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IMPACT MITIGATION FOR EMERGENCY EVENTS: THEIR EFFECTS ON DAY-AHEAD AND REAL-TIME MARKET LOCATIONAL BASED MARGINAL PRICING AT THE NEW YORK ISO*

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Abstract

The New York based electricity wholesale market (the New York Independent System Operator; NYISO), recently introduced a couple of measures that have the potential to mitigate the price impacts from a sudden and unforeseen event in a deregulated electricity market: the Price Response Load (PRL) programs. This paper tests whether the PRL programs reduced the risk premium in the electricity prices by searching for structural breaks in the difference between the forward and expected spot prices. We find that the risk premium significantly decreased with the commencement of these programs, which provides additional evidence for structural breaks in the mean of the forward discount.

Keywords: electricity market, risk premium, price response, the New York Independent System Operator

JEL Classification Code: G14, L94, Q48, R11

I. *Introduction*

Wholesale power markets have been growing rapidly and issues related to pricing in these markets have been widely discussed. One of the features of wholesale power prices is that they are subject to sudden upward spikes. This feature is attributed to the non-storability of electric power and the inelasticity of electricity demand to price changes. Even in a situation of sudden and unforeseen outages and/or shortfalls in electric power, the market is cleared without any buffer or considerable demand response. For this reason, market-clearing prices are volatile and sometimes show large spurts.

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This paper examines the effectiveness of the Price Response Load (PRL) programs. The PRL programs have the potential to mitigate the price impacts from such sudden and unforeseen events in a deregulated electricity market, and were implemented in the New York based electricity wholesale market: the New York Independent System Operator (NYISO). This paper shows how the risk premium, defined by the difference between the forward and expected spot prices, is affected by the PRL programs.

The PRL programs comprise three programs: the Emergency Demand Response Program (EDRP), the Installed Capacity/Special Case Resources (ICAP/SCR) Program, and the Day-ahead Demand Response Program (DADRP). The EDRP is a short-notice program that encourages retail electricity consumers to voluntarily reduce their demand during specific times when the electric grid could be jeopardized. The ICAP/SCR Program is a contract-based program. Retail electricity consumers are paid to make a contract in which they provide their load reduction capacity in case of an emergency. The DADRP is a consumer-initiated bidding program. Retail electricity consumers can bid their load reduction capability into the DA market. The ICAP/SCR Program was first implemented in 2000 and became practically functional from the summer of 2001. The EDRP and DADRP were also implemented in the summer of 2001.

Their performances were later presented in the NYISO PRL Program Evaluation Final Report, and their further effects were expected as follows.

> If these [PRL] programs persist in the long run and as a result market participants come to expect that real-time LBMPs [Locational Based Marginal Pricings] are likely to be lower and less variable, eventually this influence will be reflected in downward pressure on prices at which LSEs [Load Supply Entities] pay to hedge their load obligations, either through physical bilateral supply contracts or financial hedges. ("NYISO Price-Responsive Load Program Evaluation Final Report," page E-14)[1]

This suggests that the risk premium, which represents the compensation to market participants for bearing risks, can be decreased by the PRL programs because these programs have the potential to reduce the RT price volatility by making the electricity demand responsive to its higher price. This study is motivated by what the evaluation report expected, and examines whether the forward premium decreased with the programs that have the potential to reduce RT price volatilities, i.e. by the PRL programs.

To examine this, I employ a multiple structural break test developed by Bai and Perron (1998, 2003). This methodology endogenously searches out the best cutoff point of a dummy variable in a sense of the minimization of the sum of squared residuals. Since wholesale power markets are evolving with rapid policy changes, a researcher may overlook some important policy changes. In order to avoid such oversight, an endogenous searching methodology is employed.

This methodology is also used by Sakoulis and Zivot (2001) and Choi and Zivot (2007) in the context of foreign exchange rates. They explained the highly persistent behavior of the forward discount by considering multiple structural breaks. This issue has its roots in the forward discount anomaly, i.e., a negative correlation between the change in the future

[1] This sentence is excerpted from the New York Independent System Operator's publication with the NYISO's permission to use it in this paper.

exchange rate and the forward discount.[2] The definition of forward discount is the same as the definition of risk premium in this paper. At an earlier stage, Baillie and Bollerslev (1994, 2000) attributed the forward discount anomaly to the fractionally integrated (long-memory) process of the forward discount. However, several studies including Diebold and Inoue (2001) and Granger and Hyung (2004) argued that the long memory property may occur even due to the presence of structural breaks or regime switching. Sakoulis and Zivot (2001) and Choi and Zivot (2007) analyzed the evidence for long memory and structural changes in the forward discount. Both of them found multiple structural breaks in the mean of the forward discount at the time consistent with the change in the U.S. Central Bank's policy objective.

This paper has provided evidence that structural breaks in the mean of the forward discount exist not only in foreign exchange rates but also in electricity prices. Both occurred at the time of policy changes. In the case of the electricity market in New York, such policy change was the commencement of the PRL programs. The mechanism behind this result was that the PRL programs successfully led market participants to expect lower and less volatile RT prices. Therefore, they were relieved from aggressively hedging against emergency risks in the DA market, and consequently the risk premium decreased. This result was especially pronounced in the west side of the state of New York, which is a main contributor to the PRL programs.

The rest of this paper is structured as follows. Section II discusses the model and methodology, and gives the criteria to assess whether the risk premium decreased with the programs. Section III provides the empirical results. Section IV presents the conclusion.

II. *Model and Methodology*

This section specifies a model and a hypothesis to examine whether the risk premium decreased at the time consistent with the PRL programs. A forward price reflects not only the expected value of the spot price, but also risks and market participants' attitude toward these risks, i.e., the risk premium. The risk premium is formally described as follows.

$$RP_{st-1} = DA_{st} - E_{t-1}[RT_{st}] \tag{1}$$

where DA_{st} denotes the electricity forward price observed on day $t-1$ for delivery during hour s of day t, RT_{st} denotes the electricity spot price for delivery during hour s of day t, $E_{t-1}[RT_{st}]$ denotes the expected value of RT_{st} that is formed at day $t-1$, and RP denotes the risk premium. For example, if load suppliers are more eager to hedge against a risk from an upsurge in the price, then the risk premium becomes positive.

This paper allows the mean of the risk premia to vary from one regime to another. As with Choi and Zivot (2007), the situation where there are $m+1$ regimes (m breaks) in the mean of the risk premium is formally specified as follows:

$$y_{st} = a_{sj} + \varepsilon_{st} \tag{2}$$

for $j=1$, ..., $m+1$, where $y_{st} \equiv DA_{st} - RT_{st}$, $a_{sj} \equiv \overline{RP_{sj}}$ and that ε_{st} denotes white noise. The coefficient a_{sj} changes from $j=1$ to $m+1$ as the mean of the risk premia $\overline{RP_{sj}}$ changes. These

[2] The forward discount anomaly is comprehensively described in Engle (1996) and Lewis (1994).

shifts in the mean of the risk premia reflect the discrete changes in risks and the market participants' hedging attitude within the sample period.

To examine whether the risk premium decreased at the time related to the PRL programs, I use estimates of the coefficient and structural break dates that are obtained with the method developed by Bai and Perron (1998, 2003). This method enables us to estimate the coefficients together with unknown break points within the context of a linear model.[3] Specifically, the estimates of the coefficient, $\hat{a}_{sj}$ (for $j=1, ..., m+1$), and the structural break dates, $\hat{T}_1, ..., \hat{T}_m$, are used to test the following hypotheses:

Hypothesis (1) the estimated break dates $\hat{T}_1, ..., \hat{T}_m$ are related to the PRL programs;
Hypothesis (2) the shifting direction of the estimated coefficient $\hat{a}_{sj}$ is negative, which means that the mean of the risk premium $\overline{RP_{sj}}$ becomes lower.

If the estimated break date is consistent with the PRL programs and if the shifting direction of $\hat{a}_{sj}$ is negative, then I conclude that the risk premium significantly decreased at the time consistent with the PRL programs.

III. *Empirics*

1. Data and Preliminary Analysis

Daily Locational Based Marginal Pricing (LBMP) in the Day-ahead (DA) and Real-time (RT) markets is analyzed for all fifteen zones in the NYISO (including four neighbor zones) over the period November 19, 1999 through January 27, 2005.[4] In the DA market, each zonal load is scheduled for each of the 24 hours of the following day (e.g., 00:00 through 00:59, 01:00 through 01:59, and so forth), and therefore, 24 settlement prices are determined everyday for each zone. Hence, for each zone, there are 24 sets of daily DA-pricing data. Similarly, each zone has 24 sets of daily Integrated RT-pricing data. In the RT market, a contract is made every second if a match is available. Therefore, I used the Integrated RT-LBMP, which is the integrated price of all the clearing prices over the real-time contracts made in an hour.

Table 1 shows the summary statistics. Looking at the pricing through Super Zones, we can find that the mean prices in the NYC-LongIL Zone (New York City and Long Island) are higher than those in the East Super Zone (Capital to Dunwoodie) and much higher than those in the West Super Zone (West to Mohawk Valley). This is true both in the DA and RT markets. This reflects the fact that the West Super Zone has the largest number of electric power facilities, and is the major electricity exporter in the state of New York. The mean prices in the Neighbor Zone (Hydro-Quebec to PJM) are between those of the West and East Super

[3] Autocorrelation in the residuals is adjusted with Andrews (1991).

[4] The analyzed zones are West, Genesse, Central, Mohawk Valley, North, Capital, Hudson Valley, Millwood, Dunwoodie, New York City, Long Island, ISO New England, PJM, IMO, and Hydro-Quebec. A day that the RT price and/or DA price are/is not available is excluded from the data set. The excluded dates, for instance, for the 14:00 time slot are March 9-10, April 30, May 1-4, June 13-14, August 15, and October 16-24 in 2003, and January 1-4, 2004. The number of data points in each data set is somewhere between 1801 and 1806 depending on the number of the excluded data. All the data are available on the NYISO website or the website of the Center for the Study of Energy Markets (CSEM) in the University of California Energy Institute (UCEI).

Zones. The NYISO is uniquely situated in an area surrounded by other electricity markets.[5] Because of this geographic advantage, the NYISO has interconnected with its neighbors, especially to provide emergency electricity to each other. This is probably the reason why the mean prices in the Neighbor Zone hovered among those of the zones in the NYISO. For all the zones, the RT pricing is more volatile than the DA pricing. Looking at the pricing through the time slots, we can find that the mean prices for the hour 17:00 are higher than those for the other time slots. The same feature was observed by Longstaff and Wang (2004) for PJM.

As a preliminary analysis, I calculated the risk premium by using the method of Longstaff and Wang (2004):

$$E[FP_{st-1}] = \frac{1}{T}\sum_{t=1}^{T}(DA_{st} - RT_{st}). \qquad (3)$$

The unconditional expectation is taken over one year. Figure 1 shows how the mean of the forward premia varied through the sample period. The left panel is for the hour 02:00, the middle is for 05:00, and the right is for 14:00. The bar at the left-end in each super zone shows the mean risk premium from Nov. 19, 1999 to Nov. 18, 2000. The bar at the second-left shows the mean risk premium from Nov. 19, 2000 to Nov. 18, 2001, and so forth. Interestingly, the mean risk premium for 02:00 and 14:00 tends to be lower, as year goes on. A shift in the mean risk premium is especially obvious in the West Super Zone. This implies that there is, at least, one structural break in the risk premium around the time slots 02:00 and 14:00. On the other hand, the mean risk premium around 05:00 is relatively stable. This implies that there are few structural breaks for 05:00. To obtain rigorous results, I invoke a multiple structural break test developed by Bai and Perron (1998, 2003) in the next section.

2. Empirical Results

The empirical results from the Bai-Perron test are summarized in Tables 2 and 3. Table 2 shows all the detected break dates with a 5% significant level throughout the sample period from November 19, 1999 to January 27, 2005. A break date that supports both Hypotheses (1) and (2) is blocked. These mainly appear in the West Super Zone, and are consistent with the commencement of the PRL programs.

The PRL programs were launched during the summer of 2001. The final draft for the programs was confirmed on May 3, 2001. In July, twenty-three demand reduction providers were qualified to bid in the DA market under the Day-ahead Demand Response Program (DADRP), and the events of both the Emergency Demand Response Program (EDRP) and the Installed Capacity/Special Case Resources (ICAP/SCR) Program occurred from August 7 to 10, 2001.[6] The number of enrollments in these programs was 427 in 2001, and increased to 1785 in 2002. The average EDRP hourly curtailment consequently increased by 50% to 668 MW. According to the NYISO PRL program evaluation report (Neenan et al. (2002, 2003)), a higher percentage of curtailment in the EDRP and ICAP/SCR programs was pledged from the West Super Zone, and a majority of the DADRP participants are also from the West Super

[5] The NYISO is surrounded by ISO New England; Pennsylvania, New Jersey, and Maryland Interconnection (PJM); Independent Electricity Market Operator (IMO); and Hydro-Quebec.

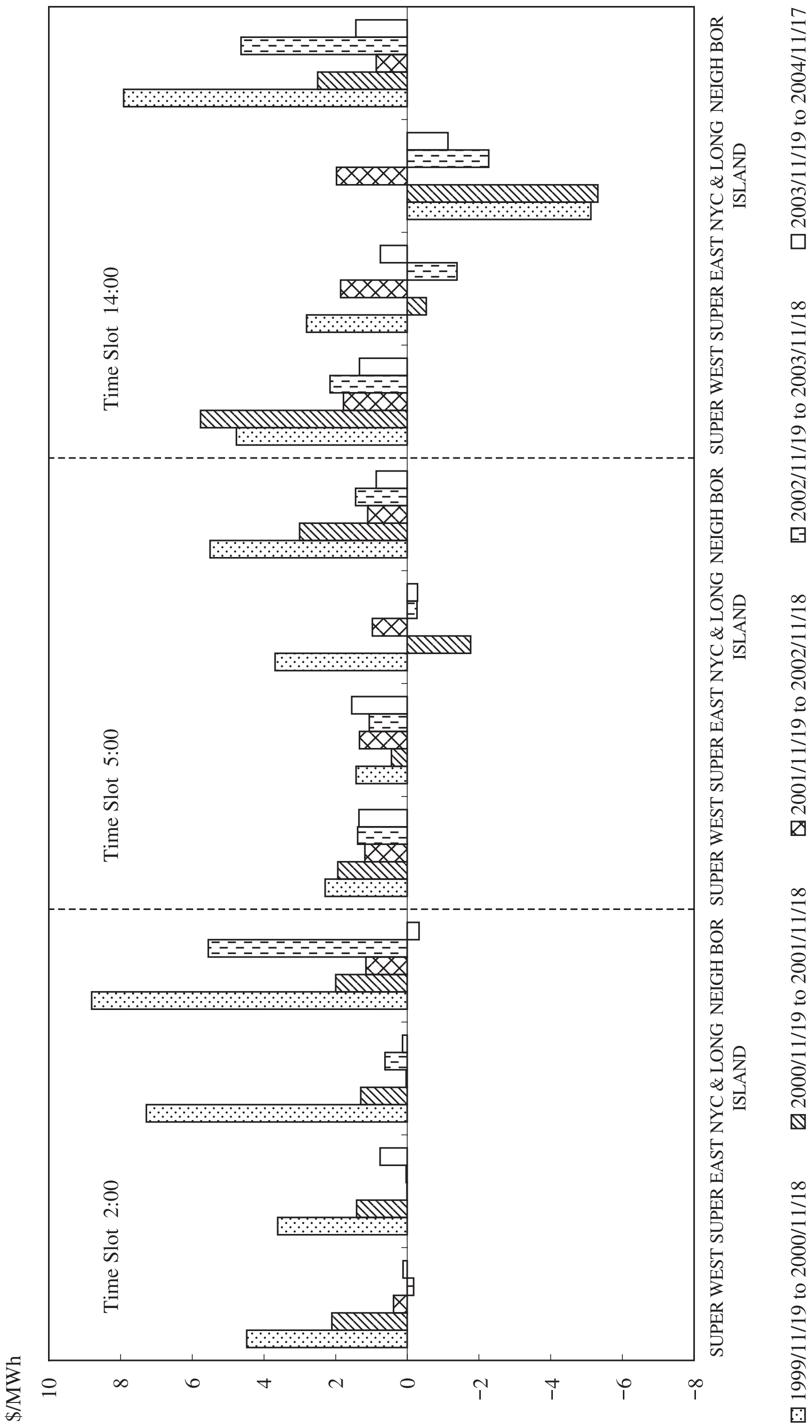
[6] These new entries brought about a substantial increase in the total number of generators. Besides May 2001, which recorded 13 new entries, the number of generators is stable.

TABLE 1. SUMMARY STATISTICS

		West	Genesse	Central	North	Mohawk Valley	Capital	Hudson Valley	Millwood	Dunwoodie	New York City	Long Island	Hydro Quebec	ISO New England	IMO	PJM
2:00	Day-Ahead Price															
	Mean	24.87	25.68	26.08	26.99	26.65	28.60	28.66	28.59	29.00	31.82	35.58	26.65	28.70	24.74	22.28
	s.d.	9.14	9.63	9.77	10.22	10.13	10.76	10.55	10.60	10.76	11.94	12.35	10.13	10.82	9.07	8.57
	Real-Time Price															
	Mean	23.60	24.82	24.46	25.45	24.94	28.44	26.91	27.17	27.60	30.44	33.18	25.32	27.59	21.61	14.14
	s.d.	17.65	18.29	18.10	18.89	18.54	20.37	19.44	19.77	19.95	22.41	24.88	46.23	32.82	38.14	72.30
5:00	Day-Ahead Price															
	Mean	27.84	28.71	29.11	29.60	30.07	31.66	31.77	31.69	32.09	34.91	38.20	29.46	31.58	27.45	25.90
	s.d.	10.71	11.23	11.25	11.51	11.68	12.05	11.87	11.93	12.12	12.92	12.15	11.35	11.98	10.39	10.45
	Real-Time Price															
	Mean	26.30	27.60	27.24	27.74	28.29	31.42	30.01	30.36	30.76	33.54	38.61	28.80	30.59	25.14	20.26
	s.d.	22.08	22.28	22.10	22.48	22.84	24.08	23.62	23.80	24.07	25.34	25.00	41.99	24.39	21.29	60.49
8:00	Day-Ahead Price															
	Mean	38.80	40.46	41.38	42.52	41.11	47.10	47.29	47.20	47.88	54.54	52.37	41.33	47.26	38.29	39.93
	s.d.	14.55	15.50	15.55	16.21	16.16	17.37	16.68	16.86	17.16	20.30	17.34	15.92	17.32	14.24	15.35
	Real-Time Price															
	Mean	36.53	38.54	38.44	39.43	38.31	46.91	45.34	46.37	47.08	54.89	54.04	39.12	47.46	37.17	36.46
	s.d.	19.28	21.16	20.73	22.09	22.00	36.39	29.90	30.22	30.67	41.78	30.82	45.14	50.35	38.90	52.65
11:00	Day-Ahead Price															
	Mean	41.84	43.65	44.61	44.09	45.73	51.97	52.60	52.59	53.40	63.01	61.13	44.14	52.27	41.03	43.41
	s.d.	16.31	16.91	16.91	17.08	17.50	25.66	23.52	23.89	24.27	28.11	25.56	16.82	24.95	15.80	17.75
	Real-Time Price															
	Mean	39.87	42.10	41.98	41.66	42.94	51.26	50.43	52.28	53.02	63.75	64.42	41.56	50.67	39.23	39.09
	s.d.	22.42	23.43	23.10	23.56	23.93	35.01	31.82	34.09	34.48	47.11	37.24	23.57	39.58	26.78	47.31
14:00	Day-Ahead Price															
	Mean	41.19	42.86	43.83	44.81	43.12	52.32	53.12	53.17	54.00	64.48	63.26	43.18	52.68	40.34	42.95
	s.d.	26.26	26.64	26.51	27.26	26.34	48.48	42.74	42.88	43.41	44.97	40.67	25.78	46.44	25.44	31.11
	Real-Time Price															
	Mean	38.55	40.30	40.21	41.07	39.80	49.75	51.10	54.07	54.79	66.25	66.24	38.92	51.03	38.19	37.15
	s.d.	34.43	35.48	35.54	36.77	36.03	51.51	53.50	59.90	59.40	74.38	60.69	48.29	58.83	35.74	61.41
17:00	Day-Ahead Price															
	Mean	46.90	48.92	49.95	49.49	51.28	57.46	58.74	58.93	59.88	69.05	72.97	49.57	57.97	46.12	48.77
	s.d.	21.61	22.56	22.66	22.98	23.58	32.64	32.94	33.80	34.30	37.45	42.19	22.68	33.23	21.19	23.36
	Real-Time Price															
	Mean	44.83	47.18	47.13	46.75	48.21	56.99	57.59	60.66	61.60	74.28	77.23	42.97	56.40	44.13	45.31
	s.d.	39.31	41.24	40.97	41.54	42.41	50.51	50.42	55.28	55.50	75.63	56.37	69.09	54.72	46.41	61.57

20:00	Day-Ahead Price																
		Mean	42.60	44.47	45.42	46.67	45.08	51.88	52.21	52.15	52.85	59.19	65.09	45.19	51.96	41.94	44.05
		s.d.	14.52	15.43	15.47	16.24	16.15	17.53	16.83	17.01	17.30	20.95	25.40	15.83	17.46	14.21	15.31
	Real-Time Price																
		Mean	41.73	43.77	43.78	44.95	43.69	51.58	51.23	53.26	54.05	63.60	72.01	42.48	51.48	40.91	39.86
		s.d.	34.08	34.46	34.10	35.48	34.79	36.75	36.98	43.99	44.47	64.06	49.00	34.41	44.78	38.19	58.54
23:00	Day-Ahead Price																
		Mean	33.05	34.36	35.07	35.61	36.31	38.56	38.98	38.77	39.21	45.06	46.33	35.14	38.12	32.24	30.79
		s.d.	10.50	11.31	11.49	11.82	12.04	12.57	12.59	12.77	13.02	14.95	14.27	12.09	12.80	10.63	10.77
	Real-Time Price																
		Mean	29.34	30.97	30.73	31.13	31.82	35.37	34.16	34.57	35.13	42.08	42.63	30.79	34.90	26.87	22.55
		s.d.	24.96	25.27	25.29	25.81	26.27	27.75	27.23	27.42	27.87	33.46	30.62	36.52	39.79	36.38	70.02

FIG. 1. THE SEQUENTIAL MOVE OF THE YEARLY MEAN OF THE FORWARD PREMIUMS



Zone. These findings are consistent with the fact that most of the blocked break dates appear in the West Super Zone. Therefore, it is reasonable to conclude that the blocked break dates are consistent with the commencement of the PRL programs.

However, despite the observation in Figure 1, the less structural breaks were found over the peak hours. This is probably because, with many irresistible price spikes, these are the most difficult hours to assess the effectiveness of the programs. Thus, we can think that the market participants could not quickly wipe away uncertainty from such irresistible price spikes, but they gradually recognized the effectiveness of the programs, which slowly decreased the risk premium. On the other hand, it agrees with the observation in Figure 1 that fewer breaks are found around the 05:00 time slots. Overall, the commencement of the PRL programs decreased the mean of the risk premium in electricity prices over the hours carrying possible moderate price spikes.

In the context of foreign exchange rates, Choi and Zivot (2007) found structural breaks in the mean of the forward discount. These breaks occurred mostly when the volatility of the forward discount was changed due to a change in the U.S. Central Bank's policy objective. Our results support theirs by providing additional evidence that structural breaks in the mean of the forward discount also exist in electricity prices.

Table 3 shows the magnitudes of the estimated coefficients for selected time slots. The first table shows estimated break dates and coefficients for 00:00. The second table shows those for 12:00. For instance, for 00:00, the West Zone experienced a structural break on June 19, 2001. Before this date, the coefficient was 5.64, which is significantly different from zero at the 1% significant level. After the break date, the coefficient declined to 0.8, which is not significantly different from zero. This suggests that the risk premium disappeared after the commencement of the PRL programs. All the blocked dates in Table 2 showed the same pattern. In addition, the amount of the risk premium, \$5.64/MWh, in the West Zone is close to the amount that Saravia (2003) found, which is \$3.97/MWh.[7] This amount had been paid by load suppliers to generators in the West Zone until the PRL programs commenced.

3. The Summary of the Results from the Bai-Perron Test

Table 4 shows the overall result for the hypotheses (1) and (2). The test detected 102 breaks throughout the time slots and zones. Among them, 54 breaks (52.9%) satisfied both the hypotheses (1) and (2). Comparing the results from each super zone, we can find that the West Super Zone satisfied both the hypotheses with the highest percentage (85.5%). This finding agrees with the fact that the West Super Zone pledged the most to the PRL programs.

7 Saravia (2003) examined whether a discrete change exists in the forward discount before and after the NYISO's virtual bidding policy by using a dummy variable. Because of her aim, she explained the amount as the forward premium that was paid until the implementation of the virtual bidding policy, i.e., November 7, 2001. However, the results from Bai-Perron test showed that the date related to the implementation of the PRL programs is superior to the implementation of the virtual bidding policy, regarding the cutoff date of the dummy variable. Bai-Perron test compares all the potential cutoff dates and endogenously selects the best cutoff point in a sense of minimizing the sum of squared residuals.

Table 2. Detected Break Dates

Table 2 shows all the detected break dates with a 5% significant level throughout the sample period from November 19, 1999 to January 27, 2005. A break date that supports both Hypotheses (1) and (2) is blocked. These mainly appear in the West Super Zone, and are consistent with the commencement of the PRL programs. Underline indicates that the coefficient increased at the break date, meaning that the mean of the risk premium became higher.

Time Slot	West	Genesse	Central	North	Mohawk Valley	Capital	Hudson Valley	Millwood	Dunwoodie	New York City	Long Island	Hydro Quebec	ISO New England	IMO	PJM
0	06/19/2001	06/19/2001	06/19/2001	06/19/2001	06/19/2001					07/16/2001 06/11/2002	06/19/2001		01/13/2001 08/07/2002 08/16/2003	03/10/2004	
1	06/05/2001	06/05/2001	06/05/2001	06/05/2001	06/05/2001										
2	06/05/2001	09/06/2000	06/10/2001	06/05/2001	06/05/2001					09/06/2000 06/19/2002	09/06/2000			10/04/2003	
3					06/04/2001					09/06/2000	09/08/2000	01/20/2001			
4												01/20/2001			
5											09/06/2000 11/17/2001				
6											08/25/2000				
7															
8															
9	10/13/2000 01/08/2001										02/02/2001 11/13/2001				
10	08/12/2001									08/31/2000	01/29/2001 11/06/2001	07/03/2001			02/15/2001
11	01/26/2001	09/27/2000	03/03/2001	08/30/2001	08/30/2001					08/24/2000		11/03/2000		11/04/2000	12/17/2000
12	08/28/2001	08/30/2001	08/28/2001	08/28/2001	08/28/2001									07/03/2001	
13	08/28/2001	08/30/2001	08/30/2001	08/30/2001	08/30/2001									08/06/2001	12/17/2000
14															
15															
16															
17															
18															
19	08/07/2001	08/07/2001	10/28/2000 08/07/2001		10/28/2000 08/07/2001							08/31/2003			
20	08/06/2001	08/06/2001	08/06/2001	08/06/2001	08/06/2001										
21	07/03/2001	07/03/2001	07/03/2001	07/03/2001	07/03/2001					07/03/2002				07/03/2001	07/03/2001
22	08/10/2001	08/10/2001	08/10/2001	08/10/2001	08/10/2001	06/17/2003	07/30/2003	04/04/2003	04/04/2003				04/22/2002 04/18/2003	09/09/2003	
23										01/17/2004	02/01/2004	03/30/2003		01/17/2004	

TABLE 3. MAGNITUDES OF THE ESTIMATED COEFFICIENTS

Table 3 shows the magnitudes of the estimated coefficients for selected time slots. The first table shows estimated break dates and coefficients for 00:00. The second table shows those for 12:00. For instance, for 00:00, the West Zone experienced a structural break on June 19, 2001. Before this date, the coefficient was 5.64, which is significantly different from zero at the 1% significant level. After the break date, the coefficient declined to 0.8, which is not significantly different from zero. This suggests that the risk premium disappeared after the commencement of the PRL programs. All the blocked dates in Table 2 showed the same pattern.

Time Slot 0:00

	West	Genesse	Central	North	Mohawk Valley	Capital	Hudson Valley	Millwood	Dunwoodie	New York City	Long Island	Hydro Quebec	ISO New England	IMO	PJM
Break Date 1	**06/19/2001**	**06/19/2001**	**06/19/2001**	**06/19/2001**	**06/19/2001**	none	none	none	none	**07/16/2001**	**06/19/2001**	none	01/13/2001	03/10/2004	none
Break Date 2										06/11/2002			08/07/2002		
Break Date 3													08/16/2003		
Coefficient Before the Break Date 1	**5.64**	**5.56**	**6.26**	**6.60**	**6.55**	**1.31**	**2.89**	**2.47**	**2.45**	**6.31**	**7.59**	**1.62**	**−8.66**	**3.13**	**6.54**
s.e.	*0.74******	*0.74******	*0.74******	*0.75******	*0.77******	*0.45******	*0.45******	*0.45******	*0.46******	*0.87******	*0.95******	*0.86****	*2.26******	*0.77******	*1.51******
Coefficient Before the Break Date 2	**0.80**	**0.23**	**1.17**	**1.11**	**1.02**					**2.18**	**1.88**		**2.29**	**−0.28**	
s.e.	*0.49*	*0.50*	*0.50****	*0.50****	*0.51****					*1.18**	*0.63******		*3.60*	*1.69*	
Coefficient Before the Break Date 3										**−1.68**			**−2.12**		
s.e.										*0.70****			*3.16*		
Coefficient After the Break Date 4													**4.34**		
s.e.													*2.66*		

Time Slot 12:00

	West	Genesse	Central	North	Mohawk Valley	Capital	Hudson Valley	Millwood	Dunwoodie	New York City	Long Island	Hydro Quebec	ISO New England	IMO	PJM
Break Date	**08/28/2001**	**08/30/2001**	**08/28/2001**	**08/28/2001**	**08/28/2001**	none	none	none	none	none	none	none	none	**07/03/2001**	none
Coefficient Before the Break Date	**5.61**	**4.89**	**5.92**	**5.84**	**6.32**	**0.86**	**1.83**	**−0.11**	**−0.05**	**0.00**	**−2.84**	**4.14**	**0.84**	**4.59**	**4.85**
s.e.	*0.71******	*0.73******	*0.73******	*0.77******	*0.78******	*0.81*	*0.72****	*0.79*	*0.79*	*0.97*	*0.78******	*0.87******	*1.01*	*1.53******	*1.33******
Coefficient After the Break Date	**0.60**	**0.69**	**1.69**	**1.66**	**1.81**									**−0.42**	
s.e.	*0.52*	*0.53*	*0.53******	*0.56******	*0.57******									*1.04*	

Table 4. Summary of the Results from the Bai-Perron Test

Table 4 shows the overall result for the hypotheses (1) and (2). The test detected 102 breaks throughout the time slots and zones. Among them, 54 breaks (52.9%) satisfied both the hypotheses (1) and (2). Comparing the results from each super zone, we can find that the West Super Zone satisfied both the hypotheses with the highest percentage (85.5%). This finding agrees with the fact that the West Super Zone pledged the most to the PRL programs.

	West Super Zone	East Super Zone	NYC-LongIL Super Zone	Neighbor Super Zone	All Zones
The Number of All the Detected Breaks	55	4	20	23	102
The Number of Consistent Break Dates	47	0	3	4	54
percentage	85.5	*0.0*	*15.0*	*17.4*	*52.9*

IV. *Conclusion*

This paper examined the effectiveness of the Price Response Load (PRL) programs by testing whether they reduced the risk premium in the electricity prices. These programs have the potential to reduce real-time price volatilities. By searching for structural breaks in the difference between the forward and expected spot prices, I found that the risk premium significantly decreased at the date related to the commencement of the PRL programs (summer 2001). This was observed over the hours carrying possible moderate price spikes, and geographically in the west side of the state of New York, which is the largest contributor to the PRL programs. This study result supports the view that these impact mitigation policies successfully relieved the market participants from aggressively hedging against emergency risks in the DA market, and also provides additional evidence for structural breaks in the mean of the forward discount.

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