Statsitical Arbitrage in single price balancing markets

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Overview

In this paper we analyse the effects of a market participant responding to price incentives for spillage and shortage positions in a single price balancing market. We propose a decision model based on forecasting the conditional distribution of the imbalance with quantile regressions and discuss the effect of time delay for statistical arbitrage decisions in the Austrian imbalance settlement process.

Two imbalance settlement designs are distinguished - single and dual balancing pricing. Single pricing means that BRP (Balancing Responsible Party) with a shortage compared to his schedule is faced with the same imbalance price as a BRP with a surplus. Thus, only one imbalance price is determined per time interval. Dual balancing pricing schemes on the other hand have separate imbalance prices, which are determined for positive imbalances (BRP surpluses) and negative imbalances (BRP shortages) for one time period [1]. The Single-price approach sets an incentive to deviate in the opposite direction to the net deviation in the control area. In this sense, the imbalancing settlement process can be interpreted as an alternative marketplace to the intra day and reserve markets.

Close to realization time, intraday markets provide price information of excess power (up- and down regulation capacity) which can be utilized in balancing markets to reduce overall real time balancing system costs. In the proposed model statistical arbitrage potentials between the intraday market and the balancing market are analysed from the perspectives of a finacial player and the system operator.

Our findings suggest that an agent responding to market signals in this way enhances real time market efficiency. With a favourable single pricing imbalance settlement design (with short information time delays and correct price signals in the imbalance settlement process), market participants can react and adapt production output or consumption to reduce system imbalances and hence overall balancing costs. The backtesting analysis suggests a win-win situation for both, the participant and the system operator.

Methods

We apply quantile regression forecasting to estimate the conditional distribution of the system imbalance and combine that approach with decision-making under uncertainty. We carry out back testing on a dataset from 2015. The model simulates a particpant buying/selling energy at the final prices on the EPEX spot intraday market and taking spillage/shortage positions into the Austrian imbalancing settlement process. We calibrate and run our forecast model for a range of time delays t-1 (lag1) to t-8 (lag 8) and study the impact on system behaviour for 15 minute time intervals. Figure 1 shows the microstructure of the problem set.

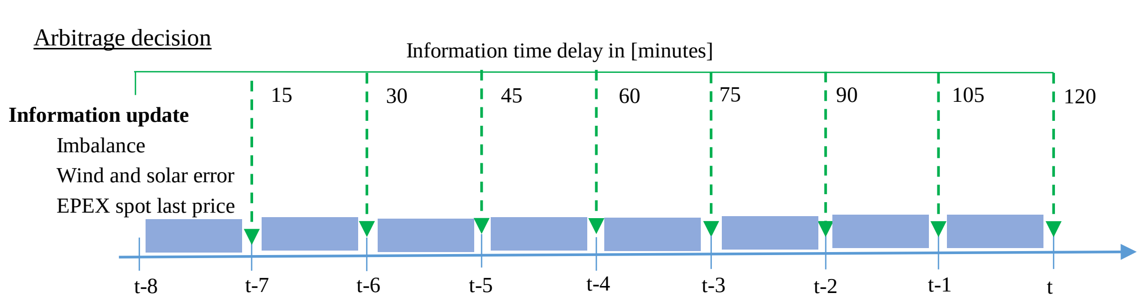

Figure 1: settlement process in Austria

We apply the expected value criterion for a risk neutral agent. The expected value for a given course of action is the weighted sum of possible pay offs for each alternative. It is obtained by summing the payoffs for each course of action multiplied by the probabilities $\rho(s_i)$ associated with each state of the market s_i. The course of action x_k is chosen which has the highest expected value $EV(x_k)$.The objective is to maximize the expected outcome for each timeinterval of the decision problem:

$$max_k \left[EV(x_k) = \sum_{i \in I} v_{i,k}\, \rho(s_i) \right]$$

Results

For short time delays, system costs have the potential to decrease significantly. For the simulation with a time lag between gate closure and realization of 15 minutes (lag 1), costs are cut from EUR 2.3 Mio to EUR 1.85 Mio. which corresponds to 19% cost savings in August 2015 (compare Figure 2). From a market players perspective realized profit contributions decreases with longer time delays as positions become progressively less accurate.

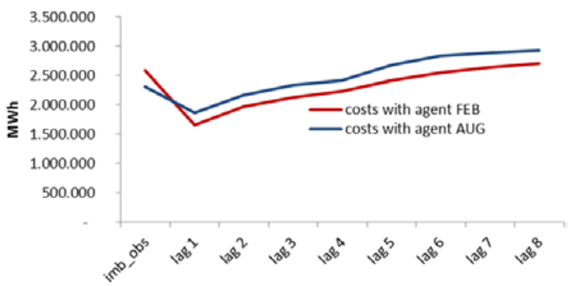

Figure 2: Observed/optimized system costs February/August 2015

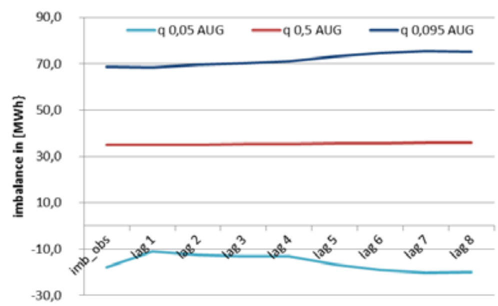

Figure 3: quantiles of observed/optimized imbalance August 2015

In figure 3 quantiles serve as an indicator for the distribution of imbalances in August 2015 for the base case (imb_obs) and the optimized scenarios with a time lag of 15 minutes (lag 1) up to 120 minutes (lag 8). The median imbalance (50%-quantile) remained stable for the optimized scenarios. The lowest 5% of imbalance obervations decreased for shorter time lags and increased for time lags 6 to 8. The 95%-quantile decreased slightly for time-lag 1 and increased for longer time delays.

A similar effect can be measured for the standard deviation of observed/optimized imbalance. The standard deviation of the imbalance decreases for the lag1-model, but, with time lagged decisions longer than 45-60 minutes (timelag 3-4) it increases above the initial observed imbalance. On the other hand we found that imbalance half-cycles (we counted the changes between positive and negative imbalance according to the counting algorithm from [2]) increased significantly.

Conclusions

The analysis points towards a potential for statistical arbitrage between gate closure prices and balancing prices in Austria. For short time delays our back-testing analysis showed a reduction of imbalance extremas and balancing costs. Our findings suggest that that usage of additional intraday flexibility enhances balancing market efficiency. With short information time delays and a favourable market design (correct price information in the imbalance settlement process), market participants can react to predicted price signals for balancing prices and adapt production output or consumption to reduce system imbalances and hence balancing costs. The backtesting analysis suggests a win-win situation for both the market participant and the system operator.

References

[1] Van der Veen RAC, Hakvoort RA. The electricity balancing market: Exploring the design challenge. Utility Policy 2016;43:186–94.

[2] Larsen EM, Pinson P, Wang J, Ding Y, Østergaard J. The Cobweb Effect in Balancing Markets with Demand Response, 12th International Conference on the European Energy Market, 2015; 2015, p. 1–8.