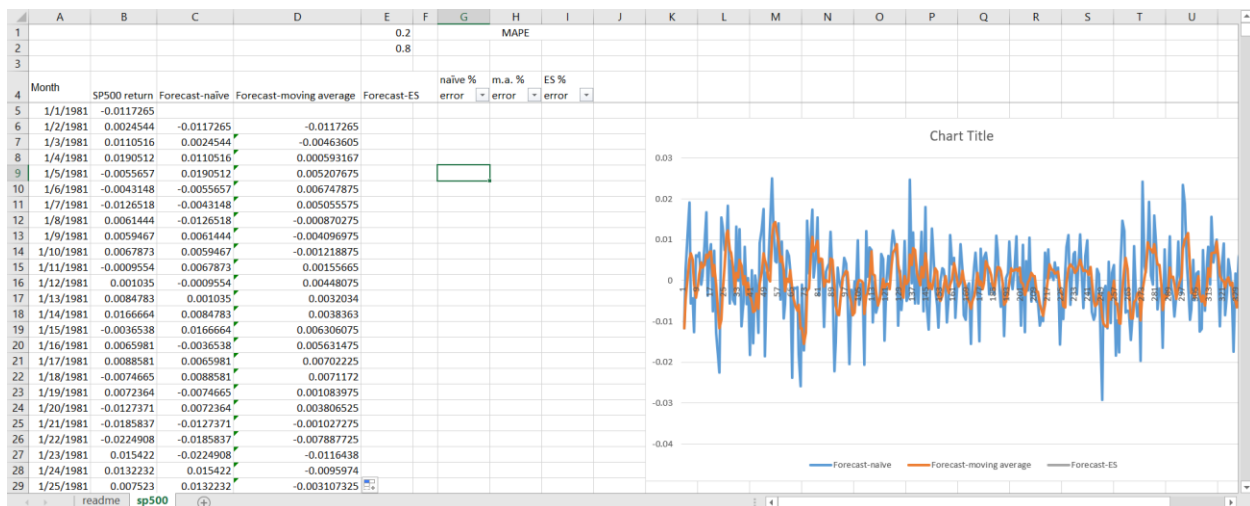


## Forecasting and time series: demo notes

Demo: sp500.xlsx

1. We would like to forecast daily returns of the S&P 500. We will use three methods:
  - a. Column C is a naive forecast. We will just use the value of the previous period to forecast the next period.
  - b. Column D is a rolling average. We will do a rolling average of the last 4 days. For the first three days of the forecast, we don't have that full history so we will just use the first 1, 2 and 3 days. Our chart and data now looks like this.



- c. For the last one, exponential smoothing, we will use the ToolPak. Go to **Data > Data Analysis > Exponential Smoothing**.
    - i. Your input range is the actual S&P data in column B.
    - ii. We will start with a damping factor of .2.
    - iii. Our output range will be the blank column E. Do *not* include the label row.

**Exponential Smoothing** ? X

**Input**

Input Range:

Damping factor:

☒ Labels

**Output options**

Output Range:

New Worksheet Ply:

New Workbook

☐ Chart Output ☐ Standard Errors

OK Cancel Help

- d. You will now see the resulting formulas used for exponential smoothing. Our damping factor is hard-coded into the formula.

	A	B	C	D	E	F	G	H	I	J
1					0.2		MAPE			
2					0.8					
3										
	Month				Forecast-exponential smoothing		naïve % error	m.a. % error	ES % error	
4		SP500 return	Forecast-naïve	Forecast-moving average						
5	1/1/1981	-0.0117265			#N/A					
6	1/2/1981	0.0024544	-0.0117265	-0.0117265	-0.0117265					
7	1/3/1981	0.0110516	0.0024544	-0.00463605	=0.8*B6+0.2*E6					
8	1/4/1981	0.0190512	0.0110516	0.000593167	0.00876492					
9	1/5/1981	-0.0055657	0.0190512	0.005207675	0.01699394					
10	1/6/1981	-0.0043148	-0.0055657	0.006747875	-0.00105377					
11	1/7/1981	-0.0126518	-0.0043148	0.005055575	-0.00366259					
12	1/8/1981	0.0061444	-0.0126518	-0.000870275	-0.01085396					
13	1/9/1981	0.0059467	0.0061444	-0.004096975	0.00274473					

- e. Let's make this more dynamic by substituting our .2 and .8 with cell references. That way we can change the damping factor and see what happens to our curve.



E1				= \$E\$2*B6+\$E\$1*E6		
	A	B	C	D	E	F
1					0.2	
2					0.8	
3						
	Month				Forecast-exponential smoothing	naïv errc
4		SP500 return	Forecast-naïve	Forecast-moving average		
5	1/1/1981	-0.0117265			#N/A	
6	1/2/1981	0.0024544	-0.0117265	-0.0117265	-0.0117265	
7	1/3/1981	0.0110516	0.0024544	-0.00463605	\$E\$1*E6	
8	1/4/1981	0.0190512	0.0110516	0.000593167	0.00876492	
9	1/5/1981	0.0055657	0.0190512	0.005207675	0.01600204	

- f. To make it easier to see the exponential smoothing forecast, you can right-click on the chart, click Select Data, and un-check the other forecasts from showing up on the chart.

Select Data Source

Chart data range: '=sp500!\$C\$4:\$E\$351'

Switch Row/Column

Legend Entries (Series)

Add Edit Remove

☐ Forecast-naïve  
☐ Forecast-moving average  
☒ Forecast-exponential smoothing

Horizontal (Category) Axis Labels

Edit

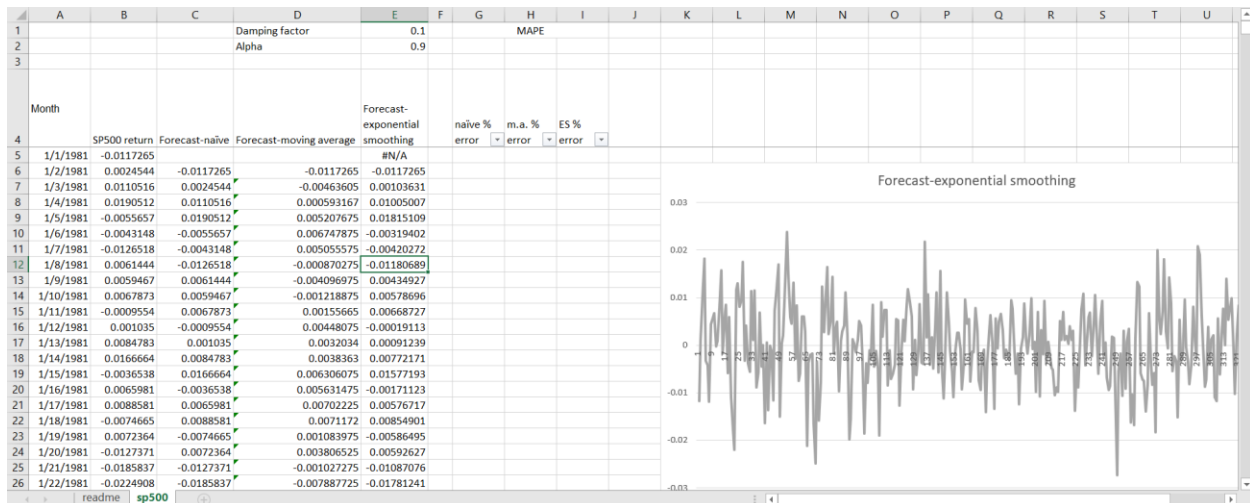
☒ 1  
☒ 2  
☒ 3  
☒ 4  
☒ 5

Hidden and Empty Cells

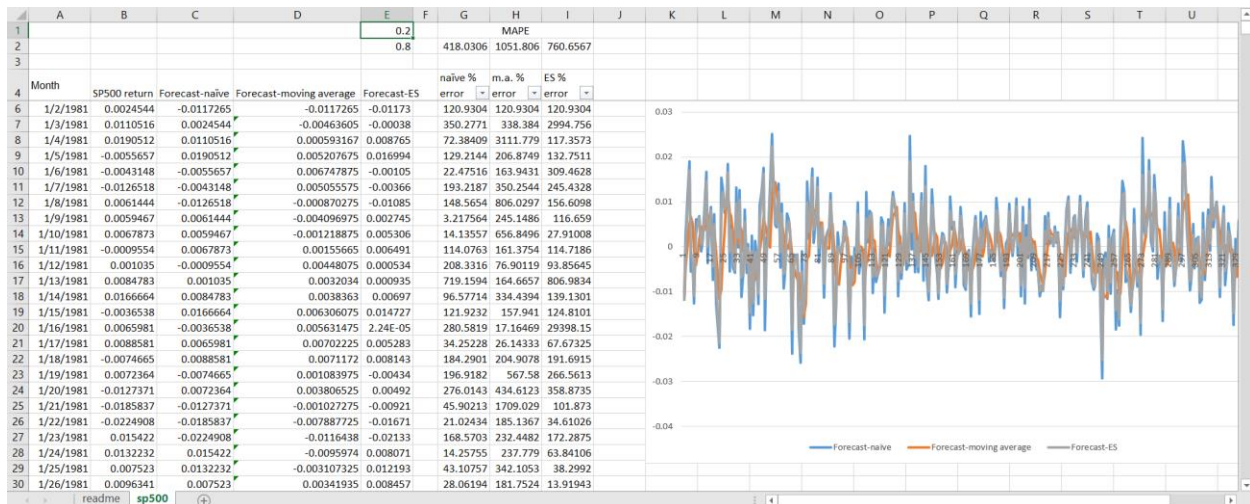
OK Cancel

- g. You will see that the more of a damping factor that is included, the more jagged the forecast is. We are weighting the current datapoint more highly.






- Now let's evaluate the accuracy of our forecasts using the mean absolute percentage error, MAPE. I have the formulas for MAPE at the bottom of the columns, so paste them, fill them down the rows and then take the average for each one. Your model should look something like this. I have turned the other forecasts back on in the chart below.




- It looks like currently the forecast with the lowest MAPE is the naïve forecast. But can we do better with the smoothing forecast by re-adjusting our damping factor to minimize MAPE? This sounds like a job for Solver:



Solver Parameters

Set Objective:  

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:  

Subject to the Constraints:

\$I\$2 >= 0

^

▼

Add


Change

Delete

Reset All

Load/Save

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method: GRG Nonlinear  Options

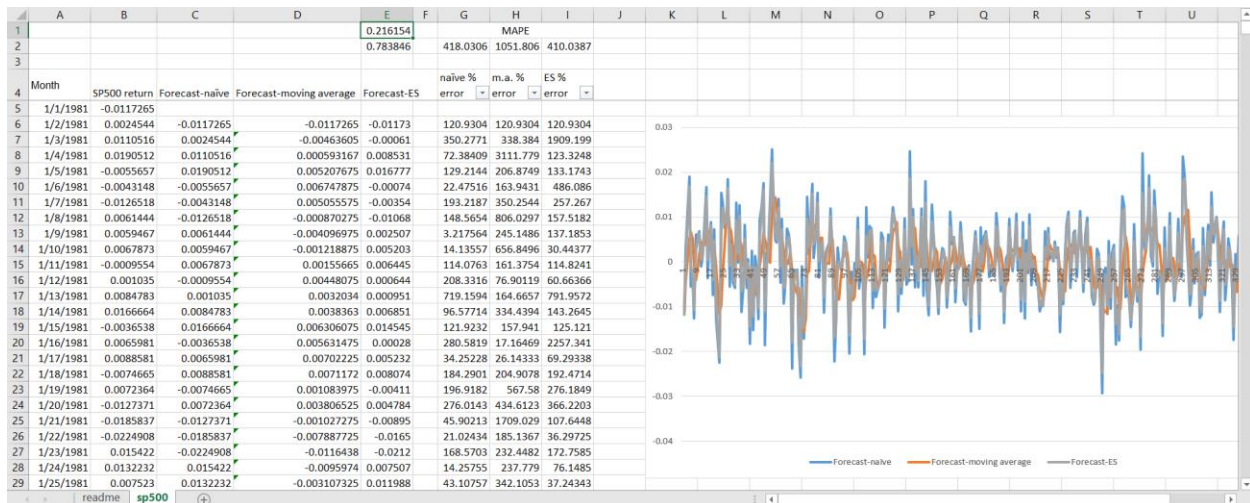
**Solving Method**

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Help
Solve
Close

4. Turns out that we can do better with exponential smoothing by optimizing the damping factor.
  - a. There is a *lot* more you could do to build up on this forecast. This is a good foundation, though.





Drill: female-births.xlsx

Turns out in this case, a very high damping factor works best. This makes the forecast line look nearly smooth. We do get a better forecast accuracy than the other methods this way.

