David Youngberg
BSAD 210—Montgomery College

LECTURE 34: ADJUSTING FOR SEASONALITY I

I. Setting Goals and Evaluating the Past
  a. Car companies set sales targets for their dealerships. If the dealership makes the target, the company pays them a bonus.
    i. Setting the right target is important. If it's too low, then meeting it would be too easy and you could have had more sales. But if you set the bar too high, no one will get the target and may not be motivated to even try.
    ii. Setting the right target is hard. One reason that makes it tricky is because car sales vary over the course of a year. Lots of people buy cars in July and few people buy in January.
    iii. To set the right target, you have to adjust for popular and unpopular times; 30 cars may be too hard in January but too easy in July.
  b. We will therefore learn how to adjust for these seasonal influences. They play a role not just in predicting car sales. Not only is this a critical skill for predicting future results, adjusting for seasonality is also useful for evaluating.
    i. Your firm just got a new CEO and the sales numbers are up. But are they high after we adjust for seasonality?
    ii. Your company just launched a new advertising campaign and sales are down. But are they down for the season?

II. Component of a Time Series
  a. Forecasting comes with pitfalls. To better understand them, let's consider the different components within a time series.
  b. *Trend Component (T)*—there's a general upward or downward movement over a long period of time. U.S. population and U.S. GDP/capita trends upward, for example.
  c. *Seasonal Component (S)*—The time series data follows a pattern consistent within a year, such the regular boom in sales during the holiday season.
    i. I focused the title of this lecture on seasonality because that's the most common type of adjustment that needs to be made.
  d. *Cyclical Component (C)*—Movements in the time series which follow the business cycle, or the boom and bust of the economy.

e. *Random Component (R)*—Our residual. Sometimes referred to as "noise." It's anything that can't be explained by the other three components.

III. Multiplicative Decomposition

a. These variations are important because if your sample size is too small, you won't get an accurate picture: you might be predicting based on data from the Christmas season, for example.

b. To correct for it, the first thing you need is enough data. An obvious problem is projecting all future sales based on holiday sales. A less obvious problem is projecting future sales based on many years during an economic expanse.

c. For simplicity, we will focus on seasonal correction. We begin by "decomposing" the time series using the multiplicative decomposition model:

$$y_t = T_t \times S_t \times R_t$$

   i. Where y_t is the time series component at period t and
   ii. The abbreviations are as above at period t.
   iii. Since cyclical patterns play out over many years, it is not relevant to our conversation here.

IV. Step 1: Identify the Seasonal Component

a. Now we turn to the *centered moving average*, or an average based on the number of periods in a cycle.

   i. Because there are four periods in a cycle (a year), our average is based on four consecutive periods. If this was monthly data, it would be based on twelve consecutive periods.
   ii. Because our average is based on four consecutive periods, we center the averages on half periods (2.5, 3.5, 4.5, etc). This is because the average of 1, 2, 3, and 4 is 2.5.
   iii. Therefore, we need an additional step to center those averages on a full period. We take the average of two averages.
   iv. Consider the hypothetical sales data below (2011/Q1 to 2013/Q4):

Period	Quarter	Sales (K)	4 Period Moving Average (K)	Centered Moving Average (K)
1	2011/Q1	$60		
2	2011/Q2	$100		
			$92.50	
3	2011/Q3	$80		$93.25
			$94.00	
4	2011/Q4	$130		$95.25
			$96.50	
5	2012/Q1	$66		$98.50
			$100.50	
6	2012/Q2	$110		$102.75
			$105.00	
7	2012/Q3	$96		$104.50
			$104.00	
8	2012/Q4	$148		$105.50
			$107.00	
9	2013/Q1	$62		$107.25
			$107.50	
10	2013/Q2	$122		$109.25
			$111.00	
11	2013/Q3	$98		$111.25
			$111.50	
12	2013/Q4	$162		$111.25
			$111.00	
13	2014/Q1	$64		$110.00
			$109.00	
14	2014/Q2	$120		$112.25
			$115.50	
15	2014/Q3	$90		
16	2014/Q4	$188		

v. Can't we just assign the first average to a period and be done with it? What difference does it make as long as it's consistent? It's because whatever period you assign that average to would be random—why number 2 rather than 3? And since we will use the resulting average directly with the original value, we want to avoid arbitrariness.

b. Because each average includes all four seasons, we've removed the seasonal component. The average also removes the random component (since that fluctuations should cancel out over time). The only thing that's left is the trend. Therefore, the centered moving average (CMA) is the trend component.

c. Using the earlier equation we can find the Ratio-to-Moving-Average (RMA) such that:

$$RMA_t = S_t \times R_t = \frac{y_t}{T_t} = \frac{y_t}{CMA_t}$$

d. Note we can calculate RMA:

Period	Quarter	Sales (K)	Centered Moving Average (K)	Ratio-to-Moving-Average
1	2011/Q1	$60		
2	2011/Q2	$100		
3	2011/Q3	$80	$93.25	0.8579
4	2011/Q4	$130	$95.25	1.3648
5	2012/Q1	$66	$98.50	0.6701
6	2012/Q2	$110	$102.75	1.0706
7	2012/Q3	$96	$104.50	0.9187
8	2012/Q4	$148	$105.50	1.4028
9	2013/Q1	$62	$107.25	0.5781
10	2013/Q2	$122	$109.25	1.1167
11	2013/Q3	$98	$111.25	0.8809
12	2013/Q4	$162	$111.25	1.4562
13	2014/Q1	$64	$110.00	0.5818
14	2014/Q2	$120	$112.25	1.0690
15	2014/Q3	$90		
16	2014/Q4	$188		

i. Note that the RMA also equals the seasonal component times the random component.

e. To isolate the seasonal component, we must eliminate the random component. Last time we took averages; we will do that again. But this time, the averages will be of different seasons. This average will be the seasonal component (S_t).

Quarter	2011	2012	2013	2014	S_t
1		0.6701	0.5781	0.5818	0.610
2		1.0706	1.1167	1.0690	1.085
3	0.8579	0.9187	0.8809		0.886
4	1.3648	1.4028	1.4562		1.408

f. When we add all the seasonable components together, we get 3.989; this is problematic because we should get four (there are four seasons).