An analysis of Supply Shocks to the Ontario Electricity Market: Export Responses and the Integration of the Ontario and New York Electricity markets.

1.1 Introduction

In this study we used Event study methodology to demonstrate the existence of export responses and to demonstrate the integration of the Ontario and New York markets. Event study methodology is widely used in financial market studies to assess the impact of new relevant information on the price of a firm's stock. For example, the impact of a merger announcement, a bond rating upgrade or a major court decision on the share price of a firm. In this study we adapt the methodology to design an innovative analytical tool to study behavioural responses to events in the Ontario electricity market.

1.2 Background

A negative supply shock to the Ontario market causes the HOEP to increase relative to the New York price. This in turn induces less export from Ontario to New York. Initially and immediately after the supply shock we expect the Ontario-New York price gap to deviate from its pre-shock equilibrium level. However as the New York market receives less export from Ontario, there is upward pressure on the price in New York. Eventually the price in New York rises to the point where the price difference between Ontario and New York narrows and may, in the long-run, return to its pre-shock equilibrium level. In the short-run the ability of traders to promptly respond to the supply shocks depend on a number of factors including their expectations about short-term future price movements and general uncertainty about the duration of the supply shocks. In the long-run fundamental market characteristics determine the equilibrium price gap.

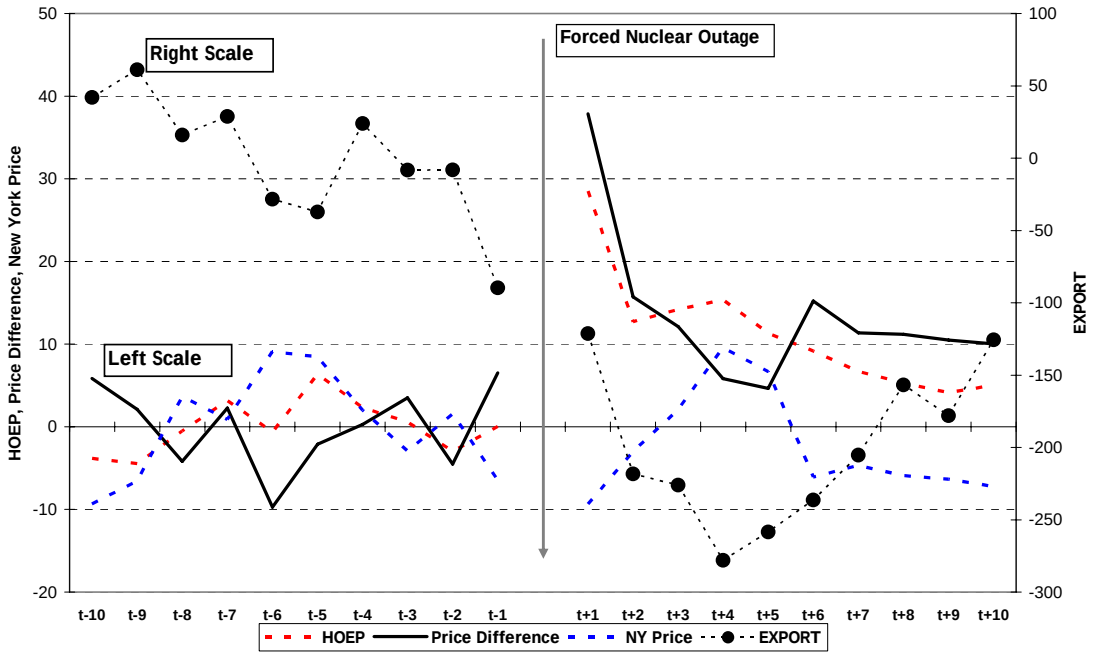
1.3 Methodology

We used hourly data over the period January 2005 to December 2006.Event analysis assumes that the supply shocks are random and independently distributed. At time zero, the event is defined and the supply shock hits the market. For each event we use the ten hours before the supply shock (t-1 to t-10) and the ten hours after the supply shock (t +1 to t+10) to specify the estimation period. All quantities and prices are then normalized to the average of the pre-event values (t-1 to t-10). Intuitively this methodology is analysing how the path of the variables is deviating from their 'normal' values over time. Absent any shocks these deviations are random and they sum to zero for a large enough time period. See Appendix A for further details on the methodology.

1.4 Results

The results of the analysis are summarised in chart 1 below. In chart 1, the normalised HOEP deviations and the normalised price difference are on the left scale. The normalised export volume is on the right scale. (Note how the scale includes negative values. The Appendix explains why the normalised values can be negative). At time t+1, there is large increase in the HOEP. As the information is absorbed by the market, traders adjust their export bids to reflect their expectations about future prices (and profits). In the Ontario market traders at time t+1 can only change their export bids for time t+4 onwards. However at time t+1, traders also have the ability to mitigate risks by cutting their transactions in the *New York* market for time t+2 onwards. This implies that some of the export reductions observed in t+2 and t+3 may be related to the implementation of this risk-mitigation strategy. The biggest reduction in export volume occurs at time t+4 reflecting largely the response of traders to the price shock within the current design of the Ontario market.

Chart 1:Pre-and Post -Event Trends



1.5 Arbitrage and the Integration of the Ontario and New York Electricity Markets

The existence of arbitrage and integration of the two markets are also illustrated in chart 1. If there were no arbitrage pressures we expect the price increase to result in a persistent large price gap between Ontario and New York. However this is not the case over the sample period examined. The negative supply shock is reflected in the large increase in the HOEP at time t+1. As discussed above, traders used available risk-mitigation strategies to cut export transactions and limit their risks and export volumes fall from time t+1 to time t+4. As a result the New York market receives reduced Ontario supply and the New York price trends upwards. The biggest price effect occurs at time t+4 coinciding with the biggest export volume reduction in the Ontario market. The very fact that the New York price trends upward

when the New York market does not receive Ontario exports provides evidence that the two markets are integrated. Were this not to be the case, the price in New York would be independent of the Ontario exports. Therefore it must be the case that the two markets are linked through the export channel(absent congestion on the intertie).The fact that the price gap returns to some trend level(as opposed to a rising trend) demonstrates the existence of arbitrage- bounded trades between the Ontario and New York markets.

1.6 Conclusion

The above analysis provides evidence that the export transactions respond to an increase in the Ontario price relative to the New York price. Furthermore the analysis suggests that the price difference between the Ontario and New York markets is bounded by arbitrage activities.

Appendix A - Event Study Methodology

The intuitive idea behind this methodology is to analyse how the trend in a variable changes after new information is available to the market. Before the event, the trend in the variable deviates randomly from the mean value of the variable. This means that for some hours the variable takes a value above its mean value and in other hours it takes a value below its mean value. (For some hours the variable can be exactly equal to its mean value). On average these deviations from the mean sum to zero. To illustrate this point, consider the example below.

Example 1

In this scenario the variable of interest is the HOEP (column 1) in the five hours before the event. The mean value of the variable is in column 2 and it reflects the 'normal' level of the HOEP before the event. Column 3 shows the deviations of the HOEP level around its mean level. Note that the average of the deviations sum to a very small number close to zero. Also note that some of the mean deviations are negative. This explains why the numbers on the axes on the chart can be negative.

Table 1: Trend in the HOEP Before the Event

Before Event

Column 1	Column 2	Column 3
HOEP	Mean of pre-event HOEP	Deviation from mean of pre-event HOEP
35	30.6	4.4
33	30.6	2.4
25	30.6	-5.6
29	30.6	-1.6
31	30.6	0.4

Table 2: Trend in the HOEP After the Event

After Event

Column A	Column B	Column C
HOEP	Mean of pre-event HOEP	Deviation from mean of pre-event HOEP
60	30.6	29.4
80	30.6	49.4
65	30.6	34.4
51	30.6	20.4
40	30.6	9.4

After the event, the analysis now tracks the trend in the HOEP, *relative to its pre-event normal level*. In Table 2 column A shows the HOEP values after the event. Column B shows the mean value of the pre-event HOEP values and column C shows the deviations of the new HOEP values from the mean value of the pre-event HOEP values. Notice now how the mean deviations are now positive and larger than the pre-event mean deviations. These large deviations reflect the impact of the event on the level of the HOEP.

In the current analysis, for each variable (HOEP, New York price, Price Gap, Export) we calculate the values in column C for each of the ten hours after each of the 39 events. Next we average those values across all 39 events. A similar calculation is done for the pre-event values. The chart plots these average normalized values to show the trends in the variables before and after the event.

Mathematical Note

Let $\overline{X}$ be the mean value of variable X. Then the deviation from the mean is simply : $X - \overline{X}$. This is shown in column 3 of Table 1 and column C of Table 2.

The average mean deviation for variable X over the number of events N is $\sum_{1}^{N} \frac{X - \overline{X}}{N}$. Let us call this metric θ. For each event and for each variable there is one value for θ before the event and one value for θ after the event.

The charts plot the values of θ for ten hours before and for ten hours after the event.

Detailed Charts

The following charts illustrate individual trends pre- and post the event. Chart 1 in the text combines all these events onto one graph.

Chart A:Pre-Event HOEP Trend

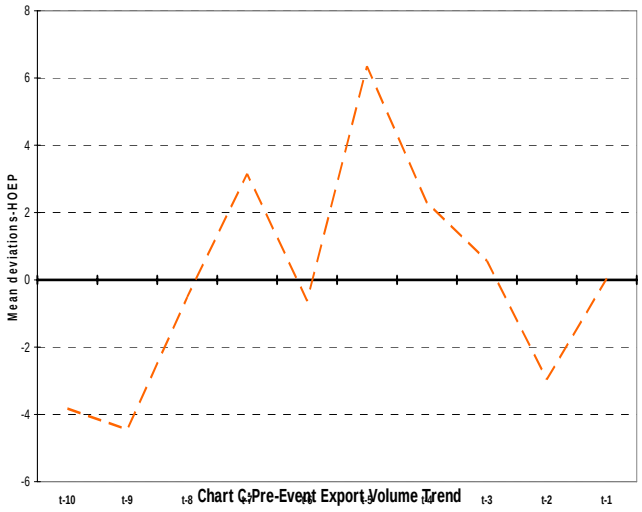


Chart 1:Post-event Trend in HOEP

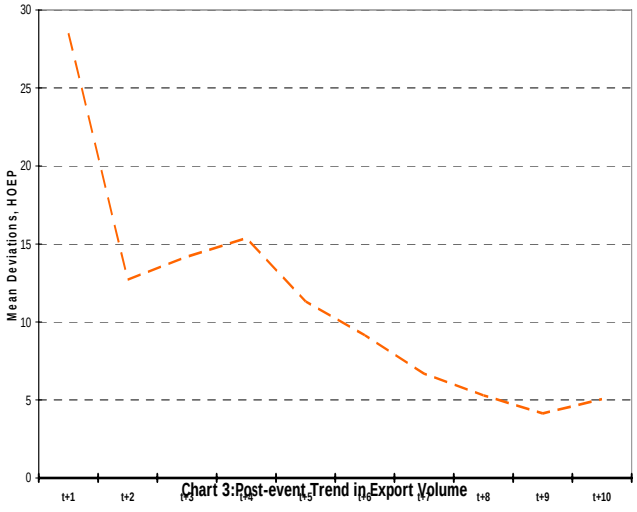


Chart C:Pre-Event Export Volume Trend

Chart 3:Post-event Trend in Export Volume

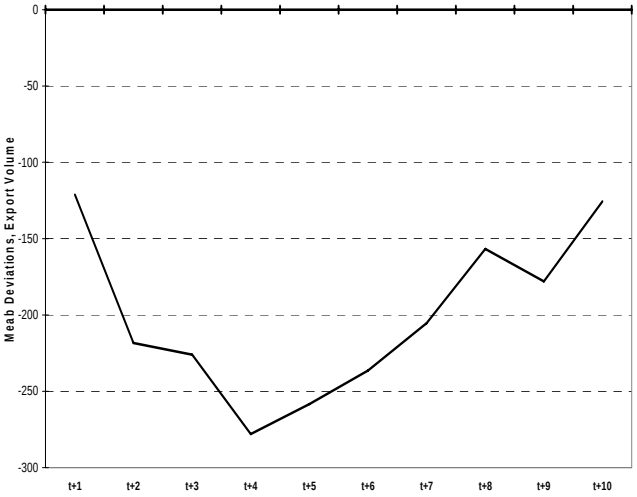


Chart A:Pre-Event New York price

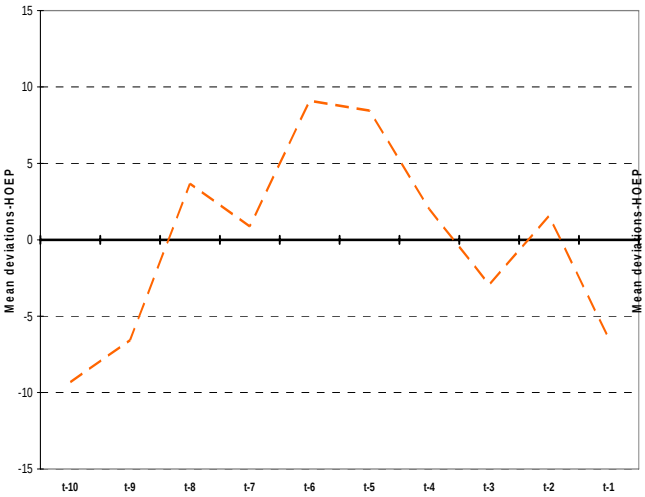


Chart A:Post-Event New York price

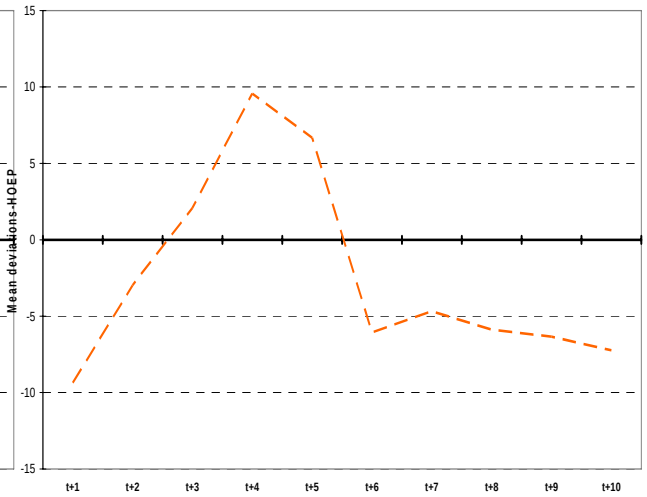


Chart B:Pre-Event Trend in Price Difference

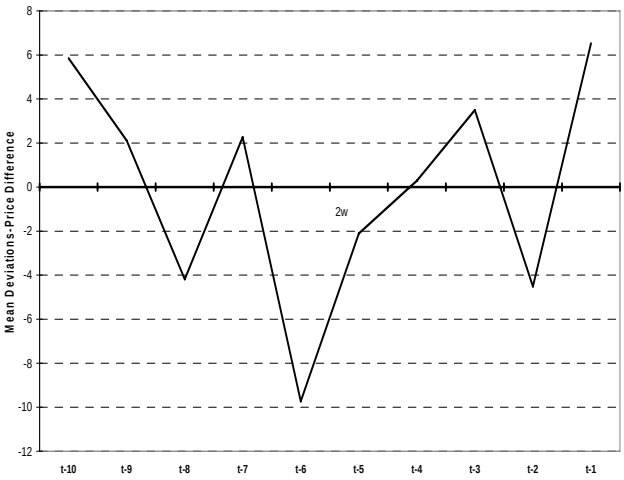


Chart 2:Post-event Trend in Price Difference