Introduction to Market Structures

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Introduction

- Market: exchange of goods and services between buyers and sellers. Mandi, Amazon, Flipkart (matching platform)
- Buyers are consumers who consume these goods and services to satisfy their wants.
- Sellers are producers who produces these goods and services.
- The exchange between these two types of agents takes place at a price.
- We study how price is determined in a market.
- The price of a good is determined based on the interaction between the buyers and sellers. This interaction is the analysis of the decision made by these two types of agents. Thus, this course consists of the study of the decision made by the consumers and the producers.
- We consider different set-ups under which decisions are taken by these agents.

- First we study how consumers take their decision on the amount of goods they want to buy. We get demand function from the study of consumer behaviour.
- The firms while deciding on the amount to produce of any particular good, they incur cost. This cost is due to the use of inputs (factors of production). We derive the cost function of each firm
- The first two modules cover the above two topics.
- In the next two modules, we take specific forms of markets and study price determination in each of them.
    - Competitive market: number of producers are huge
    - Monopoly: one producers

  There is no strategic interaction among the sellers in these two markets.

- Introduction to Game Theory: only games with complete information. We use the tools from Game Theory to study Strategic interactions.
- Next three modules are:
  - Cournot competition: quantity competition
  - Bertrand competition: Price competition
  - Stackelberg competition: sequential decisions by firms
- Other ways of strategic interactions among firms:
  - Product Differentiation
  - Entry Deterrence
  - Product bundling and tying

- What kind of consumption bundle does a consumer choose?
- Suppose there are two goods, cloth and food. Food is x_1 and Cloth is x_2.We represent these two goods as a vector of two elements. A consumption bundle is represented as $x = (x_1, x_2)$. Here the actual value of x_1 denotes the amount of food and the actual value of x_2 denotes the amount of cloth. Each point in the non-negative orthant of the xy plane represents a consumption bundle.

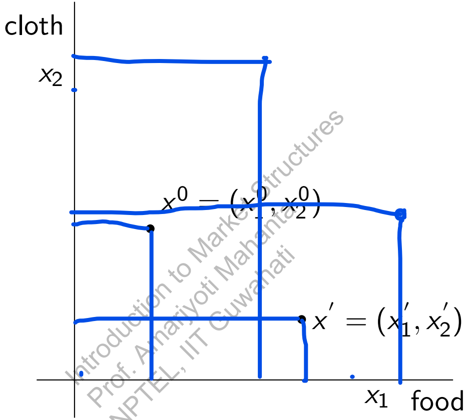


Figure: Representation of consumption bundle

- We define the preferences over the consumption bundles based on binary relation - at least as good as. Binary relation relates two objects like - is father of is a binary relation. If the set of objects are family members. The set is $\{A, B, C\}$. And A is father, B is mother and C is son. The binary relation - is father of- is valid for only son and father. In this example it is between A and C. It is not valid for A and B. If C is daughter then this binary relation is not valid.
- Another example,consider the set of positive integers and the binary relation - is greater than equal to. If we are given any two objects from this set of positive integers, we find that this binary relation is valid. $\{1, 2\}$, we can say 2 is greater than equal to 1.
- Consumers are rational, it means a consumer can choose the best bundle of goods. A bundle is best if it is at least as good as all other bundles. For the consumer to be able to choose the best bundle, we need the following assumptions.

$\{1, 2, 3, 4\}$ (is greater than equal to).

$\underline{}$ $\geq$

$\{3, 1\}$ $\{2, 1\}$, $\{1, 2\}$

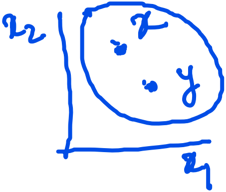
$\{3, 2\}$, $\{4, 3\}$

at least as good as $(\succsim)$

$\{a, b, c\}$ a is at least as good as b,

(a_1, a_2), (b_1, b_2), (c_1, c_2),

- Reflexivity: A bundle $x = (x_1, x_2)$ of goods must be atleast as good as itself.
- Completeness: The consumers should be able to compare all the available bundle of goods. Consider any two bundles $x = (x_1, x_2)$ and $y = (y_1, y_2)$. If the consumer can compare these two bundles then it must be; (x_1, x_2) is at least as good as (y_1, y_2) or (y_1, y_2) is at least as good as (x_1, x_2).
  If (x_1, x_2) is at least as good as (y_1, y_2) and (y_1, y_2) is at least as good as (x_1, x_2), then the consumer is indifferent to choose between these two bundles x, y.
  If (x_1, x_2) is at least as good as (y_1, y_2) and (y_1, y_2) is is not at least as good as (x_1, x_2), then consumer prefers to choose the bundle x when the bundle y is also available.



$x \succsim y$
and $y \succsim x$ then
xIy $\quad x \sim y$
indifference

$x \succsim y$ and $y \not\succsim x$
then $x \succ y$ $\quad xPy$
is preferred to

- Transitivity: Consider any three bundles of these two goods, $x = (x_1, x_2)$, $y = (y_1, y_2)$, $z = (z_1, z_2)$. We are given (x_1, x_2) is at least as good as (y_1, y_2) and (y_1, y_2) is at least as good as (z_1, z_2), then (x_1, x_2) is atleast as good as (z_1, z_2).
- Suppose completeness is violated. We have atleast two bundles $b = (b_1, b_2), c = (c_1, c_2)$ such that we dont have (b_1, b_2) is at least as good as (c_1, c_2) and (c_1, c_2) is at least as good as (b_1, b_2). In this situation we cannot compare b, c bundles. So we will not be able to choose the best bundle.
- Suppose we have three bundles a, b, c, the preference relation is of the following nature $a = (a_1, a_2)$ is preferred to $b = (b_1, b_2)$, $b = (b_1, b_2)$ is preferred to $c = (c_1, c_2)$ and $c = (c_1, c_2)$ is preferred to $a = (a_1, a_2)$. In this situation, we will not be able to choose the best bundle, we will be in a cycle. This is because transitivity property is being violated.

$x \succsim y$ and $y \succsim z$ then $x \succsim y$

$x I y$ and $y I z$ then $x I z$

$x P y$ and $y P z$ then $x P z$

$x I y$ and $y P z$ then $x P z$

$x P y$ and $y I z$ then $x P z$

$\{a, b, c\}$ $\quad a \succsim c,\ b \succsim c$

$c \succsim a,\ c \not\succsim b$

$aIc,\ bPc$

$b \succsim a$

$\{x, y, z\}$

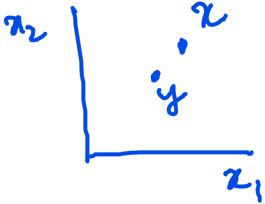
xPy and yPz then zPx

$\{x\}$ $\quad x, y, \quad y, z, \quad z, x$

$\{x, y\}$. $\quad xPy$ and yPz then xPz

xIy and yPz then xPz

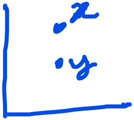
- Therefore, the above three properties allows us to order or rank all the bundles of goods. If we can order or rank the bundles then, the bundles which are at the top are the best bundles. We choose those bundles.
- We cannot do all the studies based on these three assumptions on the preferences of the consumers. We need further assumptions to generate a utility function of a consumer.
- Monotonicity (More is better) :Consider any two bundles x, y and suppose $x = (x_1, x_2) \geq y = (y_1, y_2)$. It means $x_1 \geq y_1$ and $x_2 \geq y_2$. In such situation we say that $x = (x_1, x_2)$ is atleast as good as $y = (y_1, y_2)$.
  Suppose $x = (x_1, x_2) > y = (y_1, y_2)$ which means $x_1 > y_1$ and $x_2 > y_2$, then we say that $x = (x_1, x_2)$ is preferred to $y = (y_1, y_2)$. Bundle $(4, 5)$ is preferred to $(1, 2)$.
- The preferences must be continuous. We do not need it in detail. Roughly, it means if a bundle x is preferred to bundle y. And if bundle z is close to bundle y, then x is preferred to bundle z also.



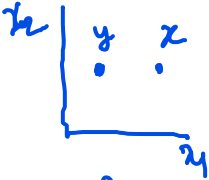
$x_1 \geq y_1$

$x_2 \geq y_2$

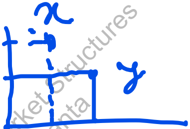
$x P y$

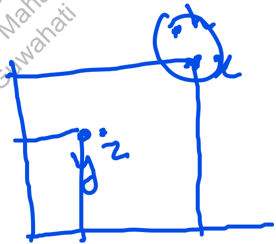


$x P y$



$x P y$



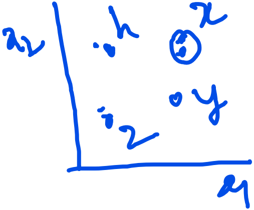


$x P z$

$x P y$

$h P y.$

- With all the above assumptions we can represent the preferences over the bundles of a consumer through a function. It is called utility function.
- $U(x_1, x_2) = U$, This utility function takes non-negative real number. The domain of this function is all the consumption bundles. It is the non-negative orthant of xy plane in case of two goods. The image is a non-negative real number.
- If bundle x is preferred to bundle y, it means $U(x_1, x_2) > U(y_1, y_2)$. If a consumer is indifferent between bundle x and y, it means $U(x_1, x_2) = U(y_1, y_2)$.
- Some example of utility function, $U(x_1, x_2) = x_1^{\alpha} x_2^{(1-\alpha)}$, where $\alpha \in (0, 1)$. This is an example of Cobb-Douglas utility function.



$U(x_1, x_2) = U_x$

$U(y_1, y_2) = U_y$

$U(z_1, z_2) = U_z$

$U(h_1, h_2) = U_z$

$U_x > U_y$

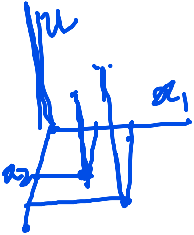
$x_2 > y_2$

$U_x > U_h$

$x_1 > h_1$

$U_z > U_z$

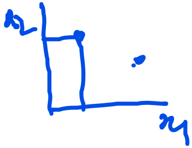
$U_x > U_y$



- $U(x_1, x_2) = log x_1 + x_2$. This is example of quasi linear utility function. It is linear in good 2 and non linear in good 1.
- $U(x_1, x_2) = x_1 + x_2$, this an example of perfect substitute. Good 1 and Good 2 are perfect substitute. Example of perfect substitute is ball pen and ink pen, Coke and Pepsi
- $U(x_1, x_2) = \min\{x_1, x_2\}$, this is an example of perfect complementary goods. Shoe and socks, pen and paper, petrol and car etc.
- We assume that the utility function of a consumer over goods is fixed. Based on this utility function we can assign a non-negative number to each consumption bundle. We can draw the level curves for each utility function.

- The level curves give us the indifference curves. Indifference curves are the combination of good 1 and Good 2, x_1, x_2) such that they provide same level of utility.
- The indifference curves are derived in the following way; We fix the utility level at U_0, from the utility function we collect all the consumption bundles (x_1, x_2) such that $U_0 = U(x_1, x_2)$. Next we fix a higher level of utility U_1 and again collect all the consumption bundles (x_1, x_2) such that $U_1 = U(x_1, x_2)$.
- In this way we generate the indifference curves. It is shown in figure below.

$$U(x_1, x_2) = x_1^{\alpha} x_2^{1-\alpha}, \quad \alpha \in (0,1)$$



$$U(x_1, x_2) = \log x_1 + x_2$$

$$U(x_1, x_2) = x_1 + x_2$$

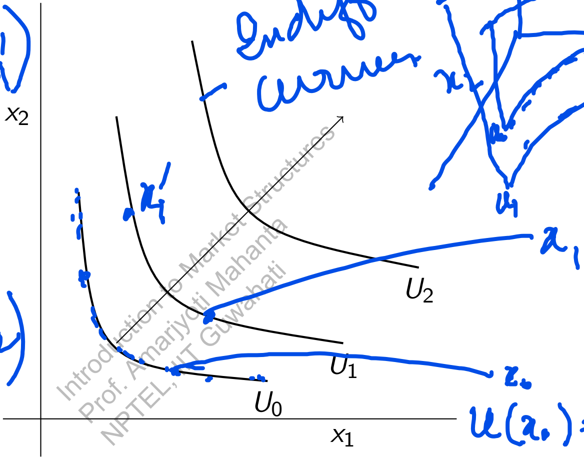
$$U(x_1, x_2) = \text{Min}\{x_1, x_2\}$$

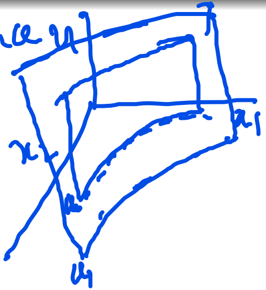
$U(x_1) = U(x_1')$

$U_1 > U_0$

$\bar{U} = U(x_1, x_2)$

Indifference curves





$U(x_0) = U(x_0')$

Figure: Indifference curves, $U_0 < U_1 < U_2$

We can also have indifference curves of the following types.

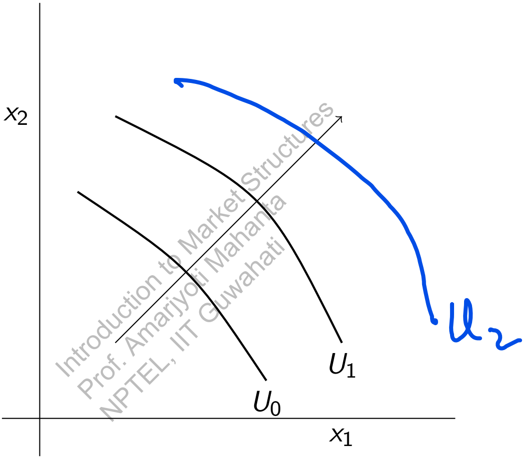
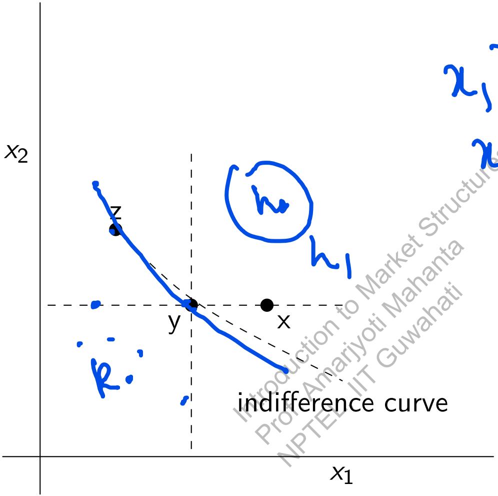


Figure: Indifference curves, $U_0 < U_1$

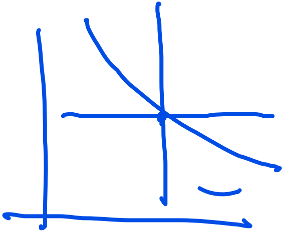
Implications of the above assumptions on the indifference curves: Monotonicity

- Consider two bundles $x = (x_1, x_2), y = (y_1, y_2)$ and suppose $x_1 > y_1$ and $x_2 = y_2$. From the monotonicity, we know that x is preferred to y. It implies $U(x) > U(y)$. The bundle x and y cannot be in the same indifference curve.
- For any bundle z to be indifferent to the bundle y,we must have either $z_1 > y_1$ and $z_2 < y_2$ or $z_1 < y_1$ and $z_2 > y_2$. This implies that indifference curves are downward sloping. We show it in figure below.
- The utility level increases in the north east direction.



$x_1 > y_1$ $\quad x P y$

$x_2 = y_2$



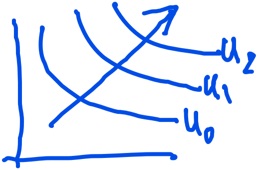
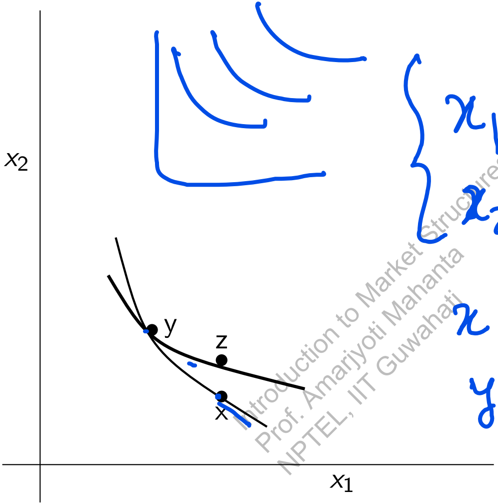


Figure: Implication of Monotonicity

Transitivity:
It implies that indifference curves cannot intersect.
Consider three bundles x, y, z as shown in figure below. Since x and y are in same indifference curve so the level of utility is same from these two bundle. Again y and z are in same indifference curve so the level of utility must be same. So from transitivity we get that the utility from x and z must be same. But if we compare x and z bundle, $x_1 = z_1$ and $z_2 > x_2$. These two bundle cannot give the same level of utility. Thus, transitivity is violated. Therefore, transitivity implies that indifference curves cannot intersect



$$\begin{cases} x_1 = z_1 \\ x_2 < z_2 \end{cases} \Big| \; z \, P \, x$$

$x \, I \, y$

$y \, I \, z$

$x \, I \, z$

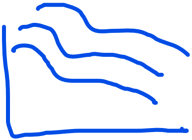


Figure: Violation of transitivity

Still we can have indifference curves of the following nature:

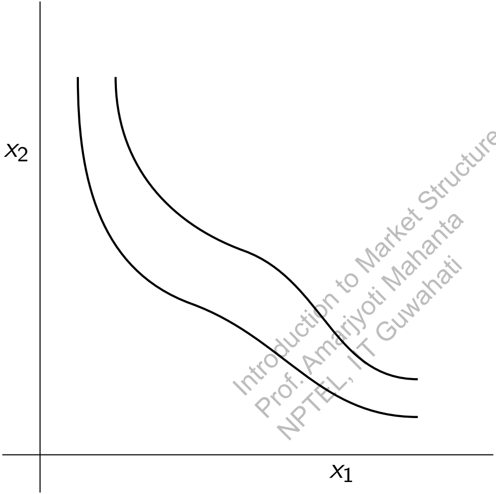


Figure: Violation of convexity

Convexity:
Consider two bundles x, y. If a consumer is indifferent between x and y bundle. Then any linear combination of x and y that is $\lambda x + (1 - \lambda)y$, $1 > \lambda > 0$ must be preferred to x and y. In other words average is preferred to extremes. Convexity along with all other conditions mentioned above ensures well behaved indifference curves.
The well behaved indifference curves are shown below.

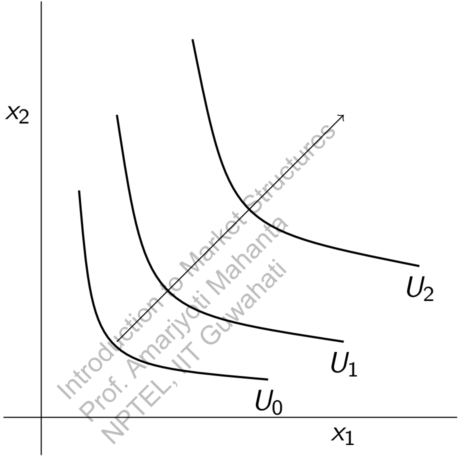


Figure: Indifference curves, $U_0 < U_1 < U_2$

We assume that the utility function is differentiable in x_1, x_2. It gives us following.

$\frac{\partial U(x_1, x_2)}{\partial x_1} = Mu_1$. It is the marginal utility from the consumption of good 1. Keeping the level of x_2 fixed, if we increase the consumption of good 1 by one unit , the additional utility we receive is $\frac{\partial U(x_1, x_2)}{\partial x_1} = Mu_1$.

It is assumed that marginal utility from a good always decreases although it is non-negative. This is called law of diminishing marginal utility.

Again $\frac{\partial U(x_1, x_2)}{\partial x_2} = Mu_2$, marginal utility from good 2. Keeping good 1 fixed at some level, if we increase the consumption of good 2 by one unit, the additional utility we receive is

$\frac{\partial U(x_1, x_2)}{\partial x_2} = Mu_2$.

We look at the movement along the well-behaved indifference curve. We know well behaved indifference are convex in nature and down sloping. It means from any point (x_1, x_2), if we increase x_1 we need to decrease x_2 to remain at the same level of utility or same indifference curves. Suppose utility is fixed at $\bar{U}$, taking total differentiation of it we get

$d\bar{U} = \frac{\partial U(x_1,x_2)}{\partial x_1} dx_1 + \frac{\partial U(x_1,x_2)}{\partial x_2} dx_2 = 0$, along an indifference curve.

$\Rightarrow \dfrac{dx_2}{dx_1} = -\dfrac{\frac{\partial U(x_1,x_2)}{\partial x_1}}{\frac{\partial U(x_1,x_2)}{\partial x_2}} = -\dfrac{Mu_1}{Mu_2} =$ marginal rate of substitution.

This marginal rate of substitution is the rate at which the consumer is willing to substitute one good for the other at a fixed level of utility. If we increase the consumption of good 1 by one unit, how much amount of good 2 the consumer is willing to decrease to remain at the same level of utility. Convexity of preferences ensures that the marginal rate of substitution decreases as we increase the consumption of good 1.

The slope of the indifference curve is $\frac{dx_2}{dx_1} = -\frac{\frac{\partial U(x_1,x_2)}{\partial x_1}}{\frac{\partial U(x_1,x_2)}{\partial x_2}} = -\frac{Mu_1}{Mu_2}$