University of Central Florida
College of Business

Business Analytics Case Study

Red Fin Reels[1]

1   Background

You are the lead Business Analyst for Red Fin Reels, a manufacturer of
fishing reels. You are looking to plan the production of your new line of
fly reels. Your main vendor is Pickerel Pro Place, a store well known for
equipment and supplies for outdoor activities. You have to make some de-
cisions about the method of manufacture of your fly reels and the location
in which these are made.

   You also need to make an assessment of the competitive situation in the
market for fly reels to make sure that you set a competitive price. Further,
you want to know the value of attributes of fly reels, relative to their cost,
so that you choose the most profitable manufacturing strategy.

1.1   Characteristics of fly reels

Fly fishing is a method of catching fish using a light-weight lure, called an
artificial fly. The fly is cast using a fly rod, reel, and a specialized, weighted
line. A fly reel is a fairly simple type of fishing reel. The main components
are a spool with a handle held in a frame with a spindle. The fly reel holds
the fishing line and backing. Its braking system applies drag that puts pres-
sure on the line and helps the user to control and bring in a fish.

   The dimensions of the fly reel determine the kind of fishing for which
the fly reel is best suited. Red Fin Reels sells a model that has a spool one

inch wide and four inches in diameter.

These fly reels are designed to be made of aluminum, with a weight of 6 ounces. Aluminum is traded in a competitive, international market and the price is currently $1.50 per pound. Your analysts expect the market for aluminum to be stable over the next year.

1.2 Manufacturing processes for fly reels

Although these fly reels are specifically designed to be made of aluminum, there exists some variety in terms of the methods of manufacture. Reels can either be cast, in a foundry, or machined, in a machine shop.

In a foundry, the aluminum is heated until the melting point, then the molten aluminum is poured into a mold the shape of the reel. It is then left to cool and the mold is later opened to reveal the reel. This process is similar to the way a candle is made, except aluminum is used in the place of the wax. The melting is done in batches, but the pouring, cooling and opening, as well as polishing the finish takes an average of about five hours of labor to complete. Casting is a reliable method of manufacture but the process results in a metal surface with slight imperfections.

In a machine shop, a reel starts out as a block of aluminum and is placed in a machine called a lathe, which spins the aluminum on an axle. A cutting device is applied to the edge of the material to carve away the corners as the aluminum spins, until the corners are completely carved off and the reel is the shape of a cylinder. The material is then carved smoothly until the diameter is shaven down to the specified dimensions, particular to the design of the reel, with a ridge on the edges of the cylinder to hold the fishing line in place. This procedure resembles the way a baseball bat or the leg of a chair or table would be made, except those are carved from wood. The procedure takes slightly longer to complete than casting: it takes one worker six hours to carve out one fly reel. The additional hour of labor pays off in that the fly reel is well balanced and the surface is smooth and shiny.

Regardless of how the spool is made, the reels can be sealed with a protective coating. This protection is more important for fly reels used in salt water fishing but still preserves the appearance and longevity of the reel in all applications. The cost of the sealing is negligible, relative to the price of the reel; the major expense is that it takes two hours of labor to complete the sealing process for each reel. The cost of this labor depends on the location in which the reels are produced.

1.3 Manufacturers

You have contacts for several manufacturers, some of whom can produce reels either by casting or machining.

1.3.1 The Yiditie Foundry

One manufacturer is a foundry located in Guangzhou, China, operated by a company called Yiditie corporation. As the name suggests, Yiditie operates a foundry with the capability to produce Red Fin's fly reels by casting. Your purchasing manager reported that you can negotiate a piece rate that amounts to a wage rate of the equivalent of USD $7 per hour of labor, according to your recommended manufacturing procedures.

Since the production takes place overseas, the reels must be shipped to the United States, and the reels must be packaged carefully to avoid damage. Thus, the shipping rate is fairly expensive: each box of 12 reels costs USD $65 to ship from Guangzhou, China to your warehouse.

1.3.2 Zhiliang Machining

The Zhiliang Machining and Manufacturing Company is located in Tianjin, which is a major manufacturing hub in China. The method of manufacturing is more advanced than that of the Yiditie foundry. In particular, Zhiliang has the facilities to produce the reels in a machine shop using precision lathes. Your purchasing manager also confirmed that you can negotiate a contract with terms for a piece rate corresponding to the same hourly wage as for the cast reels made by the Yiditie foundry. Similarly, the price of labor and the shipping cost is expected to be the same as that for production in Guangzhou.

1.3.3 Flying Eagle Machining

Your contact for manufacturing in the United States is a machine shop, patriotically called Flying Eagle Machining, located in North Carolina. This machine shop can produce machined fly reels in the same six hours as the machine shop in China, except that the price of labor is much higher, at USD $32 per hour. Your quality control officer claims that the higher wage is worth the expense because Flying Eagle uses more advanced machining methods that ensure a greater degree of precision. Another advantage of choosing this manufacturer located in the United States is that the cost of shipping is lower: delivery is only $5 per box of 12. Despite the high

regard in which your Quality Control Officer places the work of Flying Eagle Machining, whether your customers appreciate the higher quality is an empirical question.

2 Data Description

Although experienced in selling other kinds of fishing reels, Red Fin Reels is a new entrant in the market for fly reels. As such, you have little experience to guide you regarding the prices of fly reels. By engaging an industry consultant to gather relevant and appropriate information, your Marketing Department has been able to collect data concerning 248 different fly-fishing reels, over one-half of which are produced in the United States, with the remainder being produced in Asia—either in China or Korea. Each fly-fishing reel in the data set is a row, while the columns correspond to the variables whose names and definitions are the following:

Variable	Definition
Name	product name (a string)
Brand	brand name (a string)
Weight	weight of reel in ounces (a real number)
Diameter	diameter of reel in inches (a real number)
Width	width of reel in inches (a real number)
Price	price of reel in dollars (a real number)
Sealed	whether the reel is sealed; "Yes" versus "No" (a string)
Country	country of manufacture, (a string)
Machined	whether the reel is machined versus cast; machined="Yes", while cast="No" (a string)

Table 1 lists the frequencies of observations of each brand of fly reel by country of manufacture. Most brands have their manufacturing operations located in one of the three countries. Just over half of the sample of fly reels are made in the USA.

3 Preliminary Analysis

A junior analyst at your firm (whose training is limited to an undergraduate degree) has conducted some analysis of the sample to help you understand the data you have to work with.

	China	Korea	USA	Total
3-TAND	15	0	0	15
Abel	0	0	15	15
Allen	0	18	7	25
Aspen	0	0	8	8
Bauer	0	0	2	2
Cheeky	11	0	0	11
ECHO	0	12	0	12
Galvan	0	0	23	23
Hatch	0	0	8	8
Loop	0	14	0	14
Nautilus	0	0	15	15
Orvis	1	0	1	2
Ross	0	0	28	28
Sage	0	6	0	6
Taylor	0	12	0	12
TFO	0	16	0	16
Tibor	0	0	4	4
Waterworks-Lamson	0	8	24	32
Totals	27	86	135	248

Table 1: Country of Manufacture by Brand of Fly Reel

3.1 Probability Density Function By Country of Manufacture

The first step was to investigate the prices of fly reels made in the USA compared to those made in China and Korea. Figure 1 shows the kernel density estimate of the prices of fly reels made in the USA in blue, those made in China in red, and those made in Korea in green. Most of the fly reels are priced below five hundred dollars; with some skewness to the right. The modes of the distributions are similar between countries of manufacture, however, we observe more variability in the prices of fly reels made in Korea. The distribution of fly reels made in the USA is shifted toward the higher price range, compared to those made in other countries. This indicates mild support for a "Made in America" premium but it could also be the case the price difference is explained by the features of the reels made in the USA.
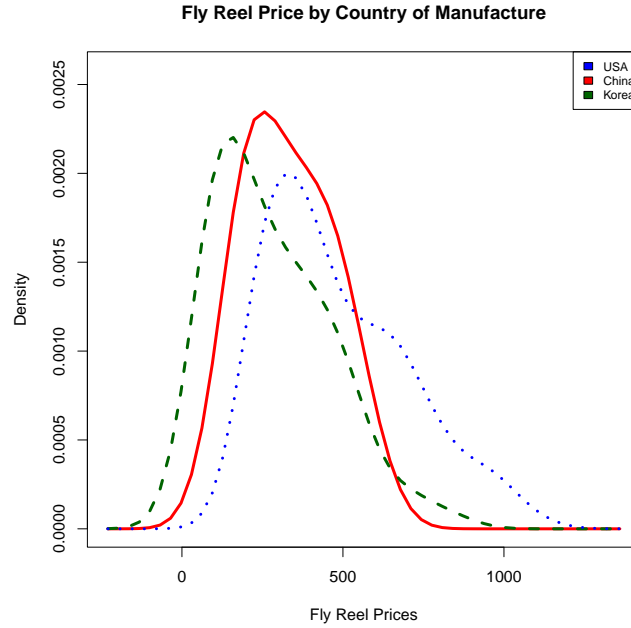
Fly Reel Price by Country of Manufacture

Figure 1: Densities of Fly Reel Prices by Country of Manufacture

3.2 Numerical Analysis of Fly Reel Characteristics

To investigate the relationship between the characteristics and prices of fly reels, the junior analyst calculated the correlation between fly reel prices and the numerical variables in the dataset. Table 2 shows the correlation between the logarithm of fly-reel prices and the numeric variables weight, diameter, and width.[2] All three variables are positively correlated with prices.

	Price	Weight	Diameter	Width
Price	1.000	0.546	0.498	0.254
Weight	0.546	1.000	0.833	0.687
Diameter	0.498	0.833	1.000	0.643
Width	0.254	0.687	0.643	1.000

Table 2: Correlation Matrix of Prices and Numeric Variables

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[2]The junior analyst claimed that the prices were better analyzed by taking the log transformation of fly-reel prices.

3.3 Visual Analysis of Fly Reel Pricing

Not wanting to be outdone, a Data Analyst at your firm produced a color-coded matrix of scatterplots of the data. In Figure 2, the Data Analyst depicted a matrix of scatterplots of the variables in the dataset with the points colored differently by country of manufacture. This confirms the numbers from the correlation matrix but also highlights the fact that the relationships between fly-reel characteristics and prices might differ by country of manufacture.
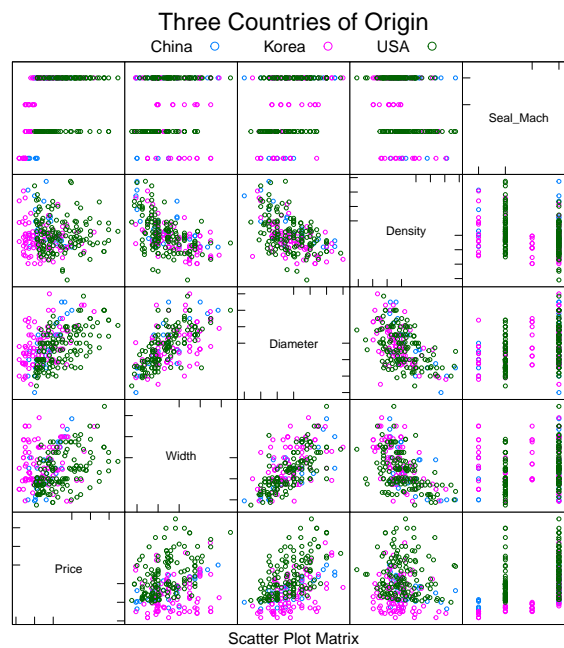

Figure 2: Scatterplots by Country of Manufacture

The Data Analyst then considered the average prices by brand of fly reel, as well as country of manufacture. Figure 3 depicts a dot chart showing the average prices in the horizontal axis in these combinations of categories.

There exists more variety, in terms of both the number of brands and price levels within the population of American fly reel manufacturers. It is especially important to consider the proliferation of fly reel brands at the high price points. This confirms the findings of the Junior Analyst that it is worth investigating further whether those fly reels benefit from the
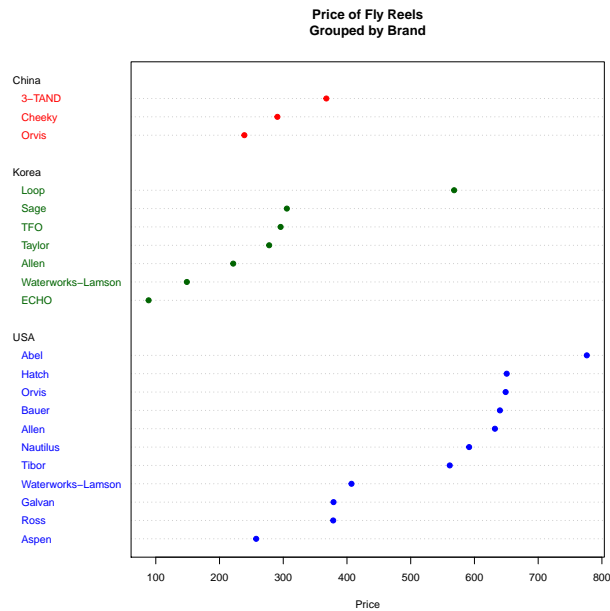
Figure 3: Average Prices by Brand and Country of Manufacture

"Made in America" premium or are simply made with more valuable—
and, perhaps, more expensive—characteristics.

4   Plan of Analysis

By this point, your analysts have exhausted all their technical know-how
to get you this much information. It is time to call in a Business Analyst to
conduct more advanced statistical analysis.

   To get started, your Project Manager has collected all the required infor-
mation in a code repository called GitHub. The material is stored under the
user name `LeeMorinUCF` in a repository `Red_Fin_Reels_Case_Study`.[3]
Your data engineer has also uploaded the data in the file `FlyReels.csv`,
which is available in the `Data` folder on the repository.

   To guide the analysis, a statistician on your team has collected a series
of R scripts and stored them in the code repository within a folder called

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[3]The code and data are available in the code repository at the following url:
`https://github.com/LeeMorinUCF/Red_Fin_Reels`.

`Code`. The statistician is traveling to a conference but was able to run the scripts, each designed to estimate a statistical model for the price of fly reels as a function of the characteristics of the fly reels. The models also specify the various inputs to the manufacturing process, to determine the value to be gained (or lost) from various manufacturing options.

The four models that the Statistician estimated are as follows.

- A linear regression model using the entire sample of fly-reel prices. These estimates were produced with the script `1_Full_Sample.R` in the `Code` folder.

- A regression analysis conducted on each of two samples: one based on the prices of American-made fly reels and the other from the reels produced overseas. The statistician then combined the conclusions within a single model with interaction terms to specify differences by country of manufacture. These estimates can be produced by running the scripts `2_Separate_Models.R` and `3_Interactions.R` in the same folder.

- Another regression model with further feature engineering to produce predictions based on the density of fly reels, which is another way of characterizing the weight of the fly reels. These estimates can be obtained by running the script `4_Density.R`.

- Perhaps to show off some advanced statistical modeling prowess, the Statistician also conducted an analysis of the potential effect of sample selection on the predicted prices. The code for the estimation using a Tobit model of Type V is available in `5_Sample_Selection.R`.

The statistician used these four models to make a set of predictions of fly reel prices for all the combinations of choices of inputs to the manufacturing process. The predictions are shown in Table 3.

Your task is to make a recommendation for the manufacturing process for the fly reels. Should the reels be produced by casting, or by machining? Should they be produced overseas or on American soil? It is now time to find out whether your Business Analytics skill set can produce a quality of analysis that justifies such a high salary.

Machined	Sealed	Made in USA	Full Sample	Interactions	Density	Tobit
No	No	FALSE	94.27	87.45	90.70	40.38
Yes	No	FALSE	202.11	167.38	173.63	86.51
No	Yes	FALSE	142.92	163.84	169.84	100.06
Yes	Yes	FALSE	306.41	313.61	325.13	214.39
No	No	TRUE	158.20	186.14	191.31	354.87
Yes	No	TRUE	339.18	356.29	366.23	354.87
No	Yes	TRUE	239.84	256.64	266.67	471.86
Yes	Yes	TRUE	514.21	491.23	510.49	471.86

Table 3: Price Estimates by Manufacturing Option