Contribution ID: **26** Type: **not specified**

Multi-Market Coupling Model: A Residual Demand Approach

Friday, April 4, 2025 11:40 AM (25 minutes)

The growing share of intermittent renewable infeed calls for further interconnection of electricity markets. The European commission defined one coupled European electricity market as the target model and aims for an expansion of the interconnecting capacities to cover at least 15 % of the electricity produced in each connected country (European Commission (2015), European Commission (2024)). For Central Western Europe (CWE), we observe that the day-ahead prices are often identical and are influenced by transmission capacities implicitly allocated by the Flow-Based Market Coupling (FBMC) methodology. However, established electricity price models often do not consider market coupling and lack implementable solutions to integrate it. Existent coupling models often assume explicit capacity allocation not following the FBMC and do not account for more than two coupled bidding zones. Due to the expected growth of interconnecting capacities, an approach using structural information and the FBMC methodology is needed. With our multi-market coupling model we want to fill this gap and answer the following research question: How can we integrate FBMC in a residual demand framework to predict electricity day-ahead prices in a mid-term horizon?

The literature with regard to market coupling can be broadly divided into approaches that predict convergence states of coupled bidding zones and approaches that predict the prices or price spreads. Saez et al. (2019) and Corona et al. (2022) use decision trees and probit regressions to estimate the price convergence between two bidding zones. Pircalabu and Benth (2017) and Christensen and Benth (2020) use reduced-form models to predict price spreads between two bidding zones. Cartea and Gonzalez-Pedraz (2012) and Pierre and Schneider (2024) apply a reduced form model for the electricity prices of two price zones. Kiesel and Kustermann (2016), Füss et al. (2017), and Alasseur and Feron (2018) use fundamental models developed and tested for two connected bidding zones.

We take the general concept of Kiesel and Kustermann (2016), integrate the supply function methodology of He et al. (2013) and apply it to a residual demand approach. First, we estimate supply functions considering fuel prices of each price zone without interconnection. These supply functions are then adapted by the residual demand that is exchanged via interconnectors. Core of the model is the iterative optimization to find the optimal interconnector flows and the corresponding supply functions. Hence, we develop a proxy of the EUPHEMIA coupling algorithm and take the Remaining Available Margins (RAMs) of every interconnector as side restrictions. We obtain FBMC parameters from JAO (2025), take further electricity market data from ENTSO-E (2025), and fuel prices from Reuters (2025). Our model enables us to extend residual demand approaches (e.g., Wagner (2014), Hain et a. (2024)) into models covering multiple markets. By taking the interconnector capacities implicitly into consideration, our model enables us to determine the effect of additional interconnector capacities on the price dynamics, the most decisive interconnector, or the value of each interconnector. Empirical tests demonstrate that we can improve the in-sample performance of a residual demand model only considering one bidding zone.

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Session Classification: Energy security and market coupling