Consumer Welfare in the Deregulated Swedish Electricity Market

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Abstract

The deregulation of the Swedish electricity market in 1996 affected both the market design and the pricing of electricity. Since 1996, the electricity price faced by consumers has increased dramatically. Due to the high electricity price and large company profits, a debate about the success of the deregulation has emerged. As such, the aim of this paper is to investigate whether or not the deregulation of the Swedish electricity market has improved consumers' welfare. The theoretical framework is an equivalent variation method and the analysis is performed using monthly data for the period January 1996 to January 2007. The results indicate that deregulation has kept the power price (excluding taxes) down and increased consumer welfare in Sweden.

Keywords: Equivalent variation, Consumer welfare, Power market.
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1 – Introduction

High electricity prices in Sweden have sparked a debate among policy-makers and politicians. Consumers have seen their electricity bills increase while power generators have earned significantly higher profits. The public debate is often steered by the media, which portrays the electricity market deregulation as the cause of high consumer prices and large producer profits. The media often emphasizes that deregulation has lowered consumers' well-being, despite the fact that the objective was the opposite. The purpose of this paper is to analyze the effects on consumer welfare caused by the deregulation of the Swedish electricity market.

Sweden deregulated its electricity market in 1996. Power production and retailing were opened up to competition, while transmission remained regulated.[1] The rationale for deregulation is to develop a more a competitive market which should lead to a more efficient use of resources. Efficiency gains should imply a lower electricity price (Bergman et al, 1994). The fact that the opposite appears to have happened does not necessarily imply that deregulation has failed; instead, the increase in consumer prices may be misleading. The price of power together with transmission costs and taxes are the components that sum to the electricity price consumers face. A review of the price development shows that taxes have gone up by more then 200 percent since 1996 while transmission costs have remained almost constant in real terms. Furthermore, environmental fees have been introduced during this period.[2] In summary, factors other than the deregulation of the market may have caused the electricity price increases for consumers.

In this paper, I analyze how the deregulation of the Swedish electricity market has affected the power price and how this, in turn, has affected consumers' welfare. The approach adopted in previous studies has been to look at the consumer welfare in terms of consumer prices (e.g. Damsgaard and Green, 2005). This study uses the Swedish area price at the Nord Pool spot market in order to isolate the effect of the deregulation on

[1] The transmission cost is the aggregated costs of transmission and distribution.
[2] The electricity taxes discussed are taxes on households and the commercial sector. The electricity taxes on industry have had a less rapid growth. Since 1 May 2003 a system of green certificates is in operation in Sweden to encourage investment in environmentally friendly power production. The CO_2 allowance market introduced in 2005 was a European Union initiative and therefore the potential impact on electricity prices is not a result of Swedish deregulation.

electricity prices per se, apart from exogenous increases in taxes or the introduction of green certificates.[3]

To answer the question of how deregulation has affected consumers' welfare through shifts in the power price, the actual price after the deregulation is compared to a hypothetical price path in absence of the deregulation. This alternative and hypothetical price path is based on the regulation guiding the Swedish power prices before 1996. The difference between the alternative price and the prevailing Swedish price is then used to calculate the effects on consumer welfare, making it possible to quantify the effects on consumer welfare from changes in the power price while excluding the impact of tax increases and other governmental interventions such as the effects of introducing green certificates.

Worldwide deregulation in the electricity sectors began in the late seventies. In 1978, Chile started to liberalize its electricity market introducing a wholesale market pool in which generators would sell their power to retailers. In 1982, the liberalization was expanded when large end-users were allowed to choose their retailer and negotiate prices. Deregulation of European electricity markets started in England and Wales (E&W) in 1990, when the industry was privatized, and competition between generators was introduced. The E&W deregulation was followed by the deregulation of the Norwegian market in 1991. Throughout the 1990's deregulation continued and today most of the OECD-countries have to some extent liberalized their electricity markets (Al-Sunaidy and Green, 2006). Sweden deregulated its electricity market in 1996 and joined Norway in the first international electricity market, Nord Pool, the same year. In recent years Nord Pool has expanded to also include Finland (1998) and Denmark (2000).[4]

Newbery and Pollitt (1997), Green and McDaniel (1998) and Domah and Pollitt (2001) discuss the welfare effects of the E&W deregulation. Newbery and Pollitt (1997) analyze the privatization of the Central Electricity Generation Board (CEGB), the owner of the generation facilities and the high-voltage net, and conclude that the welfare effects of the privatization will depend on the corporation tax level and the time span until prices have reverted to the pre-deregulated level. Domah and Pollitt (2001) analyze the

[3] It may be that deregulation has generated some spill over effects to the regulated parts of the market. Damsgaard and Green (2005) assumed that transmission costs fell one percent per year after 1996 due to the deregulation. According to Damsgaard and Green, low profits in generation in the late 1990s forced the vertically integrated companies to cut costs in distribution. Excluding these potential spill over effects will, if they exist, result in an underestimation of potential consumer welfare gains.

[4] In 2005 part of Germany was included to Nord Pool when the KONTEK bidding area opened.

effects of the privatization of twelve regional electricity companies and find that the privatization yielded significant net social benefits. However, they conclude that the benefits of the privatization were unevenly distributed, both across time and between groups in society. The deregulation in 1990 did not allow all electricity consumers to choose their electricity supplier, so it was not until 1998 that the E&W market was opened up to full competition. Green and McDaniel (1998) use Cost-Benefit analysis (CBA) to analyze the social welfare effects of the 1998 E&W restructuring. Green and McDaniel (1998) argue that consumer prices will fall, and that electricity suppliers will face high additional transactions costs in the first five years after the restructuring. Based on lower prices and additional transactions costs their main scenario shows that consumers will gain while producers will lose. Producers will lose more than consumers gain so their results indicate a social welfare loss due to the restructuring. However, the welfare loss could be converted into a surplus if competition forces the companies to make further cost savings which would be larger than the transactions costs involved.

Bowitz et al (2000) and Damsgaard and Green (2005) discuss the welfare effects of the Swedish deregulation. Damsgaard and Green (2005) study the effect of the Swedish deregulation using CBA. They build counterfactual scenarios based on how they believe the electricity price and international trade with electricity would have evolved without deregulation. They then compare the counterfactual scenarios to the actual result. Their analysis focuses on the electricity price end customers face by splitting customers into three categories: households, commercial and industry. The result in their main scenario shows that Sweden has benefitted from deregulation by a total of 10.9 billion SEK[5] up to 2004. Finally, Bowitz et al (2000) analyze the combined effect of the deregulations in Norway, Sweden and Finland. Bowitz et al (2000) conclude that until 1999 deregulation had a negative welfare effect. They found that lower average prices in the prevailing situation led to a positive consumer surplus but a negative producer surplus, which resulted in an annual net surplus of 1.5 billion NOK[6]. However, the reason for the negative overall welfare effect was an environmental dimension that assumed that the pollution costs were higher than the positive net value of consumer and producer surplus.

The rest of this paper is organized as follows. Section 2 discusses the theoretical method, section 3 describes the data and discusses the empirical

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[5] 1 SEK equals approximately 0.125 USD.
[6] 1 NOK equals approximately 0.15 USD.

model. Section 4 contains results and section 5 includes discussion and conclusions.

2 – Method

This paper studies the change in consumer welfare due to the deregulation of the Swedish electricity market using an equivalent variation (EV) approach. The difficulty with the EV approach is to find the direct or indirect utility function in order to calculate the EV. Two alternative solutions to this problem have been used in the literature. The first approach starts with specifying the direct or the indirect utility function and then derives the observable demand functions by maximizing the direct utility function subject to a budget constraint or by integrating the indirect utility function using Roy's identity. The second approach uses the observable Marshallian demand to specify the required demand systems. The second approach is econometrically preferable, as it will generate demand functions that fit the data well (Hausman, 1981). In this paper, the latter approach is used. We specify a linear Marshallian demand function for electricity based on model fit and earlier literature (e.g. Johnsen (1998), Hjalmarsson (2000) and Steen (2003)). The demand function is represented by

$$x = \beta p + \gamma y + \delta_i k, \quad i = 1,...,N, \tag{1}$$

where p is the power price, y income and k a vector containing variables that affect electricity demand. Since the interest is on the demand for electricity, an incomplete demand model for electricity is specified. A composite good is specified using the consumer price index (CPI). The power price and income are deflated using the CPI, meaning that the composite good disappears from the equation. This procedure results in a demand function that is zero degree homogeneous in price and income, and the corresponding quasi-indirect utility function and quasi-expenditure function will be exact welfare measures if they fulfil the integrability conditions (Hausman, 1981). Using expenditure functions it is possible to specify the EV measure and, if we consider a price change from p^0 to p^1, the EV measure can be written

$$EV = e\left(p^0, u^1\right) - e\left(p^1, u^1\right), \tag{2}$$

which can be used to quantify the effects on consumer welfare. Hausman (1981) showed that under these conditions all that is needed to establish the exact measure of welfare changes is knowledge of the Marshallian demand function. Following Hausman (1981) starting with equation (1) and using Roy's identity gives

$$x = \beta p + \gamma y + \delta_i k = -\frac{\partial v(p,y)/\partial p}{\partial v(p,y)/\partial y}, \tag{3}$$

which is a linear partial differential equation. In order to make welfare comparisons we need to stay on a given indifference curve, independent of the price level. This is secured by using the equation $v(p(t), y(t)) = u^1$ where u^1 is the utility level in the equivalent variation case. Differentiating $v(p(t), y(t))$ and setting it equal to zero will assure that we stay on the same indifference curve when the price changes, that is

$$\frac{\partial v(p(t), y(t))}{\partial p} * \frac{dp(t)}{dt} + \frac{\partial v(p(t), y(t))}{\partial y} * \frac{dy(t)}{dt} = 0. \tag{4}$$

Rearranging equation (4), substituting into equation (3), and using the implicit function theorem gives an expression which expresses y as a function of p in an ordinary differential equation

$$\frac{dy(p)}{dp} = \beta p + \gamma y + \delta_i k. \tag{5}$$

Solving equation (5) gives the solution

$$y(p) = Ae^{\gamma p} - \frac{1}{\gamma}\left(\beta p + \frac{\beta}{\gamma} + \delta_i k\right), \tag{6}$$

where A is the constant of the integration that depends on the initial level of utility. If we choose $A = u^1$ as the cardinal utility index we can solve equation (6) for the quasi-indirect utility function associated with the incomplete demand system

$$v\left(p^{1}, y^{0}\right) = A = e^{-\gamma p}\left[y^{0} + \frac{1}{\gamma}\left(\beta p^{1} + \frac{\beta}{\gamma} + \delta_{i} k\right)\right]. \tag{7}$$

Inverting equation (7) gives the quasi-expenditure function

$$e\left(p^{1}, u^{1}\right) = e^{\gamma p} u^{1} - \frac{1}{\gamma}\left(\beta p^{1} + \frac{\beta}{\gamma} + \delta_{i} k\right). \tag{8}$$

Before measuring the equivalent variation the integrability conditions should be checked to verify that the derived Marshallian demand function has its origin in a utility function. LaFrance and Hanemann (1989) derived the necessary restrictions to obtain exact welfare measures from an incomplete demand model. They showed that by augmenting the incomplete demand system with a composite commodity representing total expenditure on all other goods, it is possible to proceed as if the augmented system was complete. That is, for the demand function in equation (1) to be weakly integrable, equation (7) has to be continuous and homogeneous of degree zero in prices and income. Equation (7) also has to be decreasing in price and increasing in income, $\beta \leq 0$ and $\gamma \geq 0$. Finally, for equation (1) to be weakly integrable, the Slutsky substitution terms $s_{ij} = \partial x_i / \partial p_j + (\partial x_i / \partial y) * x_j$ have to be symmetric and negative semidefinite (LaFrance and Hanemann, 1989).

When the integrability conditions are fulfilled it is straight forward to calculate the equivalent variation. Using equation (2) and (8) we find that in the case of a price change from p^0 to p^1, the EV-measure can be written

$$EV = e^{\gamma\left(p^{0}-p^{1}\right)}\left[y^{0} + \frac{1}{\gamma}\left(\beta p^{1} + \frac{\beta}{\gamma} + \delta_{i} k\right)\right] - \frac{1}{\gamma}\left(\beta p^{0} + \frac{\beta}{\gamma} + \delta_{i} k\right) - y^{0}, \tag{9}$$

where $\gamma > 0$ indicates a positive income effect.

3 - Data and empirical model

3.1 Data

The data used in this paper covers the period January 1996 to January 2007. The variable description and descriptive statistics are displayed in Table 1.

Table 1 Variables, descriptive statistics, definition and data sources.

Variable	Mean*	Description
Price	221.73 (106.91)	Swedish area price. SEK/MWh Source: Nord Pool ASA
Consumption	1.34E+ 07 (2.01E+06)	Electricity consumption in Sweden in MWh (including export and import). Source: Swedish Energy Agency
Industrial production	0.99 (0.13)	Swedish industrial production index, SNI C-E. Source: Statistics Sweden
Temperature	7.04 (7.32)	Average temperature in Sweden. Weighted average using average temperature (in C°) from Malmö, Stockholm, Östersund, Umeå and Luleå. Source: SMHI
Length of day	12.34 (3.85)	Number of hours the sun is above the horizon in Gothenburg, Sweden. Source: www.stjarnhimlen.se
Inflow	5747718 (4399223)	Inflow to the water reservoirs, recalculated into MWh. Source: Nord Pool ASA.
Consumer Price Index	1.02 (0.003)	Index of the consumer prices in Sweden. Source: Statistics Sweden.
Income	1.9E+ 11 (1.78E+ 10)	Gross Domestic Product in SEK. Source: Statistics Sweden.

*Standard error in parenthesis

All variables except income are monthly observations and in real terms. Income is measured with real GDP which is not available on a monthly basis. To get monthly observations on income, GDP is interpolated from yearly observations.

3.2 The demand model

The variables in the demand model are the power price, income, temperature, length of day, and industrial production. The price that is used is the Swedish area price at the Nord Pool spot market, which is the price that the Swedish retailers face when buying power at Nord Pool.[7] The Nord Pool spot price is the foundation for the prices the Swedish consumers face.[8] Due to mark ups, green certificates and taxes, the correlation between the spot price and the retail prices is not perfect. However, calculating the correlation between the spot price and contract types for small and medium large consumers shows that the correlation between the spot price and the retail prices is high. For the flexible price contracts that retailers offer to costumers, a type of contract that has become increasingly more common each year, the correlation is as high as 99 percent. The average correlation between the spot price and the observable types of contracts is 0.68.[9] Correlation for large consumers (large industries) are not publically available but are generally believed to be at least as high.[10]

In order to deal with the apparent endogenity problem when estimating a demand model including both prices and quantities, we rely on an instrumental variable approach. In this study, the power price is instrumented using inflow to the water reservoirs, temperature and the lagged power price as instruments. We estimate the demand model with OLS, using standard errors corrected for autocorrelation and heteroscedaticity. Income measures the purchasing power of the consumers and higher income is expected to increase the demand for electricity. Temperature is measured in degrees

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[7] The spot price is important not just as the price at Nord Pool but also as a reference price for bilateral and financial contracts.

[8] Comparing the retail market in Sweden to the power market, the Nord Pool market, these markets are quite similar in terms of market structure, with the four largest firms covering over 50 percent of the market and over 100 other, small firms active in the market.

[9] The observable types of contracts are one, two, and three year contracts, flexible price contracts and standard price contracts. The correlation between Nord Pool spot price and the observable contracts are: one year 0.75, two year 0.69, three year 0.65, flexible price 0.99 and standard price contract 0.62.

[10] Large consumers often negotiate their contracts bilaterally and therefore prices are not public. Large customers often have contracts with variable prices, but the contracts are secured by hedging. An alternative is fixed price contracts with an option to re-sell electricity if the electricity is not consumed. Both of these contract types imply that the Nord Pool spot price is the relevant reference price and that that the correlation between the large customer contracts and the Nord Pool spot price should be at least as high as the correlation for the small and medium large costumers contracts.

Celsius and is used as a proxy for electricity demand for heating purposes. The climate in Sweden leads to a reverse electricity demand which, peaks in the winter (for heating use) rather then in the summer (for air conditioning use). Length of day is a proxy used to measure the demand for electricity for lighting. The winter days are shorter resulting in higher demand for electricity for lighting than in summer. The industrial production variable is used to measure the industry demand for electricity; a positive correlation between industry production and the demand for electricity is expected. Finally, monthly dummy variables are incorporated to account for any additional seasonality in electricity demand.

3.3 Alternative price

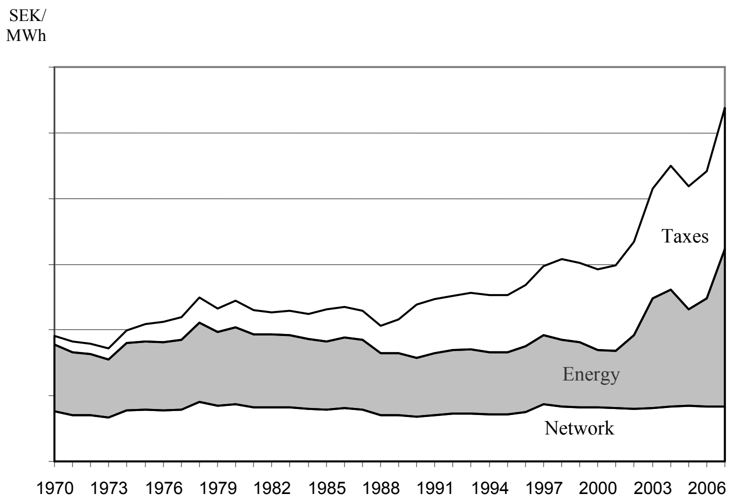
To construct the alternative price path it is important to understand how the pre-deregulated price was determined. Before deregulation, the electricity market was divided in two parts based on customer characteristics: a high and low voltage market. The high voltage market was a market for generators, large industries and retail distributors, while the low voltage market was a market for retail distributors and their consumers (Bergman et al, 1994). In addition to these markets there was a market for temporary energy exchange for generators. This market worked like an "electric power pool" and was characterized by extensive cooperation and information exchange between the participants. Generators with a shortage (surplus) of power could buy (sell) power from the "power pool". The exchange price was based on the so called split-savings principle, a method where the price was determined by the average of the buying firms' marginal cost and the selling firms' marginal cost (Hjalmarsson, 1993).

Before deregulation, the electricity market was characterized by local and regional monopolies in both generation and distribution. There was no competition between generators or between distributors (SPK 1989:8). The high voltage market, where the state owned company Vattenfall was the dominating actor with 50 percent of the generation capacity, was not directly regulated. Pricing was, however, indirectly regulated through state-ownership of Vattenfall and the formal objective of Vattenfall to break even subject to a required return.[11] This established Vattenfall as the price leader and also worked to set a price ceiling. The generators' collaboration in the "power pool" resulted in a price floor which also prevented further entry to the market

[11] The required return was equal to the depreciation on replacement values and a rate of interest on loans from the government at the bond rate level.

(Bergman et al, 1994). The pricing in the high voltage market was conducted through high voltage tariffs consisting of four elements: a fixed fee, a contractual demand charge, a peak load charge and an energy charge (SPK, 1989:8). The energy and the peak load charge were priced by marginal cost while the contractual charge and the fixed charge were determined by the rate of return constraint. The four elements of the high voltage tariff can be aggregated into three variables: transmission, energy and a fixed fee. In turn, the fixed fee and transmission are variables describing the network costs. In reality, network costs have been constant in real terms (see Figure 1). This leaves the energy part of the market as the remaining variable to explain changes in prices in the high voltage market.

Figure 1 Price decomposition, 1970-2006.



The split-saving principle used in the "power pool" before deregulation imply that the price on power could be described as an average cost of production. Damsgaard and Green (2005) also argue that the required rate of return restriction on state- and municipality-owned generators makes average cost pricing a reasonable approximation of the pricing principle on the high voltage market before deregulation. In this paper, average cost of electricity production is measured by the producer price index (PPI) for electricity production, and since the pricing principle in the regulated market was approximately equal to average cost pricing, the PPI for electricity production will be used to derive the alternative price path if the market had not been deregulated. To convert the PPI from index form to a price path, the

January 1996 power price will be used as the base. That is, the January 1996 power price is multiplied with the PPI for each month to get a price path that shows what the power price would have been without the deregulation. However, a requirement for the prevailing PPI to work as an alternative price path is that the production structure has not changed significantly during the years under study. Table 2 shows the production structure before and after the deregulation, and it shows that the production structure has remained relatively constant during these years.

Table 2 Electricity production in Sweden 1990-2006, proportions.

Year	Hydro	Nuclear	Wind	Other*	Net import**
1990	0.51	0.465	0	0.036	-0.011
1991	0.439	0.518	0	0.047	-0.004
1992	0.522	0.436	0	0.053	-0.011
1993	0.522	0.421	0	0.062	-0.006
1994	0.417	0.506	0	0.070	0.007
1995	0.474	0.472	0	0.063	-0.009
1996	0.358	0.502	0.001	0.095	0.044
1997	0.480	0.470	0.001	0.067	-0.018
1998	0.511	0.492	0.002	0.069	-0.074
1999	0.492	0.491	0.003	0.067	-0.051
2000	0.532	0.373	0.003	0.059	0.033
2001	0.521	0.460	0.003	0.064	-0.048
2002	0.446	0.441	0.004	0.075	0.034
2003	0.364	0.450	0.004	0.093	0.089
2004	0.406	0.512	0.006	0.090	-0.014
2005	0.489	0.472	0.006	0.083	-0.050
2006	0.419	0.445	0.007	0.089	0.041

Source: Swedish Energy Agency.
*Include Industrial back-pressure power, Combined heat and power, Cold condensing power and Gas turbines.
**Positive sign equals net import, negative sign net export.

Before 1996, hydro and nuclear power represented on average 90-95 percent of the generation. This has not changed after the deregulation. Note, however, that the year 1996 was a dry year with relatively little precipitation resulting in limited hydro power production, while the year 2000 was a wet year with relatively high precipitation and hydro power production. In addition, the year 2003 was a very dry year with all time low levels in the water reservoirs.[12] As such, hydro power production has varied depending on the precipitation, but this does not imply a change in the production structure. In other words, reduced precipitation leads to increased nuclear power production both before and after deregulation.[13]

3.4 Empirical EV-measure

To compute the effects of the deregulation on consumer welfare, the alternative price is set against the prevailing Swedish area price from the deregulated period. The estimated parameters from the demand function are used together with the alternative price in equation (10) to calculate the effects on consumer welfare.

$$EV = e^{\gamma\left(p^0 - p^{alt}\right)}\left[y^0 + \frac{1}{\gamma}\left(\beta p^{alt} + \frac{\beta}{\gamma} + \delta_1 temp + \sum_{j=2}^{12} \delta_j dummy\right)\right] - \frac{1}{\gamma}\left(\beta p^0 + \frac{\beta}{\gamma} + \delta_1 temp + \sum_{j=2}^{12} \delta_j dummy\right) - y^0. \tag{10}$$

The EV measure is calculated for each month in the sample and then aggregated over the whole period.

4 – Results

4.1 The demand model

The estimation is performed using a general to specific model approach, where variables whose parameters are not statistically significant

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[12] The precipitation pattern is reflected in the power price. Low reservoir levels in 1996 and 2003, resulted in higher power prices since more expensive production sources were used to meet demand. The higher prices in 2003 compared to 1996 may have been a result of the more expensive energy sources in Denmark. The even higher prices during 2005 and 2006 may have been caused by the introduction of the European market for CO_2 allowances.

[13] Net import of electricity (see Table 2) has also increased since deregulation. In this study the net import of electricity, which is four percent of market supply on average, will not be taken into account.

are removed from the model. The estimation result for the demand model is presented in Table 3.

Table 3 Estimation results of the demand function.

Variables	Coefficient	Standard Error
Constant	11137500*	1.72E+ 06
Price	-2819.31*	830.94
Temperature	-167487*	21172.2
Income	2.97E- 05*	9.40E- 06
dFebruary	-1450700*	127758
dMarch	-525577*	173577
dApril	-1798210*	242534
dMay	-1939190*	329989
dJune	-2752610*	414270
dJuly	-2286160*	464204
dAugust	-1983420*	454200
dSeptember	-2190730*	363932
dOctober	-1186670*	262745
dNovember	-1073020*	184964
dDecember	-388686*	124894
R^2 = 0.97		
Adjusted R^2 = 0.96		
N= 132		
SBIC= 1920.77		
Log-Likelihood= -1881.71		
Ljung-Box Q-statistics	Statistic	Critical value
Q(1)	1.00	3.84
Q(2)	2.03	5.99
Q(4)	2.12	9.49
Q(8)	10.00	15.51
Q(12)	12.50	21.03

* Significant at the 1 % level

All coefficients have the expected signs. The price has a negative sign meaning that a higher price reduces electricity demand. Increased income increases the demand for electricity. Warmer temperatures lead to reduced demand for electricity for heating. Length of day should intuitively have the same sign as temperature: the longer the day the less electricity required for lightning. However, we remove this variable from the demand model due to a high correlation with temperature (83 percent), causing multicollinearity problems. In addition, industrial production is not significant and is therefore excluded from the final demand model. To account for seasonal effects, monthly dummy variables for all months except January are used. The resulting negative signs tell us that the electricity demand is highest in January and lowest in the summer. The long run elasticity of demand for power is calculated and equals -0.047, which is in line with previous studies.[14] Finally, the results from the estimation of the demand model show that all integrability conditions are fulfilled. The Slutsky substitution terms are negative definite, the income parameter is positive and the price parameter is negative.

4.2 Welfare effects

To measure the effects on consumer welfare, the prevailing Swedish area price is compared to the alternative price path described in section 3.3. The resulting monthly EV-measures are discounted back to 1996 using a discount rate of 5 percent and then added together. The aggregated EV measure tells us that the deregulation has been advantageous for electricity consumers in Sweden. In total, consumer welfare has increased by 4 billion SEK in 1996 prices over the period studied.[15] The reason for this result is that while the price path under deregulation has been volatile with both dips and peaks, the alternative price has been more stable but at a higher price level (see Figure 2[16]).

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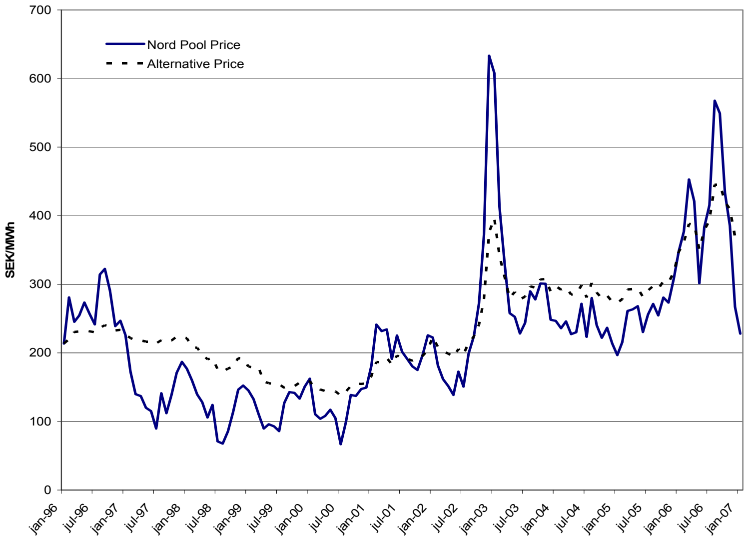
[14] For an extensive discussion about the elasticity of demand for electricity, see Nilsson and Pettersson, (2008).

[15] Discounting the EV-measure to 2007 does not qualitatively alter the results. The results drop from 4 billion SEK to 3.8 billion SEK.

[16] The underlying data used in the calculations are available from the author on request.

Figure 2 Price comparison, 1996-2007.



The less volatile alternative price path is due to differences in the pricing methods. The deregulated price is more volatile because the price is determined by supply and demand in a competitive environment, and set equal to the cost of the marginal unit of energy necessary to meet demand, while the pre-deregulated price was based on the average cost of production in the different generation facilities.[17] The average cost based price does not fluctuate as much as the marginal unit based price because a sudden demand increase (decrease) – and the subsequent price jump (dip) – is averaged out by the other facilities. In the deregulated case, a sudden demand increase will allow those generation facilities with a marginal cost lower than the marginal facility, to increase their profits. To consider the possibility that the alternative price path calculated using the PPI starts from an incorrect level, for example due to 1996 being a dry year, a sensitivity analysis is performed. The PPI is reconstructed to start both from a price level 5 percent below and 5 percent above the base scenario. The sensitivity analysis shows that a 5 percent lower initial price will lower the increase in consumer welfare from 4 billion SEK to

[17] The competitiveness of the Nord Pool market has been studied by Hjalmarsson (2000) and Bask et al. (2009). Both studies show that the Nord Pool spot price has been very close to the marginal cost of production after the deregulation.

653 million SEK, and that a 5 percent increase in the start level will improve the welfare effect to 7.3 billion SEK. However, note that the welfare effects are positive in the sensitivity analysis as well, indicating that the positive welfare effect calculated in the base scenario is quite robust to changes in the initial price level.

Comparing the results from this study to earlier studies of the deregulation of the Swedish electricity market (e.g. Damsgaard and Green, 2005 and Bowitz et al., 2000) reveals that these studies also found that the deregulation increased consumer welfare. The studies are made using different approaches and different datasets, although the results are qualitatively the same. This gives further support to the results presented in this paper.

It might be interesting to set the increase in consumer welfare in perspective. An increase in consumer welfare of 4 billion SEK is a lot of money, but spread over the 11 years of deregulation covered in this paper, and the approximately 9 million consumers (households, commercials and industry), the consumer welfare gains equal less then 100 SEK per consumer per year. The average electricity use per capita in Sweden in 2003 was approximately 16.000 kWh (Statistics Sweden). Given an average Swedish power price of 0.22 SEK/kWh, the cost for power per capita would be approximately 3.500 SEK per year, indicating a welfare gain just below three percent. In this context the magnitude of consumer welfare gain from deregulation may appear small, but the results are consistent with previous studies: deregulation has benefitted the typical Swedish electricity consumer.

5 - Conclusion

The purpose of this paper is to calculate the effects on consumer welfare due to the deregulation of the Swedish electricity market in 1996. The analysis is performed using an equivalent variation method and an alternative price path based on how the power price was set before the deregulation. When this alternative price path is compared to the prevailing Swedish area price it is clear that the deregulated price – a price based on marginal cost pricing – has been lower, on average, during the studied period, leading to an increase in consumer welfare. The results from the base scenario in this paper show that the deregulation has increased consumer welfare by 4 billion SEK. Sensitivity analysis using alternative scenarios reinforces the conclusion that the deregulation has increased consumer welfare. Set into perspective, the welfare gains from deregulation is not that impressive, less than 100 SEK per consumer per year. However the deregulation effects are positive and the consumer welfare has improved.

The results from this study can be compared to previous studies of the welfare effects of the deregulation of the Swedish electricity market. Bowitz et al (2000) found that the Nordic deregulation had increased consumer welfare by 5.6 billion NOK[18] per year between the period 1996 to 1999. Disaggregation indicates that the Swedish consumers gained 1.3 billion NOK per year after the deregulation. If this trend is extrapolated until 2006, this equals a welfare gain for consumers of 14.3 billion NOK. It should, however, be noted that extrapolating probably overestimates the welfare effects. This is because the Nord Pool price has been very high during 2003 and 2006, and high prices will decrease the welfare gain from the deregulation. Damsgaard and Green (2005) calculate several different scenarios, all showing positive effects of the deregulation. Their main scenario estimates welfare gains for all electricity consumers to be 4.2 billion SEK in total for the period 1996 to 2004. It should be noted that Damsgaard and Green (2005) use the electricity price faced by consumers, including taxes and environmental fees, while this paper uses the Swedish power price on Nord Pool. In this paper, the market effects of the deregulation have thus been separated from the political decisions that affect the price of electricity. Using this approach, it is clear that the increased price of electricity for consumers after 1996 is not due to the deregulation as such, but rather due to political decisions to increase energy taxes and to introduce green certificates.

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[18] 1 NOK equals approximately 1.2 SEK

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