Seasonal Adjustment for Short Time Series in Excel®

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The minimum length to seasonally adjust a time series in X-12-ARIMA is four years. So what can we do if we have a time series that is shorter than four years long?

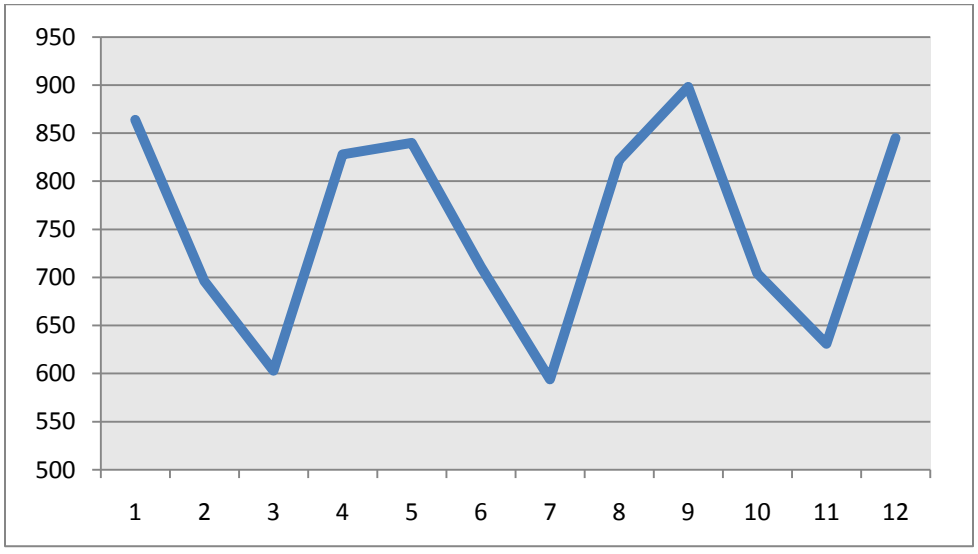
Seasonal adjustment can be difficult under the following conditions:

- The trend is not approximated by a straight line.
- Trading day and moving holiday regressors are present.
- Outliers (level shifts or point outliers) are present.

Fortunately for us, if we have a short series that is fairly well-approximated by a straight line, and if we don't need to estimate trading day, moving holidays, or outliers, then we can do a simple seasonal adjustment in Excel®. The good news is that for short series, we probably can estimate the trend fairly well with a straight line. With only a few data points for a particular month or quarter, we don't have enough data to estimate trading day or moving holiday effects anyway, so we won't try to estimate them. It may be possible to estimate outlier effects, but I will not cover that in this paper.

Below I've outlined the steps, with examples, for seasonally adjusting short series in Excel®. I will start with the simplest case and move to more complicated cases.

Case 1 — A Quarterly Series with a Flat Trend



If the trend is flat, then we can use the average for the series as the trend. An example series that is three years long is shown in the graph above. The values for this series are in the table below.

Steps to calculate the seasonal adjustment:

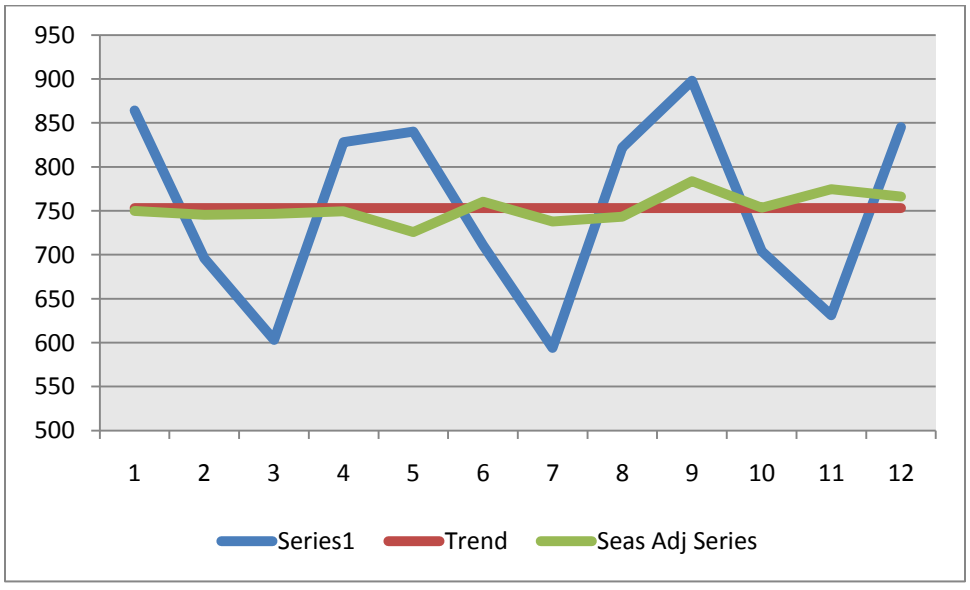
1. Calculate the average for the series. In the example series, the average is 753, so we will use this for our trend.

2. Calculate the difference between the original series and the trend. I've labeled this as "residual" in the table below. For example, for Quarter 1, 1991, we have 864 – 753 = 111.

3. Calculate the seasonal factors (SF), which are the average of the residuals for a given quarter. (Note: I usually calculate the averages once and then paste the values for the other years.) For example, the seasonal factors for all the Quarter 1 values will be (111+87+145) / 3 = 114.3333, for all the Quarter 2 values will be (-57 + -42 + -49) / 3 = -49.3333, and so on.

4. Subtract the seasonal factor from the original series to get the seasonally adjusted series. For example, for Quarter 1, 1991, we have 864 – 114.333 = 749.6667.

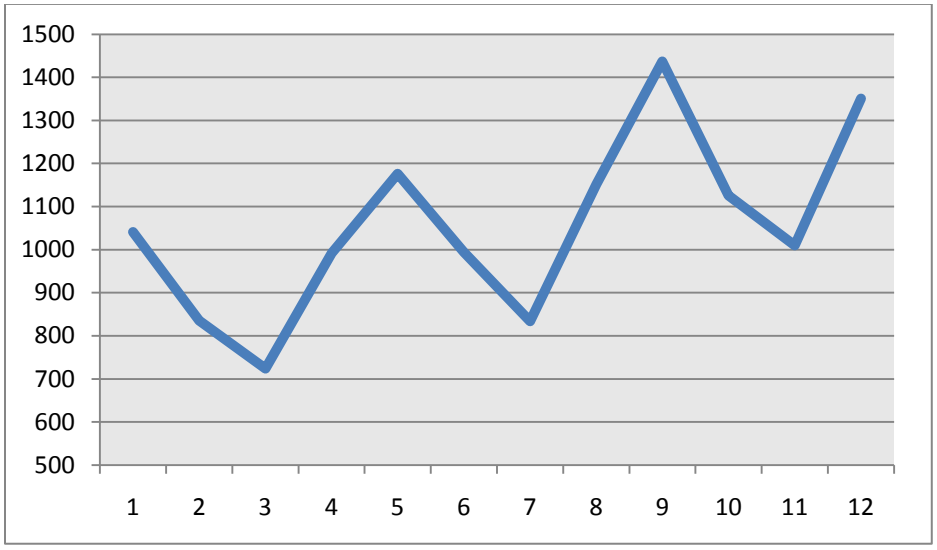
		Original	Trend	residual	SF	SA series
1991	1	864	753	111	114.3333	749.6667
1991	2	696	753	-57	-49.3333	745.3333
1991	3	603	753	-150	-143.667	746.6667
1991	4	828	753	75	78.66667	749.3333
1992	1	840	753	87	114.3333	725.6667
1992	2	711	753	-42	-49.3333	760.3333
1992	3	594	753	-159	-143.667	737.6667
1992	4	822	753	69	78.66667	743.3333
1993	1	898	753	145	114.3333	783.6667
1993	2	704	753	-49	-49.3333	753.3333
1993	3	631	753	-122	-143.667	774.6667
1993	4	845	753	92	78.66667	766.3333



Case 2 — A Quarterly Series with an Increasing (or Decreasing) Trend

Now we have a case where the trend is NOT flat, so we first have to estimate the trend that fits the data. Once we have a trend, you will see that the rest of the calculations use the formulas we used in the previous example.

This series may also have the seasonal fluctuations that depend on the level of the series, though it's a bit unclear with such a short series. We will assume that the seasonal fluctuations are steady for this series, and we will discuss the issue of increasing/decreasing size of fluctuations in Case 3 below.



The best way to estimate a straight-line trend through a series like this is with a regression analysis. If you have never done regression in Excel® before, you might not even find it as an option. The data analysis pack comes standard with Excel® in Excel 97®, Excel 2003®, and Excel 2007®, but some versions of Excel® don't install it unless you request it. If you look for data analysis and can't find it (it's under the "Data" tab in Excel 2007®), then you will need to search the Help for "data analysis" and see what you need to do on your computer to install this group of routines.

Steps to calculate the seasonal adjustment:

1. Use regression analysis to find the trend line for the data.
   a. Select Data Analysis → Regression. Select the original series as the "y" variable and an index number (see the first column below) as the "x" variable. Part of the regression results are in the text box below.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	833.4545	108.6599	7.670307	1.7E-05	591.3453	1075.564	591.3453	1075.564
X- Variable	34.23776	14.76397	2.319008	0.042845	1.341591	67.13393	1.341591	67.13393

b. The only values from this output that we need are the coefficient values for both the "Intercept "and the "X Variable." The form of the trend line is y = Intercept + (X Variable)*index. For this series, our trend line will be y = 833.4545 + 34.23776*index.

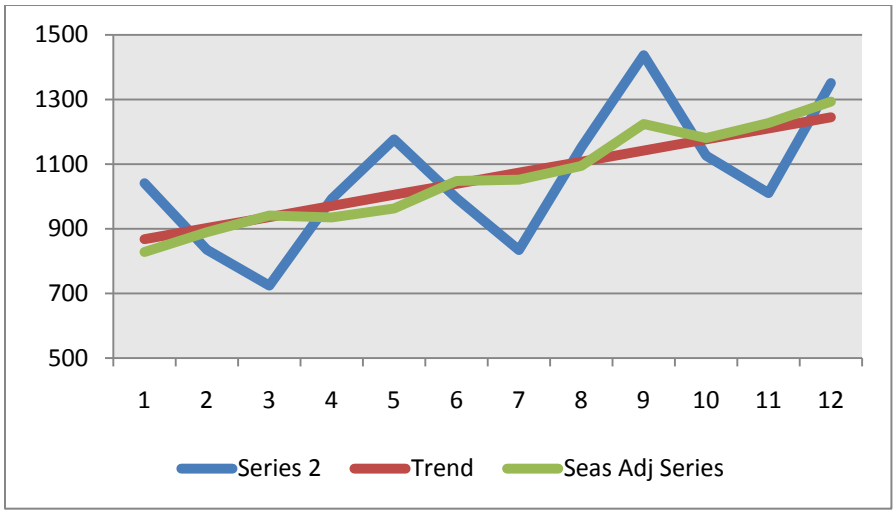
2. Calculate the trend using the equation from Step 1. For example, for Quarter 1, 1991 we have 833.4545 + 34.23776*1 = 867.6923, for Quarter 2, we have 833.4545 + 34.23776*2 = 901.93, and so on.

3. As in Case 1, calculate the difference between the original series and the trend to get the residual.

4. As in Case 1, calculate the seasonal factors (SF) as the average of the residuals for a given quarter.

5. As in Case 1, subtract the seasonal factor from the original series to get the seasonally adjusted series.

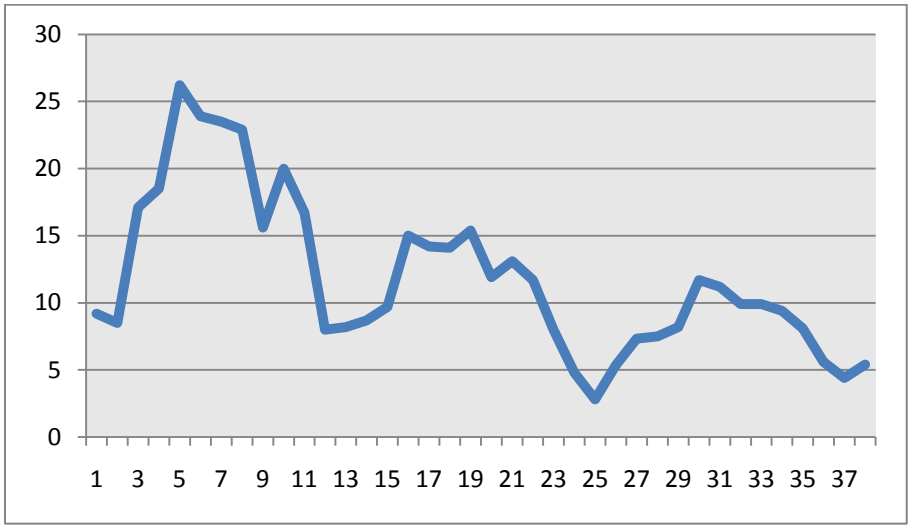
Index #			Original	Trend	residual	SF	SA series
1	1991	1	1041	867.6923	173.3077	213.3567	827.6433
2	1991	2	835	901.93	-66.93	-53.8811	888.8811
3	1991	3	724	936.1678	-212.168	-217.119	941.1188
4	1991	4	992	970.4055	21.59446	57.64342	934.3566
5	1992	1	1176	1004.643	171.3567	213.3567	962.6433
6	1992	2	994	1038.881	-44.8811	-53.8811	1047.881
7	1992	3	834	1073.119	-239.119	-217.119	1051.119
8	1992	4	1152	1107.357	44.64342	57.64342	1094.357
9	1993	1	1437	1141.594	295.4057	213.3567	1223.643
10	1993	2	1126	1175.832	-49.8321	-53.8811	1179.881
11	1993	3	1010	1210.07	-200.07	-217.119	1227.119
12	1993	4	1351	1244.308	106.6924	57.64342	1293.357



Case 3 — A Monthly Series with Changes in the Variance

This series is three years from Midwest Total Housing Starts. Because we have more points in a monthly series, I've only included the graph and not a table of values.

As in the second example, the trend is not flat. In addition to this complication, we now have a monthly series where the size of the seasonal fluctuations depends on the level of the series. This second issue is quite common in economic time series where the variation increases as the level increases (or in this case, decreases as the level decreases). When this happens, we need a variance-stabilizing transformation, and the logarithm works well for this.



Steps to calculate the seasonal adjustment:

1. Take the logarithms of the original data.

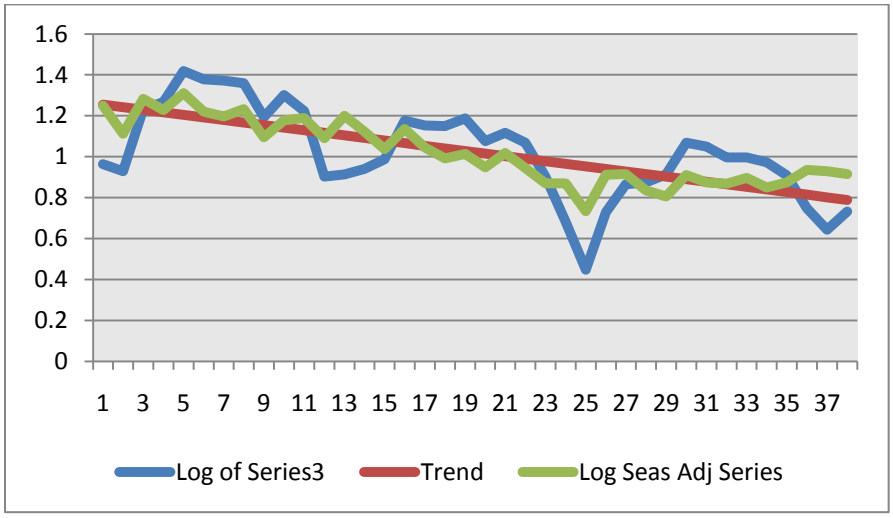
2. Use regression analysis to find the trend line for the logged data. This time the y-variable will be the logged data, with the x-variable as the index number, as before. Again, we use the coefficient values for both the "Intercept "and the "X Variable." The form of the trend line is y = Intercept + (X Variable)*index.

3. Calculate the logged trend using the equation from Step 2.

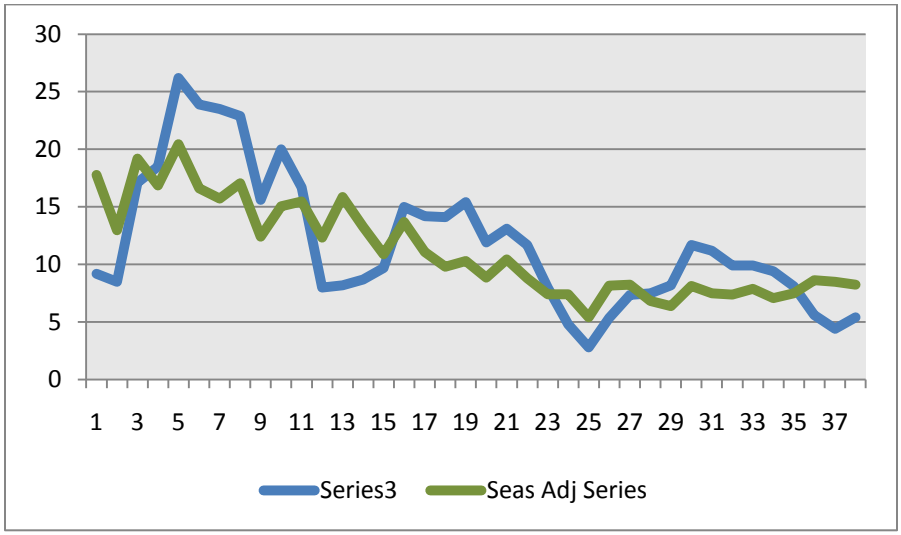
4. Calculate the difference between the logged original series and the logged trend (from Step 3) to get the residual.

5. Calculate the seasonal factors (SF) as the average of the residuals for a given month.

6. Subtract the seasonal factor from the logged original series to get the logged seasonally adjusted series.



7. To get back on the original scale, we take the logged seasonally adjusted series and use it as a power of 10.



Seasonal Adjustment for Longer Series

Now that you've seen how simple it can be to compute seasonal adjustments in Excel®, you may be tempted to use Excel® for seasonal adjustment of longer series. However, you should resist this temptation.

Many seasonal adjustment programs have built-in procedures to deal with many of the issues we see in seasonal adjustment. In particular, both X-12-ARIMA and TRAMO/SEATS have filters designed to

estimate trends that contain cycles, a very common feature in time series. Both programs have procedures for trading day and moving holiday estimation, including user-defined regressors. Both programs are also designed to be robust against extreme values. Estimating trends, trading day, holidays, and extreme values is difficult when seasonality is present, and that is why seasonal adjustment software uses iteration to make more and more refined estimates of the various components of a seasonal time series.

For more information on X-12-ARIMA, please visit

- The Census Bureau's X-12 site at http://www.census.gov/srd/www/x12a/
- My FAQ on X-12 at http://www.catherinechhood.net/safaqx12arima.html

For more information on TRAMO/SEATS, please visit

- The Bank of Spain's site at http://www.bde.es/servicio/software/econome.htm
- My FAQ on TRAMO/SEATS at http://www.catherinechhood.net/safaqseats.html

Note: All graphs in this paper were created in Excel®.

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