Why Seasonal Adjustment – DRAFT

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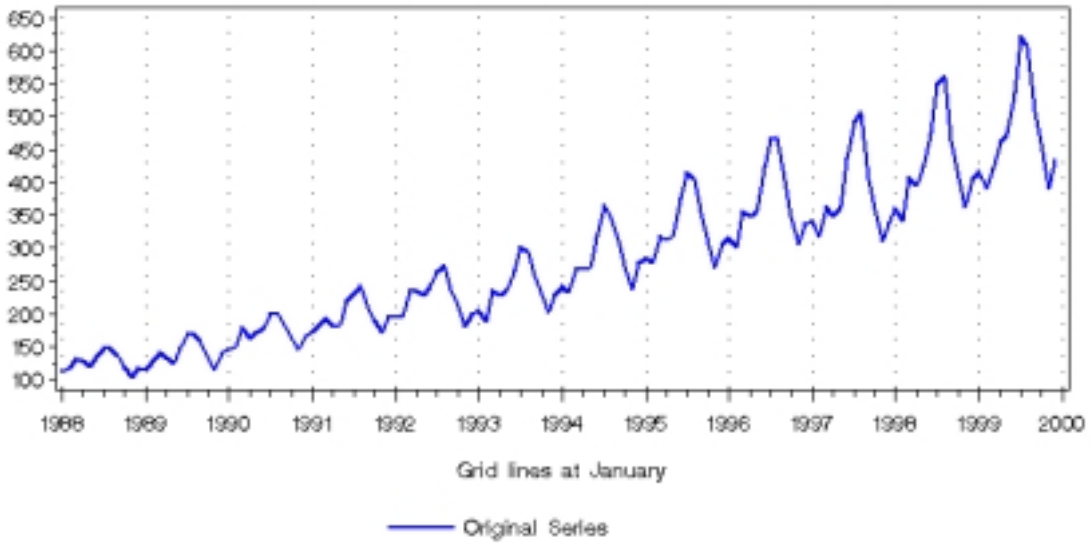
Many of the Census Bureau's economic surveys publish seasonally adjusted data. As producers of seasonally adjusted time series it is important to understand why we are making seasonal adjustments.

Economists, policy makers, and consumers use time series we publish to make decisions. They try to identify important features of economic series such as direction, turning points, and consistency between other economic indicators. Sometimes seasonal movements can make these features difficult to see, so we publish economic series with the seasonal movements removed for those who prefer to view data without seasonal movements. In this paper we will explore seasonal movements, seasonal adjustment, and we'll take a look at some of the features of economic time series.

To understand seasonal movements, we must first have some knowledge about the data where the seasonal movements occur. For our purposes, the data must be in the form of a time series. A *time series* is simply data of the same kind that are collected regularly over time. For a time series to be useful for analysis, we need data that are comparable over time. That means 1) the reporting periods must be identical (every month, every quarter, or every year), 2) that the measurements should be taken over discrete (non-overlapping), consecutive periods, and 3) that the definition of the concept and the way it is measured should be consistent over time.

Figure 1 below is a monthly time series graphed from January 1988 to December 1999.

Figure 1

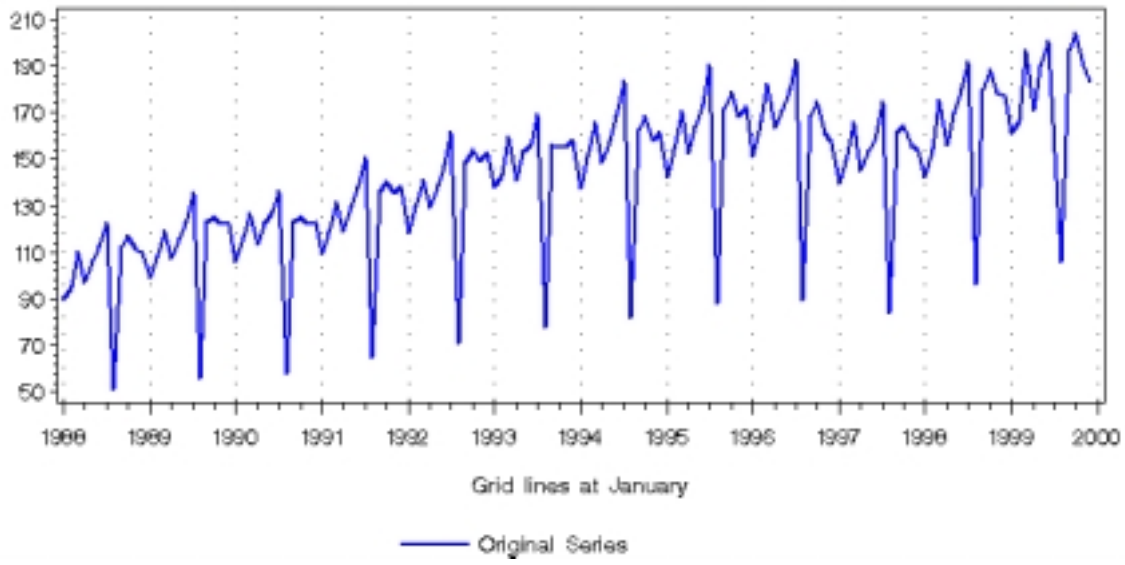


It is easy to see that the series not only fluctuates as time goes on, but it also continuously increases. Upon closer examination we can identify that the fluctuations are cyclical, i.e. the same pattern is repeated each year. For example, notice how the values for July and August are always greater than the values in December and January. These cyclical fluctuations are what we consider seasonal movements or seasonal effects.

What exactly is a seasonal effect? A seasonal effect is any effect which is stable in terms of annual timing, direction, and magnitude. Possible causes include natural factors (the weather, amount of rainfall, temperature), administrative measures (starting and ending dates of the school year, corporate policies), and social/cultural/religious traditions (fixed holidays such as Christmas).

From one time series to another, seasonal effects can vary in their size and the time period in which they occur. For example, let's take a look at a second time series graphed from January 1988 to December 1999. Notice that there is a sharp decrease in August every year and the seasonal oscillations are much more dramatic than in the series shown in Figure 1 above.

Figure 2



From these two examples we see that the seasonal effects are distinctly different from each other. Series 1 increases during the summer months while Series 2 shows a sharp drop around the same time. If we needed to compare these series in order to draw some conclusion, it may prove to be difficult to compare these series because of the seasonality.

For example, we can look at month-to-month percent changes to tell us how much each series has changed from the previous month. Looking at the August to September percent change from 1998, Series 1 shows a 17% decrease and Series 2 shows an 86% increase. This seems to indicate that things are changing dramatically in both series in opposite directions, but keep in

mind that we expect these changes to happen every year and they appear to be consistent. These large month-to-month percent changes are mostly due to the seasonal fluctuations and not to some dramatic changes. The large seasonal movements are masking smaller movements that could be used to analyze the two series.

If we were able to remove the seasonal fluctuations, then the masking effects would be gone and we would have a better view of the behavior of each series. The estimation and removal of the seasonal fluctuations is what we call *seasonal adjustment*. The basic goal of seasonal adjustment is to decompose a time series into a several different components, including a seasonal component, for the purpose of removing the seasonal effect. The resulting seasonally adjusted series won't have the large seasonal movements that can obscure smaller movements of importance to economic analysts.

Now take a look at our two example series after we have seasonally adjusted the series.

Figure 3

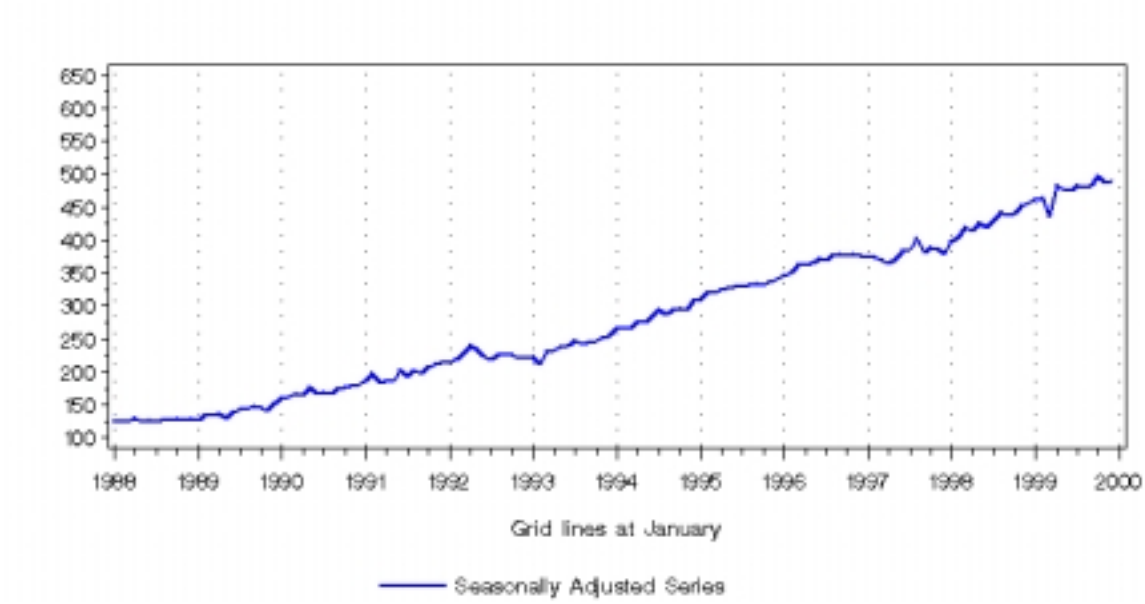
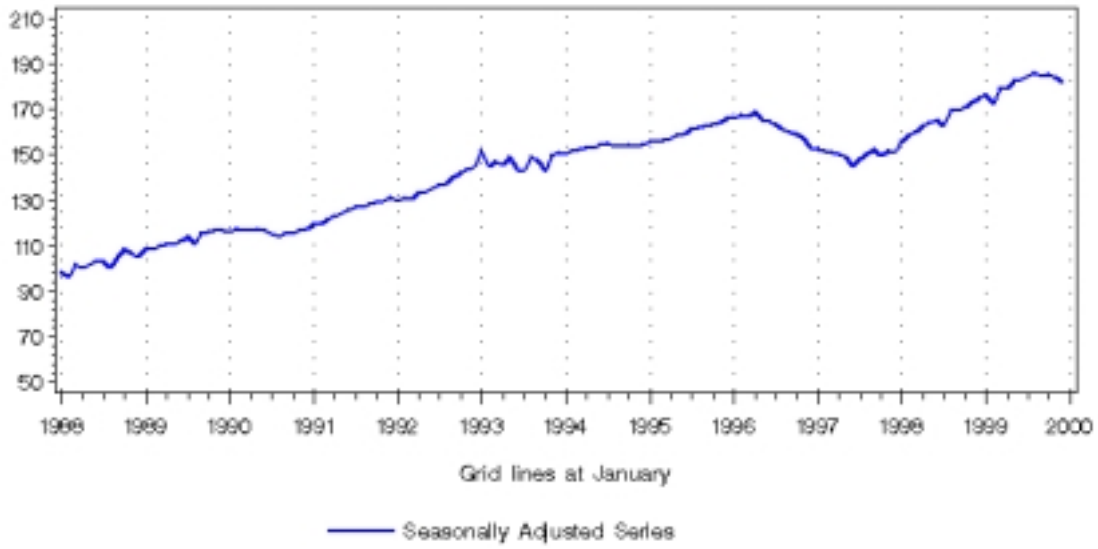


Figure 4



It is now easier to see the smaller movements since the masking effects of the larger seasonal fluctuations are gone. We can also identify where the series changes direction from increasing to decreasing or vice-versa. When a change in direction continues over a significant amount of time, then this change in direction is defined to be a turning point. Notice we can identify that Series 2 has turning points in the beginning of 1996 and another in mid-1997. Also notice that Series 1 has no apparent turning points and is continuously increasing.

Another important feature of economic time series is the comparison between different series. Recall from our two examples that in 1998 the August to September percent change was a 17% decrease in Series 1 and an 86% increase in Series 2. It is difficult to compare these results because there is no consistency between the time series. Seasonal adjustment provides the necessary consistency between time series that yields the ability to compare different series. Once we have seasonally adjusted the two example series, we can compare the month-to-month percent change from August to September again. This time Series 1 shows a 2% increase and Series 2 shows a 1% increase. This provides a more consistent way of comparing the series.

As we have seen, the removal of large seasonal movements allows the data users to have a better view of the behavior of the time series. Seasonal adjustment makes it easier for our users to see smaller movements in the series, to determine the turning points, and to compare different series.

Now that we have discussed why we are adjusting the data, you might also want to know how we seasonally adjust the data. Seasonal adjustment is a very complex procedure that doesn't provide one unique solution. To produce a good seasonal adjustment, we also need to take into account other calendar-related effects, like moving holidays and the weekday composition of a given month. We should also have a seasonal adjustment method that is robust against outliers. And since there is more than one solution, it is helpful to have diagnostics to help us evaluate different possible adjustments.

The Census Bureau standard for producing seasonally adjusted series is a program called X-12-ARIMA. You will find more details in the *X-12-ARIMA Reference Manual* (U.S. Census Bureau, 2001) and the X-12-ARIMA Quick Reference (U.S. Census Bureau, 2001). It may also be helpful to read the paper, "Getting Started with X-12-ARIMA Input Files on Your PC" by Hood and Monsell (2001).

To download X-12-ARIMA for your PC, please see the U.S. Census Bureau website at http://www.census.gov/srd/www/x12a/x12down_pc.html. At the web site, you will find program files for the latest PC version of X-12-ARIMA and the companion graphics package, X-12-Graph; files containing the *X-12-ARIMA Reference Manual*; and a link to the instructions for downloading the program.

For detailed information on the X-11/X-12 method for seasonal adjustment, see Ladiray and Quenneville (2001). For information about new features in X-12-ARIMA, see Findley, Monsell, Bell, Otto and Chen (1998).

For basic information on ARIMA time series modeling and basic seasonal adjustment, see Makridakis, Wheelwright, and Hyndman (1998). For a more advanced treatment of ARIMA time series modeling, see Box, Jenkins, and Riensel (1994).

References

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