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NPTEL ONLINE
CERTIFICATION COURSE

SUPPLY CHAIN ANALYTICS

Uncertainty in Network Design

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Outline

- The Impact of Uncertainty on Network Design Decisions
- Discounted Cash Flow Analysis
- Representations of Uncertainty
- Evaluating Network Design Decisions Using Decision Trees
- AM Tires: Evaluation of Supply Chain Design Decisions Under Uncertainty
- Making Supply Chain Decisions Under Uncertainty in Practice
- Summary of Learning Objectives



The Impact of Uncertainty on Network Design

- Supply chain design decisions include investments in number and size of plants, number of trucks, number of warehouses
- These decisions cannot be easily changed in the short- term
- There will be a good deal of uncertainty in demand, prices, exchange rates, and the competitive market over the lifetime of a supply chain network
- Therefore, building flexibility into supply chain operations allows the supply chain to deal with uncertainty in a manner that will maximize profits



Discounted Cash Flow Analysis

- Supply chain decisions are in place for a long time, so they should be evaluated as a sequence of cash flows over that period
- Discounted cash flow (DCF) analysis evaluates the present value of any stream of future cash flows and allows managers to compare different cash flow streams in terms of their financial value
- Based on the time value of money – a dollar today is worth more than a dollar tomorrow



Discounted Cash Flow Analysis

$$\text{Discount factor} = \frac{1}{1+k}$$

$$NPV = C_0 + \sum_{t=1}^T \left(\frac{1}{1+k} \right)^t C_t$$

where

$C_0, C_1, \dots, C_T$ is a stream of cash flows over T periods

NPV = the net present value of this stream of cash flows

k = rate of return

- Compare NPV of different supply chain design options
- The option with the highest NPV will provide the greatest financial return



NPV Example: ABC Logistics

- How much space to lease in the next three years
- Demand = 100,000 units
- Requires 1,000 sq. ft. of space for every 1,000 units of demand
- Revenue = \$1.22 per unit of demand
- Decision is whether to sign a three-year lease or obtain warehousing space on the spot market
- Three-year lease: cost = \$1 per sq. ft.
- Spot market: cost = \$1.20 per sq. ft.
- $k = 0.1$



NPV Example: ABC Logistics

For leasing warehouse space on the spot market:

Expected annual profit = $100,000 \times \$1.22 - 100,000 \times \$1.20 = \$2,000$

Cash flow = \$2,000 in each of the next three years

$$\begin{aligned} NPV(\text{no lease}) &= C_0 + \frac{C_1}{1+k} + \frac{C_2}{(1+k)^2} \\ &= 2000 + \frac{2000}{1.1} + \frac{2000}{1.1^2} = \$5,471 \end{aligned}$$



NPV Example: ABC Logistics

For leasing warehouse space with a three-year lease:

Expected annual profit = $100,000 \times \$1.22 - 100,000 \times \$1.00 = \$22,000$

Cash flow = \$22,000 in each of the next three years

$$\begin{aligned} NPV(\text{no lease}) &= C_0 + \frac{C_1}{1+k} + \frac{C_2}{(1+k)^2} \\ &= 22000 + \frac{22000}{1.1} + \frac{22000}{1.1^2} = \$60,182 \end{aligned}$$

The NPV of signing the lease is \$54,711 higher; therefore, the manager decides to sign the lease

However, uncertainty in demand and costs may cause the manager to rethink his decision



Representations of Uncertainty

- Binomial Representation of Uncertainty
- Other Representations of Uncertainty



THANK YOU

