SAS®
GLOBAL FORUM
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An accurate forecast is an invaluable tool for anticipating changes which may require a policy, budget, or other response. In health care, there are many potential applications including enrollment, utilization, cost, and operational processes. SAS® PROC ESM generates forecasts with the option to use a variety of different exponential smoothing methods, however, deciding on which method to use is a challenge. Using publicly available Medicare Advantage (MA) enrollment data, we will demonstrate a macro that makes selecting the best performing forecast model easy and intuitive, so that users are able to create reliable forecasts to inform decision-making.
Forecasting Made Easy: A Macro to Select an Optimal Exponential Smoothing Model Using SAS® Proc ESM

Bil Westerfield

PROC ESM

• Simple to use
• Does not require in-depth knowledge of forecasting methods
• Uses exponential smoothing methods
• All parameters associated with the specified models are optimized by PROC ESM
• De-trends and de-seasonalizes the data as needed
• Outputs forecasts, confidence limits, plots, etc.

ESM Model Options

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Type of Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMPLE</td>
<td>Single Exponential Smoothing</td>
<td>Default</td>
</tr>
<tr>
<td>DOUBLE</td>
<td>Double (Brown) Exponential Smoothing</td>
<td>Nonseasonal</td>
</tr>
<tr>
<td>LINEAR</td>
<td>Linear (Holt) Exponential Smoothing</td>
<td>Nonseasonal</td>
</tr>
<tr>
<td>DAMPED</td>
<td>Damped Trend Exponential Smoothing</td>
<td>Nonseasonal</td>
</tr>
<tr>
<td>ADJUST</td>
<td>Additive Seasonal Exponential Smoothing</td>
<td>Level &amp; Seasonality</td>
</tr>
<tr>
<td>MULTISEASONAL</td>
<td>Multiplicative Seasonal Exponential Smoothing</td>
<td>Level &amp; Seasonality</td>
</tr>
<tr>
<td>WINTERS</td>
<td>Winters Multiplicative Exponential Smoothing</td>
<td>Trend &amp; Seasonality</td>
</tr>
<tr>
<td>ADDWINTERS</td>
<td>Winters Additive Method</td>
<td>Trend &amp; Seasonality</td>
</tr>
</tbody>
</table>

What Model Option to Use?

proc esm data=enrollment plot=all;
  id date interval=month;
  forecast enrollment / model=? ?????????; run;

What will MA enrollment be by the end of 2020?

Use Case: MA Enrollment Forecast

Source: CMS Medicare Advantage Monthly Enrollment by Contract Data
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Macro Parameters

```sas
%opt_esm(dsn=enrollment, var=enrollment, holdout=6, horizon=18, fit=mape);
```

- **DSN** = dataset with date timestamp and variable to forecast
- **VAR** = variable to forecast
- **HOLDOUT** = number of data points from end of forecast to use for validation
- **HORIZON** = number of data points to forecast forward into the future
- **FIT** = fit statistic used to select best performing model (AIC, MAPE, MDAPE, MSE, or RMSE)

ESM Model Macro

```sas
%m macro esm_model(mod=, plot_title=);
proc esm data=&dsn out=_null_ outstat=stats back=&holdout lead=&holdout plot=modelforecasts;
id date interval=month;
forecast &var / model=&mod;
run;
data stats (keep=variable model mape);
set stats (where=(region_="FORECAST"));
variable = upcase("&var"); model = upcase("&mod");
run;
proc append base=forecast_stats data=stats force;
%mend;
```

Optimal ESM Macro

```sas
%m macro opt_esm(dsn=, var=, holdout=, horizon=, fit=);
%m esm_model(mod=simple, plot_title='Single Exponential Smoothing');
....
%m esm_model(mod=addwinters, plot_title='Winters Additive Exponential Smoothing');
proc sql noprint;
select model into :opt from forecast_stats having mape = min(&fit);
quit;
proc sgplot data=forecast_stats;
run;
proc esm data=&dsn out=_null_ outfor=forecast lead=&horizon plot=modelforecasts;
id date interval=month;
forecast &var / model=&opt;
run;
%mend;
```
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Macro Creates Forecast For Each Model Option

Abstract
Introduction
Methods
Results 1
Results 2
References
**Abstract**

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**Introduction**

**Methods**

**Results 1**

**Results 2**

**References**

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**Optimal Model Selection**

- **Forecast Model Performance Comparison**
  - The optimal forecast model is: **ADDWINTERS**

- **Best Performing Model on Holdout Sample**

**Value Add of ESM Forecast**

- **Linear Regression**
  - LCLM = 24,096,225
  - Forecast = 24,637,515
  - UCLM = 25,178,805
  - Range = 1,082,580

- **Optimal ESM Model**
  - LCLM = 24,494,412
  - Forecast = 24,669,678
  - UCLM = 24,844,941
  - Range = 350,529

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**Medicare Advantage Enrollment**

- **Actual: 2016-2016**
- **Forecast: 2019-2021**
- **Holdout MAPE = 0.13%**

**Confidence Interval**

**Enrollment**


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