ISOM 2700: Operations Management
Session 7.4. Revenue Management Review

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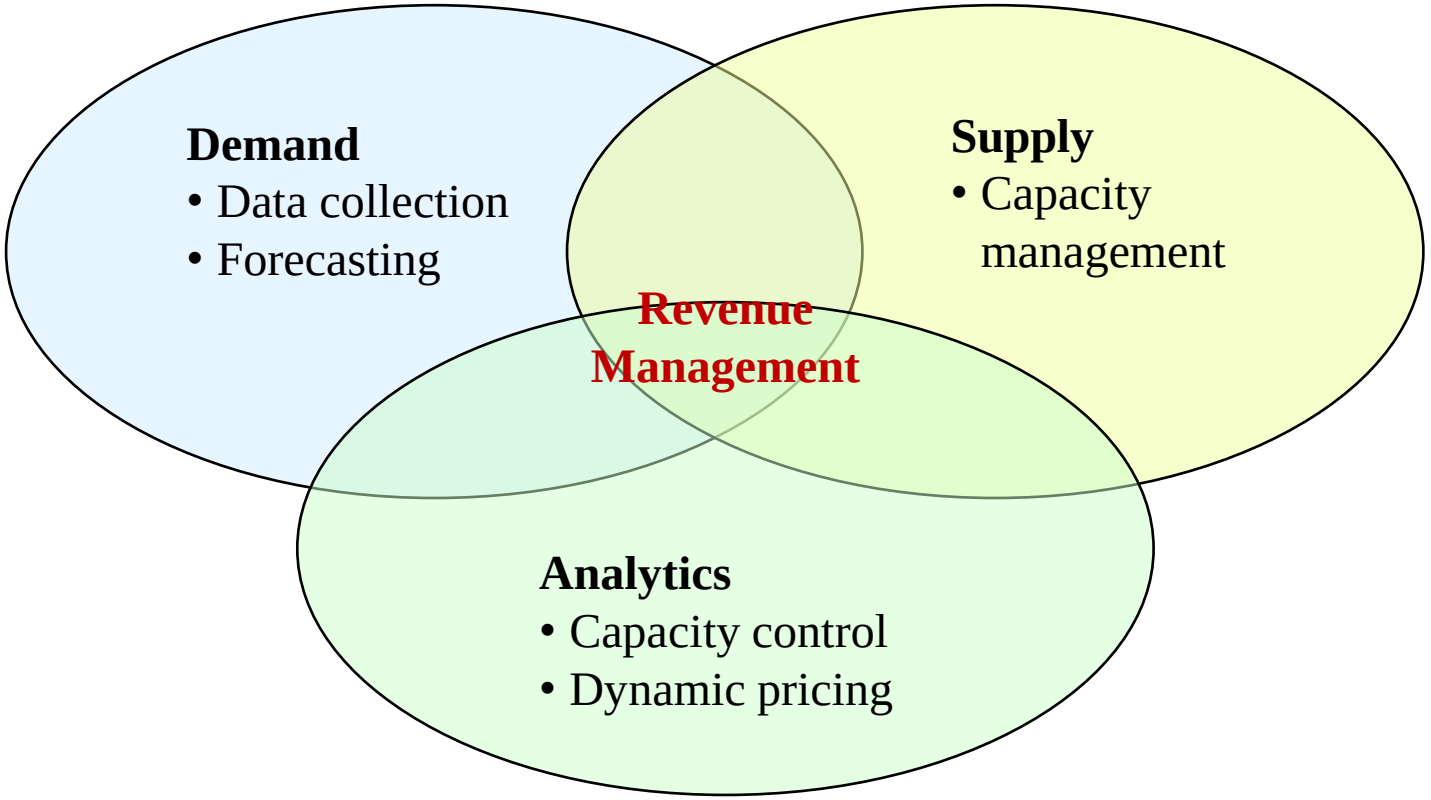
Revenue Management in a Bird's-Eye View

Sell the Right product to the Right customer at the Right price and the Right time



⇒ improve the net revenue while matching supply and demand

⇒ by changing the price or capacity allocation to different customer segmentation

Principles of Demand Forecasting

- Forecasting is only forecasting
  - **Not perfect**
- The longer the forecast horizon, the worse the forecast
- Aggregate forecasts are more accurate
- Good forecasts do not always require the use of complex forecasting models
  - "Simplicity is the ultimate sophistication"
    Leonardo da Vinci

Forecasting framework

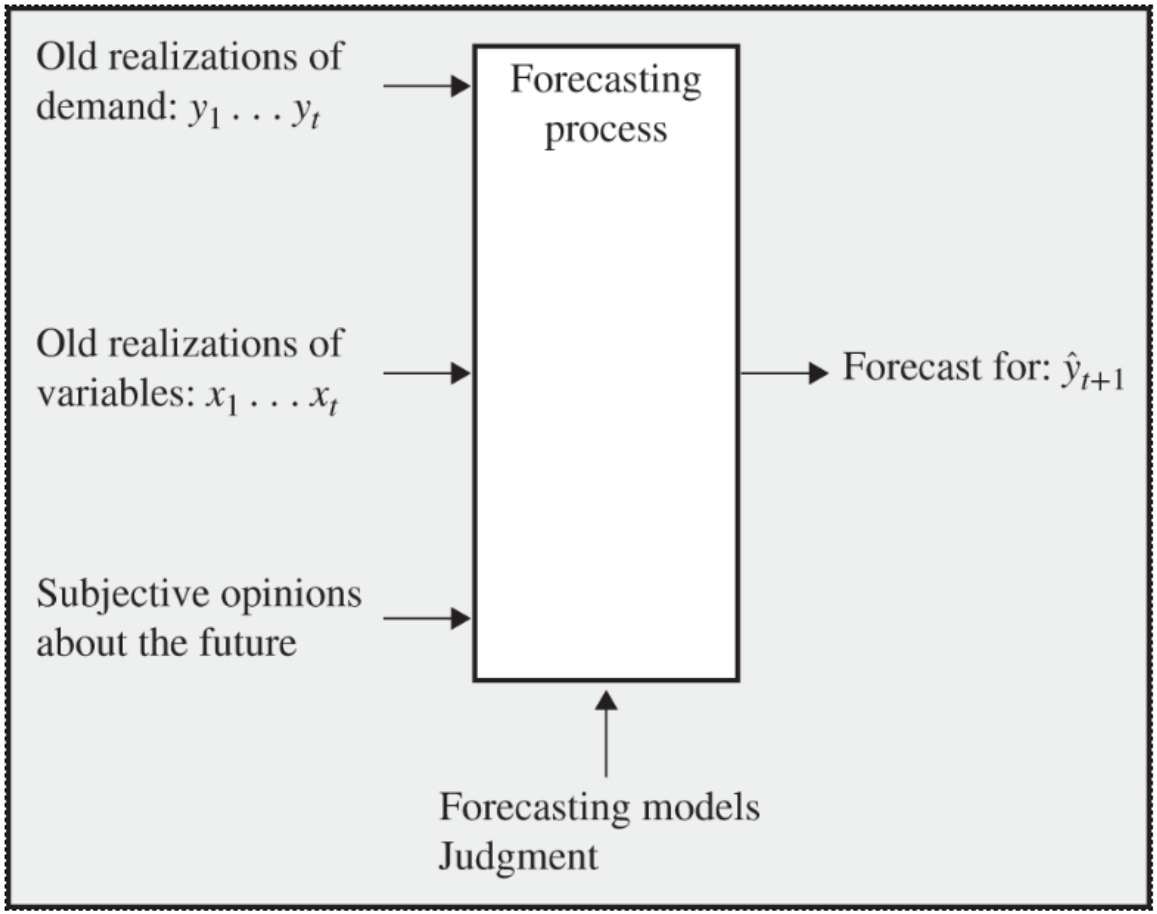


FIGURE 13.2 Forecasting Framework

Forecasting Methods

- Qualitative Forecasting Methods
  - Market research
  - Historical analogy
  - Panel consensus
  - Delphi method
- Quantitative techniques for forecasting
  - Simple and weighted moving averages
  - Exponential smoothing
  - Linear regression
- Measuring forecast accuracy

Simple Moving Average

Week	Demand
1	650
2	678
3	720
4	785
5	859
6	920
7	850
8	758
9	892
10	920
11	789
12	844

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + \ldots + A_{t-n}}{n}$$

Question: What are the 3-week and 6-week moving average forecasts for demand week 13?

Weighted Moving Average

- A weighted moving average allows any weights to be placed on each element.
- Model:

$$F_t = w_1 A_{t-1} + w_2 A_{t-2} + \ldots + w_n A_{t-n}$$

$$\sum_{i=1}^{n} w_i = 1$$

- Choosing weights:
  - Most recent data with higher weighting
  - If the data are seasonal, weights should reflect this appropriately
  - Experience and trial and error

Exponential Smoothing

- Model: $F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$

Where :

F_t = Demand Forcast for the coming time period

F_{t-1} = Demand forecast in the past time period

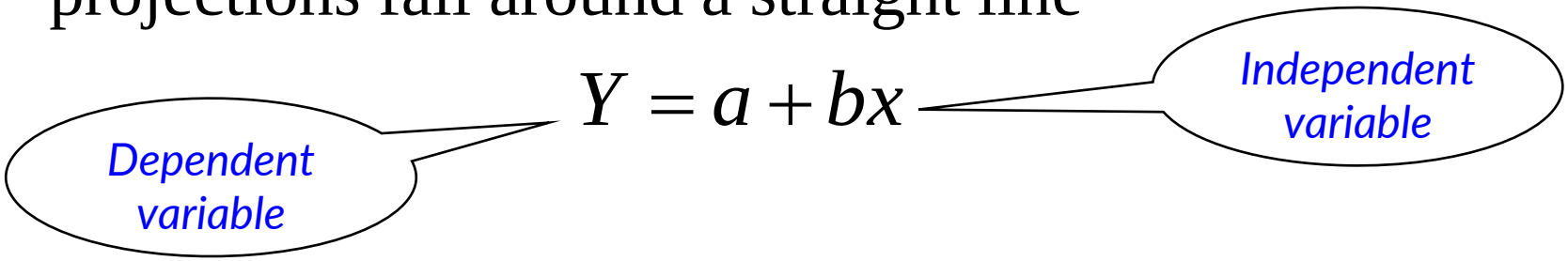
A_{t-1} = Actual demand in the past time period

α = Alpha smoothing constant

- Data
  - The most recent forecast
  - The most recent demand
  - A smoothing constant α

Simple Linear Regression

- Regression
  - identifies the relationship as a function between two or more correlated variables.
- Linear Regression: assumes that past data and future projections fall around a straight line



  - Causal relationship forecasting
  - Time series forecasting

Question

Historical demand for a product is:

	DEMAND
January	12
February	11
March	15
April	12
May	16
June	15

(1) Using a weighted moving average with weights of 0.60, 0.30, and 0.10, find the July forecast.

(2) Using a simple three-month moving average, find the July forecast.

(3) Using single exponential smoothing with a = 0.2 and a June forecast = 13, find the July forecast. Make whatever assumptions you wish.

(4) Using simple linear regression analysis, calculate the regression equation for the preceding demand data.

Measuring Forecast Accuracy

- Forecast error is the difference between the actual value and the predicted value
  - **Error = Actual – Forecast**

Measures the average magnitude of forecast errors

- Mean absolute deviation (MAD)
  - **MAD = $\sum_{i=1}^{n}$ |Actual – Forecast| / n**

Measures the bias of the forecast

- **Tracking signal**: ratio of cumulative error and MAD
  - **TS = $\sum_{i=1}^{n}(Actual - Forecast) / MAD^{n}$**

Revenue management with capacity control

- Single product: overbooking and two-fare alcass
  - Limited capacity; uncertain demand; customer segmentation
  - Multiple classes/fares: use newsvendor model to decide optimal protection level/overbooking level
- Multiple products: network capacity control
  - One product can consume multiple resources
  - Bid-price control: decide whether to accept or reject a request for some product
  - Determine bid-price of a resource: its shadow price from solving the LP problem

Question

Tom owns a small firm that manufactures “Tom Sunglasses.” He has the opportunity to sell a particular seasonal model to Land’s End. Tom offers Land’s End two purchasing options:

• Option 1. Tom offers a price of $55 for each unit, but returns are no longer accepted. In this case, Land’s End throws out unsold units at the end of the season.

• Option 2. Tom offers to set his price at $65 and agrees to credit Land’s End $53 for each unit Land’s End returns to Tom at the end of the season.

This season’s demand for this model will be normally distributed with mean of 200 and standard deviation of 125. Land’s End will sell those sunglasses for $110 each.

- How much would Land’s End buy if they choose option 1?
- How much would Land’s End buy if they choose option 2? What is the probability that Land’s End will return sunglasses to Tom at the end of the season?

Question

- Doubletree in Austin has 150 standard rooms. Doubletree generally sells those rooms through two channels, one through their own website, call center and front desk usually at a high rate and the other through agencies like Priceline at a low rate. Suppose Doubletree charges a high rate at $120 per room per night through their own channel (they never mark down the price through their own explicit channel to avoid any bad gambling image which hurts reputation) while "implicitly" sells some rooms to the agencies at a low rate of $50 per room per night. Bargain customers who seek low rate usually will buy far in advance of the premium customers through the agency channel.
  - To make it simple, suppose the customers always stay for one night, there is ample demand from the bargain customers for the low rate, and the number of premium customers is however uncertain, which is distributed according to the following table:

Number of high fare customers	Probability
90	0.10
100	0.15
110	0.15
120	0.20
130	0.25
140	0.15

Question

- (1) How many rooms shall Doubletree sell to the agencies like Priceline in advance?
- (2) What is expected total revenue of Doubletree from both channels (using your solution from part (1))?

Revenue Management with price control

- Demand function is known $\Rightarrow p^*$ by setting FOC=0
  - Linear demand function
  - Discrete demand distribution table

- Demand function is unknown
  - Leaning while doing
  - Explore-exploit tradeoff
  - How to improve the myopic pricing scheme so that it does not stick at some sub-optimal price?

Question

Consider a book retailer who sells a textbook. The seller would like to set different price for regular and student editions of the book, where student editions are available only for students. The average demand for regular edition is d^{reg} (p)=2a-bp, and the average demand for student edition is

d^{stu} (p)=a-2bp. In this case, calculate Y+Z, where

(optimal price for the regular edition) = Y x (optimal price for the student edition)

(optimal revenue for the regular edition) = Z x (optimal revenue for the student edition).

a. Less than or equal to 1

b. More than 1 and less than or equal to 2

c. More than 2 and less than or equal to 4

d. More than 4 and less than or equal to 9

e. More than 9

Question

Prior to your arrival, pricing at FashioNow was based on a survey which elicited responses from its wealthy, loyal customers. The manager at FashioNow mapped the customers' survey responses (to generic questions) to their willingness-to-pay. The results from the latest such survey is given below (Note: w(p) is the willing-to-pay distribution):

WTP ($)	Frequency
500	40
400	60
300	70
200	55
100	20

Your first task as an intern is to come up with the optimal selling price for FashioNow.