Primer on Inventory Management

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Excercises

Service Levels

Exercise 1: Imputed penalty cost

In situations where the unit penalty cost is difficult to estimate, we can use service level models. An information that is often times of interest to practitioners is the imputed penalty cost. The imputed penalty cost is the unit penalty cost of a cost model that would lead to the same solution as the solution of the service level model.

  i. Consider a manufacturer who orders raw material from a supplier. Inventory holding cost are 1 EUR per unit per day. Demand is Normally distributed with $\mu = 100$ and $\sigma = 30$. The lead time is 34 days and inventory is reviewed every day. The manufacturer uses a beta service level of 99%. What is the optimal order-up-to level S*?

  ii. If the manufacturer would use a cost model, for which value of the unit backorder penalty cost would the manufacturer obtain the same optimal order-up-to level?

 iii. Under the optimal solution, what is the average backorder level?

Exercise 2 (advanced): Exact expression for the β-service-Level

In the video, I show how an approximate expression for the beta service level can be computed. It is an approximation, because we might double count some backordered demands that have already been backordered at the beginning of an order cycle. Essentially, we computed β as

$$\beta = 1 - \frac{E\,[\text{Backorders at the end of a cylce}]}{E\,[\text{Demand in one cylce}]} \tag{44}$$

An exact expression can be derived, if we compute β as

$$\beta = 1 - \frac{E\,[\text{Backorders at the end of a cylce}] - E\,[\text{Backorders at the beginning of a cylce}]}{E\,[\text{Demand in one cylce}]} \tag{45}$$

We define a cycle as the time interval between two consecutive epochs at which a replenishment order is received. We assume a lead time of LT periods and say the inventory is reviewed every R periods.

Derive an exact expression for β based on equation (45).