Future Generation in RPM

Good News...

- You don’t need to understand the math in this presentation, each step can be examined in RPM through Analytica
- The methodology is substantially the same for future generation so for some this will be covering familiar ground
RPM Futures Risk Models

- Load
- Natural Gas
- Carbon Tax
- Electricity Price
- REC
- PTC
Scaling Forecasts

1. Forecasts such as load are input.
2. Factors that scale the input forecast are simulated. These factors are different for each future. The range of the factors is controlled by model parameters.
3. Each “future” is based on applying the factors from that future to the input forecasts.

Electric Load Example
Electric Load Example

Annual Trend Factors

- Controls Annual Spread in RPM
- Of the form:

\[ P_{t,i} = e^{\alpha_F \varepsilon_{F,i} + \alpha_L \varepsilon_{L,i}(y_t - y_0) + \alpha_Q \varepsilon_{Q,i}(y_t - y_0)^2} \]

where \( y_t = \) year at time \( t \); \( \alpha_F, \alpha_L \) and \( \alpha_Q \) are parameters; and \( \varepsilon_{F,i} \sim \varepsilon_{L,i} \sim \varepsilon_{Q,i} \sim N(0,1) \)
Seasonal Factors

- Add deviation from annual trends
- Of the form:
  
  \[ S_{t,i} = e^{\tau_{t,i}} \]

  where \( \tau_{t,i} \) is a normal random variable.

Jump Factors

- Controls temporary deviations from the annual trend, i.e. jumps
- Of the form:
  
  \[ J_{t,i} = e^{I[\beta_i < y_t - y_0 < \beta_i + \omega_i] \xi_i - I[\beta_i + \omega_i < y_t - y_0 < \beta_i + \omega_i + \xi_i] \xi_i / \gamma} \]

  where \( \beta_i \) and \( \omega_i \) and \( \xi_i \) are all uniform random variables and \( \gamma \) is a scaling factor.
Risk Model DNA

- Annual Trend Factor * Seasonal Factor * Jump Factor * Forecast
  - Carbon Tax and PTC being the exceptions
- Heavily Parameterized
- Applied to related model elements, e.g. load risk model applies same factors to heavy and light load forecast

Estimating Parameters

- Sources of estimation:
  - Forecasts from Advisory Committees, e.g. load and natural gas price forecasts
  - Historical data or adjusted historical data, e.g. weather normalized historic load and historic electricity prices
  - Expert input
Load Model Example

The load forecasts are shaped according to seasonal factors.

The forecast “spread” grows over time.

Load Model Example

Dividing the High and Low forecasts by the Medium forecasts gives a smoother trend.
Load Model Example

- Factors grow through time relatively smoothly by year
- Combining inputs, some context and RPM parametric assumptions (mostly log-normal assumptions) allows for estimating parameters for the model
- Load high/low forecast directly informs the risk model

Load Model Example

- Estimate factors using simple linear regression

That is, if \( H_t, M_t \) and \( L_t \) are the high, medium and low load forecasts respective then use regression to find \( a, b \) and \( c \) in

\[
\ln(H_t/M_t) = a + b(y_t - y_0) + c(y_t - y_0)^2 + \epsilon
\]
Load Model Example

We want a value where the probability of exceeding it is .85, which is the probability associated with the high load forecast. Since we have normality

\[ \Pr\left[ \frac{\alpha_L}{20} * \epsilon_{L,t} < \frac{\alpha_L}{20} * z_{.85} \right] = .85 \]

Thus we set

\[ b = \frac{\alpha_L}{20} * z_{.85} \]

Which implies

\[ \alpha_L = 20b / z_{.85} \]

This gives \( \alpha_F = .0102, \alpha_L = .0632 \) and \( \alpha_Q = .0221 \)

Load Model Example

- Seasonal factor only impacts volatility not the shape
- Historic load must be adjusted for DSIs
- Seasonal shapes can be estimated from the adjusted historic load
  - The factor only depends on the quarter since it is of the form
    \[ S_{t,i} = e^{q_{t,i}} \]
Load Model Example

Seasonality is inherent in the load shape

Normalizing shows each quarter has a different amount of variation beyond annual shape
Load Model Example

- Taking standard deviation after normalizing gives for each quarter

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Putting both together gives a range on the load risk model that exceeds the high and low load forecasts
Into RPM…

- Switch to Analytica to show parameters in the model and show the future generation module
- Draft technical appendix gives much more detail and covers other models and parameters
- Statistics were done in R, scripts are available upon request