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NPTEL ONLINE
CERTIFICATION COURSE

SUPPLY CHAIN ANALYTICS

Using Decision Tree for handling uncertainty

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Binomial Representations of Uncertainty

- When moving from one period to the next, the value of the underlying factor (e.g., demand or price) has only two possible outcomes – up or down
- The underlying factor moves up by a factor $u > 1$ with probability p , or down by a factor $d < 1$ with probability $1-p$
- Assuming a price P in period 0, for the multiplicative binomial, the possible outcomes for the next four periods:
 - Period 1: Pu, Pd
 - Period 2: Pu^2, Pud, Pd^2
 - Period 3: Pu^3, Pu^2d, Pud^2, Pd^3
 - Period 4: $Pu^4, Pu^3d, Pu^2d^2, Pud^3, Pd^4$



Binomial Representations of Uncertainty

- In general, for multiplicative binomial, period T has all possible outcomes $Pu^t d^{(T-t)}$, for $t = 0, 1, \dots, T$
- From state $Pu^a d^{(T-a)}$ in period t , the price may move in period $t+1$ to either
 - $Pu^{a+1} d^{(T-a)}$ with probability p , or
 - $Pu^a d^{(T-a)+1}$ with probability $(1-p)$



Binomial Representations of Uncertainty

- For the additive binomial, the states in the following periods are:
 - Period 1: $P+u, P-d$
 - Period 2: $P+2u, P+u-d, P-2d$
 - Period 3: $P+3u, P+2u-d, P+u-2d, P-3d$
 - Period 4: $P+4u, P+3u-d, P+2u-2d, P+u-3d, P-4d$
- In general, for the additive binomial, period T has all possible outcomes $P+tu-(T-t)d$, for $t=0, 1, \dots, T$



Evaluating Network Design Decisions

Using Decision Trees

- A manager must make many different decisions when designing a supply chain network
- Many of them involve a choice between a long-term (or less flexible) option and a short-term (or more flexible) option
- If uncertainty is ignored, the long-term option will almost always be selected because it is typically cheaper
- Such a decision can eventually hurt the firm, however, because actual future prices or demand may be different from what was forecasted at the time of the decision
- A ***decision tree*** is a graphic device that can be used to evaluate decisions under uncertainty



Decision Tree Methodology

1. Identify the duration of each period (month, quarter, etc.) and the number of periods T over the which the decision is to be evaluated.
2. Identify factors such as demand, price, and exchange rate, whose fluctuation will be considered over the next T periods.
3. Identify representations of uncertainty for each factor; that is, determine what distribution to use to model the uncertainty.
4. Identify the periodic discount rate k for each period.
5. Represent the decision tree with defined states in each period, as well as the transition probabilities between states in successive periods.
6. Starting at period T , work back to period 0, identifying the optimal decision and the expected cash flows at each step. Expected cash flows at each state in a given period should be discounted back when included in the previous period.



Decision Tree Methodology : ABC Logistics

- Decide whether to lease warehouse space for the coming three years and the quantity to lease
- Long-term lease is currently cheaper than the spot market rate
- The manager anticipates uncertainty in demand and spot prices over the next three years
- Long-term lease is cheaper but could go unused if demand is lower than forecast; future spot market rates could also decrease
- Spot market rates are currently high, and the spot market would cost a lot if future demand is higher than expected



THANK YOU

