DSC5211C QUANTITATIVE RISK MANAGEMENT

SESSION 11 - Workshop

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Catastrophic Risk Management

Capacity Management under Uncertainty

Objectives

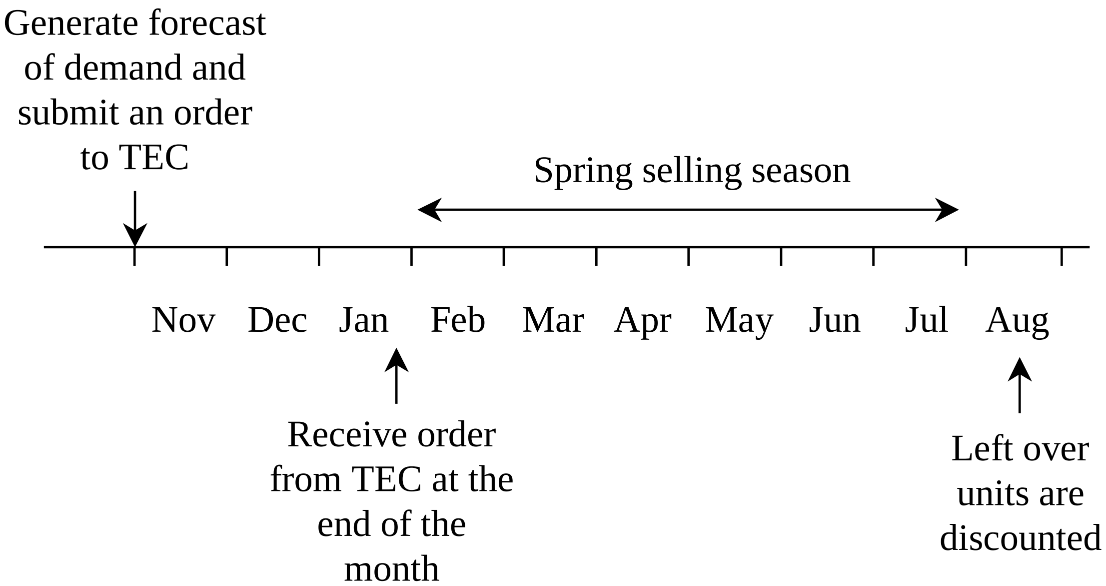
- Comparison of risk-neutral, CV@R, V@R, and Worst-case risk measures.

- Analysis the Capacity Management Problem Under Risk-Aversion.

- Explore some more features of GAMS.

The Capacity Management Model

- O'Neill's Hammer 3/2 wetsuit.



Capacity Management Implementation Steps

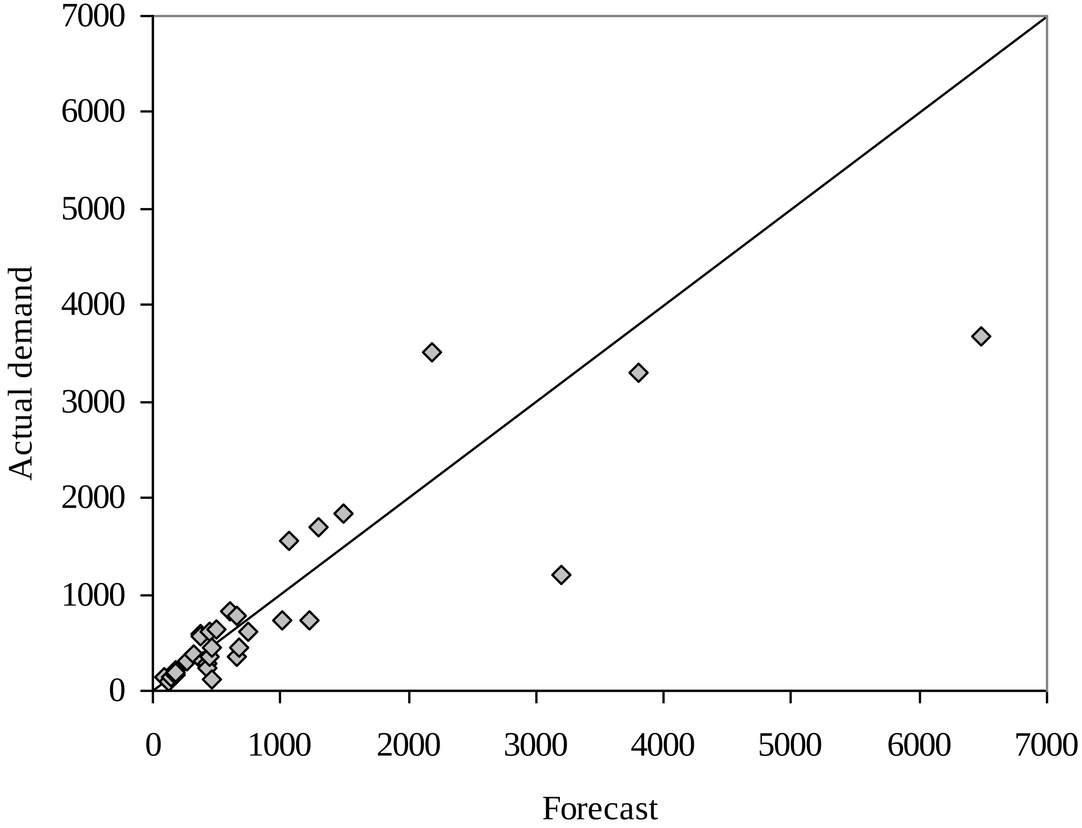
- Generate a demand model:
  - Determine a distribution function that accurately reflects the possible demand outcomes, such as a normal distribution function.

- Gather economic inputs:
  - Selling price, production/procurement cost, salvage value of inventory.

- Choose an objective:
  - e.g. maximize expected profit or satisfy an in-stock probability.

- Choose a quantity to order.

Historical forecast performance at O’Neill



O’Neill’s Hammer 3/2 normal distribution forecast

- To represent demand for the Hammer 3/2 during the Spring season O’Neill can choose a normal distribution with:
  - mean 3192
  - standard deviation 1181.

- O’Neill sells each suit for p = $190.

- O’Neill purchases each suit from its supplier for c = $110 per suit.

- Discounted suits sell for v = $90
  - This is also called the *salvage value*.

Performance Measures

- For any order quantity we would like to evaluate the following performance measures:
  - *In-stock probability*
    - Probability all demand is satisfied
  - *Stockout probability*
    - Probability some demand is lost
  - *Expected lost sales*
    - The expected number of units by which demand will exceed the order quantity
  - *Expected sales*
    - The expected number of units sold.
  - *Expected left over inventory*
    - The expected number of units left over after demand (but before salvaging)
  - *Expected profit*

Maximize Expected Profit

Profit = (*Price* - *Cost*).*Sales* – (*Cost* – *Salvage Value*) . *Leftover inventory*

- If they order 3000 Hammer 3/2s, then …
- *Expected sales* = 2620
- *Expected Left Over Inventory* =

=*Q* - *Expected Sales*

= 3000 – 2620 = 380

$$\begin{aligned} \text{Expected Profit} &= \left[(\text{Price - Cost}) \times \text{Expected Sales}\right] \\ &\quad - \left[(\text{Cost - Salvage value}) \times \text{Expected left over inventory}\right] \\ &= \$80 \times 2620 - \$20 \times 380 \\ &= \$202{,}000 \end{aligned}$$

TASK 1 – Risk-Neutral

- Using the file "hammer_neutral.gms" compute the number of wetsuits to order to maximize the expected profit.

  How does the solution change if you use 200, 1000, 10000 scenarios?

- Compute:
  - the expected sales,
  - the expected lost sales,
  - the stockout probability,
  - the expected leftover inventory.
  -

- A description on how to view the output of GAMS in excel:
  https://www.gams.com/latest/docs/UG_DataExchange_Excel.html

TASK 2 – CV@R

- Save the file with the name "hammer_CVaR.gms". Change the file to compute the CV@R. Insert the following code in the file:

```
tails(s)..        z(s)=g= var-profit(s);
cvar_eq..         cvar =e= var-1/((1-beta)*card(s))*sum(s,z(s));
Solve hammer using lp maximizing cvar;
```

Note: these equations work with PROFIT functions.

- Solve the problem in TASK 1 for MAXIMIZING CV@R, with Beta 0.9, 0.99, 0.999.

TASK 3 – General Model

- Continue working on the “hammer_CVaR.gms” file.

- Solve the ***CV@R maximization*** problem with beta:
    - 0.0, 0.25, 0.5, 0.75, 0.95, 0.99999.

What is the relationship between the CV@R, the expected Profit, and the Worst-case profit?

Summary

- We have solved the capacity management problem using risk.
- We have compared how risk measures affect the performance measure of management.
- We have looked at using the PUT feature for outputting the GAMS results into files.