UNIT 8 EFFICIENCY OF A COMPETITIVE MARKET

Structure

8.0 OBJECTIVES

After going through this unit, you will be able to:

- get an insight into the concept of Efficiency;
- explain the concept of Pareto Optimality in a General Equilibrium Framework;
- analyse equilibrium attainment through market trade;
- discuss a Competitive or Walrasian equilibrium in an Edgeworth box setting;
- estimate the set of competitive equilibrium prices and allocations;
- get an introduction to the algebra of General Equilibrium and the Walras' law;
- identify the Pareto optimality of a Competitive Equilibrium; and
- describe the two Fundamental theorems of Welfare Economics.

8.1 INTRODUCTION

Central Economic problem revolves around the notion of scarcity which arises when limited resources are rendered to satisfy unlimited wants. The mismatch between needs and means to satisfy those needs exists everywhere. Be it a consumer attempting to maximise his utility constrained by his limited budget, or a producer whose main concern is to maximise profit by minimising costs of production— all aim at attaining maximum gains from the limited resources. This is where originates the concept of Economic Efficiency.

Efficiency in literal sense refers to the process of outcome generation at lowest possible cost. This in turn results when resources are employed in the best possible way without any wastage. In Economics, Pareto optimality and efficiency are often used synonymously. An allocation is referred to as being Pareto optimal/efficient when there exit no alternate allocations which can make someone better off without making someone else worse off. The present unit begins with explaining the concept of Efficiency in a General Equilibrium framework. Subsequently, necessary tools of this framework encompassing the Edgeworth box, Pareto optimal allocation, and market trade leading to achievement of a Competitive Equilibrium, are discussed to explain the mechanism and the outcome of a free market. This theoretical stage is then followed by the algebra of General equilibrium, and later by the Walras' law.

The two bases, one — the concept of Pareto optimality or efficiency and the other — the mechanism of reaching a competitive equilibrium by a free market, will then be combined to establish the notion of "efficiency of a competitive market"— this will then be underlined by the First Fundamental theorem of Welfare Economics. The first fundamental theorem of welfare simply claims— a competitive equilibrium is Pareto efficient. This is equivalent to say, competitive equilibrium results in efficient resource allocation, so that no alternate allocation could enhance gain to someone without harming someone else. Possibility of social undesirability of Pareto optimal allocation also exists. This happens when the justice and fairness in terms of distribution of efficient allocation of resources are brought into consideration. The Second fundamental theorem of Welfare Economics then comes into picture. Under certain assumptions, it separates the goals of Efficiency and Equity, emphasising that a society may achieve any Pareto optimal resource allocation through appropriate initial resources redistribution and free trade.

8.2 THE CONCEPT OF EFFICIENCY

Scarcity of resources is the fundamental economic problem. As a rescue to this problem, Efficiency is concerned with optimal allocation of resources among different economic agents. In absolute terms, a situation can be called economically efficient if and only if— no one can be made better off without making someone else worse off. This is referred to as the Pareto efficient/optimal condition. An efficient condition could also be said to result when it becomes impossible to generate additional output unless amounts of factors employed are increased. In other words, it will not be wrong to say that in an efficient situation, production proceeds at the lowest possible per-unit cost. These statements claiming efficiency are not exactly equivalent, but they all dictate the idea that a system is said to be efficient if nothing more can be achieved given the available resources.

The equilibrium concepts you have used till now in the earlier units, are what is referred to as attainment of equilibrium by way of partial equilibrium analysis. As the name suggests, such equilibrium is achieved in one market holding what occurs in other markets, constant. This assumption would be correct when a market operates in isolation. A scenario of isolation does not exist in the present world. There exist complex interconnections between each market and firm. To get a broad view of the efficiency criterion in case of a competitive market, we will look into the general equilibrium framework. The criteria of efficiency will be discussed, based on which efficiency of a competitive market will be touched upon.

To set the stage for explaining the concept of efficiency in a general equilibrium framework, we will be adopting the following three essential assumptions that will simplify our analysis. Nonetheless, the results are still applicable in a general case.

1) Consumers and producers operate in competitive markets, implying all agents are price takers, and achieve equilibrium, given the prices.
2) There are only two goods which are produced using only two factors of production.
3) There are two consumers, each endowed with a certain quantities of the two goods which they will trade among themselves.

Initially, we will ignore production and will just consider attainment of equilibrium in consumption case. We will assume that the two consumers are each endowed with a certain quantities of the two goods, and then we will examine how they achieve equilibrium through trade with one another. This is what is typically termed a Pure Exchange economy. The approach adopted will be further extended to the efficiency attainment in production case and then to efficient allocation of two goods produced.

8.3 PARETO OPTIMALITY

Recall the concept of Pareto optimality that was introduced to you in Introductory Microeconomics (BECC-101). Named after the economist Vilfredo Pareto, *Pareto Optimality* refers to an economic arrangement where resources are allocated in such a way that there exist no alternative feasible resource allocation which will make one person better off without making someone else worse off. In this context, given a set of alternative allocations of resources, if a change from one allocation to another can make at least one individual better off without making any other individual worse off, it is referred to as *Pareto improvement*. Consequently, an allocation will be Pareto optimal when no further Pareto improvements can be made.

8.3.1 Edgeworth Box and Pareto Optimal/Efficient Allocations

Edgeworth box is a powerful graphical tool in General equilibrium analysis to study the goods trade in the market for attaining efficiency. In order to bring two agents in the market under one roof, it merges their indifference maps by inverting one of the agents ICs. The boxdepicts all possible consumption bundles for both consumers under examination (*i.e.* all feasible allocations), as well as preferences of both the individuals. Consider a hypothetical market situation with two consumers in the economy, A and B and consuming two goods, x and y. Let A's consumption bundle be given by $X_A = (x^A, y^A)$, where x^A denotes A's consumption of good x and y^A, of good y. Similarly, $X_B = (x^B, y^B)$ represents consumption bundle of consumer B. Furthermore, let $\omega_A = (\omega_x{}^A, \omega_y{}^A)$ denote an initial endowment bundle of consumer A and $\omega_B = (\omega_x{}^B, \omega_y{}^B)$ of consumer B.

Now assume, $\omega_A = (4, 1)$ and $\omega_B = (4, 5)$. An Edgeworth box is given in Fig. 8.1. Height of the box measures the total amount of good y in the economy (here, 6 units) and the width measures the total amount of good x (here, 8 units). Person A's consumption choices are measured from the lower left-hand corner (O_A), and that of person B's from the upper right-hand corner (O_B). Recall that any point inside the Edgeworth box indicates a particular distribution of the two goods among the two individuals. 'W' represents the initial endowment allocation. IC_A and IC_B are the Indifference curves representing preferences of consumer A and B, respectively.

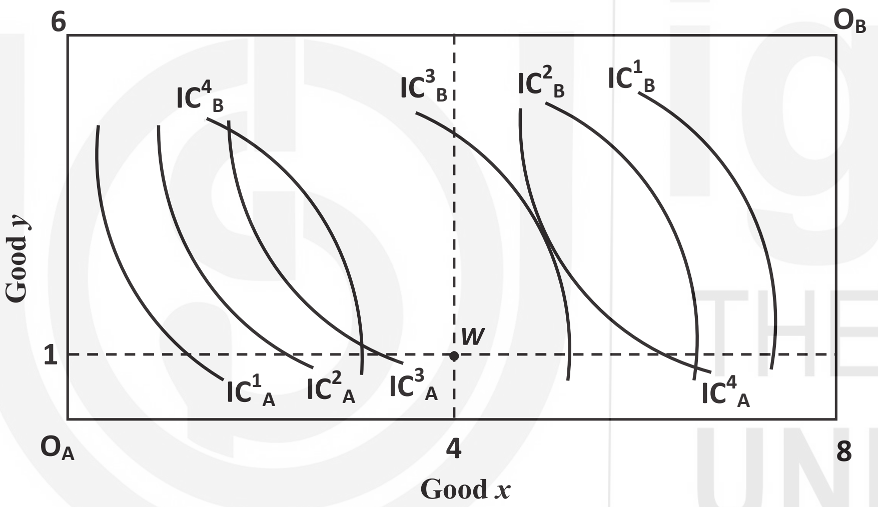

Fig. 8.1: Edgeworth Box

Important:

1) A pair of consumption bundles X_A and X_B is an *Allocation*.
2) An allocation is *feasible* (*i.e.* affordable), if and only if,

$$x^A + x^B = \omega_x{}^A + \omega_x{}^B$$

$$y^A + y^B = \omega_y{}^A + \omega_y{}^B$$

Now consider Fig. 8.2, notice that ICs of both individuals pass through W (*i.e.* the endowment). This implies that agents A and B are indifferent to their endowment allocation W compared to another points along the ICs passing through it. Further, note that all the consumption bundles to the north-east of the indifference curve that passes through W yield a higher level of utility for agent A.

Similarly, all points to the south-west of the inverted indifference curve passing through W are preferred by agent B. The lens-shaped area (the shaded region) formed by ICs of both the individual passing through W represents a set of allocation bundles that would make both consumer A and B better off compared to their initial endowment. This is what we referred to as the Pareto Improvement. Possibility of Pareto improvement in turn suggests that there can be a possibility of an equilibrium allocation, but will that be a unique one?

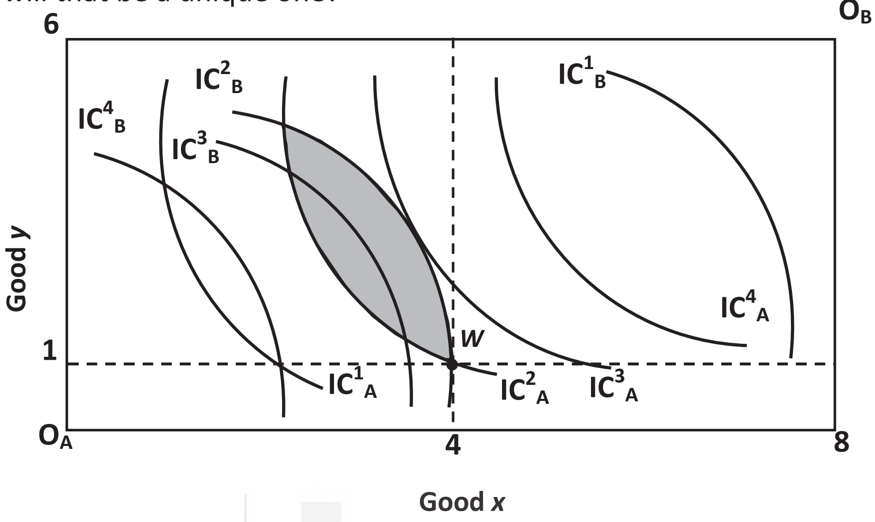

Fig. 8.2: Pareto Improvement Set

Suppose scope of Pareto improvement seizes at point Q (refer Fig. 8.3). It is easy to see that consumer A could achieve it by trading her endowment of good x to consumer B in return for her endowment of good *y*. Such a trade will allow agent A to reach a higher level of utility by consuming more units of good y than he was endowed with. Similarly, consumer B would enjoy higher utility by consuming more of good *x* than the amount he was endowed with. No reallocation from point Q can make one consumer better off without making the other worse off. An allocation of such kind is called *Pareto efficient/optimal* allocation, given the initial endowment bundle W and preferences of both the consumers. At such an allocation, all gains from trade are exhausted.

Notice that at Pareto efficient allocation Q, Marginal Rate of Substitution (MRS) is same for both the consumers. This is represented by the tangency of their respective ICs at Q. This tangency is necessary otherwise it will still be possible for them to trade to another level within the lens-shaped area.

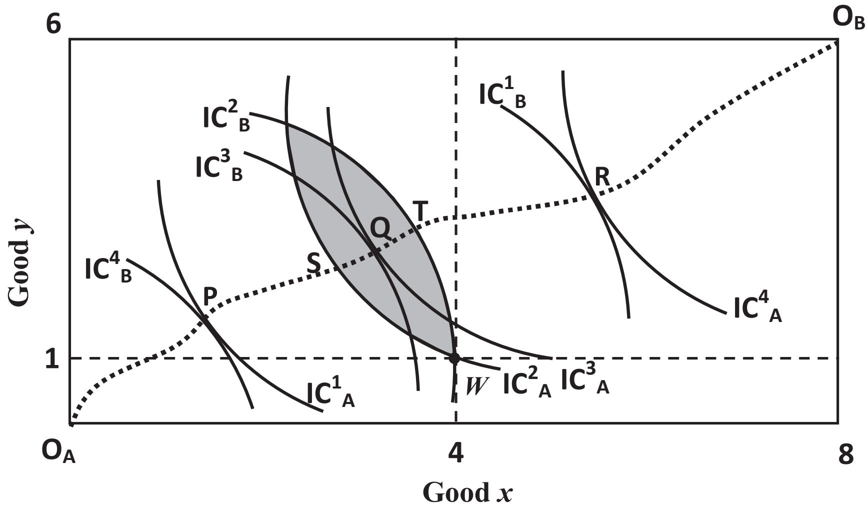

Fig. 8.3: Pareto Optimal Allocation and the Contract Curve

Remember that, Pareto efficient point (Q) is not unique. We attained such an allocation for the given initial endowment W. With change in the endowment, there will be a resultant change in the optimal bundle. Thus, there exists infinite number of efficient points— the set of which is called a *Pareto Set* or the *Contract Curve*(dotted line in Fig. 8.3). A Pareto set is composed of all the possible allocations resulting from mutually advantageous trade from any given endowment. This curve will stretch from A's origin to that of B's. It is a locus of all the points where ICs of the agents will be tangent. Points P, Q, and R, represent three such points.

Please note: For a given endowment (here W), there exists a subset of Pareto set (here, curve ST) inside the lens-shaped region formed by ICs passing through that endowment.

Example 1

Consider two individuals A and B with their preferences represented by the utility function, $U^A = (x^A)(y^A)$ and $U^B = (x^B)(y^B)^2$, respectively, where x and y are the two goods in the market. The initial endowment of individual A and B are given by $\omega^A = (1, 1)$ and $\omega^B = (2, 1)$, respectively. Compute the Pareto set.

Solution: A Pareto set consist of all those allocations of two goods at which indifference curves of the two individuals are tangent. This implies, a Pareto set is composed of all those allocations at which MRS of individual A and MRS of individual B are equal, *i.e.*, $MRS^A = MRS^B$.

For an allocation to be feasible, we require,

$$x^A + x^B = \omega_x^A + \omega_x^B = 1 + 2 = 3 \quad \Rightarrow \quad x^B = 3 - x^A \qquad \text{(i)}$$

$$y^A + y^B = \omega_y^A + \omega_y^B = 1 + 1 = 2 \quad \Rightarrow \quad y^B = 2 - y^A \qquad \text{(ii)}$$

Pareto Optimality implies, $MRS^A = MRS^B$

$$\Rightarrow -\frac{\frac{\partial U^A}{\partial x^A}}{\frac{\partial U^A}{\partial y^A}} = -\frac{\frac{\partial U^B}{\partial x^B}}{\frac{\partial U^B}{\partial y^B}}$$

$$\Rightarrow -\frac{y^A}{x^A} = -\frac{y^B}{2x^B} \qquad \text{(iii)}$$

From (i), (ii) and (iii), we get, $-\frac{y^A}{x^A} = -\frac{2-y^A}{2(3-x^A)}$

$$\Rightarrow 6y^A - 2x^Ay^A = 2x^A - x^Ay^A$$

$$\Rightarrow y^A = \frac{2x^A}{6-x^A}$$ is the required Pareto Set.

8.3.2 Market Trade for Equilibrium Attainment

Now, let us discuss the mechanism to be adopted in order to reach an optimal/efficient allocation (like Q) on the contract curve. Recall the procedure involved for attaining equilibrium by a consumer that we learnt in Unit 2. An individual attains equilibrium when his indifference curve is tangent to his budget constraint. That is, when slope of IC (which is MRS) =

slope of budget constraint [which is the Price ratio$\left(\frac{P_x}{P_y}\right)$, with P_x and P_y being prices of good x and good y, respectively]. We have just learnt— a contract curve is nothing but a locus of all equilibrium allocations so that MRS between two goods (say x and y) is equal among two consumers (say A and B). This equality does not happen at all price ratios, but only at the one where the market clears, i.e. at price ratio $\left(\frac{P_x}{P_y}\right)^*$ so that $MRS^A = MRS^B = \left(\frac{P_x}{P_y}\right)^*$.

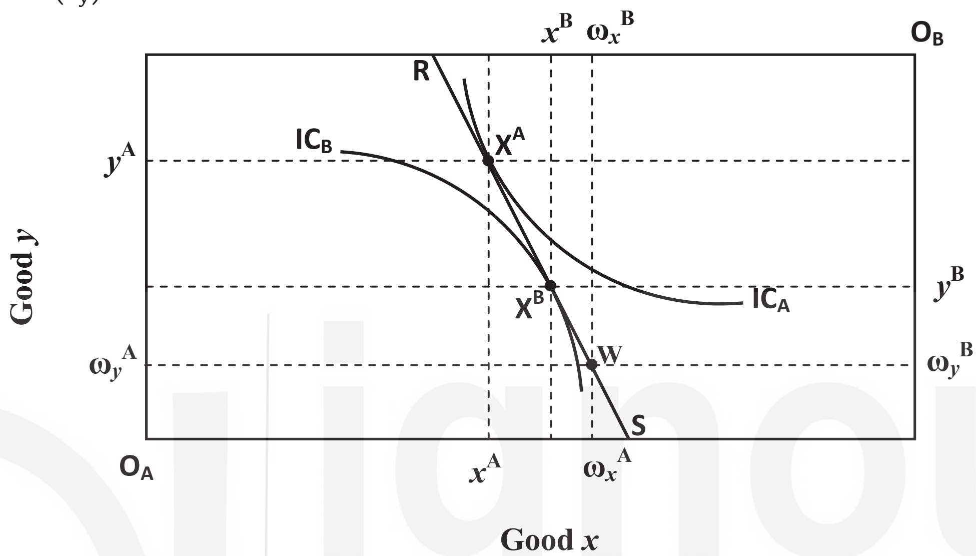

Fig. 8.4: Non-competitive Equilibrium

Consider a market situation represented by an Edgeworth box in the Fig. 8.4. Given the two individuals (A and B), participating in the consumption of two goods (x and y), in order to maximise the utility, represented by their ICs (IC_A and IC_B, for individual A and B, respectively). Let the initial endowment be represented by bundle $W = ((\omega_x^A, \omega_y^A), (\omega_x^B, \omega_y^B))$. Budget line RS represents a price ratio $\frac{P_x}{P_y}$ at which both the individual decides to trade with each other. At this price ratio, individual A demands bundle $X^A = (x^A, y^A)$ and individual B demands bundle $X^B = (x^B, y^B)$. As you may notice,

Demand for Good 1 is feasible, only when	$x^A + x^B = \omega_x^A + \omega_x^B$
Demand for Good 2 is feasible, only when	$y^A + y^B = \omega_y^A + \omega_y^B$

In other words, feasibility condition requires, excess demand of individual A (or B) for good i (where i ∈ x, y) must match excess supply of individual B (or A) for that good. But in Fig. 8.4, this is not the case, as excess supply of good x by individual A, denoted by e_x^A (= $\omega_x^A - x^A$) is greater than excess demand for good x by individual B, given by e_x^B (= $x^B - \omega_x^B$). Similar situation exists for good y. Hence, the above situation depicts a situation of Disequilibrium in the exchange market.

Symbolically, $x^A + x^B \neq \omega_x^A + \omega_x^B$ and $y^A + y^B \neq \omega_y^A + \omega_y^B$.

Check Your Progress 1

1) Explain the concept of Economic Efficiency? Is it same as Pareto optimality?

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2) In a two-good two-individual economy, two individuals A and B are represented by identical Cobb-Douglas utility function $U_i = x_i^{1/3} y_i^{2/3}$, where $i \in (A, B)$, and x and y are the two goods in the market. The initial endowment of individual A and B are given by $\omega^A = (1, 2)$ and $\omega^B = (2, 1)$, respectively.

   a) Draw an Edgeworth box for this economy, and mark the Endowment bundle.

   b) Compute the Pareto Set.

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3) "A non-competitive equilibrium is inefficient," elucidate this statement with the help of appropriate diagram.

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8.4 COMPETITIVE EQUILIBRIUM

In Fig. 8.4, there is disequilibrium in the market due to presence of excess demand for good y and excess supply for good x. The prices in the above market need to be recalibrated to the point where aggregate demand for a good equals its aggregate supply, *i.e.* when amount of a good demanded by one individual is exactly equal to the amount supplied by the other. Only then, the market is in a *Competitive Equilibrium*. This equilibrium is also called *Walrasian Equilibrium*.

In Edgeworth box setting, a competitive equilibrium results when ICs of both the individuals become tangent to each other at the ongoing price ratio. This happens on the contract curve, at the price ratio which equilibrate the trade for utility maximisation, given the initial endowment. One such equilibrium is given by point E in Fig. 8.5, where the budget line through the endowment point passes through the tangency of the ICs of the two individuals A and B. Point E ensures that both individuals attain maximum utility by reaching their highest possible IC through trade, given their initial endowment bundle W. Trade leading to equilibrium outcome happens at a unique price ratio $\left(\frac{P_x}{P_y}\right)^*$ given by the slope of the budget line passing through common tangency point and the initial endowment bundle W.

Thus at equilibrium, the following must be true:

$$MRS^A = MRS^B = \left(\frac{P_x}{P_y}\right)^* \text{ or } \frac{{MU_x}^A}{{MU_y}^A} = \frac{{MU_x}^B}{{MU_y}^B} = \left(\frac{P_x}{P_y}\right)^*$$

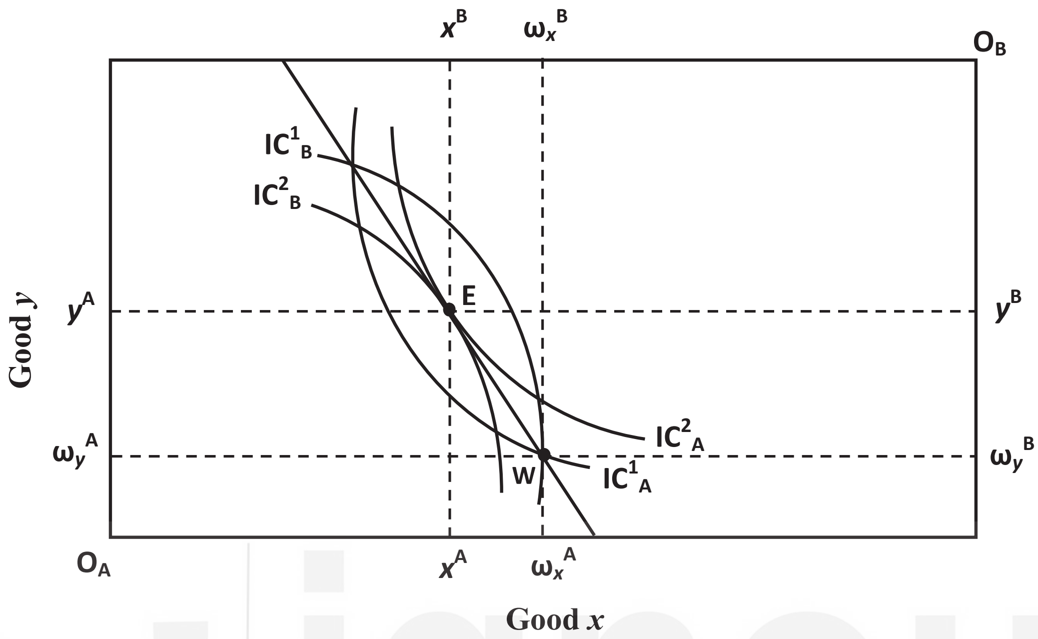

Fig. 8.5: Competitive Equilibrium

Note:

A price ratio $\left(\frac{P_x}{P_y}\right)$ and an allocation given by $[(x^A, y^A), (x^B, y^B)]$ is a competitive equilibrium if the following condition holds:

I) Each consumer is maximising his/her utility given his/her budget set, and

II) The demand for and the supply of each good are equal, *i.e.* markets clear.

Example 2

Consider the same market situation we considered above in example 1, with two individuals A and B. Given their utility functions and endowments same as was there in Example 1, find the competitive equilibrium in this economy.

Solution: Given the utility functions, we need to first ascertain the demand functions of both the agents for goods x and y. Assume income as M, and P_x and P_y be the prices of good x and goody, respectively. Let $P_x = 1$ (i.e., we are considering good x to be a numeraire good)*.

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* Let A be any individual with his initial endowment bundle for good x and y as $({\omega_x}^A, {\omega_y}^A)$. Let consumption bundle at P_x and P_y, (i.e.at the prices of good x and good y), be (x^A, y^A) respectively. Then, Budget constraint faced by this individual will be given by: $P_x x^A + P_y y^A = P_x {\omega_x}^A + P_y {\omega_y}^A$, where $P_x {\omega_x}^A + P_y {\omega_y}^A$ represents income of the individual. Notice that proportional increase in prices (P_x and P_y) leave no effect on this budget constraint, implying only the price ratio $\left(\frac{P_x}{P_y}\right)$ matters here. This allows us to normalise the price of any one good to 1, which then become the numeraire good. Another explanation to why we consider the assumption of a numeraire good is given under the Sub-section 8.5.2.

Demand functions of individual A for two goods x and y will be given by the solution of the following constrained optimisation problem:

Maximise $U^A = (x^A)(y^A)$

subject to $M^A = P_x \times x^A + P_y \times y^A$

We employ the Lagrange approach to solve the above optimisation problem:

$$\mathcal{L} = (x^A)(y^A) + \lambda (M^A - P_x x^A - P_y y^A)$$

The First order (or necessary) conditions will result in:

$$\frac{\partial \mathcal{L}}{\partial x^A} = 0 \Rightarrow (1)(x^A)^0 (y^A) = \lambda P_x \Rightarrow y^A = \lambda P_x \quad (1)$$

$$\frac{\partial \mathcal{L}}{\partial y^A} = 0 \Rightarrow (1)(x^A)(y^A)^0 = \lambda P_y \Rightarrow x^A = \lambda P_y \quad (2)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = 0 \Rightarrow M^A = P_x x^A + P_y y^A \quad (3)$$

From Equations (1) and (2), we get

$$P_y y^A = P_x x^A \quad (4)$$

From Equations (3) and (4), we get

$$M^A - P_x x^A = P_x x^A$$

$\Rightarrow x^A = \frac{1}{2}\frac{M^A}{P_x}$, which is the demand function of individual A for good x. (5)

From (3) and (5), we get the demand function of individual A for good y as $y^A = \frac{1}{2}\frac{M^A}{P_y}$.

Similar approach can be applied for finding the demand functions of individual B for good x and y, which will be given by $x^B = \frac{1}{3}\frac{M^B}{P_x}$ and $y^B = \frac{2}{3}\frac{M^B}{P_y}$, respectively.

Now we solve for the competitive equilibrium:

In Equation (5), M^A is the income of individual A, which can be ascertained from the value of his endowment bundle $(\omega_x^A, \omega_y^A) = (1, 1)$,

i.e., $M^A = (\omega_x^A) P_x + (\omega_y^A) P_y = 1 + P_y$ 6)

As we assumed $P_x = 1$, from Equations (5) and (6) we get,

$$x^A = \frac{1}{2}(1 + P_y) \quad 7)$$

Similarly, demand function of individual A for good y will become:

$$y^A = \frac{1}{2}\frac{M^A}{P_y} = \frac{1}{2}\left(\frac{1+P_y}{P_y}\right) \quad 8)$$

Demand functions of individual B for good *x* and good y, with $M^B = (\omega_x^B) P_x + (\omega_y^B) P_y = 2 + P_y$, where $(\omega_x^B, \omega_y^B) = (2,1)$, will be:

$$x^B = \frac{1}{3}\frac{M^B}{P_x} = \frac{1}{3}(2 + P_y) \text{ and } y^B = \frac{2}{3}\frac{M^B}{P_y} = \frac{2}{3}\left(\frac{2+P_y}{P_y}\right) \quad 9)$$

A competitive equilibrium price ratio will result in a price ratio $\left(\frac{P_x}{P_y}\right)$ at which market clears, *i.e.*, aggregate demand for a good equals the aggregate supply of that good (which is nothing but the endowment of that good).

Thus, at equilibrium, in case of good x,

$$x^A + x^B = \omega_x^A + \omega_x^B$$

$$\frac{1}{2}(1 + P_y) + \frac{1}{3}(2 + P_y) = 3 \qquad [\because \omega_x^A + \omega_x^B = 3]$$

$$P_y = \frac{11}{5}$$

From this, we can ascertain equilibrium allocation using the demand functions given by Equations (7), (8) and (9):

$$x^A = \frac{8}{5}, \quad y^A = \frac{8}{11}, x^B = \frac{7}{5} \text{ and } y^B = \frac{14}{11}$$

Competitive equilibrium price ratio $\left(\frac{P_x}{P_y}\right)^*$ will be given by $\left(\frac{5}{11}\right)$, and competitive equilibrium allocation bundle will be given by $\left[\left(\frac{8}{5}, \frac{8}{11}\right), \left(\frac{7}{5}, \frac{14}{11}\right)\right]$.

Check Your Progress 2

1) Explain the concept of a Walrasian equilibrium with the help of an Edgeworth box.

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2) In a two-good two-individual economy, two individuals A and B are represented by identical Cobb-Douglas utility function $U_i = x_i^{1/3} y_i^{2/3}$, where i∈(A, B), and x and y are the two goods in the market. The initial endowment of individual A and B are given by $\omega^A = (1, 2)$ and $\omega^B = (2, 1)$, respectively. Find Competitive equilibrium price ratio and goods allocation of this economy.

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8.5 GENERAL EQUILIBRIUM AND WALRAS' LAW

8.5.1 Algebra of General Equilibrium

Market economies are composed of a complex dynamic system of different economic agents, making supply and demand decisions over different commodities or factor types in order to maximise their own interests. General Equilibrium theory advocates that such pursuit of private interest by all the economic units with different motivations, integrated through a system of free markets, will result in an efficient/optimal allocation of goods and services in the economy. By General equilibrium it is meant simultaneous equilibrium in all the markets, that is, the prevalence of equilibrium in the economy as a whole. A General Equilibrium results in an array of prices for all goods so that supply equals demand simultaneously for each good in the economy. We establish the algebra of such equilibrium below:

Assuming two commodities (x and y) and two agents (A and B) in the economy, then a typical array of prices is given by a two-dimensional vector such as (P_x, P_y). Let the demand function for agent A be $x^A(P_x, P_y)$ and $y^A(P_x, P_y)$ for commodity x and commodity y, respectively. Similarly for agent B will be given by $x^B(P_x, P_y)$ and $y^B(P_x, P_y)$; further their endowment bundle be (ω_x^i, ω_y^i), where $i \in \{A, B\}$.

General Equilibrium in the economy would be established by a price vector (P_x^*, P_y^*), so that Aggregate Demand = Aggregate Supply, for each commodity. That is,

$$x^A(P_x^*, P_y^*) + x^B(P_x^*, P_y^*) = \omega_x^A + \omega_x^B \text{ and}$$

$$y^A(P_x^*, P_y^*) + y^B(P_x^*, P_y^*) = \omega_y^A + \omega_y^B$$

The above equation can be arranged in terms of Excess demand functions for the two agents:

$$[x^A(P_x^*, P_y^*) - \omega_x^A] + [x^B(P_x^*, P_y^*) - \omega_x^B] = 0 \text{ and} \quad (10)$$

$$[y^A(P_x^*, P_y^*) - \omega_y^A] + [y^B(P_x^*, P_y^*) - \omega_y^B] = 0 \quad (11)$$

Where, $[x^A(P_x^*, P_y^*) - \omega_x^A]$ is the excess demand for commodity x by agent A, similarly $[x^B(P_x^*, P_y^*) - \omega_x^B]$ is the excess demand for commodity x by agent B. Equation (10) simply says, equilibrium calls for the sum of the excess demands for commodity x by both the agents to sum to zero. In other words, at equilibrium, one agent's demand for a good must equal another agent's supply of that good. This is another way of looking at the condition of feasibility of the demand for a commodity. Equation (11) can be interpreted in a similar way.

Above equations can also be presented as follows:

$$e_x^A(P_x, P_y) + e_x^B(P_x, P_y) = 0$$

Where $e_x^A(P_x, P_y) = [x^A(P_x^*, P_y^*) - \omega_x^A]$ and $e_x^B(P_x, P_y) = [x^B(P_x^*, P_y^*) - \omega_x^B]$. Similarly, for commodity y, Equation becomes

$$e_y^A(P_x, P_y) + e_y^B(P_x, P_y) = 0$$

Further let $e_x^A(P_x, P_y) + e_x^B(P_x, P_y) = z_x(P_x, P_y)$ and $e_y^A(P_x, P_y) + e_y^B(P_x, P_y) = z_y(P_x, P_y)$, then General Equilibrium condition can be stated more precisely as:

$$z_n(P_x, P_y) = 0 \text{ , where } n \in \{x, y\}$$

8.5.2 Walras' Law

Walras' Law is given by:

$$P_x z_x(P_x, P_y) + P_y z_y(P_x, P_y) \equiv 0$$

The law simply says that for all prices (and not just the equilibrium prices) the value of aggregate excess demand is identically zero. The proof of the law is as follows:

Feasibility of demand by agent A requires:

$$P_x x^A(P_x, P_y) + P_y y^A(P_x, P_y) \equiv P_x \omega_x^A + P_y \omega_y^A$$

$$\Rightarrow P_x [x^A(P_x, P_y) - \omega_x^A] + P_y [y^A(P_x, P_y) - \omega_y^A] \equiv 0$$

$$\Rightarrow P_x e_x^A(P_x, P_y) + P_y e_y^A(P_x, P_y) \equiv 0 \qquad 12)$$

Similar equation holds for feasibility of demand by agent B:

$$P_x e_x^B(P_x, P_y) + P_y e_y^B(P_x, P_y) \equiv 0 \qquad (13)$$

Adding Equations (12) and (13), we get

$$P_x e_x^A(P_x, P_y) + P_y e_y^A(P_x, P_y) + P_x e_x^B(P_x, P_y) + P_y e_y^B(P_x, P_y) \equiv 0$$

$$\Rightarrow P_x [e_x^A(P_x, P_y) + e_x^B(P_x, P_y)] + P_y [e_y^A(P_x, P_y) + e_y^B(P_x, P_y)] \equiv 0$$

$$\Rightarrow P_x z_x(P_x, P_y) + P_y z_y(P_x, P_y) \equiv 0 \text{ (the Walras' Law)}$$

Significance of the Walras' law— Given that a set of prices bring equilibrium in any one of the markets (let say in market for good x), then as per Walras' law the remaining markets (here market for good y) would be necessarily in equilibrium. In other words, the law claims that if demand equals supply in one market then the same must be true for the other market as well.

From the identity of the law $P_x z_x(P_x, P_y) + P_y z_y(P_x, P_y) \equiv 0$, if $z_x(P_x, P_y) = 0$, that is, if market for good x is in equilibrium so that supply equals the demand for good x. Given that both P_x and P_y are positive, for the identity of Walras' law to hold true, then $z_y(P_x, P_y)$ must also equal 0. It turns out that if demand equals supply in all but one market, i.e. in (n−1) markets, then demand must equal supply in the n^{th} market as well. This has an added advantage to it, for an economy with n goods, one of the prices can be chosen as numeraire price (a price relative to which all the other prices are measured), leaving the need to find only (n−1) relative equilibrium prices. This becomes possible from the Walras' law identity that states all markets would be in equilibrium for any set of prices. This is to say, if markets are in equilibrium at a price vector $(P_1, P_2, P_3, \ldots P_n)$, then for any constant $k \in R^+$ (set of positive real numbers), markets will remain in equilibrium for a price vector $(kP_1, kP_2, kP_3, \ldots kP_n)$. Now, if we take $k = (1/P_n)$ then P_n becomes the numeraire price which will then result in a price vector of (n−1) relative equilibrium prices, given by $\left(\frac{P_1}{P_n}, \frac{P_2}{P_n}, \frac{P_3}{P_n}, \dots 1\right)$.

8.6 THE EFFICIENCY OF COMPETITIVE EQUILIBRIUM

On combining Pareto Optimality (Section 8.3) and Competitive Equilibrium (Section 8.4) conditions, efficiency of a competitive equilibrium can be verified. In a competitive equilibrium, the amount supplied of a good equals the amount demanded. This eliminates the scope for further gains from trade or any reallocation— which is nothing but the condition that needs to hold for an efficient allocation. Competitive equilibrium E in Fig. 8.5 is efficient with each individual A and B reaching the highest possible IC given their initial endowment W, so that neither A nor B can be made better off without making the other individual worse off. A general proof verifying efficiency of a competitive equilibrium is as follows:

Consider the similar situation that we have been considering so far, of a two good (x and y) and two individuals (A and B), with initial endowment W = $[(\omega_x^A, \omega_y^A), (\omega_x^B, \omega_y^B)]$. Further let trade at price ratio $\rho = \left(\frac{P_x}{P_y}\right)$ leads to competitive equilibrium bundle E = $[(x^A, y^A), (x^B, y^B)]$.

Now, suppose equilibrium bundle E is not Pareto efficient. This would mean that there exists an alternate allocation which will be strictly preferred by A and B to (x^A, y^A) and (x^B, y^B), respectively. Let it be given by $[(x_a^A, y_a^A), (x_a^B, y_a^B)]$. That is,

For individual A, $(x_a^A, y_a^A) \succ (x^A, y^A)$

For individual B, $(x_a^B, y_a^B) \succ (x^B, y^B)$

The preferred allocation must be feasible, that is,

$$x_a^A + x_a^B = \omega_x^A + \omega_x^B \text{ and } y_a^A + y_a^B = \omega_y^A + \omega_y^B \qquad (14)$$

Now, since individual A prefers (x_a^A, y_a^A) to (x^A, y^A), and given that at price ratio $\rho = \left(\frac{P_x}{P_y}\right)$ he opted for (x^A, y^A), then at ρ, bundle (x_a^A, y_a^A) must be unaffordable for A. This implies

$$P_x x_a^A + P_y y_a^A > P_x \omega_x^A + P_y \omega_y^A \qquad (15)$$

The above equation simply means that the money value of bundle (x_a^A, y_a^A) at the given price ratio exceeds the money value of bundle (x^A, y^A) opted by A at that price ratio. Similarly for individual B the following relation will hold:

$$P_x x_a^B + P_y y_a^B > P_x \omega_x^B + P_y \omega_y^B \qquad (16)$$

Adding (15) and (16), we get

$$P_x x_a^A + P_y y_a^A + P_x x_a^B + P_y y_a^B > P_x \omega_x^A + P_y \omega_y^A + P_x \omega_x^B + P_y \omega_y^B$$

$$P_x(x_a^A + x_a^B) + P_y(y_a^A + y_a^B) > P_x(\omega_x^A + \omega_x^B) + P_y(\omega_y^A + \omega_y^B) \qquad (17)$$

Using Equation (14), the LHS of Equation (17) becomes

$$P_x(\omega_x^A + \omega_x^B) + P_y(\omega_y^A + \omega_y^B) > P_x(\omega_x^A + \omega_x^B) + P_y(\omega_y^A + \omega_y^B)$$

This is an inconsistency as both the right hand side and left handside of the above inequality are actually the same. This logical inconsistency implies that the presumption of allocation $[(x_a^A, y_a^A), (x_a^B, y_a^B)] \succ [(x^A, y^A), (x^B, y^B)]$ cannot be true. This gives us the following important theorem.

8.6.1 The First Fundamental Theorem of Welfare Economics

As per First Fundamental Theorem of Welfare Economics, all competitive equilibria or Walrasian equilibria are Pareto Efficient. The theorem claims that a competitive equilibrium will exhaust all gains from trade so that an efficient allocation is attained from any given initial endowment. This theorem confirms to the result of the classical theory, *viz.* the Adam Smith's "invisible hand" hypothesis, as per which invisible hand of the market forces of demand and supply will achieve most efficient level of production, consumption and distribution of good in the society. First fundamental theorem of welfare economics supports the case for "free markets" or "*Laissez-faire*", where there exists no control by the government on production or consumption that may interfere with the free market. Only when the market mechanism fails to achieve an efficient resource allocation (which is the case of market failure resulting from monopoly, externalities, or public goods), the government intervention is justified.

However, the First Fundamental theorem — which talks about the Pareto efficiency of a competitive equilibrium — says nothing about equity or fairness of the resulting efficient resource allocation among the agents of a society. Pareto efficiency merely indicates that no one can be made better off without making someone else worse off, it gives no consideration to the distributive effects of the resultant efficient allocation. The point to note here is— Laissez-faire may produce many different Pareto optimal outcomes, with some being fairer than others, so that not all of them may be equally desirable by the society. For instance, the outcome in which one individual A has all the units of commodity x in a single commodity market is Pareto efficient, since there will be no way to make some other individual better off without making A worse off. But such an optimal allocation may not be equitable or socially desirable. This is where the need for rectifying the distributional inequities of Laissez-faire comes. Now we proceed towards a socially desirable Pareto optimum solution, with an approach which is converse to that of the first fundamental theorem of welfare economics, *i.e.*, we are considering the allocation problem from efficiency to equilibrium. Given Pareto Efficient equilibrium, as long as individual preferences are convex, there exists a set of prices at which this equilibrium becomes competitive or Walrasian equilibrium. This is known as the Second Fundamental Theorem of Welfare Economics which we further explain below.

8.6.2 The Second Fundamental Theorem of Welfare Economics

The second fundamental theorem of welfare economics suggests that the issues of efficiency and equity are distinct, and that they can be addressed simultaneously. As per this theorem, any socially desirable optimal allocation can be reached by way of the market mechanism modified with the help of lump-sum transfers. Assuming all agents (individuals and producers) are self-interested price takers, then as per Second Fundamental Theorem of Welfare Economics, almost any Pareto optimal equilibrium can be achieved through the competitive mechanism, provided appropriate lump-sum transfers (which do not change the agents' behaviour) are made among agents.

Consider Fig. 8.6 below, where we have two Pareto efficient allocations E and E′. If it is felt that equilibrium E′ is somehow better in terms of being more fair or just than equilibrium E, then a lumpsum transfer of good X from individual A to B and simultaneously a transfer of good Y from B to A, changing the endowment from W to W′, can be made. The price system can then be allowed to generate a Pareto efficient outcome E′, given the new endowment W′. Thus, as per the second welfare theorem— given all agents have convex preferences, after an appropriate assignment of endowments through redistribution, a society may achieve any Pareto efficient resource allocation as competitive equilibrium, that is, through market mechanism.

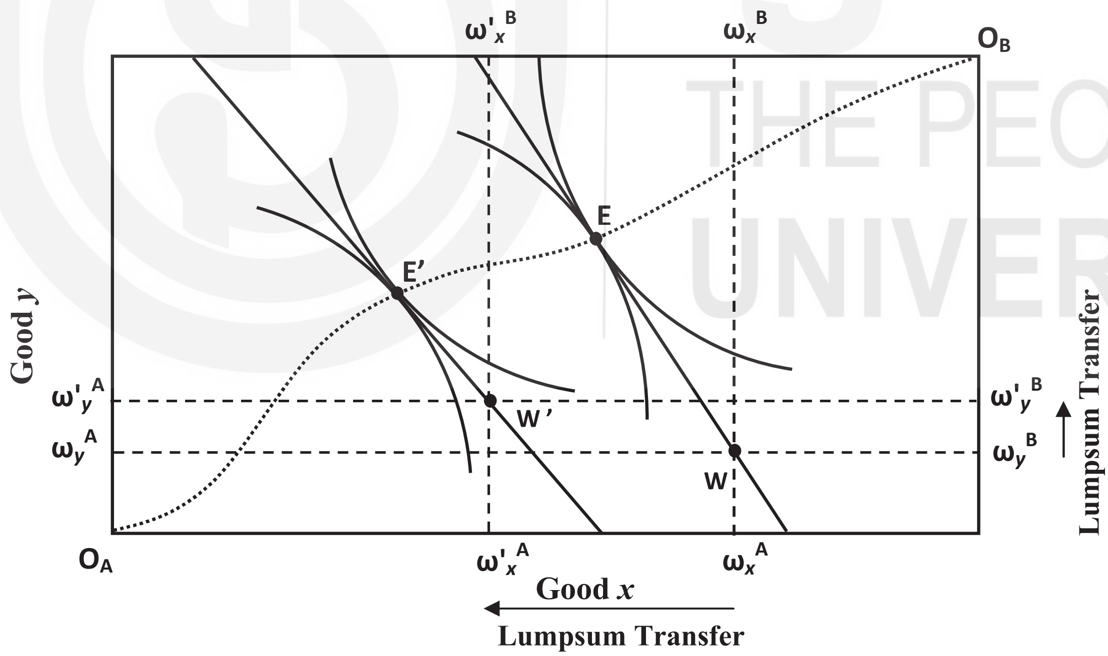

Fig. 8.6: Second Fundamental Theorem of Welfare Economics

Check Your Progress 3

1) a) State and prove the Walras' Law.

b) In an economy consisting of five markets dealing in five different commodities, determination of relative equilibrium prices in just four markets will suffice as an overall general equilibrium. Briefly explain this claim with reference to the Walras' law.

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2) Walrasian equilibrium is Pareto optimal, do you agree? Answer with appropriate proof for your claim.

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3) The Second Fundamental Theorem of Welfare Economics treats the concepts of efficiency and equity distinctly. Explain.

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8.7 LET US SUM UP

Efficiency or Pareto optimality is the situation of maximum outcome with minimum costs. In economic theory, Pareto optimality is attained when it becomes impossible to make someone better off without making someone else worse off. Such a condition is a characteristic feature of a Competitive or a Walrasian equilibrium. The present unit explained this feature within a General Equilibrium framework, where free market trade resulted in a Pareto optimal/ efficient competitive equilibrium.

We used the tools like an Edgeworth box, to explain the condition for Pareto Optimality and the market trade mechanism, in order to arrive at competitive equilibrium. It was followed by the algebra of General equilibrium, which was then followed by the Walras' law. Subsequently, a formal algebraic proof was provided to establish that competitive equilibrium is Pareto optimal/ efficient. This was further demonstrated in terms of efficiency and equity by the First and the Second Fundamental theorems of Welfare Economics.

8.8 ANSWERS OR HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Economic Efficiency refers to a state of optimal allocation of scarce resources among different economic agents. Yes, both Pareto Optimality and Economic efficiency mean the same. They both refer to reaching a best possible allocation of scarce resources, so that no

reallocation can make someone better off without making someone else worse off.

2) a) Refer Section 8.3 and draw.

b) Pareto set is given by $x_a = y_a$ or $x_b = y_b$.

Hint: Refer Example 1 under Sub-section 8.3.1. A Pareto set is composed of all those allocations at $MRS^A = MRS^B$. Here, $MRS^A = \frac{1}{2}\frac{y_a}{x_a}$ and $MRS^A = \frac{1}{2}\frac{y_b}{x_b}$.

3) Refer Sub-section 8.3.2 and answer.

Check Your Progress 2

1) Refer Section 8.4 and answer.

2) $x_a = y_a = \frac{5}{3}$ and $x_b = y_b = \frac{4}{3}$, and equilibrium price ratio $\left(\frac{P_x}{P_y}\right)^* = \frac{1}{2}$.

Hint: Refer Example 2 under Section 8.4 and answer. Demand functions of each individual for each good will be given by: $x^A = \frac{1}{3}\frac{M^A}{P_x}$; $y^A = \frac{2}{3}\frac{M^A}{P_y}$; $x^B = \frac{1}{3}\frac{M^B}{P_x}$; $y^B = \frac{2}{3}\frac{M^B}{P_y}$.These can then be solved to find the equilibrium price ratio and the associated quantity demanded of each good.

Check Your Progress 3

1) a) Refer Sub-section 8.5.2 and answer.

b) This is true, that for an economy of five markets, estimation of relative equilibrium prices of just four markets will be adequate for determining an overall general equilibrium. This claim is based on the Walras' Law identity: $P_x z_x(P_x, P_y) + P_y z_y(P_x, P_y) \equiv 0$, which holds true for any price vector and not just equilibrium price vector. That is, if all the five markets are in equilibrium at a price vector given by (P_1, P_2,P_3, P_4, P_5), then they will also be at equilibrium at a relative price vector given by $\left(\frac{P_1}{P_5}, \frac{P_2}{P_5}, \frac{P_3}{P_5}, \frac{P_4}{P_5}, 1\right)$. Thus, relative equilibrium prices of just four markets will then be required to be estimated for overall general equilibrium.

2) Refer Section 8.6 and answer.

3) Refer Sub-section 8.6.2 and answer.

8.10 REFERENCES

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KEY WORDS

Average Cost Function : Derived by dividing cost function with the output level, average cost function determines per unit minimum cost of producing a specific level of output, given the per unit factor prices.

Average Revenue (AR) : TR per unit of goods and services is AR, which is determined by dividing TR with total output.

Break-even : Level of output where TR = TC or AR = AC and Economic profits are zero or firm is earning normal profits.

Completeness : For all available alternative bundles A and B, the consumer should be able to make a categorical statement as to whether he regards A to be at least as good as B, B to be at least as good as A, or both. That means our consumer does not suffer from lack of information.

Consumer Surplus : A measure of consumer's benefit, it is given by the difference between the amount the consumers are willing and able to pay for a good or service and the amount that they actually pay.

Compensating Variation : As a monetary measure of utility change, it tells us how much money should be given to the individual to compensate him or her for the price change.

Constant Returns to Scale (CRS) : When all factors of production are increased in a given proportion, output increases in exactly the same proportion.

Capital Deepening Technical Progress : Technical progress is capital-deepening (or capital using) if along line on which K/L ratio is constant, $MRTS_{LK}$ increases.

Concave Function : A function f(x) is said to be concave on an interval if, for all *a* and *b* in that interval, $f(ta + (1 - t)b) \geq t f(a) + (1 - t) f(b)$ for $t \in [0,1]$.

Conditional Factor Demand Functions : A function of factor prices and output, specifying cost minimising levels of factors employed to produce a specific level of output at the given per unit factor prices.

Constrained Optimisation : It is the process of finding the optimal values of certain variables, that is,

		optimising them with respect to one or a series of constraints.
Cost Function	:	It is given by, C (w, r, Q*) = L*(w, r, Q*) w + K* (w, r, Q*) r. A function of factor prices and output, cost function gives the minimum cost of producing a specific level of output (Q*), given the per unit factor prices (w and r).
Cost Minimisation	:	A basic rule determining the optimal mix of factors to produce a specific level of output at the least cost.
Convex Function	:	A function f(x) is said to be convex on an interval if, for all *a* and *b* in that interval, $f(ta + (1 - t)b) \le t f(a) + (1 - t) f(b)$ for $t \in [0,1]$.
Contract Curve	:	It is a set of all Pareto optimal allocations of resources among two economic agents in the Edgeworth box.
Discrete Good	:	A good available only in discrete amounts, i.e. 1,2,3….. etc.
Decreasing Returns to Scale (DRS)	:	When all factors of production are increased in a given proportion, output increases proportionately less than inputs.
Equivalent Variation	:	As a monetary measure of utility change, it tells us how much money should be taken away from the individual at the original price to have the equivalent effect on his utility as that of a price change.
Expected Utility	:	Expected utility of an event having two or more possible outcomes occurring with some probabilities, is a weighted average of the utilities of each of its possible outcomes (with respective probabilities as weights).
Expected Value	:	It is the average value that a random variable takes, given the probability of occurrence of each value.
Elasticity of Technical Substitution	:	Given by the ratio of proportionate change in factor-proportions (or input ratios) to the proportionate change in marginal rate of technical substitution.
Expansion Path	:	A locus of efficient (or minimum cost) factor combinations, given by the tangency between the isoquant curves and the isocost lines, for different output levels.

Equilibrium	:	Equilibrium indicates state of balance. Firm is said to be in equilibrium when it has no incentive to change its level of output.
External Diseconomies	:	External diseconomies accrue to the firm, when increase in the industry's output leads to upward shift in cost curves, indicating increase in cost of production for each level of output.
External Economies	:	External economies accrue to the firm, if expansion in the supply of industry shifts cost curves downward, i.e., reduces cost for each level of production.
Efficiency	:	It is the state resulting in maximum possible outcome from employment of minimum possible inputs.
Edgeworth Box	:	A tool of General equilibrium analysis, it is used to analyse market trade between two economic agents trading in two different commodities.
Firm	:	A Unit which employs factors of production to produce goods and services.
Gamble	:	A game of chance or an event with uncertain outcomes.
General Equilibrium	:	A simultaneous equilibrium situation in all the markets of the economy. *Please note*: General Equilibrium is also sometimes referred to as the Competitive or Walrasian Equilibrium.
Homogenous Function	:	A function f (x) is homogenous of degree k if $f(tx) = t^k f(x)$ for all $t > 0$.
Homothetic Function	:	A monotonic transformation of a Homogeneous function. $f(x)$ is homothetic if and only if $f(x) = g(h(x))$ where $h(\ .\ )$ is homogenous of degree 1 and $g(\ .\ )$ is a monotonic function.
Homogenous	:	Identical in all respects.
Indifference	:	If a consumer finds bundle A to be at least as good as bundle B and bundle B to be at least as good as bundle A, he is said to be showing indifference between A and B.
Indifference Curve	:	A locus of all the bundles that give equal level of utility or satisfaction to the consumer.

Indifference Map	:	A set of indifference curves in the commodity space.
Intertemporal Budget Constraint	:	Budget constraint that an individual faces when he has to make decision over two or more time periods. As per it lifetime consumption equals lifetime income.
Intertemporal Decision-making	:	When decision is made across the time periods.
Intertemporal Preferences	:	Preferences of an individual over bundles of intertemporal consumption, that is, preference for consumption in different time periods.
Isoquants	:	Isoquants are contour lines representing all those input combinations which are capable of producing the same level of output.
Isocost Line	:	This shows all the different combinations of two inputs that a firm can purchase or hire with given input prices and budget.
Increasing Returns to Scale (IRS)	:	When all factors of production are increased in a given proportion, output increases proportionately more than inputs.
Long-run Production Function	:	Technical relationship showing maximum output that can be produced by a set of inputs, assuming quantities of all inputs vary.
Linear Homogeneous Production Function	:	Homogeneous production function of first degree implies that if all factors of production are increased in a given proportion, output also increases in the same proportion. This represents the case of constant returns to scale.
Labour Deepening Technical Progress	:	Technical progress is labour-deepening if, along a radial through the origin (with constant K/L ratio), $MRTS_{LK}$ increases.
Long-run Cost Function	:	Given by, C_L (W, Q) =W X (W, Q), it gives the minimum cost of producing a specific level of output, given the factor prices, in the long-run, that is when all the factors become variable.
Long Run	:	It is a production period in which all factors of production (inputs) can be changed to increase output. None of the inputs will remain fixed.

Marginal Rate of Substitution	:	The rate at which the consumer can substitute one commodity for the other in his/her consumption bundle without changing the utility, or while remaining on the same indifference curve.
Marshallian Demand Curve	:	Marshallian demand curve gives the quantity of good demanded by a consumer at each price, given the income or wealth situation, and assuming all the other factors impacting demand for a good as constant.
Marginal Rate of Technical Substitution (MRTS)	:	MRTS is the rate at which one input can be substituted for another input with the level of output remaining constant.
Marginal Cost Function	:	Derived as a partial derivative of the cost function with respect to the output level, marginal cost function determines minimum addition to the total cost from producing an additional unit of output.
Marginal Cost (MC)	:	Change in Total cost (TC) incurred when there is very small change in quantity (Q) produced, which is determined by dividing change in TC with change in Q.
Marginal Revenue (MR)	:	Change in TR when there is very small change in quantity (Q) sold, which is determined by dividing change in TR with change in Q.
Market	:	Any medium through which buyers and sellers interact to exchange their goods and services.
Non-Discrete Good	:	Also called continuous goods, such goods can be purchased and sold in any amounts, like 0.1, 1.1, 1.5, …etc., and not just in discrete amounts.
Numeraire Good	:	A good in terms of which the prices of all the other goods are expressed. The price of such a good then becomes Re. 1. For example, consider two goods X and Y, with their prices being Rs. 5 and Rs. 10, respectively. If good X is to be considered as a numeraire good, then price of good Y will be Rs. 2X.
Neutral Technical Progress	:	Technical progress is neutral if it increases the marginal product of both factors by same percentage so that $MRTS_{LK}$ (along any radial) remain constant.

Normal Profit : It is minimum amount of profit that entrepreneurs are seeking to invest their resources in production. It is their transfer earning which indicates their returns from opportunity cost.

Output Elasticity : It measures responsiveness of output to change in quantity of a factor (or input). For a production function, Q = f (L), output elasticity is given by:

$\frac{\%\text{ change in } Q}{\%\text{ change in } L}$.

Probability Distribution : It is a schedule representing values a random variable takes, along with their probability of occurrence.

Perfectly Elastic Demand : Even if there is negligible change in prices, quantity would change by very large amount.

Pareto Optimality : An efficient allocation of resources, so that no further reallocation could make someone better off without making someone else worse off.

Pareto Improvement : It is referred to the reallocation of resources making at least one individual better off without making someone else worse off.

Quasi-linear Preferences : Preferences represented by the utility function of the form, U(x, y) = y + v(x), where y and x are the two goods, and *v*(*x*), a function of good x. Such preferences are called quasi-linear because the utility function is linear in one good (y) and non-linear in the other (x).

Reflexivity : Consumer has fully reflected on available choices, has no confusion, he does not waver in his assessment of any bundle A, that is, he does not end up regarding bundle A as inferior to itself.

Reservation Price : It is the limit to the price of a good or a service. From buyer's point of view it is the maximum price that a buyer is willing to pay; and from seller's point of view, it is the minimum price that a seller is willing to accept for selling a good or service.

Risk Aversion : A person who is not ready to take risk is called a risk averse individual and this behaviour is termed as risk aversion.

Risk Neutrality	:	A person who neither likes nor dislikes risk is called a risk neutral individual and this behaviour is called risk neutrality.
Risk Preference	:	Completely opposite to risk aversion is risk preference, where an individual prefers to take risk.
Strict Preference	:	If a consumer finds bundle A to be at least as good as bundle B but B is not at least as good as bundle A, he is said to be not indifferent between bundles A and B. Here, he strictly prefers bundle A over B.
Short-run Production Function	:	Technical relationship showing maximum output that can be produced by a set of inputs, assuming quantity of at least one of the inputs kept constant.
Short-run Cost Function	:	Given by, $C_S (W, Q, X_F) = W_V X_V (W, Q, X_F) + W_F X_F$, it gives the minimum cost of producing a specific level of output, given the factor prices, in the short-run, that is when there exist some fixed and some variable factors of production.
Short Run	:	It is a production period in which all factors of production (inputs) cannot be changed to increase output. Some inputs remain fixed.
Shut down	:	It is level of output where AR is equal to the minimum Average Variable Cost (AVC) and losses are equal to total fixed cost.
Super Normal Profit	:	It is also known as Economic profit, that is, firms are earning more than normal profit or greater than their opportunity cost.
Scarcity	:	It refers to the fundamental economic problem arising from the fact that resources are limited but society's demand for them is unlimited.
Transitivity	:	This property amounts to expecting consumer to be consistent in his choices. If bundle A is at least as good as B and bundle B is at least as good as C, then bundle A should be at least as good as C.
Total Revenue (TR)	:	TR is total proceeds from the sale of quantities of the product in the market. TR is determined by multiplying quantity with prices.
Uncertainty	:	It simply means lack of certainty, that is, when probability of occurrence of an event

is not 1. Certain events occur with probability 1.

Von Neumann-Morgenstern Theorem	:	In decision theory, the von Neumann-Morgenstern utility theorem shows that, under certain axioms of rational behaviour, a decision-maker faced with risky (probabilistic) outcomes of different choices will behave as if he or she is maximising the expected value of some function defined over those outcomes. This function is known as the von Neumann-Morgenstern utility function.
Weak Preference	:	Whenever a consumer finds bundle A to be at least as good as bundle B, we say, he has weakly preference for bundle A over B.
Walras' Law	:	Aggregate value of the excess demands across all the markets must equal zero. This implies, for general equilibrium to exist in a market economy— excess demand in any one market must be matched by an equal value of excess supply in some other market or markets.

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