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Market performance and bidders' bidding behavior in the New York Transmission Congestion Contract market

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ABSTRACT

Using publicly available bidder level bids data for Transmission Congestion Contracts (TCCs) and the realized awards of TCCs in the NYISO monthly reconfiguration auctions from June 2000 to December 2004, we examine both market performance and bidders' bidding behavior in the auctions. The data show significant under-pricing in the realized awards of TCCs. Theories suggest that under-pricing may arise from risk-aversion, monopsonistic market power or winner's curse. Our empirical analysis illustrates that all of the three effects play a role in the NYISO TCCs market. Both market performance and bidders' bidding strategies can be best explained by the theoretical model with asymmetric information and risk-averse bidders.

1. Introduction

In 2002, the Federal Energy Regulatory Commission (FERC) called for the centralized locational marginal pricing as the cornerstone of its Standard Market Design (SMD). The design of locational marginal pricing specifies a single market clearing price at each location that reflects the locational marginal cost and locational value of energy. Differences in locational energy prices reflect the cost of congestion between those locations. Therefore, LMP folds the price of transmission into the price of energy and provides a market-based method for congestion management.

The New York Independent System Operator (NYISO) began operations in November 1999. The basis of the NYISO market operation is a locational based marginal price (LMP), which is consistent with the proposed FERC requirement for SMD. The NYISO calculates LMP for eleven within-state zones, four neighboring zones and over 400 generation buses. In the absence of any transmission loss and transmission constraints, LMP is the same for all locations. This ideal operating condition is known as "equal lambda" dispatch. In real power networks, the presence of transmission congestion requires a departure from this dispatch to satisfy the most efficient operation. Prices are higher at locations that are import-constrained and lower at locations that are export-constrained. Since electricity is traded at LMP, the differences between locational prices represent congestion charges that the generators at low-priced locations pay to supply power to the customers at high-priced locations. The associated price variations and uncertainty of congestion charges for transmission create a demand by electricity buyers and sellers for instruments to hedge price fluctuations and "lock-in" a price for transmission prior to the day-ahead market. To satisfy this demand, the NYISO created Transmission Congestion Contracts (TCCs) to market participants and allocated them mainly through auctions.

Compared with the rich theoretical literature on transmission congestion contracts (Hogan, 1992; Joskow and Tirole, 2000) and auction mechanism (Ausubel, 1997; Ausubel and Cramton, 2002; Back and Zender, 2001; Klemperer, 1999; Kremer and Nyborg, 2004; Wang and Zender, 2002; Wilson, 1979), the empirical literature on TCCs has been relatively limited so far. Adamson and Englander (2004) and Siddiqui et al. (2005) conducted empirical analyses on the market performance of NYISO TCCs monthly reconfiguration auction and initial auction respectively and demonstrated high inefficiency in both markets. Deng et al. (2004) demonstrated that the auction structure itself could result in market inefficiency unless the bid quantities for each TCC were very large as compared to the awarded quantities.

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Previous papers, however, do not explain market inefficiency by analyzing bidders' bidding behavior in TCCs market. This paper analyzes empirically the market performance and bidders' bidding behavior in the NYISO TCCs monthly reconfiguration auction using publicly available TCCs awards data and bidder-level bids data. The NYISO TCCs auction is carried out with a uniform price format, and bidders can submit multiple bids for multiple units of the same TCCs. Our empirical analyses are thus based on the theoretical models of multi-unit uniform price auction for divisible goods. Specifically, the theories proposed by Wilson (1979), Back and Zender (1993) and Wang and Zender (2002) are tested in this paper. We find that the cleared TCCs are under-priced significantly, which amounts to a significant profit for bidders. Our empirical analyses on bidders' bidding behavior show that risk-aversion, monopsonistic market power and winner's curse all affect bidding behavior. This paper documents for the first time in the literature the empirical evidence of the winner's curse in the NYISO TCCs auction. Both market performance and bidders' bidding strategies can be best explained by the theoretical model with asymmetric information and risk-averse bidders. To our knowledge, this paper is the first attempt to study bidders' bidding behavior in the NYISO TCCs monthly reconfiguration auction.

The rest of the paper is organized as follows. Section 2 describes the NYISO market. In Sections 3 and 4, we review the theories on equilibrium bidding strategies in uniform price auction for divisible goods and their empirical implications. Section 5 provides the empirical analyses of the performance of TCCs auction. The empirical analyses of bidders' bidding behavior are carried out in Section 6. Section 7 concludes.

2. NYISO Transmission Congestion Contract (TCC) market

In this section, we provide a summary of the institutional aspects of the NYISO TCCs market. The design of TCCs market is tightly linked to the design of the day-ahead (DA) electricity market, which is based on the LMP of the NYISO. The LMP of location i at time t is calculated as:

$$\mathrm{LMP}_{i,t} = \mathrm{MP}_t + \mathrm{ML}_{i,t} - \mathrm{MG}_{i,t} \tag{1}$$

where MP is the marginal price for electricity at an NYISO selected reference bus; ML and MG are marginal prices for losses and congestion respectively.

Because both load and the availability of transmission capacity vary over time, the incidence of network congestion, congestion charges, and thus the differences in locational prices also vary widely over time. The uncertainty of congestion charges for transmission uses under LMP system creates a demand for congestion hedges. TCCs are created to satisfy this demand. A TCC is always defined by a Point of Injection (POI), a Point of Withdrawal (POW) and an effective period. POI and POW can be any of the NYISO zones and generation buses. A TCC entitles (obligates) the holder to collect (pay) the DA congestion rents associated with one megawatt (MW) of transmission between the specified POI and POW if the congestion rents are positive (negative). The DA congestion rents of a TCC are determined by the difference in the congestion component of the DA LMP between the POW and POI for each hour of the effective period defined in the TCC. According to this definition, the congestion rent of 1 MW TCC from POI to POW with effective period from $t1$ to $t2$ can be represented as:

$$R = \sum_{t=t1}^{t2} [MG(POW,t) - MG(POI,t)] \tag{2}$$

The TCCs in the NYISO are mainly allocated through centralized TCCs auction conducted by the NYISO. The NYISO currently holds two types of auctions. One is initial auction held every 6 months to sell TCCs with relatively long effective periods (5-year, 2-year, 1-year or 6-month). The other is monthly reconfiguration auction which has been held on monthly basis since May 2000. It sells the TCCs whose effective period is the whole month following the auction. The monthly reconfiguration auction allows market participants to purchase and sell relatively short-term TCCs. Bidders can adjust their bidding strategies more timely and flexibly according to updated market conditions through monthly auction than through initial auction. We focus our analyses on monthly reconfiguration auction in order to catch richer bidding behavior.

The NYISO TCCs auction is multi-unit uniform price auction. Winning buyers are obligated to pay market clearing price and entitled to collect the congestion rents between the specified POI and POW. From June 2000 to December 2004 (inclusive), 48 valid monthly reconfiguration auctions were held. They award totally 117,703 MW TCCs and 1766 distinct TCC pairs defined by (POI, POW) combination. The awarded TCCs are under-priced significantly with $26.8 million net profit gained by TCCs buyers. The significant and persistent underpricing in the realized awards of TCCs motivates us to model bidders' strategic bidding behavior. The objective is to find main factors contributing to bid-shadings.

3. Theories on equilibrium bidding strategies in uniform price auction for divisible goods

In the auction literature, there are two general types of auctions, private value and common value auctions. Under a private value auction, a bidder's valuation is based on personal preferences. A bidder's belief about the value of auctioned goods would not be affected by the revelation of other bidders' private information. By contrast, in a common value auction, the auctioned goods typically have an objective, though unknown value during the bidding process. Therefore, different bidders' estimation of the value of the auctioned goods has a common value component, and is affiliated with other bidders' valuation. A winning bidder would update his estimate upon revealing other bidders' signals. In the NYISO TCCs auction, all of the winning bidders will be paid the same congestion rents for the same cleared TCCs. If we assume that bidders only care about cash flows, a common value auction should be a good approximation for TCCs auction. Therefore, the theoretical models on the NYISO TCCs auction are based on the common-value auction with multi-unit uniform price format.

Many empirical analyses (Cammack, 1991; Gordy, 1999; Keloharju et al., 2002) find that bidders usually shade their bidding prices below their expected values on the auctioned goods. As suggested by theories, three factors can explain bidders' bid-shading behavior in the common-value auction with multi-unit uniform price format. These factors are risk aversion, monopsonistic market power, and the winner's curse due to asymmetric information.

First, if a bidder is risk-averse, he would bid a lower price than his expected value on the auctioned goods to compensate for the risk he bears when estimating the stochastically unknown true value of the auctioned goods.

Second, the under-pricing equilibrium may be the result of exercising monopsonistic market power by bidders. It was first proposed by Wilson (1979) and refined by Back and Zender (1993). Each bidder is faced with an upward-sloping residual supply curve if every bidder submits a decreasing demand schedule. It implies that a bidder is a monopsonist over his own residual supply. The monopsonistic market power will result in a bidding price below the bidders' expected value on the auctioned goods.

Third, as suggested by Ausubel (1997), the winner's curse may be very active in common-value multi-unit auction with asymmetric information. Wang and Zender (2002) demonstrate that underpricing can result from the winner's curse. In a common value auction, a bidder conditions his bid on the information revealed by winning a particular quantity of the goods. Since winning more means that others do not value the good as highly as he might, winning a larger quantity of the goods is worse news about the goods' value. A