The Price of Power

A quantitative study of price elasticity of demand during high electricity prices in Southern Sweden

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Abstract:

Unprecedentedly high electricity prices became a pressing issue for consumers in 2021-2022, causing political debate and shedding light on the hourly electricity prices. Out of the four Swedish electricity areas created to facilitate an effective electricity market, this thesis will focus on SE3 and SE4 in the South of Sweden, which experienced the highest prices in 2021-2022. The relatively low-price period of 2019-2020 is compared to the relatively high-price period of 2021-2022 in order to capture potential effects of persistent high prices on price elasticity of demand in the medium- to long-run. An ordinary least squares method was firstly used, estimating positive elasticities not in line with economic theory. Using a two-stage least squares method, with wind speed as an instrument variable for the day-ahead electricity spot price, the price elasticity of demand estimates are higher in 2019-2020 compared to 2021-2022, with a decrease in price elasticity between 41 and 51 percent. Results also show regional variability, with SE4 having a consistently higher price elasticity and showing greater reduction in elasticity in the second period compared to SE3. The results indicate a negative effect of persistent high prices on medium- to long-run price elasticity of demand, with some regional variability. Less medium- to long-term adjustments in relation to new price levels and factors relating to expected economic compensation are discussed as possible reasons for the overall decreasing effect of high electricity prices. Regional differences in price levels are discussed as a factor influencing regional variability in the results.

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1. Introduction

At the end of 2021, global energy markets experienced a major crisis when a number of different factors resulted in a dramatic increase of the price of energy. Firstly, the supply of energy was decreased in 2021 due to factors such as economic recovery from the COVID-19 pandemic, reduced investments in the gas and oil industry, maintenance delays due to the COVID-19 pandemic and disadvantageous weather (International Energy Agency, n.d). Secondly, the subsequent war in Ukraine decreased the energy supply further, especially in Europe, as less Russian gas was exported (International Energy Agency, n.d).

Due to its interconnectedness with the European electricity grid, the Swedish electricity market was also affected by the supply shock (The Swedish Energy Markets Inspectorate, 2022). The Swedish electricity market is divided into four bidding areas; SE1, SE2, SE3 and SE4 (see Figure 1 in section 2.1), whose function being primarily to harmonize the electricity market and to govern production and consumption in the market (Svenska kraftnät, 2022). Electricity prices increased in all Swedish bidding areas in the second half of 2021, with the largest increase occurring in SE3 and SE4 in southern Sweden (Statistics Sweden, 2022). The increased price level persisted during 2022, and returned to lower price levels in 2023 (Svenska kraftnät, 2023a).

The dramatic increase in prices resulted in major public discussion regarding effects on consumers and the economy, including relating high electricity prices to increasing prices of other goods. The effects of the increase were deemed severe enough to motivate retroactive governmental compensation for costly electricity bills (The Government Offices of Sweden, 2022). Furthermore, as a result of the high price levels, hourly price agreement became more popular in the Swedish electricity market in 2022 (Sveriges Television, 2022a).

In a Swedish context, estimates of price elasticity have been made in previous research both for periods of several years and shorter periods of a few months. Vesterberg (2017), Stenman and Dimov (2021) and Eriksson Lind and Heikurainen (2022) are all examples of relatively recent studies estimating price elasticity of electricity demand over a time period of several years, all find evidence of inelastic electricity demand in Sweden. Eliasson (2022) finds similar evidence for inelastic demand when investigating a time period of six months, also exemplifying research into price elasticity during persistent high electricity prices.

Even though there are several previous studies regarding price elasticity of electricity demand, there is a lack of research on the effect of persistently high prices on price elasticities over a longer time frame than short-run both in Sweden and internationally. Using the definition of medium- to long-run price elasticity presented by Borenstein (2009) defining it as a two-year period, this thesis aims to contribute to filling this research gap. The full period of interest, 2019-2022, will therefore be split up into two two-year periods, 2019-2020 and 2021-2022, in order to capture possible effects of persistent high electricity prices. Since SE3 and SE4 experienced the most dramatic price increases in 2021-2022 out of the Swedish bidding areas, their price elasticity of demand is studied. The study will focus on consumers without balancing responsibility since consumers with such responsibility have an obligation to regulate their electricity usage to balance consumption in the region (Svenska kraftnät, 2023b). Both ordinary least squares and two-stage least squares will be used to estimate the price elasticity of demand, the latter using wind speed as an instrument variable for day-ahead electricity spot prices because of endogeneity issues.

The investigated question is formulated as such:

How is medium- to long-run price elasticity of electricity demand affected by persistent high electricity prices?

This research question will be answered through the two following subquestions:

Is the price elasticity of electricity demand different in a period of lower prices, 2019-2020, compared to a period of higher prices, 2021-2022?

Are there differences in price elasticity of electricity demand in SE3 versus SE4 during investigated time periods?

The rest of the thesis is organized into seven sections. Section two will discuss relevant background information in the context of the Swedish electricity market followed by sections three describing and discussing relevant theoretical framework. In section 4, the findings of previous research is presented and discussed. Section five will present the method and data used in this thesis, section six following with a presentation of the found results. A discussion of the found results will follow in section seven and relevant conclusions are drawn in section eight.

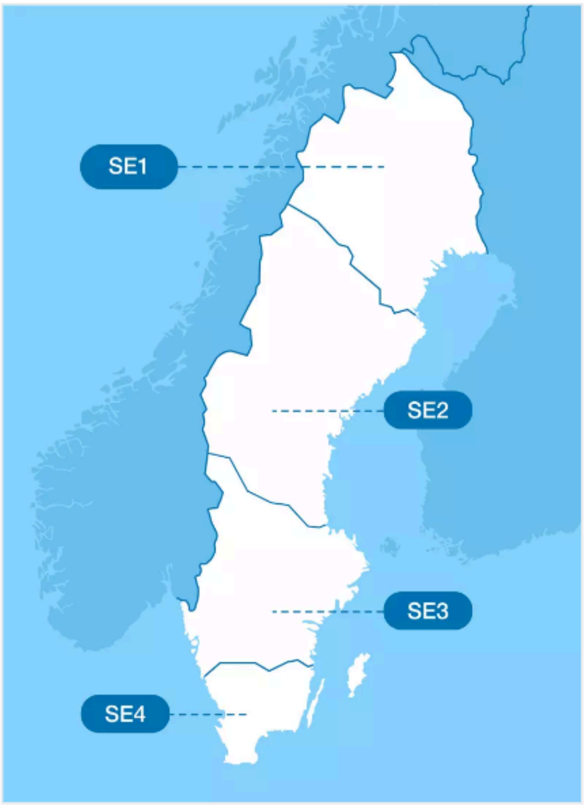
2. Background

This section will present relevant background information in the context of the Swedish electricity market.

2.1 The Swedish energy market

Across the four bidding areas in Sweden; SE1, SE2, SE3 and SE4, there are different levels of supply and demand for electricity (Svenska kraftnät, 2022). The bidding areas are displayed in Figure 1 below, with SE1 in the north and SE4 in the south of Sweden. Transportation of electricity longer distances is limited, due to limitations of the power lines in transporting the large amounts of electricity that is required (ibid). Furthermore, the Swedish power system is configured to transport electricity from the North of Sweden to the South, but the amount of transmission can vary (Svenska kraftnät, 2020). Some areas are especially at risk to be overloaded, referred to as *bottlenecks*, areas where demand could be higher than what is possible to safely transport (ibid). Furthermore, there is no constant capacity, instead it is affected by consumption, production and levels of export and import (ibid).

Figure 1: Bidding areas in Sweden (El.se, 2024)



2.1.1 Electricity supply in Sweden

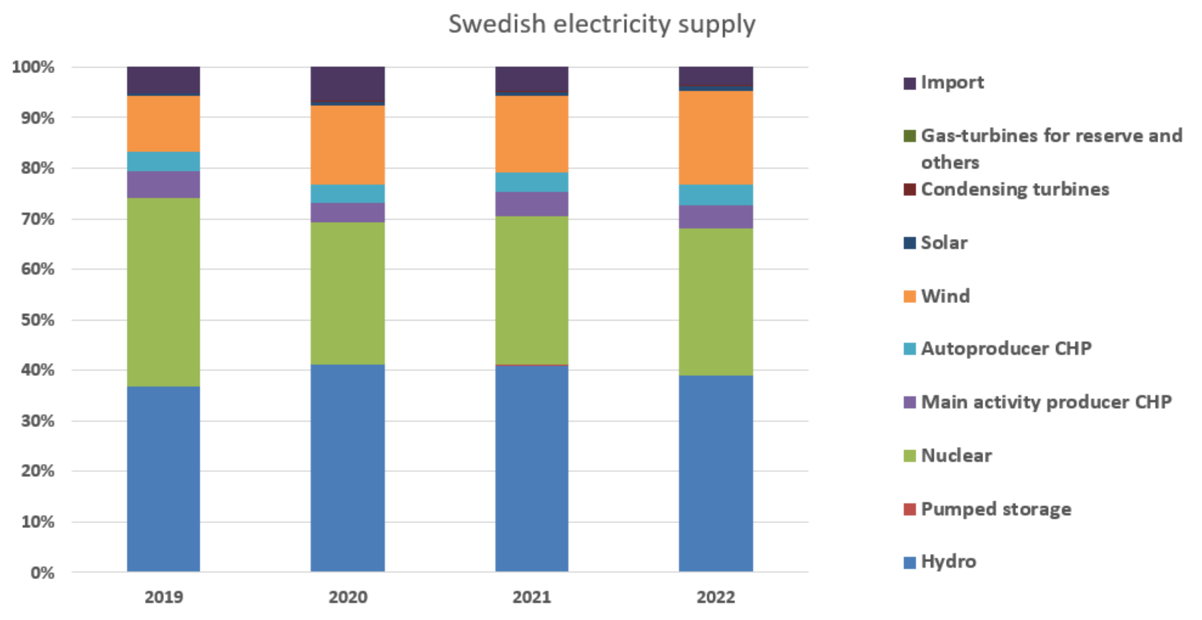
Electricity supply is a key factor when studying price levels in the electricity market. Being a net exporter of electricity (Swedenergy, 2023), the electricity supply in the Swedish electricity market is mostly domestically produced (Statistics Sweden, 2023b). As shown by Table 1, the total supply of electricity in the Swedish electricity market has increased between 2019 and 2022, the lowest electricity supply being in 2020 and the highest being in 2021 (Statistics Sweden, 2023b).

Table 1: Total supply in the Swedish electricity market (GWh) per year during the period of 2019-2022, using data from Statistics Sweden (2023b).

Total supply of electricity in the Swedish electricity market (GWh)				
Year	**2019**	**2020**	**2021**	**2022**
Total supply	177493	175644	180120	179323

There are several different power sources in the Swedish electricity production mix. As shown by Figure 2, the top three power sources in the Swedish electricity market are; hydro power, nuclear power and wind power (Statistics Sweden, 2023b). During the 2019-2022 period, domestic nuclear power generation decreased, while the domestic generation from wind power increased (Statistics Sweden, 2023b).

Figure 2: Swedish electricity supply 2019-2022 per power source, using data from Statistics Sweden (2023b).



As described in Table 2, there are some variations between the electricity power generation in SE3 and SE4. One initial difference is the fact that the total power generation in SE3 is substantially higher than in SE4. Another key difference is the lack of nuclear power generation in SE4, providing a large part of the electricity generated in SE3. There is also a difference regarding the amount of hydro power generation between the bidding areas, SE3 having a greater hydro power generation than SE4. Wind power generation is a prominent part of the power generation in both bidding areas, which is of relevance for this thesis.

Table 2: Power generation per power source in SE3 and SE4 2019-2022 (GWh), using data from Statistics Sweden (2023b).

	Power generation per power source in SE3 and SE4 2019-2022 (GWh)				
	Power source	2019	2020	2021	2022
SE3	Hydro power	10362	11100	11342	7578
	Wind power	6950	8585	8007	8098
	Solar power	447	708	1002	1219
	Nuclear	66130	49198	52965	51944
	Conventional thermal power	9266	7197	8711	8648
	Total	93155	76788	82027	77487
SE4	Hydro power	1251	1274	1225	961
	Wind power	4193	4480	3981	4937
	Solar power	175	262	408	649
	Nuclear	0	0	0	0
	Conventional thermal power	2871	2395	3088	3358
	Total	8490	8411	8702	9905

2.1.2 Day-ahead spot price

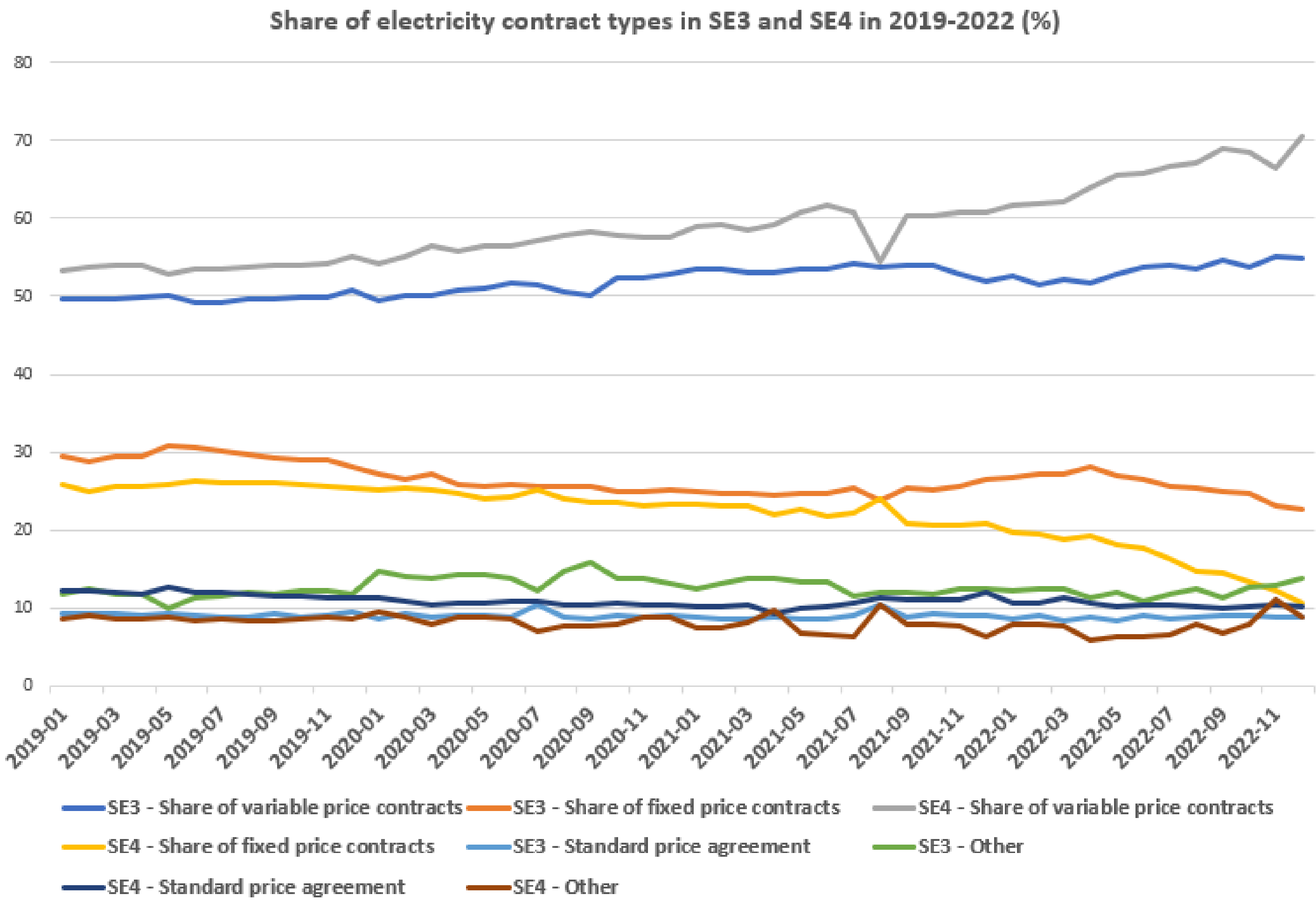
The day-ahead spot price is based on a market where firms can buy or sell energy in an auction for the upcoming 24 hours, with a bidding price for every hour and bidding zone (Nord Pool, n.d.a). In a Swedish context this is done in the Nord Pool power market (Nord Pool, n.d.b), where market actors bid for the specific quantity of energy they are willing to buy or sell the next day (Nord Pool, n.d.a). Since the Nord Pool power market incorporates the Nordic and Baltic countries, the day-ahead spot price for one bidding area is affected by market conditions in several other bidding areas (Nord Pool, n.d.c). The day-ahead spot price affects consumer price in the sense that it dictates the electricity price for companies providing electricity and therefore the price they sell it for, mostly affecting consumers with flexible price electricity contracts (Bixia, 2024).

2.1.3 Consumer electricity contracts

There are different types of electricity contracts in Sweden (Elen.se, 2023). Standard price agreement is an electricity contract type the consumer is assigned if one does not choose an electricity contract (ibid). Fixed price agreement is a contract type with a fixed price, which could be beneficial for consumers who want to plan ahead and know how high the electrical bill will be during the winter (ibid). Variable price agreement is a contract type where price varies based on prices set in the electricity trade market (ibid). There is also mixed agreement, where 50 percent normally is a fixed price and the rest is similar to the variable price (ibid). In 2022, hour-price agreement became more popular in the electricity market as a result of soaring electricity prices (Sveriges Television, 2022a). With hour-price agreement, consumers pay the hourly price of electricity based on when they consume (The Swedish Consumer Energy Markets Bureau, 2023). Furthermore, the contract types for industrial consumers are; standard agreement, fixed price agreement, variable price agreement, mixed price agreement and hour-price agreement (Elmarknad.se, 2023).

The distribution of different types of electricity contracts are displayed in Figure 3. One important observation is that the share of variable price contracts gradually increases in both SE3 and SE4 over the 2019-2022 period. The share of fixed price contracts has, in general terms, the opposite trend over time, with a larger share of fixed contracts in SE3 and SE4 in 2019 compared to 2022.

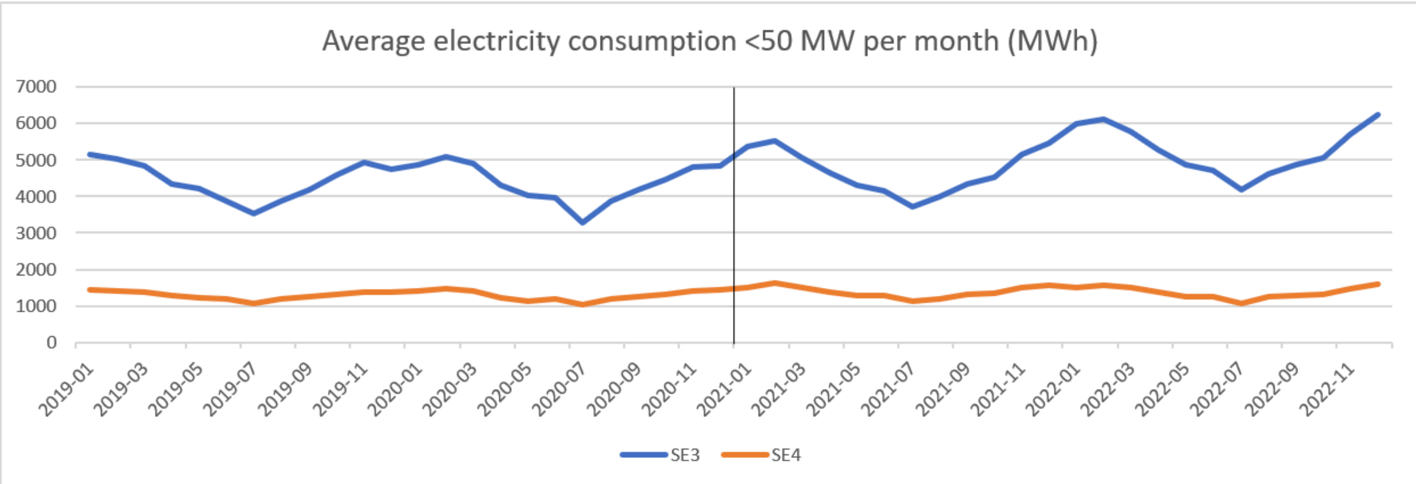
Figure 3: Share of electricity contract types in SE3 and SE4 in 2019-2022, using data from Statistics Sweden (2023a).



2.1.4 Electricity consumption below 50MW

Electricity consumption of consumers in SE3 and SE4 using electricity below 50 MW for the 2019-2022 period is described in Graph 3 below. In general, seasonal patterns can be observed, with a higher consumption during the colder months and lower consumption during the warmer months of the year (Svenska kraftnät, 2023c). Furthermore, a clear difference can be seen regarding the level of total electricity consumption between the bidding areas as consumers in SE3 consume more electricity than consumers in SE4.

Graph 3: Average monthly consumption of electricity in SE3 and SE4 MWh, 2019-2022, using data from Svenska kraftnät (2023c).



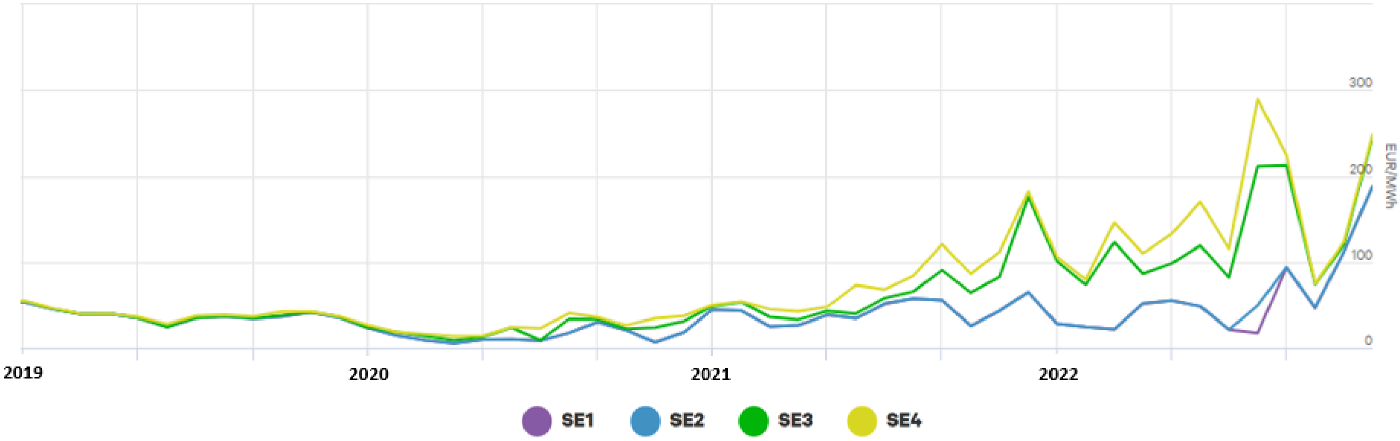
2.2 Price shock and persistent high prices in the electricity market

As mentioned earlier, global energy markets experienced substantial price increases at the end of 2021. As shown by Graph 4, the most substantial electricity day-ahead spot price increases occurred in bidding areas SE3 and SE4 in the South of Sweden. In comparison to these bidding areas, the prices in SE1 and SE2 did not increase as much during the 2021-2022 period. Notably, the average day-ahead electricity spot price in the 2019-2020 period was consistently more similar across all Swedish bidding areas than during the 2021-2022 period.

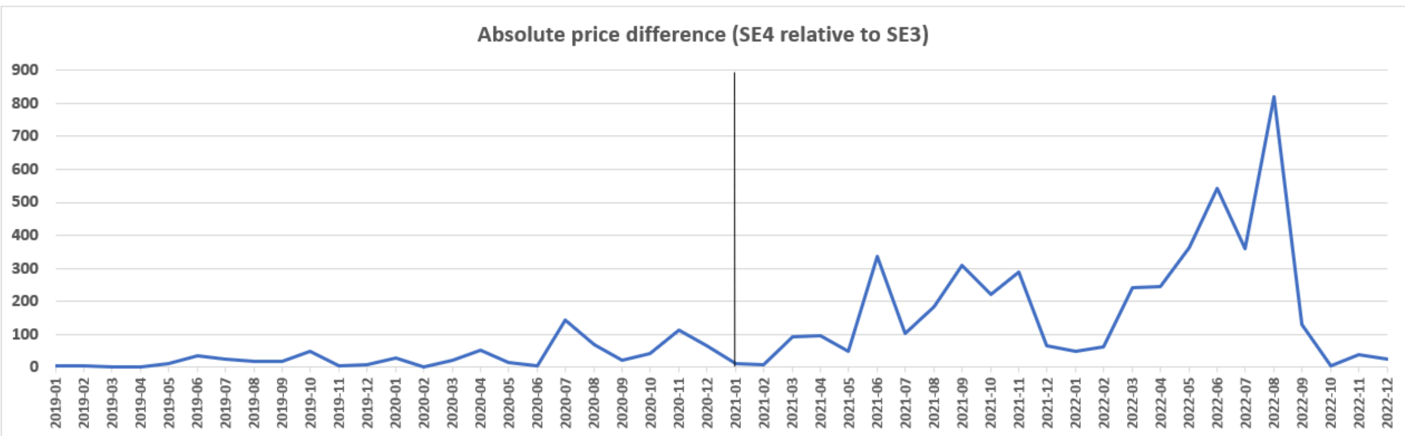
Since the thesis will focus on the SE3 and SE4, further comparison of their respective price dynamics is relevant. As shown in Graph 5, the price difference between SE3 and SE4 in absolute terms show a great increase as 2021 starts. Before 2021, the absolute price difference fluctuates between approximately 50 to 150 EUR. After surpassing January 2021, one can observe more dramatic differences in price. In 2021 price fluctuates between a difference of approximately 100 to over 300 EUR. However, the biggest difference is shown in 2022, where the price difference goes up to over 800 EUR over the timespan of six months, to then go back to previous levels, at the end of 2022.

As shown in Graph 6 there are also major price differences in SE3 relative to SE4. The biggest difference occurs in July of 2020, where the price difference is 60 percent, furthermore there are two more substantially large differences. One in April of 2020 (35 percent) and in June of 2021 (45 percent).

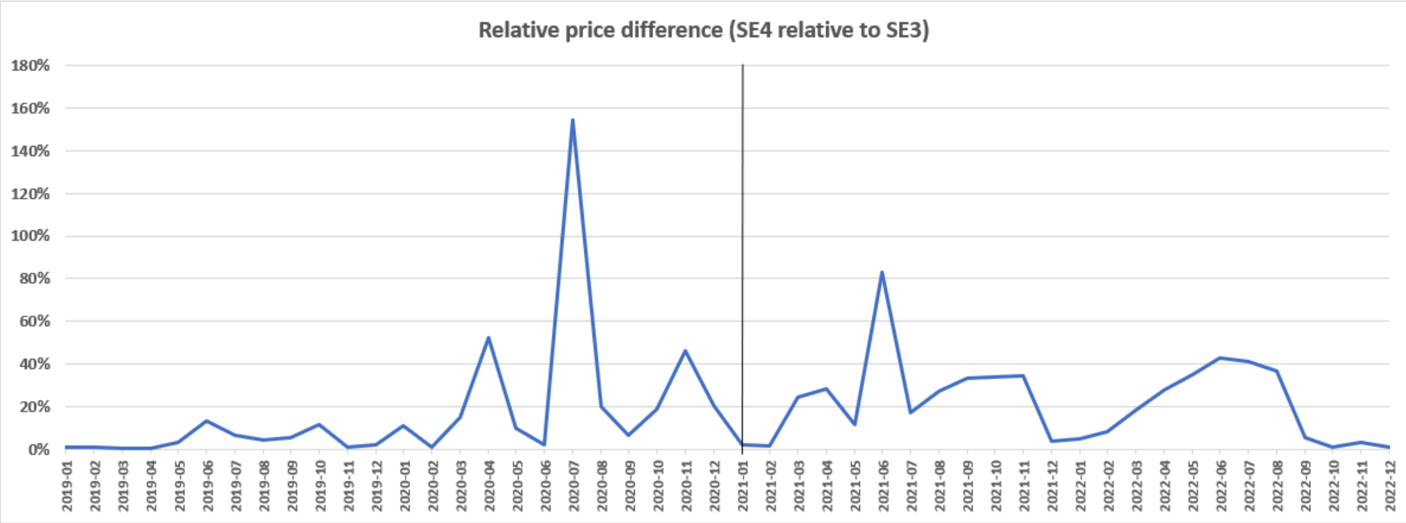
Graph 4: Average monthly electricity price in SE1, SE2, SE3 and SE4 shown in Euro per MWh, 2019-2022 (Nord Pool, n.d.b).



Graph 5: Price differences in absolute terms between monthly average price in SE3 and SE4 in SEK for the 2019-2022 period, SE4 relative to SE3, using data from Energinet (2023).



Graph 6: Price differences in relative terms between monthly averages SE3 and SE4 in SEK for the 2019-2022 period, SE4 relative to SE3, using data from Energinet (2023)



2.2.1 Effects of increased prices

The increased electricity prices in 2021-2022 caused major public discussions and led to a public focus on hourly electricity prices and consumption. An example of this is how the Swedish Energy Agency urged the Swedish public to adapt their hourly consumption patterns and avoid using electricity at peak-hours (Swedish Energy Agency, 2023). Political debate regarding the electricity price crisis also led to governmental economic support for electricity costs in Sweden (The Government Offices of Sweden, 2022). Swedish households were given retroactive financial support for their electricity consumption in two rounds (ibid). Households in all of Sweden were given support for their consumption during November and December of 2022, while households in SE3 and SE4 also got support for their consumption from October 1st to September 30th (ibid). The time period October 1st 2021 to September 30th 2022, was also used by firms when applying for support for future electricity costs (The Swedish Tax Agency, 2023).

3. Theoretical framework

In this section, the relevant theoretical framework will be presented and discussed.

3.1 Supply and demand

The supply and demand curves illustrate the quantity and price of goods in the market. The market equilibrium is reached when the traders in the market have the possibility to buy or sell as much as they want (Perloff, 2017). *Equilibrium price* is at the price where the consumers can consume their preferred amount, and *equilibrium quantity* is the quantity suppliers sell at that price, and the amount that consumers buy (ibid). The model is relevant to analyze the relationship between buyers and sellers in the market, and describe how much sellers are able to sell and how much buyers are willing to buy (ibid). This applies to the electricity market since it is a market where consumers and firms trade with each other (ibid).

3.1.1 The demand function

The demand function estimates the relationship between price and quantity demanded, together with other factors that affect transactions. Substitutes, income, complements, taste, consumers' access to information and income are examples of other factors that influence quantity demanded (Perloff, 2017). Substitutes are defined as goods that consumers view as similar to each other; one good can be substituted for another (ibid). Complements are goods that consumers prefer to consume in bundles; to consume in pairs with another complement (ibid). The demand function is displayed in Equation 1 where Q stands for quantity demanded, p for price of said product, pc for price of a complement and Y for income of the consumers' (ibid).

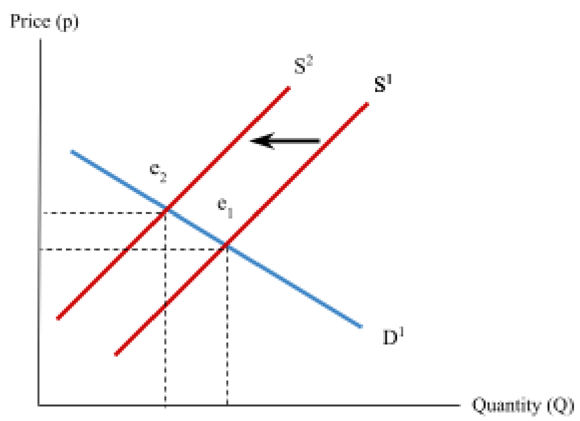
Equation 1: Demand function (Perloff, 2017)

$$Q = D(p, pc, Y)$$

3.1.2 The effects of supply shocks on the equilibrium

Generally, an economic shock is defined as "...an unexpected exogenous disturbance that has a significant impact on the economic system." (Bhattacharya & Kar, 2005). This entails that the supply curve shifts along the demand curve (Perloff, 2017) as shown in Graph 1. An increase in price in the form of a price shock moves the supply curve to the left from S^1 to S^2 which creates a new equilibrium price e_2 (ibid).

Graph 1: Effect of a price shock on the equilibrium price (Perloff, 2017)



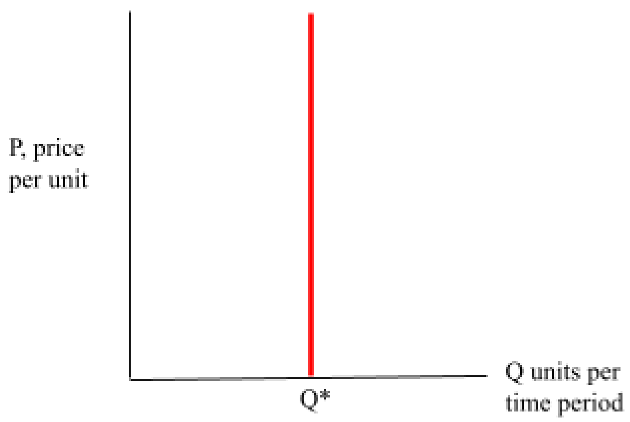
3.2 Price elasticity of demand

Price elasticity of demand refers to the proportional demand change of a good as a result of a one percent price change of that good (Conway & Prentice, 2020), as shown by Equation 2 below with Q representing demand and p representing price. If the relative change in demand is smaller than the price change, a good can be considered an inelastic good (ibid). The demand curve for a perfectly inelastic good, with a constant demanded quantity no matter the price, is shown in Figure 4 below. An elastic good on the other hand experiences the opposite relative effect of a one percent price change, meaning that the demand is altered proportionally more than the price (ibid). Electricity can in general be described as an inelastic good (Athukorala et al. 2019), with some differences between household and industrial price elasticity of demand (Conway & Prentice, 2020). According to Conway and Prentice (2020), such difference between household and industrial consumers may partly be due to households having less substitutes for electricity available.

Equation 2: Price elasticity of demand

$$Percentage\ change\ in\ quantity\ demanded\ /\ percentage\ change\ in\ price\ = (\Delta Q/Q)\ /(\Delta p/p)$$

Figure 4: Perfectly Inelastic Demand (Perloff, 2017)



3.2.1 Time frames of price elasticity of demand

As described by Yin et al. (2016), the distinction between short-term and non-short term price elasticity of electricity demand lies in the possibility for the consumer to optimize electricity consuming hardware given price levels. While fully possible in the long run, such optimization is more difficult for consumers in the short run (ibid). Bernstein and Griffin (2006) underline the limited possibility for electricity consumers to substitute their hardware in reaction to prices in the short run because of the associated high costs. For example, replacing a refrigerator with a more electricity efficient substitute can be costly and should thus be seen as an optimization possible in the longer run for the consumer (ibid). Therefore, the price elasticity of electricity demand should be relatively non-responsive in the short run and become more elastic in the long term when consumers have time to adjust.

Regarding a specific time frame, Csereklyei (2020) describes short-run price elasticity as being captured within a year. Specific time frame definitions of longer time frames than short-run price elasticity vary, one being a two-year period used by Borenstein (2009) to estimate medium- to long-run price elasticity of electricity demand.

3.3 Oligopoly

An oligopoly is a market form that is characterized by a small number of firms. Oligopolies can be divided into two groups; one with high product differentiation and one with low product differentiation (Perloff, 2017). Firms in oligopolistic markets are also large in proportion to the market, since there are few of them (ibid). Some electricity markets could be characterized with oligopolistic traits, since there are a small number of firms, and the firms are large in relation to the market they operate in (ibid).

In oligopolistic electricity markets, the bidding structures involved enable market actors to attain the maximum amount of producer surplus (Bompard et al., 2007). Through gaming behavior, suppliers of electricity may offer their electricity at a higher price than the marginal cost to increase their surplus (ibid). Thus, if a specific electricity market is characterized as an oligopoly, its equilibrium prices can be expected to be higher than equilibrium prices in a perfect competition market (ibid). At the same time, the level of price elasticity of demand can also affect the degree of oligopoly power. Bompard et al. (2007) underlines how an increase in price elasticity of demand decreases the possibilities of producer surplus for market actors. Thus, an increase in price elasticity of demand could be described as having a positive impact on the performance of the electricity market (ibid).

3.4 Summary of theory

Theory regarding supply and demand is central for this thesis, more specifically the effect of price changes on demand and market equilibrium. Theory related to price elasticity of demand over different time frames is discussed, describing differences in possibilities for consumers to adapt to price changes as it is difficult in the short run. Theory regarding oligopoly market structures and their relation to price elasticity of demand is also discussed.

4. Previous empirical research

This section will present and discuss previous empirical research related to the topic of this thesis.

4.1 Previous results

Table 3 describes previous results relevant for this thesis. Multiple previous researchers have estimated negative price elasticity including; Csereklyei (2020), Borenstein (2009, Bönte et al. (2015), Burke and Abayasekara (2018) and Alberini et al. (2019), Miller & Alberini (2016). However, Bernstein and Griffin (2006) estimated a positive price elasticity of electricity demand. The two-stage least square model has been used by Csereklyei (2020), Borenstein (2009) and Bönte et al. (2015). Furthermore, Alberini et al. (2019), Burke & Abayasekara (2018) and Miller & Alberini (2016) all used both OLS and TSLS to estimate price elasticity of demand. Generally one can observe a similar price elasticity of demand in the European countries; Csersky (2020) and Bönte et al. (2015). Furthermore, one can observe higher price elasticity of demand in Ukraine during higher energy prices (Alberini et al., 2019).

Table 3: Medium- and long-run price elasticity of electricity demand estimates by previous research.

Article	**Country**	**Time period**	**Price elasticity of demand**	**Sector**	**Model**
Csereklyei (2020)	EU	1996 - 2016	Between −0.53 and −0.56.	Residential	2SLS
Borenstein (2009)	USA	2000-2006	-0.17, -0.15 and -0.12	Residential	2SLS
Bönte et al. (2015)	Germany and Austria	2010 - 2014	-0.43	Residential and industrial	2SLS

Bernstein & Griffin (2005)	USA	1997-2004	Between -1.75 and 1.4	Regional residential	OLS
Burke & Abayasekara (2018)	USA	2003-2015	-1	Residential and industrial	OLS and 2SLS
Alberini et al. (2019)	Ukraine	2013-2016	Between -0.2 and -0.5	Residential	OLS and 2SLS
Miller & Alberini (2016)	USA	1997-2009	-0.671	Residential	OLS and 2SLS

4.2 Effects of persistent high prices on the price elasticity of demand

Research regarding the effects of persistent high prices on the price elasticity of demand is, to the best of the authors' knowledge, sparse. One example however is Alberini et al. (2019) who investigate the effects of a period of extreme increases in electricity price on the price elasticity. In Ukraine, between Januari 2013 and April 2016 prices increased by approximately 300 percent. The authors conclude that price elasticity was 50 percent more pronounced in the first three months of the price shock (Alberini et al. 2019). Although Alberini et al. (2019) investigate a time period shorter than the two-year period investigated in this thesis, their findings regarding consumer behavior in the context of substantial and persistent price increases are relevant for this thesis.

4.3 Summary of previous empirical research

Derived from previous empirical research it is to expect that the estimated price elasticity of demand should be negative for electricity in this thesis. Furthermore, as previously mentioned, one investigated source (Bernstein & Griffin, 2005) estimated a positive result for the maximum price elasticity, which is not in line with theoretical background or other investigated research.

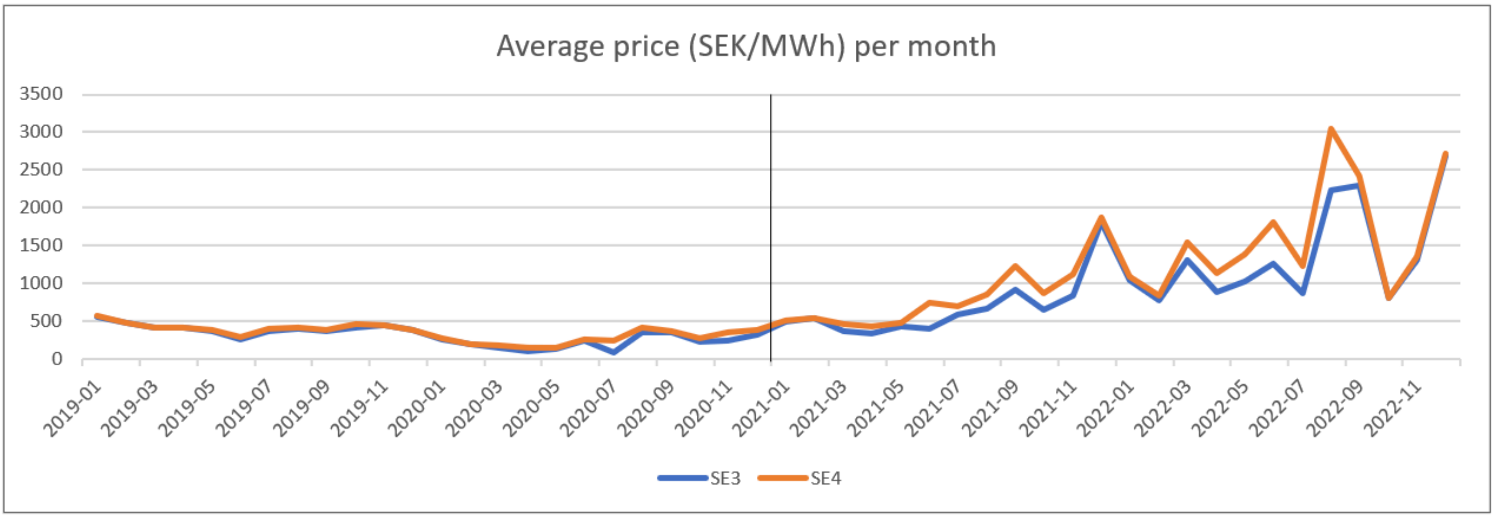
5. Method and data

In this section, the method and data used in the thesis will be presented and discussed. It will commence by discussing the definition of price elasticity time frame for the thesis, followed by descriptions of the methods and data used.

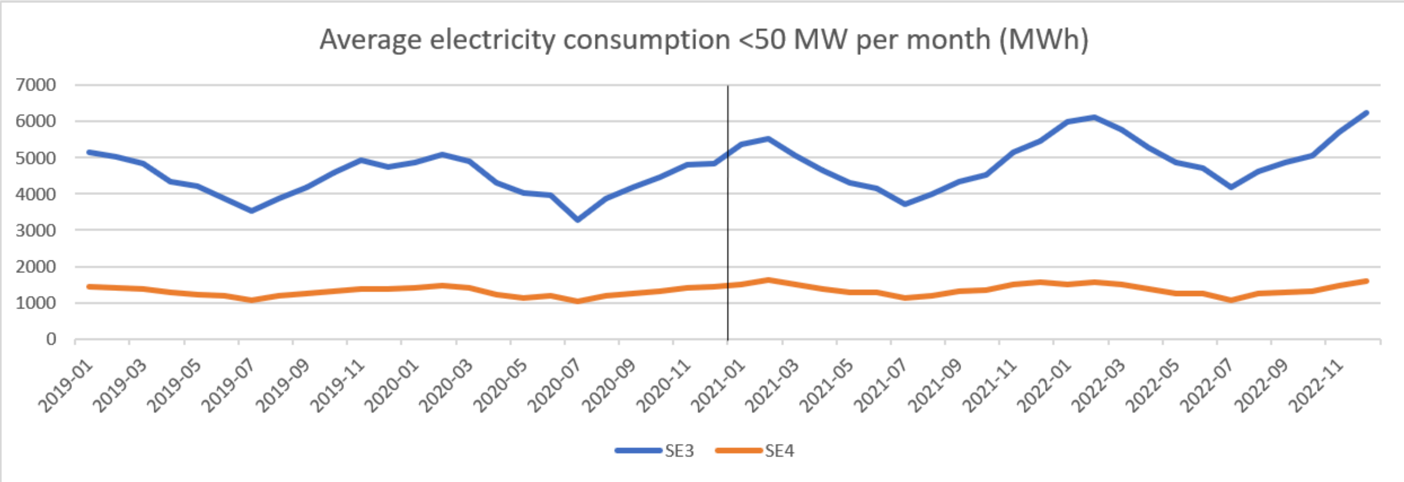
5.1 Two year periods to capture effects of persistent high price levels

This thesis will utilize the definitions used by Csereklyei (2020) and Borenstein (2009) regarding time frames of price elasticity. Firstly, Csereklyei (2020) describes that short run price elasticity is captured annually. Borenstein (2009) adds to this when using two-year periods to investigate medium- to long-run price elasticity. Thus, this thesis will use two-year periods as a definition of medium- to long-run, splitting up the 2019-2022 period into two two-year periods: 2019-2020 and 2021-2022. As described by Graph 8 and 9, the first period of 2019-2020 was a period with relatively low prices and the second period of 2021-2022 was characterized by dramatic increase and subsequent persistently high electricity prices in the bidding areas SE3 and SE4. Each of the two-year periods, as well as the full 2019-2022 period will be analyzed using both methods presented below. This will be done for SE3 and SE4 pooled together and separately in order to capture both overall price elasticity estimates for the South of Sweden, as well as regional estimates for the relevant time periods. The analysis of SE3 and SE4 separately is motivated both by the second research subquestion and regional differences in electricity price and consumption presented in Graph 8 and 9.

Graph 8: Average price (SEK/MWh) per month, 2019-2022, based on data from Energinet (2023)



Graph 9: Average consumption (MWh) per month, 2019-2022, based on data from Svenska kraftnät (2023c)



5.2 Method

This section will present methods used in this thesis, presenting and discussing both the ordinary least squares and two-stage least squares model used.

5.2.1 Ordinary least squares

One of the most popular methods to estimate price elasticity of electricity consumption is ordinary least squares, OLS (Zhu et al. 2018). Furthermore, the ordinary least squares model is defined as an estimation model (Wooldridge, 2012). The OLS estimator measures the coefficients in a way that the regression line is as similar to the data set as possible (Stock & Watson, 2020). This is measured by adding the sum of squared mistakes estimating Y, when given the variable X (ibid). To give the linear regression model of OLS, this estimator then develops (ibid). Thus, the population data is described by a given linear model;
$Yn = \beta n + BnX$ (ibid).

Three OLS regression specifications will be used for each of the time periods and the bidding areas, separate and pooled together, as described below by OLS Model 1-3. Onwards, these specifications will be referred to Model 1, Model 2 and Model 3 in accordance with the descriptions below. All models are so-called log-log models where variables are logarithmized, this is done to be able to estimate elasticity of demand directly from the β-koefficient. Similar specifications have been used by Eriksson Lind and Heikurainen (2022) and Stenman and Dimov (2021), with some differences as described in 5.6. As described further in 5.5.6, log(fixed price contracts) and quarter year dummies will not be used in the same regression due to collinearity issues. Since Model 3 includes controls for time trends, the quarter year dimmies, it is deemed to be the model with the most trustworthy estimates. All regressions will be performed using STATA.

OLS Model 1:

$$log(consumption) = log(price) + error\ term$$

OLS Model 2:

$$log(consumption) = log(price) + log(temperature) + work\ day\ dummy + log(fixed\ price\ contracts) + error\ term$$

OLS Model 3:

$$log(consumption) = log(price) + log(temperature) + work\ day\ dummy + quarter\ year\ dummies + error\ term$$

5.2.2 Endogeneity problem

Wooldridge (2012) describes how an endogeneity problem of simultaneity can occur when using variables that are affected by market mechanisms in a regression. This may be an issue in the context of this thesis because of the previously described market process setting the price of electricity. Angrist and Kreuger (2001) adds that an OLS is not sufficient to identify the price elasticity of demand over time since the regression traces out either supply or demand. To tackle this issue one could use an instrumental variable to address other factors that 1) affect demand conditions but not conditions of cost or 2) affect cost conditions but not conditions of demand (Wooldrigde, 2012).

5.2.3 Two-stage least squares

A two-stage least squares, 2SLS, is constructed in this thesis to handle the endogeneity problem in the previous OLS-model. In the context of previously described endogeneity problems, the 2SLS method is fitting since it enables estimation in a context of endogeneity where the error terms of the dependent variable and the independent variables are correlated (Maydeu-Olivares, 2019). The two-stage least squares utilizes an instrument variable to estimate values of the problematic predictor and values for the unproblematic predictor, this is considered the first stage (Stock & Watson, 2020). The unproblematic predictor is then used to estimate a linear model of regression of the dependent variable, which is considered the second stage (ibid).

Moreover, for an instrument to be considered valid it must fill the following conditions;
1) exogeneity; the instrument must be exogenous and hence have no partial effect on the dependent variable, 2) instrument relevance; the instrument must be correlated with the variable x (Stock & Watson, 2020). A threshold of F-value above 10 for the first stage regression will be used to determine the validity of the instrument in this thesis, in accordance with Andrews and Stock (2005). Wind speed will be used as an instrument variable for price in this thesis, as described further in 5.5.3.

Three 2SLS, second stage, regression specifications will be used for each of the time periods and the bidding areas, separate and pooled together, as described below by 2SLS Model 1-3. Onwards, these specifications will be referred to Model 1, Model 2 and Model 3 in accordance with the descriptions below. All models are so-called log-log models where variables are logarithmized, this is done to be able to estimate elasticity of demand directly from the β-koefficient. Similar specifications have been used by Eriksson Lind and Heikurainen (2022) and Stenman and Dimov (2021), with some differences as described in 5.6. As described further in 5.5.6, log(fixed price contracts) and quarter year dummies will not be used in the same regression due to collinearity issues. Since Model 3 includes controls for time trends, the quarter year dimmies, it is deemed to be the model with the most trustworthy estimates. All regressions will be performed using STATA.

2SLS Model 1:

$$log(consumption) = log(wind\ speed) + error\ term$$

2SLS Model 2:

$$log(consumption) = log(wind\ speed) + log(temperature) + work\ day\ dummy + log(fixed\ price\ contracts) + error\ term$$

2SLS Model 3:

$$log(consumption) = log(wind\ speed) + log(temperature) + work\ day\ dummy + quarter\ year\ dummies + error\ term$$

Multiple studies have used 2SLS to estimate the price elasticity of demand of electricity (Burke & Abayasekara, 2018; Hirth et al., 2022; Csereklyei, 2020; Bönte et al., 2020). Moreover, it has been frequently used in a Swedish context (Stenman & Dimov, 2021; Eriksson Lind & Heikurainen, 2022) as well as when using hourly electricity price and consumption data (Knaut & Paulus, 2016). Several previous studies have also chosen to use both OLS and 2SLS and compare results in respective groups (Burke & Abayasekara, 2018; Alberini et al., 2019; Miller & Alberini, 2016). For example, when comparing results for an OLS versus 2SLS Miller and Alberini (2016) estimates a 27 percent difference in price elasticity of demand when going from OLS to 2SLS. This underlines the importance of the 2SLS-method, in order to minimize bias and make correct estimates, as well as comparing its results to the OLS-results.

It is also recognized that the usage of an instrument variable has its limitations and potential risks. One of them being endogeneity in the instrument which would make the estimations for the 2SLS method inconsistent (Stock, 2001). Furthermore there are also potential risks in the strength of the instrument (ibid), which is tested in the first stage regression using the F-value.

5.3 Fixed effect, controls for time trends and adjustment of standard errors

Fixed effects will be incorporated in both the OLS- and 2SLS-models when data from SE3 and SE4 are pooled together and analyzed. This is a so-called panel-fixed effect, which is used in order to capture bidding area specific characteristics in the estimation of price elasticity. Adjustment of standard errors will also be conducted for all regressions, in order to control for potential heteroskedasticity. Heteroskedasticity, when not controlled for, could potentially lead to the standard errors being invalidated (Wooldridge, 2012). The function vce(robust) in STATA, is used to make such adjustments. Furthermore, controls for time trends will be incorporated through quarterly dummy variables in all regressions (see 4.5.6).

5.4 Data

This section will present and discuss the data used, its sources and relevance of hourly data.

5.4.1 Data sources

This study has utilized secondary data from Svenska kraftnät (2023c) regarding electricity consumption, Energinet (2023) regarding day-ahead spot prices, Swedish Meteorological and Hydrological Institute (2023) regarding temperature and wind, Google Calendar (2023) regarding working days and Statistics Sweden (2023a) share of fixed price electricity contracts. All the collected data is estimated on an hourly basis, except för the working day data. The reliability for the datasets from Svenska kraftnät and Swedish Meteorological and Hydrological Institute is high since it is concluded by Swedish government agencies. The same reason for reliability is also applicable to Energinet, since it is owned by the Danish state (Energinet, n.d).

5.4.2 Using hourly data

The usage of hourly data for electricity consumption and prices as well as temperature and wind speed is motivated by both customer relevance and statistical inference possibilities. Firstly, it is assumed that hourly data provides a more detailed analysis when analyzing factors such as consumption, price, temperature and wind speed that can change multiple times a day. It is also assumed that the hourly day-ahead spot price is a relevant proxy for consumer prices, not only for households with variable price contracts, but also customers planning on renewing their fixed price contract. Collected data regarding *consumption* of electricity is used as a proxy for *demand* for electricity, a similar method as used by Knaut and Paulus (2016) and Eliasson (2022).

5.5 Variables

In this section the variables used in this thesis are presented and discussed.

5.5.1 Electricity demand - dependent variable

The independent variable of electricity demand is derived from the electricity consumption data from Svenska kraftnät (2023c), the agency responsible for the Swedish transmission system (Svenska kraftnät, 2023d). Using yearly reports on hourly electricity consumption per bidding area, data for the 2019-2022 period has been compiled. Consumption from customers using electricity over 50 MW has been excluded, since the thesis focuses on consumers without balancing responsibility and production and industrial facilities using such electricity have a balancing responsibility (Svenska kraftnät, 2023e).

5.5.2 Electricity price - independent variable

The electricity price data for each of the examined bidding areas has been collected from Energinet and their hourly day-ahead spot price database (Energinet, 2023). The price data has been converted from Euro to SEK using daily exchange rate data from the European Central Bank (European Central Bank, 2023). The exchange converted prices have then been logarithmized in order to fit the chosen log-log regression model. Furthermore, all prices were increased with 1, in the form of x +1 to exclude values of zero, as suggested as a solution by Bellégo et al. (2022). Furthermore, negative values of price were adjusted to a low number close to zero to fit the log-log regression model.

5.5.3 Wind speed - instrument variable

Wind speed is chosen as an instrument variable for the day-ahead spot price to be used in the 2SLS regressions. Bönte et al. (2015) argue that wind speed is a relevant instrument for the day-ahead electricity spot price due to the fact that it affects wind power generation, thus also affecting the price. The relevance of using wind speed as an instrument for the day-ahead electricity spot price in a Swedish context partly due to how a considerable part of the electricity supply in Sweden, as well as SE3 and SE4 specifically, comes from wind power. It has also been used in previous research into the price elasticity of demand in Swedish bidding areas, for example by Eriksson Lind and Heikurainen (2022).

Using Swedish Meteorological and Hydrological Institute (2023) data , hourly wind speed data has been collected from five meteorological stations in each bidding area chosen to represent the geographical distribution of wind turbines (The County Administrative Board, 2023) while also limiting problems with missing hourly data. The chosen meteorological stations for SE3 are Borlänge, Fårösund, Hällum, Jönköping and Kettstaka, the chosen ones for SE4 are Helsingborg, Malmö, Ronneby-Bredåkra, Växjö and Ölands norra udde. Missing hourly data was handled by calculating the average value of before and after the missing values. Hours with missing data were given the average value of the hours before and after with non-missing values, using python code. The average percentage of missing values per measure point was found to be under one percent for all relevant time periods and panels, with nearly identical missing percentages in 2019-2020 and 2021-2022 for SE3 and SE4 together and low variation between the bidding areas when separated (see appendix for further description). Furthermore, no systematic drop off of data was identified. The average hourly wind speed in each bidding area has been calculated and logarithmized before included in the model. Averaging wind speed per bidding area has previously been used by Erikson Lind and Heikurainen (2022) as an operationalization of wind speed, although they used daily averages.

5.5.4 Temperature - control variable

Temperature is a key exogenous variable when estimating the demand responses in the electricity market. Electricity consumption is affected by temperature since higher temperature is associated with lower consumption of electricity, and hence, lower temperatures are associated with higher electricity consumption (Knaut and Paulus, 2016).

Using hourly temperature data from Swedish Meteorological and Hydrological Institute between 2019-2022 (Swedish Meteorological and Hydrological Institute, 2023), temperatures from five measure points in each bidding area were collected and used to calculate an average hourly temperature. The measure points, Swedish Meteorological and Hydrological Institute weather stations, were chosen to reflect the approximate population distribution, while at the same time not suffering from extensive missing hourly data. Gävle, Göteborg, Jönköping, Stockholm and Örebro were chosen for SE3 and Karlskrona-Söderstjerna, Malmö-Sturup Flygplats, Målilla, Torup and Växjö were chosen for SE4. Missing hourly data was handled by calculating the average value of before and after the missing values. Hours with missing data were given the average value of the hours before and after with non-missing values, using python code. The average percentage of missing values per measure point was found to be below one percent for all relevant time periods and panels, with identical missing percentages in 2019-2020 and 2021-2022 for SE3 and SE4 together and low variation between the bidding areas when separated (see appendix for further description). Additionally, no systematic drop off of data was identified. The average temperature data was then converted from degrees Celsius to Kelvin in order to handle the prevalence of negative- and zero-values when using a logarithmic regression model, a method previously used by for example Stenman & Dimov (2021) and Knaut & Paulus (2016).

5.5.5 Work day dummy - control variable

Working days are also a relevant factor when studying electricity demand. Used by Hofmann and Byskov Lindberg (2023) when estimating electricity demand response in Norway during the energy crisis in 2021-2022, hourly demand can be affected by whether it is a working day or not. Data regarding non-working days in Sweden has been collected from Google Calendar (2023). This data has then been converted to an hourly basis in order to fit the rest of the data. Knaut & Paulus (2016) regarded the holiday season in December as non-working days, therefore 24 December to 31 of December is regarded as non-working days in this thesis. Non-working days have been given the value zero and working days the value one.

5.5.6 Share of fixed price contracts - control variable

Previous research has found a difference in price elasticity of demand between different electricity contract types. Vesterberg (2017) argues that fixed price contracts entail a small or no price variation of price, finding that households with variable price contracts have a higher price elasticity of demand compared to ones with fixed price contracts. Jonsson & Målsten (2023) adds to its relevance for this thesis, finding that having a electricity contract with real time pricing is associated with a larger increase in price elasticity because of high electricity prices in Sweden compared to contracts with other forms of pricing. Thus, it is relevant to control for differences in contract types over time when estimating the price elasticity of electricity demand.

In order to incorporate differences in electricity contract shares, a variable describing the share of fixed price contracts on a monthly basis was constructed using data from Statistics Sweden (2023a) combining the share of 1-, 2- and 3-year fixed price contracts. A variable describing the share of variable price contracts was considered, but opted out since hourly price contracts was not included in the publicly available data for the relevant period (Statistics Sweden, 2023a).

However, when testing a logarithmized variable describing the share of fixed contracts it was found that such variable had several correlations over 0.5, with the quarter year dummy variables (as shown in Table 4 below). Notably, correlations of -0.633 and -0.783 are found for SE4 in 2019-2020 and 2021-2022 respectively. Because of these problematic correlations, the fixed price contracts variable will not be used in combination with the quarter year dummies.

Table 4. Correlation matrix showing correlations above 0.5 or under -0.5 between logarithmized fixed price electricity contract share and quarter dummy variables. Time and panel are shown in parenthesis.

Correlation matrix - correlations >0.5/<-0.5	Quarter dummy 2	Quarter dummy 8	Quarter dummy 13	Quarter dummy 16
log(fixed price contracts)	0.502 (SE3 2019-2020)	-0.530 (SE3 2019-2020)	0.516 (SE3 2021-2022)	-0.574 (SE3 2021-2022)
		-0.663 (SE4 2019-2020)		-0.783 (SE4 2021-2022)

5.5.7 Quarter year dummy - time fixed effect

Quarter year dummy variables are added as time fixed effects in the models. There are 15 quarter year dummy variables, each representing a quarter of a year throughout the 2019-2022 time period, with the first quarter being the reference period for time period 2019-2020. For the second period (2021-2022) the first quarter of 2021, ninth quarter of the 2019-2022, is constructed as the reference period. The time fixed effects are constructed to capture unobservable factors that change over time while constant for SE3 and SE4.

5.5.8 Summary of variables

In Table 5 below, the variables used in this thesis are summarized.

Table 5: Summary of variables

Variable name	Variable type	Unit	Source	Description	Used in method(s)
Consumption < 50MW	Dependent variable	MWh	Svenska kraftnät (2023c)	Demand for electricity (consumption) in megawatt per hour as aggregated demand (consumption) daily from the period 2019-2022. The variable is logarithmized to estimate the elasticity from the beta-coefficient in the regression.	OLS and 2SLS
Price	Independent variable	SEK/MWh	Energinet (2023)	Price for electricity estimated in SEK per	OLS and 2SLS

				megawatt per hour on daily basis	
Wind speed	Instrumental variable (IV)	M/s	Swedish Meteorological and Hydrological Institute (2023)	The hourly average wind speed in m/s from Swedish Meteorological and Hydrological Institute in 5 meteorological stations in each bidding area in SE3: Borlänge, Fårösund, Hällum, Jönköping and Kettstaka. and 5 meteorological stations in SE4: Helsingborg, Malmö, Ronneby, Växjö and Öland Norra.	2SLS
Temperature	Control variable	Kelvin*	Swedish Meteorological and Hydrological Institute (2023)	The hourly average temperature in Celcius (°C). Retrieved from SHMI and converted to kelvin from 5 meteorological stations in SE3: Stockholm, Gothenburg, Jönköping, Eskilstuna and Gävle, and 5 meteorological stations in SE4: Malmö, Växjö, Kalmar, Helsingborg and Karlskrona.	OLS and 2SLS
Work day dummy			Google Calendar (2023)	Dummy variable controlling for the effect of working days in Sweden, taking the value 1 for every hour of a work day and otherwise 0.	OLS and 2SLS
Fixed price contracts	Control variable		Statistics Sweden (2023a)	Variable describing the share of fixed price electricity contracts.	OLS and 2SLS
Quarter year dummy 2-16	Time fixed effects	0:1		Time, quarter wize (3 months)	OLS and 2SLS

*The SI-unit kelvin is used to convert Celcius (°C) to positive numbers, making logarithmization of all variables possible.

5.6 Variables excluded from the models

In the presented econometric models, a few variables included in previous research have been excluded. Firstly, there is no economic development variable included in the models unlike some previous research (Eriksson Lind & Heikurainen, 2022; Stenman & Dimov, 2021). Since hourly price and consumption data is used in this thesis and the available data regarding regional economic development on a yearly basis, it is difficult to include in the model. Furthermore, there was no available data for 2022 at the time of writing this thesis.

Another excluded economic variable related to electricity price is tariff charges. Tariff charges are paid by consumers for the use and maintenance of the electricity grid (The Swedish Consumer Energy Markets Bureau, 2020). This charge varies for consumers depending on several factors such as power grid company choice, electricity consumption and fuze type (The Swedish Energy Market Inspectorate, 2021). Because of this variation and subsequent difficulty to construct a function variable describing tariff charge changes, such variable has been excluded from the econometric models.

The COVID-19 pandemic is another factor excluded in the model. van Zoest et al. (2023) found that the COVID-19 pandemic affected household and industry electricity consumption, resulting in an increase for the first and a decrease for the latter. Since price elasticity of electricity demand in the EU has been found to be lower in households (Csereklyei, 2020), it is possible that this change in consumption could affect the overall price elasticity of electricity demand in the Swedish electricity market. A descriptive analysis will therefore be included when discussing the results but not directly in the econometric model, an approach previously used by Eriksson Heikurainen & Lind (2022), in combination with the time series dummies.

Public information regarding electricity price is also a relevant factor in the context of price responsiveness that is excluded from the econometric model. When investigating the effectiveness of real time pricing in terms of balancing supply and demand of electricity, Fabra et al. (2021) underline the importance of public information availability in the context of customer price responsiveness. Vesterberg (2017) adds that information availability, such as extensive media focus, about electricity prices increases the price responsiveness of customers. Thus, differences in public information availability, from for example media, between the two investigated periods may bias the results.

Another factor excluded from the model is regarding the market concentration and potential oligopolistic structures. As discussed previously, electricity markets with oligopolistic traits tend to be relatively non responsive to changes in price (Bompard et al., 2007). To control for potential market concentration effects on the price elasticity of demand was considered, but opted away from due to lack of publicly available relevant data. Therefore, the results may contain omitted variable bias due to changes in market concentration. It must also be pointed out that relevant theory suggests that the price elasticity may affect oligopoly behavior, thus including such a variable may have resulted in collinearity issues. Furthermore, to the best of the authors', no previous estimations of price elasticity of demand in a similar context has used such a variable.

5.7 Descriptive statistics

In Table 6 below the descriptive statistics for the relevant variables are shown.

Table 6: Descriptive statistics.

Variable	Obs.	Mean	Std. dev.	Min	Max
Log(Consumption <50MW)	70,128	0.798815	0.6712716	6.467412	9.023444
Log(Price)	70,128	5.990808	1.474869	-25.32844	9.050252
Log(Wind speed)	70,128	1.216792	0.4897678	-2.302585	2.617396
Log(Temperature)	70,128	5.638806	0.0265471	5.542958	5.722441
Work day dummy	70,128	0.9479808	0.2220673	0	1
Log(Fixed price contract)	70.128	3.174412	0.1886117	2.360854	3.430765
Quarter dummy 2	70,128	0.0622861	0.2416762	0	1
Quarter dummy 3	70,128	0.0629706	0.2429117	0	1
Quarter dummy 4	70,128	0.0629991	0.2429631	0	1
Quarter dummy 5	70,128	0.0622576	0.2416245	0	1
Quarter dummy 6	70,128	0.0622861	0.2416762	0	1
Quarter dummy 7	70,128	0.0629706	0.2429117	0	1
Quarter dummy 8	70,128	0.0629991	0.2429631	0	1
Quarter dummy 9	70,128	0.0615731	0.2403803	0	1
Quarter dummy 10	70,128	0.0622861	0.2416762	0	1
Quarter dummy 11	70,128	0.0629706	0.2429117	0	1
Quarter dummy 12	70,128	0.0629991	0.2429631	0	1
Quarter dummy 13	70,128	0.0615731	0.2403803	0	1
Quarter dummy 14	70,128	0.0622861	0.2416762	0	1
Quarter dummy 15	70,128	0.0629706	0.2429117	0	1
Quarter dummy 16	70,128	0.0629991	0.2429631	0	1

6. Results

In this section the results from the regressions (OLS and 2SLS) will be presented and interpreted for the two bidding areas SE3 and SE4 during the whole period 2019-2022 and the two periods separately, 2019-2020 and 2021-2022. A summary of the results will be presented at the end.

6.1 Ordinary least squares

This section presents the OLS price elasticity estimates for SE3 and SE4 pooled together and separately. Estimates for the 2019-2022, 2019-2020 and 2021-2022 periods will be presented.

6.1.1 OLS results

In Table 7 below, the OLS price elasticity of electricity demand estimates are presented for each of the studied periods using both pooled and separate data from the relevant bidding areas. As shown by Table 7, all of the OLS estimates are positive and statistically significant, also when controlling for temperature, working days and time trends with Model 3. Similar results were found using OLS regression Model 1 and 2, as shown in appendix. This entails that a one percent increase in price would result in increase in electricity consumption, meaning a positive price elasticity. This result is not in line with economic intuition, however it is in line with economic theory describing an endogeneity problem in the context of price elasticity of demand estimation in the electricity market. These results indicate that OLS regression is not, as described in economic theory, fitting for further investigation into the topic of this thesis.

The adjusted R^2 values are generally small for the ordinary least squares model and between 0.258 and 0.487. The R^2 values entail that the independent variables of this regression can explain 25.8-48.7 percent of the variation in the dependent variable. Hence the fit of the model is between 25.8 percent and 48.7 percent. Although, there is no great variation between the electrical areas SE3 and SE4 or over investigated time periods.

Table 7: Price elasticity of demand estimated using OLS in SE3 & SE4 pooled and separately for 2019-2022, standard errors are in the parentheses.

OLS	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4
	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Log(price)	0.078*	0.077***	0.080***	0.039*	0.037***	0.041***	0.049*	0.046***	0.051***
	(0.00146)	(0.0102)	(0.0111)	(0.00224)	(0.00313)	(0.00348)	(0.00224)	(0.00342)	(0.00374)
Control for temperature	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for working days	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for share of fixed price contracts	No	No	No	No	No	No	No	No	No
Controls for time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.308	0.377	0.258	0.358	0.487	0.294	0.347	0.462	0.278
N	35088	17544	17544	35040	17520	17520	70128	35064	35064

6.2 Two-stage least squares

Given the presented results from the OLS estimations of the price elasticity of electricity demand, the focus onwards will solely be on 2SLS estimates. These results will be presented in four parts: results from first stage regressions, results for SE3 and SE4 pooled, SE3 separately and SE4 separately. Consequently, differences over time and between the bidding areas will be displayed.

6.2.1 Results from first stage regression

In Table 8 below, the results from the first stage regression are shown. The first stage regression regresses price on wind speed, both logarithmized. The key result is that the F-value is over the previously described threshold of 10 for all panels and time periods. This ensures the validity of wind speed as an instrument for price. Furthermore, all of the regressions yield negative and statistically significant coefficients, with similar adjusted R^2-values between SE3 and SE4 for each given time period. The adjusted R^2-values are slightly higher overall in the 2021-2022 period compared to the 2019-2020 period.

Table 8: First stage regression results

2SLS: First stage	log(price)								
	2019-2020			2021-2022			2019-2022		
	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4
log(wind speed)	-0.370*	-0.381***	-0.359***	-0.777*	-0.822***	-0.735***	-0.618*	-0.639***	-0.597***
Adj. R^2	0.032	0.033	0.030	0.049	0.053	0.046	0.042	0.044	0.040
F-value	1049.15	380.87	353.08	322.38	477.13	765.40	862.70	934.91	1224.68
Prob > F	0.020	0.000	0.000	0.035	0.000	0.000	0.022	0.000	0.000
N	35088	17544	17544	35040	17520	17520	70128	35064	35064

6.2.2 Results for SE3 and SE4 pooled together

In Table 9 below, the results from the 2SLS estimates for SE3 and SE4 pooled together for the time periods 2019-2020, 2021-2022 and 2019-2022 are shown.

2019-2020

For the 2019-2020 period, the price elasticity is statistically significant and negative, with the effect of price on electricity consumption decreasing as control for temperature and working days as well as time fixed effects are added in Model 3. With these variables added the β-coefficient is -0.212, meaning that for every percent increase in the price, the consumption decreases by 0.212 percent while keeping everything else constant. This result is statistically significant. The effect of temperature is not significant when adding time fixed effects. Work day does however have a significant effect on electricity consumption, with a β-coefficient of 0.247 meaning that a day being a work day results in an increase of approximately 28 percent in electricity consumption.[1] The effect of fixed price contracts is estimated as statistically significant and positive in Model 2.

2021-2022

The pooled results for SE3 and SE4, in the 2021-2022 period can also be observed in Table 9. The effect of price is statistically significant and negative, with a decreased effect as control variables for temperature and working days as well as time fixed effects are added in Model 3. With these added, the price elasticity is estimated to -0.113, meaning that a one percent increase in price results in a 0.113 percent decrease in electricity consumption. The effect of temperature is also found to be statistically significant also after adding time fixed effects. The β-coefficient for temperature is -2.601, meaning that a one percent increase in the temperature results in a 2.601 percent decrease in electricity consumption keeping everything else equal. There is also a statistically significant effect if the chosen day is a working day, the β-coefficient of the work day dummy is 0.184, which signals its effect on electricity demand.

[1] Using the previously presented formula: log(consumption) = log(windspeed) + log(temperature) + workday dummy + quarter year dummies + error term

This entails that a day being a work day results in an approximate 20.2 percent increase of electricity consumption. The effect of the share of fixed price electricity contracts is statistically insignificant. The effect of the share of fixed price contracts is not statistically significant when estimating Model 2.

2019-2022

For the entire period of 2019-2022, the price is estimated to have a statistically significant and negative effect on electricity consumption. The effect is decreased as controls for temperature and working days as well as time fixed effects are added in Model 3, the final β-coefficient being -0.149. This entails a price elasticity of electricity demand meaning that a price increase of one percent results in a 0.149 percent decrease in electricity consumption ceteris paribus. The temperature is also found to have a statistically significant and negative effect on electricity consumption with time fixed effects added, with the final β-coefficient estimate being -1.715. This means that a one percent increase in temperature decreases the electricity consumption by approximately 1.715 percent. The effect of a day being a work day is also found to be statistically significant, although positive, when having added time fixed effects. The work day dummy β-coefficient for the 2019-2022 period is 0.213, entailing that a day being a work day results in an increased electricity consumption of approximately 23.7 percent. The effect of the share of fixed price contracts is statistically significant and negative. Model 2 estimates a statistically significant and negative effect of the share of fixed price contracts on electricity consumption.

Table 9: Results from 2SLS estimates for SE3 and SE4 pooled together, standard errors are in the parentheses below the coefficients.

2SLS: SE3 and SE4	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Log(price)	-0.316***	-0.315***	-0.212***	-0.140***	-0.137***	-0.113***	-0.174***	-0.177***	-0.149***
	(0.0437)	(0.0371)	(0.0514)	(0.0116)	(0.0126)	(0.0158)	(0.0211)	(0.0310)	(0.0295)
Log(temperature)		-3.831***	0.180		-3.741***	-2.601***		-3.900***	-1.715***
		(0.708)	(0.573)		(0.372)	(0.317)		(0.476)	(0.354)
Work day dummy		0.296***	0.247***		0.200***	0.184***		0.245***	0.213***
		(0.0296)	(0.0226)		(0.0315)	(0.0289)		(0.0368)	(0.0262)
Log(fixed price contract)		1.722***			-0.115			-0.437***	
		(0.0711)			(0.0628)			(0.0486)	
Controls for time trend	No	No	Yes	No	No	Yes	No	No	Yes
N	35088	35088	35088	35040	35040	35040	70128	70128	70128

6.2.3 Results for SE3

In Table 10, the results from the 2SLS estimates for SE3 in the time periods 2019-2020, 2021-2022 and 2019-2022 are shown.

2019-2020

The results show a significant effect of the price in the time period 2019-2020, with the effect decreasing as control variables for temperature and working days as well as time fixed effects are added in Model 3. With these added, the price elasticity in SE3 in the time period is estimated to be -0.163, meaning a one percent increase in price results in a 0.163 percent decrease in electricity consumption, keeping everything else constant. The β-coefficient is -0.294, meaning that a one percent increase in temperature results in a 0.294 percent decrease in electricity consumption. When controlling for time fixed effects and temperature in Model 3, the β-coefficient of the work day dummy in SE3 is 0.226, meaning that a day being a work day results in an approximately 25.4 percent increase in electricity consumption keeping everything else equal. The effect of the share of fixed price contracts is statistically significant and positive. The effect of the share of fixed price contracts is found to be statistically significant and positive in Model 2.

2021-2022

The results also show a significant effect for price elasticity in the time period 2021-2022. Adding chosen controls for temperature and working days together with time fixed effects in Model 3, price elasticity of demand for 2021-2022 in SE3 is -0.097, meaning a one percent increase in price results in a 0.097 percent decrease in electricity consumption, keeping everything else constant. The temperature is also found to have a statistically significant effect on electricity consumption in Model 3, with a β-coefficient of -2.838, meaning that a one percent increase in temperature results in a 2.838 percent decrease in electricity consumption. Furthermore, working days are also found to have a statistically significant effect on electricity consumption with a β-coefficient of 0.156 after time effects have been added. This entails that a day being a work day results in an increase in electricity consumption of approximately 16.9 percent. The effect of the share of fixed price contracts is statistically significant and positive. Model 2 estimates a statistically significant and positive effect of the share of fixed price contracts on the electricity consumption.

2019-2022

For the entire period of interest for this thesis, 2019-2022, there is a statistically significant and negative effect of price on electricity consumption in SE3. With controls for temperature and working days as well as time fixed effects added in Model 3, the β-coefficient for price is -0.119, entailing a price elasticity of electricity demand meaning that a one percent increase in the price results in a 0.119 percent decrease in electricity consumption. The temperature is also found to have a statistically significant effect in Model 3 and negative effect on electricity consumption, the β-coefficient being -1.977 with time fixed effects included in the regression. This means that a one percent increase in temperature results in a 1.977 decrease in electricity consumption. Furthermore, working days are also found to have a statistically significant effect on electricity consumption, although a positive one. With time fixed effects added, the β-coefficient is 0.188 meaning that a day being a work day increases electricity consumption by approximately 20.7 percent. The effect of the share of fixed price contracts is statistically significant and negative in Model 2.

Table 10: Results from 2SLS estimation for SE3, standard errors are in the parentheses below the coefficients.

2SLS: SE3	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Log(price)	-0.273***	-0.278***	-0.163***	-0.129***	-0.123***	-0.0968***	-0.153***	-0.148***	-0.119***
	(0.0184)	(0.0185)	(0.0117)	(0.00814)	(0.00735)	(0.00645)	(0.00723)	(0.00664)	(0.00602)
Log(temperature)		-4.440***	-0.294*		-4.037***	-2.838***		-4.300***	-1.977***
		(0.130)	(0.119)		(0.0794)	(0.119)		(0.0703)	(0.0905)
Work day dummy		0.267***	0.226***		0.167***	0.156***		0.211***	0.188***
		(0.0132)	(0.00844)		(0.0119)	(0.00924)		(0.00875)	(0.00654)
Log(fixed price contract)		1.592***			0.432***			-0.441***	
		(0.109)			(0.0488)			(0.0239)	
Controls for time trend	No	No	Yes	No	No	Yes	No	No	Yes
N	17544	17544	17544	17520	17520	17520	35064	35064	35064

6.2.4 Results for SE4

In Table 11 below, the results from the 2SLS estimates for SE4 in the time periods 2019-2020, 2021-2022 and 2019-2022 are shown.

2019-2020

When including controls for temperature and working days together with time fixed effects in Model 3, the price elasticity in SE4 for time period 2019-2020 is estimated to -0.265, entailing that a one percent increase in the price results in a 0.265 percent decrease in electricity consumption keeping everything else equal. The effect of temperature is also found to be significant, although when adding time fixed effects the β-coefficient is negative in SE4. The β-coefficient is 0.887 in Model 3, entailing a for this analysis situation where a one percent increase in temperature results in a 88.7 percent increase in electricity consumption. The effect of working days is significantly positive, with a β-coefficient of 0.271 with time fixed effects added. This means that a day being a work day increases the electricity consumption by approximately 31.1 percent. Model 2 finds a statistically significant and positive effect of fixed price contracts on the electricity consumption.

2021-2022

For the time period 2021-2022 in SE4, the price elasticity is estimated to -0.128 in with controls for temperature and working days as well as time fixed effects added in Model 3.

This entails that one percent increase in price results in a 0.128 percent decrease in electricity consumption. Thus the results show a higher price elasticity in SE4 than SE3. The effect of temperature is also negative and statistically significant when controlling for time fixed effects. The β-coefficient for temperature in SE4 is -2.184, entailing that one percent increase in temperature results in 2.184 percent decrease in electricity consumption. Working days are also found to have a statistically significant effect on electricity consumption after including time fixed effects in the regression. The β-coefficient for period 2021-2022 in SE4 is 0.213, entailing that a day being a work day results in an increase of approximately 23.7 percent increase in electricity consumption. The effect of the share of fixed price contracts on electricity consumption is estimated to be negative and statistically significant.

2019-2022

For the entire period of interest for this thesis, 2019-2022, the price is found to have a statistically significant effect on electricity consumption in SE4. When controls for temperature and working days are added together with time fixed effects in Model 3, the price elasticity is estimated to be -0.178 meaning that a one percent increase in the price of electricity results in a 0.178 percent decrease in electricity consumption. The effect of temperature is also found to be statistically significant and negative, with a β-coefficient of -1.241 with time fixed effects added. This entails that a one percent increase in temperature results in a 1.241 percent decrease in electricity consumption. The effect of working days are also found to be statistically significant, although positive. The β-coefficient of 0.240, with time fixed effects added, means that a day being a work day increases the electricity consumption by approximately 27.1 percent. A negative and statistically significant effect of the share of fixed price contracts on electricity consumption is estimated in Model 2.

Table 11: Results from 2SLS estimation for SE4, standard errors are in the parentheses below the coefficients.

2SLS: SE4	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Log(price)	-0.360***	-0.353***	-0.265***	-0.152***	-0.150***	-0.128***	-0.195***	-0.210***	-0.178***
	(0.0234)	(0.0225)	(0.0177)	(0.00807)	(0.00786)	(0.00757)	(0.00789)	(0.00845)	(0.00787)
Log(temperature)		-3.008***	0.887***		-3.313***	-2.184***		-3.332***	-1.241***
		(0.143)	(0.183)		(0.0888)	(0.162)		(0.0793)	(0.133)
Work day dummy		0.327***	0.271***		0.233***	0.213***		0.284***	0.240***
		(0.0198)	(0.0144)		(0.0141)	(0.0119)		(0.0117)	(0.00936)
Log(fixed price contract)		1.607***			-0.153***			-0.495***	
		(0.139)			(0.0174)			(0.0234)	
Controls for time trend	No	No	Yes	No	No	Yes	No	No	Yes
N	17544	17544	17544	17520	17520	17520	35064	35064	35064

6.3 Summary of results

This section will summarize the results of this thesis, summarized results of 2SLS Model 3 regressions are displayed in Table 12 below.

An initial finding, not included in Table 12, is the fact that OLS regression does not yield price elasticity estimates in line with economic theory and intuition. The OLS regressions continuously yield positive price elasticity estimates for the studied time periods, while the 2SLS regressions yield negative ones. Thus the focus of the results have been on 2SLS estimates.

Another key finding is regarding the difference in price elasticity estimates throughout the investigated period. When comparing the price elasticity estimates for SE3 and SE4 pooled together and separated, over time, the estimates are consistently higher in the 2019-2020 period than in the 2021-2022 period. The estimates for the 2019-2022 period is, since it contains both two year periods, falls in the middle of the estimates for 2019-2020 and 2021-2022. Another key finding is how the price elasticity estimates are consistently higher in SE4 compared to SE3. For both the 2019-2020 and 2021-2022 periods as well as the 2019-2022 period in its entirety, the price elasticity of demand is higher in SE4. The estimates from the pooled analysis is, logically, consistently in the middle of the separate estimates. Compared to the 2019-2020 period, the price elasticity decreases in the 2021-2022 by approximately 41 percent in SE3 and approximately 53 percent in SE4. Thus there is a larger decrease in price elasticity of demand in SE4 than SE3.

The temperature is found to have mostly statistically significant and negative effects on electricity consumption. The only statistically significant deviation from this is for SE4 in the 2019-2020 period, which is not in line with economic theory. The results also show that a higher temperature decreases the electricity demand more in SE3 compared to SE4, as well as more in the 2021-2022 period than the 2019-2020 period.

The estimated effect of the share of fixed price electricity contracts, not summarized in Table 12, is to some extent unison for both SE3 and SE4 pooled together as well as separate. In all cases, the effect of fixed price electricity contracts for the 2019-2020 period is statistically significant and positive, as well as being statistically significant and negative for the 2019-2022 period. The estimates for the 2021-2022 period are not as homogenous, finding a significant positive estimate for SE3 and a significant negative for SE4. All estimates were found without including controls for time trends.

Lastly, the effect of working days on electricity is consistently statistically significant and positive for all estimates. The effect was smaller in the 2019-2020 period than the 2021-2022 period and the results show a bigger effect in SE4 compared to SE3 for each of the time periods.

Table 12. Summary of results from 2SLS estimates, standard errors are in the parentheses below the coefficients.

2SLS: Summary	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4
	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Log(price)	-0.212***	-0.163***	-0.265***	-0.113***	-0.0968***	-0.128***	-0.149***	-0.119***	-0.178***
	(0.0514)	(0.0117)	(0.0177)	(0.0158)	(0.00645)	(0.00757)	(0.0295)	(0.00602)	(0.00787)
Log(temperature)	0.180	-0.294*	0.887***	-2.601***	-2.838***	-2.184***	-1.715***	-1.977***	-1.241***
	(0.573)	(0.119)	(0.183)	(0.317)	(0.119)	(0.162)	(0.354)	(0.0905)	(0.133)
Work day dummy	0.247***	0.226***	0.271***	0.184***	0.156***	0.213***	0.213***	0.188***	0.240***
	(0.0226)	(0.00844)	(0.0144)	(0.0289)	(0.00924)	(0.0119)	(0.0262)	(0.00654)	(0.00936)
Controls for share of fixed price contracts	No	No	No	No	No	No	No	No	No
Controls for time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	35088	17544	17544	35040	17520	17520	70128	35064	35064

7. Discussion

In this section the presented results will be discussed in the context of previously described economic theory and literature. Firstly, differences in price elasticity between the investigated periods will be discussed, then differences between SE3 and SE4, differences between OLS and 2SLS and lastly possible omitted variable bias.

7.1 Differences in price elasticity between 2019-2020 and 2021-2022

The main finding of this thesis is the difference in price elasticity between the 2019-2020 and 2021-2022 periods. In relation to relevant economic literature, a possible explanation for the lower price elasticity in 2021-2022 compared to 2019-2020 could be differences regarding optimization in proportion to price levels. It may have been more difficult for consumers to fully adapt to the electricity prices in 2021-2022 given the severity of the price increases compared to 2019-2020. Given that adjustments to high electricity prices often require expensive replacement of electricity consuming hardware (Bernstein & Griffin, 2005), it is reasonable to believe that optimization of electricity consumption proportional to the electricity price was more expensive in 2021-2022 than 2019-2020. Such difference in conditions for optimization could have been a factor resulting in a weaker relationship between price and consumption.

Another possible explanation given by economic theory is regarding the role of publicly available information for price elasticity. Although the public attention to electricity prices did not seem to have the expected effect (see 6.4), public knowledge regarding governmental compensation to electricity prices may have had an effect on the price elasticity in the 2021-2022 period. Government proposals in early 2022 (SVT, 2022b) to compensate consumers for high electricity prices may, amongst other political proposals, have resulted in public belief that some form of compensation would come. Such belief could have resulted in less adjustments related to electricity consumption and therefore a weaker relationship between price increases and consumption decreases in the 2021-2022 period.

In relation to previous research, the findings of this thesis are both expected and unexpected. Firstly, the findings of this thesis are not in line with the previous study by Alberini et al. (2019), where the authors captured a higher price elasticity in a period of higher price. This could be because of Alberini et al. (2019) investigating the short-run price elasticity of demand, the structure of the model, or combination of consumer structure, where they only investigated residential consumers, and this thesis focuses on both residential and industrial consumers. Also, the fact that Alberini et al. (2019) studied Ukraine and this thesis Sweden could be another factor explaining the different findings. Eliasson (2022) finds a slightly higher price elasticity of demand in Sweden during a lower period (Q3 of 2021) compared with a higher price period (Q4 of 2021), thus having results in line with the findings of this thesis. A similarity of importance due to the fact that the latter half 2021 is a shared time period of interest with this thesis. However, it must be pointed out that Eliasson (2022) estimates a short-term price elasticity, similarly to Alberini et al. (2019), which differs from the price elasticity estimated in this thesis. Moreover, the results from Eliasson (2019) only display a small difference in price elasticity between two investigated periods, Q3 and Q4, while the results found in this thesis display a larger difference in price elasticity between 2019-2020 and 2021-2022 period. This difference could possibly be derived from the different time frames used, as Eliasson (2019) investigates a six month period while two-year periods are used in this thesis. Furthermore, the estimated price elasticity of the first period, 2019-2020, estimates results before the dramatic price increase, which also could contribute to the large difference in price elasticity.

In terms of generalizability, it is important to stress that due to regional differences between the South and North of Sweden, there may be limited generalizability of the findings of this thesis to other electricity bidding areas in Sweden. Such cautiousness should also be taken when generalizing to other countries.

7.2 Difference between SE3 and SE4

The overall higher price elasticity of electricity demand found in SE4 compared to SE3 is reasonable in relation to relevant economic theory. As described by Graph 5-6, the electricity price is oftentimes higher in SE4 than SE3 during the 2021-2022 period. This could have resulted in more medium- to long-run adjustments by consumers in SE4 compared to SE3 as a reaction to the higher prices. Thus also resulting in a stronger effect of price on consumption in SE4 compared to SE3.

The fact that the decrease in price elasticity between the two-year periods is slightly larger in SE4 compared to SE3 could also be due to differences in price levels. Since electricity prices tended to be higher in SE4 compared to SE3, with more dramatic absolute differences in the 2021-2022 period, it may have been more difficult and costly for consumers in SE4 to adjust to the 2021-2022 price levels compared to consumers in SE3.

The overall difference between SE3 and SE4 regarding the level of price elasticity is consistent with previous findings by Eriksson Lind and Heikurainen (2022), as they also find a higher price elasticity of demand in SE4 compared to SE3. However, the difference between SE3 and SE4 found by Eriksson Lind and Heikurainen (2022) is bigger than the one found by this thesis. Eriksson Lind and Heikurainen (2022) describe a price elasticity of demand for SE3 as -0.036 and -0.101 for SE4, the price elasticity for SE4 being approximately 281 percent higher than for SE3. In this thesis price elasticity for SE4 is found to be larger than SE3 by approximately 163 percent for 2019-2020, 132 percent for 2021-2022 and 150 percent for 2019-2022. These differences in finding may be due to different time intervals for the observations and inclusion of controls for gross regional product, GRP, since Eriksson Lind and Heikurainen (2022) use daily averages and include GRP.

It is possible that the differences in results are biased to some extent by differences between the bidding areas regarding missing values in the data sets regarding temperature and wind speed. However, the fact that the differences found are in line with previous findings and can be theoretically motivated, combined with the de facto low difference in percentages missing, indicate that such bias is limited.

7.3 Difference between OLS and 2SLS

The difference in results from OLS compared to 2SLS is another finding of this thesis, the OLS regressions yielding positive elasticities while the 2SLS regressions yield negative ones. These findings are in line with the previously discussed issues of endogeneity in the context of the electricity market. Since the price and demand are set in dependence of each other, the positive price elasticities found are expected. Furthermore, a similar difference between OLS and 2SLS is also found by Eriksson Lind and Heikkurainen (2022), Stenman and Dimov (2021) when investigating the Swedish electricity market. Thus, this phenomenon is not unprecedented.

7.4 Possible omitted variable bias

As explained previously, the exclusion of variables related to economic development is excluded in the regression models of this thesis because of issues with observation intervals and lack of updated data. Although the time-fixed effects are thought to be controlling for some types of economic development like inflation, regional differences between SE3 and SE4 in terms of economic development are not controlled for. Thus, it is important to note that there may be omitted variable bias when comparing the price elasticity of demand in the two bidding areas over time. Eriksson Lind and Heikurainen (2022) does for example find a bigger effect of gross regional product in SE4 than SE3, however still finding a higher price elasticity of demand in SE4 compared to SE3.

Another possible source of omitted variable bias is potential differences in tariff charges. Since there is no econometric consideration of such charges in the regression models, there is a possibility that found estimates could be impacted by unobserved heterogeneity over time and between SE3 and SE4. However, it is difficult to estimate the extent of such bias.

Another possible source of bias is changes in electricity contract composition in the electricity market. Although the share of fixed price electricity contracts are included in the model to some extent, when adding time fixed effects such variable is excluded. Thus, the results may contain bias due to changes in electricity contracts. Furthermore, there may also be bias due to the fact that the share of fixed price contracts is described on a monthly basis while other factors such as electricity consumption is described on an hourly basis. In the context of this thesis, it is also difficult to draw conclusions regarding the relationship between electricity price and electricity contract types. As described, price dynamics should affect consumers more if a large number of consumers have variable price contracts but it may also be argued that the price could affect electricity contracts choice if current and expected prices determine fixed contract electricity prices. That said, since a higher share of consumers in SE3 and SE4 had fixed price contracts in 2019-2020 compared to the 2021-2022 does indicate that the higher price elasticity found in 2019-2020 compared to 2021-2022 is not because of changes in contact composition.

The COVID-19 pandemic is another source of potential omitted variable bias. Although Sweden did not experience a lockdown, measures to limit spreading of the COVID-19 virus did include recommendations that could affect electricity consumption such as working from home when showing symptoms for COVID-19. Previously described findings by van Zoest et al. (2023) of changed consumption patterns for households and to some extent industry could relate to the results found in this thesis. Knowing that price elasticity of demand in the EU tends to be lower for households compared to industry (Csereklyei, 2020), the increased consumption by households and decreased consumption by industry during the pandemic may have contributed to the lower price elasticity in the 2021-2022 period. However, as previously argued, the split between 2019-2020 and 2021-2022 is convenient in the sense that both periods contain approximately a year with COVID-19 restrictions in Sweden (The Public Health Agency of Sweden, 2023). This means that both periods should be affected by omitted variable bias from the COVID-19 pandemic to some extent, although the second one for a longer period.

The role of potential oligopoly structures in the Swedish electricity market in the context of this thesis is difficult to estimate. It may be argued that price dynamics could have been different with more electricity suppliers for example, thus potentially also affecting the price elasticity and differences of such between the two-year periods. There could also be differences in regards to the number of market actors between SE3 and SE4, resulting in different market conditions potentially affecting their respective price elasticity. Therefore, differences in market concentration is potentially a source of bias over time as well as in the context of regional differences.

Furthermore, the decrease in price elasticity in the 2021-2022 period does not seem to support the findings of Vesterberg (2017) regarding the effect of public information and media coverage. Vesterberg (2017) describes an increase in price responsiveness as a result of media coverage, but such an effect cannot be clearly observed in the results found by this thesis while at the same time not possible to rule out completely.

Furthermore, the fact that the data sets used for temperature and wind speed contain missing hourly values may have resulted in bias of the results. Lastly, the exclusion of negative variation in price may also have affected the results, possible demand responses to negative prices are not picked for example. However, the negative price points of data were few which would limit the effect.

8. Conclusion

The aim of this thesis was to investigate the effect of persistent high electricity prices on price elasticity of demand. Using hourly price and electricity consumption data for the bidding areas SE3 and SE4 in the south of Sweden from the 2019-2022 period, the price elasticity of demand was estimated. The full period was split up into two two-year periods, 2019-2020 and 2021-2022, the second one having persistent high prices. Estimates were conducted for both two-year periods as well as the full period for SE3 and SE4 separately and pooled together. An OLS approach was firstly used, finding a small positive price elasticity of demand. Regressions using 2SLS conversely found negative price elasticities for all investigated time periods, finding that more inelastic estimates for the 2021-2022 period in both bidding areas. During 2019-2020 price elasticity of demand was -0.163 for SE3 and -0.265 for SE4, the period after (period with higher electricity prices) price elasticity of demand was -0.113 for SE3 and -0.128. Furthermore, the 2SLS estimates also indicate higher price elasticity in SE4 than SE3 consistent over all time periods, as well as a bigger decrease in price elasticity between 2019-2020 and 2021-2022 in SE4 compared to SE3. Acknowledging the possibility of omitted variable bias from COVID-19 and regional economic development, these findings indicate a negative effect of persistent high prices on medium- to long-run price elasticity of demand. Possible reasons for these findings could be different levels of medium- to long-run adjustment to the new electricity prices as well as consumer anticipation of economic compensation. The findings also indicate regional differences in the effect of persistent high prices on the medium- to long-run price elasticity of demand, with regional differences in price and possible subsequent consumer adjustments being discussed as a plausible explanation.

Future research into the effect of persistent high electricity prices in medium- to long-run price elasticity of demand could incorporate the sources of possible omitted variable bias discussed in this thesis. Firstly, further research into the effect of persistent high prices on medium- to long-run price elasticity of demand is needed to determine the validity of the discussed possible explanations for the results found by this thesis. Furthermore, incorporating the effect of COVID-19, contract composition, public information and oligopoly market structures is of importance to properly understand the dynamics of price elasticity caused by price changes. Regional economic development variables are also relevant additions for future research, especially to estimate regional differences.

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Appendix

Correlation matrix

SE3 and SE4 2019-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~_2	quart~_3	quart~_4
log_consum~w	1.0000								
log_price	0.0631	1.0000							
log_wind_s~d	0.0574	-0.2038	1.0000						
log_temper~e	-0.2014	-0.0747	-0.0258	1.0000					
work_day_d~y	0.0364	0.0722	-0.0138	0.0865	1.0000				
log_fixed_~t	0.4724	-0.1787	0.0265	-0.0372	0.0262	1.0000			
quarter_d~_2	-0.0381	-0.0422	-0.0312	0.1119	-0.0417	0.2170	1.0000		
quarter_d~_3	-0.0633	-0.0072	-0.0539	0.2448	0.0607	0.2090	-0.0668	1.0000	
quarter_d~_4	0.0086	0.0041	0.0141	-0.1207	-0.0534	0.1722	-0.0668	-0.0672	1.0000
quarter_d~_5	0.0278	-0.1511	0.1385	-0.1690	0.0348	0.1155	-0.0664	-0.0668	-0.0668
quarter_d~_6	-0.0461	-0.2200	-0.0176	0.0983	-0.0417	0.0609	-0.0664	-0.0668	-0.0668
quarter_du~7	-0.0692	-0.1150	-0.0550	0.2453	0.0607	0.0576	-0.0668	-0.0672	-0.0672
quarter_du~8	0.0097	-0.1325	0.0418	-0.0654	-0.0534	0.0128	-0.0668	-0.0672	-0.0672
quarter_du~9	0.0545	0.0165	0.0379	-0.2969	0.0344	0.0061	-0.0660	-0.0664	-0.0664
quarter_d~10	-0.0142	-0.0127	-0.0361	0.0846	-0.0417	-0.0345	-0.0664	-0.0668	-0.0668
quarter_d~11	-0.0469	0.1095	-0.0810	0.2565	0.0607	-0.0229	-0.0668	-0.0672	-0.0672
quarter_d~12	0.0347	0.0966	0.0221	-0.1538	-0.0534	-0.0493	-0.0668	-0.0672	-0.0672
quarter_d~13	0.0754	0.1052	0.0726	-0.2230	0.0344	-0.0631	-0.0660	-0.0664	-0.0664
quarter_d~14	0.0082	0.1209	-0.0383	0.0894	-0.0417	-0.0961	-0.0664	-0.0668	-0.0668
quarter_d~15	-0.0218	0.1132	-0.0847	0.2525	0.0607	-0.2724	-0.0668	-0.0672	-0.0672
quarter_d~16	0.0567	0.0857	-0.0036	-0.1230	-0.0534	-0.4883	-0.0668	-0.0672	-0.0672

	quart~_5	quart~_6	quarte~7	quarte~8	quarte~9	quart~10	quart~11	quart~12	quart~13
quarter_d~_5	1.0000								
quarter_d~_6	-0.0664	1.0000							
quarter_du~7	-0.0668	-0.0668	1.0000						
quarter_du~8	-0.0668	-0.0668	-0.0672	1.0000					
quarter_du~9	-0.0660	-0.0660	-0.0664	-0.0664	1.0000				
quarter_d~10	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	1.0000			
quarter_d~11	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	1.0000		
quarter_d~12	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	1.0000	
quarter_d~13	-0.0660	-0.0660	-0.0664	-0.0664	-0.0656	-0.0660	-0.0664	-0.0664	1.0000
quarter_d~14	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	-0.0664	-0.0668	-0.0668	-0.0660
quarter_d~15	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664
quarter_d~16	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664

	quart~14	quart~15	quart~16
quarter_d~14	1.0000		
quarter_d~15	-0.0668	1.0000	
quarter_d~16	-0.0668	-0.0672	1.0000

SE3 2019-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~_2	quart~_3	quart~_4
log_consum~w	1.0000								
log_price	0.3789	1.0000							
log_wind_s~d	0.2127	-0.2105	1.0000						
log_temper~e	-0.4123	-0.1079	-0.0250	1.0000					
work_day_d~y	0.1003	0.0654	-0.0129	0.0815	1.0000				
log_fixed_~t	-0.1344	-0.0185	0.0244	0.0171	0.0239	1.0000			
quarter_d~_2	-0.1418	-0.0313	-0.0374	0.1160	-0.0417	0.4747	1.0000		
quarter_d~_3	-0.2265	0.0037	-0.0468	0.2407	0.0607	0.4083	-0.0668	1.0000	
quarter_d~_4	0.0241	0.0152	-0.0025	-0.1300	-0.0534	0.2802	-0.0668	-0.0672	1.0000
quarter_d~_5	0.0744	-0.1433	0.1573	-0.1612	0.0348	0.0603	-0.0664	-0.0668	-0.0668
quarter_d~_6	-0.1495	-0.2204	-0.0314	0.1029	-0.0417	-0.0897	-0.0664	-0.0668	-0.0668
quarter_du~7	-0.2544	-0.1353	-0.0452	0.2445	0.0607	-0.0991	-0.0668	-0.0672	-0.0672
quarter_du~8	0.0117	-0.1445	0.0348	-0.0623	-0.0534	-0.1998	-0.0668	-0.0672	-0.0672
quarter_du~9	0.1558	0.0233	0.0460	-0.2893	0.0344	-0.2110	-0.0660	-0.0664	-0.0664
quarter_d~10	-0.0709	-0.0257	-0.0460	0.0880	-0.0417	-0.2451	-0.0664	-0.0668	-0.0668
quarter_d~11	-0.1760	0.1040	-0.0900	0.2518	0.0607	-0.2254	-0.0668	-0.0672	-0.0672
quarter_d~12	0.0908	0.0917	0.0313	-0.1582	-0.0534	-0.0866	-0.0668	-0.0672	-0.0672
quarter_d~13	0.2937	0.1117	0.0767	-0.2209	0.0344	0.0667	-0.0660	-0.0664	-0.0664
quarter_d~14	0.0750	0.1039	-0.0385	0.0984	-0.0417	0.0876	-0.0664	-0.0668	-0.0668
quarter_d~15	-0.0190	0.1050	-0.0847	0.2478	0.0607	-0.1489	-0.0668	-0.0672	-0.0672
quarter_d~16	0.2333	0.0992	-0.0043	-0.1307	-0.0534	-0.4073	-0.0668	-0.0672	-0.0672

	quart~_5	quart~_6	quarte~7	quarte~8	quarte~9	quart~10	quart~11	quart~12	quart~13
quarter_d~_5	1.0000								
quarter_d~_6	-0.0664	1.0000							
quarter_du~7	-0.0668	-0.0668	1.0000						
quarter_du~8	-0.0668	-0.0668	-0.0672	1.0000					
quarter_du~9	-0.0660	-0.0660	-0.0664	-0.0664	1.0000				
quarter_d~10	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	1.0000			
quarter_d~11	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	1.0000		
quarter_d~12	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	1.0000	
quarter_d~13	-0.0660	-0.0660	-0.0664	-0.0664	-0.0656	-0.0660	-0.0664	-0.0664	1.0000
quarter_d~14	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	-0.0664	-0.0668	-0.0668	-0.0660
quarter_d~15	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664
quarter_d~16	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664

	quart~14	quart~15	quart~16
quarter_d~14	1.0000		
quarter_d~15	-0.0668	1.0000	
quarter_d~16	-0.0668	-0.0672	1.0000

SE4 2019-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~_2	quart~_3	quart~_4
log_consum~w	1.0000								
log_price	0.3122	1.0000							
log_wind_s~d	0.2499	-0.2005	1.0000						
log_temper~e	-0.2782	-0.0509	-0.0311	1.0000					
work_day_d~y	0.1151	0.0791	-0.0147	0.0928	1.0000				
log_fixed_~t	-0.1066	-0.2560	0.0586	0.0139	0.0380	1.0000			
quarter_d~_2	-0.0850	-0.0532	-0.0252	0.1087	-0.0417	0.2182	1.0000		
quarter_d~_3	-0.1501	-0.0180	-0.0609	0.2517	0.0607	0.2274	-0.0668	1.0000	
quarter_d~_4	0.0267	-0.0069	0.0302	-0.1118	-0.0534	0.2070	-0.0668	-0.0672	1.0000
quarter_d~_5	0.0902	-0.1593	0.1204	-0.1791	0.0348	0.1834	-0.0664	-0.0668	-0.0668
quarter_d~_6	-0.1240	-0.2204	-0.0042	0.0943	-0.0417	0.1392	-0.0664	-0.0668	-0.0668
quarter_du~7	-0.1580	-0.0952	-0.0645	0.2485	0.0607	0.1368	-0.0668	-0.0672	-0.0672
quarter_du~8	0.0450	-0.1211	0.0486	-0.0694	-0.0534	0.0927	-0.0668	-0.0672	-0.0672
quarter_du~9	0.1670	0.0099	0.0301	-0.3080	0.0344	0.0845	-0.0660	-0.0664	-0.0664
quarter_d~10	-0.0142	0.0001	-0.0266	0.0819	-0.0417	0.0246	-0.0664	-0.0668	-0.0668
quarter_d~11	-0.1034	0.1154	-0.0724	0.2642	0.0607	0.0383	-0.0668	-0.0672	-0.0672
quarter_d~12	0.1143	0.1019	0.0131	-0.1505	-0.0534	-0.0571	-0.0668	-0.0672	-0.0672
quarter_d~13	0.1562	0.0991	0.0686	-0.2275	0.0344	-0.1351	-0.0660	-0.0664	-0.0664
quarter_d~14	-0.0240	0.1381	-0.0382	0.0806	-0.0417	-0.2009	-0.0664	-0.0668	-0.0668
quarter_d~15	-0.1085	0.1218	-0.0848	0.2600	0.0607	-0.4304	-0.0668	-0.0672	-0.0672
quarter_d~16	0.1055	0.0727	-0.0029	-0.1159	-0.0534	-0.7223	-0.0668	-0.0672	-0.0672

	quart~_5	quart~_6	quarte~7	quarte~8	quarte~9	quart~10	quart~11	quart~12	quart~13
quarter_d~_5	1.0000								
quarter_d~_6	-0.0664	1.0000							
quarter_du~7	-0.0668	-0.0668	1.0000						
quarter_du~8	-0.0668	-0.0668	-0.0672	1.0000					
quarter_du~9	-0.0660	-0.0660	-0.0664	-0.0664	1.0000				
quarter_d~10	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	1.0000			
quarter_d~11	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	1.0000		
quarter_d~12	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	1.0000	
quarter_d~13	-0.0660	-0.0660	-0.0664	-0.0664	-0.0656	-0.0660	-0.0664	-0.0664	1.0000
quarter_d~14	-0.0664	-0.0664	-0.0668	-0.0668	-0.0660	-0.0664	-0.0668	-0.0668	-0.0660
quarter_d~15	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664
quarter_d~16	-0.0668	-0.0668	-0.0672	-0.0672	-0.0664	-0.0668	-0.0672	-0.0672	-0.0664

	quart~14	quart~15	quart~16
quarter_d~14	1.0000		
quarter_d~15	-0.0668	1.0000	
quarter_d~16	-0.0668	-0.0672	1.0000

SE3 and SE4 2019-2020

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quarte~2	quarte~3	quarte~4
log_consum~w	1.0000								
log_price	0.0511	1.0000							
log_wind_s~d	0.0655	-0.1765	1.0000						
log_temper~e	-0.1888	-0.0646	-0.0464	1.0000					
work_day_d~y	0.0468	0.0976	-0.0296	0.0784	1.0000				
log_fixed_~t	0.6059	0.2095	-0.0347	-0.0631	0.0304	1.0000			
quarter_du~2	-0.0297	0.0778	-0.0656	0.1568	-0.0610	0.3252	1.0000		
quarter_du~3	-0.0672	0.1525	-0.0987	0.3688	0.0889	0.2937	-0.1431	1.0000	
quarter_du~4	0.0401	0.1763	-0.0000	-0.2146	-0.0783	0.1596	-0.1431	-0.1440	1.0000
quarter_du~5	0.0687	-0.1512	0.1806	-0.2914	0.0509	-0.0439	-0.1422	-0.1430	-0.1431
quarter_du~6	-0.0417	-0.2961	-0.0459	0.1350	-0.0610	-0.2426	-0.1422	-0.1431	-0.1431
quarter_du~7	-0.0761	-0.0742	-0.1002	0.3696	0.0889	-0.2570	-0.1431	-0.1440	-0.1440
quarter_du~8	0.0418	-0.1111	0.0401	-0.1263	-0.0783	-0.4202	-0.1431	-0.1440	-0.1440

	quarte~5	quarte~6	quarte~7	quarte~8
quarter_du~5	1.0000			
quarter_du~6	-0.1422	1.0000		
quarter_du~7	-0.1430	-0.1431	1.0000	
quarter_du~8	-0.1431	-0.1431	-0.1440	1.0000

SE3 2019-2020

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quarte~2	quarte~3	quarte~4
log_consum~w	1.0000								
log_price	0.3326	1.0000							
log_wind_s~d	0.2347	-0.1825	1.0000						
log_temper~e	-0.3662	-0.1004	-0.0513	1.0000					
work_day_d~y	0.1398	0.0883	-0.0346	0.0673	1.0000				
log_fixed_~t	-0.0108	0.4159	-0.0403	-0.0055	0.0344	1.0000			
quarter_du~2	-0.1034	0.0943	-0.0736	0.1632	-0.0610	0.5023	1.0000		
quarter_du~3	-0.2289	0.1684	-0.0873	0.3622	0.0889	0.3996	-0.1431	1.0000	
quarter_du~4	0.1442	0.1923	-0.0235	-0.2293	-0.0783	0.2037	-0.1431	-0.1440	1.0000
quarter_du~5	0.2184	-0.1394	0.2061	-0.2788	0.0509	-0.1310	-0.1422	-0.1430	-0.1431
quarter_du~6	-0.1149	-0.3004	-0.0650	0.1424	-0.0610	-0.3605	-0.1422	-0.1431	-0.1431
quarter_du~7	-0.2704	-0.1219	-0.0850	0.3683	0.0889	-0.3763	-0.1431	-0.1440	-0.1440
quarter_du~8	0.1258	-0.1410	0.0300	-0.1213	-0.0783	-0.5304	-0.1431	-0.1440	-0.1440

	quarte~5	quarte~6	quarte~7	quarte~8
quarter_du~5	1.0000			
quarter_du~6	-0.1422	1.0000		
quarter_du~7	-0.1430	-0.1431	1.0000	
quarter_du~8	-0.1431	-0.1431	-0.1440	1.0000

SE4 2019-2020

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quarte~2	quarte~3	quarte~4
log_consum~w	1.0000								
log_price	0.3081	1.0000							
log_wind_s~d	0.2716	-0.1743	1.0000						
log_temper~e	-0.2050	-0.0394	-0.0465	1.0000					
work_day_d~y	0.1319	0.1072	-0.0246	0.0913	1.0000				
log_fixed_~t	-0.0455	0.2136	-0.0018	0.0111	0.0551	1.0000			
quarter_du~2	-0.0699	0.0615	-0.0577	0.1517	-0.0610	0.3455	1.0000		
quarter_du~3	-0.1631	0.1372	-0.1101	0.3803	0.0889	0.4104	-0.1431	1.0000	
quarter_du~4	0.0906	0.1608	0.0232	-0.2011	-0.0783	0.2475	-0.1431	-0.1440	1.0000
quarter_du~5	0.1813	-0.1636	0.1554	-0.3084	0.0509	0.0685	-0.1422	-0.1430	-0.1431
quarter_du~6	-0.1260	-0.2930	-0.0269	0.1286	-0.0610	-0.2835	-0.1422	-0.1431	-0.1431
quarter_du~7	-0.1744	-0.0265	-0.1154	0.3752	0.0889	-0.3107	-0.1431	-0.1440	-0.1440
quarter_du~8	0.1169	-0.0815	0.0501	-0.1333	-0.0783	-0.6625	-0.1431	-0.1440	-0.1440

	quarte~5	quarte~6	quarte~7	quarte~8
quarter_du~5	1.0000			
quarter_du~6	-0.1422	1.0000		
quarter_du~7	-0.1430	-0.1431	1.0000	
quarter_du~8	-0.1431	-0.1431	-0.1440	1.0000

SE3 and SE4 2021-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~10	quart~11	quart~12
log_consum~w	1.0000								
log_price	0.0409	1.0000							
log_wind_s~d	0.0575	-0.2198	1.0000						
log_temper~e	-0.2070	-0.0611	-0.0136	1.0000					
work_day_d~y	0.0265	0.0665	0.0022	0.0942	1.0000				
log_fixed_~t	0.6586	-0.0833	0.0114	-0.0832	0.0344	1.0000			
quarter_d~10	-0.0467	-0.1170	-0.0328	0.1340	-0.0609	0.1175	1.0000		
quarter_d~11	-0.0941	0.0378	-0.0992	0.3686	0.0890	0.1332	-0.1433	1.0000	
quarter_d~12	0.0236	0.0214	0.0537	-0.1909	-0.0782	0.0999	-0.1433	-0.1442	1.0000
quarter_d~13	0.0826	0.0335	0.1282	-0.2853	0.0503	0.0805	-0.1415	-0.1424	-0.1424
quarter_d~14	-0.0144	0.0528	-0.0360	0.1405	-0.0609	0.0399	-0.1424	-0.1433	-0.1433
quarter_d~15	-0.0580	0.0425	-0.1047	0.3630	0.0890	-0.1815	-0.1433	-0.1442	-0.1442
quarter_d~16	0.0554	0.0075	0.0156	-0.1490	-0.0782	-0.4539	-0.1433	-0.1442	-0.1443

	quart~13	quart~14	quart~15	quart~16
quarter_d~13	1.0000			
quarter_d~14	-0.1415	1.0000		
quarter_d~15	-0.1424	-0.1433	1.0000	
quarter_d~16	-0.1424	-0.1433	-0.1442	1.0000

SE3 2021-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~10	quart~11	quart~12
log_consum~w	1.0000								
log_price	0.3350	1.0000							
log_wind_s~d	0.2409	-0.2294	1.0000						
log_temper~e	-0.4623	-0.0967	-0.0073	1.0000					
work_day_d~y	0.0675	0.0597	0.0096	0.0944	1.0000				
log_fixed_~t	0.0968	0.0269	0.0421	-0.0294	0.0220	1.0000			
quarter_d~10	-0.2242	-0.1298	-0.0482	0.1386	-0.0609	-0.2181	1.0000		
quarter_d~11	-0.3895	0.0342	-0.1139	0.3623	0.0890	-0.1727	-0.1433	1.0000	
quarter_d~12	0.0280	0.0185	0.0677	-0.1971	-0.0782	0.1339	-0.1433	-0.1442	1.0000
quarter_d~13	0.3468	0.0451	0.1353	-0.2826	0.0503	0.4681	-0.1415	-0.1424	-0.1424
quarter_d~14	0.0040	0.0346	-0.0370	0.1527	-0.0609	0.5163	-0.1424	-0.1433	-0.1433
quarter_d~15	-0.1437	0.0355	-0.1060	0.3568	0.0890	-0.0038	-0.1433	-0.1442	-0.1442
quarter_d~16	0.2511	0.0281	0.0144	-0.1596	-0.0782	-0.5744	-0.1433	-0.1442	-0.1443

	quart~13	quart~14	quart~15	quart~16
quarter_d~13	1.0000			
quarter_d~14	-0.1415	1.0000		
quarter_d~15	-0.1424	-0.1433	1.0000	
quarter_d~16	-0.1424	-0.1433	-0.1442	1.0000

SE4 2021-2022

	log_co~w	log_pr~e	log_wi~d	log_te~e	work_d~y	log_fi~t	quart~10	quart~11	quart~12
log_consum~w	1.0000								
log_price	0.2884	1.0000							
log_wind_s~d	0.2492	-0.2142	1.0000						
log_temper~e	-0.3393	-0.0345	-0.0240	1.0000					
work_day_d~y	0.0997	0.0734	-0.0047	0.0949	1.0000				
log_fixed_~t	-0.0139	-0.0901	0.0418	-0.0427	0.0643	1.0000			
quarter_d~10	-0.0771	-0.1048	-0.0181	0.1303	-0.0609	0.2859	1.0000		
quarter_d~11	-0.2136	0.0415	-0.0853	0.3788	0.0890	0.3071	-0.1433	1.0000	
quarter_d~12	0.1187	0.0243	0.0404	-0.1861	-0.0782	0.1705	-0.1433	-0.1442	1.0000
quarter_d~13	0.1832	0.0220	0.1214	-0.2908	0.0503	0.0556	-0.1415	-0.1424	-0.1424
quarter_d~14	-0.0920	0.0710	-0.0351	0.1286	-0.0609	-0.0370	-0.1424	-0.1433	-0.1433
quarter_d~15	-0.2214	0.0497	-0.1035	0.3731	0.0890	-0.3643	-0.1433	-0.1442	-0.1442
quarter_d~16	0.1053	-0.0129	0.0168	-0.1389	-0.0782	-0.7825	-0.1433	-0.1442	-0.1443

	quart~13	quart~14	quart~15	quart~16
quarter_d~13	1.0000			
quarter_d~14	-0.1415	1.0000		
quarter_d~15	-0.1424	-0.1433	1.0000	
quarter_d~16	-0.1424	-0.1433	-0.1442	1.0000

OLS Model 1 regression results

OLS	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Log(price)	0.071**	0.071***	0.071***	0.039*	0.041***	0.038***	0.053	0.057***	0.049***
	(0.00154)	(0.00760)	(0.00852)	(0.000195)	(0.00323)	(0.00312)	(0.00245)	(0.00383)	(0.00311)
Control for temperature	No	No	No	No	No	No	No	No	No
Control for working days	No	No	No	No	No	No	No	No	No
Controls for share of fixed price contracts	No	No	No	No	No	No	No	No	No
Controls for time trend	No	No	No	No	No	No	No	No	No
Adj. R^2	0.102	0.111	0.095	0.096	0.112	0.083	0.119	0.144	0.097
N	35088	17544	17544	35040	17520	17520	70128	35064	35064

OLS Model 2 regression results

OLS	Log(consumption < 50MW)								
	2019-2020			2021-2022			2019-2022		
	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4	SE3 & SE4	SE3	SE4
	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Log(price)	0.074*	0.075***	0.072***	0.035**	0.035***	0.035***	0.046*	0.050***	0.044***
	(0.00154)	(0.00970)	(0.00899)	(0.000195)	(0.00323)	(0.00303)	(0.00245)	(0.00337)	(0.00306)
Control for temperature	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for working days	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for share of fixed price contracts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for time trend	No	No	No	No	No	No	No	No	No
Adj. R^2	0.204	0.264	0.159	0.251	0.313	0.204	0.236	0.311	0.181
N	35088	17544	17544	35040	17520	17520	70128	35064	35064

Average percentage of missing values per measure point in data sets regarding temperature and wind speed

Average percentage of missing per measure point for temperature			
	SE3 & SE4	SE3	SE4
2019-2022	0,4%	0,4%	0,4%
2019-2020	0,4%	0,2%	0,6%
2021-2022	0,4%	0,5%	0,2%

Average percentage of missing per measure point for wind speed			
	SE3 & SE4	SE3	SE4
2019-2022	0,6%	0,4%	0,4%
2019-2020	0,6%	0,3%	0,2%
2021-2022	0,5%	0,6%	0,5%