Arbitrage on European Energy Markets

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Keywords: Electricity, Arbitrage, Commodity Markets.

Abstract: Aim of this paper is to present arbitrage opportunities within chosen European energy commodities, specifically electricity sold on German, Polish, French, Slovak, Czech, Italian, Hungarian markets. As the main product was chosen BL CAL+1 – electricity future of next year delivery. Energy exchange market correlations and differentials are calculated and compared with the costs related to transfer of the commodity. Final possible profit as well as risks (and related possible loses) are expressed. All possible arbitrage options, country law, tax and market specifics are considered. Final conclusion whether the arbitrage is possible, how difficult it is to find such situations is stated, as well as the formula, which variables are necessary to focus on for time arbitrage calculation based on various data inputs.

1 INTRODUCTION

Recent situation in energetics correspond with globalization trend in other sectors. Energy futures are sold in centralized commodity exchanges across European countries, for example commodity exchange EEX (European Energy Exchange) covers electricity futures from most European countries (Austria, Belgium, Bulgaria, Czech Republic, the Netherlands, France, Great Britain, Germany, Greece, Hungary, Italy, Scandinavia (Denmark, Finland, Norway, Sweden), Poland, Romania, Serbia, Slovakia, Slovenia, Spain and Switzerland and most recently Japan). Nevertheless those products are with financial settlement only, so that the traders use them for hedging their products to avoid risks and then when financial settlement is over, they buy the electricity on spot market (in case of Czech Republic it is traded on OTE (the Czech electricity and gas market operator) operating daily electricity market). This market runs as a blind auction, and if the subject is not successful in this auction, there is possibility to furthermore adjust volumes on intraday market (with higher spread and lower liquidity) or to be charged the missing purchase volume with final imbalance price. This final imbalance price depends on final situation of system imbalance, whether the subject imbalance is the same sign of number as system imbalance, regarding this is the subject charged with imbalance price or receives the counter-imbalance price.

What this information means in praxis? Commodity exchange products are only tool to avoid bigger losses and make hedging, but it is not a place providing the traders opportunity to get real future deliveries. This tool is to be used only avoiding risk, that the price of current fixed contracts multiplies within the period before delivery. After purchase of this future, current price is financially cleared with the purchased price, so if the price doubles at the end, price difference between final price and purchase price is paid buyer, but they still need to buy the real delivery products at producers, or indirectly at OTE daily market. Price of next year future at the yearend has different price as price on daily market for next days, so this cover price risks, but in previous 3 years the spot price was more convenient than the future price.

Also, this system brings opportunity for price speculations, prediction usage for time arbitrages and also but less likely arbitrages within countries. As the price volatility increased in recent years, this is current concern of more and more people working in field of energetics.

2 METHODOLOGY

Is it possible to predict based on today market changes tomorrow prices (price speculation)? Is it possible to find arbitrage opportunities, when it is profitable to transfer electricity across borders

Sedláček, P.
Arbitrage on European Energy Markets.
DOI: 10.5220/0011357900003355
In *Proceedings of the 1st International Joint Conference on Energy and Environmental Engineering (CoEEE 2021)*, pages 57-61
ISBN: 978-989-758-599-9

(location arbitrage)? To answer first question, econometric modelling above historical data is used, to answer second, historical opportunities were searched.

When looking for price speculation, econometric predictions were used for determining near future and receiving some profits from this and further assessed. If the difference of prices today and tomorrow is higher than the spread, the deal is profitable.

Table 1. Methods used in this model.

Purpose	Method	Complexity criterion
Predictor engineering	PCA	Variance
Predictor preselection	Lasso	5-fold CV error
	Ridge	5-fold CV error
	RF	5-fold CV error
Lag determination	ARIMAX	AIC
Model specification	ARIMAX	AIC

There were selected data time series from January 2015 to December 2019, such as electricity market prices (BL cal+1) in Germany, Poland, France, Slovakia, Czech Republic, Italy, Hungary, contracted quantities per day in Czech Republic, gas prices (NCG cal+1 and cal+2), LGO (light gas oil), oil, coal and uranium, prices of emission allowances, information about daily electricity production by source and prices on spot electricity market of that day, exchange rates of CZK/EUR and EUR/USD, weather data (temperature, sunshine and wind), day of week, stock exchange indexes (PX and DAX), stocks of ČEZ and EON (Czech and German electricity trading and distributing companies).

Several drawbacks like multicollinearity, autocorrelation, missing values, necessity to detect high number of irrelevant variables and debatable stationarity, are to be expected. Regarding satisfying satisfy stationarity assumption, one day differences was used. As notable from Table 1, Lasso and Ridge are maintaining linear structure shared with ARIMAX models. Last method - Random Forests – was chosen for endurance against different scales, multicollinearity and autocorrelation thanks to random sampling from data common to all bagging algorithms. (Pedregosa, 2011) Also, as a CART based method, RF are able to deal with missing observations by surrogate splits. (Greene, 2000)

Multicollinearity would be expected in financial markets setting, Principal Components Analysis (PCA) was used to orthogonalize some of the predictors exhibiting high correlation as well as to engineer new predictors with potentially higher prediction power (Hastie, 2003). Reducing our feature space by mentioned methods, ARIMAX assess variable relevance better (Hyndman,2019). It is suitable for ability to take full advantage of non-trivial link between past and present values and for interpretability and transparency common to all linear models. Prediction on strictly independent test sample was developed, accurately assessing model's prediction abilities.

When searching for location arbitrage possibilities, analytical methods and comparison are used.

3 RESULTS

3.1 Time Electricity Arbitrage (Statistical)

When looking for time arbitrage, time series that might affect electricity future were chosen from various fields and as well as their possible delay, so that it would be possible to predict on their behalf and thus gain profit.

Table 2. Econometric modelling output.

Coal spot price Germany	DAX index	NCG Germany cal+2	Weather - temperature	Coal index (NL)
-0.0052	4e-04	0.2178	0.0148	0.0679
s.e. 0.0016	1e-04	0.0766	0.0050	0.0144

sigma^2 estimated as 0.1672: log likelihood=-423.4

Table 3. Confusion matrix.

Obs. / Pred.	0	1
0	107	75
1	62	104

Results of this econometric modelling in table 2 and table 3 is possibility to predict tomorrow price increase (based on today data) with 62 % chance, decrease with 59 %. This percentage seems a bit low, nevertheless using this strategy should be profitable in long term period. Final significant predicators for tomorrow electricity future price are today change in coal prices (reflecting that highest volume of electricity in Czech republic is produced in coal power plants, DAX (German stock index reflecting German economy), weather forecast for tomorrow (°C) and long-term gas contract price. We must consider not only the spread "gap", but also the fact, that this tool is only 10 % better then coincidence. R squared value would be around 0,1 explaining that 90 % is coincidence and we predict remaining 10 %., so therefore the model is very unstable, the key indicators and number can change within time, so they would have to be updated very often for commercial use. Even this might produce profits due to high volatility as presented below on Figure 1.

3.2 Location Electricity Arbitrage

Every country in Europe has different electricity price. There is possibility to buy product at different country and buy border transfer (transferring real commodity, so real delivery contract only, no financial settlement products). This service is operated by JAO company (jao.eu), running as an auction. On this auction there are used mostly daily, monthly and yearly products. If the bidder is successful (demand meets supply), there is allocated volume to be transferred. The winner does not have to use the whole volume (it is right to transfer, not obligation).

When looking on historical final data to answer, whether the transfer option is convenient and it is possible to gain better price using foreign future price and transfer option than domestic future, historical data from JAO were used. There is only one auction for yearly product for following year.

For example:

CZ->SK 26.11.2019 for 2020 at 1,36 EUR/MWh, price differential of this day at EEX: 48,56 –> 44,8 = -3,76

SK->CZ 26.11.2019 for 2020 at 0,03 EUR/MWh, price differential of this day at EEX: 44,8 –> 48,56 = 3,76

DE->FR 14.12.2018 for 2019 at 6,34 EUR/MWh, price differential of this day at EEX: 50,93 –> 63,65 = 12,72

FR->DE 14.12.2019 for 2019 at 0,71 EUR/MWh, price differential of this day at EEX: 63,65 –> 50,93 = -12,72

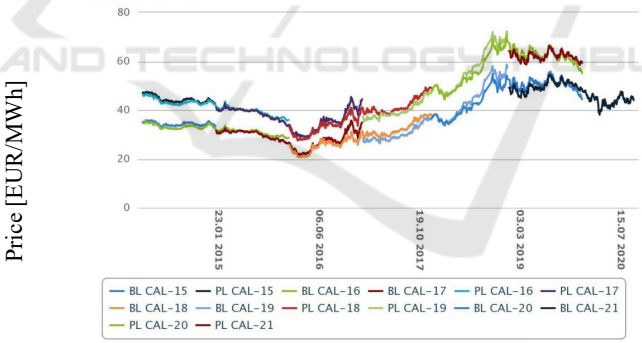

Figure 1. Electricity price historical data (CZ cal+1) (PRE, 2020)

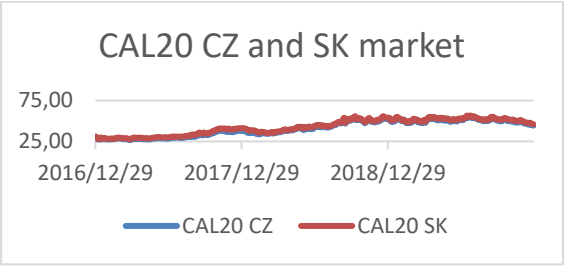

Figure 2. CZ and SK market price historical differences for CAL20.

From data in figure 2 is obvious, that some transfers are more convenient than other, nevertheless to make this deal and gain profit from it, there have to by some conditions fulfilled. The company must have status of electricity trader in both countries (necessary license in both countries), excessive volumes of electricity, that the company really needs to transfer and consume in different country, or to have a buyer of real commodity in this country. Only transferring to other country because of low transfer price and then selling the volumes on daily markets would be extremely risky. There is current trend, that spot prices are lower than future prices (but this can of course change).

To get real settlement future the first step would be contract with an electricity producer willing to sell, which would be further used for transfer. This real product is not hard to get, but it comes with guarantees and prepayments from the side of powerplant owner. Guarantees and prepayments are inevitable, as if the company buying the contract for next year goes into insolvency, there would be a not hedged delivery and loss would be on side of supplier (difference of settled and current price).

This means it would be more convenient if the delivery in other country is really needed in another branch of same company, then just buying the product for speculation on price difference. But even this scenario is possible – after calculating price difference in countries, nominating willingness to transfer between those countries for price lower than this difference, and if bid is successful, buying product in one country and look for buyer in another.

To sum up, As the products on EEX or PXE (Power Exchange Central Europe) are financial only, but border transfer rights are real deliveries, so it is not possible to think about buying financial product, buying border transfer (real) and sell it on another market as financial product. Nevertheless attendance of the auction is important for companies selling real product on several markets, so they can take advantage and transfer their own volumes (produced at their powerplants or bought from partner powerplants via bilateral contracts) to other countries and avoid higher price differences than transfer fee.

Taxes are another thing to be mentioned. As the condition is that the company must have branches and license in both countries, this trade is basically selling the volumes (revenues) at price raised by transfer costs (costs –> revenues) from one company (from one branch) to another (costs). There is no VAT between electricity traders. This trade seems straightforward, but we can imagine situation, when in the portfolio of Czech company are several purchases with different price. Company decides to transfer part of it to branch in Slovakia, choses some exact deal that transfers (with additional costs) abroad. As the company has chosen some cheap purchase, potential profit was thus transferred from Czech Republic to Slovakia. In Czech Republic is corporate profit tax 19 %, meanwhile in Slovakia is 15 % (for smaller entities). Profit was realized in Slovakia when the electricity was sold to Slovak households and 4 % were saved on taxes.

3.3 Other Arbitrage Options in Energetics

There is time to time another possibility of arbitrage in energy sector such as Euro-Asian LNG (liquefied natural gas) arbitrage in 2019. In this case it was convenient to transfer LNG on tankers, but this window usually closes quickly, as the market reacts on the arbitrage possibility with price reduction the or the arbitrager fills the gap. (Zawadzki, 2019)

When looking for arbitrage opportunities, Balkan countries are in the field of energies said to be last haven, but also this gap is closing. (Flášar, 2016)

Considering time arbitrage via real instrument, accumulator and pumped-storage power plants can be mentioned. The principle of consuming electricity at off-peak hours and delivering at peak hours is more and more popular, in case of accumulators, the investment return rate is getting under 10 years, resulting in future wider usage and production. (technickytydenik.cz, 2020)

4 CONCLUSIONS

The time arbitrage is possible and easiest way is purchasing futures (EEX – financial settlement) and sell it later, but the chance of success of prediction tool is 62:38, the price difference must exceed buy-sell spread, the model is very unstable and also it is connected with fees paid to the commodity exchange. If the company needs to buy some volumes anyway to final customers portfolio, they can make purchases regarding to this model prediction, if they are successful, they can sell some volumes with immediate profit, if not, they can hold those volumes as final real delivery prices (thus receive smaller profits in next year).

Location arbitrage is only reachable for product with real settlement and is convenient only if the volumes transferred via borders are consumed by the company branch or if there is a buyer willing to buy straight ahead, otherwise it would be too risky to wait

on final prices on daily market. The transfers are with restricted capacities, which should be beard in mind when purchasing the remaining volumes. If successful, companies can gain here the profits from arbitrage as well as tax benefits.

Main contribution of this paper is advice for companies considering possibility to enter another market as well as all people working on research on factors having impact on electricity prices and market behaviour. Main conclusion is knowledge, that we can partially predict tomorrow electricity prices, what factors have impact, that the model is keen for frequent changes and that having branches abroad can gain profits to companies trading electricity.

ACKNOWLEDGEMENTS

The support of the Masaryk University internal grant No. 2182 is gratefully acknowledged.

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