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Price Formation and Market Power in Germany's Wholesale Electricity Markets

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Study commissioned
by the Verband der Industriellen Energie- und Kraftwirtschaft (VIK)/
Association of German Industrial Energy Consumers

Dresden University of Technology

Chair for Energy Economics and Public Sector Management

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Executive Summary

- This study analyzes price formation and market power in Germany's wholesale electricity markets. Today, the exercise of market power is a critical issue for many global electricity markets, but particularly for Germany's oligopolistic markets. For the purposes of this study, we define market power as "the ability to alter profitably prices away from competitive levels" (Mass-Collell, et al., 1995, p. 383).
- Electricity generation in Germany is dominated by a duopoly with a market share of about 55%; the four largest suppliers own about 85% of generation capacity. The few existant studies of wholesale electricity prices suggest that such market dominance leads to prices that do not correspond to competitive market outcomes. Additional concerns arise when the lack of competition fosters inadequate or inappropriate regulatory mechanisms that also hamper competitive development.
- This study shows that Germany's wholesale markets are not sufficiently competitive. We develop several quantitative models that reveal the insufficient levels of competition in generation and trading:
    - a competitive benchmark model shows that real prices are significantly higher than competitive prices, in particular in mid- and peak-loads
    - an econometric analysis shows that price changes for CO_2-allowances are passed on to the market asymmetrically: CO_2 price increases are passed on directly, whereas CO_2 price decreases are passed on far less directly
    - the wholesale electricity market responds less directly than other markets to fundamental price changes; we use the U.K. as an example (Markov-Switching Regime Model)
    - a Supply Function Equilibrium (SFE) analysis shows a high potential for market power abuse by the dominant duopoly
    - the balancing markets are artificially split into four market segments, and we find inadequate competition in each segment
    - the market for trans-border electricity transmission capacity is structured inefficiently, leading to welfare losses and little outside competition.
- We conclude that the German electricity sector requires a more robust competitive market design, accompanied by corresponding improvements in regulatory policies. Elements of the latter should include divestiture of incumbents' plant capacities; virtual divestiture of capacity; termination release of long term-contracts; extension of cross-border capacities; vertical unbundling; and finally, proactive support for the entry of new participants.

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1 Introduction to Market Power Analysis

1.1 Market power

Market power is usually defined as “the ability to alter profitably prices away from competitive levels” (Mass-Collell, et al., 1995, p. 383). Contrary to “normal” markets such as mineral water, today’s electricity markets are prone to market power issues (for a survey, see Twomey et. al 2004) because electricity cannot be stored; its demand is inelastic; and vertical integration exists between generation and transmission. Empirical evidence shows that market power is present in almost all electricity markets around the world.

Economic theory suggests that market prices depend on i) the form of competition (quantity competition, price competition, strategic behavior, etc.) and ii) the number of competitors in a given market. The reference benchmark case (“competitive equilibrium”) corresponds to the equilibrium between demand and supply, given by the real marginal cost curves of the producers.

In this context, the question about short- vs. long-term marginal costs is important. Short-term marginal costs are the relevant benchmark as long as the capacities are fixed; thus, only fuel costs, costs of CO_2-emission allowances, and variable operation expenditures are the marginal costs. Long-run marginal costs can be charged when the market is capacity-constrained. The current situation in Germany is the former, i.e. overcapacity. In that situation, the competitive price will be determined by the *short-run* marginal costs of the last producer dispatched.[1]

1.2 Exercising market power

According to Stoft (2002, p. 321) market power in electricity markets can be analyzed in three levels:

1. Strategic exercising of market power
2. Effects on quantities and prices
3. Implications of market power on the distribution of rents, allocation and social welfare

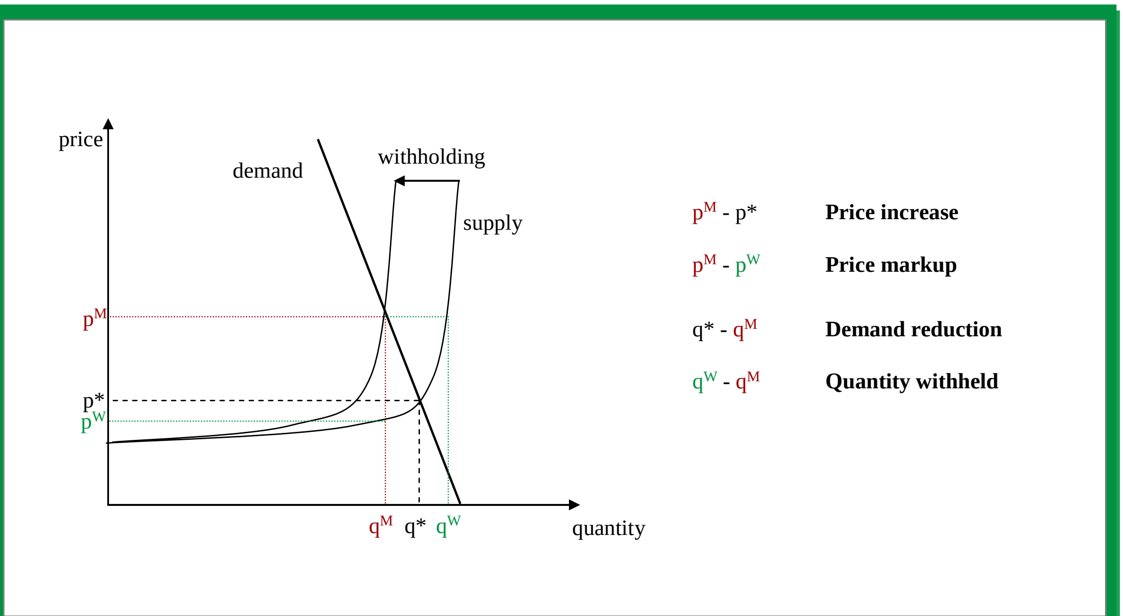
1. In principle, two possibilities exist to exercise market power: *physical* withholding of generation or *financial* withholding (i.e. high bid prices). Both strategies can be considered as equivalent; ex-post, it is difficult to determine whether the withholding was physical or financial; physical withholding is more difficult to detect. Either type of withholding leads to a new equilibrium between demand and supply at a higher price level and lower quantities (Figure 1).
2. The exercise of market power leads to four price – or quantity – effects (Figure 1). The first is the *quantity withheld* ($q^W – q^M$) which represents the amount of plant capacity taken out

[1] Stoft (2002, p. 129) shows that short-run marginal cost, including opportunity cost of capacity constraints, is sufficient to cover variable and fixed costs; it also provides an overview of the issue.

of the market (physical withholding) or priced excessively (financial withholding) by strategic players, thus shifting the supply curve to the left and upward respectively. Then a new intersection between supply and demand occurs, leading to a higher price level. The difference between these two is the *price distortion* (p^M - p*). As demand for electricity is inelastic, the quantity difference between the competitive and the distorted market equilibrium (q* - q^M) is generally lower than the quantity withheld. The difference between the distorted price and the marginal generation costs at the reduced quantity (p^M - p^W) corresponds to the *price markup* on competitive supply.

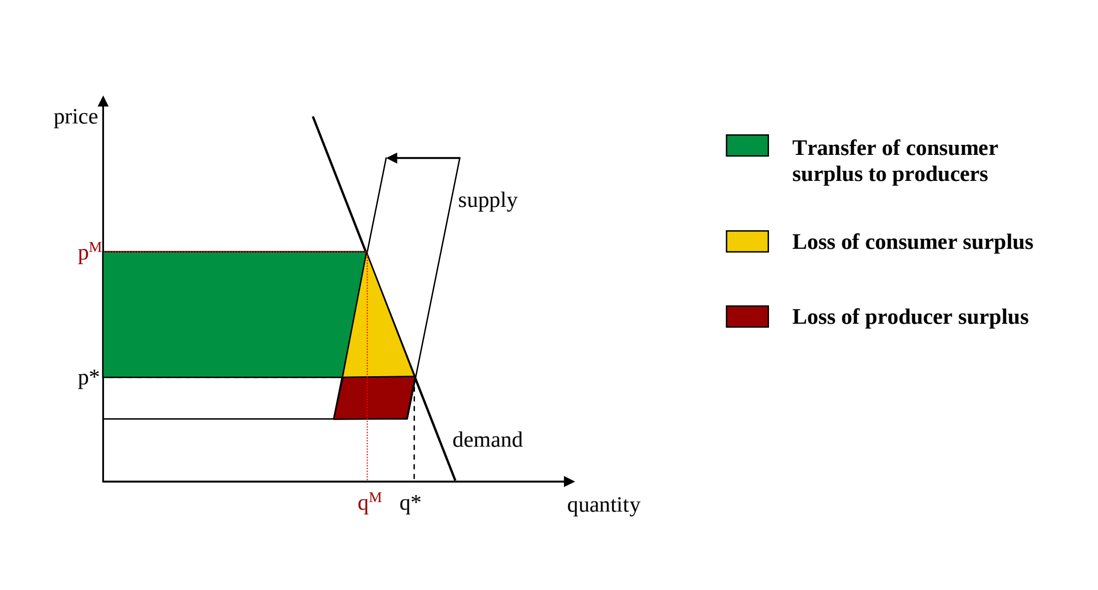
3. The exercise of market power has two effects on welfare (i.e. the sum of producer and consumer surplus): in quantitative terms, the redistribution of consumer rent to producer rent plays the most important role (Figure 2). In addition to the welfare transfer there also is a deadweight welfare loss: because of the reduced availability of plants, demand is not satisfied although the marginal willingness to pay is above marginal generation costs under competitive conditions. Producers also lose a portion of their welfare from the less efficient generation employed in their withholding strategies. The transfer of rent from consumers to producers over-compensates this loss, making strategic bidding profitable.

Figure 1: Strategy of withholding



Source: Stoft (2002, p.320)

Figure 2: Welfare transfer due to market power



Source: Stoft (2002, p. 333)

2 German Market Structure and Literature Survey

2.1 Structure

The German electricity market design today includes the following:

- *a long-term market:* electricity producers sell their production up to several years in advance, and consumers can secure their supplies; there is active trading with financial products (options, futures) and physical contracts (forwards)
- *a spot market:* physical and financial trading occurs in a classical day ahead market;
- *a balancing market for physical supplies:* producers can bid positive or negative balancing energy

The available indicators for price developments are the spot and futures prices at the European Electricity Exchange (EEX) in Leipzig. The EEX trades supplies for specific time periods, such as four-hour blocks or single hours. Trading takes place in so-called one-shot auctions: suppliers and consumers bid individual supply and demand functions which are then aggregated. At present, there is no mechanism to determine whether supply functions correspond to real-time prices or whether the bidding is affected by market power.[2]

In addition to electricity generators, traders are also active. Therefore the supply curve does not entirely correspond to the marginal cost curve of electricity generators; it may also represent

[2] Such mechanisms are now in place in the California electricity market (Market Surveillance Committee). In the aftermath of the Western Market Crisis of 2000-2001, the U.S. Congress expanded the Federal Energy Regulatory Commission's market monitoring functions and enforcement; in January 2007, FERC dedicated a Webpage to the subject: http://ferc.gov/market-oversight/market-oversight.asp

rents from trading activities. However, if one assumes a competitive trading market, the supply curve is only marginally different from the cost curves bid by the generators.

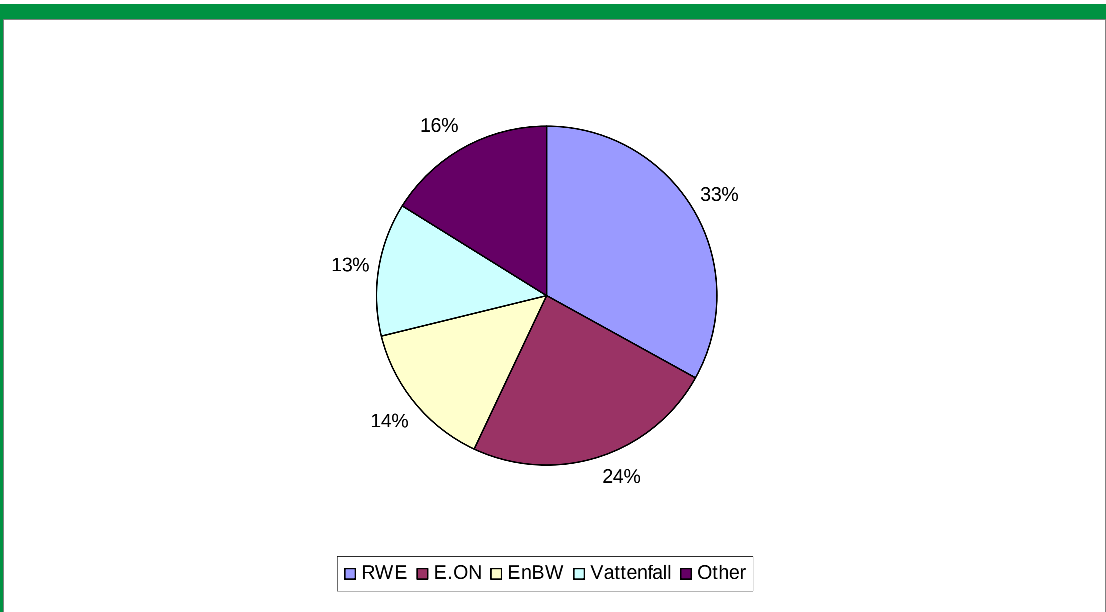
Germany's wholesale market is characterized by large percentages of nuclear, lignite and hard coal capacities, large capacities for natural gas-fired plants and an increasing capacity for wind. In 2004 the total available generation capacities reached 117 GW for a total production of 570 TWh (Table 1). The generation is characterized by a high degree of concentration: The German cartel assumes that there is a dominant position held by two producers (RWE and E.ON) with about 55% of capacity; the four largest suppliers (in addition EnBW and Vattenfall) hold a market share of about 85% of capacity (Figure 3).

Table 1: German power plant capacities, 2004

<table>
<tr><th>Plant type</th><th>Capacity [GW]</th><th>Generation [%]</th></tr>
<tr><td>Nuclear</td><td>20,6</td><td>28</td></tr>
<tr><td>Lignite</td><td>19,7</td><td>26</td></tr>
<tr><td>Coal</td><td>25,1</td><td>22</td></tr>
<tr><td>Natural Gas</td><td>16,2</td><td>10</td></tr>
<tr><td>Hydro</td><td>4,2</td><td rowspan="3">5,9</td></tr>
<tr><td>Pump Storage</td><td>5,7</td></tr>
<tr><td>Wind</td><td>16,6</td></tr>
<tr><td>Oil</td><td>6,0</td><td rowspan="2">5</td></tr>
<tr><td>Other</td><td>3,3</td></tr>
<tr><td>Sum</td><td>117 GW</td><td>570 TWh</td></tr>
</table>

Source: VDEW (2005)

Figure 3: Current market share by generator

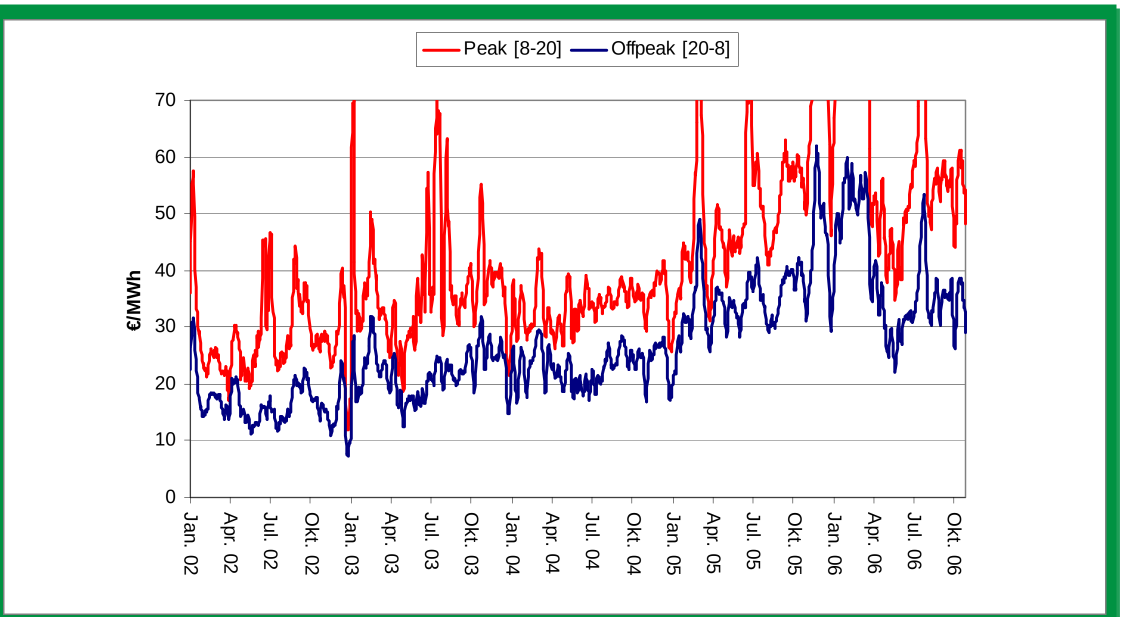


Source: RWE (2006), E.ON (2005, 2006), Vattenfall (2005), EnBW (2005), VDEW (2005)

2.2 Price developments

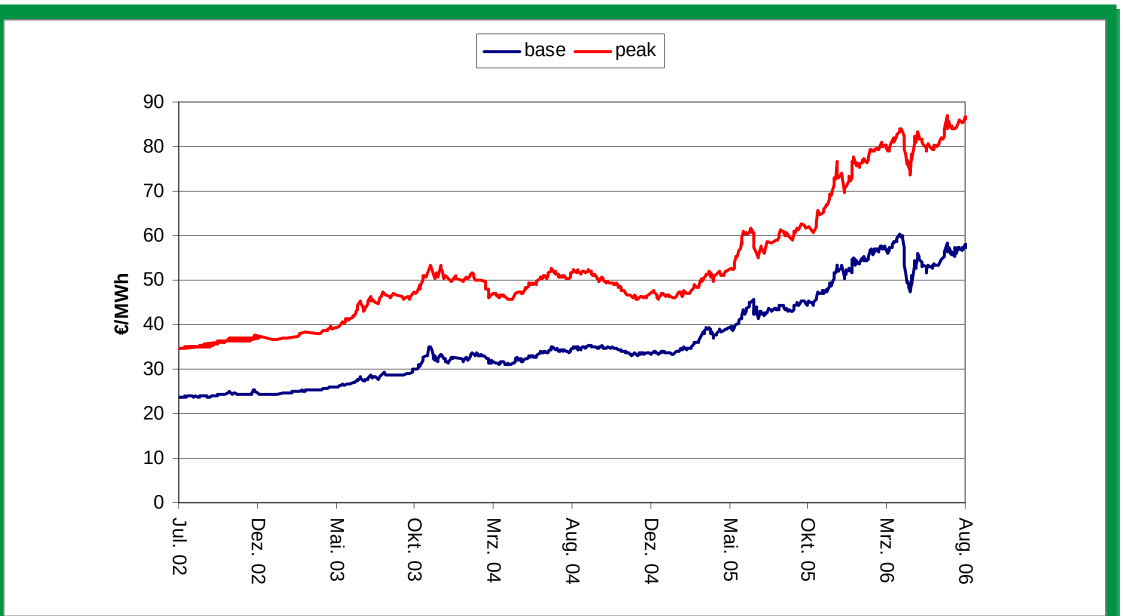
Figure 4 shows the developments of spot prices at the EEX between 2002 and 2006 (peak and off-peak). Since the onset of trading on the EEX, prices have continuously increased. The average price in 2005 was about 80% higher than in 2002; this trend continued through 2006. Figure 5 shows the price developments of forward contracts for the next year; this price trend is also increasing. The parallel development of base and peak load is surprising, because the underlying parameters (fuel costs, emissions) are very different.

Figure 4: Average EEX spot prices



Source: EEX (2006)

Figure 5: EEX Phelix-Year-Future, prices for following year



Source: EEX (2006)

2.3 Literature survey on German market power

There is little analysis on market power in Germany. However, the extant studies concur that the significant level of market power observable in different segments of the electricity industry is being exploited to increase corporate profits. In a study first published in 2004, Müsgens (2006) developed a competitive benchmark analysis for Germany. The author calculated the marginal costs of electricity generation and compared them with the EEX average prices between June 2000 and June 2003. Müsgens rejected the hypothesis that prices correspond to competitive market outcomes; following summer 2001, he found an increasing discrepancy between the wholesale prices and the estimated marginal costs, which reached 50% of marginal costs in 2003.

Ellersdorfer (2005) developed a Cournot model with two periods and many side conditions. His model incorporated four large German electricity producers competing within the context of the European market and accounted for transportation capacities. He also concluded that the German producers' market power potential was substantial. The prices he observed were well above the competitive benchmark prices, even though they were below the estimated Cournot prices. The Lerner indices (the uplift on marginal costs) were in the range of 0.53-0.59 for ENBW and 0.65-0.82 for RWE. By examining his competition scenario, he notes that price increases have increased profits by about 2 bn. Euro per supplier, and that the "competitive fringe" has benefited by about 3 bn. Euro.

The most recent paper on German market power (Schwarz and Lang, 2006) analyzed the impact of fundamental price changes and market power on electricity prices. They decomposed the price changes between 2000 and 2005 and identified the relative share of market power in the respective price increases. According to their analysis, market power has played an important role in the price increases of 2003 (10 Euro as compared to marginal costs of 25 Euro). In 2004, this share decreased slightly in 2004, but rose again in 2005. Schwarz and Lang concluded that the price increase in 2005 was due to the approximately similar effects resulting from increasing fuel prices, the introduction of CO_2 allowance trading and market power.

Last, the Sector Enquiry by the European Commission (2007) also shows significant market power issues throughout the European Union, and especially in Germany. Its chief findings include:

- most wholesale markets show a high degree of supplier concentration
- vertical integration is a dominant factor in many electricity markets
- international trade is insufficient to provide pressure on domestic producers
- a low degree of transparency exists in the electricity markets;
- price formation is complex; consumers have little confidence in the competitiveness of the markets

According to the EC's report, data on Germany confirm the findings. Thus, even though demand has risen, generators have reduced capacity by 4.2 GW (1.3 GW of new construction vs. 5.5 GW of plant closures). 3.7 GW of the retired power plants had low generation costs. The European Commission also suggests extensive inefficiency of the existing capacity: mid-load power plants have relatively low load factors (30-40%) while several more expensive power plants show load factors of 70-90%.

3 Competitive Benchmark Analysis

3.1 Model description

We utilize an indirect approach to identify signs of market power abuse by developing a "competitive benchmarking analysis" (CBA) to compare the observed market outcomes with estimated marginal costs. We expect that a large difference will indicate strategic corporate behavior.

Our analysis covers two and a half years (2004 until summer 2006) using publicly available data. We also use a power plant database including all German plants (> 100 MW). We calculate marginal generation costs by accounting for plant type, age, fuel type and fuel prices. In addition, a variable component for personal and material expenses is considered. When emission allowance trading began in 2005, we included the prices for CO_2-certificates as opportunity costs. Plant-specific CO_2-emissions include age and fuel type. Arranging the plants in ascending order of generation costs yields the competitive merit order of the German market.

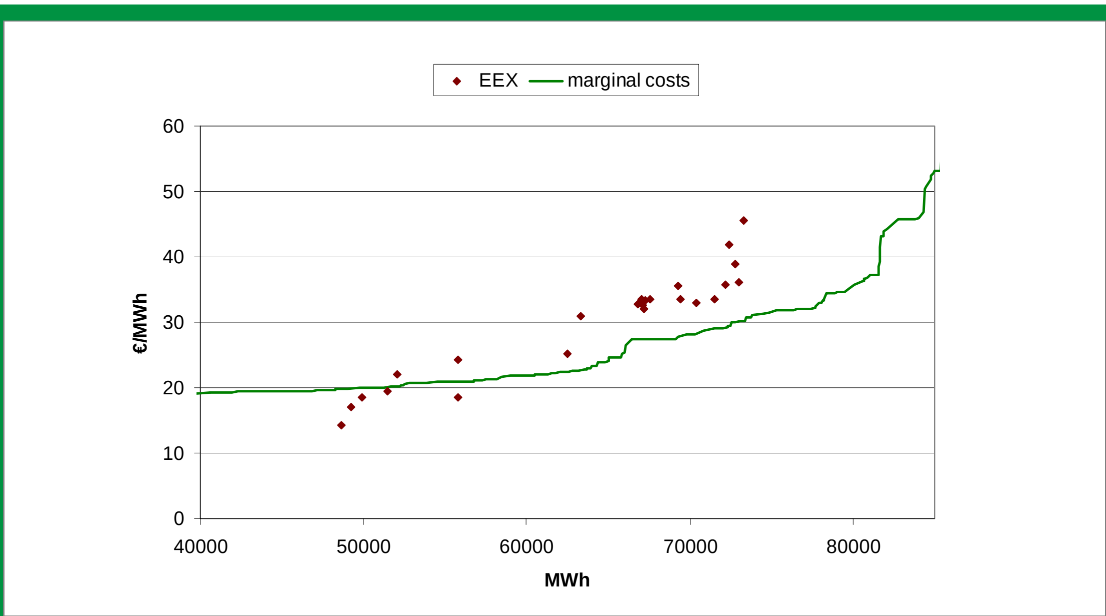
Load is given by UCTE data for Germany for each third Wednesday of a month; thus, we can analyze 30 days. We note that as wind energy capacities are gaining share, their volatile output greatly influences market prices. To account for this effect we approximate the daily wind input based on historical wind speed and wind capacity information.

Prices are taken from the EEX. Its spot market covers about 20% of the German demand; the remaining energy is traded forward or over-the-counter (OTC). The spot market is assumed to be the relevant reference market price. Combining the demand with the merit order and the observed prices yields the difference between the competitive market outcome and the real one.

3.2 Results

Our analysis shows a clear divergence between modeled competitive prices and observed market results, especially during peak and medium-term loads. For 2004 the analysis shows a clear markup on marginal costs of 18.5% on average. More than 25% of the time, markups exceed 30%. Figure 6 shows the divergence between modeled marginal costs and observed market results for a representative weekday (April 21) in 2004. During off-peak hours, the market prices are below the marginal costs (since base load plants have high start-up costs). Thus, it may be less costly to continue production than to shut down during off-peak (nighttime) hours. During mid-term and peak load, market prices are well above marginal costs. The differences in markups between off-peak and peak can be observed for every day in 2004. With increased load, the markups (relative as well as absolute) increase as well. Particularly during mid-term load (80-90 % of the daily peak load), significant divergences of more than 60% can be observed.

Figure 6: Prices and marginal costs, April 21, 2004

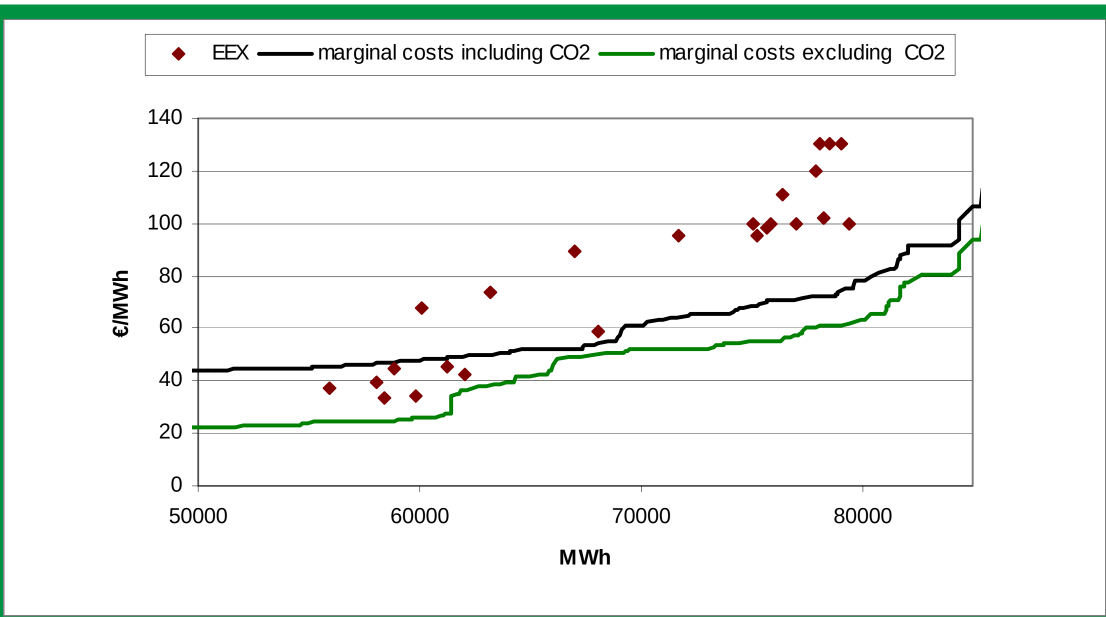


Source: Own calculation

When emission allowance trading began in 2005, the situation changed since opportunity costs for allowances are included in the marginal cost calculation. In 2005 the average markup during peak time is 13.5% and in 2006 24.5%. Similar to the previous year, we observe that the markups increase with load levels, although the highest markups now occur in peak load phases. Negative markups during peak times are mainly observed during the summer months of 2005. Since winter 2005, the situation seems to have stabilized with large markups in peak times.

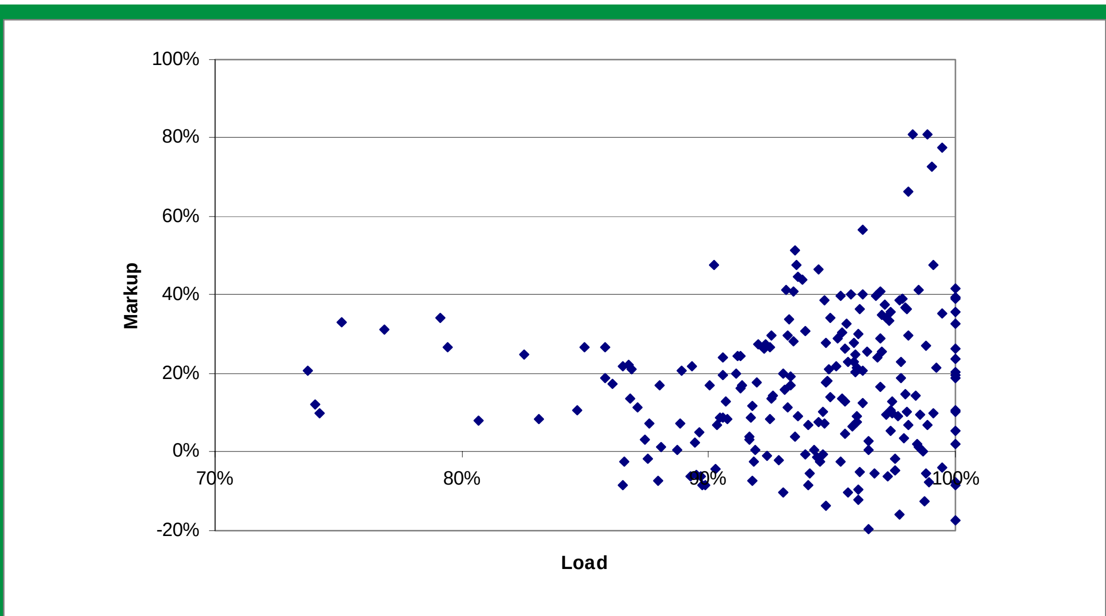
Figure 7 shows the situation for a representative day (December 21) in 2005. The lower curve presents marginal costs excluding allowances, whereas the upper curve integrates the costs for allowances. A significant markup especially close to peak load can be observed. By examining the overall data, we find that on average the markups (relative and absolute) increase with the load level and indicate strategic behavior: Figure 8 shows the relative markups on competitive benchmark prices from 2005-2006. Once again, the most significant markups occur in peak-load and mid-term load: during peak load situations, capacity is scarce and small changes to plant availability have a greater impact on market prices, thus making market power abuse particularly profitable.

Figure 7: Prices and marginal costs, December 21, 2005



Source: Own calculation

Figure 8: Markup on marginal costs, 2005-2006



Source: Own calculation

3.3 Sensitivity Analysis

Due to the limitations of publicly available data (import and export data as well as reserve markets have not been considered), we carry out an additional robustness test by calculating the gap between the observed market results and the modeled marginal costs in terms of load and/or generation capacity. Due to the shape of the merit order, even small changes in the demand level can lead to significant price movements. The hypothetical load level (in which the observed market prices match the marginal costs) therefore yields a proper estimation of the error potential of missing data.

For the year 2004, the analysis shows an average gap of 9 GW during peak times. Thus the demand level must be 9 GW higher or the available generation capacity 9 GW lower than modeled to match the market prices and marginal costs. Compared with the average peak load in Germany of less than 80 GW, an error of 9 GW appears to be extensive. We note that observations, especially in May, June, September and November, even show gaps of up to 19 GW. These errors cannot completely be explained by absent data on exports and reserve markets, again proving the robustness of our model.

After the introduction of emission allowances (2005), the observed gap remains significant. In the first half of 2005 the average difference is 7.3 GW with peaks of up to 16 GW. During summer and fall the results are less stringent, although one still observes gaps of up to 10 GW. During the winter 2005/2006 the error is about 11 GW with peaks of 16 GW. In spring and summer 2006 significant gaps of up to 10 GW remain. Thus the sensitivity analysis supports the conclusion that strategic behavior plays a significant role on the German market.

4 Additional Model Results

In addition to the CBA model, further quantitative model analysis confirmed our finding that Germany lacks a sufficiently competitive wholesale market.

4.1 Asymmetric cost pass-through of CO_2-emission allowance prices

With the introduction of the EU emission trading scheme (EU ETS), CO_2-emission allowances have become a considerable cost factor for electricity generators. Using a regression model we show that rising allowance prices have a stronger impact on electricity prices than falling allowance prices. This indicates that generators directly pass through the increasing cost to their customers but hesitate to do the same for declining costs. If true, this strategy is an exercise of market power.

In a functioning competitive market, prices correspond to the marginal cost of the last producing unit. In this case, a small cost increase should in general lead to the same absolute electricity price change as an equally sized cost decrease. This hypothesis of symmetric cost pass-through can be validated using a regression model: electricity price changes are explained by four variables: a constant, the time trend, price changes for natural gas and for emission allowances. This basic model of symmetric cost pass-through contains only one variable for positive and negative price changes; next, it is compared with an alternative formulation where positive and negative emission allowance price changes are considered separately. Thus, there is evidence for asymmetric cost pass-through if: 1. the estimated coefficients for emission allowance price increases are greater than the emission allowance price decreases; 2. if the asymmetric model provides a better explanation of the price changes.

Both models are estimated using nine working days' rolling averages of EEX electricity prices, TTF natural gas prices and EEX emission allowance prices for 2005 and 2006. Table 2 summarizes the estimation results. The parameters for emission allowance price increases (base 2.2, peak 3.1) are always higher than those for emission allowance price decreases (base 0.7, peak 0.7). By using an F-test we demonstrate that the asymmetric model provides a better explanation of the electricity price changes.[3] Therefore, we reject the hypothesis of symmetric cost pass-through, which consequently provides evidence for asymmetric cost pass-through and market imperfection.[4]

In Figure 9 we plot the long-term effects of the asymmetric cost pass-through schematically. Each emission allowance price increase causes an immediate electricity price increase of the same size. A decrease of emission allowance prices, however, is only partly passed through to customers, leading, ceteris paribus, to unfounded electricity price increases in the long run. Therefore asymmetric cost pass-through can be viewed as a "soft" form of strategic pricing that is difficult to detect.

Table 2: Influence of cost changes on electricity price changes in the German wholesale market, 2005-2006

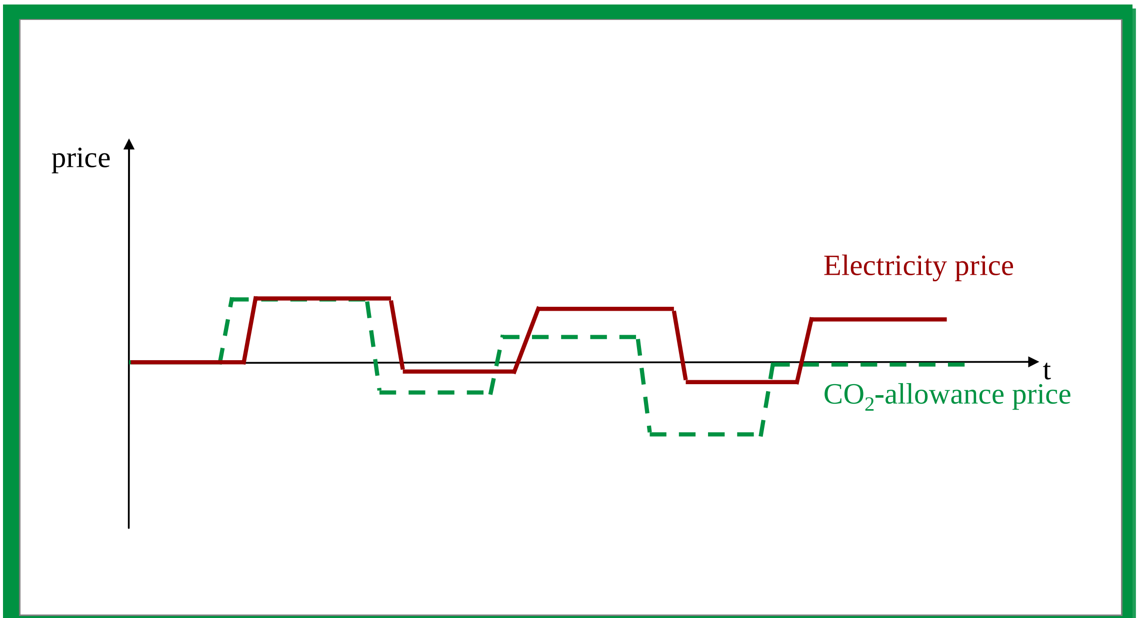
	model	*constant*	*time trend*	*Natural gas price*	*CO_2-emmsiison allowance price*		*R^2*
					increase	*decrease*	
base	*symmetric*	-5.6**	0.04**	2.5**	**1.1****		0.31
	asymmetric	-8.4**	0.05**	2.6**	**2.2****	**0.7**	0.31
peak	*symmetric*	-8.7**	0.07**	3.6**	**1.4****		0.27
	asymmetric	-13.2**	0.07**	3.8**	**3.1****	**0.7**	0.27

Source: Calculations by the authors; significance level: ** 1%, * 5%

[3] The F-test statistic for the similarity of the asymmetric and symmetric model is 4.93 in peak and 5.00 in base. As the critical value is 3.87 at the 95% confidence level, the null hypothesis can be rejected in both cases.

[4] When interpreting the results one must be aware that regressing rolling averages produces autocorrelated residuals; that emission allowance prices and natural gas prices are slightly correlated; and that the low R^2 may point to the omission of other explanatory variables (e.g. demand). Thus, the parameter estimates may be inefficient. The simplifications, however, are unlikely to have an effect on the overall conclusion.

Figure 9: Asymmetric cost pass-through



Source: Own calculation

4.2 Comparing competition in the German and U.K. wholesale markets

In this section, we compare the degree of competitiveness in the German and U.K. wholesale markets. To assess whether the differences in market structure and design are reflected in the market outcomes, we cannot simply compare the wholesale electricity prices, since the differences in cost and demand curves in both countries obscure our analysis. Instead, we ask how effective each country's generation costs are in explaining the electricity prices.[5] Recalling that prices in competitive markets should link direct to the marginal cost of the marginal power plant, we first examine marginal generation costs. We develop a new cost-based electricity price model which recognizes that since electricity can be produced with different technologies, the marginal generation costs will depend on the fuel prices (coal, natural gas) and on emission allowances. We select base load (e.g. nuclear or wind), coal, natural gas and peak load (e.g. oil). The marginal costs in each of these technology regimes depend on the sum of fuel prices, emission prices and a fixed component. For example, the cost of coal generation depends heavily on coal prices and emission allowance prices. If coal power plants are the marginal units (normally during medium demand), both coal and emission allowance prices will determine the price of electricity (see Figure 10). Based on electricity, coal, natural gas and emission prices, our model estimates the likely marginal technology at each point in time, as well as the influence of each cost factor on the marginal cost for each technology (the so-called Markov-Switching Regime Model).

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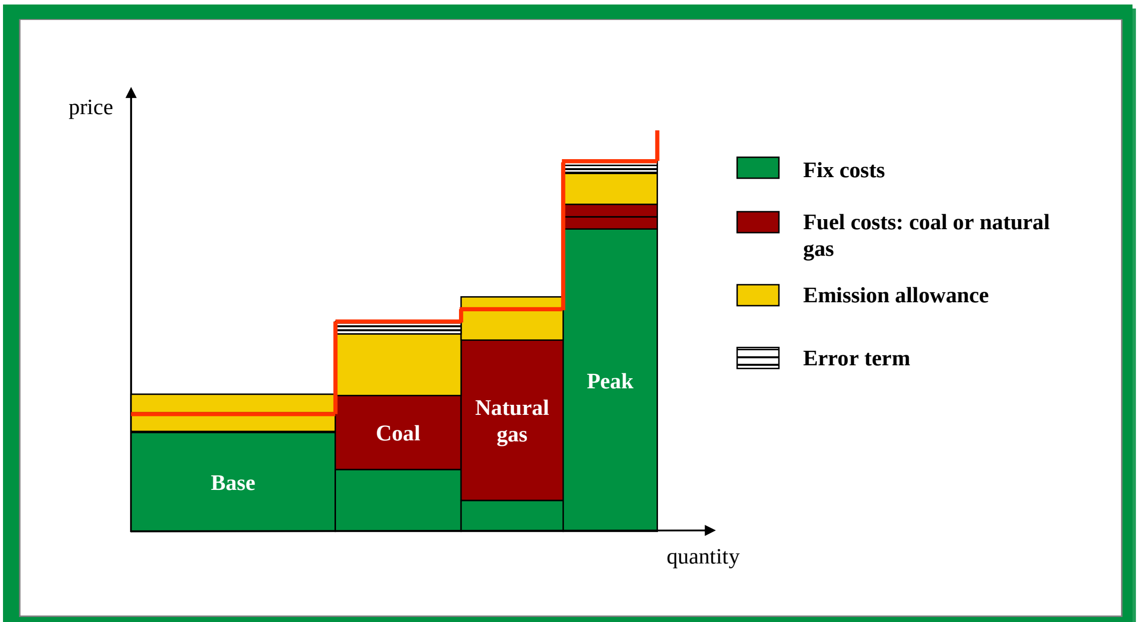
[5] This section is based on Zachmann (2006).

Figure 10: Electricity price formation model (schematic)



Source: Own calculation

The model is estimated for Germany and the UK for the third and thirteenth hours of each workday (the third hour represents a low- and the thirteenth hour a high-demand situation).[6] Table 3 presents the average prices in the technology regimes and their share of occurrence. The regimes can clearly be distinguished; our model is able to explain more than 70% of the thirteenth-hour and more than 80% of the third-hour electricity price variations for both countries.

However, we observe in the German market model that both the average prices in the coal regime and the average prices in the natural gas regime more than double from the third to the thirteenth hour. By contrast, the differences are significantly less severe in the U.K. model. This indicates that German prices are less cost driven since doubling the marginal cost in the same technology regime is unlikely (although we expect some increase if less efficient power plants become marginal during peak load). Furthermore, the model cannot explain 18% of the German base and 29% of the German peak electricity price movements whereas only 10% (respectively 22%) of the U.K. price variations cannot be explained by the cost model (Figure 11).

The results above provide evidence that using an assumed marginal cost pricing model will give improved data about electricity price formation. We attribute the deviations observed in German electricity prices from the estimated marginal cost structure to the lesser degree of competition that allows German generators to depart from marginal cost pricing.

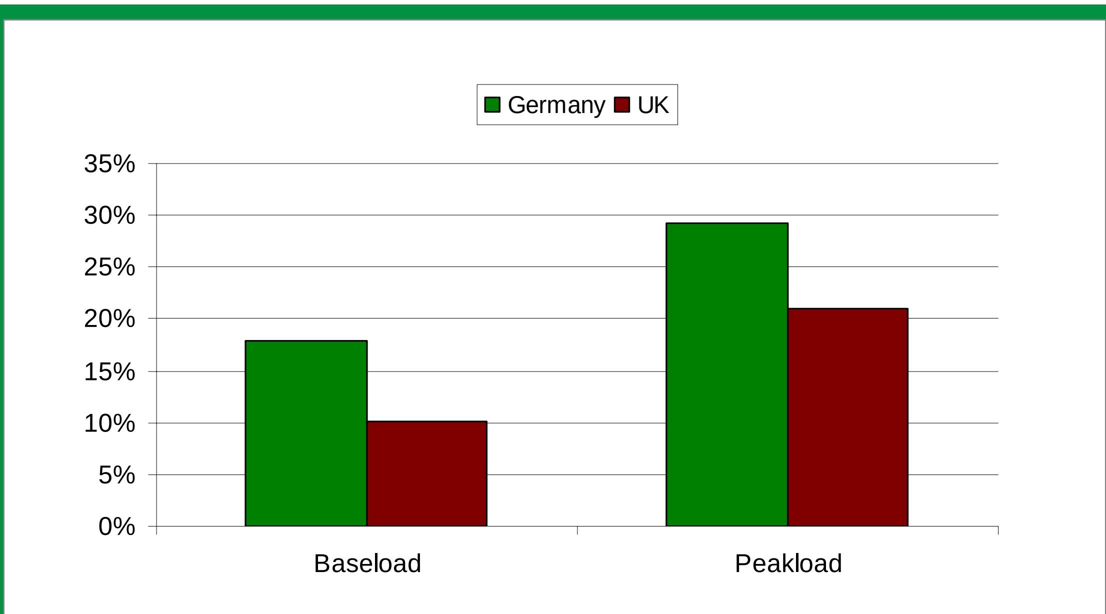
[6] The data for the German case consists of EEX electricity prices, daily EEX emission allowance prices, ARA coal prices and TTF natural gas prices for t 2002-2006; for the U.K. market model we use UPKX electricity prices, NBP natural gas prices, EEX emission allowance and ARA coal prices.

Table 3: Estimated characteristics of the technology regimes, 2002-2006

Technology	*Average price [€/MWh]*	*Variance*	*Share as marginal technology*
EEX, 3rd hour; R^2: 82%			
base load	14.41	33.26	28%
coal	18.97	14.59	37%
natural gas	26.56	12.96	35%
EEX, 13th hour; R^2: 71%			
coal	39.56	35.39	47%
natural gas	52.68	60.53	43%
peak load	87.64	1072.91	10%
UKPX, 3rd hour; R^2: 90%			
base load	18.23	6.76	27%
coal	23.55	4.72	39%
natural gas	40.27	55	34%
UKPX, 13th hour; R^2: 78%			
coal	30.49	13.41	37%
natural gas	50.42	81.06	51%
peak load	102.68	1031.82	12%

Source: Own calculations

Figure 11: Share of price changes not explained by the cost model, 2002-2006



Source: Own calculation

4.3 Other issues

Developing the analysis further, we find more indicators of Germany's insufficiently competitive market (for details see Hirschhausen/Weigt/Zachmann, 2007, Chapter 9). We apply a Supply Function Equilibrium model (SFE) that allows the estimation of theoretical markups as a result of a high market concentration. This approach determines the optimal supply curve a company is willing to submit if actual demand is uncertain. The SFE model reveals that significant markups are likely to occur in the case of a dominant duopoly or quadropoly and verifies our hypothesis that the given market structure has a high potential for market power abuse.

The market for reserve power is a crucial component of electricity markets because it allows capacity to be transferred from the wholesale market (the same effect as physical withholding). Germany's balancing market comprises three technical segments (primary, secondary and tertiary reserve). Because each grid company is responsible for network security within its area, the balancing market is split into four localized markets with a total amount of about 7 GW or roughly 10% of peak load. Even though tertiary reserve is now traded on a common platform (as of December 1, 2006), primary and secondary reserves are still traded within the four grid areas. The present structure greatly reduces market efficiency.

Another factor impeding competition is the lack of cross-border trade. Not only are cross-border capacities insufficient to balance supply and demand, but they are also used inefficiently. This is due to an inefficient auction design ("explicit auctions"), and the conflict of interest among Germany's vertically integrated utilities about transmission capacity ownership. At the moment, the utilities are only legally unbundled, and transmission and generation still remain in the hands of one company; thus, the transmission grids can be used to block market participation by external players.[7] Most of Germany's cross-border lines are governed by explicit auction, a mechanism that does not account for flow-based effects, thus leading to reduced cross-border line usage. Explicit auctions also foster cross-border capacity foreclosure by buying capacity in the critical direction, reducing possible competition by external players.[8] Given that Germany has more than 15 GW of cross-border capacity, efficient congestion management would increase overall market competitiveness.

5 Summary and Conclusions

Market power is a significant problem in electricity markets throughout the world. Its presence can be explained both by the previous monopolistic structure of most electricity markets, maintaining vertical integration between electricity generation and transmission, and the size and scale of today's large producers. The extent of abuse affects the transition from monopolistic to competitive electricity markets. Available literature and theoretical foundation are by now sufficiently developed to indicate the welfare and distributional aspects of market power. These analyses have been particularly stringent in markets with more transparency and publicly available data, such as the U.K. and the U.S. By contrast, market power and its impacts on competition and design are only now emerging as critical topics in continental Europe, and in Germany. The few existing studies on Germany's experience to date suggest that electricity markets are under-performing.

[7] One possibility is the reduction of possible import capacity of cross-border lines by using inefficient congestion management methods.

We developed several quantitative models to bring to light the insufficient levels of competition in generation and trading: A competitive benchmark model showed that real prices are significantly higher than competitive prices (based on marginal cost analysis), in particular in mid- and peak-load periods. An econometric analysis showed that price changes in CO_2-allowances are passed on to the market asymmetrically: CO_2 price increases are passed on directly, whereas CO_2–price decreases are passed on far less directly. The German wholesale electricity market was shown to respond less directly to fundamental price changes than in the U.K. market (Markov-Switching Regime Model). Further, an SFE analysis demonstrated a high potential for market power abuse by the dominant duopoly.

We also found that Germany's balancing markets which are artificially split into four market segments show low degrees of competition in each segment. We noted that the market for trans-border electricity transmission capacity is structured inefficiently, leading to welfare losses and little outside competition.

We conclude that German electricity sector requires a far more competitive market design and the corresponding regulatory policies to support competitive development. Elements of this policy should include: the divestiture of incumbents' plant capacities; virtual divestiture of capacity; elimination of long-term contracts; extension of cross-border capacities; vertical unbundling; and proactive encouragement of new market participants.

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[8] This procedure is prohibited on paper by the auction rules as each traded capacity must be used.

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