The Mismatch Cost and Decision Lead Time

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The Mismatch Cost

- The mismatch cost is incurred because we have to decide our order quantity before knowing demand
- It can be estimated by comparing the expected profit given placing the order after receiving perfect information about demand with the expected profit given demand volatility exposure

Expected profit when the order is placed after observing demand

- Expected demand $= e^{\frac{\sigma^2}{2}}$ times median demand
- For price p and cost c our expected profit is $(p - c)$ times expected demand

Review: expected profit under demand volatility exposure (lognormal demand)

1. Estimate the demand volatility σ (4 ways)
2. Estimate the critical fractile $\frac{c_u}{c_u+c_o}$
3. Translate the critical fractile into the number of standard deviations z to order: $z = \Phi^{-1}(\frac{c_u}{c_u+c_o})$
4. Use z and σ to calculate the fill rate
5. Multiply the fill rate by expected demand to get expected sales
6. Use z and σ to calculate the order quantity
7. Expected leftover inventory: order quantity less expected sales
8. Expected profit is expected sales times profit per unit sold less expected left-over inventory times the decrease in residual value

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Estimating the mismatch cost

Let's consider two different approaches to estimating the mismatch cost

- The decrease in profit as demand volatility exposure increases
- The cost worth paying to reduce demand volatility exposure: For example, what cost should we be willing to pay to the responsive supplier to be able to postpone our order until we know demand with certainty?

Calculating the break-even cost for the responsive supplier

- We denote the cost from the long-lead-time supplier as c_l, and that of the responsive supplier as c_o
- Let $\mathbb{E}(\pi) = \mathbb{E}(S)(p - c_l) - \mathbb{E}(LOI)(c_l - s)$ designate the expected profit under demand volatility exposure
- The expected profit when the order is placed after observing demand (a decision lead time of 0) is $\mathbb{E}(D)(p - c_0)$
- Setting $\mathbb{E}(\pi) = \mathbb{E}(D)(p - c_0)$ we solve for $c_0 = p - \frac{\mathbb{E}(\pi)}{\mathbb{E}(D)}$

The impact of decision lead time on demand volatility

- A convenient outcome of our assumption of demand following a lognormal distribution is that the volatility increases with the square root of the decision lead time
- If we double the decision lead time, volatility is expected to increase by $\sqrt{2}$
- If we decrease the decision lead time by 70%, volatility is expected to decrease to $\sqrt{0.3}$ of its original value