SAS® GLOBAL FORUM 2020

MARCH 29 – APRIL 1
WASHINGTON, DC

USERS PROGRAM

Forecasting Made Easy: A Macro to Select an Optimal Exponential Smoothing Model Using SAS® Proc ESM

Bil Westerfield

Abstract

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.

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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.

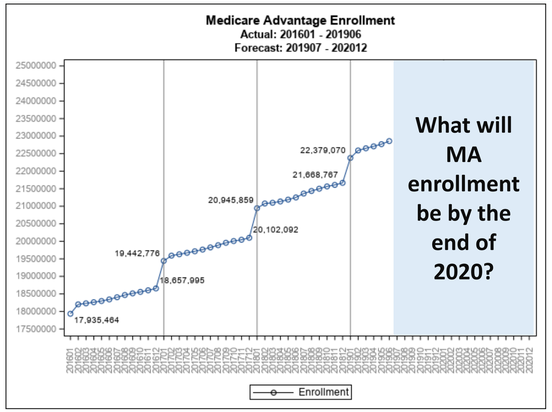
ESM Model Options

Model	Description	Type of Model
SIMPLE	Single Exponential Smoothing	Default
DOUBLE	Double (Brown) Exponential Smoothing	Nonseasonal
LINEAR	Linear (Holt) Exponential Smoothing	Nonseasonal
DAMPTREND	Damped Trend Exponential Smoothing	Nonseasonal
ADDSEASONAL	Additive Seasonal Exponential Smoothing	Level & Seasonality
MULTSEASONAL	Multiplicative Seasonal Exponential Smoothing	Level & Seasonality
WINTERS	Winters Multiplicative Exponential Smoothing	Trend & Seasonality
ADDWINTERS	Winters Additive Method	Trend & Seasonality

What Model Option to Use?

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

Use Case: MA Enrollment Forecast



Source: CMS Medicare Advantage Monthly Enrollment by Contract Data
Available at: https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MCRAdvPartDEnrolData/

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Macro Parameters

%***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

```
%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;
run;

%mend;
```

Optimal ESM Macro

```
%macro opt_esm(dsn=,var=,holdout=,horizon=,fit=);

%esm_model(mod=simple, plot_title='Single Exponential
Smoothing');
....
%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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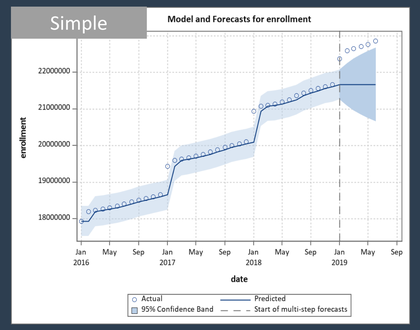
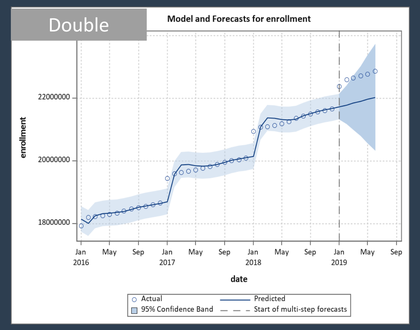
Macro Creates Forecast For Each Model Option

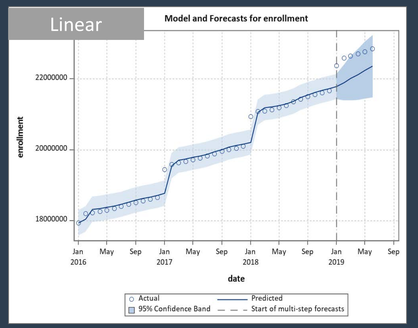
Simple



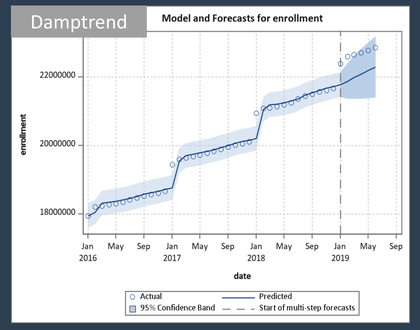
Double



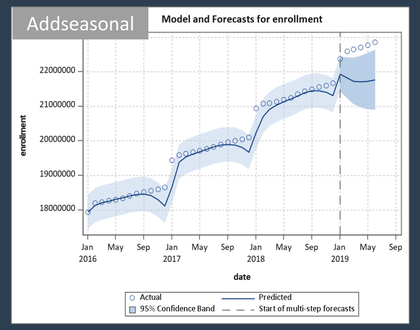
Linear



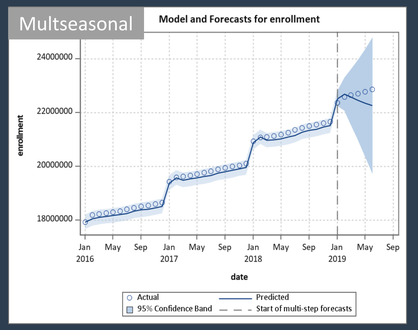
Damptrend



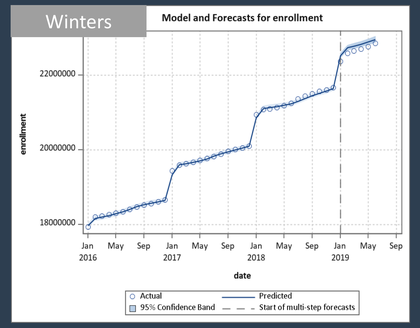
Addseasonal



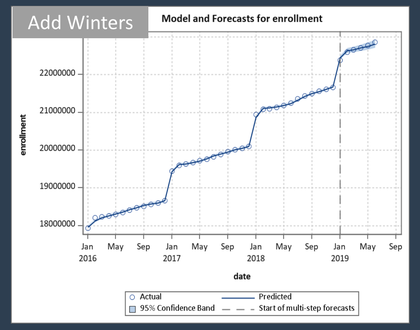
Multseasonal



Winters



Add Winters



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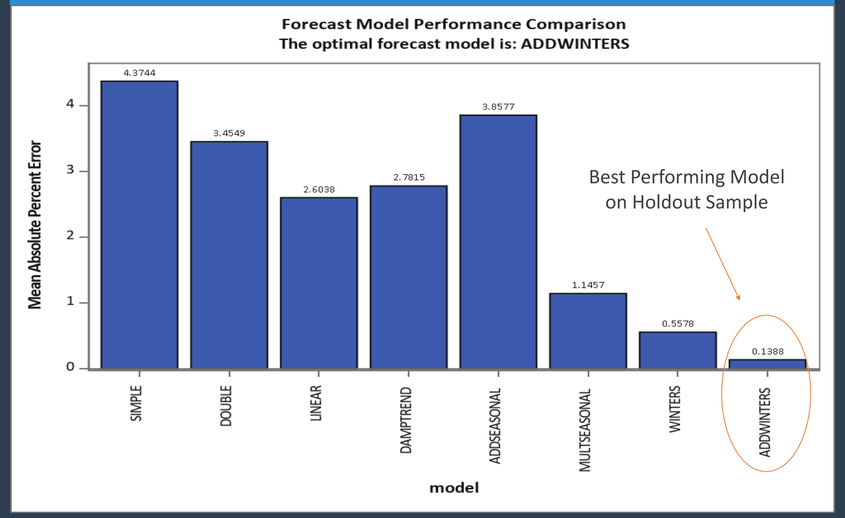
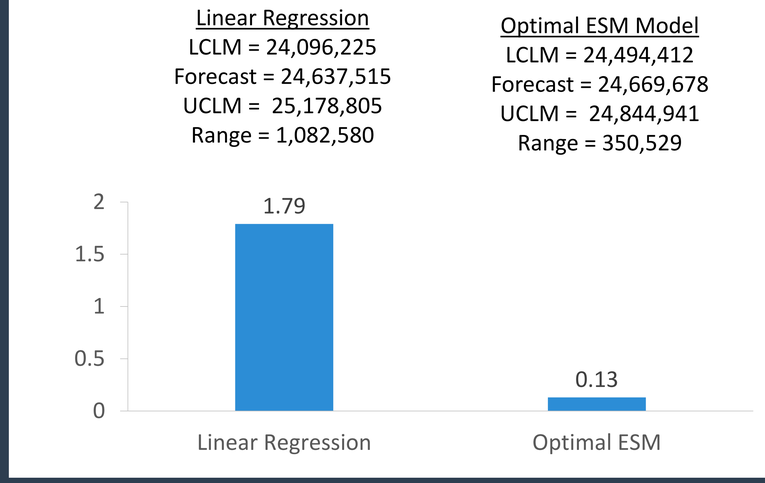
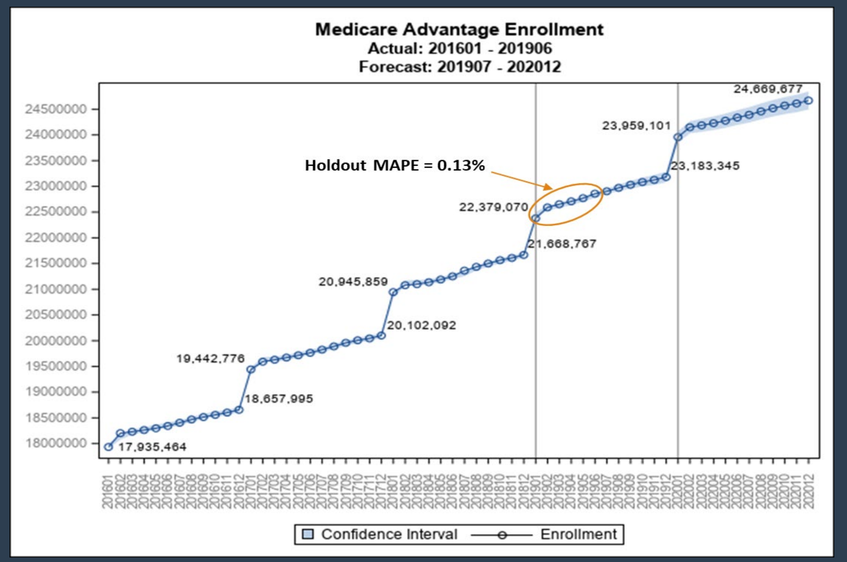
Optimal Model Selection



Value Add of ESM Forecast





References

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