1991, removed the right but maintained the obligation; thereafter, consumers have had the opportunity to remain with the incumbent retailer (who is obliged to act as a retailer of last resort), but they are free to contract with a different retailer if they so wish.

The removal of retail monopoly rights was perhaps the most significant element of the 1990 reform. The only structural change was the separation of transmission and generation, with the spinoff of Statnett – the new transmission and system operator – from the state-owned Statkraft; otherwise, there were no forced changes to either ownership or company structure. Established retail businesses remained vertically integrated within companies that typically had both generation and network arms and, in most cases, were owned by local governments.[4] The wholesale market – which had been in operation as a national power exchange for the main generators since 1970 – was opened to other players, including traders and large consumers, but otherwise remained essentially the same.

The opening up of the market came without safeguards; in particular, there was no regulation of retail tariffs, even for the household segment.[5] One seemed to rely upon the assumption that utilities under local ownership would continue to offer electricity at cost-reflective prices.

Competition for industrial consumers, especially the larger ones, became effective almost immediately, once the distance-related transmission tariffs were replaced by a system of nodal tariffs in 1992. In the household segment however, very little happened until a set of new regulations were introduced in 1997-98.

Complaints that incumbent retailers levied unreasonably high fees on consumer who wanted to switch to a different retailer, or delayed the switching process unduly, lead to a series of regulatory measures. Switching fees were first capped in 1992, at a level of NOK 5 000, and were gradually brought down to NOK 246 in 1995;[6] in 1997, switching fees were abolished altogether, implying that consumers do not incur any direct pecuniary costs of switching retailer. Initially, consumers could switch retailer at the end of each quarter only; from 1998, consumers could switch retailer whenever they wanted. Retailers and distribution companies were allowed a maximum of two weeks to process a switch.

In 1998, a revised system of profiling consumers not on hourly meters was introduced.[7] From the same time, data exchange between retailers and distributors had to be performed electronically (distribution companies are responsible for metering). The fee that retailers have to pay distributors for these and other services is capped; as of 2008, it stands at 4 000 Norwegian kroner (NOK) per year (independently of the number of consumers involved). Although structural unbundling between distribution and retailing is generally not required, regulations mandate non-discrimination of retailers and "Chinese walls" between the distribution arm and other parts of the business.[8] In 2005, the government considered a proposal to require separate billing of retail and distribution charges – thereby removing a potential competitive advantage of incumbent retailers (who are the only ones that can offer single billing) – but eventually decided against it; invoices must however be in a standardised format.

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4 Regulations that required separation of accounts between competitive (retail, wholesale and generation) and monopoly (transmission and distribution) elements of the business were however introduced. These have later been strengthened (see below).

5 Indeed, retail tariffs have never subject to explicit price regulation.

6 At time of writing (early 2008), the Norwegian krone corresponds to 0.19 US dollars or 0.125 Euro. A krone is divided into 100 øre.

7 Joskow and Tirole (2006) contains a discussion of the economics of profiling electricity customers.

8 As of 2007, utilities with more than 100 000 network consumers are required to legally separate their retailing and network businesses; however, since most utilities are small, this regulation only applies to a handful of companies. There has been some debate as to whether the regulatory framework is sufficient to ensure a level playing field between incumbent and alien retailers, see for instance ESA (2006).

In cooperation with consumer authorities, and with support of the Norwegian Water Resources and Energy Directorate (NVE), the electricity supply industry developed a set of standardised retail products. Retailers who offer these products are required to post their prices on the web page of the Norwegian Competition Authority (NCA). We discuss products and price information in more detail below.

The Retail Market

In Norway, electricity is the primary energy source for domestic usage. Some households use oil or wood for heating, but very few use gas (gas grids are virtually non-existent, but there is some use of bottled gas, especially in holiday homes). There has been a gradual shift in the composition of energy consumption from oil towards other sources, especially wood. According to Statistics Norway, in 2005 electricity accounted for 76.1 percent of total household energy consumption, oil 5.4 percent, wood 16.8 percent, district heating 1.0 percent and other sources 0.6 percent. Energy consumption varies from year to year, mostly due to changes in outside temperature.

**Figure 1: Number of retailers. Source: NCA and NVE.**
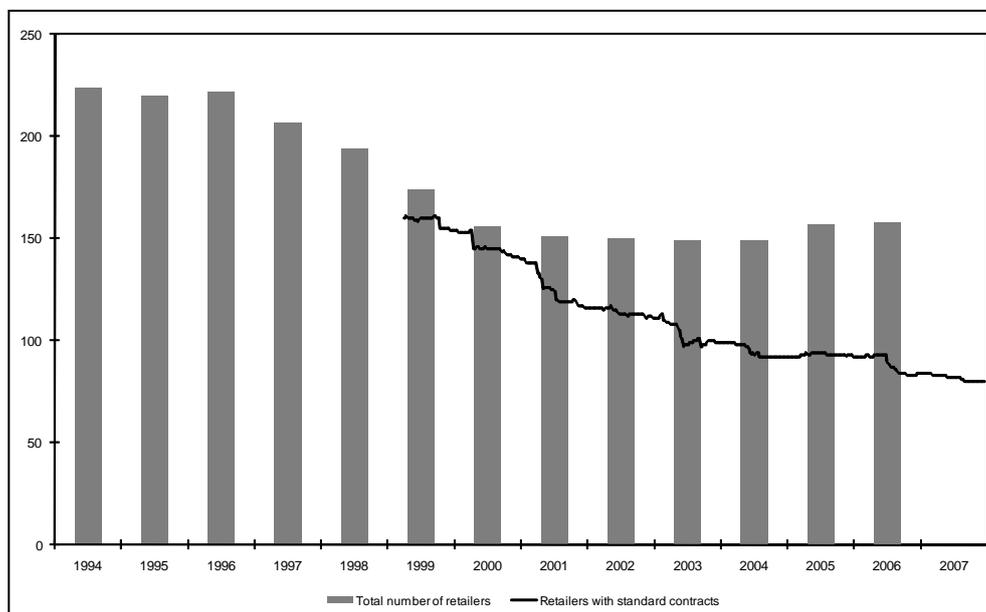
At the end of 2006, 345 companies held licenses for trading electricity (OED, 2006); of these, 110 were involved in generation, 149 were involved in grid management and operation, while 72 were involved in both of these activities. The number of trading companies who are active at the retail end of the market was falling for a long period, but has recently increased somewhat. As seen in

Figure 1, the number of retailers fell from 224 in 1994 to a low of 149 in 2004, subsequently increasing to 158 in 2006. Not all retailers offer standardised retail products; the number of retailers offering such products has fallen gradually and was down to around 80 in mid-2007.

Most retailers restrict their offers to consumers in certain regions, usually limited to the geographical area covered by the associated distribution company (or companies). A smaller number of retailers are "nationwide"; that is, they offer to supply any consumer, independently of his or her

geographical location. As seen from Figure 2, the number of nationwide retailers has varied between 10 and 35 over the last 7 years, recently stabilising just below 20.[9]

**Figure 2: Number of nationwide retailers. Source: NCA.**
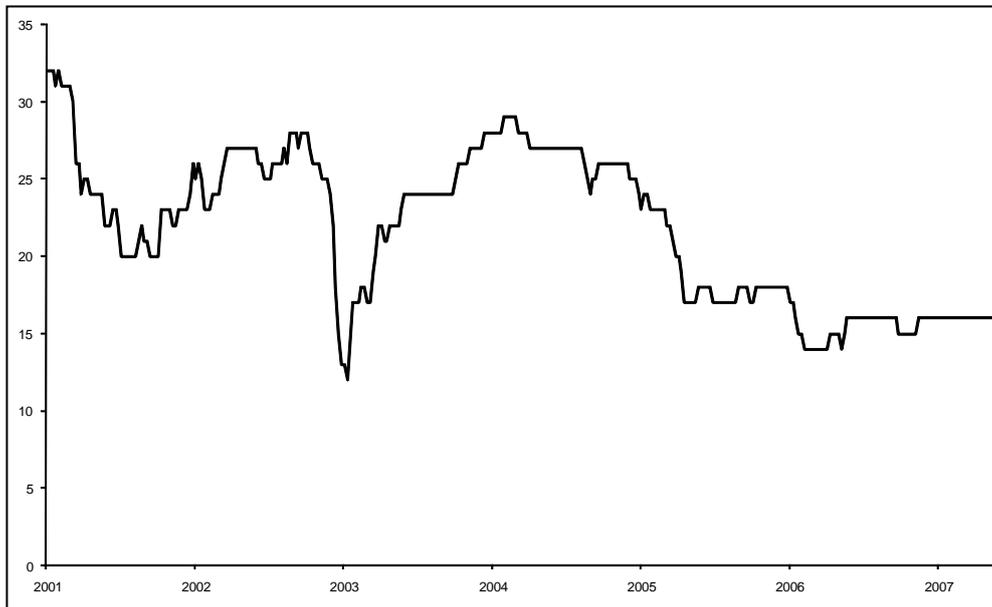
The changes in number of retailers reflect a range of different developments. The downward trend is mostly explained by mergers, typically by larger retailers taking over the business of their smaller neighbours (often such mergers have involved both the retailing and distribution arm of the business). In addition, there has been entry and exit of independent retailers. Some of these have based their business on combining electricity retailing with other activities; an example is Statoil, the major Norwegian oil and gas producer, who sold electricity through its network of petrol stations, but eventually found the electricity business non-viable and left the market. Other independent retailers have been set up with electricity retailing as their core business; two notable examples are NorgesEnergi and Forbrukerkraft, which both succeeded in building up a considerable customer base, but were eventually bought by established retailing-distribution groups (Hafslund and Agder Energi, respectively). While some independent retailers have survived, there has also been a number of unsuccessful attempts at entering the market, often in the form of purely internet-based business concepts.

Although there have been some developments in industry structure, incumbents have generally been able to maintain a dominant market position. Figure 3 shows market shares for the five largest retailers in a given region, averaged over the 28 largest supply regions (NVE, 2007). At the beginning of 2007, the average market share of these dominant retailers was 72.7 percent, down from 75.7 percent at the beginning of 2005. The decline in the market shares of the dominant retailers has been mirrored in an increase in the market share of the number twos. There is considerable variation among regions; in 2007, the market share of the dominant retailer varied between 29.8 and 95.0 percent in these supply regions, while that of the number two varied between 2.5 percent and 41.5 percent.

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9 The large fall in 2002/2003 was mostly due to the fact that a number of retailers temporarily withdrew their products from the market after the wholesale price spike.

Figure 3: Retailer market shares. Source: NVE.
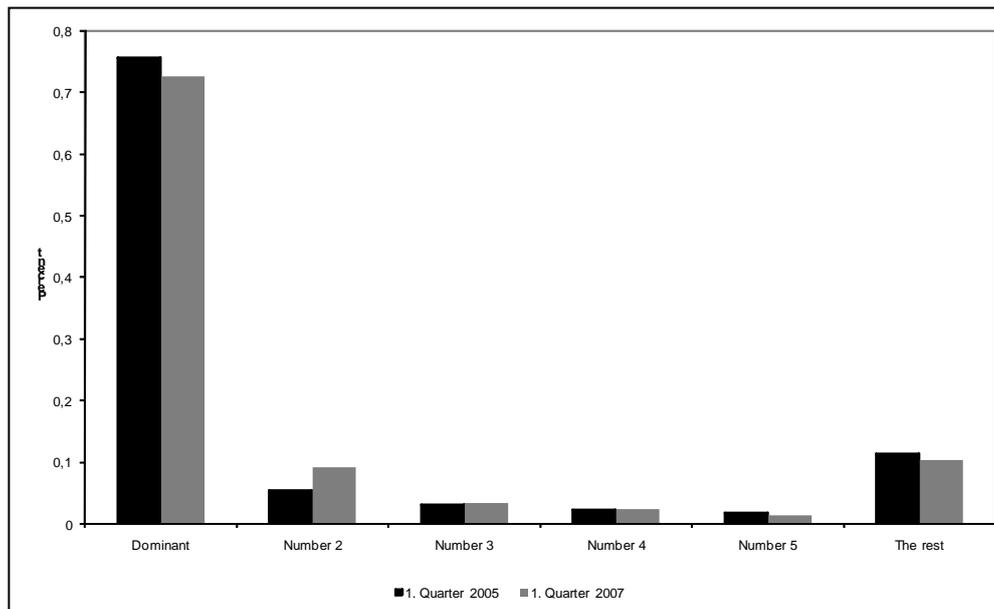
Products

In 1996, the electricity industry in cooperation with the Consumer Ombudsman designed a so-called Standard Agreement for Power Supply. The agreement regulates contractual terms such as entry into and termination of the contract, metering, pricing and exchange of information. Retailers may offer contracts that contain additional terms or terms that differ from the Standard Agreement (eg. concerning mode of payment); however, most households buy their electricity under contracts that are in accordance with the Standard Agreement (see also the next section).

Under the Standard Agreement, retailers offer one or more of the following products:

A variable-price product, for which retailers set a price per kWh (in addition to any fixed fees). The price may be changed once every week, but the retailer is obliged to inform customers about price changes, and a change does not take effect until two weeks after such information has been provided. Customers must be notified directly if the price change is "substantial" (i.e. if the total change in price since the last time the consumer received such notification exceeds 2.5 øre/kWh); otherwise, it is sufficient to make the change known in a "suitable manner" (such as posting the price on the NCA web page). The variable-price product is typically the default product; in other words, if a consumer has never changed either product or retailer, he or she will be consuming this product supplied from the incumbent retailer.

A spot-price product, for which price equals monthly NordPool Elspot wholesale price, plus any fixed fees and/or mark ups.

A fixed-price product, for which price is set at a given level for a longer period of time, typically one to three years. For these products, consumers have to agree to be bound by the contract for the duration of the pricing period.

Retailers supplying either of these products are obliged to submit information on their prices to the Norwegian Competition Authority, who posts the information on its web page.[10]

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10 There is no similar obligation for contracts that are not in accordance with the Standard Agreement; indeed, some retailers that used to offer Standard Agreement contracts have changed contractual terms and do no longer figure on the Competition Authority web page; see also above.

While traditionally the variable-price product has dominated the household segment, increasingly retailers see spot price as their main (and sometimes only) product. The spot-price product is less costly to administer (eg., there is no need to inform about price changes) and does not require hedging of wholesale price risk.

Retailers generally do not bundle electricity with other products. Some retailers have made combined offers for electricity and oil (for domestic heating). There are also examples of companies offering to manage consumers' electricity contracts, as well as contracts for other services. Some retailers offer various fringe benefits, such as advice on energy conservation, electrical products (eg. energy-saving light bulbs and heat pumps) and coupons/rebates in selected stores. For practical purposes, one may view the electricity retailing business as limited to electricity only.

Price Formation – Variable-Price Products

In this section, we consider price formation for the variable-price product. The analysis is based on historical price information from the Norwegian Competition Authority.[11] As explained above, retailers that offer products on terms that accord with the Standard Agreement for Power Supply are obliged to provide price information to the Competition Authority. As of the beginning of 2008, 82 retailers were registered with price offers for the variable-price product; of these, 18 were nationwide retailers.

Retailers may submit price offers – including changes to existing offers – at any time, and the web page is updated every ten minutes. Price offers take effect two weeks after they have been registered. The Competition Authority stores price offers for its historical data base once a week (on Sunday at 23.50 or 11:50 pm). The historical database does not contain information about which regions retailers are willing to supply, except for whether or not a retailer's offer is 'nationwide', i.e. the retailer is willing to supply any location.[12]

Since price offers may contain both fixed and variable elements, the unit price depends on the level of consumption. Throughout we restrict attention to unit prices for a consumer with an annual consumption of 20.000 kWh (a typical level for a Norwegian household).

Prices

Figure 4 plots the development of retail prices week by week over the period January 1999 to June 2007. In the figure, we have included the lowest and highest price offer, as well as the median and the (un-weighted) average of all offers.

In addition to the fact that prices vary considerably through time – a feature essentially explained by variations in underlying wholesale prices due to changes in hydrological conditions – two features stand out. One is the nature of the lowest price offers; these are not just considerably below the average, but also follow a different pattern. Some retailers have been obliged by their local-government owners to supply cheap electricity to the local population (the offers are consequently restricted to consumers within the area of the associated distribution company). Supply is backed by an abundance of hydro power. Since this phenomenon is relatively rare, and of limited importance for the overall market, we devote no more attention to it here.

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11 See www.kt.no (in Norwegian only).

12 The Competition Authority started reporting whether price offers were nationwide in 2001.

Figure 4: Retail prices: variable-price products. Source: NCA.
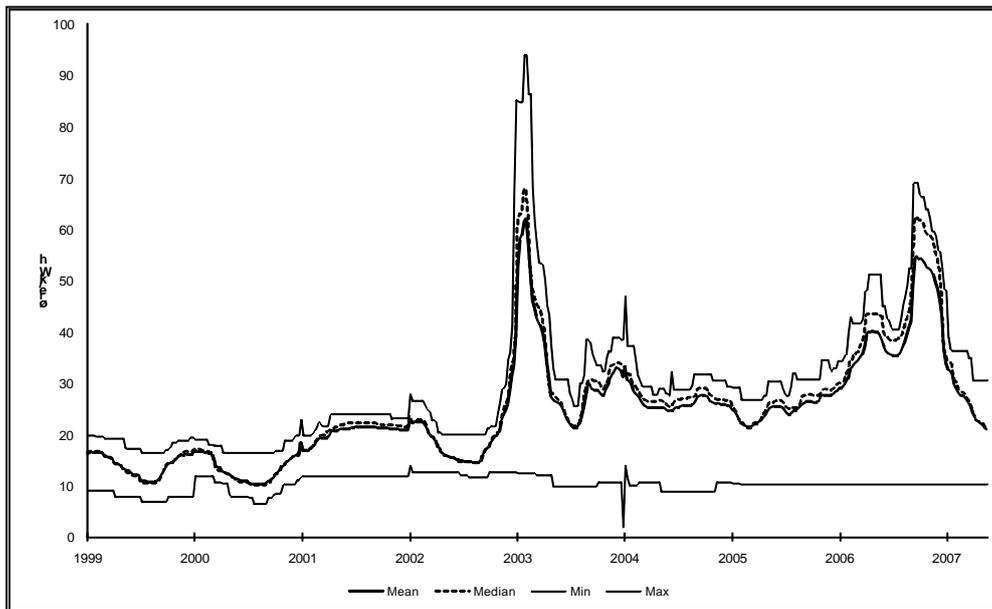
A second notable feature of the prices plotted in Figure 4 is the variation around the mean; in particular, the highest price offers often exceed the average by a considerable amount. This feature is to some extent explained by differences in wholesale prices across regions (wholesale spot prices differ between price areas whenever there are capacity constraints in the transmission network). However, it would seem that high price offers may also result from incumbents targeting consumers who are unwilling to switch retailer. We analyse this phenomenon in a later section; in this section, we concentrate attention on the more competitive end of the market.

Figure 5 contains a plot of weekly prices over the period 2001-2007 for a selection of five retailers. The selection includes all retailers that have had nationwide offers throughout the period. The figure also shows the wholesale spot price (weekly average).[13]

Retail prices have followed the underlying wholesale price quite closely. This is true even in periods of strong price variation, such as during the winter of 2002-3 and the autumn of 2006. There is a tendency that retail prices lag the wholesale price, especially at times when the wholesale price falls sharply; this is particularly noticeable at the end of 2006. A possible explanation for the 2006 development was that the fall in wholesale price was unexpected; under normal market conditions the price should have stayed high during the winter – with a peak in January – but, due to unusually high temperatures and wet hydrological conditions, prices started falling already at the end of the autumn.

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13 The spot price reported here is the so-called NordPool Elspot price, which is calculated from bids and offers without taking account of constraints in the transmission network and acts as the reference price for other wholesale products (futures, forwards etc.). As explained below, actual spot prices may differ between supply areas as a result of market splitting.

Figure 5: Retail prices: selected nationwide retailers. Source: NCA.
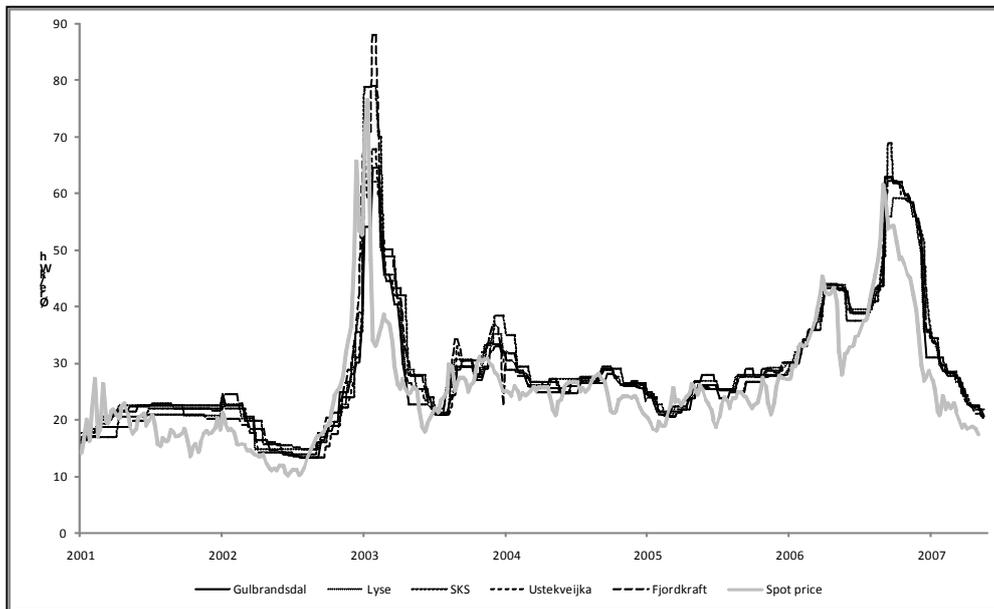
There appears to be no systematic difference between the pricing behaviour of these five retailers. This is further confirmed by Figure 6, which shows week-by-week differences in the various prices from the sample mean. Below, we examine pricing behaviour further by means of econometric techniques.

Figure 6: Price differences from sample mean. Source: NCA.
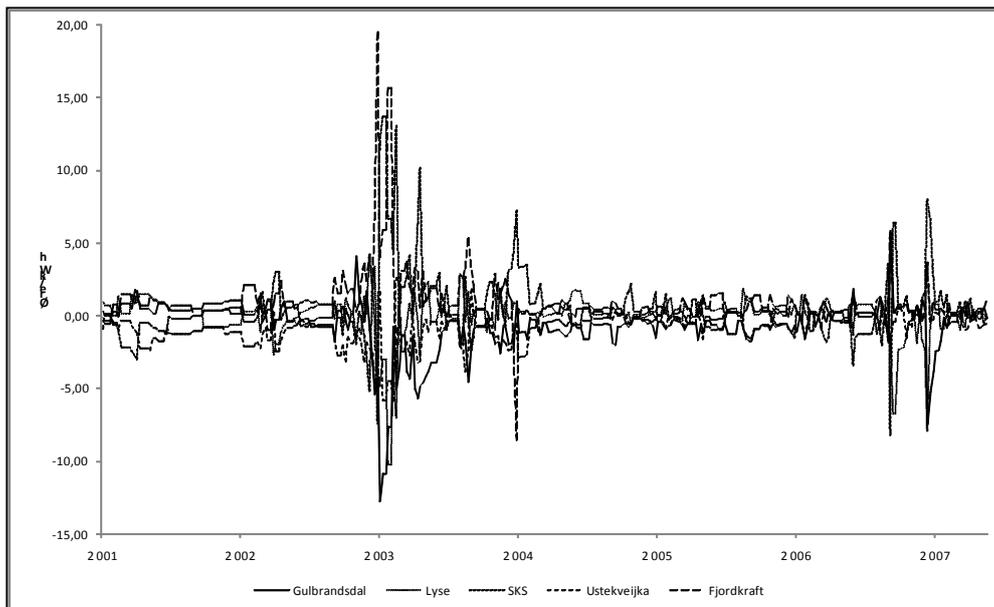
Arbitrage

One way of measuring systematic price variation across retailers is to consider gains from arbitrage, i.e. gains consumers may obtain from switching retailer. Table 1 reports the difference in electricity purchasing costs for a consumer with an annual consumption of 20 000 kWh who, rather than staying with one particular retailer for the whole year, follows a perfect-foresight, optimal switching strategy between the five retailers. For example, a consumer who consistently switched to the cheapest retailer every other week would pay 488 kroner less than what he or she would pay if staying with Gudbrandsdal for the whole of 2001; this would amount to a 9 percent saving on the total electricity bill.

Table 1: Potential gain from switching retailer, kroner and percent.

Year	Fjordkraft	Gudbrandsdal	Lyse	SKS	Ustekveikja
2001	449 (9%)	488 (9%)	385 (8%)	221 (4%)	89 (2%)
2002	952 (17%)	392 (8%)	478 (9%)	384 (8%)	17 (0%)
2003	1460 (14%)	119 (1%)	685 (7%)	1726 (17%)	510 (6%)
2004	337 (5%)	51 (1%)	321 (5%)	489 (7%)	108 (2%)
2005	330 (5%)	7 (0%)	297 (5%)	182 (3%)	143 (2%)
2006	404 (4%)	225 (2%)	174 (2%)	424 (4%)	303 (3%)

The above numbers – which vary between 0 and 17 percent – are clearly upper bounds on the potential gain a consumer could expect from switching; in particular, and apart from the somewhat unrealistic assumption of perfect foresight, these numbers do not take into account costs of switching. If, for example, we assume that the (opportunity) cost of switching is 20 kroner per switch (about a tenth of the average hourly wage of a blue-collar worker), the annual cost of switching would be 525 kroner; clearly, such costs would (except in a few cases) wipe out estimated gains from switching.

Table 2: Potential gain from switching to a spot-price contract, kroner and percent.

Year	Fjordkraft	Gudbrandsdal	Lyse	SKS	Ustekveikja
2001	67 (1%)	106 (2%)	3 (0%)	-161 (-3%)	-293 (-6%)
2002	-282 (-5%)	-843 (-16%)	-757 (-15%)	-851 (-17%)	-1218 (-26%)
2003	1856 (18%)	515 (6%)	1082 (12%)	2123 (20%)	907 (10%)
2004	307 (4%)	21 (0%)	291 (4%)	459 (6%)	78 (1%)
2005	124 (2%)	-199 (-3%)	91 (1%)	-24 (0%)	-63 (-1%)
2006	969 (8%)	748 (7%)	696 (6%)	946 (9%)	825 (8%)

While Table 1 provides a measure of systematic price variation between retailers, Table 2 provides a measure of the extent to which retail prices systematically exceed wholesale prices. In the table, we have calculated the difference in electricity costs for a consumer with an annual consumption of 20 000 kWh who chooses a spot-price product with a mark up of 2 øre/kWh (which corresponds to the average mark up on this product over the period in question) rather than the variable-price product of one particular retailer for the whole year; in other words, the table shows (expected) gains from arbitrage between the two different products. For example, in 2001 a consumer who bought the spot-price product rather than the Gudbrandsdal variable-price product would gain 106 kroner, or 2 percent of his or her electricity bill.

These numbers suggest that retail prices have not deviated systematically from wholesale prices; or, alternatively, variable-price products have not been consistently more expensive than spot-price products.[14] In 2002, retail prices were on average below the wholesale price, reflecting the sharp increase in spot prices during the autumn that retail prices never really caught up with. In 2003, retail prices again lagged the wholesale price, but this time prices were falling and so retail prices were on average above the wholesale price. A similar situation arose in 2006.

A simple price-setting model

In order to consider pricing strategies in more detail, we consider the following, very simple model for retail-price setting:

$$p_t^r = \beta_0 + \beta_1 p_t^f + \beta_2 p_{t-1}^r + \varepsilon_t,$$

where p_t^r is retail price for week t, p_t^f is wholesale price for that same week, p_{t-1}^r is the retail price for the preceding week and ε_t is an error term. The coefficients β_0, β_1 and β_2 are estimated separately for each of the five nationwide retailers referred to above over the period starting in the first week of 2001 and ending in the nineteenth week of 2007 with the Ordinary Least Squares (OLS) method.

For the dependent variable – the retail price – we use the prices described above. For the wholesale price we use the futures price for deliveries two weeks ahead. The idea is that retailers base their retail-price offers on the opportunity cost during the relevant supply period, which, at the margin, is likely to be given by the wholesale price.[15]

The table below summarises results. The model explains almost all of the variation in the data and, except for the constant terms, all coefficients are significant at the 1 percent level. Retailers adjust prices gradually to changes in the underlying wholesale price; about a quarter of the weight is put on the wholesale price, while three quarters are put on the retail price of the previous week.

Table 3: Estimation results: variable-price products, nationwide retailers.

	Fjordkraft	Gudbrandsdal	Lyse	SKS	Ustekveikja
Constant	-0.375	0.039	0.526	-0.270	-0.196
	(0.283)	(0.016)	(0.280)	(0.430)	(0.291)
Wholesale price	0.355	0.225	0.235	0.280	0.242
	(0.018)	(0.016)	(0.017)	(0.026)	(0.018)
Lagged retail price	0.693	0.785	0.763	0.753	0.776
	(0.017)	(0.016)	(0.018)	(0.023)	(0.017)
R^2	0.975	0.973	0.972	0.945	0.971

While we can reject the hypothesis that coefficients are the same across retailers, there is in effect very little difference between their estimated behaviour. Fjordkraft stands out from the others, with a larger coefficient on the wholesale price and a correspondingly smaller coefficient on the lagged retail

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14 Note that this finding is in contrast with earlier studies who found that spot-price products generally outperform variable-price products; while we concentrate on disaggregated data for competitively priced products, these earlier studies are based on aggregate data that also covers default contracts which are often priced non-competitively; see also below.

15 Since the spot price typically differs from the futures price, and since demand cannot be perfectly forecasted, there could potentially be problems associated with using the futures prices as a proxy for the wholesale price. We discuss this and other potential difficulties with the econometric analysis in the Appendix.

price, implying that it tends to adjust its retail price offers more quickly to changes in the underlying wholesale price. Lyse is the only retailer for which the constant term is significantly different from zero.

At the steady-state point, i.e. where $p_t^r = p_{t-1}^r = p^r$, we find (ignoring the error term)

$$p^r = \frac{\beta_0}{1 - \beta_2} + \frac{\beta_1}{1 - \beta_2} p^f.$$

In other words, retailers are following a pricing strategy that effectively consists of a mark-up on the wholesale price plus (or minus) a fixed term. The above equation may alternatively be written

$$\frac{p^r}{p^f} = \frac{\beta_0}{1 - \beta_2} \frac{1}{p^f} + \frac{\beta_1}{1 - \beta_2}.$$

The left-hand side may be interpreted as a gross mark up on the wholesale price, taking into account the constant term. Table 4 produces numerical values based on the regression results (the gross mark up has been evaluated at the sample mean). We find that the gross mark up varies between 104.4 and 110.8 percent; in other words, on average the retail price is set between 4.4 and 10.8 percent higher than the wholesale price. Of course, given the imprecision with which some of the underlying coefficients are estimated we would not want to put too much emphasis on specific values, nor the fact that they differ between retailers.

Table 4: Mark-ups: variable-price products, nationwide retailers

	Fjordkraft	Gudbrandsdal	Lyse	SKS	Ustekveikja
$\frac{\beta_0}{1-\beta_2}$	-1.219	0.182	2.223	-1.092	-0.877
$\frac{\beta_1}{1-\beta_2}$	1.155	1.044	0.994	1.135	1.081
$\frac{\beta_0}{1-\beta_2}\frac{1}{p^f} + \frac{\beta_1}{1-\beta_2}$	1.109	1.051	1.077	1.094	1.048

However, we would like to claim that these mark ups indicate cost-reflective pricing, or at least very small profit margins. With an average wholesale price of 26.6 øre/kWh over the estimation period, a mark up of 7.5 percent (the average for these five retailers) implies net revenues of 399 kroner on a consumer with an annual consumption of 20.000 kWh. Note that this revenue shall not only cover administrative costs associated with handling the consumer (marketing, announcing price changes, payments, complaints etc.), but also any cost of sourcing electricity not reflected in the futures price, such as congestion charges, consumption profiles skewed towards high-price periods and price risk. As we explain in the Appendix, although these latter costs are probably not very high, they do constitute real costs for the retailer.

In the Appendix, we discuss the statistical properties of the estimations and we also report results from alternative estimations, including different sample periods and the introduction of more explanatory variables. The overall impression is that results reported here are robust.

Price Formation – Fixed-Price Product

In this section, we analyse pricing of fixed-price products along the same lines as for variable-price products. Again, the analysis is based on data published on the web page of the Norwegian Competition Authority, which has reported information on these products since Week 38, 2003. There are retail products on the market that offer fixed prices for up to three years ahead; however, we restrict attention to contracts of one-year duration, which are the most popular fixed-price contracts (see below).

Figure 7 shows retail prices for fixed-price products since such information was first reported and up until Week 19, 2007. We see much the same pattern as for variable-price products: prices adjust to changes in underlying supply conditions; some retailers offer the product at what is in effect subsidised prices; and some retailers offer prices that exceed the mean by a considerable amount (although the high-pricing retailers seem to have become more sensitive to overall market developments over time).

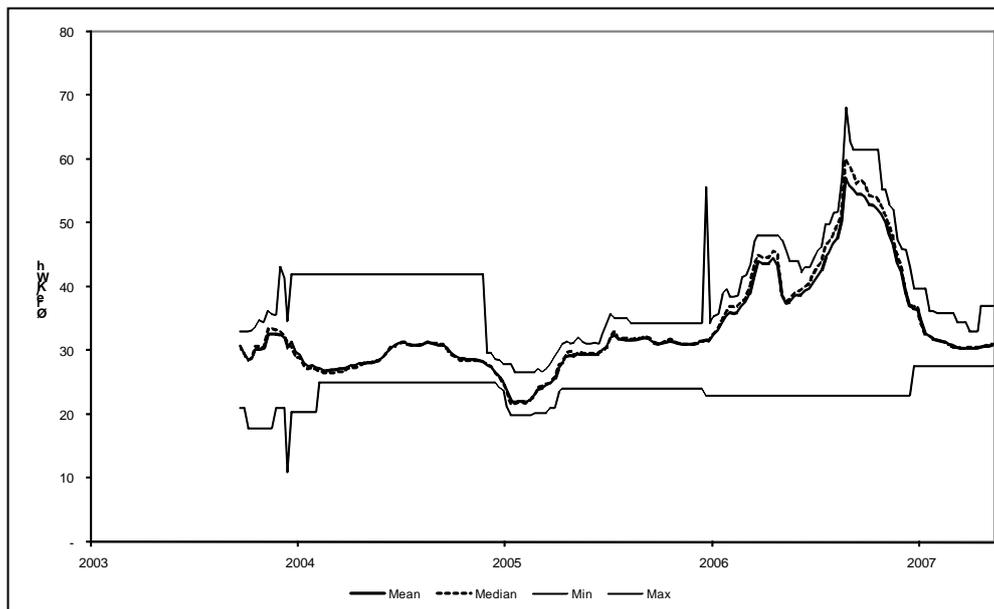**Figure 7: Retail prices: fixed-price products. Source: NCA.**

Figure 8 shows prices for nationwide retailers who have been present in the market for the entire period for which we have data. Again, we see no systematic tendency for price differences; prices move closely together, sometimes exceeding and sometimes falling below each other. For comparison purposes, we have also shown the futures wholesale price for the corresponding supply period (i.e. the one-year period from two weeks ahead of the week in which the price is set).[16] Retail prices follow the wholesale price, albeit with a mark up and a tendency to a lag.

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16 See the Appendix for a description of how this price is constructed.

Figure 8: Retail prices: selected nationwide retailers. Source: NCA.
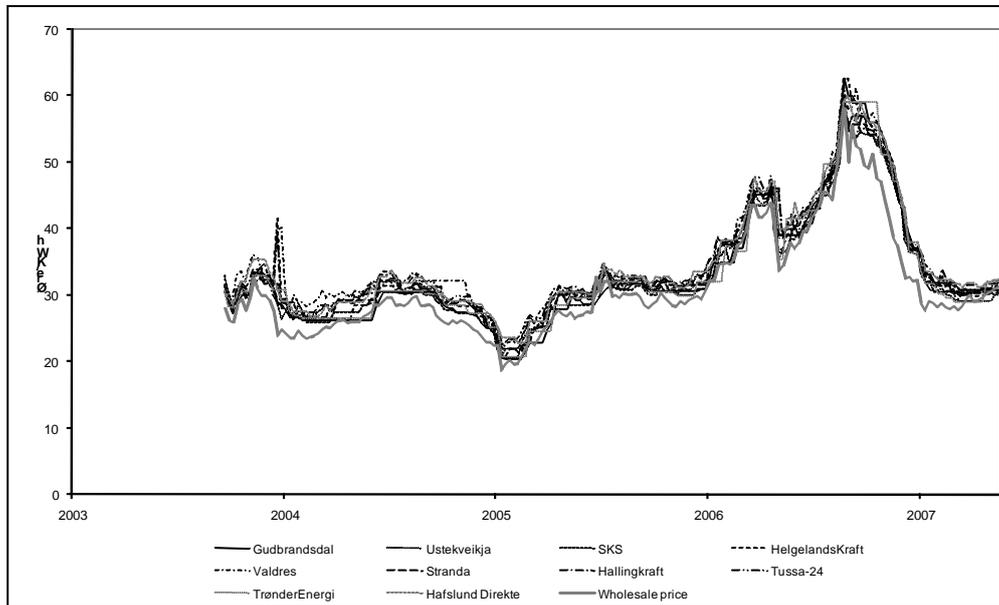
As for the variable-price product, we have investigated to what extent a simple model captures the price setting of retailers. Here we regress the retail price for deliveries in the year starting from two weeks hence on the (futures) wholesale price for that same year and the corresponding retail price offered the previous week.

Table 5 summarises results from a regression on the sample of nationwide retailers described above for a period starting in Week 38, 2003 and ending in Week 19, 2007. Again, although there are differences between retailers, the overall picture is that behaviour is similar. There is a tendency that retailers put more weight on the wholesale price when they set prices for the fixed-price products compared to what they do when pricing variable-price products; here about half the weight is put on the wholesale price, implying a faster adjustment to the underlying cost of sourcing electricity.

Table 5: Estimation results: fixed-price products, nationwide retailers.

	Gudbrandsdal	Hafslund Direkte	Hallling-kraft	Helgelands-kraft	SKS
Constant	-1.405	0.341	0.824	-0.375	-0.214
	(0.218)	(0.275)	(0.285)	(0.426)	(0.289)
Wholesale price	0.405	0.432	0.465	0.488	0.497
	(0.020)	(0.026)	(0.028)	(0.041)	(0.029)
Lagged retail price	0.663	0.604	0.556	0.565	0.540
	(0.017)	(0.024)	(0.027)	(0.036)	(0.028)
R^2	0.994	0.989	0.988	0.974	0.987

14

	Stranda Energiverk	Trønder Energikraft	Tussa-24	Ustekveikja	Valdres Energiverk
Constant	0.275	-1.074	1.318	0.717	0.740
	(0.287)	(0.390)	(0.455)	(0.325)	(0.454)
Wholesale price	0.443	0.442	0.502	0.475	0.419
	(0.026)	(0.035)	(0.039)	(0.029)	(0.041)
Lagged retail price	0.585	0.621	0.510	0.536	0.609
	(0.024)	(0.030)	(0.038)	(0.028)	(0.038)
R^2	0.987	0.979	0.969	0.983	0.971

Again, the results suggest that competition is strong, at least in the sense that the mark-up is small; the mark-up of retail price over wholesale price calculated at the steady-state, sample-mean varies between 7.2 and 13 percent. While these mark ups are larger than those reported above for variable-price products, given that costs of sourcing electricity not reflected in futures prices (congestion charges, consumption profiles skewed towards high-price periods and price risk) are likely to be greater for fixed-price products, the margins would seem to indicate cost-reflective pricing.

Price Formation – Spot-Price Products

In this section, we analyse pricing of spot-price products. As for fixed-price products, the Norwegian Competition Authority started publishing prices for these products in Week 38, 2003.

Retailers differ in the way they structure the pricing of their spot-price products; while some retailers simply add a fixed per kWh mark-up to the wholesale price, others include a fixed annual fee as well. Again we concentrate attention on average mark-ups for a consumer with an annual consumption of 20 000 kWh.

Figure 9 shows mark ups for retailers who have offered the spot-price product nationwide during this period. Only a few retailers have been in the market for the entire period; indeed, many have been present for a short period only.[17] Most retailers have kept the mark up constant, although there are examples of both upwards and downwards adjustments. With the exception of Hallingkraft, who have not only increased its mark up, but also kept it very high during the entire period, mark ups have tended to move downwards, partly because of individual adjustments and partly because new entrants have come in with lower mark ups than those of retailers already present in the market.

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17 As explained above, the fact that retailers disappear from the NCA web page does not necessarily imply that they withdraw the product from the market altogether, but may be because they have changed their product so that it no longer satisfies the conditions of the Standard Agreement; clearly, retailers who choose this strategy will, to the extent that consumers use the NCA web page to inform themselves of market prices, have greater difficulties in reaching new customers.

Figure 9: Spot-price mark up: nationwide retailers. Source: NCA.
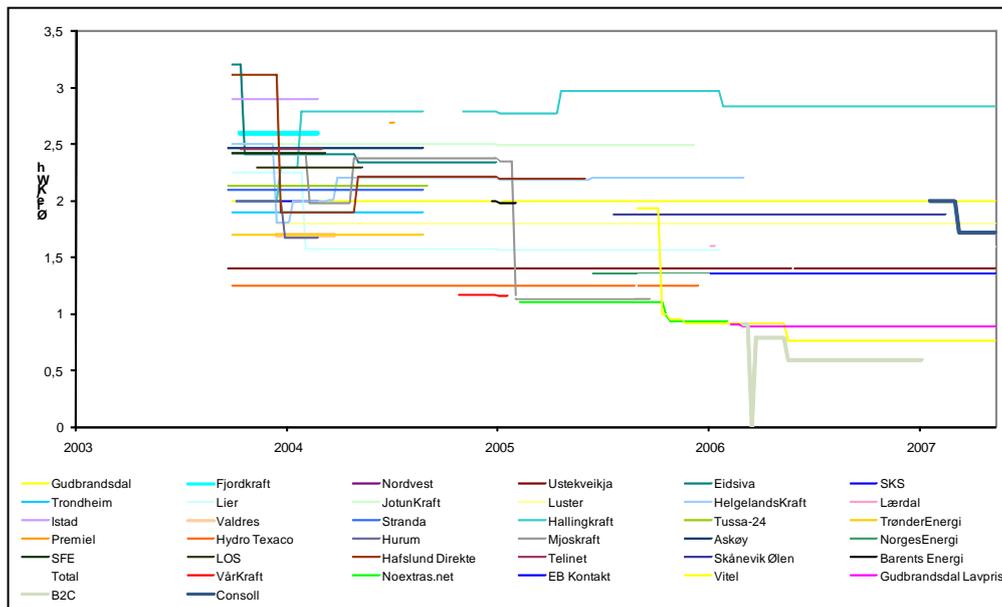
The mark ups vary from below 1 øre/kWh to almost 3 øre/kWh, or between 3 and 10 percent of the average spot wholesale price over this period. Since we have no information about the number of customers or market share of individual retailers, we cannot tell whether high-pricing retailers have been able to keep their customers; in particular, it may well be that although Hallingkraft offers its product nationwide, in effect it has no customers outside of its region. In any case, the gain from moving from the most expensive to the least expensive of the retailers is no more than 400 kroner per year, or 3.5 percent of the total electricity bill.

Market Power and Price Discrimination

We have seen that the highest retail prices tend to be considerably above the market average. One reason for high prices may be high costs of supplying certain regions; in particular, the Norwegian system operator uses market splitting to balance demand and supply in periods of transmission constraints, thereby raising the wholesale price in areas which would otherwise experience a supply deficit. However, this effect is unlikely to fully explain the observed price differences (see the Appendix). An alternative explanation is market power; in particular, we may hypothesize that retailers exploit the reluctance of some of their customers to switch supplier. In this section, we investigate this hypothesis.

A retailer who wants to exploit the reluctance (or inability) of customers to switch will do so by keeping up the price on its variable-price contract, which is the default contract for consumers who have never switched. To the extent that customers are reluctant to switch supplier, but not product, the retailer may keep up prices on its other products also. A retailer with such a pricing strategy will have little success in attracting consumers from other regions. Indeed, we may expect retailers who aim to exploit their local customer base to refrain from offering to supply consumers in other regions (which anyway involves additional costs); concentrating on the local market will be more attractive the larger is this market and the higher is the retailer's market share. Alternatively, retailers may decide to pursue a strategy of price discrimination, by offering a set of alternative contracts; if successful, such retailers may be able to exploit the local customer base while at the same time compete successfully for customers in other regions.

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Investigation of the regional-monopoly hypothesis is difficult for a number of reasons. Firstly, and as explained above, some regional retailers do not pursue profit-maximising strategies; although only a few actually subsidise their customers others aim at prices that are cost reflective; we therefore have difficulties distinguishing between retailers who do not have market power and retailers who do not exploit it. Secondly, we do not have data that would allow us to analyse the relation between price-setting behaviour and market size and market share.

What we have done is to explore the price setting of variable-price products along the lines set out above for retailers who have consistently figured among the most expensive. The regression analysis shows that although mark ups are higher (typically between 13 and 18 percent), the behaviour of the high-pricing regional retailers is quite similar to their nationwide competitors. We refer to the Appendix for details.

Turning to the hypothesis that retailers price discriminate by offering different sets of contracts aimed at, respectively, loyal local customers and customers from other regions, we find that this phenomenon is not prevalent, but it does exist. Table 6 below shows prices for the products offered by Hafslund for a particular week in 2006.[18] Hafslund, one of the largest retailers and owned by the company that also owns the distributor covering the Oslo region, offers two sets of products, named "Strøm" ("Current") and "Direkte" ("Direct"). The Strøm products are only available to customers in the region covered by the associated distributor,[19] and the Strøm variable-price contract is the default for consumers who have never switched retailer or product. The Direkte products are offered to all Norwegian consumers.

Table 6: Prices offered by Hafslund for Week 21, 2006

Contract	Variable price		Spot price		Fixed price	
	Fixed annual payment, kroner	Price per kWh, øre	Fixed annual payment, kroner	Mark-up per kWh, øre	Fixed annual payment, kroner	Price per kWh, øre
Strøm	599	52.90	75	2.5	300	49.90
Direkte	0	49.95	75	2.5	0	49.90

The Strøm products tend to be more expensive than the corresponding Direkte products. There is no difference for the spot-price products. For the fixed-price products, the price per kWh is the same, but only Strøm involves a fixed fee. For the variable-price products, Strøm not only involves a fixed fee but also a higher price per kWh.

A possible explanation for these discrepancies is differences in product characteristics or contractual terms. "Direkte" requires payment using direct debit or electronic invoicing; also, all communication with the retailer has to be done over the internet.[20] In addition, customers buying a "Strøm" product – who, by definition, are located within the region of the associated distribution

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18 Other examples of similar behaviour include Gudbrandals Energi and SKS, which, in addition to their regular products, offer the cheaper "Energi lav" ("Energy Low") and "Enkel" ("Simple") products, respectively.

19 The region includes the municipalities Asker, Aurskog-Høland, Bærum, Drammen, Eidsvoll, Fet, Frogn, Gjerdrum, Hurdal, Kongsberg, Lørenskog, Nannestad, Nedre Eiker, Nes (Akershus), Nittedal, Oppegård, Oslo, Rakkestad, Rygge, Råde, Rælingen, Skedsmo, Sørum, Ullensaker, Vestby, Ås, Øvre Eiker.

20 Information about these and other terms may be found at www.hafslund.no.

network – will receive a single bill, covering both the cost of energy and distribution. According to a product-differentiation interpretation, the extra cost of the Strøm products reflects the willingness to pay for single billing and the opportunity to choose method of payment.[21] However, it is difficult to reconcile this interpretation with the fact that differences in payments are not uniform across products.

An alternative explanation is price discrimination. This explanation is consistent with the fact that there is no difference between the spot-price products;[22] consumers who have chosen such a product have not only made a deliberate choice of product, but they have also chosen a product that makes it particularly easy to compare offers across retailers and hence to switch retailer. The price-discrimination hypothesis is also consistent with the observation that the greatest difference in price is for the variable-price contracts; customers buying Strøm variable price are probably the least sensitive to price and hence the profit from exploiting their willingness to pay is likely to be the greatest. The fact that there is a fixed fee on Strøm fixed price, but not on Direkte fixed price, may be because Strøm fixed price is bought by consumers who are unwilling to switch retailer, but who do seek the reduction in price risk offered by a long-term contract.

Figure 10 below shows the difference in unit price for the two variable-price products over the period 2003 to 2007, as well as the NordPool spot price. The Direkte product has been consistently cheaper, although the difference has shifted around somewhat. Some of the changes are due to the fact that prices of the two products have not always been adjusted at the same time, but there are also longer-lasting variations in the price difference. The price difference tended to increase along with the rise in the underlying spot price during the winter 2005-6. However, the difference then fell back sharply as prices peaked in 2006 and has remained at an historical low since then. A possible explanation for the recent fall is the increased tendency to switching alluded to above (see also the next section).

Figure 10: Hafslund Strøm and Direkte variable-price products. Source: NCA.

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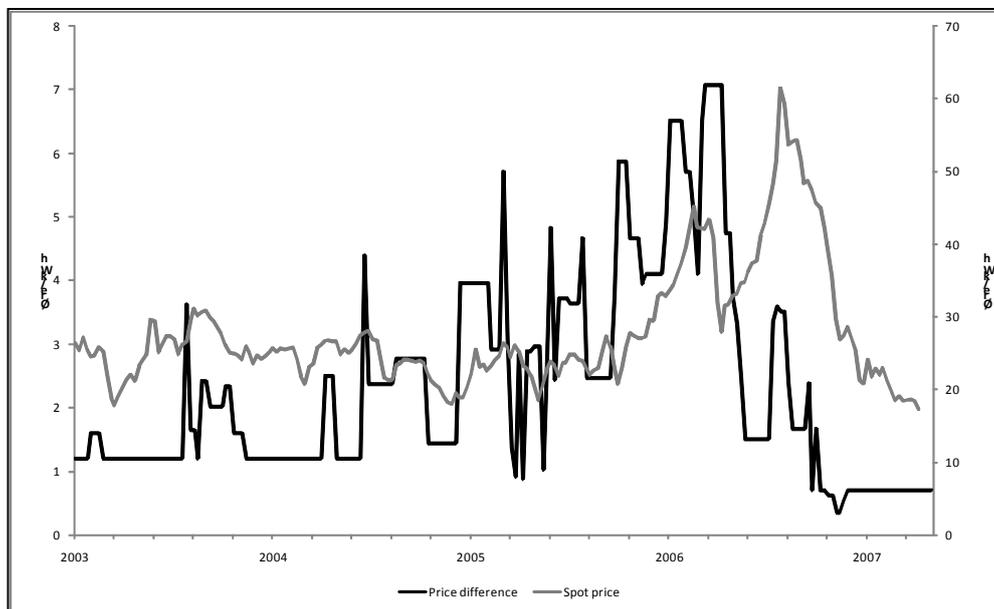
21 Although some consumers may consider alternative payment methods more attractive, they are generally more expensive, both because of the various transaction fees involved and because of the time required to undertake payment, for example by visiting a bank.

22 The Hafslund spot-price product differs from the Standard Agreement spot-price product (hence the price is not reported on the Competition Authority web page); Hafslund uses a consumption-weighted average of the daily spot price, while the Standard Agreement requires use of the monthly spot price as reported by NordPool. This, and the fact that the terms

Table 7 below reports annual cost for a consumer with an annual consumption of 20 000 kWh of choosing the Strøm and the Direkte variable-price products of Hafslund for the years 2004 to 2006.

Table 7: Annual cost of Hafslund variable-price products, kroner. Source: NCA.

Contract	2004	2005	2006
Strøm	7 794	6 303	10 890
Direkte	7 533	7 173	11 735
Difference	438 (6.2%)	876 (13.9%)	845 (7.8%)

Consumer Behaviour

In the preceding sections we have investigated retailer behaviour. In order to understand this behaviour, we need to consider the behaviour of their customers also. In this section, we describe consumers' choice of product and retailer, and we provide a discussion of (monetary and other) costs associated with switching product and/or supplier.

Choice of retailer

Every quarter, the Norwegian Water Resources and Energy Directorate conducts a survey among the main distribution companies on consumer switching (NVE, 2007). For the household segment (which includes holiday homes), the survey covers 82.4 percent of all metering points.[23] Results are scaled in order to produce national-level numbers.[24]

Figure 11 gives the share of households that have a supply contract with their incumbent retailer, i.e. the retailer associated with the local distribution company. The share of households under contract with incumbents has been steadily declining; it was above 95 percent at the beginning of 1999 and had fallen to 72 percent at the beginning of 2007, the lowest figure ever observed. These average figures mask considerable variation between regions; at the end of 2006, the market share of incumbents varied from 30.5 percent to 95 percent.


(Contd.)

of the Hafslund spot-price product are not particularly attractive, suggests that Hafslund is not pursuing very actively customers for this product outside of its region.

23 The survey covers the 28 largest distribution regions. The Norwegian Water Resources and Energy Directorate states that the decision to restrict attention to these regions was based on the argument that smaller distribution companies would have only limited administrative resources to undertake this sort of reporting and hence should be exempted. To the extent that retailers and/or consumers in smaller regions behave differently from retailers and consumers in larger regions, the selection criterion will affect results. We do not have information that allows us to investigate this issue.

24 In the surveys covering the period from the first quarter of 1999 up and including the third quarter of 2001, scaling was based on a figure of 2.2 million for the total number of Norwegian households; for the fourth quarter of 2004, the corresponding number was 2.28 million, while from the first quarter of 2005 the number has been set to 2.30 million. These changes in definitions do influence results, although not to such an extent as to affect conclusions.

Figure 11: Share of households with the incumbent retailer. Source: NVE.
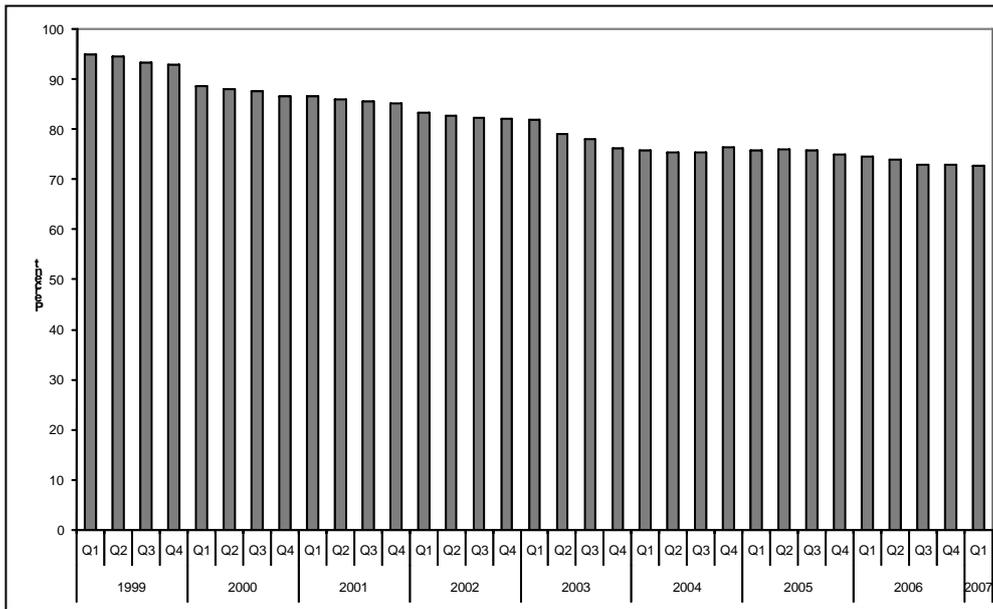
The figures on incumbent market share understate the extent of switching, as they do not distinguish between consumers who have always remained with the incumbent retailer and consumers who have left the incumbent retailer but subsequently returned.

Figure 12 shows the number of households that have switched retailer during the relevant quarter, as well as the Nordpool spot price on a weekly basis. The number of households switching retailer has varied considerably over time. There was a substantial surge in switching activity during and after the price shock in 2002-3. Following the price rise in 2005, switching activity again increased in 2006.

Figure 12: Retailer switching. Sources: NVE/Nordpool.
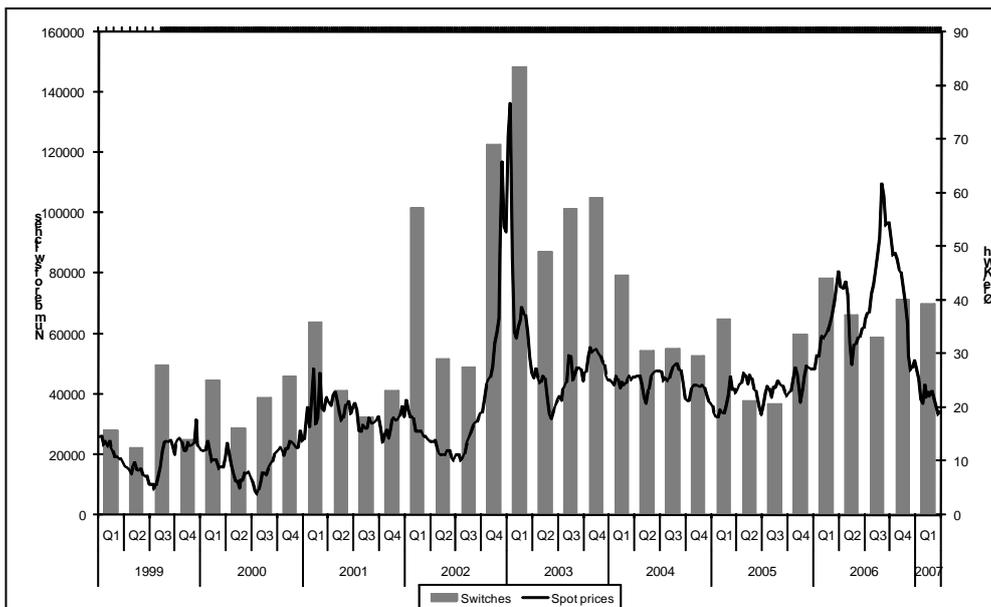
Choice of product

Figure 13 gives the share of households with different types of products over the period 2000-2007. The share of households with a variable-price product has been on a downward trend; it was 88.9 percent in the first quarter of 2001 and had fallen to 49.5 percent in the first quarter of 2007. The decrease is not monotone: from the end of 2001 to the beginning of 2003, the share was increasing; however, from the first quarter of 2003, following the unusually high prices during the winter of 2002-2003, the share fell sharply and has since been falling more or less continually.

Figure 13: Distribution of products, source: NVE.
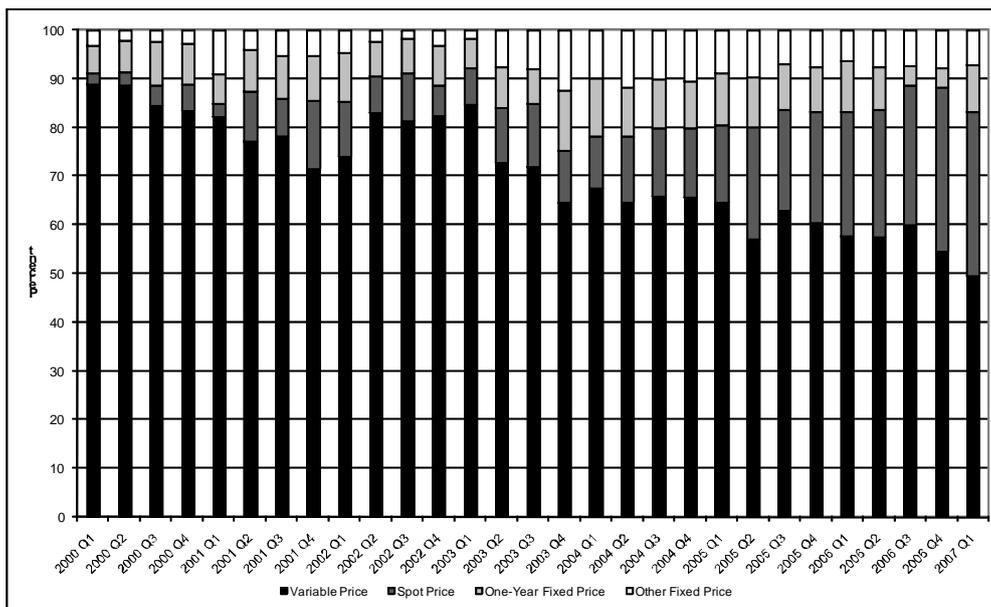
The share of households buying a spot-price product was fairly low – typically below 10 percent – until 2004. After that, the share has increased rapidly and had reached 33.7 percent in the first quarter of 2007. While the price shock in 2002-2003 was clearly important in affecting consumer awareness about the availability of different products, the popularity of the spot-price product may also have been influenced by the fact that the Norwegian Competition Authority started publishing price information on this product in Week 38, 2003. In addition, as pointed out above, some retailers have changed their default product from variable price to spot price.

The share of households on longer-term, or fixed-price, contracts has varied over time, without any clear trend. The share increased considerable after the winter of 2002-2003 – reaching a peak of 21.8 percent in the first half of 2004 – but has since fallen.

The evidence presented in this and the previous subsection suggests two clear trends: (i) a shift from incumbent retailers to alien retailers on the one hand, and (ii) a shift from variable-price to spot-price products on the other.

It is not obvious that these trends are related, especially since retailers tend to offer the same products; in other words, it is generally not necessary to switch retailer in order to switch product, nor is it necessary to switch product in order to switch retailer. In principle, the choice of product and the choice of retailer involve different considerations: a switch between products may be seen as a response to changes in attitude towards (price) risk; a switch between retailers is a response to differences in the attractiveness of offers. However, to the extent that switching is a result of increased

awareness of how the electricity market works and which offers are available, it may well be that switching of retailer and products happen in parallel.

In order to cast some light on these issues, in the next subsection we consider costs associated with switching between retailers and products.

Switching costs[25]

There are no direct monetary costs associated with switching either retailer or product. A simple way to switch is to follow the link from the web page of the Norwegian Competition Authority (or some other such page that offers price comparisons) to the homepage of the chosen retailer, fill in the relevant form and submit it electronically – the rest of the work is undertaken by the relevant distributor and retailers. While the procedure is simple, it does involve the opportunity cost of time involved; however, even assuming that that the whole operation takes half an hour – including acquiring an overview of the available retailers and their offers – the cost would amount to no more than 100 kroner (based on the average pay of a blue-collar worker).

Some consumers apparently find costs associated with double billing, which is generally required when choosing a retailer different from the one associated with the local distribution company, of considerable significance. Figure 14 presents information about the importance consumers attach to double billing, obtained from a survey conducted by TNS Gallup in the third quarter of 2005 (as part of their quarterly Energibarometer), where respondents were asked the question 'What is the importance of having a single bill for energy and network tariffs?'. More than half the respondents graded the importance to 4 or more on a scale from 1 to 6 and only one in five found double billing to be of 'very little importance'.

Figure 14*: Importance of double billing. Source: TNS Gallup.*
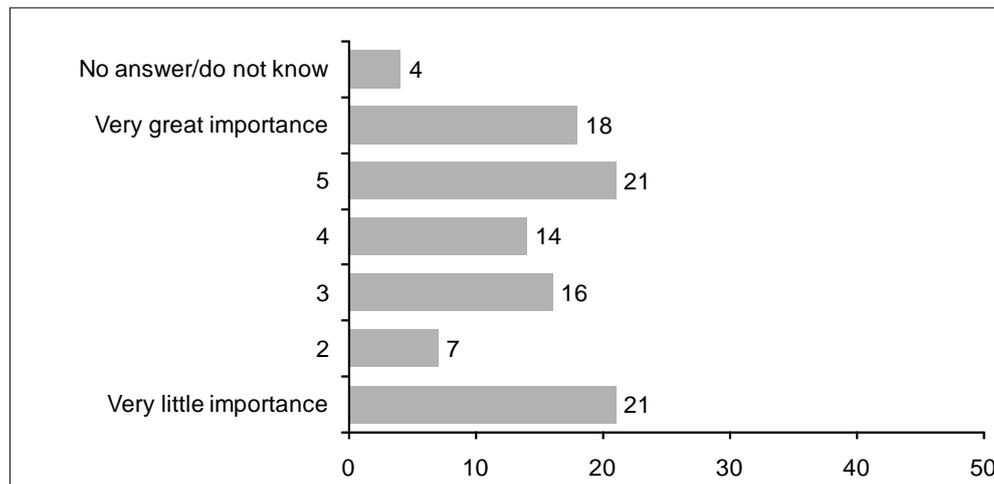
In addition to monetary costs, there may be non-monetary or "psychological" costs involved with switching, such as the dislike of spending time on electricity shopping, the uneasiness of entering into new and unfamiliar territory and perceived risks associated with choosing an alien supplier. There is some evidence that these types of costs may be substantial, at least for some consumers. In the TNS Gallup survey referred to above, less than one in five were willing to switch for a gain of 5-6 øre/kWh, while half the respondents required a gain of more than 50 øre/kWh (i.e. more than the actual price of

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25 For theory on switching costs in electricity retail markets, see Sturluson (2003); for empirical analyses, see for example Guiletti *et al* (2005) on the UK and Ek and Söderholm (2008) on Sweden.

electricity!) in order to switch. Among the group of consumers who had made a switch during the previous twelve months, the required gain was less, but still seemed rather extreme.

The only interpretation of these results seems to be that many consumers are not particularly well informed about either electricity prices or the functioning of the market. This is further confirmed by information provided in Figure 15, which summarises responses to the question 'Have you considered switching retailer?'. More than half the respondents had not done so, and of those who had, three quarters had decided not to switch.

Figure 15: Considering switching. Source: TNS Gallup.
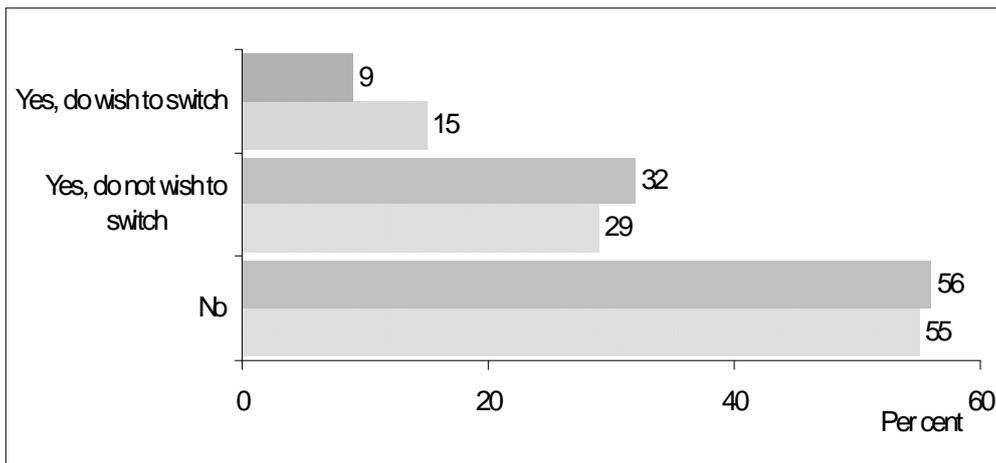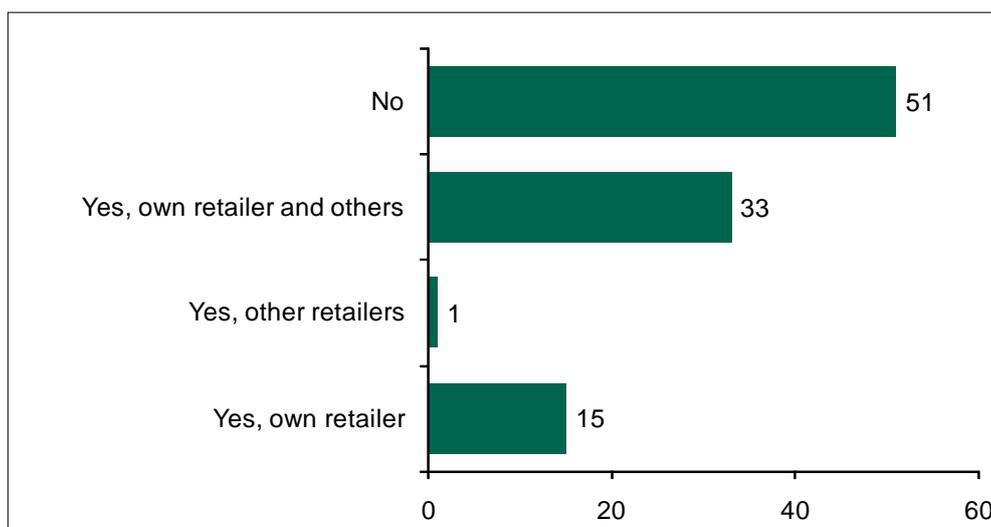

Figure 16 summarises response to the question 'Do you watch prices?. Again, more than half the respondents do not, and only a third actually compare prices.

Figure 16: Price awareness, percent. Source: TNS Gallup.

Conclusion

Our reading of the evidence presented in this paper is the following. Those consumers willing and able to participate actively in the market seem to get a fair deal: there is a variety of suppliers and products to choose from, competition is strong and prices are close to costs. Those consumers who, for one reason or another, remain passive may however end up paying more; whether they do, and by how much, depends on the strategy of their local supplier, but costs may exceed the best available offers by 10-15 percent.

It is in some sense surprising, more than 15 years after deregulation, and with electricity prices regularly making headline news – particularly during the price shock of 2002-3 – that market awareness is so limited, at least among a substantial group of consumers.[26] Electricity costs constitute a significant part of Norwegian household budgets, switching is apparently easy, and there are gains to be made (especially for many consumers who have never switched). Even so, a large number of consumers do not exploit the opportunities; indeed, many seem entirely ignorant about the possibilities they face.

Perhaps the explanation is simply that our standard is too strict. It is beyond the present study to undertake a detailed comparison of the electricity market with other markets, but even a superficial glance at the evidence seems to suggest that maybe the electricity market does not perform especially badly. For example, media regularly present overviews on bank interest rates, with seemingly persistent differences, but with little or no response from banking customers.[27] Similarly, although prices differ substantially between insurance companies, there is limited consumer switching.

One could argue that such comparisons are of limited interest; what matters is whether the market in question may be improved. From this perspective, the Norwegian market seems to do reasonably well, at least compared to electricity markets in other countries. We believe the regulatory framework – including the regulation of relations between distributors and retailers, provision of price information and ease of switching – explain much of the success of the Norwegian market, but more fundamental features are also important; in particular, the continual and substantial variation in electricity prices – between seasons and years – contributes to an awareness about prices that facilitates price-based competition.

On the other hand, the combination of price variation and the choice of default contract may have made price comparisons more difficult. Since prices change continually due to variations in underlying costs, sometimes in an unpredictable manner, it is difficult to get a grip on the gains from switching between the variable-price products of different suppliers. Had the default contract been of the spot-price type instead, price comparisons would have been considerably simpler, since consumers only needed to compare mark ups. Such contracts are becoming increasingly popular, but their market penetration depends on active decisions by the individual consumer; those consumers who never switch are stuck with a variable-price product.[28] From 2010, all distributors are required to introduce hourly metering for households. This is meant to provide consumers with incentives to adjust to real-time changes in prices, but may also lead to the introduction of new types of contracts; as such, it may provide an opportunity for an evolution towards a more transparent market.

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26 Lack of information may not be the only explanation. One of the authors of this paper, supposedly an expert on the Norwegian electricity market, took 10 years to make his first switch; he has not switched further, even though he could do so at a gain...

27 See NCA (2006) for a discussion of customer switching in the Nordic markets for bank services.

28 Consumers who move location and do not make an active choice of product, as well as consumers who are returned to their local retailer in its capacity as supplier of last resort (say, because the contractual relation with their original supplier is severed), are given a spot-price contract by default.

The final, and most difficult, question is of course whether retail competition has improved market performance overall. Our analysis does not allow us to answer this question completely, for two reasons. First, in order to provide an answer we would need to make a comparison with the hypothetical alternative, taking account of potentially different developments on market structure, efficiency improvements, innovation and so on. Second, the answer depends on the weight one puts on different interests; for example, those consumers who are active on the market are likely better off, while those who are not may not have benefitted.[29] In other words, if the goal was to create new opportunities for consumers, the reform would seem a success; however, if the goal was to protect does unwilling or unable to exploit such opportunities, it is not clear that there has been a real gain.[30]

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[29] From this perspective, it would be useful to know more about those who are active and those who are not; unfortunately, we do not have access to such information, but it would seem an interesting area for further research.

[30] The Norwegian experience may be contrasted with the Danish, where, after third-party access was extended to all consumers in 2003, the government required retailers to supply their local customers at regulated prices. These prices are set quarterly, based on an average of futures prices on the wholesale market and with retailer-specific, regulated mark ups. The mark ups have been set so low that it has been very difficult for other retailers to compete and hence effective competition has not evolved (Olsen *et al*, 2006).

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Appendix

In this Appendix, we discuss in more detail the regressions presented in the main text.

Variable-price Products

As explained above, retail prices are taken from the historical database of price offers as registered by the Norwegian Competition Authority. Retailers can submit price offers – including changes to existing offers – at any time, and the web page is updated every ten minutes. Price offers take effect two weeks after they have been registered. The Competition Authority stores price offers for its historical data base once a week, on Sunday at 23.50 (11:50 pm). The retail price series therefore contains weekly observations of what is in effect a 'continuous' time series.

Future prices are taken from the historical database of Nordpool, which registers such prices daily. In order to produce a wholesale price comparable to the retail price, we have done as follows. Firstly, for each day of the week, we have constructed an average futures price for the week starting two weeks ahead. For example, for a price offer made on Monday Week *t*, which is valid from Monday through Sunday Week *t*+2 (since the price may be changed again after a week), the futures price is simply given as the futures price on Monday Week *t* for deliveries in Week *t*+2. The corresponding number for Tuesday Week *t* – where the offer is valid from Tuesday Week *t*+2 through Monday Week *t*+3 – is given as the weighted average of the futures prices on Tuesday Week *t* for deliveries in Week *t*+2 and *t*+3, respectively, with weights 6/7 for the price for deliveries in Week *t*+2 and 1/7 for the price for deliveries in Week *t*+3. Futures prices for the other days are constructed correspondingly.

Secondly, we assume the time of the retail price offer is uniformly distributed across the week. Consequently, the price offer registered on Sunday (the last day of the week) in Week *t*, is – with equal probability – valid from either day in Week *t*+2. We therefore take our futures-price variable to be the average of the futures price constructed for each weekday.

Using the futures price as an expression for the wholesale price may be reasonable, given that retailers have the opportunity to secure this price for deliveries at the time when the offer is made. However, the actual cost of sourcing supplies may differ for a number of reasons.

Firstly, since demand cannot be forecasted perfectly, retailers cannot be fully hedged at the margin. We have not investigated the potential effects of this discrepancy in any great detail. However, given that the Nordpool markets are generally considered efficient, it is unlikely that there are substantial systematic differences between the expected spot price and the futures price. Also, even though demand cannot be forecasted perfectly, it can in fact be forecasted with very high accuracy, at least in the short to medium term. Overall therefore, the error of using the futures price rather than the spot price as a proxy for wholesale price is likely to be minimal.

A second reason why the futures price and actual cost of sourcing energy in the wholesale market may differ is that while the futures price is related to the market-wide Elspot price, the actual spot price will differ between pricing areas whenever there are transmission constraints. The difference in price between pricing areas may be hedged on a monthly, but not on a weekly, basis. Consequently, retailers face a risk that the cost of supplying a customer in any given area differs from the market mean. The exposure to this risk depends on the geographical composition of the retailer's customer base. We have no information that allows us to assess the importance of this effect. However, since the geographical price differences do not tend to remain the same for longer periods of time, we conjecture that this effect is not very important.

Third, and finally, since the futures price is based on a flat profile over the week (that is, it corresponds to the sale or purchase of a fixed quantity for every hour of the week) while consumption

typically varies hour by hour, there may be a systematic difference between the average and the consumption-weighted wholesale price. In order to cast some light on the importance of this effect, in Figure 17 we have plotted consumption levels and spot prices over the 24-hour cycle. The consumption data is taken from a measurement undertaken by the distributor Istad over the period January 1 to December 31, 2006 among a sample of 543 hourly-metered household consumers located in the middle of Norway. As far as we know, this sample is representative of the Norwegian market. The price data are taken from the Nordpool spot market. Based on these numbers, the averaging effect is of limited importance; the weighted spot price exceeds the average spot price by less than 0.6 percent.

Figure 17: Daily consumption and spot-price profiles. Source: Istad/NordPool.
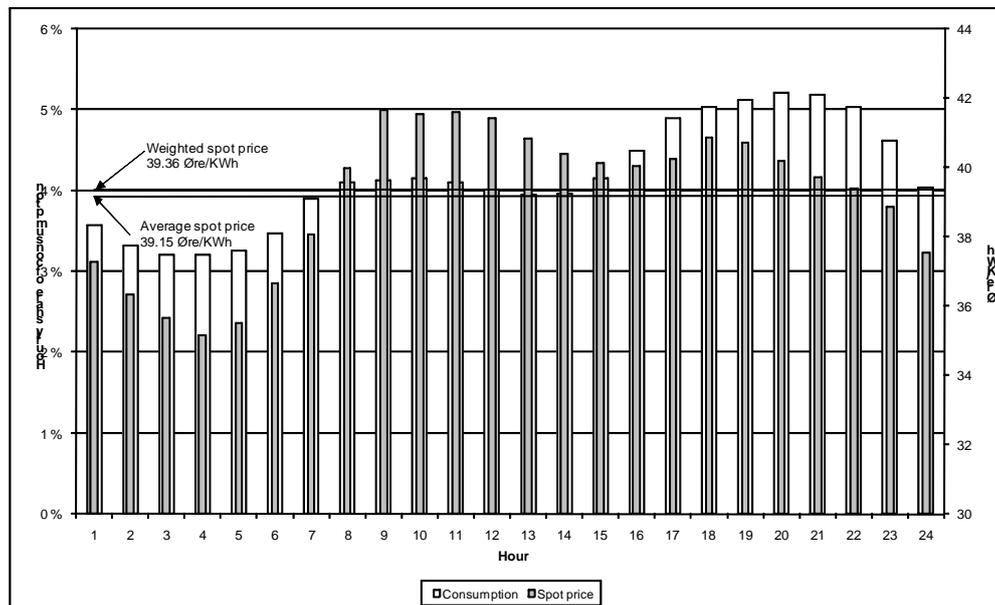

Table 8 reports summary statistics for the various variables that forms the basis for the regressions.

Table 8: *Summary statistics: variable-price products, nationwide retailers.*

Variable	Obs	Mean	Std Dev	Min	Max
Futures price	332	26.607	11.056	10.251	82.072
Retail price Fjordkraft	332	29.516	11.958	14.813	88.000
Retail price Gudbrandsdal	332	27.951	10.696	13.281	64.693
Retail price Lyse	332	28.621	10.525	14.813	62.113
Retail price SKS	332	29.111	12.300	13.902	79.000
Retail price Ustekveikja	332	27.831	11.252	13.402	68.605

In the main text we reported results from OLS regressions undertaken for each retailer separately. We have however undertaken a series of alternative regressions in order to test the robustness of these results.

Given the panel nature of the data set, it might seem natural to start from the hypothesis that a single model can be applied for all retailers. We have tested such a model by use of the Seemingly Unrelated Regression (SUR) method (Green, 2000). This method allows for testing of parameters jointly between retailers based on Wald-tests. Such tests show that, at a 5 percent significance level, we can reject the hypotheses that all retailers behave identically, that is, all coefficients are the same across retailers. If we exclude Fjordkraft, we can still reject the hypothesis that coefficients are identical for the rest; however, we cannot reject the hypothesis that the coefficients on the lagged retail price and future price are equal across retailers, nor can we reject the hypothesis that all the constant terms are equal. Nevertheless, we have not imposed such parameter restrictions and have instead based our analysis on separate regressions for each individual retailer.

The SUR method also accounts for correlation between error terms in the regressions for individual retailers. Indeed, a Breush-Pagan test of independence of error terms across retailers is rejected at a 1 percent significance level for all regression models. However, it turns out that the SUR method produces essentially the same results as the OLS method and, for simplicity, we therefore decided to concentrate on the latter.

The table below reports a number of specification tests for the regressions reported in the main text. The AR represents a Lagrange-multiplier test for residual autocorrelation, the ARCH a test for autoregressive conditional heteroscedasticity, while Normality represents a test for whether residuals are normally distributed (for details about these tests see Hendry and Doornik, 2001). The upper number in each cell gives the value of the test statistic, while the lower number is the probability of observing this value given that the null hypothesis is true.

Table 9: Specification tests: variable-price products, nationwide retailers.

	Fjordkraft	Gudbrandsdal	Lyse	SKS	Ustekveikja
AR 1-26 lags, $F_{(26,302)}$	2.838	1.763	3.378	3.654	2.868
	0.000	0.014	0.000	0.000	0.000
ARCH 1-26 lags, $F_{(26,276)}$	5.107	2.634	0.756	0.428	0.808
	0.000	0.000	0.801	0.994	0.737
Normality, $Chi^2(2)$	403.4	1068.5	887.3	337.4	341.6
	0.000	0.000	0.000	0.000	0.000

The tests indicate that residuals are autocorrelated and that they are not normally distributed. Moreover, heteroscedasticity is present in the regressions for Fjordkraft and Gudbrandsdal.

The presence of autocorrelation is particularly troublesome, as it may indicate that the estimated coefficients are skewed, or, at worst, that the correlation between the retail price and the wholesale price is spurious. We have therefore investigated this issue in some detail.

In the model reported in the main text we base our inference on the assumption that variables are stationary, such that standard inference may be conducted. However, a quick look at the price series reveals that it will be difficult to characterise the prices as following a specific integrated process, of I(0), I(1) or higher order for that matter; in particular, from

Figure 5 we see that retail prices sometimes remain constant for many periods, in fact up to 28 weeks for one retailer (this is likely to be a reason for the observed autocorrelation also). Indeed, a KPSS-test where the null hypothesis is that the variables are I(0) cannot be rejected (for details on this test, see Kwiatkowski *et al*, 1992). Furthermore, an augmented Dickey-Fuller (ADF) test shows that we cannot reject the hypothesis that variables are I(1) (for details on this test, see Hendry and Doornik, 2001).[31]

To test the robustness of our results – particularly the relation between retail and wholesale prices – we have undertaken an alternative estimation of an error-correction model where we consider variables as following I(1) processes. The model is in first differences, with up to 26 lags of both the retail and the wholesale price. In addition, the model includes the levels of both the retail and the wholesale price (lagged one period):

$$\Delta p_t^r = \gamma_0 + \sum_{i=1}^{26} \gamma_i^r \Delta p_{t-i}^r + \sum_{i=0}^{26} \gamma_i^f \Delta p_{t-i}^f + \gamma^r p_{t-1}^r + \gamma^f p_{t-1}^f + \varepsilon_t.$$

The model is reduced from general to specific in PcGets, by eliminating variables with insignificant coefficients (for details on this approach, see Hendry and Krolzig, 2001). We cannot reject an assumption that the variables constitute a cointegrated vector, and the coefficients on the levels variables are significant at the 1 percent level.[32] None of the specific models suffers from autocorrelation, but the presence of heteroskedasticy could not be rejected in the models for Lyse and Gudbrandsdal.

Given that the constant terms turn out to be insignificant, and hence were eliminated in the specific model, the (steady-state) mark up on the wholesale price is given by the value of $-\gamma^f / \gamma^r$. It turns out that these numbers differ by less than 1 percent from the results reported in the main text, confirming that these are indeed robust.

As a further test of robustness, we have undertaken regressions based on the model reported in the main text with more variables. We have constructed a number of variables in order to see if retailers tend to increase their prices by more or less than the (expected) change in the underlying wholesale price. The "Trend-up" variable equals the two-week futures price described above multiplied by a dummy, where the dummy is equal to 1 if both the four-week futures price exceeds the two-week future and the two-week futures price exceeds the spot price; this variable therefore aims at measuring to what extent pricing strategies are affected by the fact that underlying wholesale prices are on an upward trend. The "Trend-down" variable is constructed in a corresponding fashion. The "Convex" variable equals the two-week futures price multiplied by a dummy that equals 1 if the difference between the four-week futures price and the two-week futures price is greater than the difference between two-week futures price and the spot price; this variable therefore aims at measuring to what extent pricing strategies are affected by the fact that the rise in underlying wholesale prices is accelerating. The "Concave" variable is constructed in a corresponding fashion. We do no report results of estimations that include these variables here since we could not reject the hypothesis that these coefficients are zero at a 5 percent significance level. The only coefficients that were

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31 For Fjordkraft, the hypothesis that the retail price follows an I(1) process cannot be rejected at the 1 percent confidence level, but it can be rejected at the 5 percent level.

32 An exception is Fjordkraft, where the coefficients on the levels variables were eliminated through the general-to-specific process. Given the long number of lags of both the retail price and the wholesale price in the estimated specific model, we draw the conclusion that the wholesale price does indeed affect setting of the retail price also for Fjordkraft, although we are less certain about the exact nature of the long-run relationship between these prices for this retailer. If we allow for one break in the data series, the hypothesis of an long-run relationship can no longer be rejected.

significantly different from zero at a 5 percent level were the Convex variable for Fjordkraft and Gudbrandsdal.

We have also split the sample in two, where the first period runs from the beginning of 2001 to the end of 2003 and consequently includes the price spike of the winter of 2002-3. While the estimated coefficients do not differ much between these periods, we can reject at a 1 percent significance level the simultaneous hypotheses that all coefficients are the same across the two periods. However, testing the retailers one by one, we cannot reject that the hypothesis that the models of SKS, Fjordkraft and Gudbrandsdal are the same.

Fixed-price Products

For the fixed-price products we again use the prices weekly observations in the historical database of the Norwegian Competition Authority. The wholesale price corresponding to the one-year fixed-price product quoted at the Norwegian Competitive Authorities web page in week *t* is the price for delivery in weeks *t*+4 to *t*+56. Such a one-year contract does not exist at Nord Pool power exchange. We have therefore constructed a wholesale price by weighting future contracts at Nord Pool with a monthly consumption profile for the period t+4 to t+56. For the first week of the delivery period we use the corresponding weekly contract; for the subsequent six months we use monthly contracts; and, finally, for the last part of the delivery period we use quarterly contracts (or seasonal or yearly contracts for the earlier part of the sample period when quarterly contracts did not exist). The monthly consumption profile is the weighted average of consumption profiles used by Norwegian utilities and reported in Statistics Norway's "Household expenditure survey for the year 1998/1999".

Table 10 provides summary statistics for all nationwide retailers that have all been on the market for the period Week 38, 2003 to Week 19, 2007.

Table 10: Summary statistics: fixed-price products, nationwide retailers.

Variable	Obs	Mean	Std Dev	Min	Max
Weighted yearly futures price	189	30.992	7.632	18.630	58.027
Retail price, Gudbrandsdal	189	33.137	8.932	20.360	62.560
Retail price, Hafslund Direkte	189	34.696	8.191	22.880	59.920
Retail price, Halllingkraft	189	34.257	7.900	22.280	59.988
Retail price, Helgelandskraft	189	33.876	8.552	20.904	62.600
Retail price, SKS	189	33.002	8.138	20.600	60.000
Retail price, Stranda Energiverk	189	33.776	7.994	21.960	59.880
Retail price, Trønder Energikraft	189	33.250	8.803	20.640	59.104
Retail price, Tussa-24	189	34.441	7.842	22.560	60.080
Retail price, Ustekveikja	189	33.306	7.722	20.720	59.000
Retail price, Valdres Energiverk	189	35.053	8.211	21.872	61.208

Table 11 provides numerical values for mark ups, derived from regressions results and calculated as described in the section on variable-price products.

Table 11: Mark ups: fixed-price products, nationwide retailers.

	Gudbrandsdal	Hafslund Direkte	Hallling-kraft	Helgelands-kraft	SKS
$\frac{\beta_0}{1-\beta_2}$	-4.174	0.861	1.855	-0.863	-0.465
$\frac{\beta_1}{1-\beta_2}$	1.204	1.092	1.046	1.121	1.080
$\frac{\beta_0}{1-\beta_2}\frac{1}{p^f}+\frac{\beta_1}{1-\beta_2}$	1.070	1.120	1.106	1.093	1.065

	Stranda Energiverk	Trønder Energikraft	Tussa-24	Ustekveikja	Valdres Energiverk
$\frac{\beta_0}{1-\beta_2}$	0.662	-2.834	2.691	1.549	1.891
$\frac{\beta_1}{1-\beta_2}$	1.068	1.165	1.025	1.025	1.070
$\frac{\beta_0}{1-\beta_2}\frac{1}{p^f}+\frac{\beta_1}{1-\beta_2}$	1.090	1.074	1.112	1.075	1.131

Price discrimination

Table 12 provides summary statistics for the 10 most expensive regional retailers for the period Week 1, 2001 to Week 19, 2007. "10 most expensive regional retailers" is taken as the 10 retailers who have figured most frequently (i.e. the largest number of weeks) among the 10 retailers with the highest retail price offers in any given week.

Table 12: Summary statistics: fixed-price products, 10 most expensive retailers.

Variable	Obs	Mean	Std Dev	Min	Max
Futures price	332	26.607	11.056	10.251	82.072
Retail price, Hålogaland kraft	332	30.248	11.248	15.402	83.798
Retail price, Ishavskraft	332	30.430	11.426	15.103	80.798
Retail price, Kraftinor	332	31.378	12.231	16.603	93.798
Retail price, Malvik everk	332	30.482	12.318	15.402	84.750
Retail price, Nesset kraft	332	25.483	6.324	15.095	49.734
Retail price, Nordmøre energiverk	332	29.942	11.109	15.579	68.400
Retail price, Raumakraft	332	30.062	10.824	15.095	73.968
Retail price, Røyken kraft	332	31.254	11.698	15.176	71.226
Retail price, Troms kraft marked	332	29.942	11.155	14.644	68.704

Error! Not a valid bookmark self-reference. summarises results from a regression on the sample of 10 most expensive retailers for a period starting in Week 1, 2001 and ending in Week 19, 2007.

Table 13: *Estimation results: variable-price products, 10 most expensive retailers.*

	Hålogaland kraft	Ishavs-kraft	Kraftinor	Malvik everk	Nesset kraft
Constant	0.241	0.824	0.417	-0.062	0.739
	(0.308)	(0.330)	(0.434)	(0.348)	(0.381)
Wholesale price	0.258	0.385	0.376	0.298	0.047
	(0.017)	(0.023)	(0.027)	(0.023)	(0.009)
Lagged retail price	0.765	0.636	0.668	0.742	0.924
	(0.017)	(0.022)	(0.024)	(0.020)	(0.016)
R^2	0.971	0.966	0.971	0.966	0.971

	Nordmøre energiverk	Raumakraft	Røyken kraft	Troms kraft marked
Constant	0.270	0.496	0.428	0.208
	(0.315)	(0.283)	(0.336)	(0.297)
Wholesale price	0.237	0.222	0.263	0.219
	(0.017)	(0.016)	(0.020)	(0.016)
Lagged retail price	0.781	0.788	0.763	0.799
	(0.017)	(0.016)	(0.019)	(0.016)
R^2	0.971	0.966	0.947	0.965

Table 14 provides numerical values for mark ups, derived from regressions results.

Table 14: *Mark-ups: variable-price products, 10 most expensive retailers.*

	Hålogaland kraft	Ishavs-kraft	Kraftinor	Malvik everk	Nesset kraft
$\dfrac{\beta_0}{1-\beta_2}$	1.026	2.265	1.254	-0.241	9.678
$\dfrac{\beta_1}{1-\beta_2}$	1.099	1.059	1.132	1.155	0.612
$\dfrac{\beta_0}{1-\beta_2}\dfrac{1}{p^f}+\dfrac{\beta_1}{1-\beta_2}$	1.137	1.144	1.180	1.146	0.975

	Nordmøre energiverk	Raumakraft	Røyken kraft	Troms kraft marked
$\dfrac{\beta_0}{1-\beta_2}$	1.234	2.336	1.809	1.034
$\dfrac{\beta_1}{1-\beta_2}$	1.081	1.044	1.109	1.088
$\dfrac{\beta_0}{1-\beta_2}\dfrac{1}{p^f}+\dfrac{\beta_1}{1-\beta_2}$	1.128	1.132	1.177	1.127

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