SAS GLOBAL FORUM

Statistics and Samples: Judging Time Series Models Automatically

Udo Sglavo
SAS Inc.

What We Will Discuss Today

- Is my forecast accurate?
- Illustrative example
- Reconciliation

Automatic Forecasting Process: The big picture

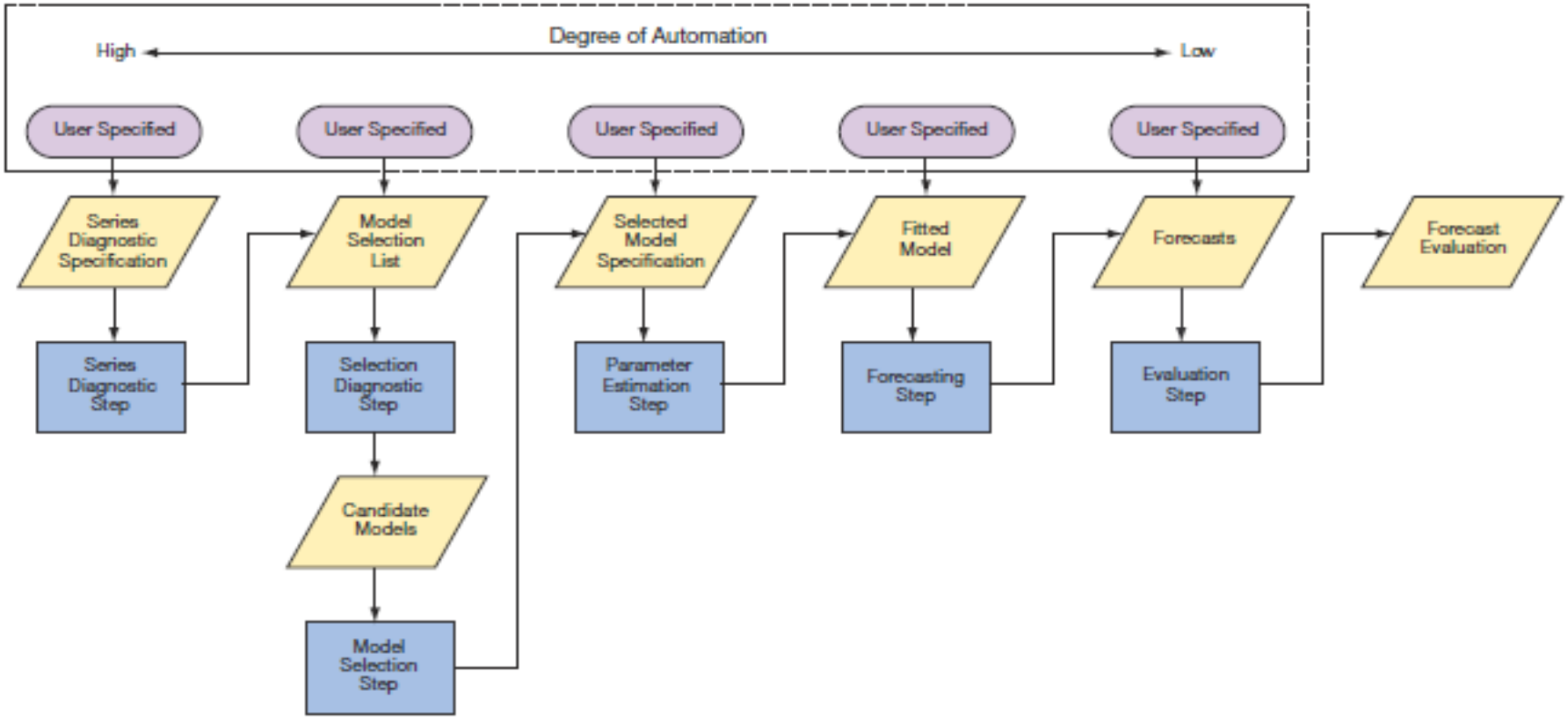
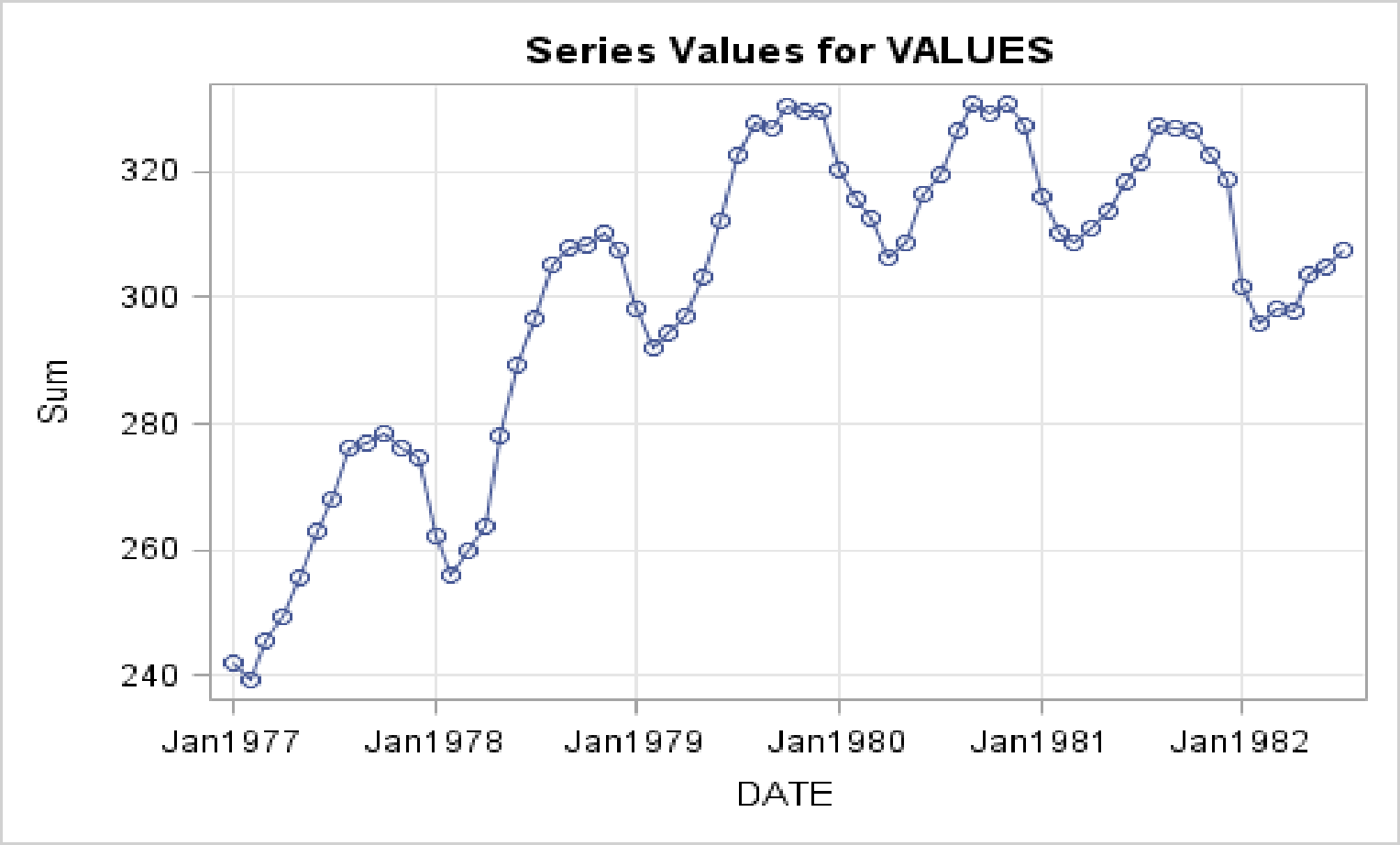


Figure 2: Automatic forecasting information flow

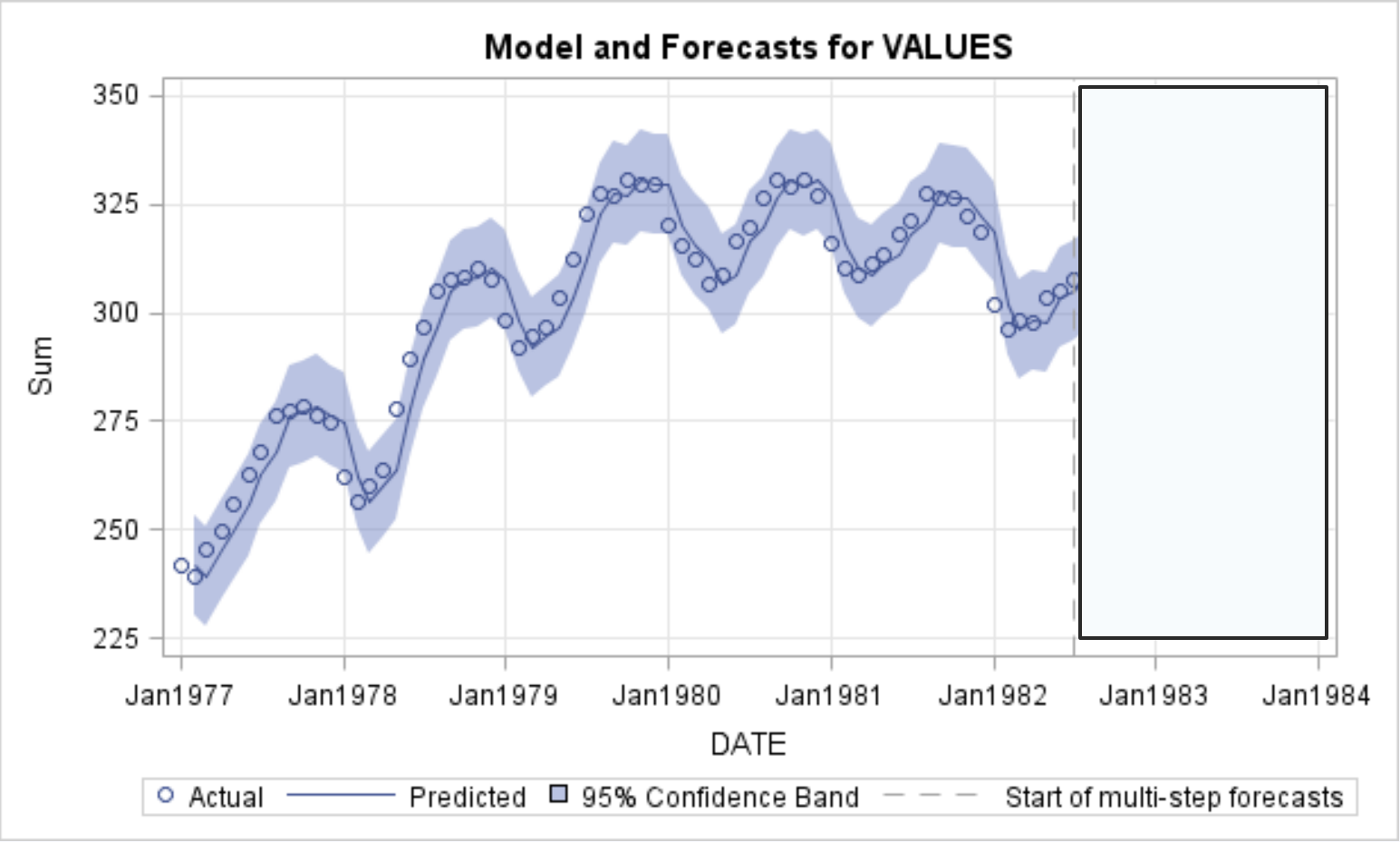
- For details see the white paper

  '***Large-Scale Automatic Forecasting Using Inputs and Calendar Events' by Michael Leonard***

Example Series



Is This An Accurate Forecast?



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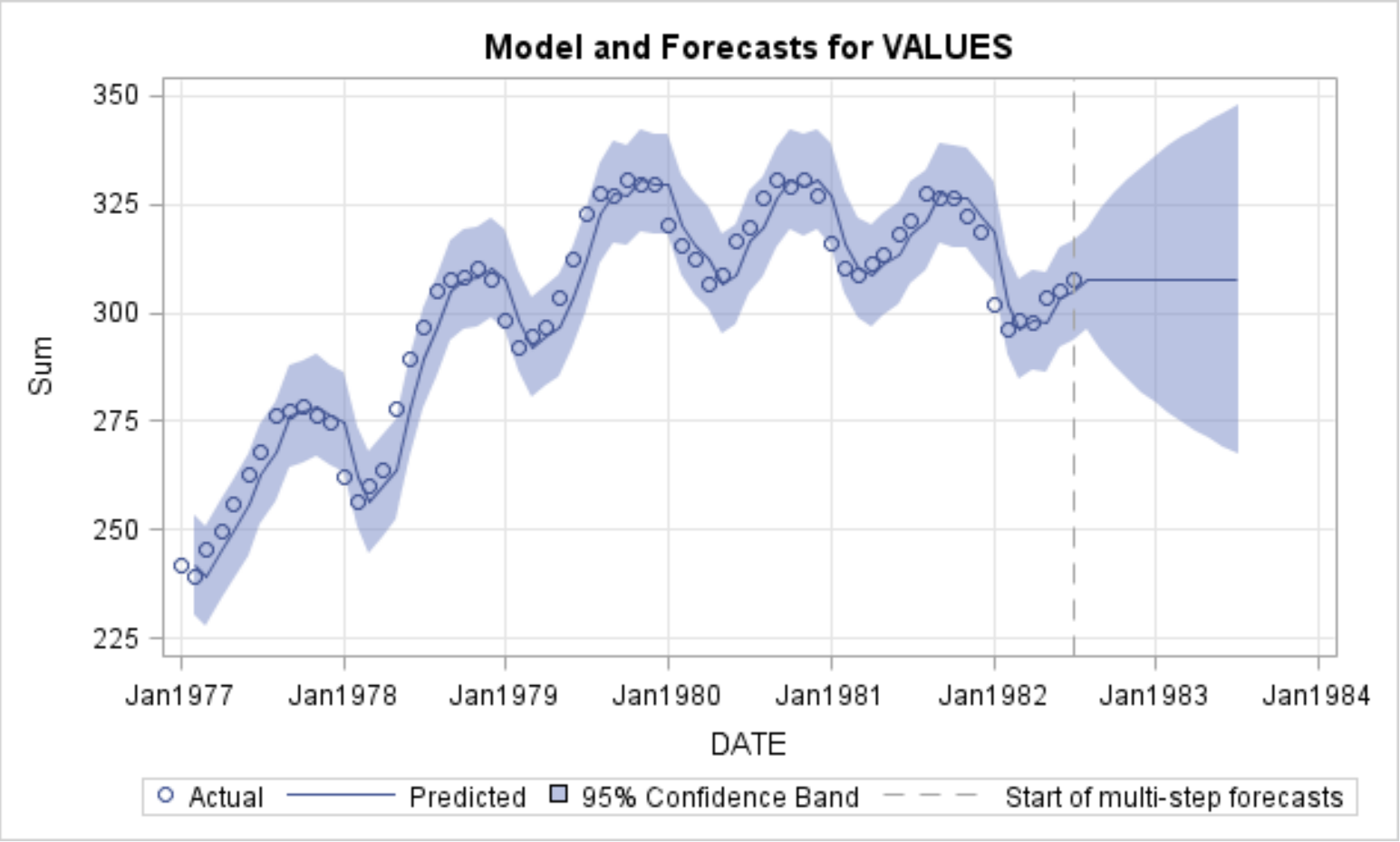

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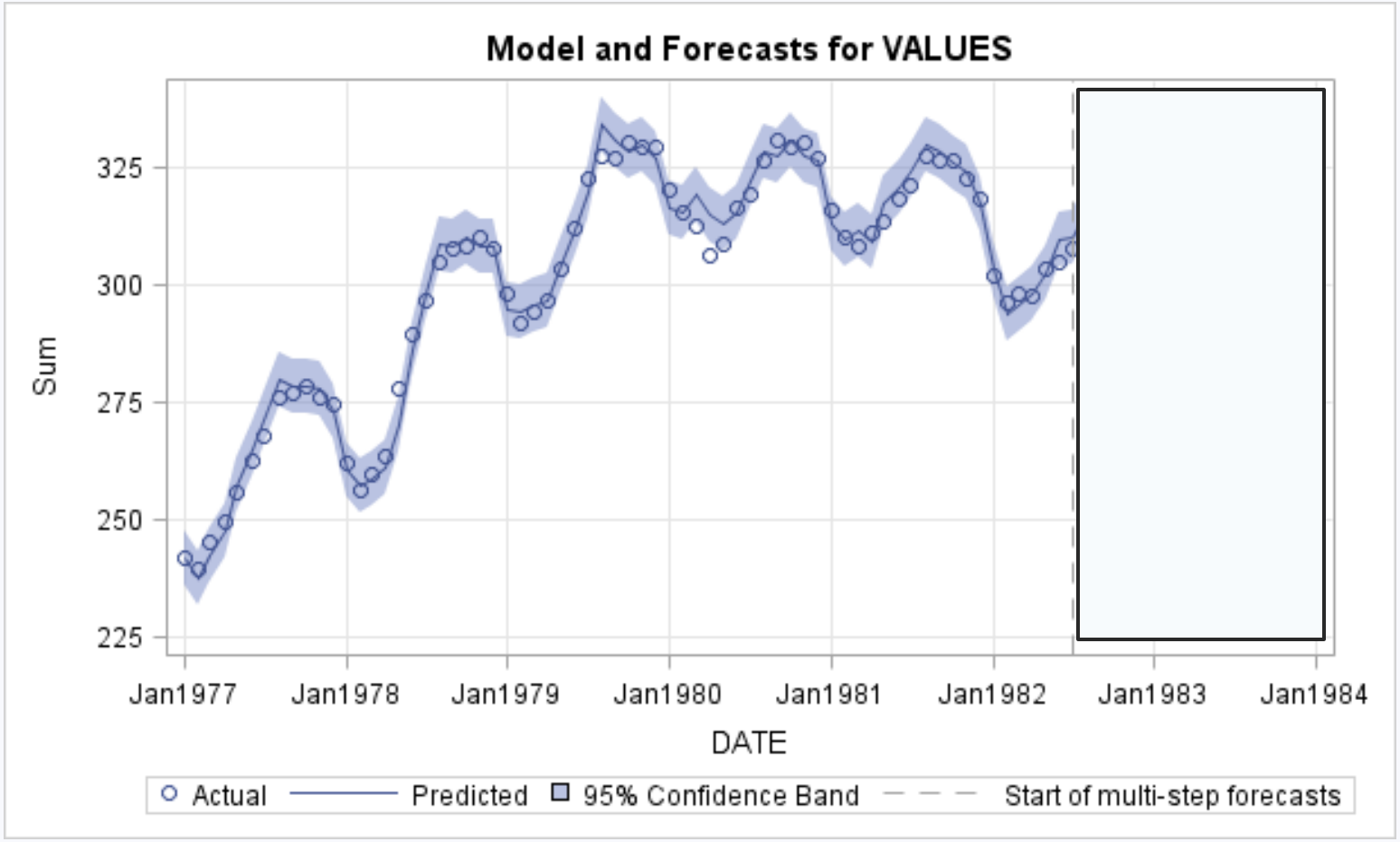

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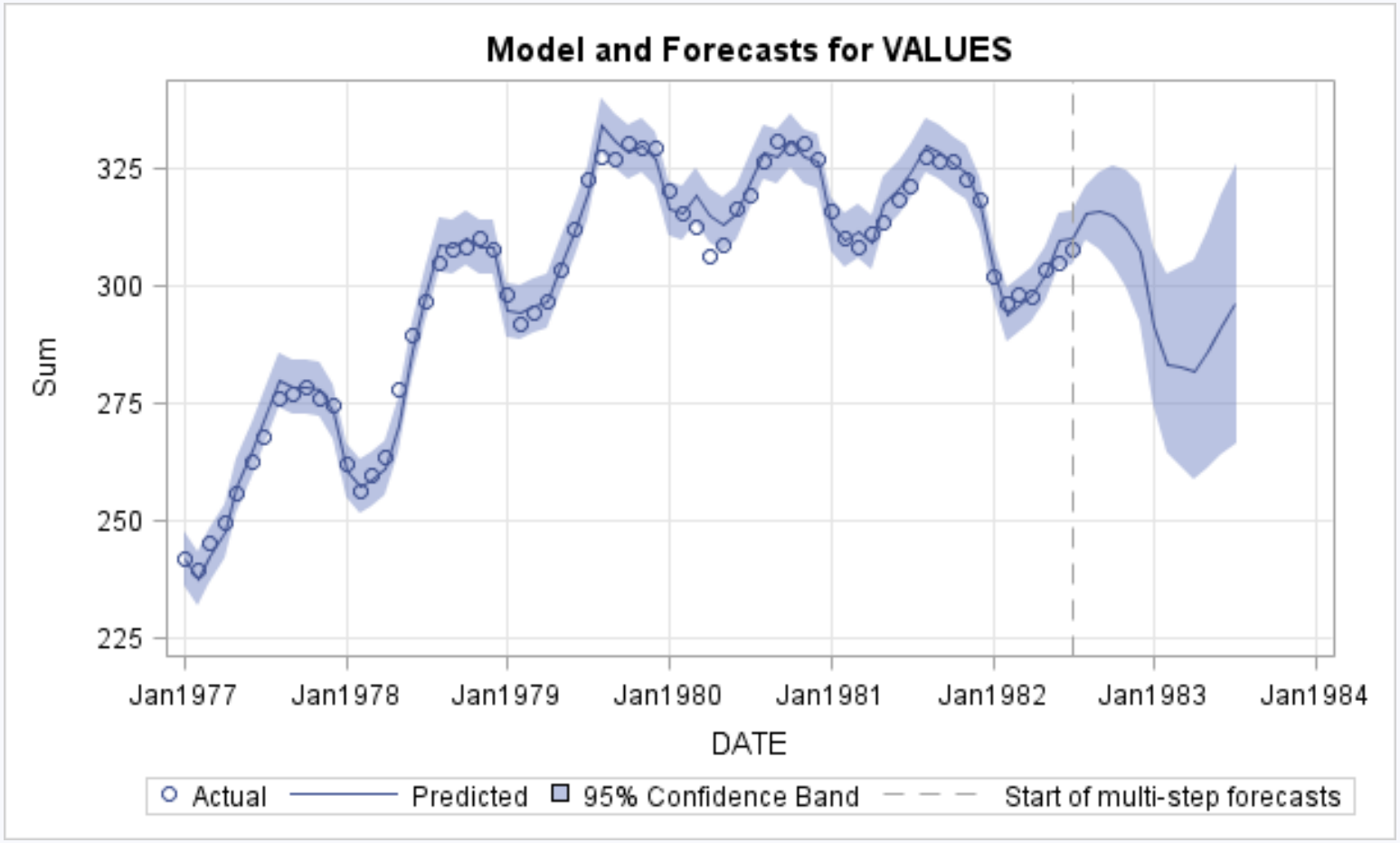

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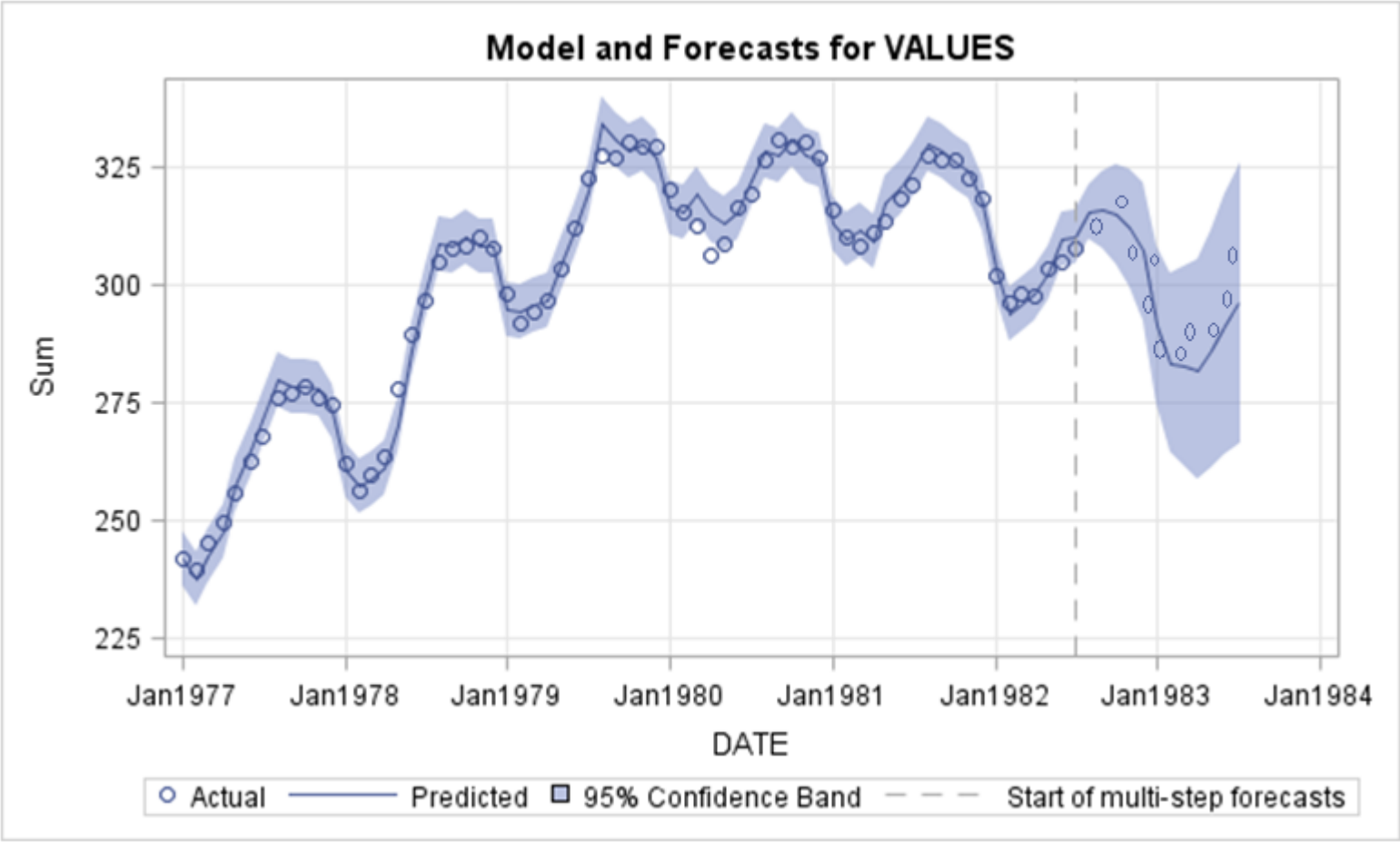

Prediction Error Analysis

- Initial Fit Statistics
  - evaluate the initial model fit (fit region, in-sample)
- Selection Statistics
  - select between competing models (selection region/hold out sample, in-sample)
- Fit Statistics
  - evaluate model fit for the selected model (fit region)
- Performance Statistics
  - evaluate model selection process for the selected model (performance region, out-of-sample)

Regions

<table>
<tr><td colspan="3">Historical Time Series
(1,...,T)</td></tr>
<tr><td colspan="2">In-Sample Region
(1,...,T – B)</td><td>Out-Sample Region
(T – B + 1,..., T)</td></tr>
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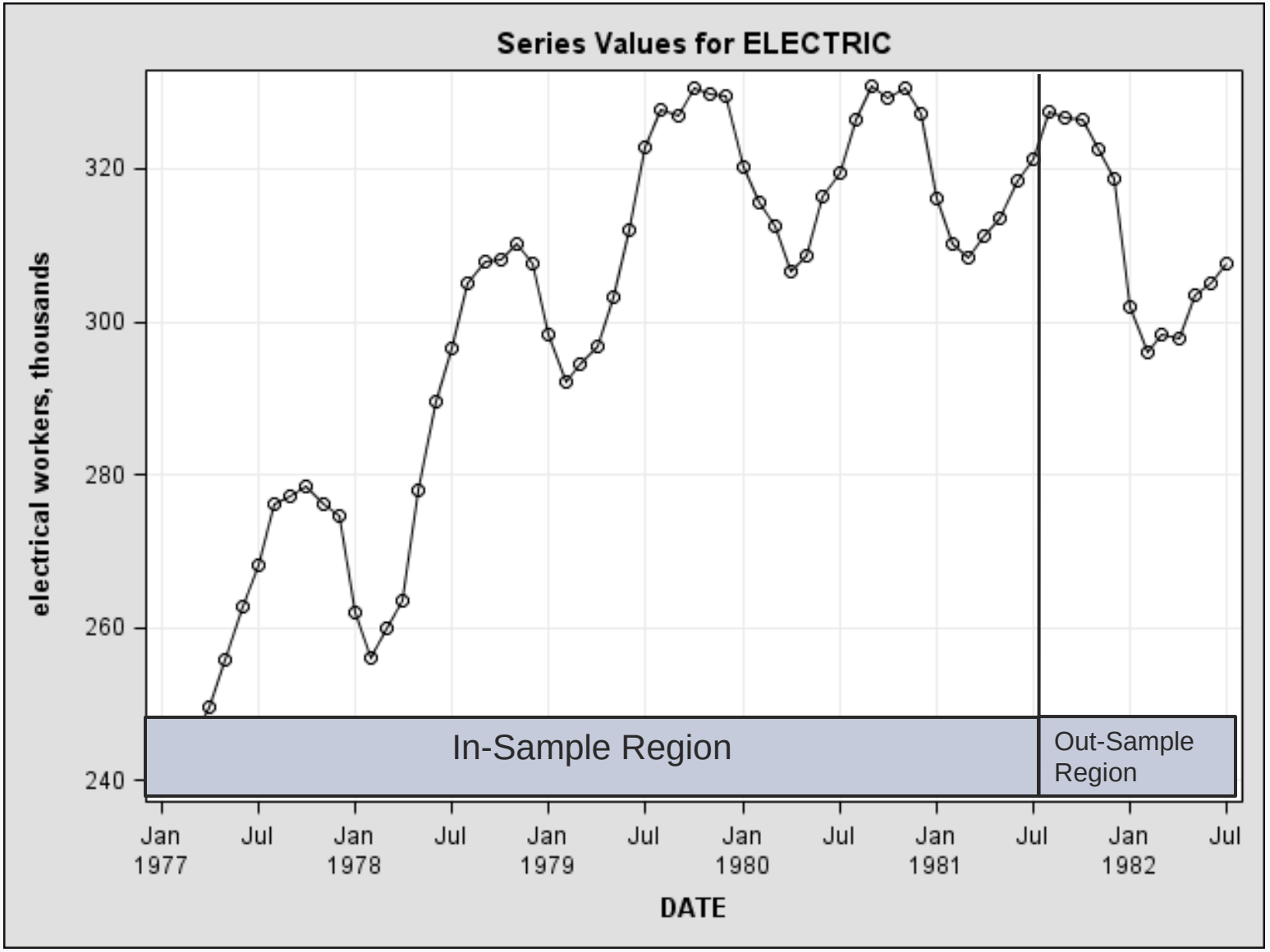
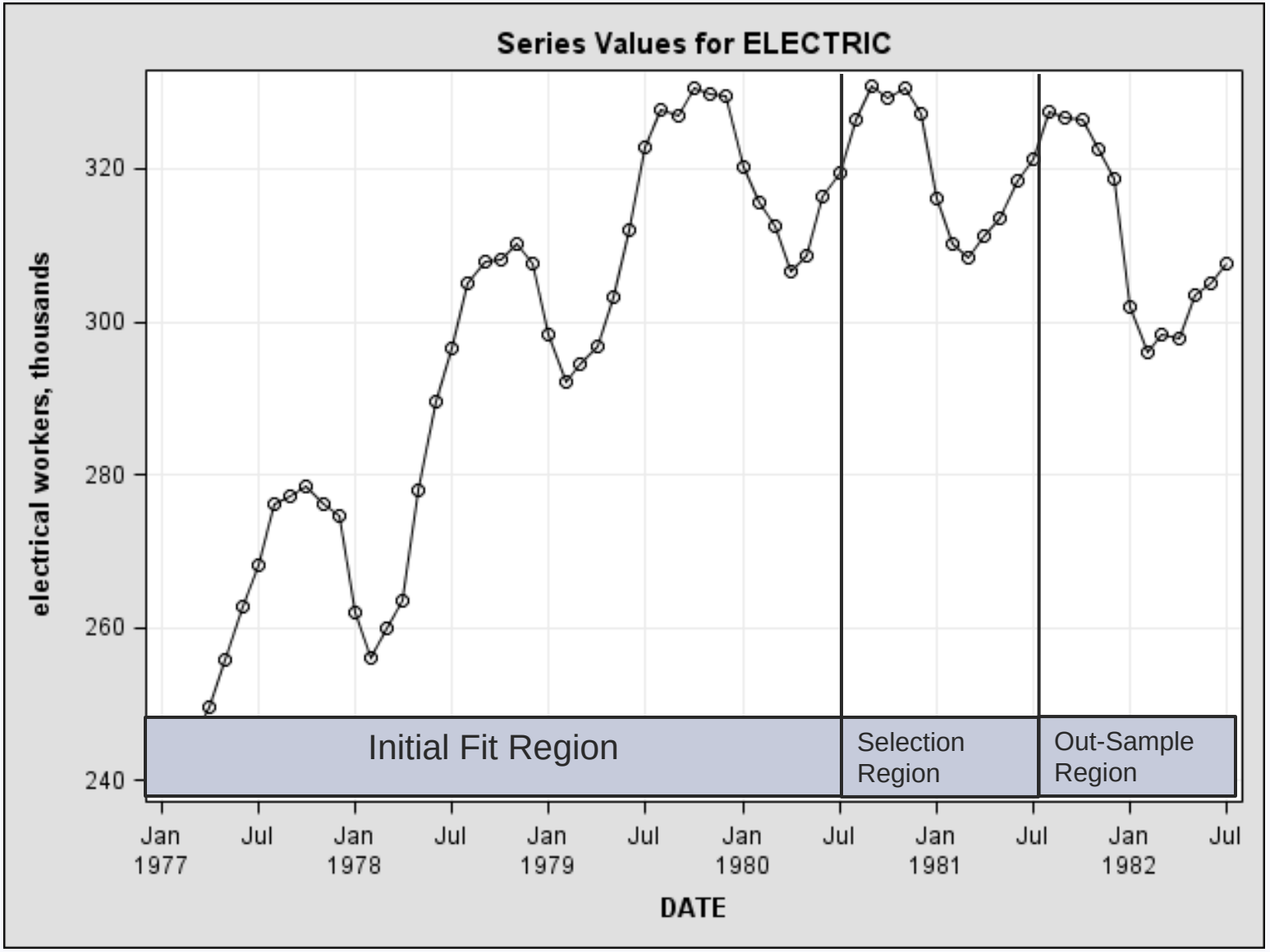
(T – B + 1,..., T – B + L)</td></tr>
</table>

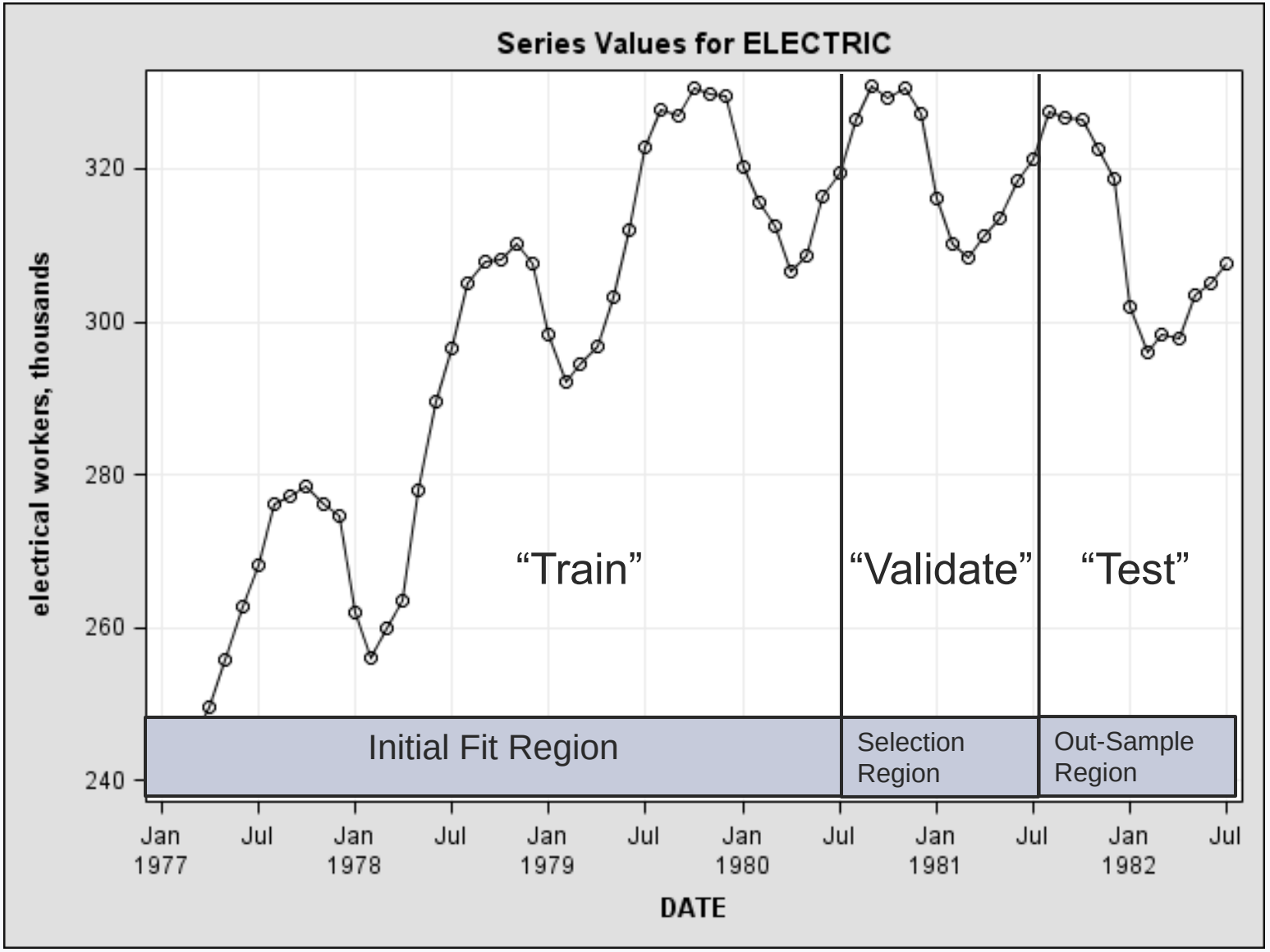
T= length of time series

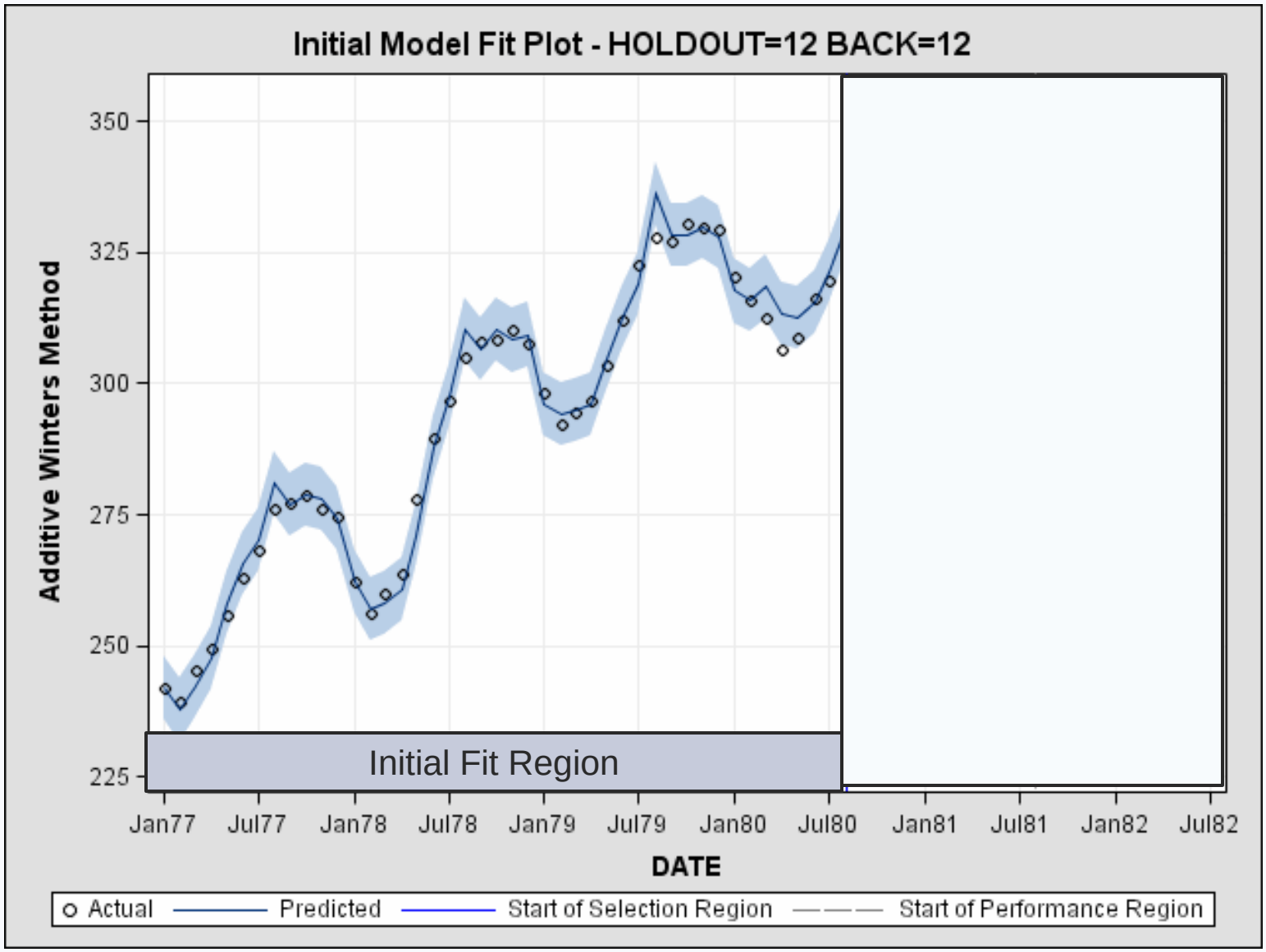
H=hold-out region (in sample)

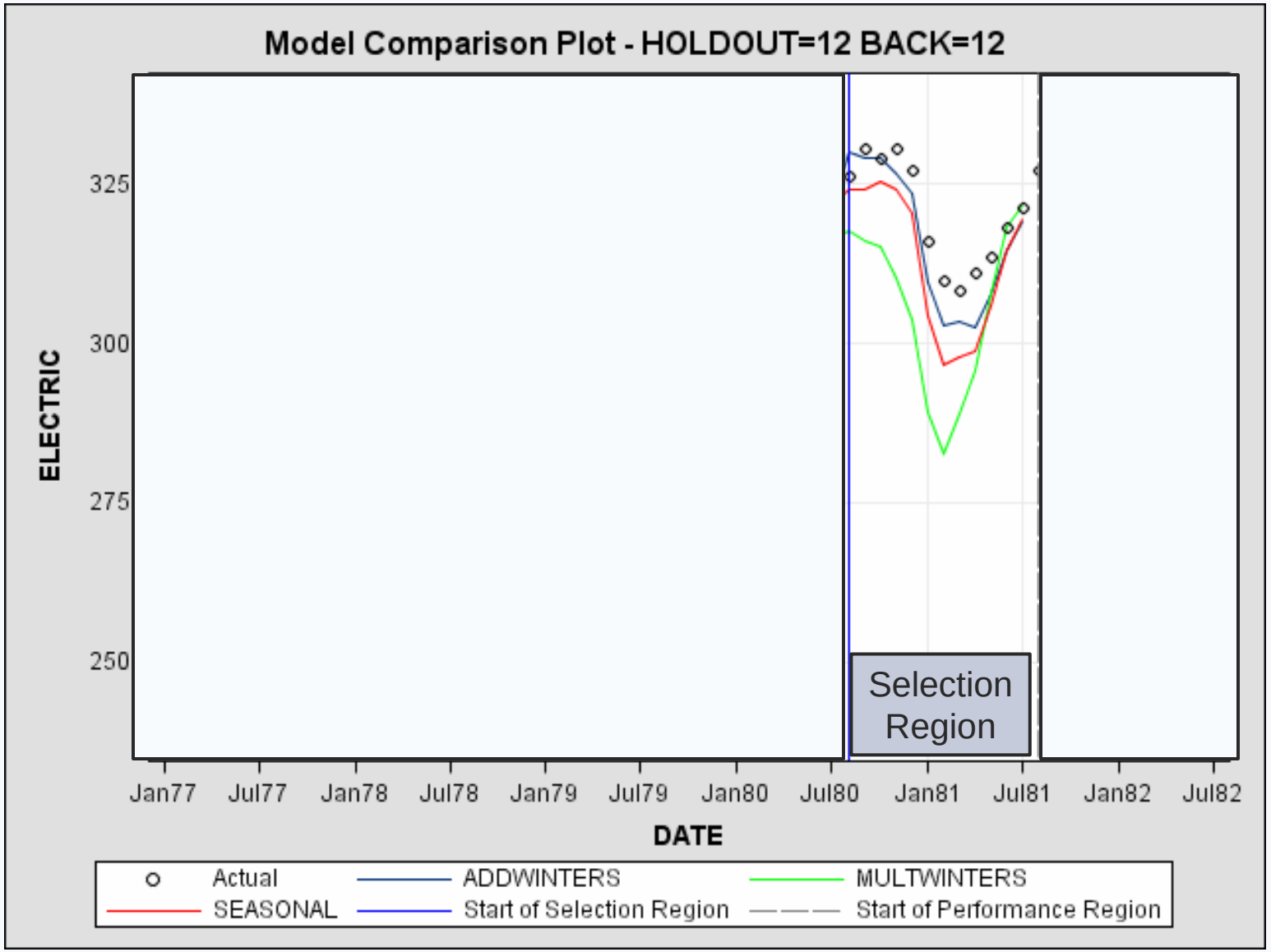
B=holdback region (out-of-sample)

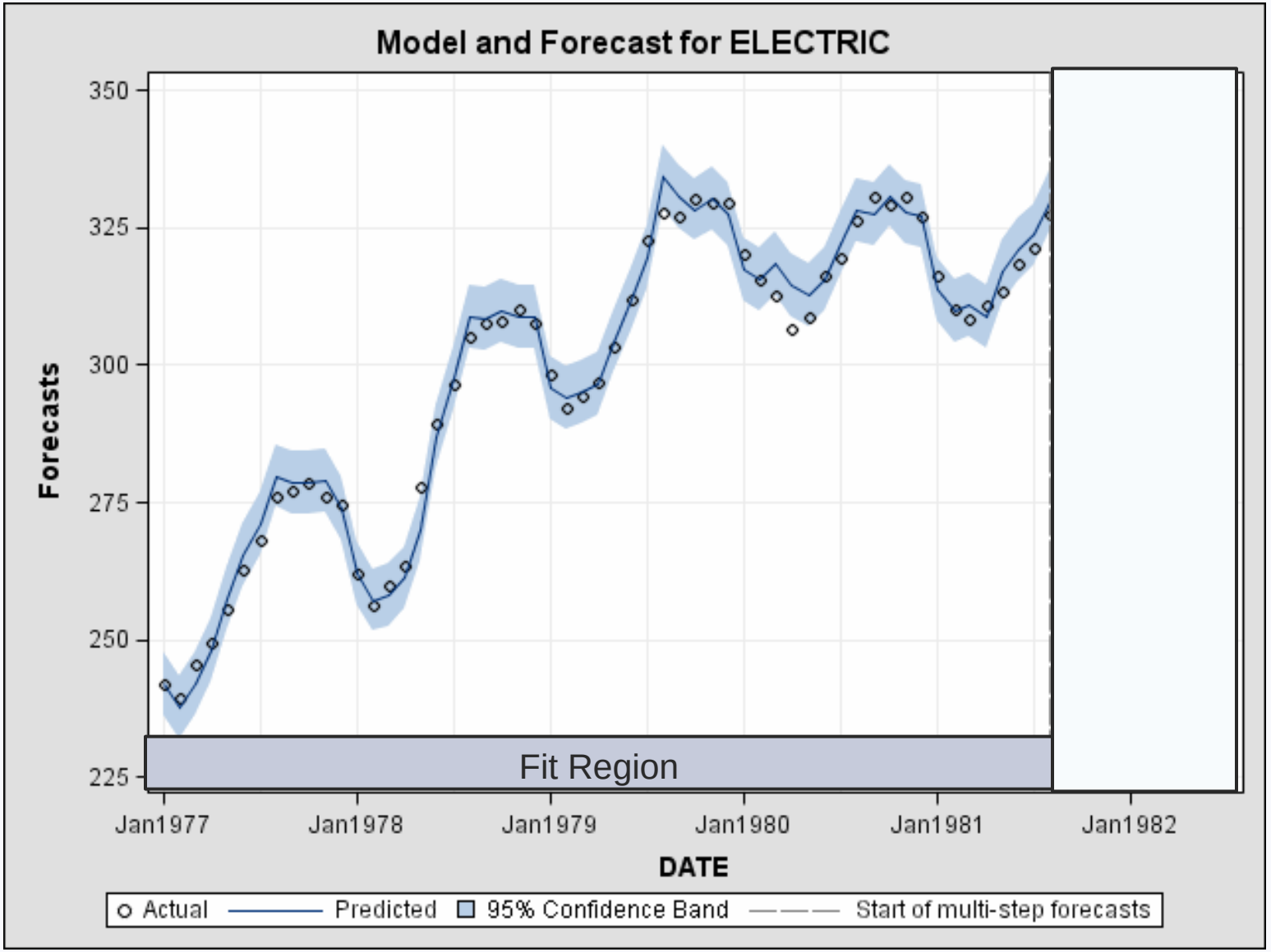


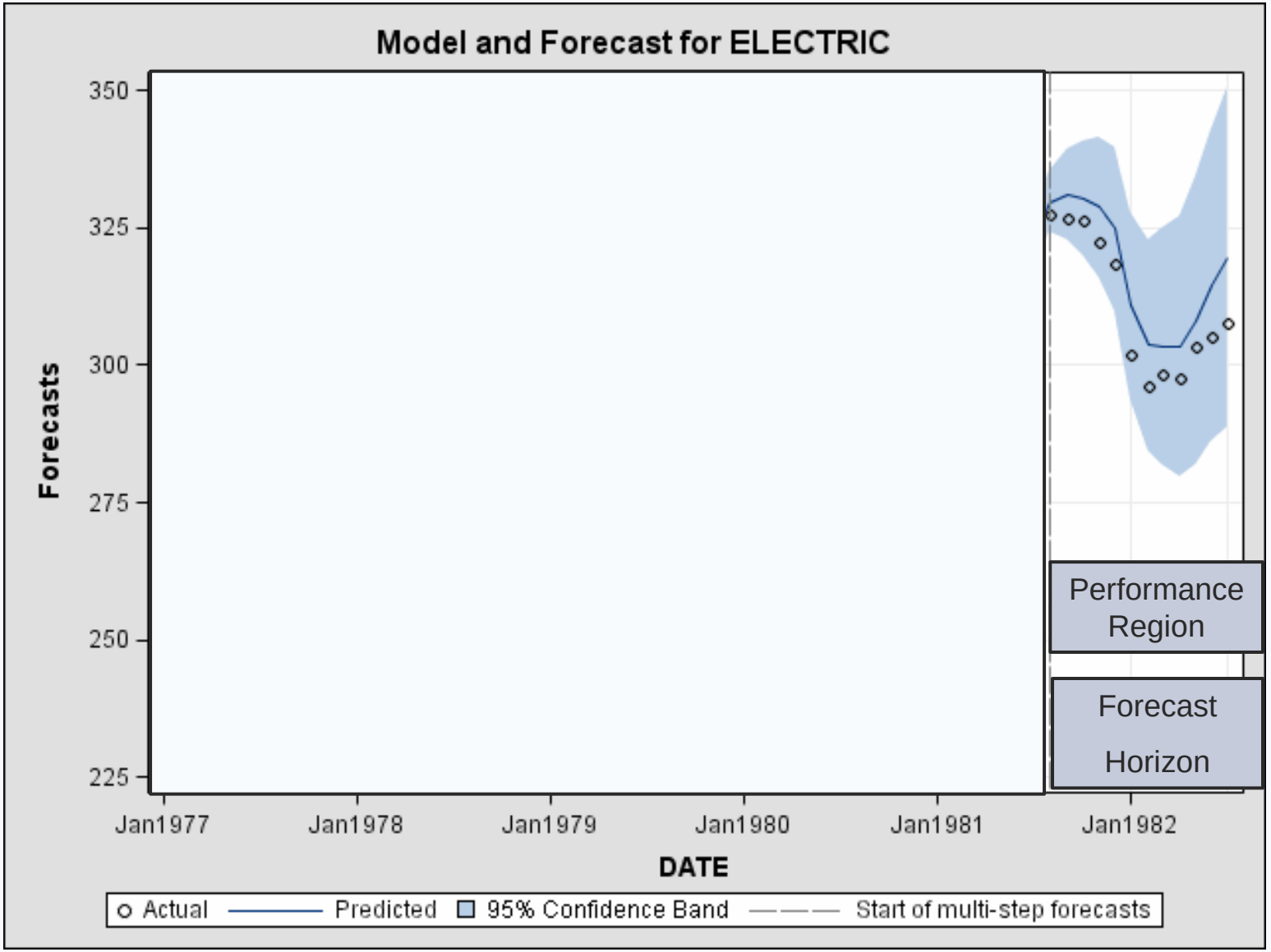










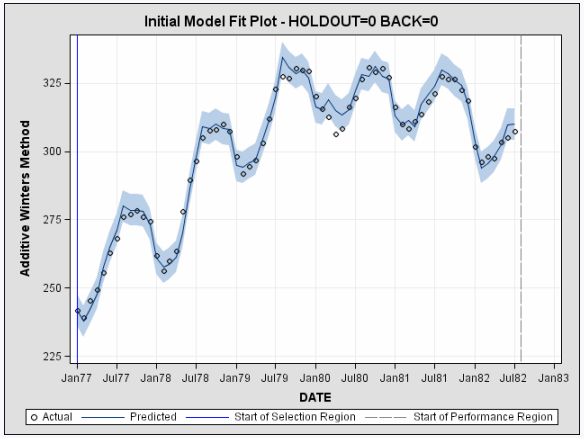


What We Will Discuss Today

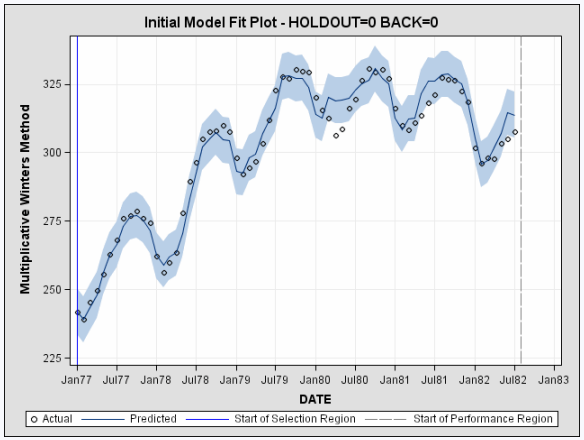
- Is my forecast accurate?
- Illustrative example
- Reconciliation

Time Regions (H = 0, B = 0)

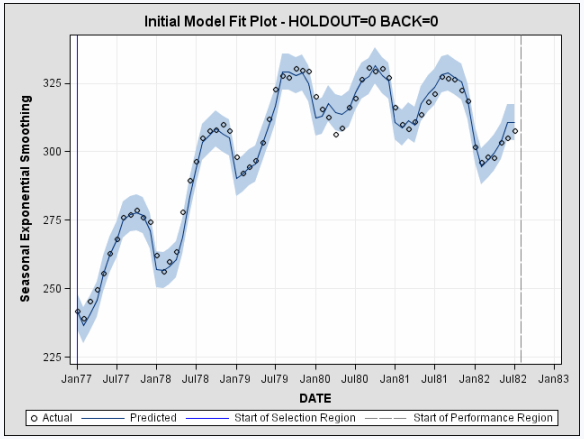
Historical Time Series (1,...,T)	
In-Sample Region (1,...,T)	
Selection Region (1,...,T)	
Fit Region (1,...,T)	Forecast Horizon (T + 1, ..., T + L)



Additive Winters Method



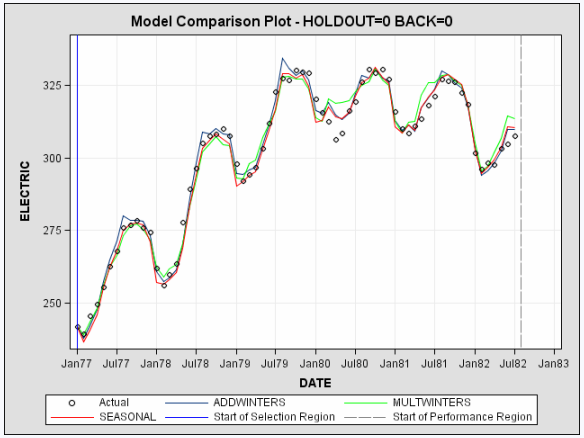
Multiplicative Winters Method



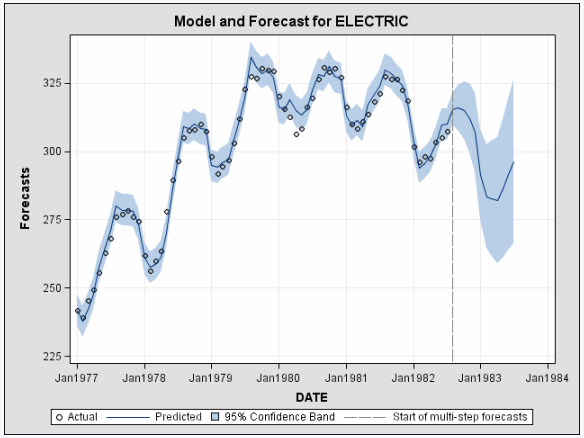
Seasonal Smoothing Method

Time Regions (H = 0, B = 0)

Historical Time Series (1,...,T)	
In-Sample Region (1,...,T)	
Selection Region (1,...,T)	
Fit Region (1,...,T)	Forecast Horizon (T + 1, ..., T + L)



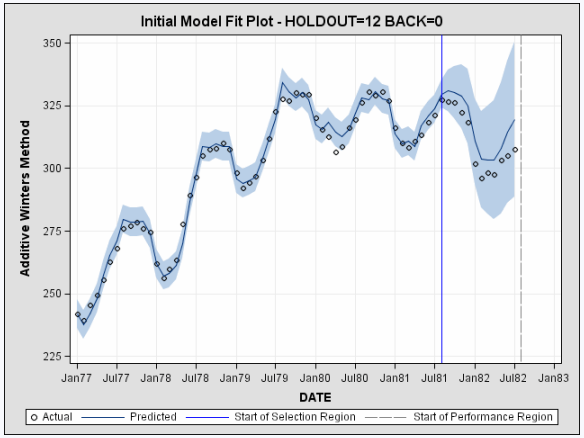
Model Comparison Plot



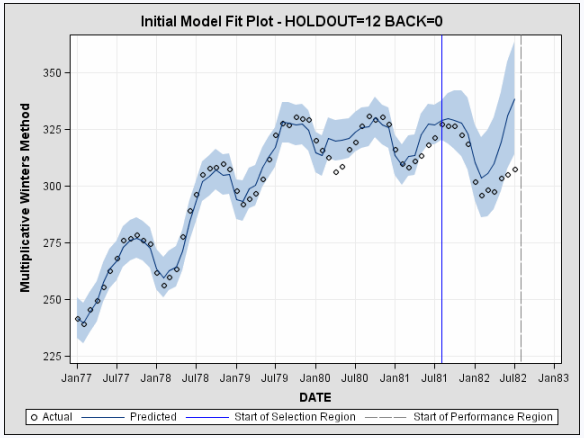
Selected Model Plot

Time Regions (H > 0, B = 0)

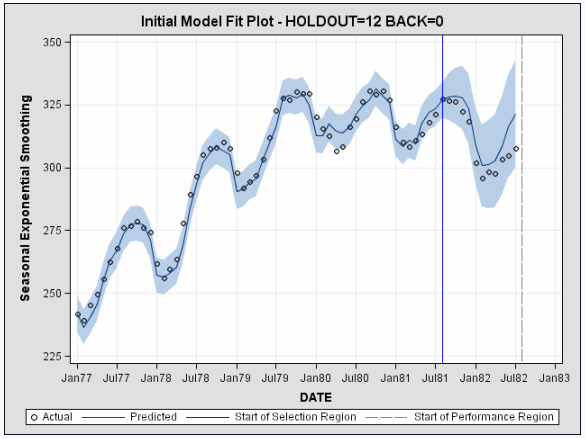
Historical Time Series (1,...,T)		
In-Sample Region (1,...,T)		
Initial Fit Region (1,...,T – H)	Selection Region (T – H + 1, ...,T)	
Fit Region (1,...,T)		Forecast Horizon (T + 1, ..., T + L)



Additive Winters Method



Multiplicative Winters Method



Seasonal Smoothing Method

Time Regions (H > 0, B = 0)

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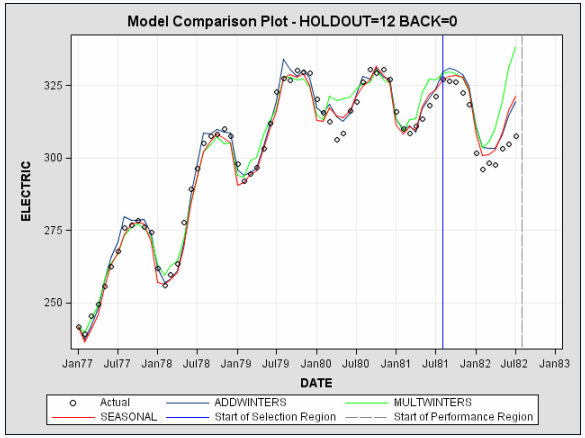

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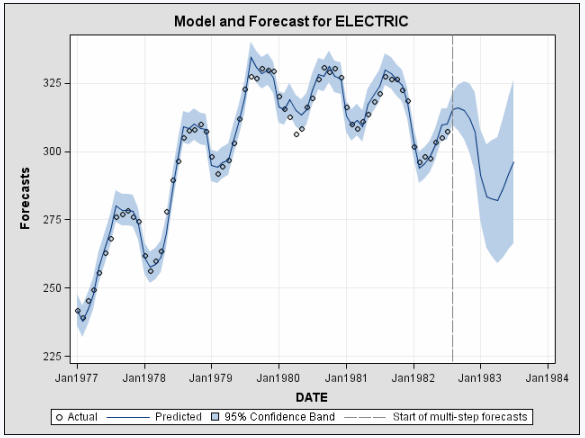
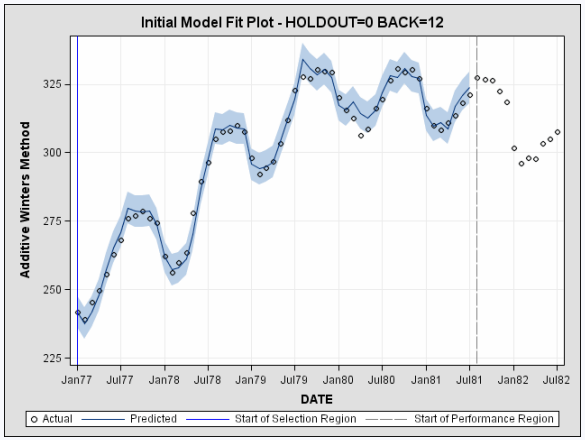


Selected Model Plot

Time Regions (H = 0, B > 0)

Historical Time Series (1,…,T)	
In-Sample Region (1,…,T – B)	Out-Sample Region (T – B + 1,…, T)
Selection Region (1,…,T – B)	Performance Region (T – B + 1,…, T)
Fit Region (1,…,T – B)	Forecast Horizon (T – B + 1,…, T – B + L)



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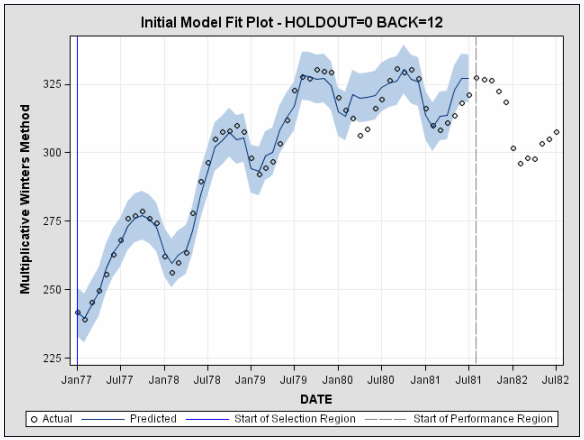

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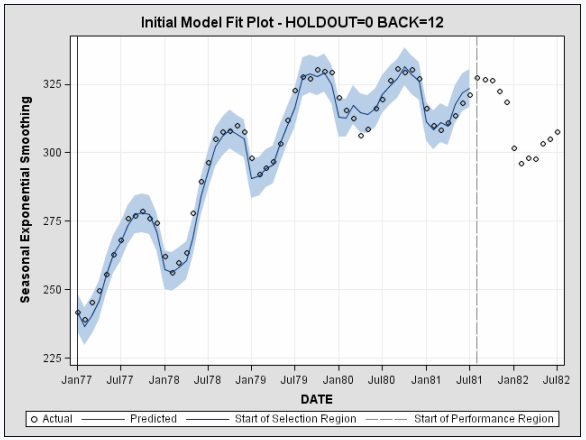

Seasonal Smoothing Method

Time Regions (H = 0, B > 0)

Historical Time Series (1,…,T)	
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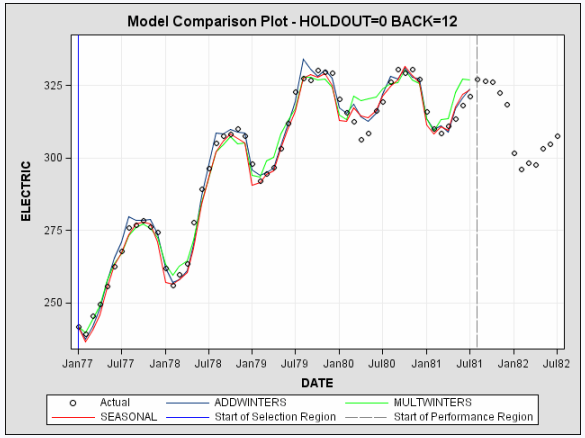

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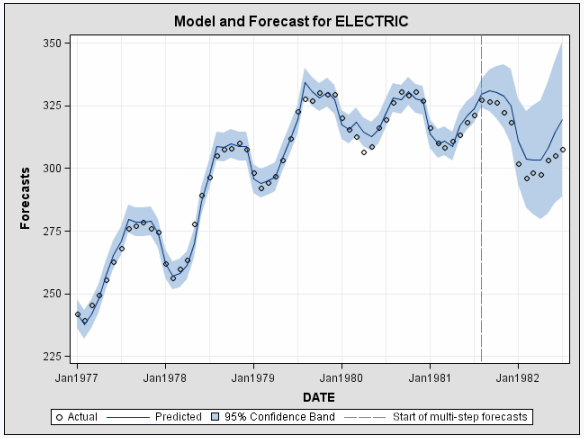

Selected Model Plot

Time Regions (H > 0, B > 0)

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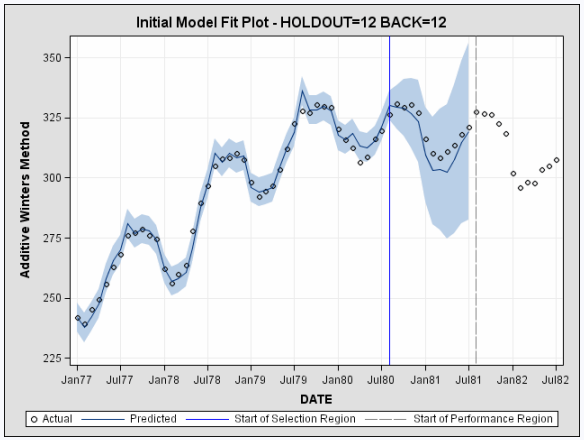

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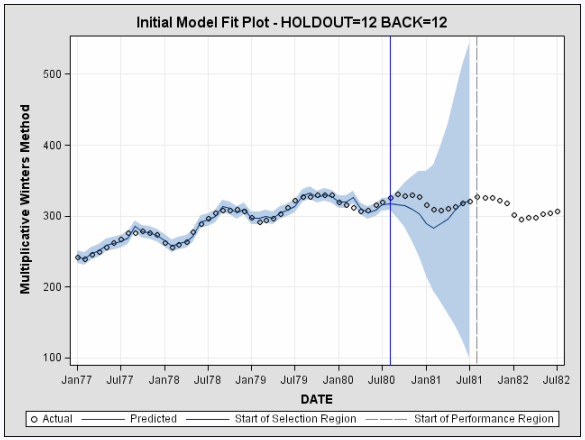

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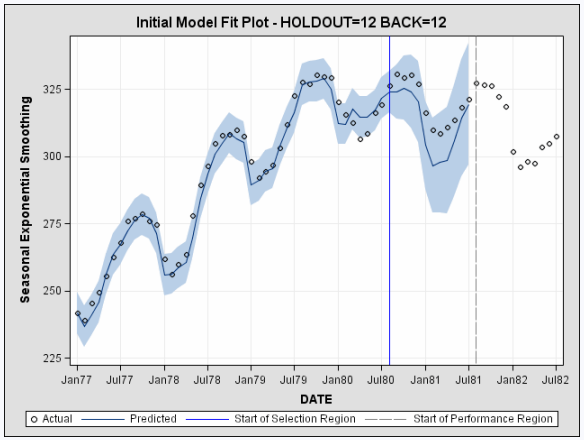

Seasonal Smoothing Method

Time Regions (H > 0, B > 0)

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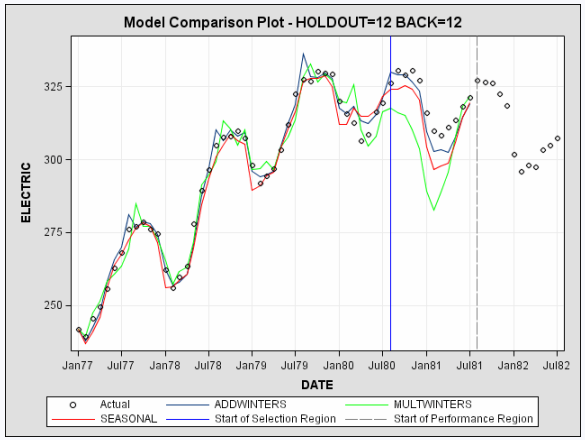
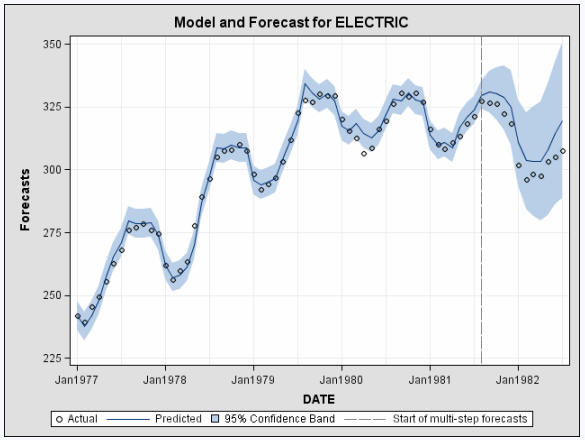




Model Comparison Plot

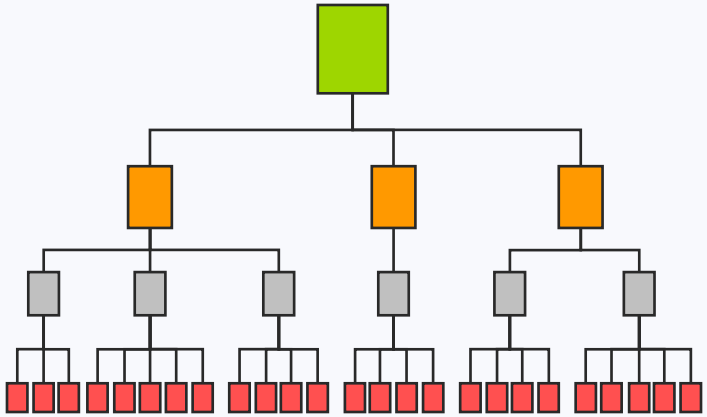
Selected Model Plot

What We Will Discuss Today

- Is my forecast accurate?
- Illustrative example
- Reconciliation

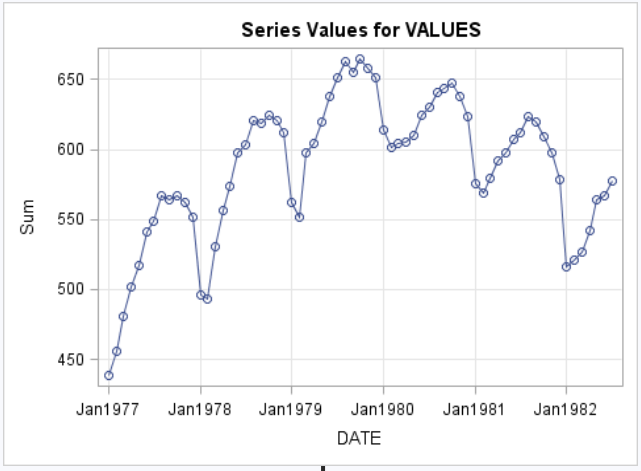
Prediction Error Analysis

- Reconciliation Statistics
  - Computed for the predictions associated with the selected statistical time series model or the predictions associates with the reconciled predictions

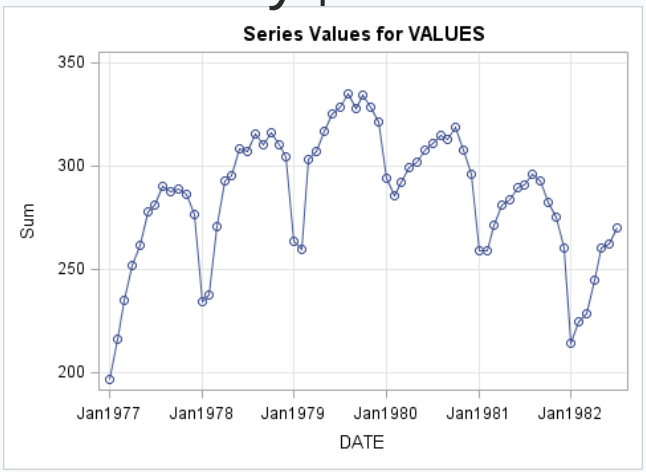


Example Series

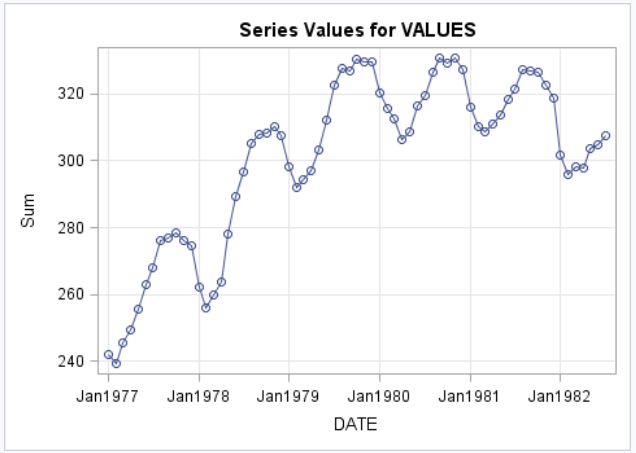
Workers



Masonry

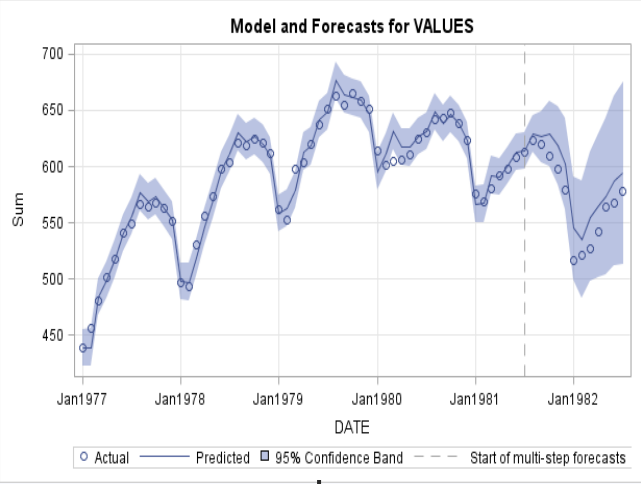


Electric

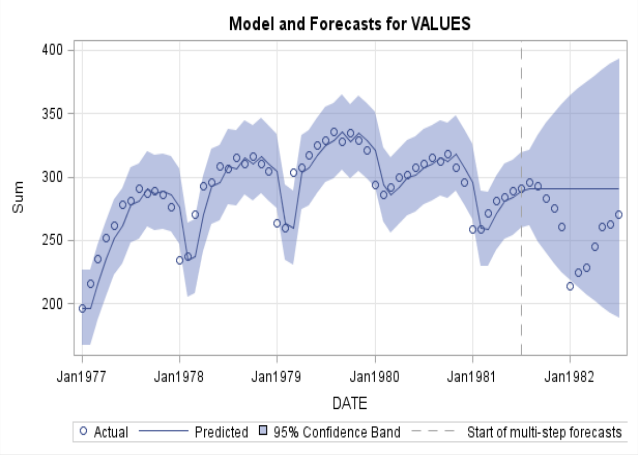


Example Series (H>0 B>0)

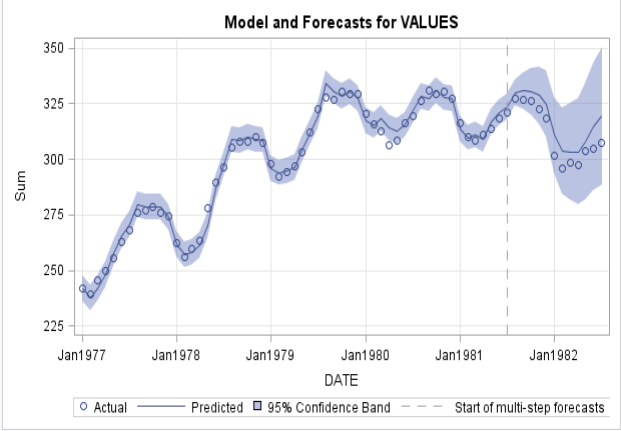
Workers



Masonry



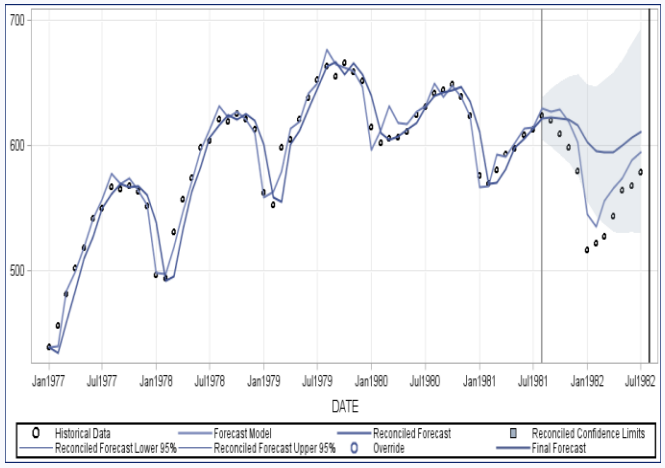
Electric



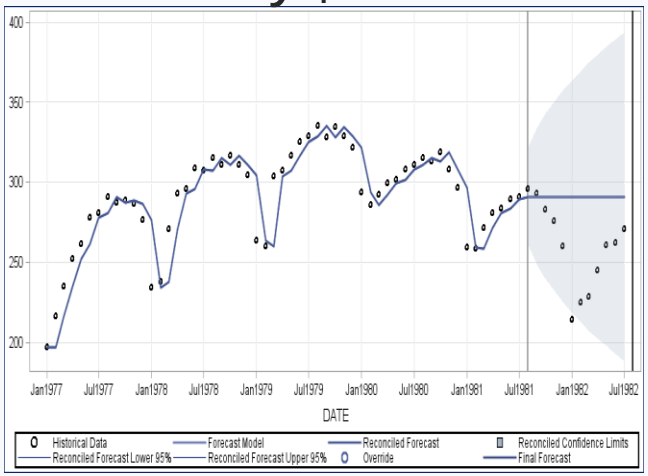
Example Series (H>0 B>0)

Bottom Up Reconciliation

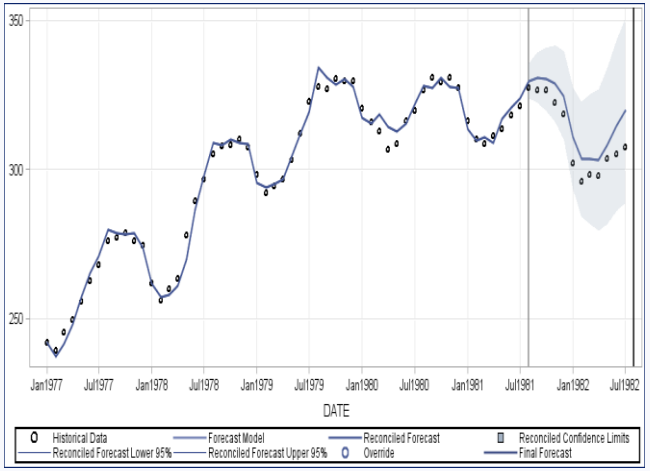
Workers



Masonry



Electric



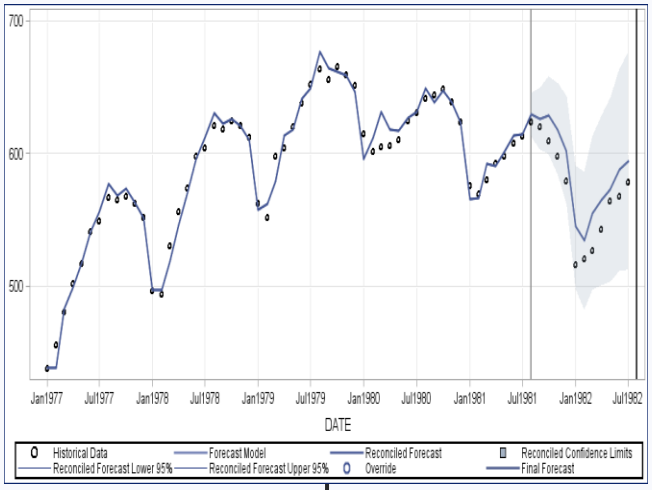
Example Series (H>0 B>0)

Top

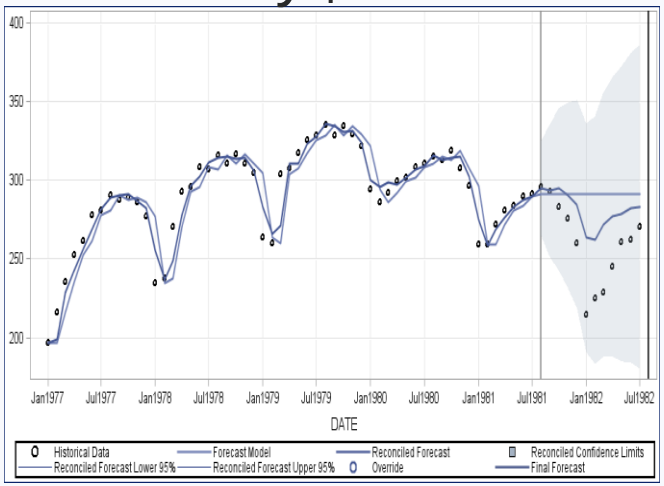
Down

Reconciliation

Workers



Masonry



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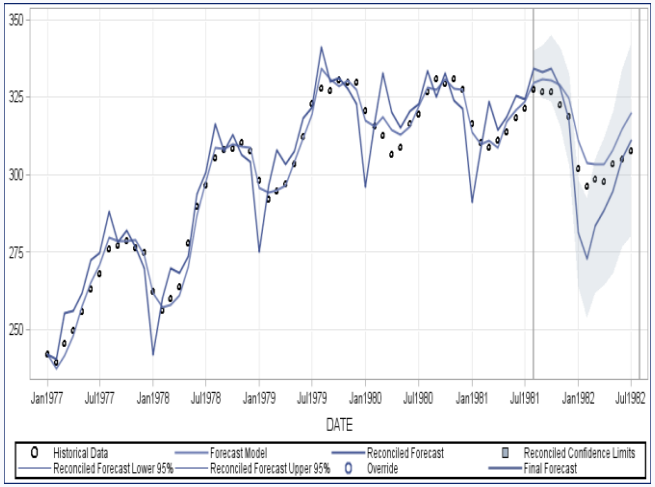


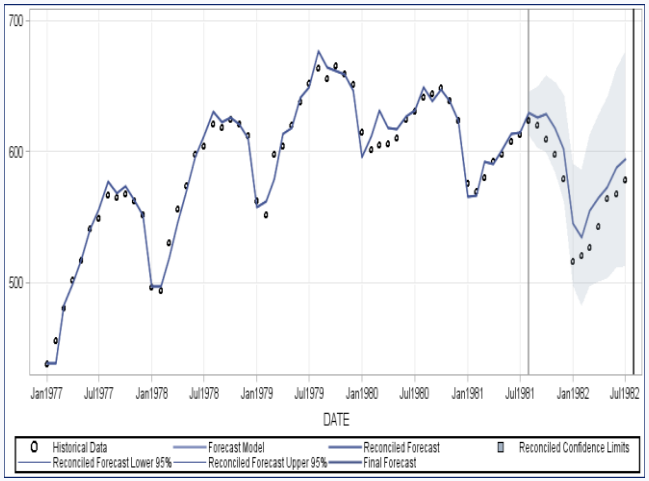
Better Example (H>0 B>0)

Top

Down

Reconciliation

Workers



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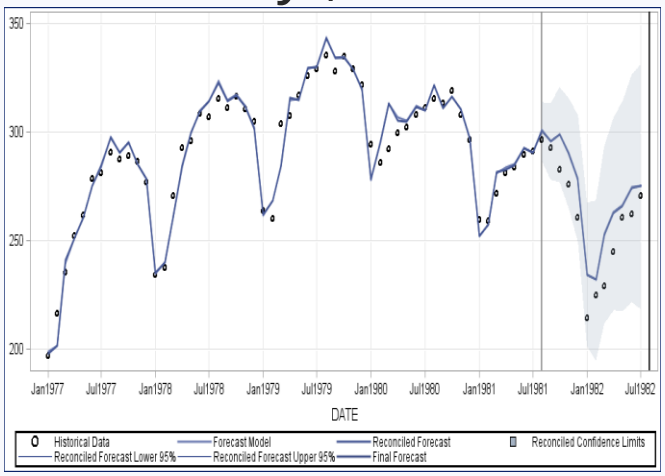
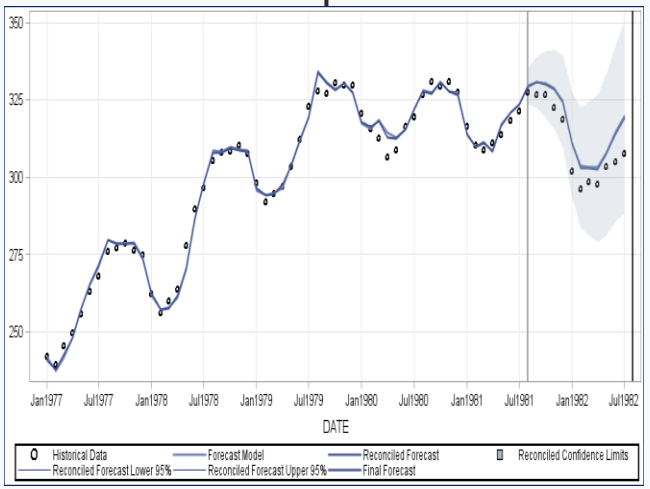


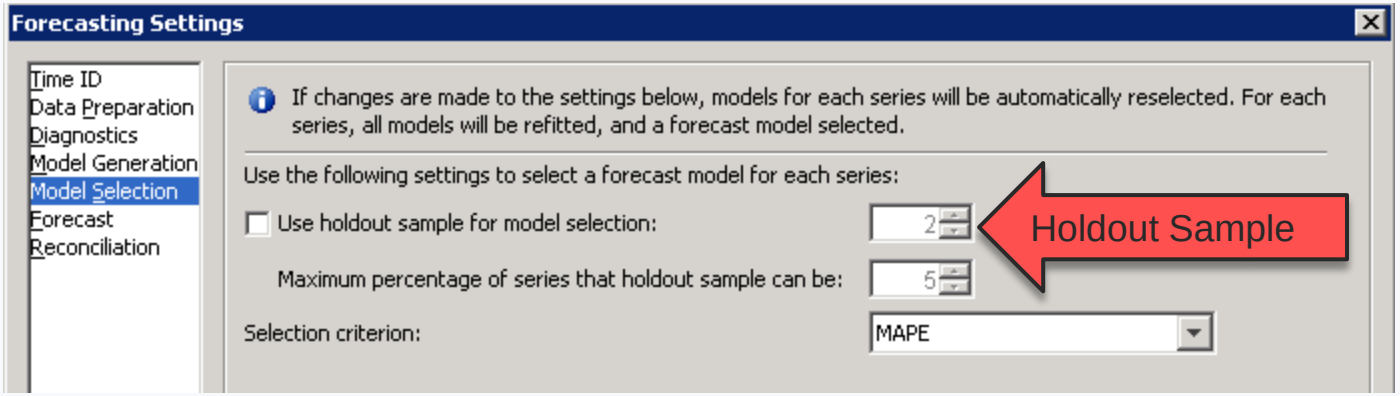
Electric

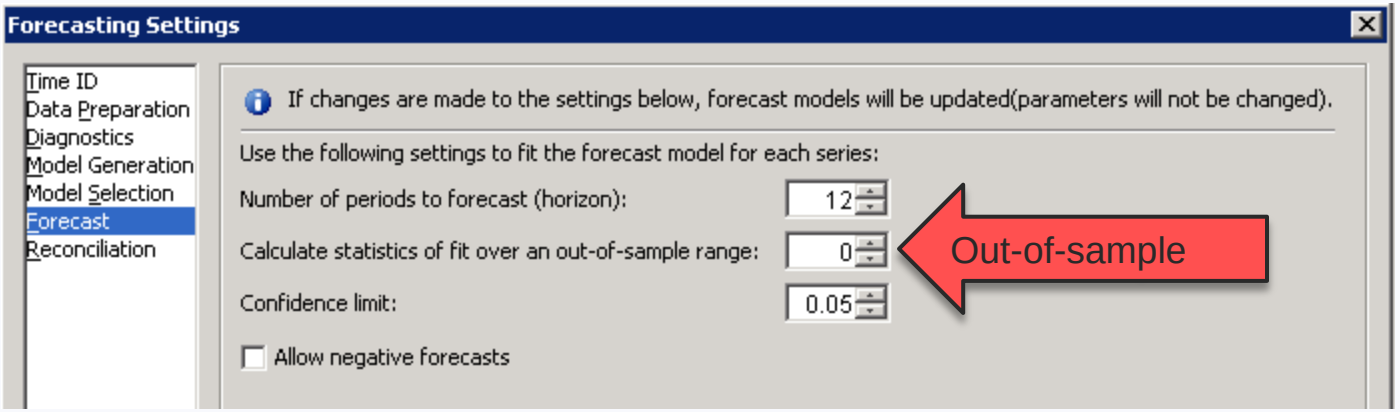


Syntax: SAS High-Performance Forecasting

- HOLDOUT=
  - specifies the size of the holdout sample to be used for model selection.
- BACK=
  - specifies the number of observations before the end of the data that the multistep forecasts are to begin
- Available in
  - HPFDIAGNOSE (holdout, back)
  - HPFSELECT (holdout)
  - HPFENGINE(holdout, back)
  - HPF (holdout, back)

SAS Forecast Studio 3.1





Findings

- Hold-out strategies are useful for judging time series models automatically
- We need to distinguish in-sample and out-of-sample data
- Out-of-sample data allows for an unbiased performance evaluation of forecasting models
- Ultimately we want to compare against “future actual values” and re-adjust our models