B A Economics Third Semester
ECD 1341 Micro Economics-II
Module IV ,Unit-10

Economics of Uncertainty and Basics of Linear Programming

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Definition of Uncertainty and Risk

- **Uncertainty/Risk** : Both concepts deal with the probability of loss or the chance of adverse outcomes.
- **Uncertainty** :The possible outcomes and their probabilities are unknown.
- **Risk**: All possible outcomes of managerial decisions and their probabilities are completely known.

Concepts of Uncertainty

- **Strategy:** It refers to one of the several alternative courses of action that a decision maker can take to achieve a goal.
- **States of Nature**: It refers to the conditions in the future that will have a significant effect on the degree of success or failure of any strategy.
- **Pay off Matrix:** It is a table which shows the possible outcomes or results of each strategy under each state of nature.

Measurement of Risk

- **Probability** : Livelihood of particular outcome occurring ,denoted by p. The number p is always between zero and one.
- **Expected Value (EV)** : It is a weighted- average payoff, where the weights are defined by the probability distribution.
- **Variance :** It measures the spread of the probability distribution.
- **Standard deviation :** It measures the dispersion of the possible outcomes from the expected value.

Expected Utility Hypothesis

- The **expected utility hypothesis** states that the utility of an agent facing uncertainty is calculated by considering utility in each possible state and constructing a weighted average. The weights are the agent's estimate of the probability of each state.
- The expected utility is thus an expectation in terms of probability theory.
- The general rule is that individuals seek to maximises expected utility when there is risk

Individual Behaviour Towards RISK

- The action of individuals in a situation of risk will depend upon their attitude towards risk.
- **Types of individual risk behaviours** :
- **Risk-Lovers(Risk Seeking /Taking)** :Those who prefer risk.
- **Risk- Averters:** Those who seek to avoid or minimize risk.
- **Risk Neutrality**: Those who focus on expected returns and disregard the dispersion of returns.

Methods to Reduce Risks

- Prevention/avoidance of Risks
- Reduction of Risks
- Shifting or transferring of Risks
- Spreading Risks

LINEAR PROGRAMMING

- Linear programming is widely used mathematical modeling technique to determine the optimum allocation of scarce resources among competing demands. Resources includes raw materials, manpower, machinery , time money and space.
- Objectives of business decisions frequently involve *Maximizing profit or Minimizing costs.*
- Linear Programming model consists of linear objectives and linear constrains, which means that the variable in a model have a proportionate relationship.

Characteristics of Linear Programming Model

- Linearity
- Non-negative Constraints
- Optimality
- Certainty
- Divisibility
- Finiteness
- Additivity

LP Model Formulation

- **Objective Function**
  - a linear relationship reflecting the objectives of an operation
  - most frequent objective is to maximize profit or to minimize cost
- **Decision variables**
  - an unknown quantity representing a decision that needs to be made. It is the quantity the model needs to determine.
- **Constraint**
  - a linear relationship representing a restriction on decision making

GENERAL LINEAR PROGRAMMING MODEL

A general representation of LP model is given as follows:

Maximize or Minimize, $Z = p_1 x_1 + p_2 x_2 \ldots\ldots\ldots\ldots\ldots\ldots p_n x_n$

Subject to constraints,

$w_{11} x_1 + w_{12} x_2 + \ldots\ldots\ldots\ldots\ldots\ldots w_{1n} x_n \leq \text{ or } = \text{ or } \geq w_1 \ldots\ldots\ldots\ldots\ldots$(i)

$w_{21} x_1 + w_{22} x_2 \ldots\ldots\ldots\ldots\ldots\ldots w_{2n} x_n \leq \text{ or } = \text{ or } \geq w_2 \ldots\ldots\ldots\ldots\ldots$ (ii)

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$w_{m1} x_1 + w_{m2} x_2 + \ldots\ldots\ldots\ldots\ldots\ldots w_{mn} x_n \leq \text{ or } = \geq w_m \ldots\ldots\ldots\ldots$(iii)

Non-negativity constraint,

$x_i \geq 0$ (where i = 1,2,3 .....n)

Solution

Decision variables completely describe the decisions to be made (in this case, by Manager). Manager must decide how many corrugated and ordinary cartons should be manufactured each week. With this in mind, he has to define:

xl be the number of corrugated boxes to be manufactured.
x2 be the number of carton boxes to be manufactured

Objective function is the function of the decision variables that the decision maker wants to maximize (revenue or profit) or minimize (costs). Manager can concentrate on maximizing the total weekly profit (z).
Here profit equals to (weekly revenues) – (raw material purchase cost) – (other variable costs).
Hence Manager's objective function is:

Maximize $z = 6X_2 + 4X_2$

Constraints show the restrictions on the values of the decision variables. Without constraints manager could make a large profit by choosing decision variables to be very large. Here there are three constraints:

Available machine-hours for each machine
Time consumed by each product

Sign restrictions are added if the decision variables can only assume nonnegative values (Manager can not use negative negative number machine and time never negative number)

All these characteristics explored above give the following **Linear Programming** (LP) problem

$\max z = 6x_1 + 4x_2$ (The Objective function)

s.t. $2x_1 + 3x_2 \le 120$ (cutting timeconstraint)

$2x_1 + x_2 \le 60$ (pinning constraint)

$x_1, x_2 \ge 0$ (Sign restrictions)

A value of (x_1,x_2) is in the **feasible region** if it satisfies all the constraints and sign restrictions.

This type of linear programming can be solve by two methods

1) Graphical method
2) Simplex algorithm method

Graphic Method

Step 1: *Convert the inequality constraint as equations and find co-ordinates of the line.*

Step 2: *Plot the lines on the graph.*

(***Note:*** If the constraint is ≥ type, then the solution zone lies away from the centre.

If the constraint is ≤ type, then solution zone is towards the centre.)

Step 3: *Obtain the feasible zone.*

Step 4: *Find the co-ordinates of the objectives function (profit line) and plot it on the* graph representing it with a dotted line.

Step 5: *Locate the solution point.*

(*Note: If the given problem is maximization,* **Z***max then locate the solution point at* the far most point of the feasible zone from the origin and if minimization, Zmin then locate the solution at the shortest point of the solution zone from the origin).

Step 6: Solution type

i. If the solution point is a single point on the line, take the corresponding values of x_1 and x_2.
ii. If the solution point lies at the intersection of two equations, then solve for x_1 and x_2 using the two equations.
iii. If the solution appears as a small line, then a multiple solution exists.
iv. If the solution has no confined boundary, the solution is said to be an unbound solution.

Objective function line (Profit Line)

Equate the objective function for any specific profit value Z,

Consider a Z-value of 60, i.e.,

$6x_1 + 4x_2 = 60$

Substituting $x_1 = 0$, we get $x_2 = 15$ and

if $x_2 = 0$, then $x_1 = 10$

Therefore, the co-ordinates for the objective function line are (0,15), (10,0) as indicated objective function line. The objective function line contains all possible combinations of values of xl and x2.

Therefore, we conclude that to maximize profit, 15 numbers of corrugated boxes and 30 numbers of carton boxes should be produced to get a maximum profit. Substituting

$x_1 = 15$ and $x_2 = 30$ in objective function, we get

$Z_{max} = 6x_1 + 4x_2$

$= 6(15) + 4(30)$

Maximum profit : Rs. 210.00