Chapter 12
Participation and Efficiency in the New York Financial Transmission Rights Markets

Seabron Adamson and Geoffrey Parker

12.1 Introduction

As many authors have observed, the allocation of scarce transmission capacity presents a major market design challenge. The electric power system is subject to generation and transmission technology constraints that make it difficult to define tradable property rights for physical transmission. This difficulty has led economists to instead create markets for financial transmission rights (FTRs) settled against the congestion price component of locational marginal prices (LMPs) (Hogan 1992). This market structure has been increasingly adopted in the United States and other countries.

While there has been a substantial literature on the relative attractiveness of FTR markets over other market design, there has been significantly less empirical analysis of how these markets have performed in practice. In this chapter, we trace the operation of the one of the earliest FTR markets, operated by the New York Independent System Operator (NYISO). In particular, we present new analysis showing how the mix of firms that have participated in the NYISO FTR markets has changed over time. We also summarize the econometric analysis of Adamson et al. (2010) on FTR market efficiency and learning over time.

12.2 Transmission Congestion Pricing in New York

NYISO, along with the Pennsylvania, New Jersey, Maryland Interconnection (PJM), was one of the first LMP markets in the United States and has conducted periodic FTR auctions since 1999. The NYISO publishes day-ahead and real-time

S. Adamson (✉) • G. Parker
Tulane Energy Institute, Tulane University, New Orleans, LA 70118, USA
e-mail: sadamson@tulane.edu; gparker@tulane.edu

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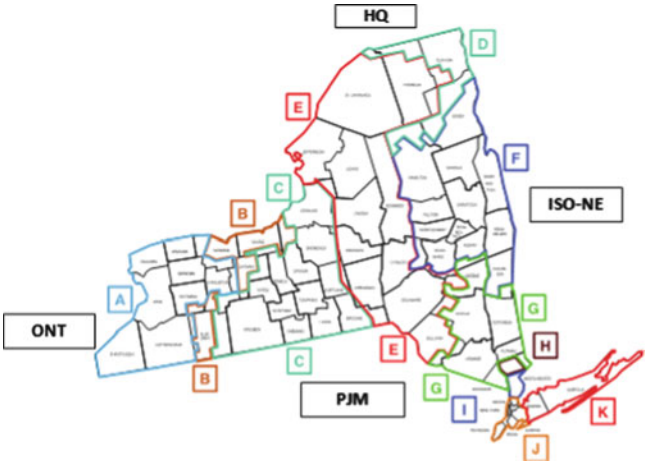

Fig. 12.1 NYISO load zones (Source: NYISO)

Table 12.1 Zones and import zone names in NYISO

Zone	Zone name	Zone	Zone name
A	West	I	Dunwoodie
B	Genesee	J	New York City
C	Central	K	Long Island
D	North	HQ	Hydro Quebec
E	Mohawk Valley	PJM	PJM
F	Capital	IMO	Ontario
G	Hudson Valley	ISONE	New England
H	Millwood		

LMPs at numerous points across New York State's power grid, which has a complex interconnected topology. These LMPs include a congestion price component reflecting the impact of transmission constraints.

Under the NYISO market design generators are considered to generate at their bus, while loads are considered to consume in a load zone. The NYISO grid is divided into 11 load zones – labeled "A" to "K" as shown in Fig. 12.1 below – plus 4 import zones that are used to price imports and exports to and from the neighboring PJM and ISO-New England markets in the US and the Ontario (IESO) and Hydro Quebec (HQ) markets in Canada.

Prices are denoted in dollars per megawatt-hour. For example, a generator which produces 100 MW for an hour at a specific node x within Zone A will be paid 100 times the node x price for that hour while a load at a specific node z of 10 MW in Zone J will pay 10 times the local price for that hour (Table 12.1).

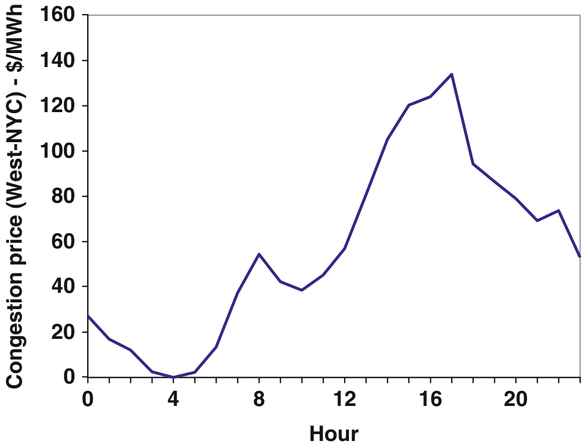

Fig. 12.2 Example of NYISO congestion prices over a day (Source: Adamson et al. 2010)

12.3 New York Financial Transmission Rights Markets

Although this spot market pricing system is effective at addressing the realities of power flow on an interconnected grid, on its own it poses substantial financial risks for both generators and users of power. As can be seen in Fig. 12.2, there can be substantial congestion price volatility across a single day. This example shows the hourly congestion charge (per MWh) in each hour for a hypothetical bilateral transaction between the West Zone (Zone A) and New York City (Zone J) for 1 day in early July 2008.

Given the magnitude and volatility of congestion prices in an LMP market, a method is needed to hedge the price risks posed by spot power prices that vary from location to location and by hour. In response to this problem, Hogan (1992) proposed a system of financial hedging contracts designed to mitigate the component of this risk associated with congestion. These financial hedging contracts – fundamentally similar to financial swaps – pay the owner of the congestion contract the quantity (in MW) times the congestion price difference between a specified Point of Injection (PoI) and Point of Withdrawal (PoW) for each hour in the term of the contract. These FTRs are called “transmission congestion contracts” or “TCCs” in the NYISO lexicon; we will use the more standard “financial transmission rights” term in this chapter. In the NYISO markets, FTRs play the role that ordinary point-to-point transmission rights play in physical market designs, although in this case they act solely as financial swaps and have no direct effect on system operations.

For example, a monthly FTR might be defined with a PoI of Albany and a PoW of New York City. For each hour in the month, the FTR holder is paid the difference between the NYC and Albany congestion prices. FTR payments over an hour (or longer periods) can be negative – an FTR is an obligation to pay the sum of congestion price differences even if this sum is negative.

NYISO has conducted periodic FTR auctions since 1999. Market participants include utilities, marketers, generators and financial firms such as banks and hedge funds. In New York, FTRs have been sold for varying durations – ranging from 1 month to 2 years. As described above, a 1-month FTR is the right to hourly differences between congestion prices at two specified locations for the period of a calendar month. Since the FTR is defined as an obligation, and not an option, it may have a negative value, in which case a reverse auction is used to allocate it. Both positive and negative FTRs are allocated in the same auction. An auction of FTRs covering a month is conducted early in the preceding month, so that a FTR covering the month of November, for example, will be auctioned in early October.

12.4 Participation in New York FTR Auctions

NYISO publishes extensive data on its FTR auctions; this information specifically identifies the market participant that was awarded the FTR, the contract duration, the price paid, and the POI/POW pair that defines the FTR.[1] Note that the dataset identifies only FTRs awarded, but does not identify bidding firms that did not win in the auction.

In the first New York auctions, FTRs were generally of short duration, with a term of less than or equal to 6 months. In 2001 and 2002, more longer-term (e.g. 2 years) FTRs were offered, but this trend has since reversed and more recently 1 year and shorter FTRs have become the norm, as shown in Fig. 12.3.

The NYISO dataset also includes data on grandfathered FTRs. These FTRs were awarded to market participants in the early days of NYISO operations to replace pre-existing physical transmission rights in the grid, before market opening. Many New York utilities had such rights, some of which were of very long duration. Under the NYISO tariff, these holders of existing transmission rights had the option to convert them into FTRs and many did so. As these FTRs were not awarded in the auctions, and represented existing transmission rights in the grid, these have been excluded from our analysis.

Using the NYISO data, it is possible to examine trends in the number and POI/POW locations of FTRs awarded and to classify the market participants awarded FTRs. FTR market participants have been divided into five classes for this analysis:

- ***Utilities:*** This category includes New York investor-owned utilities, state agencies that serve loads in NYISO (such as the New York Power Authority) and a number of smaller municipal utilities. Out-of-state utilities acquiring FTRs in the NYISO auctions – which would typically be done by a competitive marketing group – are not included in this category.
- ***Generators/marketers:*** This category includes the major NYISO generators, out-of-state utilities selling power into NYISO, and the power marketing firms, many of which are part of combined generation/marketing firms.

[1] http://www.nyiso.com/public/about_nyiso/understanding_the_markets/financial_markets/. Accessed 17 Sept 2011.

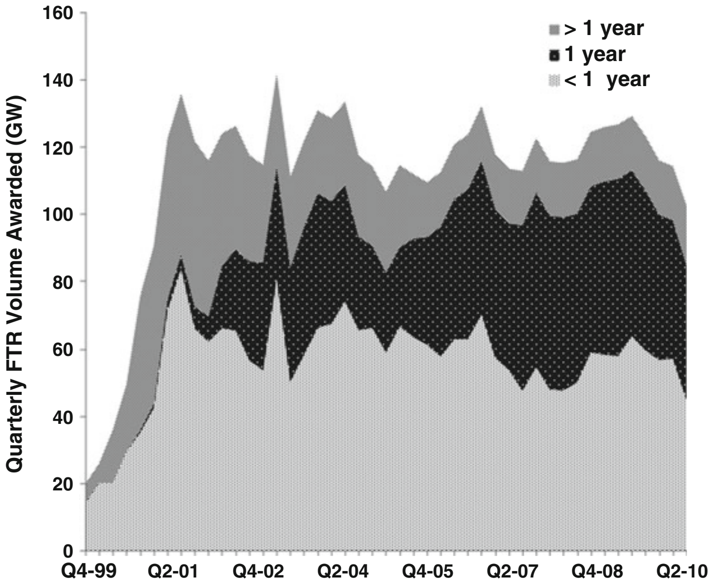

Fig. 12.3 Quarterly FTR awards by contract duration (Source: NYISO)

- ***Retailers:*** The competitive retail sector in New York consists of firms which primarily market electricity directly to individual end-use customers.
- ***Banks:*** The major Wall Street investment banks, through various proprietary and commodity trading desks, are active in the NYSIO FTR markets.
- ***Funds:*** This category includes non-bank hedge funds and trading groups. Many of the funds most active in the NYISO market are specialized entities; some of which that focus almost entirely on the FTR markets in NYISO and other U.S. markets.

It is not possible, using this data, to classify neatly those FTRs acquired for "speculation" versus "hedging" purposes. Some generalizations, however, can be made. Utility and retailer FTR purchases, given the nature of these firms, have most likely been made to hedge congestion risk. For example, a New York City utility or retailer that had a purchase contract with a generator upstate, but had load obligations downstate, would be exposed to risk in the congestion component of LMPs; this could be hedged using FTRs. At the opposite extreme, hedge funds and other specialized trading groups generally do not have offsetting load exposures and their FTR purchases most likely represent allocations of purely speculative capital.

The FTRs purchased by generators/marketers and the bank trading desks cannot be classified a priori as being for hedging or speculative purposes. These entities both engage in speculative trading but also have extensive portfolios of power positions that FTRs can help to hedge. For example, an upstate generator could sell power under a contract to a downstate customer fixing the price at the customer's

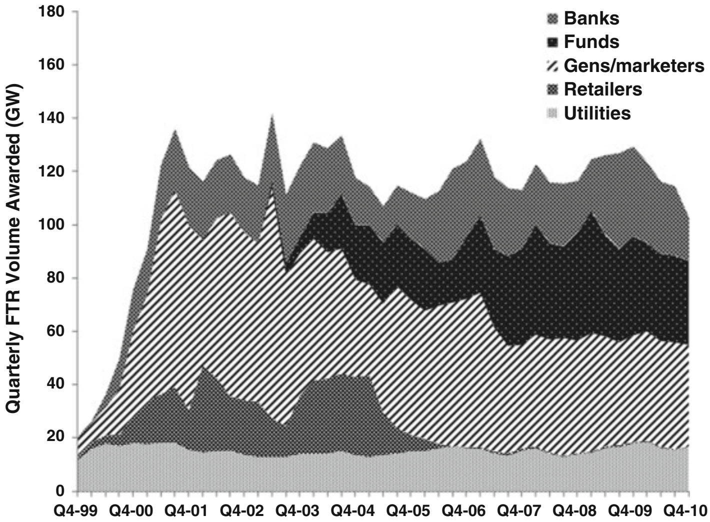

Fig. 12.4 FTR awards by participant type and quarter (Source: NYISO)

location; an FTR could then be used to hedge the congestion component of the basis risk. Similarly, a bank trading desk may enter into a swap position with a customer in one zone but have some of the risk offset by a corresponding purchase in another zone. Again this risk could be managed using FTRs. Overall however, both the marketers and investment banks are known to allocate significant amounts of speculative capital to FTR trading and at least a significant fraction of these total volumes likely represent speculative transactions.

Figure 12.4 shows the total volume of FTRs awarded (in gigawatts) in NYISO by quarter, broken down by category of market participant. The volume of FTRs awarded by NYISO grew quickly in 2000 and 2001, and has remained largely stable ever since.

The primary trend apparent in Fig. 12.4 is the increasing importance of financial sector firms (banks and funds) over time. These two classes of market participants were of minimal significance in the early days of the NYISO FTR markets but now represent approximately half of all FTR volumes. Conversely, retailers were important in the 2000–2005 period, but are no longer significant FTR market participants, reflecting perhaps the state of the competitive retail market in New York. The share of FTRs awarded to utilities has remained relatively constant over the period.

The most congested major interfaces in the NYISO system are those that cross into the downstate New York City and Long Island zones (Zones J and K in Fig. 12.1). For FTRs with a POI or POW in Zones J and K, a similar pattern emerges in Fig. 12.5 in terms of market participation, with a somewhat higher share of financial sector FTRs awarded to funds in comparison to investment banks. Utilities received a larger share of these FTRs, reflecting perhaps their interest in hedging risks associated with power purchase contracts upstate.

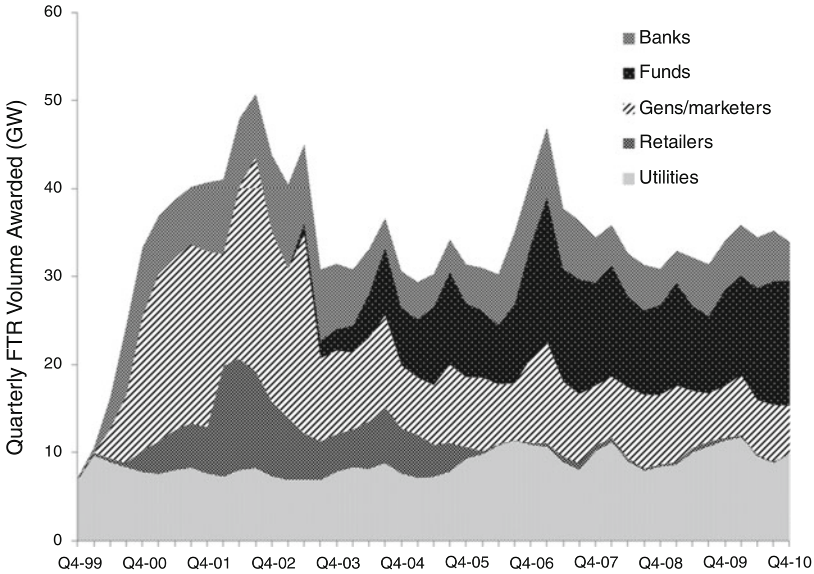

Fig. 12.5 FTR awards involving New York City/Long Island zones (Source: NYISO)

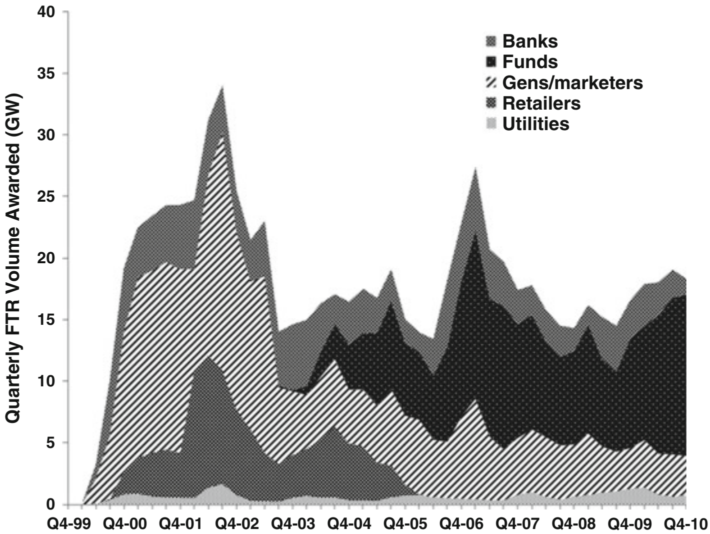

Fig. 12.6 FTRs awarded solely within New York City/Long Island Zones (Source: NYISO)

The trend of increasing share of FTRs awarded to financial sector firms is even stronger for FTRs that have both a POI and POW within Zones J and K (New York City and Long Island), as shown in Fig. 12.6. Few of these FTRs have been acquired by utilities, and since 2007 the majority of FTRs within NYC/LI have been awarded to specialist funds. The investment banks have played a smaller role in this component of the FTR auctions. The funds' focus on zones J and K may not be surprising given that there appear to be participation and informational costs unique to the NYC/LI market that have prevented transaction profits from being eliminated (Adamson et al. 2010).

12.5 Efficiency of New York FTR Auctions

FTRs settled against day-ahead locational congestion prices allows congestion price risks to be hedged, while allowing the system operator to centrally commit and dispatch all generation units while meeting transmission security constraints. The FTR-based market design thus allows market participants to hedge price risk while allowing the system to maintain least cost unit commitment and dispatch.

In LMP-based markets, such as New York, longer-term contracts (including FTRs) are effectively financial hedges settled against spot prices. In the case of FTRs, these are spot congestion price differences. Examining the efficiency of FTR markets in an LMP-based design such as that of NYISO therefore provides some insights into the longer-term allocative efficiency of the whole market.

Several authors have examined FTR market efficiency, in many cases relying on NYISO data. An early analysis concluded that the NYISO FTR market was highly inefficient in its early operations, circa 2000–2001 (Siddiqui et al. 2005). Their analysis examined only four auctions in the early years of the market (and is hence based on only four independent data points). Adamson and Englander also suggested that NYISO FTR auctions were initially highly inefficient, although efficiency did improve somewhat over time (Adamson and Englander 2005).

A recent paper documented a significant divergence between spot and forward prices for 1-month TCCs in the NYISO in 2006 and 2007, finding that forward prices exceeded spot in 2006 and spot exceeded forward in 2007 (Hadsell and Shawky 2009). As the authors of the paper themselves point out, the dependence of realized congestion charges on large low frequency shocks (e.g., 2005s Hurricanes Katrina and Rita) makes estimating the expected profit from forward contracts using a short time series of observations problematic. Adamson, Noe, and Parker analyzed a much larger and richer data set and the results of their analysis are summarized below (Adamson et al. 2010).

From a more theoretical perspective, Deng, Oren, and Meliopoulos postulated that the inherent design of these FTR auctions, rather than limits on price discovery and information flows, may lead to inefficiency (Deng et al. 2004). In their model, FTR auction clearing prices will differ from expected FTR payoffs, even if bidders have perfect foresight, depending on the quantity of bids in the auction, due to the simultaneous feasibility constraints imposed in the FTR auction design.

Below, we discuss the econometric models Adamson et al. (2010) used to test hypotheses about FTR market efficiency and whether including a dynamic component in a learning model helps to improve the model fit. We then describe the data set they used to estimate model parameters and their summary statistics.

12.6 Econometric Models to Test Efficiency and Learning

Learning has been studied by economists, perhaps most famously, in the analysis of airplane manufacturing costs conducted by Wright (1936). Argote provides a comprehensive review of learning models and econometric specifications (Argote 1999). Most of this analysis has been performed in log-linear models with the underlying relation of a time variable to capture learning effects. However, in this case neither realized spot prices nor forward FTR prices need must be positive. Therefore, it is difficult to apply the standard log-linear learning framework to FTR markets. Thus, Adamson et al. (2010) analyzed two econometric specifications that do not require commitment to the unbiased forward rate hypothesis and do not require positive prices.

Their base model is the classic joint hypothesis test for bias and efficiency in a forward market (Engel 1996).

$$S_t = \beta_0 + \beta_1 F_t + \mu \tag{12.1}$$

S_t is the spot price in period t (in this case, the sum of realized congestion rents), F_t is the forward price for delivery in period t (in this case, the price paid for the FTR in the auction), and μ is an error term. If the market is efficient, then the intercept β_0 will not differ systematically from zero and the constant term β_1 will not differ systematically from one.

The second, dynamic model is specified as:

$$S_t = \beta_0 + \beta_{01}/(1+t) + \beta_1 F_t + \beta_{11} F_t/(1+t) + \mu \tag{12.2}$$

The dynamic model relates spot prices to forward prices through a constant linear relation (β_{01}) subject to diminishing bias over time. This model also allows the linear relation itself (β_{11}) to vary over time so that the model approaches a long-run equilibrium value. Learning is indicated by non-zero coefficients for these dynamic effects. The joint hypothesis test of H0: $\beta_0 = 0$ and $\beta_1 = 1$ can be used to examine the long run efficiency of the market.

12.7 New York FTR Auction Data

To test the base and dynamic models discussed above requires data on the forward FTR prices, and the realized spot congestion prices. This section describes the operations of the New York FTR markets in more detail and how forward and spot prices for FTRs are calculated.

Adamson et al. (2010) analyzed a large data set of all NYISO 1-month FTR auctions over the period from September 2000 through June 2006.[2] There were 2,250 unique PoI/PoW (source/sink) combinations in this data set, between both points and zones within the NYISO control area. Each set of monthly results often included prices for multiple contracts with the same source and sink zone.[3]

The spot congestion prices are subject to many of the same shocks and hence are not independent. Therefore robust regression models were used to verify model significance and correct standard errors (Huber 1964; White 1980).

Adamson et al. split their data set into four groups by contract type and geography. First, their data set was separated by "positive" FTRs – those for which a positive price was paid by the winning bidder in the auction – and "negative" or "counterflow" FTRs, where the auction price is negative.[4] The efficiency of positive and negative contract auctions was found to be quite different so analysis was done separately on positive and negatively priced contracts.

Adamson et al. also analyzed the New York City/Long Island region (Zones J and K in Fig. 12.1) separately from the others. Congestion within these two zones is qualitatively and quantitatively different from elsewhere in the NYISO, owing to the very high load and generation density of the transmission system within this region, especially during summer periods, and a complex pattern of voltage as well as thermal constraints creating transmission congestion.[5] Thus, the analysis was split into four major groups: (1) positive contracts not solely within zones J and K, (2) negative contracts not solely within zones J and K, (3) positive contracts solely within zones J and K, and (4) negative contracts solely within zones J and K.

Table 12.2 shows the summary statistics for the time series data divided into these four groups. FTR spot and forward prices are very fat tailed, with many more extreme observations than one would expect from a normal distribution with a similar variance (Corrado and Su 1996).

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[2] These data sets includes Day-Ahead congestion prices, TCC auction bids and TCC auction results for over 9,000 FTRs as obtained from the NYISO website.

[3] The "source zone" is the zone in which the POI is located and "sink zone" is the zone in which the corresponding POW for the FTR is located.

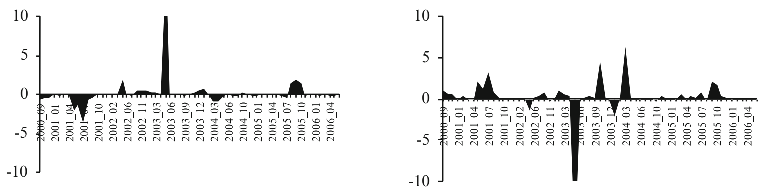
[4] For a counterflow FTR, the winning bidder is paid to take the FTR but has the obligation to pay congestion rents to the TSO. Counterflow FTRs are sold in the same auctions as positive FTRs.

[5] Significant parts of the New York City transmission grid are operated to a higher reliability standard than the rest of the New York market: using an N-2 criterion rather than the usual N-1 standard (NYISO 2008).

Table 12.2 Summary statistics for positive/negative FTRs by group

Group 1: Positive FTR contracts						
Crossing outside zones J & K	*Mean*	*Std. dev.*	*Kurtosis*	*Min*	*Max*	*N*
Spot price (MW-month)	$626	$1,887	28	−$7,351	$19,618	2,719
Forward price (MW-month)	$653	$1,693	34	$0	$22,520	2,719
Spot – forward	−$28	$1,360	44	−$19,688	$11,226	2,719
Quantity (MW-month)	26	66	139	0	1,160	2,719
Transaction profit $	$4,039	$210,638	1,585	−$2,807,776	$9,568,143	2,719
Group 2: Negative FTR contracts						
Crossing outside zones J & K	*Mean*	*Std. dev.*	*Kurtosis*	*Min*	*Max*	*N*
Spot price (MW-month)	−$659	$2,543	28	−$19,894	$3,703	2,992
Forward price (MW-month)	−$808	$2,415	25	−$24,597	$0	2,992
Spot – forward	$148	$1,489	46	−$11,254	$21,847	2,992
Quantity (MW-month)	26	60	126	0	1,147	2,992
Transaction profit $	$3,060	$150,326	305	−$1,658,063	$4,343,408	2,992
Group 3: Positive FTR contracts						
Solely within zones J & K	*Mean*	*Std. dev.*	*Kurtosis*	*Min*	*Max*	*N*
Spot price (MW-month)	$1,706	$3,221	20	−$11,495	$36,852	1,923
Forward price (MW-month)	$1,061	$1,484	12	$0	$12,500	1,923
Spot – forward	$645	$2,917	15	−$11,882	$29,358	1,923
Quantity (MW-month)	14	28	116	0	564	1,923
Transaction profit $	$10,962	$78,746	228	−$849,082	$1,956,745	1,923
Group 4: Negative FTR contracts						
Solely within zones J & K	*Mean*	*Std. dev.*	*Kurtosis*	*Min*	*Max*	*N*
Spot price (MW-month)	−$1,076	$2,961	14	−$26,511	$11,500	1,625
Forward price (MW-month)	−$1,701	$2,102	11	−$21,889	$0	1,625
Spot – forward	$625	$2,644	12	−$19,565	$21,776	1,625
Quantity (MW-month)	14	23	24	0	220	1,625
Transaction profit $	$4,489	$84,511	128	−$1,207,868	$1,432,660	1,625

Source: Adamson et al. (2010)

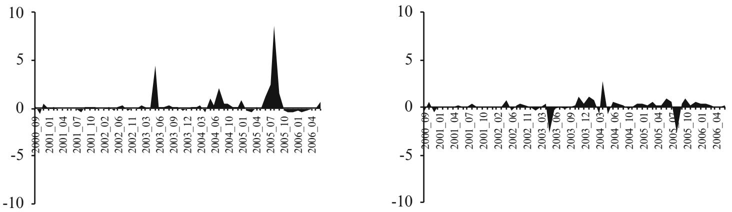


Group 1: Total Transaction Profits ($M) by month (Positive Contracts outside NYC/Long Island)

Group 2: Total Transaction Profits ($M) by month (Negative Contracts outside NYC/Long Island)

Fig. 12.7 Total transaction profits by month ($M) for groups 1&2 (Source: Adamson et al. 2010)

Figure 12.7 presents transactions profits for contracts that cross outside the New York City/Long Island market for positive and negative contracts. Figure 12.8 details transactions profits for contracts solely within the New York market for both positive and negative contracts.



Group 3: TotalTransaction Profits ($M) by month (Positive Contracts within NYC/Long Island) Group 4: Total Transaction Profits ($M) by month (Negative Contracts within NYC/Long Island)

Fig. 12.8 Total transaction profits by month ($M) for groups 3&4 (Source: Adamson et al. 2010)

Table 12.3 Regression results for base and dynamic models – groups 1&2

	Group 1: Positive		Group 2: Negative	
Model	Base	Dynamic	Base	Dynamic
Dep variable:	S	S	S	S
(B_0) Constant	104.8***	94.6***	38.4	30.9
	(30.9)	(24.7)	(22.4)	(20.2)
(B_1) Forward	0.798***	0.919***	0.864***	0.944***
	(0.057)	(0.042)	(0.041)	(0.036)
(B_{01}) 1/(1 + t)		−471		552
		(392)		(296)
(B_{11}) Forward/(1 + t)		−1.75***		−1.76***
		(0.20)		(0.15)
Wald test	[6.93]**	[7.45]***	[16.4]***	[3.72]*
($B_0 = 0$ & $B_1 = 1$)				
N	2,719	2,719	2,992	2,992
Robust F statistic	196	164	436	238
R^2	0.510	0.560	0.674	0.701

* p<0.05, ** p,0.01, *** p<0.001. Source: Adamson et al. (2010)

The left hand panel of Fig. 12.7 shows that initially transaction profits were negative for positive contracts not entirely within New York City and Long Island. After this initial period of about 12.5 years, transactions profits were on average non-negative. The right hand panel of Fig. 12.7 presents transactions profits on negative contracts not entirely within New York City/Long Island. Early transaction profits were positive, followed by a final period in which transaction profits were small in absolute size.

The left hand panel of Fig. 12.8 depicts the transactions profit on positive contracts entirely inside the New York City/Long Island zones. Initially profits were small in absolute magnitude. However, toward the end of the sample period, very large positive profits were realized, the largest profit spike being associated with Hurricanes Katrina and Rita in 2005, which created major shocks in US natural gas markets and hence power prices. The right hand panel of Fig. 12.8 shows that for negative contracts entirely in the New York City/Long Island zones the absolute

Table 12.4 Regression results for base and dynamic models – groups 3&4

	Group 3: Positive		Group 4: Negative	
Model	Base	Dynamic	Base	Dynamic
Dep variable:	S	S	S	S
(B_0) Constant	725.4***	684.7***	116.5	206.3*
	(86.9)	(101.5)	(90.3)	(93.7)
(B_1) Forward	0.924***	1.170***	0.701***	0.819***
	(0.090)	(0.126)	(0.064)	(0.075)
(B_{01}) 1/(1 + t)		3,020**		−4,199***
		(1,065)		(737)
(B_{11}) Forward/(1 + t)		−9.73***		−5.36***
		(1.81)		(1.41)
Wald test	[66]***	[68]***	[49]***	[17]***
($B_0 = 0$ & $B_1 = 1$)				
N	1,923	1,923	1,625	1,625
Robust F statistic	105	48	119	45
R^2	0.181	0.193	0.248	0.252

* p<0.05, ** p,0.01, *** p<0.001. Source: Adamson et al. (2010)

Table 12.5 Expected long run spot – forward price differences

$/MW-month	Group 1	Group 2	Group 3	Group 4
Mean forward price (in year 6)	$598	−$960	$1,131	−$2,033
Expected spot price in long run	$644	−$876	$2,007	−$1,458
Dynamic regression model standard error	$1,258	$1,392	$2,894	$2,562
Expected long run spot – forward price	$46	$84	$876	$575

Source: Adamson et al. (2010)

variability of contract profit was smaller. On average profits were positive throughout the study period.

Tables 12.3 and 12.4 summarize results for the base and dynamic models for each of the groups.

The results in Table 12.4 below indicate that the market for contracts solely within the New York City/Long Island sample (zones J and K) was less efficient than that for contracts that are outside New York City/Long Island. For positive contracts, the constant (β_0) was significantly above zero for both the static and dynamic model. For negative contracts, the coefficient on forward price was significantly less than one, leading to high positive expected spot – forward price differences.

Table 12.5 presents expected spot – forward price differences (per MW-month) that are calculated using the parameters from the dynamic model. A "representative" contract price is modeled using the mean forward price seen in the last 12 months of the data set.

Expected spot – forward prices are positive for all four groups, but are much larger for contracts that are within the New York City and Long Island zones. However, the corresponding standard errors are much larger than the expected profits in all cases and are especially large for groups 3 and 4, indicating a high likelihood of negative profit on any given transaction.

The implication of this table is that expected profits from participating in the FTR market are positive, but are highly variable, indicating that many market participants realize negative returns.

12.8 Conclusions

This chapter has presented descriptive data on the entities that have participated in NYISO FTR auctions and how the efficiency of these auctions has changed over time. The analysis shows that direct load-serving entities such as utilities and competitive retailers have purchased a relatively small fraction of FTRs auction, although they may have benefitted indirectly from energy price hedges sold to them by generators and marketers (who were major FTR purchasers) in their load zone. The most noteworthy aspect of the participation analysis has been the rapid rise in importance of financial institutions (including bank trading desks and specialist funds) in the New York FTR markets.

The importance of these financial sector entities in the NYISO FTR markets is especially pronounced for FTRs with a POI and POW solely within the New York City and Long Island zones. This may reflect the fact that this market appears to be less efficient from an economic perspective and hence trading profits on average may be larger. We have previously hypothesized that the costly modeling systems and staff required to analyze this complex transmission system may limit the willingness of firms to participate given the overall small size of the market, helping preserve positive expected transaction profits over time.

From a broader market design perspective, the results of the analysis of Adamson et al. (2010) are encouraging. Confirming the results of earlier analyses, the initial efficiency of the FTR auctions was relatively low, although it improved quickly over time, consistent with rapid learning by market participants. This suggests that the overall forward-looking allocative efficiency of these FTR market designs is generally robust.

Analysis of FTR auction data should allow a range of other research questions to be addressed. The NYISO FTR market was one of the first to begin operations, but subsequently several others have started in the United States. It may be hypothesized that initial efficiency would be higher, or learning more rapid, in these later markets, given that many of the same firms participate. The rich level of firm-level data should allow hypotheses of firm entry and exit to be tested using FTR market data.

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