

# **MAXIMIZING AIRLINE PROFITABILITY**

**IEMS 310**

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## **Background & Objective:**

Westjet Airlines is Canada's leading low-cost airlines, operating Boeing 737 flights that fly to most major cities in Canada and serves destinations in the United States, Mexico and the Caribbean. The goal of this project is to maximize the profitability Westjet's New York-Vancouver sector by maximizing the revenue from the sector and minimizing the overall fixed costs in an uncertain environment.

Gross Profit is given by the following formula:

$$\textit{Profit} = \textit{Revenue} - \textit{Operating Costs} - \textit{Fixed Costs}$$

In the airline industry, revenue is uncertain and depends on market demand. Operating costs are fairly constant per seat.mile for a particular operation. Fixed costs depend on the type of aircraft and constitute a large proportion of the costs.

An important question facing any airline operation is how to maximize its profits over a long term given an uncertain demand. The project seeks to achieve this goal for Westjet's New York-Vancouver operation by:

1. Revenue Maximization by deciding the number of expensive and cheap seats to sell in a setting where consumer demand is uncertain.
2. Aircraft Purchase/Lease decision-making to use option values to minimize the long term fixed costs.

## 1. REVENUE MAXIMIZATION:

This is a yield management problem to determine Westjet's optimal discount seat allocation in their Boeing 737-800 flight from New York to Vancouver, in order to maximize the revenue generated from the flight. The airplane has a capacity of 166 seats, and there is only one class which is the Economy class. We created a model simulating the relationship between revenue, demand and behaviors of two different types of customers: business and leisure. Data used in the problem is gathered from Westjet Airlines website.

There are two types of fares for each flight: discount (\$161) and full fare (\$316). The decision of the number of discount seats involves a tradeoff between business travelers, who are willing to buy the tickets at either discount or full price, and leisure travelers, who would only buy the discount fare. From a historical data, it is estimated that 60% of customers demanding a seat will be business travelers, and the rest comes from the leisure travelers group.

### Assumptions:

- Cost for the flight is fixed.
- Discount fare and full fare tickets are kept fixed throughout the model.
- The total demand for this flight is normally distributed with a 68% chance that the demand is between 150 and 210. Thus, the expected total demand is 180 seats.
- Starting seven days prior to the departure, only full fare tickets will be available. If discount fare tickets are still available a week prior to the flight's departure, we will decide to end the sale of these discount fares because business travelers comprise the majority of the demand at this time and will purchase the full fare ticket if necessary.
- 25% of business travelers would purchase full fare tickets.
- The airline cannot raise the allocation of discount fare seats once all discount fare seats have been sold.

### The model:

1. Input variables
  - Total Demand, DT:  $N(180,30)$
  - Number of business travelers, DB:  $N(108,18)$
  - Capacity, C: 166
  - Percentage of discount seats taken by business travelers,  $p = 25\%$
2. Basic relationship underlying the model

- Revenue

$$= \$316 * \# \text{ of Full fare tickets} + \$161 * \# \text{ of Discount tickets}$$

- # of discount seats allocated

$$= \# \text{ of business travelers taking discount seats} + \# \text{ of leisure travelers taking discount seats} = S = p * S + (1-p) * S$$

- # of business travelers taking discount seats

$$= \% \text{ of discount seats taken by business travelers} * \# \text{ of discount seats allocated} = p * S$$

- # of full fare tickets

$$= \# \text{ of business travelers taking full fare tickets} = \# \text{ of business travelers} - \# \text{ of business travelers taking discount seats} = DB - p * S$$

- Revenue

$$= 316 * \# \text{ of business travelers taking full fare tickets} + 161 * (\# \text{ of business travelers taking discount seats} + \# \text{ of leisure travelers taking discount seats}) = 316 * (DB - p * S + 161 * [p * S + (1-p) * S])$$

### 3. Inputs in @Risk

- # of leisure travelers taking discount seats

$$= \max[\min(\text{total demand} - \# \text{ of business travelers}, \# \text{ of leisure travelers taking discount seats}), 0]$$

$$= \max[\min(DT - DB, (1-p) * S), 0] = \max[\min(DT - DB, 0.75 * S), 0]$$

- # of business travelers taking discount seats

$$= \max[\min(\# \text{ of business travelers taking discount seats}, \# \text{ of business travelers}), 0]$$

$$= \max[\min(p \cdot DB, DB), 0] = \max[\min(0.25 \cdot DB, DB), 0]$$

- # of business travelers taking full fare tickets

$$= \max[\min(\text{capacity of the airplane} - \text{\# of business travelers taking discount seats} - \text{\# of leisure travelers taking discount seats}, \text{\# of business travelers} - \text{\# of business travelers taking discount seats}), 0]$$

$$= \max\{\min(C - \max[\min(DT - DB, (1-p) \cdot S), 0] - \max[\min(p \cdot DB, DB), 0], DB - p \cdot S), 0\}$$

$$= \max\{\min(166 - \max[\min(DT - DB, 0.75 \cdot S), 0] - \max[\min(0.25 \cdot DB, DB), 0], DB - 0.25 \cdot S), 0\}$$

#### 4. Results from @Risk

After running 1000 iterations on @Risk, we found the revenues generated under each case of number of discount seats allocated. We examined the data and determined the optimal number of discount seats is 71, which will yield revenue of \$38,032.85.

#### Findings:

Our analysis revealed that the optimal number of discount fare tickets in terms of revenue to be 71 seats for this flight of Westjet Airlines. We hope this model would be useful in their future ticket sales decision making process. We would like to stress the fact that this is merely a test pilot model, and will need more data points to validate the model's success.

## 2.0 AIRCRAFT PURCHASE/LEASE DECISION-MAKING

Based on the results of the revenue analysis, the goal of this part is to evaluate whether Westjet should buy or lease a Boeing 737 for their New York-Vancouver flights. The goal is to determine under what range of leasing prices is leasing is preferred over buying.

#### Assumptions:

- We are using the revenue-optimization model and output data- mean, s.d. And the assumptions regarding the number of seats
- life span for an aircraft is 20 years
- Interest rate set at 13%
- The cost of per seat is constant for both coach and business class, \$4 each
- The plane will fly two round trips during a day, with a mean revenue a year of  $(38032-4*71)*2*365=27763076$
- The demand function is determined by airline's own price, competitor's price and average income level. Normal distribution for the demand with only own price influence, negative log-normal distribution for the decreasing effect of competitors' price on the demand, binomial distribution for the change of income level
- cost for buying is 80 million by realistic research
- The company can always stop the lease in the end of the first year if the gain from leasing  $< 0$  , however, it might still be the case where the gain from leasing is less than the expected gain from leasing. Leasing is always more expensive than buying per unit time but the option values are created by the fact that at the end of the first year, if profits are low, the airline can end the lease and SHUT DOWN the operation. It is the value created by availability of information.

#### The model:

##### 1. Input variables

- Mean, standard deviation of the revenue function considering only the influence from own price
- Revenue distribution
- The Minimum of the revenue function which indicate the possible range for the leasing price since if the leasing price is lower than the minimum of the revenue, no buy/ lease consideration is needed.
- Compute the distribution under integer numbers(in the value of million) by round down or round up the revenue in thousand

##### 2. Basic relationship underlying the model

- Probability of achieving specific level of Revenue (per flight)  
 $=2*\text{normdist}(A8,38.032,4.191,\text{TRUE})-$   
 $0.5*\text{lognormdist}(A8,38.032,4.191)+0.005*\text{binomdist}(A8,50,0.5,\text{TRUE})$
- If the revenue from the fist year is greater than the leasing cost, the airline will continue to operate. Otherwise, the airline will stop the lease and with no loss in the following years.

##### 3. Results from computation

###### Buying (value in million)

$$\text{Expected profit} = 20*(-0.988303+27.63076)=532.8486$$

where 0.988303 is the present value of first year's payment for buying. Derived in the following way

$$\text{Cost} = pv + pv \cdot (1 + \text{Interest rate}) + pv \cdot (1 + \text{Interest rate})^2 + \dots + pv \cdot (1 + \text{Interest rate})^{19}$$

$$= pv \cdot [(1 + \text{Interest rate})^{(19+1)} - 1] \cdot 1 / (\text{Interest rate} + 1 - 1) = 80$$

pv is the only unknown, which gives us the only solution  $pv = 0.988303$

27.63076 is the mean of the profit (expected, derived from the seating problem with the assumption of cost per seat)

### Leasing

Expected profit = sigma of

probability of achieving certain revenue \* (revenue - leasing price), if revenue < leasing price

probability of achieving certain revenue \* (revenue - leasing price) \* 20, if revenue > leasing price

Expected profit from leasing > 532.8486 to make leasing preferred

Thus leasing price should be less than 23 million to make leasing preferred

### Conclusion:

Revenue function is bell shaped and is skewed to the right.

Whether or not having the lower leasing price, the revenue will remain the same which may result from the uncertain demand, then at the end of the lease, the airline can take the loss for one year, but it might be the case that for all future years, the profitability of the airline is higher than buying. Only when leasing price is less than 23 million. Leasing is preferred.

### References:

All information was collected from the following websites:

Aircraft Specifications - Wikipedia's Boeing 737 website: [http://en.wikipedia.org/wiki/Boeing\\_737](http://en.wikipedia.org/wiki/Boeing_737)

Airline Specifications - Westjet's Website: <http://www.westjet.com/>

Other general information: Seat Guru's website: <http://www.seatguru.com/>