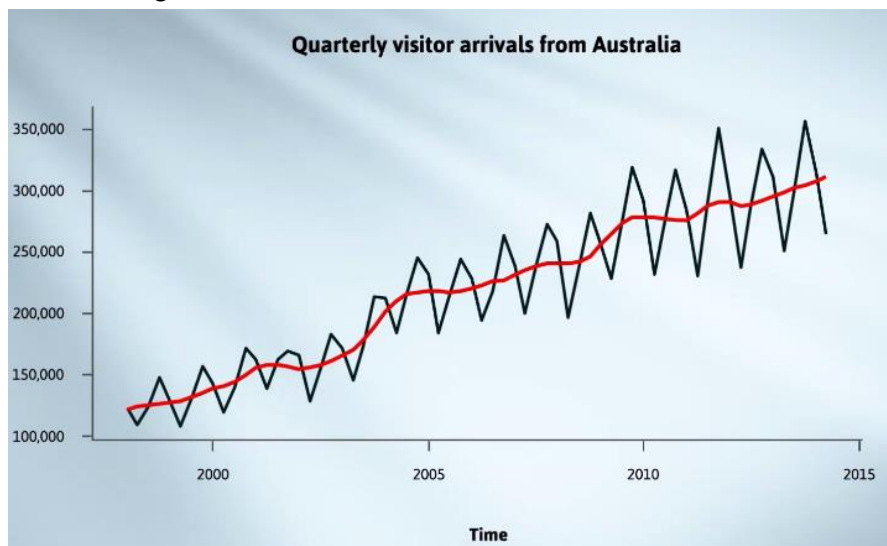


## WEEK 8

### SEASONAL DECOMPOSITION AND FORECAST, PART II by Chris Wild

At the end of Part One, we showed this plot of visitor arrivals from the US, with the trend plus additive seasonal swings superimposed in red. There's a slight suggestion that the swings are too wide at the left-hand end, where the series-trend is low, and not wide enough in the places where the series-trend is high.

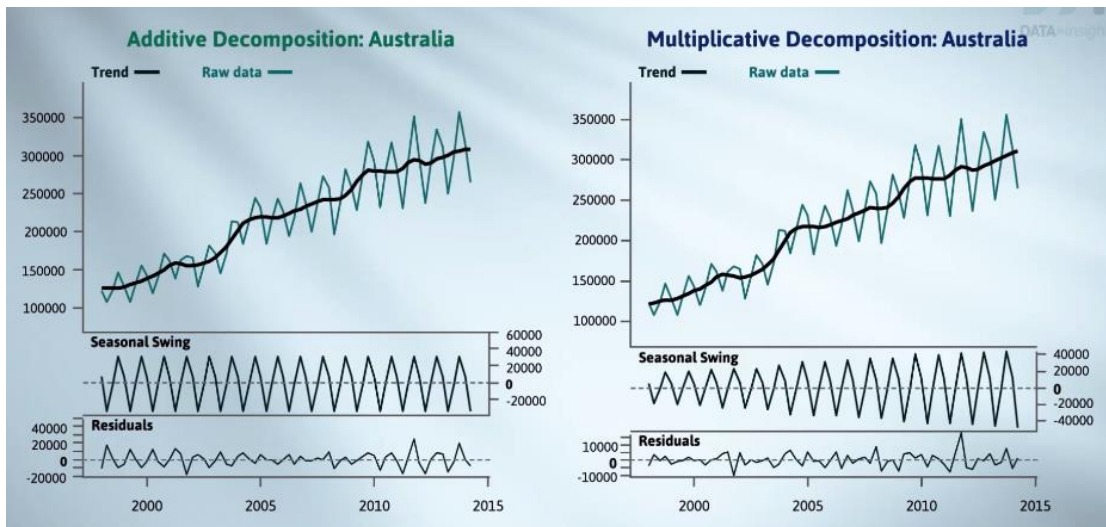


This is much more dramatically so with the visitors from Australia. Here, it's really obvious that the seasonal swings are a lot smaller towards the left-hand side (where the trend is lower) and a lot bigger towards the right-hand side (where the trend is higher).

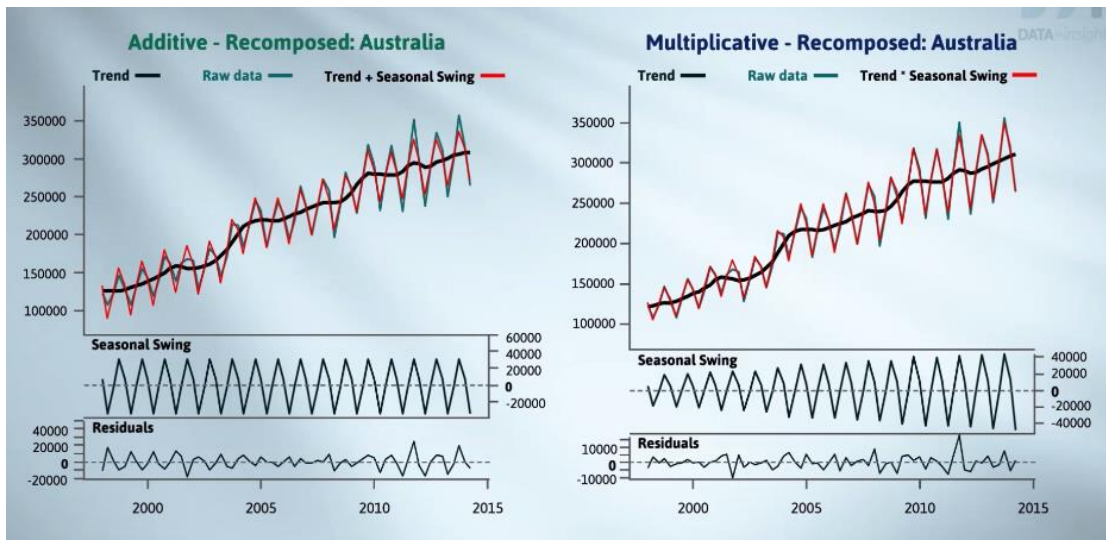
The swings being bigger when the trend is higher is an extremely common pattern. It's present in all the series we have in this data set. Multiplicative decompositions often work well with series that look like this.

We have another way of looking at series. Instead of thinking of the seasonal swings adding to the trend, they multiply the trend value.

This is the "multiplicative model" and we get a multiplicative decomposition. We'll postpone getting to grips with exactly what multiplicative means and look at the results when we do an additive and a multiplicative decomposition of the Australian series in iNZight. Here they are now.



The multiplicative decomposition on the right is obviously a better reflection of what we see. This is from iNZight's Recomposition facility.

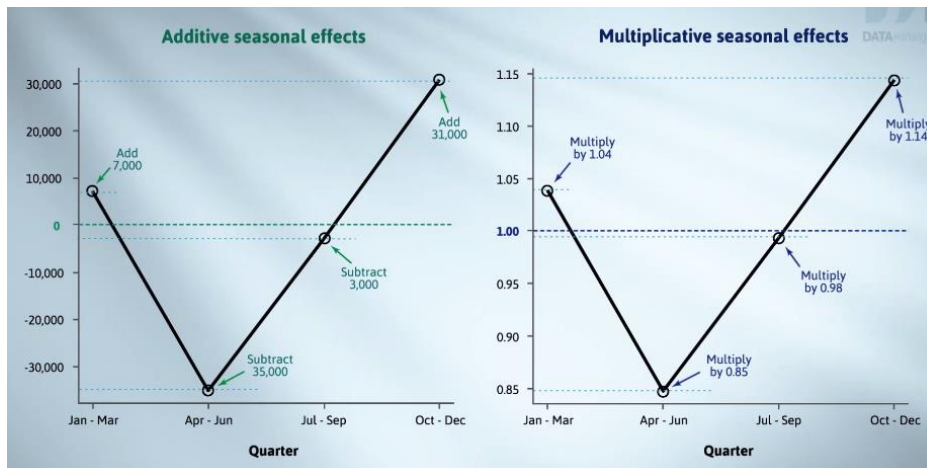


Looking at the top panels, we can contrast what is predicted by trend+seasonal swing and the actual series in both cases.

Here they've been blown up so we can see into them better.

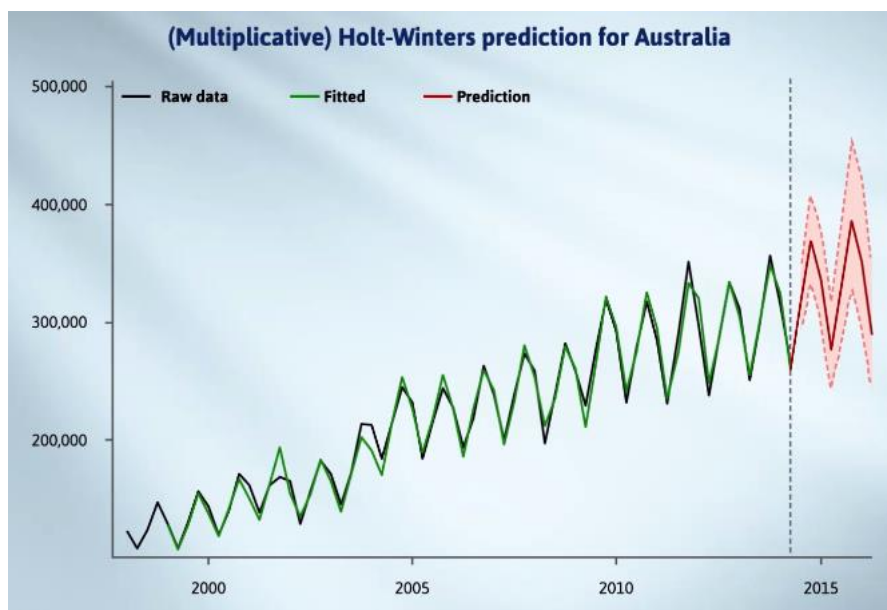
The multiplicative one is clearly doing much better. The additive one is swinging too widely at the left-hand side, and not widely enough on the right-hand side. This is the additive seasonal plot for the Australian series. This is what we're used to looking at, while this is the multiplicative seasonal plot. The left-hand plot hasn't changed.

It's the one on the right that I'd like you to concentrate on. I'll take these two and put them side by side.



The additive model is telling us what we should add on. (We've seen how to interpret these sorts of effects.) The multiplicative model is telling us what we should multiply by. Note the horizontal line at zero on the additive plot. Adding zero makes no change, whereas the horizontal line on the multiplicative plot is at one. In a multiplicative world, one is the no-adjustment value because multiplying by one makes no change.

The multiplicative seasonal effects are telling us that the January to March figures will be about 1.04 times what you'd expect from the trend (or 4% above). The April to June figures are about 0.85 times the trend value (15% below average in some sense). July to September is about 0.98 times (2% below). And October to December is about 1.14 times what you'd expect from the trend (14% above). And we saw this one is working very well here. As we've said, the main reason why people worry about identifying and estimating patterns like the ones we've been seeing, it's because they want to then take them and project them into the future. They want to use them for forecasting what's going to happen next.



Here's the forecast for the next two years for Australia. It is projected forward to the trend and the seasonal swings giving the red lines. It's also put confidence bands (in pink) around the

forecast. The text window gives the numerical values. It's all been done using a statistical technique called the Holt-Winters method.

The details are complicated and involve several levels of smoothing. Holt-Winters is the only forecasting method implemented in iNZight. Holt-Winters is a good general purpose forecasting method when the trend is basically monotone (which means it's either rising or it's falling, but it's not doing both).

Beyond this you'll have to learn more. We'll give you references to other ways of forecasting in an accompanying article. A final point here. Forecasting is a special case of projection in a region where you have no data. We warned you about this back in Week Three. All sorts of things can go wrong.

But in many situations, analysts supporting decision makers just have to do the best they can, knowing there are no guarantees. In the words of famous baseball player, Yogi Berra, "It's tough to make predictions, especially about the future"<sup>1</sup>. In the next video, we'll show you the benefits of comparing related series.

[<sup>1</sup>A variant of this quote is often attributed to Niels Bohr but seems to have even earlier Danish sources.]