**Forecasting Sales at Ska Brewing Company**

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**Abstract**

Ska Brewing Company, located in beautiful Durango, CO, has seen double digit growth for over a decade, but will this growth continue? In this case study, you get to help Ska forecast their total sales and barrels of beer sold in 2013. A quick look at the data reveals that the growth at Ska has been non-linear, so standard forecasting techniques don’t necessarily work. Additionally, Ska experienced two record years after expanding their capacity in 2008 – how will these outliers potentially skew the results?

This case study comes from the craft brewing industry where exceptional growth has been the norm since the 1980’s. Students will do some research into the craft brewing industry at the beginning of the case. The main point of the case is that forecasting is not a “one-size-fits-all” kind of exercise, a trap that some textbooks and professors can fall into. Linear models don’t necessarily work when growth appears to be exponential, at least without some thought put in by the forecaster. Several different forecasting techniques are suggested, and in the end, the students are challenged to put them all together into one final prediction.

Students doing this case should have a working knowledge of MS Excel and some background in basic statistics (or, the instructor should be ready to patiently explain these topics to them). The students will first try standard, linear regression, then use the exponential fitting tool in Excel. Next, the students will look at growth as a percent and (hopefully) see that it has been fairly consistent, barring two record years. Students will then remove the outliers, after identifying them using Tukey’s Method, and make a third prediction for both sales and barrels sold.

This case is designed for undergraduate business students, but might work for MBA students who would require less hands-on help from the instructor. The basic concept is straightforward and requires little class time for explanation, with most of the time on the case spent in a computer lab crunching the numbers. The data for this case are real (and from a brewery!) which tends to encourage student interest.

**Background**

Ska Brewing Company is a purveyor of fine craft beers located in Durango, CO. With their flagship Pinstripe Red Ale and True Blonde Ale, medal-winning Buster Nut Brown Ale and Steel Toe Stout and seasonal Mexican Logger and Euphoria Pale Ale, Ska has enjoyed double digit growth for over a decade with no signs of slowing down. Learn more about Ska by visiting their tasting room at 225 Girard Street, Durango, CO or online[[1]](#footnote-1).

In the early 90’s, founders/owners Dave and Bill were dissatisfied with watered-down corporate beer and decided to take matters into their own hands, literally. They began brewing their own beer in their basement, much to the delight of everyone who knew them. Eventually, it became clear that they might be able to make a living doing what they loved to do and they founded Ska Brewing Company in 1995 with third owner/founder Matt. Through hard work and a laser like focus on brewing great beer, Ska continued to grow and in 2008 the company moved into its $4.8 million, 24,000 square-foot world headquarters. In 2012, Ska brewed over 25,000 barrels of beer (1 barrel = 2 standard kegs = 252 pints = 4032 ounces) with sales exceeding $6.5 million.

Ska was not alone in its success. Durango, a town with less than 20,000 people, has four long-term successful breweries/brewpubs, a brand new brewpub that opened in 2012 and another one in the works. Rather than considering these other breweries as competition, Ska has worked together with them (as well as others across the state of Colorado) to brew specialty beers for festivals and other occasions; Ska also contract brews beer for Steamworks Brewing Company (using their recipes) since Steamworks has exceeded their own brewing capacity. Owner Dave calls this unique relationship “coopitition.” Durango and Ska are just examples, however.

The craft brewing industry has seen phenomenal growth during the last three decades across the United States and in other countries as well. According to the Brewers Association[[2]](#footnote-2), the craft brewing renaissance started in the late 1970’s and saw periods of incredible growth during the 1990’s. Historically, before Prohibition, small breweries were everywhere across the United States; the 18th Amendment caused most of the small breweries to go out of business and only the larger breweries survived until the 21st Amendment repealed Prohibition thirteen years later. It took several decades for smaller breweries to begin the resurgence which we see today.

But our concern is more specific: Will the growth and success at Ska continue? Is Ska able to anticipate how much beer it will produce and what sales will be to plan wisely for the future? In fact, current plans are to increase brewing capacity yet again, a costly investment with potentially high returns. Is this a good decision or not? This is where *you* come in.

**Mission**

Despite their success, Ska is still a relatively small operation. The company has one main numbers person, accountant Erik. In a nutshell, Erik would like to predict Ska sales and barrels for the current year 2013. He has done some of this work on his own, but he would like you to confirm (or refute) his forecasts and do so in much more detail for which Erik is too busy (presumably since he spends his days counting all of Ska’s money).

Even a cursory glance at the information in the table shows that both the number of barrels and sales are increasing annually at a pretty good clip. In fact, both values have shown tenfold growth between the years 2000 and 2012. What will these two numbers look like at the end of 2013? You may have studied forecasting techniques previously and hopefully you learned that when forecasting real data, there is no “one-size-fits-all” approach; ahead you will try several approaches and then combine them together to make a final prediction.

Your task is not only to forecast these two values for 2013, but to give Erik, Dave, Bill and Matt a better picture of what’s happening overall with their business. To do so, you will be asked to produce several graphs, both on annual and monthly bases, to consider growth as a percentage, and to consider the likely errors that go along with your forecasts. ~~You will first be asked to learn a little more about the brewing industry in general, to give you a better idea of the current status of craft brewing. Your final report should be thorough, professional and accurate. Good luck!~~

**~~Questions About Breweries~~**

1. ~~What is a craft brewery? How is it different from a brewpub? Go online and research these definitions. You should fairly easily find a quantitative definition of the number of barrels produced by a craft brewery (or microbrewery). For comparison, find out how many barrels are produced annually by a very large brewery such as Anheuser-Busch, MillerCoors or Heineken. Write up a paragraph or two with your findings and as always, be sure to cite your sources.~~
2. ~~Are there any local breweries in your area? If so, which categories do they fall under? If not, why not? Discuss the feasibility and likely success or failure of a new brewery in your area. Of course, a cool name like Ska may be one of the keys to a new brewery’s success; What will you name your new brewery?~~
3. ~~The claim was made earlier that the “craft brewing industry has seen phenomenal growth during the last three decades.” Go online and find evidence to support this claim. Specifically, how many craft breweries are there now compared to thirty years ago? How has the craft brewing market share grown (out of total beer sales)? How have the major breweries reacted to the growth of craft brewing? Write up a paragraph or two with what you learn.~~

**Questions About Ska’s Annual Data**

1. Onto Ska’s annual data: Use MS Excel to draw *and include* scatter plots of **both** year versus barrels **and** year versus sales. [Hint: Change the year range from 2000 – 2012 to 0 – 12 to simplify the equations of the curves that Excel will eventually fit to the data.] What kind of curve do both scatter plots look like? Consider the barrels data first, then repeat for the sales data:
   1. Have Excel fit a linear trendline to the data and determine the equation of the line and the r2 value. Interpret the slope of the line and the coefficient of determination. Is this a good fit?

Each additional year is expected to increase barrels sold by 1715 barrels, and increase sales by $460,048.

The R^2 is the correlation coefficient squared. 3

* 1. The pattern on the graph should be clearly non-linear. Now instead, have Excel fit an exponential curve to the data and again determine the equation of the curve and the r2 value. Is this a better fit?

**This is a better fit because it better represents the exponential growth experienced after year 9, and doesn’t over predict years 2 – 8.**

* 1. Using the equation for the curve from part b, plug in 13 (or 2013) to get your first forecast. Does it seem reasonable, or does it seem too low or too high?

**BBLS = (13, 21685.3)**

**Sales = (13, 5909202)**

**Both estimates are reasonable if we expect growth to regress, but otherwise they seem too low.**

* 1. The fit from part b and forecast from part c are OK, but not great. As we saw earlier this term, the Excel exponential curve fit uses a short cut that doesn’t always provide the “best” fit. Now, fit the best exponential curve by minimizing the sum of errors squared using Solver. What is this equation? Forecast year 13 (2013) using this equation.



**The equation for BBLS is 1531\*e^0.235\*x**

**The prediction for year 13 is 32276.**

**The equation for Sales is 40000\*e^(0.4\*x) and the prediction for year 13 is $7,250,890.**

* 1. Draw and include the data points with the curve of the equation from part d fitted to them. Does this look like a better fit than on part b?

**For BBLS, this is clearly a better fit. For Sales, it looks equally good or worse than the excel solution.**

\*\*\* Be sure to do parts a – e for both barrels and sales. \*\*\*

1. Reconsider the graphs from question 1. Although the growth does appear to be exponential, your predictions in parts c and d shouldn’t quite look right. Let’s try it another way: Consider the last four points on each graph, from 2009 to 2012. Ignoring the rest of the data, do those four points appear to have an (obvious) pattern?
   1. Using only the last four years’ data, fit a *line* for **both** barrels **and** for sales. Interpret both the slope and r2 value for each line.

**BBLS: y = 4750x - 31191  
R² = 0.9988**

**99.9% of the variation in y is explained by x, and each additional year, barrels increase by 4750.**

**Sales: y = 1E+06x - 7E+06  
R² = 0.9975**

**99.8% of the variation in y is explained by x, and each additional year, sales increase by $1,000,000**

* 1. Plug in a 13 into each line to get your second forecast for barrels and sales in 2013. How confident do you feel with these predictions?

BBLS: 

I feel confident because this continues the upward trend by an appropriate amount.

Sales: 

**I don’t feel particularly confident because this reverses the upward trend in sales by half of a million dollars, and this is not intuitively compatible with an increase in BBLS.**

1. Your predictions in question 2 might seem pretty good, but take it one step further:
   1. For both barrels and sales, determine the Mean Absolute Deviation (MAD) for each of your predictions. What are your forecasts for 2013 including the MAD? What information does the MAD tell you?

Sales Exp



Barrels Exp Fit











**The MAD is the mean absolute deviation and it tells you the sum of each deviation from the mean, scaled by the number of observations. It does not tell you which direction your predictions are missing, or whether one predication is missing by a lot and the others are spot on, rather it tells you the total amount your predictions deviate from the mean.**

**The Mean absolute percentage error shows you the average percent of how much your predictions miss their actual y, but again does not tell you direction. On average, each barrel prediction misses the actual y by 0.78%. On average, each sales prediction misses the actual y by 34%.**

* 1. Repeat part a but now for the MAPE, Mean Absolute Percentage Error. Interpret the MAPE.

**See Above**

* 1. As one final check, repeat what you did in question 2 but this time use the data from 2008 to 2011 in order to predict 2012 and compare your prediction for 2012 to the actual value. Do this for both barrels and sales. Does this forecasting method appear to be promising?





**This process works well for barrels but it underpredicts sales consistently. Thus, potentially combining a different forecasting method for sales with the linear method for barrels will lead to the best prediction. Additionally, barrels could alone be forecasted and then sales could be predicted against barrels.**

1. In parts 1c, 1d and 2b, you forecasted barrels and sales for 2013. Consider one more way to do this before you make your final decision. Determine the percentage growth for both barrels and sales for each year. For example, from 2000 to 2001, barrels increase from 2595 to 3025, or a growth rate of (3025 – 2595)/2595 = 17%. Calculate these rates for years 1 to 12 for both columns of data.
   1. Determine the average and median growth rates for both barrels and sales.

|  |  |
| --- | --- |
| **BBLS Av** | **22%** |
| **BBLS Med** | **17%** |





* 1. Now considering **only** sales, draw a scatter plot of year versus sales growth. Do any of the growth rates look like outliers? [Hint: Recall that Ska moved into their new world headquarters in 2008, increasing their brewing capacity tremendously.]

**2008 to 2009 looks like an outlier, and 2009-2010 could be an outlier, especially if 2008-2009 is not considered in the data.**

* 1. The outliers in part b might be obvious, but they aren’t always so easy to identify. So, use standard Tukey’s Method to find the outliers. For each column of percentage data, determine the first and third quartiles; these are the points where 25% of the data are below and 25% of the data are above, respectively. [Hint: Use Excel’s =quartile() function to find both Q1 and Q3.] Calculate the IQR = Q3 –Q1 and the range of “typical” values [Q1 – 1.5\*IQR, Q3 + 1.5\*IQR]. Any data point within the range is typical, whereas any point outside of the range is atypical, or an outlier. What are the two outliers for each column in this case?

Sales

|  |  |  |
| --- | --- | --- |
| 9 | 53% | Outlier |
| 10 | 38% | Outlier |

Barrels

|  |  |  |
| --- | --- | --- |
| 9 | 47% | Outlier |
| 10 | 37% | Outlier |

* 1. Eliminate the outliers and recalculate the average and median growth rates for both barrels and sales. Multiply these growth rates by the 2012 actual values for barrels and sales and make your third set of forecasts for 2013. How do you feel about these predictions?

** Prediction for 2013 Sales, Med and Mean are both 20%**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Barrels**  **17.43%** | **mean** | **13 mean** | **30254.8018** | **1.174** |
| **16.43%** | **med** | **13 median** | **29997.0948** | **1.164** |

* 1. As a side note, Erik the accountant asked the owners to do a quick, back-of-the-beer-coaster estimate of what growth would be for 2013. Their immediate response was “20%.” Would you say that Dave, Bill and Matt are guessing, or that they know their business very well?

**The owners were spot on, probably because they are intimately familiar with their sales and production, and also a little luck.**

**Questions About Ska’s Monthly Data**

Another concern at Ska is seasonal variation. The brewery is much busier during the summer months than they are during the winter months. Two possible explanations for this phenomenon are that 1) people simply buy more beer during the summer and 2) Ska releases two very popular seasonal beers, Mexican Logger and Euphoria Pale Ale, at the beginning and end of the summer season. To get a better handle on the seasonal variations at Ska, your task is to draw some clear pictures of what’s happening (sometimes called data visualization).

1. Thirteen years provides 156 months’ worth of data. In Excel, develop one column from 1 to 156. In the next column, list the barrels sold for each year in chronological order (so the first 12 data points will be the 196.5 – 238.1 from year 2000, the next 12 will be the 243.2 – 258.9 from year 2001, etc.) [Hint: You can build this using simple cut/copy and paste or there’s likely a better way.] In the third column, list all the monthly sales data.
   1. Graph a scatter plot of **both** month versus barrels **and** month versus sales.



* 1. Look carefully at the last four years of each graph. When does Ska tend to get busier during these four years? Does each graph indicate that summertime is crunch time? Which months in particular appear to be the busiest?





**It appears that there is a seasonal spike towards May, June and July every year of the last four years.**

1. For our next forecasts for 2013, predict each month of 2013 and add them to the scatter plot from question 5. As you did in question 4, use only the last four years from 2009 to 2012 to forecast 2013.
   1. For each month, make a linear forecast using the monthly data from 2009 to 2012. So, for example, to predict barrels for January of 2013 use the data points 706.6, 1017.3, 1272.4 and 1484.9 and make a straightforward linear prediction. Do this for both barrels and sales for each month.





* 1. Now, add these forecasted values onto the scatter plots from question 5. Make the forecasted values a different color from the actual data to make them stand out and label the final graphs accordingly. These two graphs should give the stakeholders at Ska a clear picture of what 2013 might look like, depending on how accurate the forecasts end up being, of course. According to the two graphs (including actual monthly data and forecasted values), when will Ska be busiest in 2013?

**May June and July will be the busiest months for barrels and sales.**

* 1. Continuing to use just the last four years’ data, figure out how to use the =FORECAST.ETS function in Excel to predict each month of 2013. Sum up these values for our final set of forecasts for barrels and sales totals in 2013.



* 1. Like part b above, draw pictures of your forecasts using the “Forecast Sheet” function in Excel (under the Data tab). Draw the picture for just the last four years’ data first. This one should look pretty good and it’s a very easy way to draw the graph that took time in part b. Note: This function may not be available on Apple computers, but it’s still worth seeing. Some students may have to break down and do some work on a PC.

* 1. Now draw the picture using Forecast Sheet for all the monthly data going back to 2000. On this one, the forecasted values should look too low? Why?
  2. And finally, just for the heck of it, figure out how to draw a “Sparkline” of the all the monthly barrels and sales in a single cell. Pretty cool, huh?

**Conclusion**

Congratulations, you have just completed a very thorough analysis of Ska Brewing Company’s production in barrels and sales figures. At this point, it might be worth reconsidering how accurate forecasts will help Ska. According to Erik, “An accurate sales budget is the root of the entire budgeting process.” In addition, Dave says that accurate forecasts would help “tremendously” allowing Ska to “increase efficiencies from a production standpoint” and help “make decisions on if Ska could enter any new markets.”

Now it’s time to tie everything together and make your best forecasts for 2013 for both barrels and sales. Thoughtfully combine all of your previous forecasts to come up with just two numbers. Be bold and use a large font, *you* are an expert now!

|  |  |  |
| --- | --- | --- |
| **Year** | **Forecasted Barrels** | **Forecasted Sales** |
| 2013 |  |  |

1. <http://www.skabrewing.com/> [↑](#footnote-ref-1)
2. <http://www.brewersassociation.org/pages/about-us/history-of-craft-brewing> [↑](#footnote-ref-2)