

POWER ABUSE



CANDOLE RESEARCH

Power Abuse

ČEZ and the abuse of dominant market power

By Jan Ondřich and Martin Bebiak

June 2011

Acknowledgements

Many thanks to Candole analysts Razvan Grecu and Jana Hays for their help in researching this study, and to those market participants happy to share their thoughts with us. We thank Roman Binter of the Department of Statistics at the London School of Economics for his comments. Special thanks to James de Candole for editing the text.

Authors

Jan Ondřich is a partner and leads the analytical work of the firm. He holds an MSc from the London School of Economics. He is the author of our earlier study, ČEZ Unplugged (March 2010).

Martin Bebiak is an analyst. He specialises in competition and market analysis in the area of electricity generation and trading. He holds a Master in Economics from the Vienna University of Economics and Business.

For further information, please visit www.candole.com

Disclaimer

This study was not commissioned and has been produced by Candole Partners for information purposes only. The details listed herein are indicative only and may be amended at any time. Candole Partners provides no guarantee as to the accuracy or completeness of this study and does not accept liability for losses that might arise from making use of the information contained herein. It does not constitute an offer and is not a recommendation by Candole Partners to buy or sell securities, related financial instruments or to participate in any particular investment or trading strategy in any jurisdiction. Indications of past performance are no guarantee of a positive performance in the future. The analysis and conclusions contained in this report were established by Candole Partners and may have already been used for other reports. The opinions expressed herein are those of Candole Partners at the time of writing and do not directly benefit any of Candole Partner's clients and are in no way indicative of opinions of any of Candole Partners clients. Candole Partners does not work for any coal-mining companies. Candole Partners is not involved in any investment or trading strategy, proprietary or on behalf of any of its clients, in any asset classes which would benefit from dissemination of any opinion contained in this study. We reserve the right to make amendments. This report may not be reproduced either in whole or in part without the written permission of Candole Partners.

Copyright 2011 Candole Partners. Cover image by www.dobrovodsky.cz

TABLE OF CONTENTS

1. Introduction.....	4
2. Market Power and Consumer Loss	6
3. Relevant Market: Czech or European?.....	8
3.1. Interconnectors used to full capacity.....	9
3.2. Similar prices, different price dynamics.....	11
4. Market Concentration: No competition.....	19
4.1. Herfindahl Hirschman Index	19
4.2. Residual Supply Index.....	20
5. Concentrated at each level	22
5.1. Vertical foreclosure	22
5.2. Margin squeeze	24
6. Conclusion	28
Works Cited	30

1. INTRODUCTION

In an earlier study, [ČEZ Unplugged](#) (March 2010), we explained reasons for ČEZ's profitability, which is unmatched by its peers with comparable fuel mix. We concluded that these abnormally high profit margins can be attributed to exogenous factors quite independent of the quality of the firm's management. The most important of these is the fact that ČEZ is able to sell its output at German prices, while enjoying the Czech cost base. German electricity price is relatively high because German producers will have to bear the full cost of carbon from 2013; the fact that environmental charges are much higher in Germany than in the Czech Republic; the relatively high share of gas in the German fuel mix; and the German decision not to continue its nuclear program. ČEZ's exposure to these risks is marginal.

Furthermore, we argued that the most important reason for ČEZ's ability to charge German prices while enjoying a Czech cost base is its dominant market power at home. We speculated that the European wholesale electricity market may not yet be fully functional and therefore ČEZ's potential dominant position should be considered in a Czech, not European context. And finally we touched upon the relationship between market concentration and price cost mark-ups, which may explain ČEZ's exceptional profit margins.

In Power Abuse, we go further and explain in more detail how ČEZ's dominant market power allows it to earn margins which are significantly higher than those of its peers. In Chapter 3, we define the relevant market for assessing whether ČEZ has the dominant market power, and whether and to what extent it abuses its power. We run various tests commonly used by the US Justice Department, Ofgem and the European Commission for example, and conclude that the Czech market is the relevant market for the purpose of competition analysis. We consider this conclusion to be the most valuable contribution of the study. It directly contradicts ČEZ's frequent and unsubstantiated assertion that the relevant market is the European market. The fact that ČEZ's relevant market is the Czech Republic should have profound consequences for Czech government policy in the energy sector. We explore what these consequences might be in our concluding remarks.

In Chapter 4, we measure market concentration on the Czech market using the Herfindahl Hirschman Index and the Residual Supply Index. Both measures show that the Czech Republic has one of the most concentrated markets in Europe, comparable only to France and Belgium. The Residual Supply Index shows that the combined generation capacities of ČEZ's competitors are unable to satisfy Czech

demand. In peak hours in winter for example, ČEZ's competitors are able to cover only 30% of demand. As a result, ČEZ is the pivotal supplier in the Czech Republic and the potential for market abuse is high.

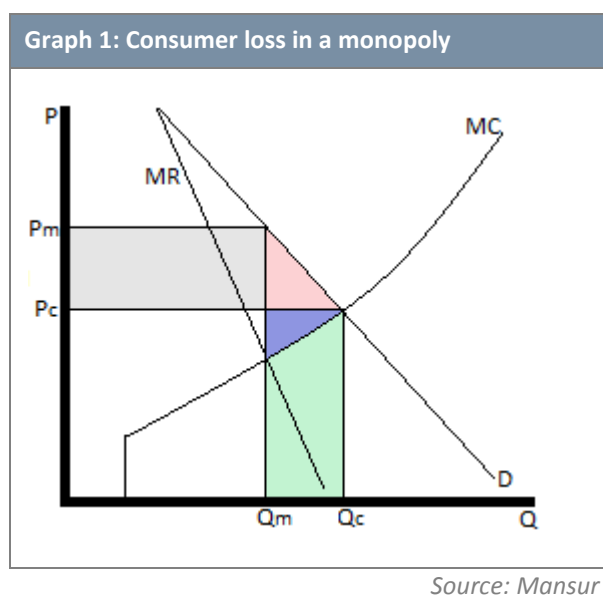
We then quantify the price cost mark-up ČEZ is able to generate over its marginal costs as a result of this dominance. German producers, who compete on an oligopolistic market, have price cost mark-ups of around 20-50%. We calculate that ČEZ's price cost mark-up is 220%, the highest value of any European country surveyed by London Economics in its seminal study issued by the European Commission in 2007. Perhaps even more shocking than ČEZ's price cost mark-up is the fact that electricity on the day-ahead market in Prague is more expensive than in Germany for almost half of hours in a year, contrary to the widely-held belief in the Czech Republic that Czech prices are the same or lower than German prices.

In Chapter 5, we show the effects of the monopolistic wholesale electricity market in the Czech Republic. We indicate that as a result of its dominant market power in the generation sector, ČEZ is able to preserve its margin at the expense of other market participants and consumers by engaging in two forms of uncompetitive behaviour: vertical foreclosure and margin squeeze. ČEZ is able to prevent new market entrants from entering the market and from taking advantage of the unusually high spread between marginal costs of production and prevailing electricity price in the Czech Republic. It can do this because it is vertically integrated and enjoys the dominant position on the most important market in the value chain - electricity generation.

There are strong indications that ČEZ uses the practice of margin squeeze to keep the margins low in both the lignite and the retail sectors. Lignite is the most important fuel in the Czech Republic since the Czech marginal power plant is the lignite-fired plant. Our findings in this area remain inconclusive because the data necessary for running formal tests is private accounting. The national competition authority, however, may demand this data from market participants. The Czech competition office has recently started a formal inquiry into the functioning of the Czech energy sector and we may expect that it shall succeed in proving beyond reasonable doubt what we have been able only to surmise in the area of margin squeeze.

2. MARKET POWER AND CONSUMER LOSS

There are several advantages to competition in the electricity generation market. Generators must bid their lowest price and use scarce resources efficiently in order to survive on the competitive market. Consumers benefit through lower electricity price and profit margins are distributed evenly between generators and customers. In economic theory, this distributional effect is described as welfare transfer from producers to consumers (Green and McDaniel 1998). This concept is shown in Graph 1.



Producers in the competitive market are price takers. Price in perfectly competitive market equals marginal costs of the marginal producer (the additional producers needed to produce electricity to satisfy given demand). In comparison, the monopolist maximises his profits by setting his marginal costs so that they equal his marginal revenues. When compared to a perfectly competitive market, a monopoly produces a lower quantity for a higher price. In a monopolistic market, the loss to society as a result of higher- than-optimum price and lower-than-optimum quality supplied is shown by the pink triangle (consumer surplus¹) and blue triangle (producer surplus²). The gray box is the surplus profit the monopolist earns and which consumers must pay. All this is caused by the misallocation of resources by the monopoly and its ability to dictate the price in the market.

Economic literature has made numerous contributions to proving the gains achieved by introducing competition in the electricity markets. These gains have been quantified similarly both in the United

¹ The utility derived from the difference between the customer's willingness to pay and the actual price he pays for the good.

² The difference between the price the producer is willing to sell the good for and the actual price he sells it for.

States and Europe. For example, Fabra and Toro (2004) use regression analysis to show that the increase of competition in the electricity generation markets of England led to a reduction of price mark-ups. Similar findings were made by Bower (2002). A commonly cited study by London Economics dealt with this issue by inspecting the electricity markets of six different European countries. Among its many conclusions, it found that competitive markets have considerably lower price mark-ups than concentrated markets. While the uncompetitive French electricity market had a price mark-up of around 149.6%, the more competitive German market had a considerably smaller price mark-up of 20-50% (London Economics 2007).

Lower prices and higher consumer welfare are not the only benefits of competitive markets. It is believed that stronger competition helps increase the efficiency of firms. This leads to better resource efficiency, less pollution and more investments into newer technologies. The European Union passed three liberalization packages in an attempt to increase competition, transparency and enable the creation of a common electricity market.

Our study focuses on potential competition issues in the Czech electricity sector. Our analytical methods are those used by regulatory offices and competition authorities in Europe and the United States specifically for the electricity sector. Our research considers both the horizontal structure of the generation sector, as well as effects of vertical integration of the value chain.

3. RELEVANT MARKET: CZECH OR EUROPEAN?

The definition of the relevant product and geographical market is the first step in competition analysis. In particular, before we proceed with the analysis of whether ČEZ is the dominant market participant, we must first define which market is relevant as our reference point. Defining the product market is a simple task, since electricity is a homogenous good and impossible to differentiate for the end consumer.

On the other hand, defining the geographic market is a trickier task. The relative difficulty of identifying clearly the relevant wholesale electricity market is what allows ČEZ to refute competition-related criticism: It simply refers to an alleged European wholesale electricity market of which it controls less than 4% (ČEZ a.s. 2011). Surprisingly, the Czech authorities continue to take this assertion at face value, without demanding proof of why a European market should be treated as relevant for competition analysis.

In this chapter we test the assumption that the Czech Republic is part of a wider European market. We do this in two ways. First, we analyse bidding for interconnector capacities. Congestion of these interconnectors would mean that trading between countries is limited, and thus the assumption that the Czech Republic is part of a European market is weakened. Second, we test the European market assumption by analysing the convergence of electricity prices between the Czech Republic and Germany, a continental trading hub.

Since electricity is a homogenous good, prices in the Czech Republic equal those in Germany if the two countries are part of the same market. If Czech prices differ from German prices, the assumption of the European market must be rejected.

There are four possible outcomes in our analysis:

1. **Abundant interconnector capacities, equal prices.** This means there is a functioning European market and ČEZ's market power should be assessed in the context of the European market.
2. **Abundant interconnector capacities, different prices.** This would mean that functioning of the market may be hampered either by grid bottlenecks within countries or by behaviour such as transmission withholding.
3. **Shortage of interconnector capacities, different prices.** Under this outcome, the Czech Republic is clearly the relevant market.

4. **Shortage of interconnector capacities, equal prices.** This may be caused by two factors. First, such a situation may arise if the price of inputs and load curves are equal in both markets – i.e. producers in both countries face the same marginal costs and demand curves. Second, if variable costs and demand curves vary, such an outcome may be caused by collusion between producers in the lower-marginal cost country, which would be bidding their output in a way which would copy price development in a higher marginal cost country.

3.1. Interconnectors used to full capacity

In this section we analyse whether interconnector capacities linking the Czech Republic to neighbouring markets are enough to satisfy cross-border trade, enabling the European market to function properly. At first glance, the Czech electricity market seems to be well connected to its neighbours. In 2009, all generators in the Czech Republic produced 82,250 GWh of electricity of which 22,230 GWh were exported. Therefore around a quarter of electricity production was exported, while 8,586 GWh of electricity were imported (Energetický regulační úřad 2010). The export figures also include transit electricity. The net transfer capacity³ of Czech interconnectors is listed for summer 2010 in the table below. The NTC export capacity of 5,800 MW seems high considering the Czech total installed generation capacity of 18,300 MW (2009). However, we show later in this study that these capacities are not sufficient to cover all flows of electricity between the Czech Republic and neighbouring countries.(ENTSO-E 2011)

	Import	Export
Germany	800	2,100
Austria	600	800
Slovakia	1,100	2,100
Poland	1,900	800

Source: ENTSO-E

A functioning European market means that electricity can be traded between different countries without any restrictions in interconnector capacities. As a result, if interconnector capacity demand exceeds supply, then the interconnectors are congested and the regional market is dysfunctional. We test this assumption by comparing demand for interconnectors to actual available capacities. We use data provided by the Central Allocation Office, which organises the auctioning of interconnector capacities of the Czech Republic and neighbouring countries. There are three types of auctions for

³This is the maximum capacity exchange between two countries taking into account certain security standards and technical uncertainties on future network conditions. (ENTSO-E 2011)

capacities: yearly, monthly and daily. The results for 2010 yearly auctions are presented in Table 2 below.

Direction	Number of Auction Participants	Number of Bids	Total Requested Capacity (MW)	Total Promise of Capacity (MW)	Capacity Ratio Requested / Promise	Auction Price (EUR/MWh)
ČEPS → 50HzT	26	167	1,800	305.0	5.9	1.95
50HzT → ČEPS	22	89	865	195.0	4.4	0.23
ČEPS → TENNET	30	189	2,116	450.0	4.7	2.08
TENNET → ČEPS	26	102	1,070	200	5.4	0.23
ČEPS → PSEO	0	0	0	0	0	0.00
PSEO → ČEPS	12	97	645.0	45.0	14.3	2.16

Source: Central Allocation Office, Own calculations

Even though the net transfer capacity of Czech interconnectors appeared to have been large at first glance, the auctions of yearly capacities show that demand clearly exceeds the available capacity. The situation is especially critical with Polish capacities to the Czech Republic, where demand is 14.3 times higher than the available capacity. This problem prevails with all interconnectors, with the exception of Czech capacities to Poland, where there is no demand. A similar situation prevails at auctions for monthly as well as daily capacities, which are summarised in the tables below. Data for daily auctions are calculated for the first quarter of 2011, as data on daily auctioning is available from January 2011.

In summary, these results throw doubt upon the assumption of a single European electricity market. We expect prices to vary between the Czech Republic and Germany because there is no single market. We shall now test this assumption.

Direction	Number of Auction Participants	Number of Bids	Total Requested Capacity (MW)	Total Promise of Capacity (MW)	Capacity Ratio Requested / Promise	Auction Price (EUR/MWh)
ČEPS → 50HzT	18.9	90.7	1,199.8	386.3	3.4	1.00
50HzT → ČEPS	9.9	23.8	321.8	96.7	3.3	0.19
ČEPS → TENNET	22.1	104.5	1,536.3	413.8	3.8	1.04
TENNET → ČEPS	11.3	25.4	352.8	93.8	3.8	0.23
ČEPS → PSEO	0	0	0	0	0	0
PSEO → ČEPS	15.5	69.5	664.8	203.3	4.1	0.6

Source: Central Allocation Office, Own Calculations

Table 4: Daily Interconnector Auctions in 2010

Daily Auctions Q1 2011	Number of Auction Participants	Total Requested Capacity (MW)	Total Promise of Capacity (MW)	Capacity Ratio Requested / Promise	Auction Price (EUR/MWh)
ČEPS → 50HzT	10.2	780.9	149.5	5.2	2.23
50HzT → ČEPS	10.1	1,441.3	1,149.4	1.3	0.01
ČEPS → TENNET	11.9	889.8	270.3	3.3	1.40
TENNET → ČEPS	13.7	1,820.7	1,420.5	1.3	0.01
ČEPS → PSEO	6.1	374.3	211.6	1.8	1.10
PSEO → ČEPS	8.1	671.7	437.6	1.5	1.67

Source: Central Allocation Office, Own calculations

3.2. Similar prices, different price dynamics

In this section, we shall demonstrate that the relevant market for ČEZ is not European but Czech. In competition economics, if the correlation between two prices is 0.8 or higher, then the products in question are assumed to belong to the same market. If the correlation is below this threshold, then the markets are considered to be separate. Applying the correct methodology, which we describe in detail below, we estimate the coefficient to be 0.2, which shows that the Czech and German wholesale electricity markets are separate. ČEZ's assertion that it operates in a European market is based upon a simplistic comparison of averaged nominal prices. This approach violates the ground rules of statistical analysis.

At this point, we would recommend the general reader to skip to the last paragraph of this section to be found on page 18.

So let us now test our working assumption that the Czech Republic and Germany are separate markets based upon price correlations. Generally, European and U.S. competition law use the SSNIP test (Small but Significant Non-transitory Increase in Price) to define the relevant market. The purpose of this test is to establish whether a small change in price would motivate the customer to switch his supplier (U.S. Department of Justice and Federal Trade Commission 2010). In our case we test if a firm in the Czech Republic can increase its price without having to fear competition from neighbouring countries. If this were true, a customer could not switch to a non-Czech supplier when the Czech company increases its price significantly (Juselius and Stenbacka 2008).

If products in two markets belong to the same market, their prices will be strongly correlated over time (Stigler and Sherwin 1985). Generally, the higher the correlation between the two prices, the stronger the proof that both geographic areas belong to the same relevant market. Normally, academic literature gives a price correlation coefficient of more than 0.8 as an indication that the goods are

competing in the same market (Motta 2004). This methodology is based on the theory of arbitrage in international trade: If there is free trade, arbitrage between the markets will erode price difference, and prices in the two markets would become equal (Zachmann 2005).

Let us now test the assumption of one market. First, we shall conduct a simple two-tailed t-test of difference in means. This will help to determine whether differences in prices between the Czech Republic and Germany are statistically significant and so allow us to reject a hypothesis of one market. The mean day-ahead price in the Czech Republic was €43.70 in 2010 and €44.48 in Germany. The mean off-peak prices were €33.66 in the Czech Republic and €38.64 in Germany and the mean peak-load prices were €50.75 and €50.33 respectively.

Table 5 below summarises the basic descriptive statistics of the two series. Given that the distribution of our series, just like any asset-price series, is fat-tailed, we also present median prices, since mean prices are somewhat misleading. The simple t-test rejects the null hypothesis, that the difference between the two means is zero, at the 5% significance level.⁴ The result of the test tells us, that in fact the two prices are different. This is our first indication that the assumption of the single market may not be sustainable.

	Base	Off-Peak	Peak
Czech Rep. (Mean)	€43.70 (1,105.17Kč)	€36.66 (927.13 Kč)	€50.75 (1,283.47Kč)
Czech Rep. (Median)	€45.00 (1,138.05Kč)	€38.00 (961.02Kč)	€50.44 (1,275.63Kč)
Germany (Mean)	€44.48 (1,124.90Kč)	€38.64 (977.21Kč)	€50.33 (1,272.85Kč)
Germany (Median)	€45.09 (1,140.33Kč)	€39.98 (1,011.09Kč)	€50.03 (1,265.26Kč)

Source: EEX and OTE, Own calculations

Exhibit 1: Relevance of day-ahead prices

We work with day-ahead prices for three sound reasons.

First, the day-ahead market trades a standardised product which is comparable across borders and in time. For example, prices for OTC contracts are not easily comparable because these contracts are all different in terms of the obligations they impose on the parties.

Second, the day-ahead market is liquid and flexible by which we mean it reacts immediately to changing market fundamentals (Zachmann 2005). For example, the PXE year-ahead futures market may be trading higher volume in certain hours, but there are a significant number of hours in which no

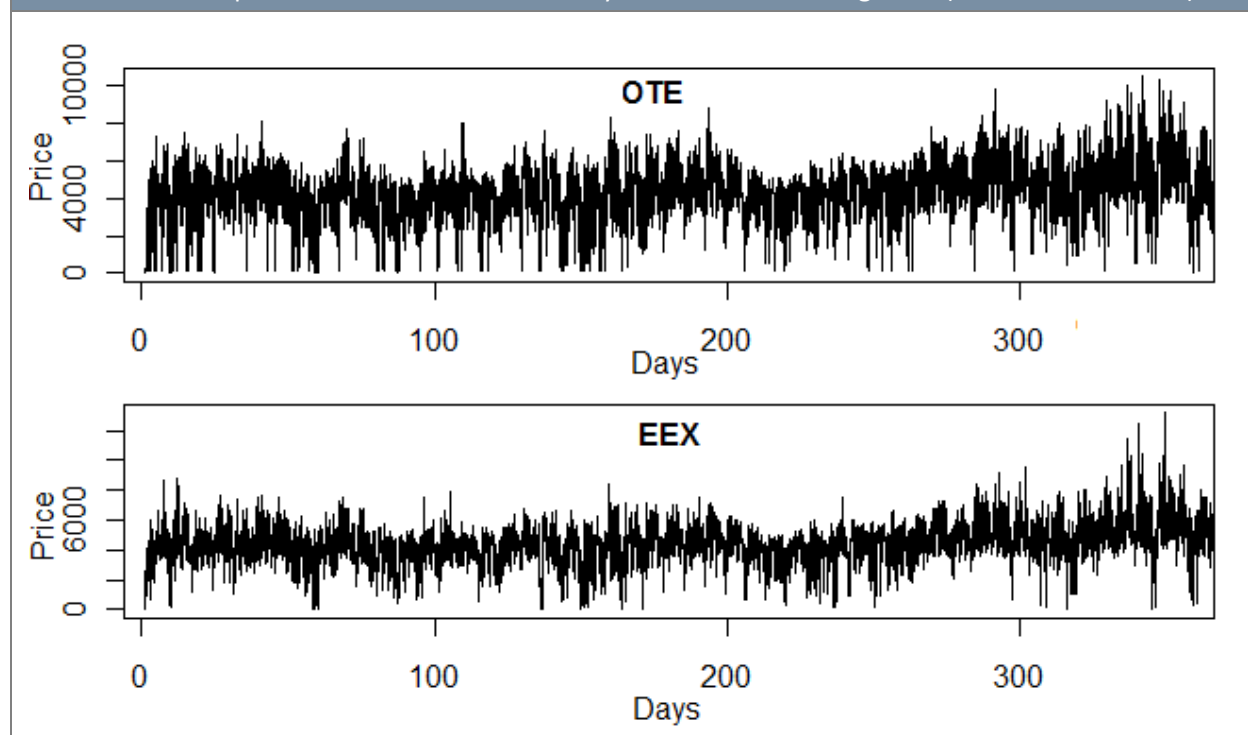
⁴ T Statistic = -3.531316251; p-value = 0.000414569

transactions occur. This means its price is not representative of short run market fundamentals.

Third, the day-ahead market can be defined as the marginal electricity market, the market which satisfies the residual demand. The day-ahead market is quite distinct from the OTC and year-ahead markets, from where base demand is supplied. The day-ahead market is precisely where we expect market participants to be realising their arbitrage opportunities stemming from momentary imbalances between demand and supply in the Czech Republic and Germany. In other words, in line with the Efficient Markets hypothesis, we can assume that OTC and year-ahead contract prices reflect all the market knowledge about future demand and supply conditions. If this assumption holds, arbitrage opportunities do not exist. This is because Czech and German market participants act on the same information. Given that electricity is a non-storable commodity, the short-lived deviations from equilibrium (or planned) supply and demand make hourly prices very volatile and this is where arbitrage opportunities emerge. If the Czech Republic and Germany can be assumed to be one market, arbitrage would quickly erode these deviations.

Our analysis of interconnector capacities shows that the interconnector capacity is limited, and therefore we expect prices to diverge, especially in peak times, and arbitrage between the Czech Republic and Germany to fail. At all levels of demand, the price should be set by the producer with the lowest marginal costs. If both markets show different prices, this demonstrates that arbitrage has failed and so we must reject the assumption of the single market. We plot the nominal data in Chart 1 below.

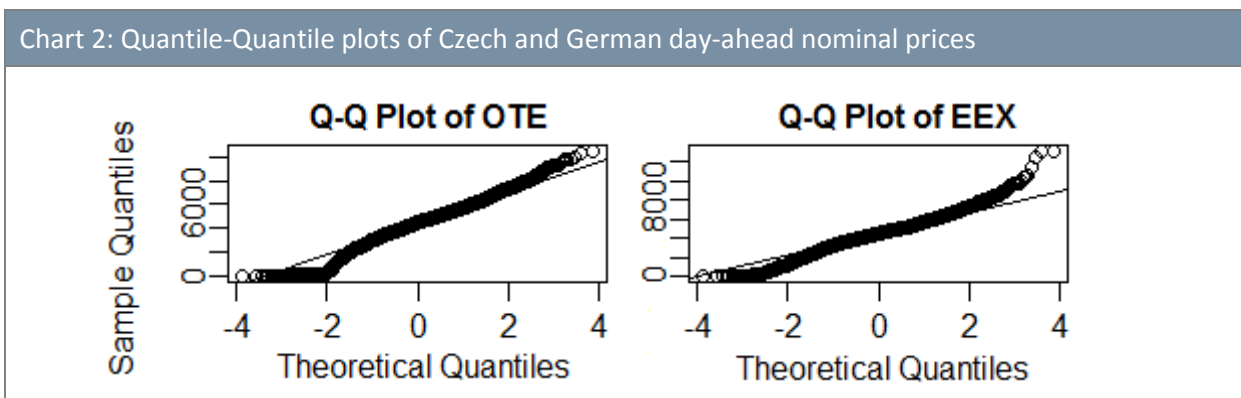
Chart 1: Nominal prices of Czech and German day-head markets during 2010 (Values in Eurocents)



Source: EEX and OTE, Own calculations

We use correlation⁵ and co-integration⁶ analysis of Czech and German hourly day-ahead prices over 2010 to establish whether the two markets should be considered as one market. Before calculating the necessary statistics, we need to clean the raw data so that the analysis produces robust and unbiased results.

The raw data exhibit two types of properties, which may lead to spurious correlation coefficients. In the first group of properties, depicted in Chart 2 and 3, we find fat-tails (leptokurtic distribution), heteroskedasticity, autocorrelation, and the effects of compounding. To address these properties, we apply logarithmic transformation to the data and, as a result, our data now approximate log-normal distribution.



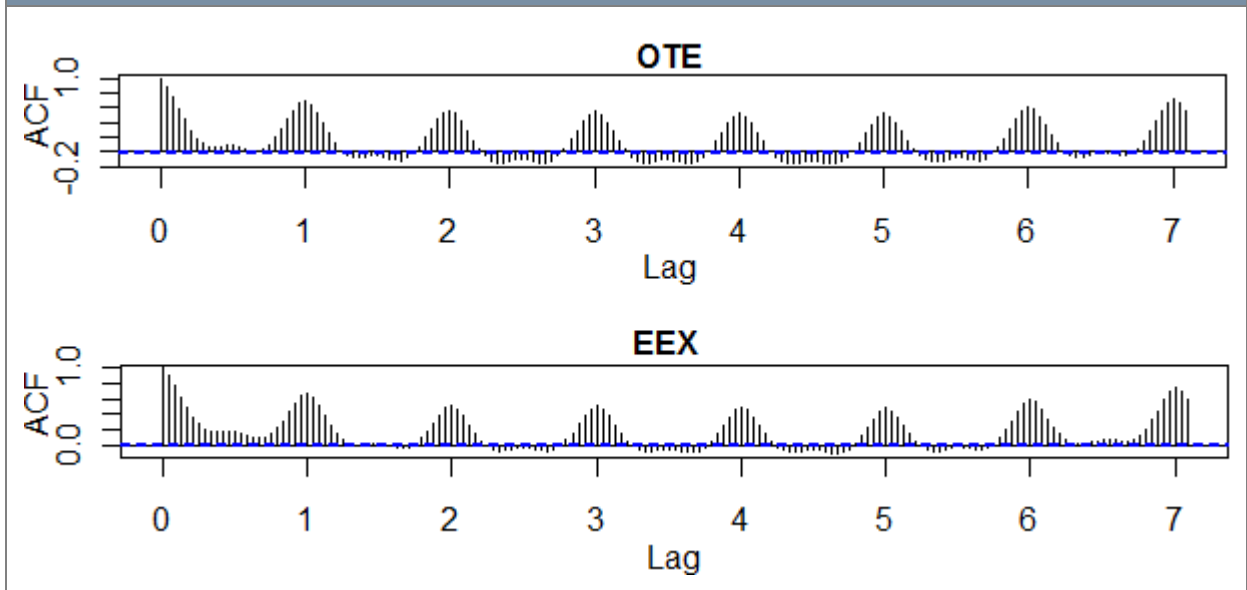
Source: EEX and OTE, Own calculations

In particular the strong autocorrelation shown in Chart 3 appears to have been one of the more important reasons for the overstated correlation. This is because there is a strong correlation between values of the same hour in the data series. For example, the price of electricity in the first hour of day 1 will be strongly correlated with the price in the first hour of day 2. There is also significant correlation between prices in adjacent hours, meaning autocorrelation decays only after a significant time span. Chart 3 below shows that there is a persistent correlation of electricity prices throughout the week.

⁵A statistic showing the linear dependence between two variables, (0= no correlation; 1= perfect positive correlation; -1=perfect negative correlation)

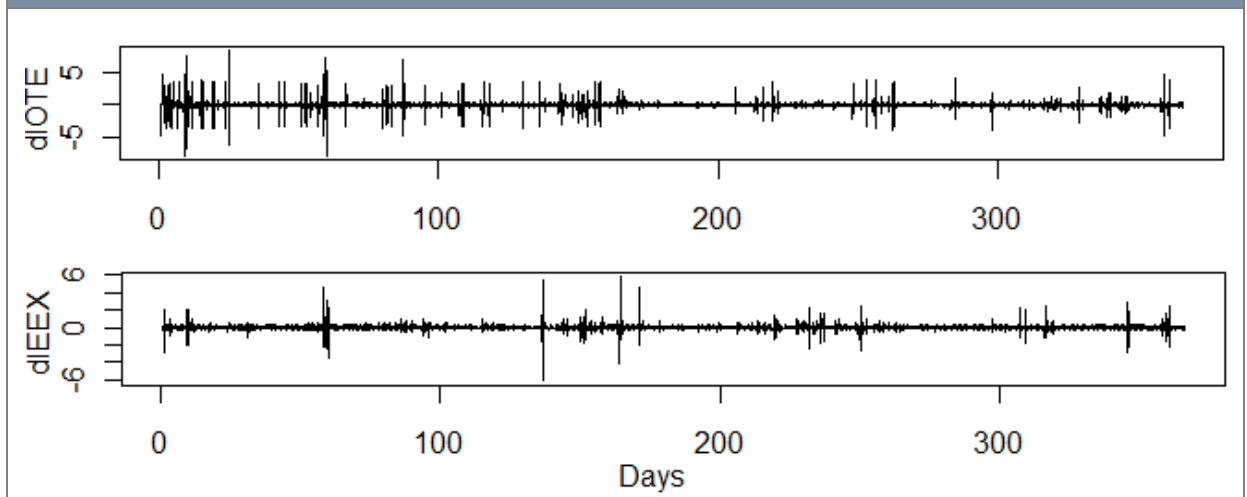
⁶ A property where two series are non-stationary, but the linear combination of both series is stationary.

Chart 3: Correlograms of Czech and German day-ahead nominal prices



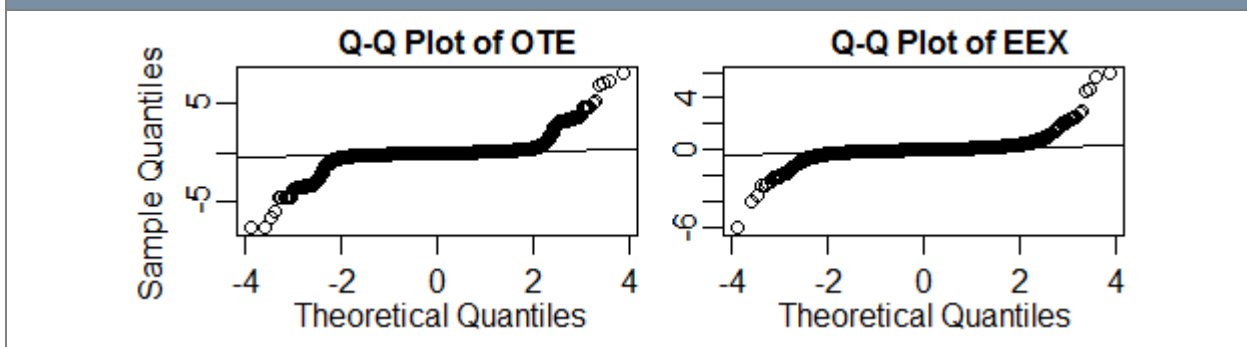
Source: EEX and OTE, Own calculations

Chart 4: First differences of logarithms of Czech and German day-head prices

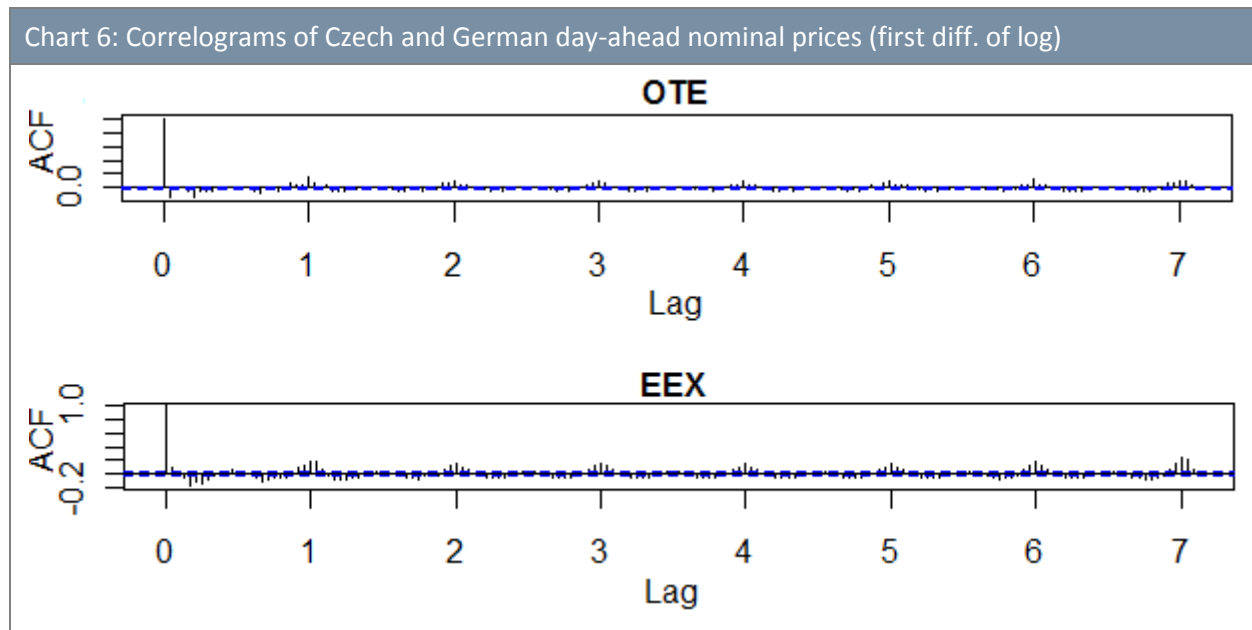


Source: EEX and OTE, Own calculations

Chart 5: Q-Q plots of Czech and German day-ahead prices (first diff. of log)

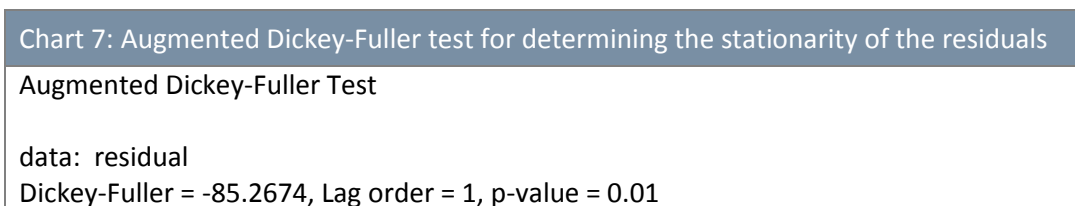


Source: EEX and OTE, Own calculations



Source: EEX and OTE, Own calculations

Second, the data are co-integrated. We test Czech and German prices for co-integration using the test proposed by Alexander (1999). We check whether the spread between the two price series is constant. We regress the logarithm of Czech and German day-ahead prices and obtain the residuals which we test for stationarity. If the residuals are stationary, this means that spread is indeed constant and the two series are co-integrated. The Augmented Dickey-Fuller test confirms stationarity and therefore the co-integration between both residuals of the two variables at the order of 1. We adopt a practice commonly used in financial markets analysis of asset prices, and work with log-returns of day-ahead prices to address these issues.



Source: Own calculations

Charts 4, 5 and 6 above present the data after logarithmic transformation and differencing. A quick glance at the transformed data and inspection of relevant statistics indicate that most of the deficiencies have now disappeared. Autocorrelation has been eliminated although a lag of one period is still present.

Table 6 below shows just how strongly biased the analysis of nominal data is. Based on a simplistic review, one would reach the conclusion that, indeed, the Czech Republic and Germany are one market.

Table 6: Result of correlation test between Czech and German nominal day-ahead prices

	Czech Republic – Germany
Correlation Coefficient	0.85

Source: EEX and OTE, Own calculations

The results of calculations using the correct methodology (summarised in Tables 7 and 8 below) show the extent to which the nominal data overstated the correlation. The correlation between the two countries has now become very weak, and is significantly below the threshold. Table 8 below shows the persistence of correlations based on the application of the correct methodology.

Table 7: Result of correlation test between Czech and German day-ahead prices (first diff. of log)

	Czech Republic – Germany
Correlation Coefficient	0.18

Source: EEX and OTE, Own calculations

Table 8: Correlation coefficients of Czech and German day-ahead prices (first diff. of log)

	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter
Correlation	0.24	0.15	0.20	0.12

Source: EEX and OTE, Own calculations

We shall now control for the extent to which the difference in prices may be explained by differences in load, and thus further verify the validity of the results. We test that the true difference in prices is in fact zero. We do this because the difference in prices might be explained by differences in the load curve of the respective countries.

German demand is significantly higher than Czech and for this reason we index the load curves. This ensures that they are at the same nominal level. We then transform the load data using the same method as for prices. We show the extent to which the difference in prices can be explained through the difference in loads, using OLS regression.

Indeed, our model shows that differences in load have statistically significant explanatory value for differences in price. The low R^2 shows that profiles of Czech and German load curves are so similar that differences in loads explain only 0.35% of variation in Czech-German prices. In addition, we calculate Generalised Least Squared regression to eliminate the effects of heteroskedasticity. This is because variance of the load curves is not constant. Table 9 below shows that differences between the two procedures are negligible.

Table 9: Result of OLS and WLS Regression between price and load differences		
Price Difference- Load Difference	Coefficient	R ²
OLS Regression	0.931***	0.0035
WLS Regression	0.926***	0.0035

Source: EEX, OTE and ENTSO-E, Own calculations

These results confirm our assertion that the Czech Republic and Germany are separate markets. In addition, our model rules out the possibility that price differences are caused by differences in loads. These price differences may be explained by differences in production costs. Prices will be higher in the country with higher production costs, other things being equal. Price differences may also be explained by differences in market structures. In general, microeconomic theory predicts that prices are higher in highly concentrated markets. In the following chapters, we explain which of these reasons causes the difference in prices in the two countries.

4. MARKET CONCENTRATION: NO COMPETITION

Market concentration and market power of firms can be measured using a number of methods. The assumption is that the more concentrated the market, the more likely the firms are capable of abusing their dominant position. In our study, we use two measures of market concentration. First we calculate Herfindahl Hirschman Index, which is used universally by competition authorities for various product markets. And secondly, we calculate the Residual Supply Index, which was developed specifically to address the particularities of the electricity sector and is used by scholars and regulators specialising in the sector.

4.1. Herfindahl Hirschman Index

The Herfindahl-Hirschman Index is a measure of market concentration used universally for various different markets. It is the sum of the squares of the individual companies' market shares active in the market. Due to the squaring of the market shares, it is more sensitive to markets dominated by one or few large companies. The following table shows the classifications for the results of the HHI used by competition authorities.

	Moderate Concentration	High Concentration
European Commission ⁷	>1,000	>2,000
U.S. Department of Justice ⁸	>1,500	>2,500

Source: European Commission and U.S. Department of Justice and Federal Trade Commission

The HHI was calculated by using installed capacity and yearly production as a measure for market share, yielding two similar results. Both values are for 2009, and are based on data provided by the publication "Annual Data Summary of Electric Power System of the Czech Republic 2009" from the Czech energy regulator (Energetický Regulační Úřad). Before calculating the HHI, we cleared the data of effects of cross-ownership between companies. The results are listed in the following table.

HHI	Based on Production	Based on Installed Capacity
Czech Republic ⁹	5,680	4,713

Source: Energetický Regulační Úřad, Own calculations

⁷ Values from (European Commission 2010)

⁸ Values from (U.S. Department of Justice and Federal Trade Commission 2010)

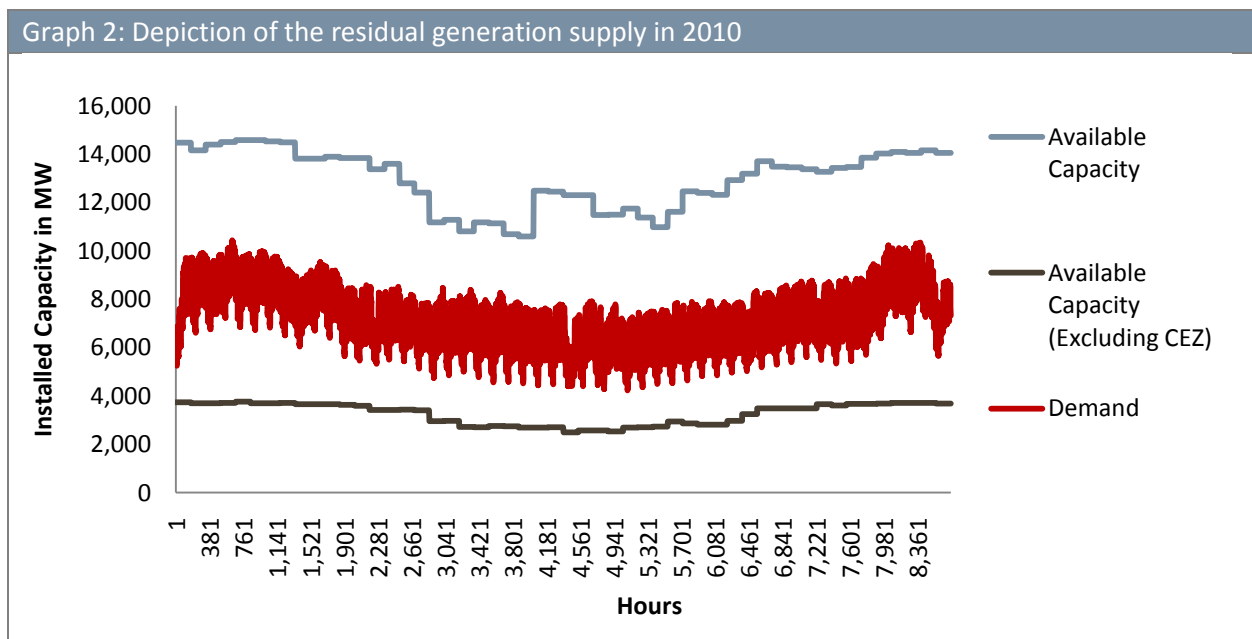
⁹ Calculated with data from (Energetický regulační úřad 2010)

Both values are significantly above the threshold considered to be indicative of high concentration. The results are high compared to other European countries. For example, Germany has an HHI of 1,914 based on installed capacity, while Great Britain has an HHI of 1,068. Belgium and France are the only European markets with as high a market concentration as the Czech Republic: Belgium with an HHI of 8,307 and France an HHI of 8,592 (London Economics 2007). Such a high concentration is caused by the large market share of the incumbent ČEZ, with accounts for 68% of installed capacity or 75% of yearly generation.

4.2. Residual Supply Index

The Residual Supply Index is a measure of market concentration specific for the electricity sector. It shows how dependent the market is on the supply of the largest generator. This indicator is calculated by dividing the available installed capacity (excluding the capacity of the largest generator) by demand. If the resulting value is smaller than 1, then there is not enough available capacity to satisfy demand. As a result, the largest generator is essential (pivotal) for the functioning of the market and has the opportunity to abuse his dominant position. The index can be calculated for multiple periods to show how often the generator is in the position to dictate the market.

We use several sources to compile the index. Data for demand was obtained from ENTSO-E hourly load values. Supply was calculated by subtracting available capacities of ČEZ (largest generator) from the total available capacities. Available capacity is measured averaged weekly and takes planned outages into consideration.



Source: ČEPS and ENTSO-E, Own calculations

Graph 2 above is a simple representation of supply and demand throughout the year of 2010. It is a graphical representation of RSI: The competition of ČEZ does not have enough capacities to cover demand throughout the whole year. As a result, ČEZ has the possibility of abusing its dominant position during the whole year. A description of the actual RSI calculations is presented in Table 12.

	ČEZ Pivotal	Median	Peak	Low
Czech Republic	100%	0.4495	0.7140	0.3235

Source: ČEPS and ENTSO-E, Own calculations

We calculate RSI for every hour of the year, thus we have 8,736 results for RSI, which we average for the year. Table 12 above shows that the competition of ČEZ is capable of covering on average only 60% of demand throughout year. The competition is capable of covering a maximum of around 71% of demand during end of summer. In winter, during peak demand, they cover only a minimum of 32% of demand.

RSI differs significantly from country to country, but the Czech Republic belongs to the more concentrated markets. The Czech Republic is comparable to countries like France and Belgium, where the market leader is pivotal 100% of the time. Spain, Germany and the Netherlands have a lower concentration, where the market leader is pivotal around 50% of the time. The country with the most competitive market is the Great Britain, where the market leader is pivotal around 2% of the year (London Economics 2007).

5. CONCENTRATED AT EACH LEVEL

The previous section identified the vast dominance of ČEZ in the electricity generation sector using quantitative procedures applied by competition authorities in countries such as Germany, the United Kingdom and the United States. In this section, we argue that ČEZ's dominant position in this sector enables it to control other levels of the value chain in the electricity sector. We analyse effects the concentration in the generation sector has on upstream and downstream markets, and on the final consumer. In addition, we review practices which dominant firms employ to make use of their dominant position in order to increase their profit margins at the expense of potential competitors, suppliers and final consumer.

5.1. Vertical foreclosure

Vertical foreclosure is a form of market behaviour where a vertically integrated firm dominant in one level of production prevents the entry of a new competitor into the market by means of its control over the essential input. In the electricity generation sector, such behaviour is most likely to occur in the fuel production sector. Ownership of fuels such as gas, lignite or hard coal not only gives a significant edge over other market competitors, but also discourages other firms from entering the market.

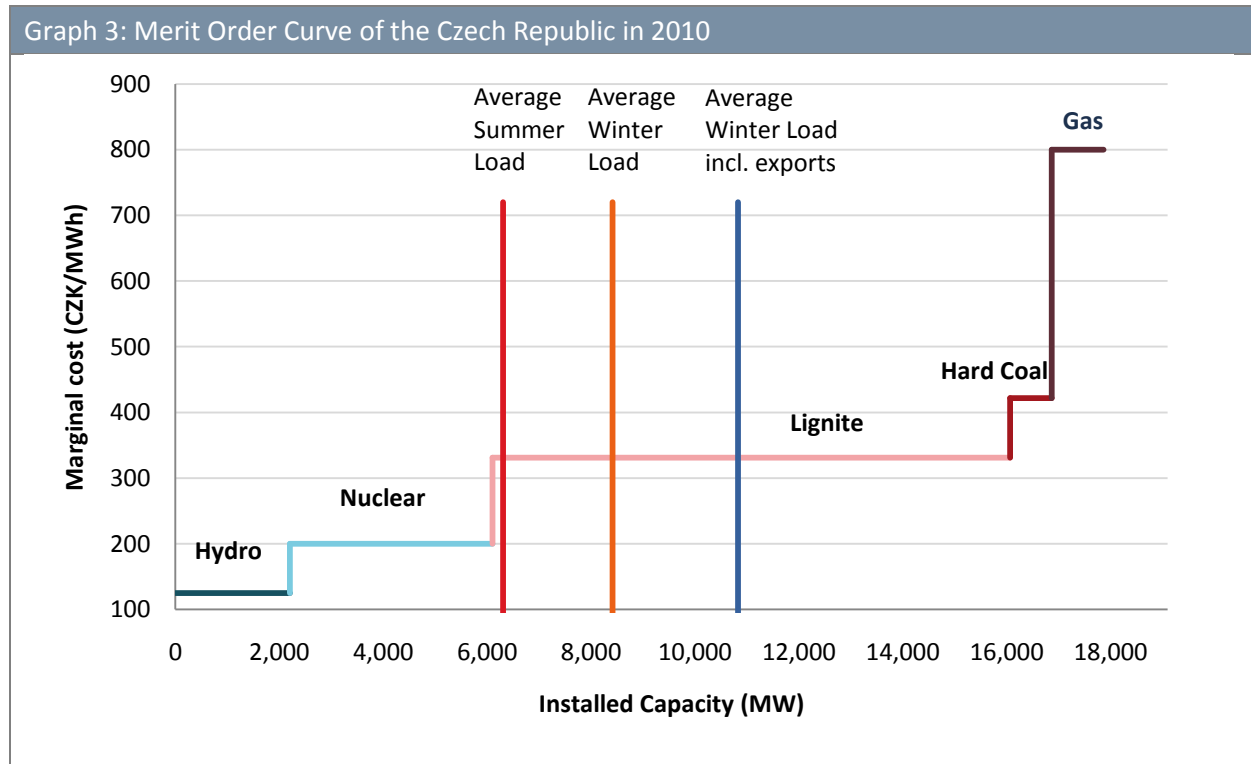
We argue that lignite is the essential input in the Czech electricity market. The Czech lignite fleet accounts for around 9,969 MW of installed capacity, or almost 50% of total installed capacity in the Czech Republic. Of these capacities, around 60% are owned by ČEZ. The Czech merit order curve of the Czech Republic which we estimate in Graph 3 confirms this expectation. Lignite is the price setting marginal power plant as it covers the average base and peak load curves.¹⁰

The merit order curve depicted below is based on our estimation of variable costs such as fuel, operation and maintenance (O&M) and emissions fees. We estimate fuel and O&M costs from data published in annual statements of relevant market participants. Emissions fees are based on fees listed in the Czech Republic's Clean Air Act (Law #86, 2002 Sb.).¹¹ We obtain emission values by calculating averages for each fuel type from individual power plant data published in the Integrated Pollution

¹⁰For the purpose of our analysis we disregard renewable sources such as solar and wind plants since they do not participate on the free market. Renewable sources enjoy preferential grid access and their price is set by feed-in tariffs, and therefore are irrelevant for the estimation of the merit order curve, since they are always "in-the-merit". In addition, the installed capacity of these two sources of energy was insignificant for the observation time of this report (2009-2010).

¹¹SOx= 1,000 CZK/tonne, NOx=800 CZK/tonne, PM10= 3,000 CZK/tonne.

Registry of the Czech Republic.¹² Our estimated merit-order curve disregards the cost of carbon since CO₂ allowances were allocated for free in the Czech Republic for the current trading period.



The merit-order curve indicates that lignite production is key in keeping potential entrants out of the market. This is especially so since ČEZ sources most of its lignite from its own coal mines. The lignite mining sector is an oligopolistic market in which three companies cover almost 100% of the entire market. Through its subsidiary, Severočeské doly, ČEZ owns 48.6% of the market, while its competitors Czech Coal (31.9%) and Sokolovska uhelna (18.9%) lag significantly behind (Severočeské doly a.s. 2009). This creates two advantages for ČEZ. ČEZ is capable of supplying its own coal fleet with up to 50% of its own coal supplies, guaranteeing comparatively low prices for its generation fleet (Severočeské doly a.s. 2009). This means that around half of ČEZ's lignite fuel costs can be assumed to be fixed, which allows ČEZ significantly to expand its margin with increasing electricity prices at the expense of the margin of alternative lignite suppliers. Additionally, since much of the lignite supply is contracted by the district heating suppliers on long-term supply contracts, it is almost impossible for a potential new entrant to secure fuel in the Czech Republic at a competitive price. Such circumstances allow ČEZ successfully to prevent the entry of new competitors in the generation market.

¹² Obtained from Integrovaný Registr Znečištění <http://tomcat.cenia.cz/irz/>

5.2. Margin squeeze

A margin squeeze takes place when a dominant company on one level of production manages to sell its inputs to a downstream market at such a market price that the downstream company cannot survive or effectively compete. This happens when the upstream firm sells an input to one or more downstream firms and simultaneously competes against those firms in the downstream market. In the case of ČEZ, its dominant position in the electricity generation sector would make it possible for it to abuse its position in downstream markets, such as retail, and the upstream mining market. Specifically, an effective use of margin squeeze requires certain preconditions. For instance, margin squeeze is very effective when the product in question is a homogenous good. Electricity is a perfect example of a homogeneous good in the sense that electricity from one supplier is indistinguishable from the electricity of a different supplier. Further preconditions for margin squeeze are listed below (Organisation for Economic Co-operation and Development 2009).

Vertical integration: One of the main requirements for a margin squeeze is vertical integration of the firm. ČEZ is an ideal example of this since the only level of production it is not active in is the transmission sector, which is operated by ČEPS. ČEZ is active in the fuel production (Severočeské doly), generation, distribution (in 5 of 8 distribution regions) and retail.

Existence of dominant position in an upstream input market: The higher the market power of a firm in the upstream market, the more likely it is that this firm will make use of margin squeeze. For example, if a company intends to constrict the margin in the generation sector, it must have a dominant position in the fuel production sector. If it wants to diminish the margin in the retail sector, it must have a dominant position in the generation sector. Since ČEZ is active on almost all markets it can make use of margin squeeze at almost any level of production. Later in this section, we show that the highest margins are earned in the generation sector. Exactly the market ČEZ is dominant in.

Downstream market not competitive: Margin squeeze is most efficient if the downstream market is not fully competitive. This enables the vertically integrated firm to control prices in such a manner that if it increases the price of an input, competitors in the downstream markets cannot pass the price increase on to their customers (Organisation for Economic Co-operation and Development 2009). As we point out above, the mining sector is an oligopolistic market in which ČEZ enjoys the largest share, while generation it is essentially a monopoly. The most competitive sector is retail however; here as well ČEZ remains the market leader, with around 44% of the market share in terms of end customers.

Input provided by the dominant company is irreplaceable: There would be no retail market without ČEZ. This is because ČEZ has the largest share of the generation sector. This refers to the problem of high market concentration mentioned earlier.

ČEZ does not require a large margin in the retail sector since it earns the majority of its margin in the sector it is most dominant in. To do this, ČEZ does not need a dominant position in the retail sector, since only a partial market share is necessary to enable it to dictate the price in retail. By having a share in this sector, it can set a price which enables only a small margin, this way forcing the other retailers to follow its lead. This way ČEZ essentially becomes a price setter in a market it is not dominant in. This creates several advantages for ČEZ. First, it enables it to retain its margin in the generation sector. Additionally, the small margin helps deter future entrants from entering the retail sector. More importantly, it helps ČEZ create a false notion of competition in a market where there is none. To put it simply: End consumers buy their electricity from retailers, who buy their electricity from ČEZ. In the end, all end consumers buy their electricity from ČEZ, and therefore finance its large margins.

However, the effects of margin squeeze are not limited to upstream markets controlling prices downstream. The reverse may also occur. ČEZ's dominance in downstream market helps it to reduce margins in the upstream markets, where ČEZ possesses a significant market share. The combination of its dominant position in the generation sector with the large share of the lignite market endows ČEZ with a very strong negotiation position. As a result, ČEZ is able to maintain lignite prices low, meaning the bulk of the margin remains in the generation sector.

Since ČEZ fulfils all of the criteria above, it is in the perfect position to make use of margin squeeze. Its significant position in retail combined with its dominance in the mining and generation sectors, makes margin squeeze in retail a viable option for ČEZ. Nevertheless, since one needs access to accounting of market participants in order to prove effects of margin squeeze, we can only surmise that the probability of ČEZ engaging in any of the above described practices is high. It remains up to the competition office to prove beyond doubt that ČEZ engages in the margin squeeze and to quantify its effects.

The size of ČEZ's generation margin may be approximated by the dark and clean dark spread. To determine the dark spread, we assume that ČEZ buys lignite from its subsidiary Severočeské doly at a price of CZK 29/GJ; this lignite contains an average calorific content of 12,610 kJ/kg (UNFCCC 2011). We used the average day-ahead price for 2010 to obtain an average wholesale electricity price. This average price is CZK 1,105/MWh. We assume conversion efficiency rate of ČEZ's lignite fleet of 34%. We include CO₂ prices even though ČEZ is over-allocated with CO₂ allowances. We disregard the windfall profits ČEZ earns from the sale of these allowances in order to be conservative. We therefore

assume a CO₂ price of €15 and an emission factor of 1.05 t/MWh. SO_x, NO_x and PM₁₀ prices were obtained similarly to values for the merit order curve, which we explain above (Česká informační agentura životního prostředí 2011). We calculate with average emissions of the ČEZ lignite fleet of approximately NO_x 5,736 tonnes, SO_x 5,612 tonnes and PM₁₀ 224 tonnes for 2009 (Česká informační agentura životního prostředí 2011). For Germany, we assume lignite to be priced at €1.9/GJ, a calorific content of 10,000 kJ/kg and average conversion efficiency at 38%. To calculate the German clean dark-spread we also assume a CO₂ price of €15 and an emission factor of 1.05 t/MWh. The final results are summarized in Table 13.

	Base	Off-Peak	Peak
Average dark-spread for ČEZ	€31.55 (798.11Kč)	€24.52 (620.07Kč)	€38.43 (971.86Kč)
Average dark-spread in Germany	€24.66 (623.65Kč)	€18.82 (475.96Kč)	€30.51 (771.60Kč)
Average clean dark-spread for ČEZ	€15.65 (395.72Kč)	€8.61 (217.68Kč)	€22.52 (569.46Kč)
Average clean dark-spread in Germany	€10.73 (271.36Kč)	€4.89 (123.37Kč)	€16.58 (419.31Kč)

Source: Own calculations

To show the extent to which ČEZ can increase its margins in the generation sector, we calculate the Lerner Index and Price Cost Mark-up (PCMU) of the generation sector based on the marginal costs of lignite, as it is the price setting marginal power plant in the Czech Republic. Then, we calculate the average base, peak and off-peak wholesale prices to determine the indexes, according to the standard methodology – see Table 14 and 15 below (London Economics 2007).

The market equilibrium price in the electricity market is defined by the merit order rule. In perfect competition the market price should be equal to the variable cost of the marginal power plant. A result of 0% for the Lerner Index would indicate perfect competition, while 100% would mean that the whole profit margin goes to the firm. The average Lerner Index (69%) and PCMU (223%) show a relatively high margin for ČEZ, the result of high concentration in the generation market and, presumably, an efficient use of margin squeeze.

	Base	Off-Peak	Peak
Lerner Index ČEZ	69.0%	63.1%	73.2%
Lerner Index Germany	55.4%	48.7%	60.6%
Lerner Index ČEZ + CO ₂	33.4%	20.6%	42.4%
Lerner Index Germany + CO ₂	24.1%	12.7%	32.9%

Source: Own calculations

	Base	Off-Peak	Peak
Price Cost Mark-up ČEZ	222.9%	170.9%	273.7%
Price Cost Mark-up Germany	124.4%	94.9%	153.9%
Price Cost Mark-up ČEZ + CO2	50.1%	25.9%	73.7%
Price Cost Mark-up Germany + CO2	31.8%	14.5%	49.1%

Source: Own calculations

The German values correspond to the results found by London Economics (Lerner Index: 21.2%; PCMU: 27.0%), which also use day-ahead markets and include the cost of emissions in their calculations. Our mark-ups for Germany are slightly higher since we compare mark-ups for a lignite plant, which is the marginal plant in the Czech Republic. The marginal plant in Germany is a CCGT; therefore the real mark-up in Germany will be lower. Similarly, London Economics finds that concentrated markets have a significantly higher Lerner Index and Price Cost Mark-up than competitive markets. While the moderately concentrated German market has a Lerner Index of 21.2% and a PCMU of 27.0%, the highly concentrated French market has a Lerner Index of 59.6% and a PCMU of 147.2%. The same relationship applies to our comparison between the moderately concentrated German market and highly concentrated Czech market.

The Czech results are even higher. These exceptionally high figures shown in Table 14&15 can be explained by one phenomenon: Czech costs for inputs and German prices. As a result of ČEZ's apparent abuse of dominant market power, the input prices in the electricity generation sector are significantly below German levels, but the prices of electricity correspond to German prices and are often even higher in peak times, as we show below in Table 16. We should emphasize that these results are conservative, since they already include ČEZ's CO₂ costs. CO₂ allowances will be allocated for free in the Czech Republic until 2013, with only a gradual reduction in free allocation until 2020, combined with the fact CO₂ allowances will be fully auctioned from 2013 in Germany, means that ČEZ is likely to keep and possibly expand the price cost mark-up.

	Base	Off-Peak	Peak
Total hours	4,250	1,794	2,456
% of total hours	48.52%	40.96%	56.07%

Source: OTE and EEX, Own calculations

In brief, through the practice of margin squeeze, ČEZ is capable of keeping most of the profit margin in the value chain. And through vertical foreclosure, it can prevent potential competitors from entering the market.

6. CONCLUSIONS AND RECOMMENDATIONS

In Power Abuse we demonstrate that the relevant market for ČEZ for the purpose of competition analysis is Czech, not European. We consider this conclusion to be the most valuable contribution of our study. It directly contradicts ČEZ's frequent and unsubstantiated assertion that the relevant market is the European market. The fact that ČEZ's relevant market is the Czech Republic should have profound consequences for government policy in the energy sector. This is because ČEZ, as our analysis shows, is clearly the pivotal supplier on the Czech market. As a result, ČEZ's dominance in the generation sector combined with its significant market presence in both the lignite mining and retail sectors, raises suspicions of anti-competitive behaviour known as margin squeeze, which we describe in Chapter 5.2.

Despite the European Commission's best efforts, the single European electricity market is far from reality. Even after three liberalisation packages, electricity generation markets remain largely national, with at best the rudiments of future regional electricity markets, such as the successful market couplings between Germany and Austria, and between Czech Republic and Slovakia. For this reason, we believe the Czech government itself should start addressing now the deficiencies of the Czech market identified in this study. It must agree on what objectives the energy sector is required to meet, and then structure the sector accordingly.

The government has an alternative. It might decide that electricity generation is a special case requiring greater government involvement than other sectors of the economy. The government may wish to use the national energy champion to pursue an environmental or social agenda, such as investment into energy savings, or low consumer and industry prices. If so, it must acknowledge that such a dominant firm distorts the market at all levels of production, and it must regulate the dominant firm in such a way which would approximate outcomes under a competitive market. For example, the government should, by regulation (either ex-ante or ex-post), protect firms in those sectors of the energy market which are not deemed crucial for the attainment of the government's objectives, and where market competition is possible, such as retail.

Or the government might decide that electricity is a commodity like any other, and so need not interfere with the market, with the exception of those parts of the value chain defined as natural monopolies, such as the transmission and distribution networks. In this case, the government must take steps to ensure that the Czech market is competitive. We recommend that at the very least, the government should take measures which would result in an approximation of an oligopolistic market structure, with the HHI close to 2,000. This is a realistic ambition given the relatively small size of the Czech market and individual plants relatively large share of total installed capacity, with the large share

of nuclear plants in particular, for which it may be difficult to attract buyers. Under this scenario, the government would need to make ČEZ divest 2,410 MW of lignite installed capacity (as we show above, lignite-fired plants are the marginal power plants in the Czech Republic), possibly together with 1,100 MW of pumped-storage capacity. The Czech HHI would then fall to 2,386, which could be considered an approximation of an oligopolistic market (Germany has the HHI of 1,914). Given the importance of lignite for the Czech generation market, we would recommend as well that ČEZ be obliged to divest Severočeské doly, thereby creating a market in the most important fuel for the generation sector. Needless to say, these assets would have to be sold to several individual buyers to maximise the chances of a real market emerging. And of course, to minimise the risk of those assets being sold to a firm, which though formally separate, would act as a proxy for ČEZ.

WORKS CITED

- Alexander, Carol. "Correlation and Co-integration in Energy Markets." *ICMA Centre*. 1999. <http://www.icmacentre.ac.uk/pdf/energy.pdf>.
- Bower, John. "Why Did Electricity Prices Fall in England and Wales? Market Mechanism or Market Structure?" *Oxford Institute for Energy Studies*, 2002.
- CAO Central Allocation Office. *5 TSOs Auctions*. 2010. http://www.central-ao.com/index.php?option=com_content&view=article&id=125:5tsos&catid=68:5tsos&Itemid=150.
- ČEPS. *On-line data*. 2010. <http://www.ceps.cz/detail.asp?cepsmenu=3&IDP=426&PDM2=0&PDM3=0&PDM4=0>.
- Česká informační agentura životního prostředí. *Integrovaný registr znečišťování: Vyhledávání úniků a přenosů*. 2011. <http://tomcat.cenia.cz/irz/>.
- ČEZ, a.s. "ČEZ Group Annual Report 2009." 2009.
- Energetický regulační úřad. *Roční zpráva o provozu ES ČR 2009 - ERÚ*. 2010. http://www.eru.cz/user_data/files/statistika_elektro/rocni_zprava/2009/index.htm.
- Engle, Robert F., and Granger Clive W. "Co-integration and Error Correction: Representation, Estimation, and Testing." *Econometrica*, 1987: 251-276.
- ENTSO-E. *Monthly Consumption Values*. 2011. <https://www.entsoe.eu/db-query/consumption/monthly-consumption-of-a-specific-country-for-a-specific-range-of-time/>.
- . *NTC Values - Intro to the NTC Matrix and BCE Maps*. 2011. <https://www.entsoe.eu/resources/ntc-values/>.
- European Commission. *EU Competition Law: Rules Applicable to Merger Control*. 2010. http://ec.europa.eu/competition/mergers/legislation/merger_compilation.pdf.
- Fabra, Natalia, and Juan Toro. "The Fall in British Electricity Prices: Market Rules, Market Structure, or Both?" *Universidad Carlos III de Madrid*, 2004.
- Green, Richard, and Tanga McDaniel. "Competition in Electricity Supply: will "1998" be worth it?" *Fiscal Studies*, 1998: 273-293.
- Juselius, Mikael, and Rune Stenbacka. *The Relevant Market for Production and Wholesale of Electricity in the Nordic Countries: An Econometric Study*. Discussion Paper No. 222, Helsinki: University of Helsinki and HECER, 2008.
- London Economics in association with Global Energy Decisions. *Structure and Performance of Six European Wholesale Electricity Markets in 2003, 2004 and 2005*. Brussels: European Commission, Directorate General for Competition, 2007.

Mansur, Erin T. "Measuring Welfare in Restructured Electricity Markets." *The Review of Economics and Statistics*, 2008: 369-386.

Motta, Massimo. *Competition Policy: Theory and Practice*. Cambridge: Cambridge University Press, 2004.

Organisation for Economic Co-operation and Development. *Policy Roundtables: Margin Squeeze*. Paris: OECD, 2009.

Severočeské doly a.s. "Skupina Severočeské doly: Výroční zpráva 2009." 2009.

Stigler, George J., and Robert A. Sherwin. "The Extent of the Market." *Journal of Law and Economics*, 1985: 555-585.

U.S. Department of Justice and Federal Trade Commission. *Horizontal Merger Guidelines*. 2010.
<http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf>.

UNFCCC. *National Inventory Submissions*. 2011.

Zachmann, Georg. "Convergence of Electricity Wholesale Prices in Europe?: A Kalman Filter Approach." *German Institute for Economic Research*, 2005.