Cross-product Manipulation in Electricity Markets, Microstructure Models and Asymmetric Information

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Executive summary

Due to the lack of economic storage, the existence of capacity and transmission constraints, and the small price elasticity of demand in the short run, physical electricity markets are vulnerable to price manipulation. This may increase the total cost of serving electricity demand, lead to market outcomes that do not reflect underlying fundamentals, and have implications for the distribution of profits and losses among market participants. An extensive literature exists on the exercise of supplier market power in electricity markets, and monitoring and mitigation rules are in place to detect this type of price manipulation in real-time physical markets. In contrast, a policy concern raised by enforcement actions of the Federal Energy Regulatory Commission focuses on price manipulation involving forward electricity markets and related financial positions: market participants may act against their economic interest in the day-ahead market to artificially move prices and gain profits on related financial positions (like financial transmission rights or FTRs) that make up for any direct losses. A major challenge is to develop and apply forward market analytical frameworks and models. This task is more difficult than for the real-time market, and the theoretical foundations and empirical implications of day-ahead price manipulation remain poorly understood. A theory (or theories) of forward market manipulation would help FERC administer principles-based enforcement and serve three main purposes: explain what market imperfections allow day-ahead price manipulation to be sustained over time, quantify its price impact in a transparent way, and provide empirical implications that may be tested in the data to determine if actions were consistent with manipulation.

To illustrate this point, our paper makes three contributions. First, building on the Kumar and Seppi (1992) model for cash-settled financial transactions, we construct an example of electricity market equilibrium price manipulation under uncertainty where asymmetric information creates limits to arbitrage. A trader without superior information on market fundamentals can successfully manipulate the spot settlement price of a futures contract because her positions are confused with those of two informed traders. On average, the manipulator expects to lose money in the spot market, but earn higher profits in the futures market by randomizing her order between long or short positions with equal probability.

Our second contribution consists in examining the empirical and welfare implications of the equilibrium of the modified Kumar and Seppi (1992) model, and comparing these implications to

those from three benchmark models. Cross-product manipulation creates a transitory divergence between spot prices and expected liquidation values. However, spot prices appear unbiased in the long term (i.e., manipulation does not lead to systematic forward premia), suggesting that long-run price convergence does not fully determine market efficiency. Manipulation also increases the variance of the spot aggregate positions, and creates a positive (albeit small) correlation between the spot price and the manipulator's related financial positions. With regard to welfare implications, manipulation determines a redistribution of ex ante profits and losses among market participants. With one informed trader in the spot market, manipulation hurts futures noise traders, but benefits spot noise traders and the informed trader. Adding a second informed trader in the spot market reduces the overall profitability of the cross-market manipulation strategy and aggregate profits for the informed traders due to increased market liquidity, while benefiting noise traders in both futures and spot markets.

Third, insights of a model of cross-product manipulation in financial markets may not carry over under conditions that apply in electricity markets, which are characterized by capacity constraints, loop flows and non-convexities. In particular, while the assumption of normally distributed random variables allows derivation of closed form solutions in an analytically tractable model, FTRs are constrained by the capacity of the transmission system. Our simulation results indicate that the main predictions of the theoretical model are not affected by futures position limits, and are robust to alternate parameter values and distributional assumptions.

The adaptation of the Kumar and Seppi analysis illustrates the type of theoretical analysis that should guide market manipulation inquiries. This is an existence demonstration that market manipulation is at least possible in principle. According to this theory, a key element allowing manipulation to exist in equilibrium is given by the randomization of trading strategies, including randomization of related financial positions. This would correspond to randomization of FTR positions in electricity markets. Absent such randomization, the market would soon uncover the arbitrage opportunities and eliminate the profitability for the manipulator. Analysis of FTR positions suggests that randomization was not observed empirically in the alleged price manipulation case involving Louis Dreyfus Energy Services in MISO. Thus, some other model (possibly involving limits to arbitrage other than asymmetric information) would be needed to demonstrate that the observed behavior implied cross-product manipulation.