The Calculation of Fuel-Cost Adjusted Load-Weighted PJM LMPs

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In a competitive market, changes in LMP result from changes in demand and changes in supply. As competitive offers are equivalent to the marginal cost of generation and fuel costs make up from 80 to 90 percent of marginal cost, fuel cost is a key factor affecting supply and therefore the competitive clearing price. In a competitive market, if fuel costs increase and nothing else changes, the competitive price will also increase. In assessing changes in LMP over time, the PJM MMU generally examines three measures: nominal LMP, load-weighted LMP and fuel-cost adjusted load-weighted LMP. Nominal LMP measures the change in reported prices. Load-weighted LMP measures the change in reported prices weighted to reflect what customers in total actually pay for energy based on the fact that actual MWh purchases vary by time period. Fuel-cost adjusted load-weighted LMP measures the change in reported prices actually paid by load after accounting for the change in prices that reflects changes in underlying fuel prices and the fact that actual MWh purchases vary by time period.

The PJM MMU applies an indexing method to adjust nominal LMPs for changes in fuel costs. The index has three components: a term that measures the fuel prices in each period; a term that measures the proportion of time marginal generating units use each fuel type in each period; and a term that measures the MWh generated in each period. The MMU fuel cost index is calculated as a Fisher price index. The Fisher index is a chain-weighted index. A chain-weighted index permits both the MWh generated and the fuel prices to change between periods rather than restricting the change to fuel prices only.

The Fisher Index is the geometric average of the Laspeyres and Paasche indices.

The general formulation of the Laspeyres Index is:

$$P_l(p^0, p^1, q^0) = \frac{\sum_{i=1}^{n} p_i^1 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$$

The general formulation of the Paasche Index is:

$$P_p(p^0, p^1, q^1) = \frac{\sum_{i=1}^{n} p_i^1 q_i^1}{\sum_{i=1}^{n} p_i^0 q_i^1}$$

where, in general, p_i represents the price of the ith item and q_i represents the corresponding quantity transacted in the time period under consideration. The subscript i refers to the ith commodity in the group of n items that make up the value aggregate.

The general formulation of the Fisher index is:

$$P_f = \sqrt{P_l P_p}$$

More specifically, the MMU calculates the Fisher index in the following way:

The year over year monthly Laspeyres index comparing month m, year t to month m, year t+1 is:

$$P_l(p^{t,m}, p^{t+1,m}, q^{t,m}) = \frac{\sum_{i=1}^{n} p_i^{t+1,m} q_i^{t,m}}{\sum_{i=1}^{n} p_i^{t,m} q_i^{t,m}}$$

where $p^{t,m}$ and $q^{t,m}$ denote the month m and year t price and quantity vectors.

The year over year monthly Paasche index comparing month m, year t to month m, year t+1 is:

$$P_p(p^{t,m}, p^{t+1,m}, q^{t,m}, q^{t+1,m}) = \frac{\sum_{i=1}^{n} p_i^{t+1,m} q_i^{t+1,m}}{\sum_{i=1}^{n} p_i^{t,m} q_i^{t+1,m}}$$

The year over year monthly Fisher index comparing month m, year t to month m, year t+1 is:

$$P_f(p^{t,m}, p^{t+1,m}, q^{t,m}, q^{t+1,m}) = \sqrt{\frac{\sum_{i=1}^{n} p_i^{t+1,m} q_i^{t,m}}{\sum_{i=1}^{n} p_i^{t,m} q_i^{t,m}}} \sqrt{\frac{\sum_{i=1}^{n} p_i^{t+1,m} q_i^{t+1,m}}{\sum_{i=1}^{n} p_i^{t,m} q_i^{t+1,m}}}$$

Finally, the exact Fisher index calculation used by the MMU is:

$$P = \sqrt{\frac{\sum_{i=1}^{n} p_i^{t+1,m} L^{t,m} s_i^{t,m}}{\sum_{i=1}^{n} p_i^{t,m} L^{t,m} s_i^{t,m}}} \sqrt{\frac{\sum_{i=1}^{n} p_i^{t+1,m} L^{t+1,m} s_i^{t+1,m}}{\sum_{i=1}^{n} p_i^{t,m} L^{t+1,m} s_i^{t+1,m}}}$$

where p_i represents the price of the ith fuel type, s_i represents the proportion of the time that the ith fuel type is marginal and $L^{t,m}$ represents the quantity of electricity generated during the respective month and year.

To calculate the fuel-cost adjusted load-weighted average LMP for year t+1, the hourly LMP for each month is divided by the corresponding monthly Fisher index and these hourly LMPs are then averaged on a load-weighted basis for the year. The year over year increase in fuel-cost adjusted load-weighted average LMP is then calculated by comparing this result for year t+1 to the load-weighted average LMP for year t.