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in the Nordic Electricity Markets.
The case of Elsam

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# On the Exploitation of Market Power in the Nordic Electricity Markets. The case of Elsam

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**Abstract**

In this paper a test is made of whether the Danish electricity producer, Elsam partly or fully exploits its temporary dominant position in hours of congestion at the Nordic electricity market. There seems to be evidences suggesting that Elsam is successful in pursuing its objective of having a price in Western Denmark close to the maximum price of the surrounding and connected areas.

JEL classification: L12, L21, L22, l)4, C1

Keywords: Electricity markets, Objectives of the firm, exploitation of dominant positions.

# 1 Introduction

The Nordic market for electricity was created during the nineties. A Norwegian market was created in 1993, Sweden joined in 1996, Finland in 1998 and Denmark in 1999-2000. The market called the Elspot Market is now, since January 2002, operated by a company called Nord Pool Spot AS. Information on the activities can be found on http://www.nordpool.com/.

The following information can be found: "The Nordic Elspot market concept has these key features:

- The Elspot concept is based on bids for purchase and sale of hourly contracts using three different bidding types: hourly bids, block bids and flexible hourly bids that cover all 24 hours of the next day.
- Within Norway - and at the interconnections between the Nordic countries - price mechanisms are used to relieve grid congestion (bottlenecks), by introducing different Elspot area prices. Within Sweden, Finland, and Denmark, grid congestion is managed by counter-trade purchases based on bids from generators.
- The Elspot market's System Price is the price of Elspot power where there is no grid congestion. The Elspot System Price prevails throughout the Nordic Power Exchange area when there is no grid congestion between bidding areas.
- The total geographic market is divided into bidding areas; these may

become separate price areas if the contractual flow of power between bid areas exceeds the capacity allocated for Elspot contracts by transmission system operators. When such grid congestion develops, two or more area prices are created.

- Elspot prices are determined through auction trade for each delivery hour. The System Price (also called the Elspot System Price) and Area Prices are calculated after all participants' bids have been received.

Elspot Market Products

The Elspot market is a day-ahead physical-delivery power market and the deadline for submitting bids for the following day's delivery hours is 12 am (noon). The products traded on the Elspot Market are bids of a one-hour duration, block bids and flexible hourly bids. Participants use an Internet application called Elweb for submitting bids to Elspot's trading system, or use EDIEL communication to submit their bid forms to the marketplace.

Contracts: Elspot market contracts are one-hour-long physical power (delivery to or take-off from the grid) obligations; minimum contract size is 0,1 MWh/h.

Hourly Bidding: An hourly bid is a sequence of price/volume pairs for each specified hour. Volumes are stated in MWh. In bidding, purchases are designated as positive numbers; sales as negative numbers.

Block Bid is an aggregated bid for several consecutive hours with a fixed bidding price and volume. The block bid price is compared with the average hourly price within the block period. A block bid must be accepted in its entirety; if accepted the contract covers all hours and the volume specified in the bid.

Flexible Hourly Bid is a sales bid for a single hour with a fixed price and volume. The hour is not specified, but instead the bid will be accepted in the hour with the highest price, given that the price is higher than the limit set in the bid. For more information about bidding types download the following bidding brochure (pdf-format).

Elspot bidding form

Participants submit their bids (to make or take delivery) on bidding forms[1] covering all 24 delivery hours. At the Elspot marketplace, a purchase and sales curve and an equilibrium-point for each hour are established using the price/volume pairs in the participants bidding forms". *See* NordPoolSpot (2004).

One might be tempted to conclude that the whole Nordic area must be considered one market due to these arrangements, but such a conclusion is not valid. In fact, due to the limitations of the capacity to transport electricity between geographical areas, the Elspot geographical market is divided into bidding areas which may become separate price areas "if the contractual flow of power between bid areas exceeds the capacity allocated for Elspot contracts by transmission system operators". The main bid areas are illustrated on the map found on http://www.nordpool.com/marketinfo/index.html. The arrows illustrate the connection between the areas within the Nordic countries and the connections from Finland to Russia (12), Sweden to Germany (8) and (9), East Denmark to Germany (10) and  West Denmark to Germany (11). Notice, that Norway is divided into two bid areas North Norway and South Norway, and Denmark is also divided into two bid areas West Denmark (Jutland and Funen) and East Denmark (Zealand etc.), but the Danish bid areas have no direct connection.

Some of the bid areas are dominated by a single producer. In West Denmark the dominant producer is Elsam[2] and in East Denmark the dominant producer is E2. Hower, an important aspect of the Danish market is that the electricity lines and the administration and organisation of the networks are operated by an independent company ELTRA[3].

In the following we will concentrate on the strategic behavior of Elsam.

The bid area of West Denmark, which is the area where Elsam is the dominant producer of electricity, is connected to South Norway, Sweden and Germany. Hence, when the connections to South Norway and Sweden are congested West Denmark is an isolated price zone in the Elspot market. If the connection to Germany is congested as well, West Denmark is an isolated market. Hence, three questions arise. The first question is whether Elsam partly or fully exploits its temporary dominant position, as indicated by the company's publicly declared goal "to be as close to the highest price of the surrounding areas as possible" and the second question is whether the company is able to create "congestion" themselves. The third question is under which conditions their declared goal is optimal.

In this paper we try to answer mainly the first question, and whether Elsam successfully fulfills its declared objective to a reasonable degree. However, the second question will be touched upon in the discussion.

Several other studies have been made on the Nordic Elspot market. In the study by Haldrup and Nielsen (2004) it is found that a regime switching model long memory model is appropriate in forecasting electricity prices. Hence, the results indicate that the model for the bottleneck periods is different from the model for the periods where no congestion exists. Johnsen, Verma, and Wolfram (1999) find that there exists some empirical evidence for higher prices in periods with congestion in Norway, while Hjalmarsson (2000) finds no evidence of the use of market power using weekly data. Steen (2003) like Hjalmarsson models the demand side by a Bresnahan-Lau model, uses hourly data, and finds that the producers in South Norway take advantage of the market power in bottleneck periods, but the economic significance is found to be low, as the bottleneck periods between South and North Norway are limited in numbers.

In this study we include the German side as well. Although Germany is not included in the Nordic Elspot market, it is obvious that the German electricity production must have some influence on the Nordic market. Part of the electricity trade between the Nordic countries and Germany is based on longer term contracts as is the electricity trade between Finland and Russia. In addition, the transmission capacity between Denmark and Germany is allocated by use of yearly, monthly and daily auctions, which use the "use-it-or loose it" principle, which is less efficient than the so-called "market coupling" system, which is going to be introduced in the near future. The use of long term contracts and the "use-it-or loose it" principle implies that the electricity in a given hour may go from high price areas to low price areas. Another possible explanation for this phenomenon may of course also be coursed by an attempt to congest a link in order to exploit the stronger position. Whether such a strategy is profitable depends upon whether the loss in creating the congestion by sending electricity to a lower priced area is smaller than the profit obtained in your home market, which is either its own bidding area or maybe connected to areas with even higher prices.

In this paper a test is made of whether Elsam partly or fully exploits its temporary dominant position in hours of congestion, and fulfills the company's publicly declared goal " to be as close to the highest price of the surrounding areas as possible". The null hypothesis is that they are not and such a hypothesis is very clear rejected. Hence, although rejection of the null does not imply that the alternative is true there seems to be evidences suggesting that Elsam is successful in pursuing its objective of having a price in Western Denmark close to the maximum price of the surrounding and

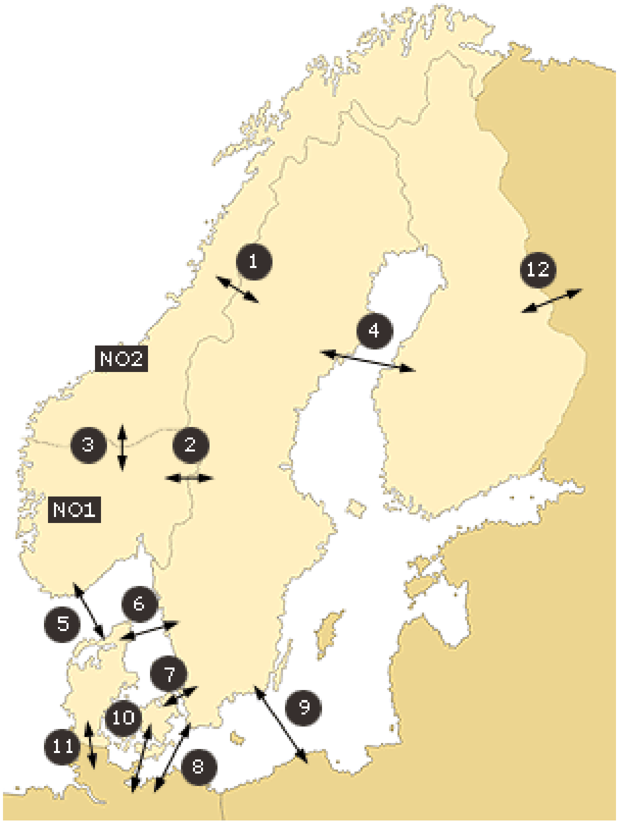


Figure 1: The Elspot market

connected areas.

## 2 The market position of Elsam.

Elsam is by far the most important producer of electricity in Western Denmark, see Konkurrencestyrelsen (2004) and Nordic-Competition-Authorities (2003). The total production capacity in Western Denmark was 7051 MW in 2002 of which Elsam produced 60%. The capacity consists of coal-fired and natural gas-fired combined heat and power stations (CHP). Some of these are big centrally located power stations with a capacity of 3596 MW of which Elsam owns 100%, others are smaller decentralized power stations, the main production of which is heat and with a capacity of 1523 MW of which Elsam controlled 16% in 2002. Finally, windmills accounted for a somewhat uncertain capacity of 1932 MW, with Elsam being the largest single producer with 20%. The production of the windmills is forced upon the system, and contributes to the uncertainty in predicting future supplies and capacity requirements, due to the difficulty in predicting the wind.

The networks were operated by ELTRA, an independent company, which was owned by consumers and municipalities, but with some cross ownership to Elsam. However, the network can be seen as independent of the producers. The tariffs of the transmission system were regulated and consisted of an entry charge and an exit charge. The import/export transmission capacity from/to Western Denmark to/from Norway were 1000MW, to/from Sweden 670 MW, and to/from Germany 800MW or a total of 2470 MW.

# 3 The price data.

The data applied in the current study are hourly price series for (South) Norway, $Pno_t$, Sweden, $Psv_t$, (North) Germany, $Pty_t$, and Western Denmark, $Pdkv_t$. 26280 consecutive hourly observations on the 4 price series from 2001 to 2003 are applied. The price series can be downloaded from http://www.econ.au.dk/vip_htm/shylleberg/webpage/shpage.html in Section Data Files[4].

The price data indicate that hourly electricity prices and thereby the hourly market for electricity in Western Denmark are different from the markets in the surrounding and connected area in a considerable number of hours, and that while the Norwegian and Swedish markets seem to be quite correlated, the German market is behaving quite differently from them.

Descriptive statistics for the series are shown in Table 1. It is seen that the mean of the hourly prices is much lower in Germany than in the three Nordic areas, where Norway and Sweden have the highest mean with West Denmark close by. However, the price variations are much lower for Norway and Sweden than for Western Denmark, and especially Germany. By smoothing the price series by a Moving Average over a day or week, the differences in the variations between the series become much smaller. Together with the maximum hourly price in Germany being 7 times as high as the maximum hourly prices in Norway and Sweden this indicates that the differences are due to a relatively few extreme hourly prices in Germany. The Danish prices possess similar characteristics, but to a lesser extent than the German prices.

| *Hourly Prices* | *Pdkv* | *Pno* | *Psv* | *Pty* |
|---|---|---|---|---|
| **Mean** | 206.30 | 215.07 | 215.53 | 188.84 |
| **Median** | 181.50 | 184.73 | 186.68 | 163.54 |
| **Standard Deviation** | 126.15 | 113.46 | 111.92 | 172.05 |
| **Minimum** | 0.01 | 19.44 | 15.08 | 0.15 |
| **Maximum** | 4429.81 | 1776.88 | 1776.10 | 12774.94 |
| **Count** | 26280 | 26280 | 26280 | 26280 |
| ***Moving Average 24 hours: Daily*** | | | | |
| **Mean** | 206.34 | 215.11 | 215.57 | 188.90 |
| **Median** | 188.14 | 185.90 | 189.00 | 176.67 |
| **Standard Deviation** | 84.13 | 109.58 | 105.50 | 94.91 |
| **Minimum** | 61.25 | 80.08 | 76.12 | 32.09 |
| **Maximum** | 1215.82 | 862.41 | 862.41 | 1845.66 |
| **Count** | 26257 | 26257 | 26257 | 26257 |
| **Moving Average 168 hours: Weekly** | | | | |
| **Mean** | 206.65 | 215.33 | 215.88 | 189.13 |
| **Median** | 192.26 | 187.27 | 190.26 | 174.83 |
| **Standard Deviation** | 64.19 | 107.62 | 102.51 | 61.26 |
| **Minimum** | 112.28 | 100.35 | 106.76 | 76.19 |
| **Maximum** | 635.18 | 818.52 | 818.52 | 705.92 |
| **Count** | 26113 | 26113 | 26113 | 26113 |

Table 1. Descriptive statistics for the price series

The simple correlations between the price series are shown in Table 2. The correlations between the German prices and the highly correlated Norwegian and Swedish prices are quite low also when the prices are smoothed. The Danish hourly prices have a correlation with the Norwegian and Swedish hourly prices of 0.5-0.6, a correlation which is increased to 0.7 and 0.9 by smoothing by daily and weekly moving averages, while the correlation between the Danish and the German price is around 0.4 in all three cases.

| Correlations: Hourly prices | *Pdkv* | *Pno* | *Psv* | *Pty* |
|---|---|---|---|---|
| Pdkv | 1 | | | |
| Pno | 0.52 | 1 | | |
| Psv | 0.57 | 0.97 | 1 | |
| Pty | 0.36 | 0.14 | 0.20 | 1 |
| **Correlations: Moving Average 24 hours: Daily** | ***Pdkv*** | ***Pno*** | ***Psv*** | ***Pty*** |
| Pdkv | 1 | | | |
| Pno | 0.70 | 1 | | |
| Psv | 0.72 | 0.99 | 1 | |
| Pty | 0.43 | 0.17 | 0.21 | 1 |
| **Correlations: Moving Average 168 hours: Weekly** | ***Pdkv*** | ***Pno*** | ***Psv*** | ***Pty*** |
| Pdkv | 1 | | | |
| Pno | 0.86 | 1 | | |
| Psv | 0.87 | 0.99 | 1 | |
| Pty | 0.43 | 0.20 | 0.23 | 1 |

Table 2. Price correlations

Thus, from the table of correlations we find that the prices in Western Denmark are different from the prices in the surrounding but connected areas.

This is also shown in Tables 3 to 5, where it is seen that the prices in Western Denmark are different from the North German prices in practically all hours, in fact $Pdkv_t$ is more than 5% higher than $Pty_t$ in 55% of the hours and more than 5% lower in 31.4% of the hours[5].

| The distribution of Pdkv around Pno | | Hours | | Hours | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Pno-Pdkv>0 | Pno-Pdkv>5% of Pno | 5345 | 20.3 | 8587 | 32.7 |
| | 5% of Pno>Pno-Pdkv>1% of Pno | 1934 | 7.4 | | |
| | 1% of Pno>Pno-Pdkv>0 | 1308 | 5.0 | | |
| Pno-Pdkv=0 | | | | 13244 | 50.4 |
| Pdkv-Pno>0 | 1% of Pno>Pdkv-Pno>0 | 510 | 1.9 | 4449 | 16.9 |
| | 5% of Pno>Pdkv-Pno>1% of Pno | 436 | 1.7 | | |
| | Pdkv-Pno>5% of Pno | 3503 | 13.3 | | |
| Total | | | 49.6 | 26280 | 100 |

Table 3 $Pdkv_t$ and $Pno_t$

| The distribution of Pdkv around Psv | | Hours | | Hours | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Psv-Pdkv>0 | Psv-Pdkv>5% of Psv | 5092 | 19.4 | 7526 | 28.6 |
| | 5% of Psv>Psv-Pdkv>1% of Psv | 1944 | 7.4 | | |
| | 1% of Psv>Psv-Pdkv>0 | 490 | 1.9 | | |
| Psv-Pdkv=0 | | | | 15588 | 59.3 |
| Pdkv-Psv>0 | 1% of Psv>Pdkv-Psv>0 | 143 | 0.5 | 3166 | 12.0 |
| | 5% of Psv>Pdkv-Psv>1% of Psv | 432 | 1.6 | | |
| | Pdkv-Psv>5% of Psv | 2591 | 9.9 | | |
| Total | | | 40.7 | 26280 | 100 |

Table 4 $Pdkv_t$ and $Psv_t$

The prices in Western Denmark are different from the Norwegian prices in 50% of the hours, and from the Swedish prices in 41% of the hours. In both comparisons the Danish prices are to the low side of the Norwegian and Swedish prices.

| The distribution of Pdkv around Pty | | Hours | | Hours | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Pty-Pdkv>0 | Pty-Pdkv>5% of Pty | 8245 | 31.4 | 10026 | 38.2 |
| | 5% of Pty>Pty-Pdkv>1% of Pty | 1387 | 5.3 | | |
| | 1% of Pty>Pty-Pdkv>0 | 394 | 1.5 | | |
| Pty-Pdkv=0 | | | | 1 | 0.0 |
| Pdkv-Pty>0 | 1% of Pty>Pdkv-Pty>0 | 371 | 1.4 | 16253 | 61.8 |
| | 5% of Pty>Pdkv-Pty>1% of Pty | 1483 | 5.6 | | |
| | Pdkv-Pty>5% of Pty | 14399 | 54.8 | | |
| Total | | | 100.0 | 26280 | 100 |

Table 5 $Pdkv_t$ and $Pty_t$

Hence, there seems to be no evidence in favor of neither the hypothesis that the whole connected area can be considered one market operating all hours, nor the hypothesis that the Nordic part i.e. Sweden, South Norway and Western Denmark forms one market operating in most hours. A result which supports the findings of Haldrup and Nielsen (2004).

A comparison of the Swedish and South Norwegian prices is made in Table 6 and in 71% of the hours the two areas have the same price, while the prices are more than 5% apart in only 17% of the hours. In addition, the distribution of $Psv_t$ around $Pno_t$ is symmetric. This indicates that these two areas are much closer connected than the other areas.

| The distribution of Psv around Pno | | Hours | | Hours | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| | Pno-Psv>5% of Pno | 1869 | 7.1 | | |
| Pno-Psv>0 | 5% of Pno>Pno-Psv>1% of Pno | 817 | 3.1 | 3857 | 14.7 |
| | 1% of Pno>Pno-Psv>0 | 1171 | 4.5 | | |
| Pno-Psv=0 | | | | 18621 | 70.9 |
| | 1% of Pno>Psv-Pno>0 | 657 | 2.5 | | |
| Psv-Pno>0 | 5% of Pno>Psv-Pno>1% of Pno | 636 | 2.4 | 3802 | 14.5 |
| | Psv-Pno>5% of Pno | 2509 | 9.5 | | |
| Total | | | 29.1 | 26280 | 100 |

Table 6 $Psv_t$ and $Pno_t$

# 4 The strategy of Elsam

The question to be answered now is whether Elsam's strategy of having the price in Western Denmark being as close to the maximum price of the surrounding area as possible has been successful. In answering this question we will make the following assumption:

*Assumption: If Pdkv equals the price in a surrounding area, no congestion exists on the connection between West Denmark and that area.*

Obviously it may be discussed whether a small deviation from a price in a surrounding area implies congestion or no congestion, but the results will not differ significantly if less than a 1% deviation was taken to mean no congestion, as is seen from the tables above.

In Table 7 it is shown that $Pdkv_t$ is equal to the maximum of the prices in the surrounding areas in 8138 hours out of the total 26280 hours corresponding to 31%, and that the maximum price is more than 5% higher than the Danish price in 48.3% of the hours

| The distribution of Pdkv around maximum(Pno,Psv,Pty) | | Hours | | Hours | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| max price-Pdkv>0 | max price-Pdkv>5% of max price | 12689 | 48.3 | 16758 | 63.8 |
| | 5% of max price>max price-Pdkv>1% of max price | 3020 | 11.5 | | |
| | 1% of max price>max price-Pdkv>0 | 1049 | 4.0 | | |
| maxprice-Pdkv=0 | | | | 8138 | 31.0 |
| Pdkv-max price>0 | 1% of max price>Pdkv-max price>0 | 68 | 0.3 | 1384 | 5.3 |
| | 5% of max price>Pdkv-max price>1% of max price | 228 | 0.9 | | |
| | Pdkv-max price>5% of max price | 1088 | 4.1 | | |
| Total | | | 69.0 | 26280 | 100 |

Table 7. $Pdkv_t$ and $\max[Pno_t, Psv_t, Pty_t]$

The figures in Table 7 include the hours when the price between Western Denmark and the price in one of the other areas are the same, and where therefor the lines between the two areas are not congested by assumption.

This problem is solved in Table 8 where the rows indicate the number of hours where the absolute difference between the Norwegian, the Swedish or the German price to the Danish price is at its minimum but still positive difference. Hence, in 4329 hours the absolute price difference $\mid Pno_t - Pdkv_t \mid > 0$ was the smallest among the three price differences $\mid Pno_t - Pdkv_t \mid > 0$, $\mid Psv_t - Pdkv_t \mid > 0$ and $\mid Pty_t - Pdkv_t \mid > 0$. The columns indicate the number of hours $Pno_t$, $Psv_t$,or $Pty_t$ is the maximum price among the three prices. In order not to double count hours where the position as the maximum price is shared between two or three areas, the column indicating the number of hours where for instance $Pty_t$ is the maximum price, only counts the hours where $Pty_t \neq Pno_t$ or $Pty_t \neq Psv_t$.

| Number of hours | Pno max | Psv max | Pty max | Total |
|---|---|---|---|---|
| | | Psv NE Pno | Pty NE Pno, Psv | |
| **Abs(Pno-Pdkv)>0 min** | 3545 | 92 | 692 | 4329 |
| **Abs(Psv-Pdkv)>0 min** | 3984 | 143 | 886 | 5013 |
| **Abs(Pty-Pdkv)>0 min** | 2389 | 115 | 1603 | 4107 |
| **Total** | 9918 | 350 | 3181 | 13449 |

Table 8 Absolute positive price deviations and the max price

A test of the hypothesis of independence of the rows and columns of Table 8 can be performed by use of the test statistic

$$Q = \sum_{i=1}^{3} \sum_{j=1}^{3} \frac{[x_{ij} - x_{i\cdot}x_{\cdot j}/x_{\cdot\cdot}]^2}{x_{i\cdot}x_{\cdot j}/x_{\cdot\cdot}} \sim \chi_4^2, \qquad (1)$$

where $x_{ij}, i = 1, 2, 3; j = 1, 2, 3$ is the $(i, j)$ element, $x_{i\cdot}$ and $x_{\cdot j}$ are the row and column sums respectively, while $x_{\cdot\cdot}$is the total sum. Under the null of independence $Q$ is distributed as $\chi_4^2$. The value of the statistic is $Q = 795.97$ which gives a p-value of $1 - \text{ChiSquareDist}(795.97; 4) = 0.0$

Hence, the null hypothesis of independence is rejected at every conceivable choice of significance level. Another and possibly more appropriate test is the binomial test, where the null hypothesis is that Elsam is not able to get close to maximum price of the surrounding areas in more hours than would be expected by chance. Hence, under the null, the expected number of hours in the diagonal of Table 8 should be one third of the total number of hours. The test is based on the statistics

$$z = \frac{\widehat{\pi} - 1/3}{\sqrt{\frac{(1/3)(2/3)}{x_{..}}}} \sim N(0,1), \tag{2}$$

where $\widehat{\pi} = (3545 + 143 + 1603)/13449 = 0.393$. Hence

$$z = \frac{0.393 - 1/3}{\sqrt{\frac{(1/3)(2/3)}{13449}}} = 14.69, \tag{3}$$

which gives a p-value of $1 - \text{NormalDist}\,(14.69; 0, 1) = 0.0$. Hence, although rejection of the null does not imply that the alternative is true there seems to be evidences suggesting that Elsam is successful in pursuing its objective of having a price in Western Denmark close to the maximum price of the surrounding and connected areas.

Notice, that the tests presented above are biased in favour of the null as the hours where $Pdkv_t$ is equal to the maximum price are not counted as "success" hours for Elsam, but as hours where there is no congestion on the lines. However, as the null is clearly rejected the bias poses no problem for the results reported.

# 5 Conclusion

In this paper a test is made of whether Elsam partly or fully exploits its temporary dominant position in hours of congestion, and fulfill the company's publicly declared goal " to be as close to the highest price of the surrounding areas as possible". The null hypothesis is that they are not and such a hypothesis is very clear rejected. Hence, although rejection of the null does not imply that the alternative is true there seems to be evidences suggesting that Elsam is successful in pursuing its objective of having a price in Western Denmark close to the maximum price of the surrounding and connected areas.

The questions not answered in this paper are whether Elsam is able to create "congestion" and whether the actually do create congestion, and under which conditions their declared goal is optimal compared to a full exploitation of their temporary monopoly.

**Acknowledgement 1** *.An earlier version of the paper, written in Danish, was used by the Danish competition authorities in the merger case between Elsam and NESA in the Spring of 2004 , see Konkurrencestyrelsen (2004). The paper has been presented at the Tartu conference on Law and Economics, August 2004. Comments from the participants are gratefully acknowledged.*

# Notes

[1]See http://www.nordpool.com/information/index.html.

[2]For more in formation see the hompage of Elsam at ahttp://www.elsam.com/index.dsp?area=1004

[3]For more in formation see the hompage of ELTRA at http://www.eltra.dk/composite-11286.htm

[4]Some of the observations in the four price series, each with 26280 observations, are zero. It is assumed that the billing area is out of the market then and the value is replaced by the average of values 24 hours before and 24 hours after. If one of these values is zero the values 48 hours before and after are used etc. For $Pdkv_t$ 116 zeros were replaced, while 3 , 3, and 16 zeros were replaced in $Pno_t$, $Psv_t$, and $Pty_t$, respectively.

[5]In fact, the distributions of Norwegian and Swedish prices around the German prices are even wider and skewer than the distibution of the Danish prices around the German prices.

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