

[Academic Script]

**Edgeworth Box** 

Subject:

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**Business Economics** 

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Unit – 3 General Equilibrium

Lecture – 1 Edgeworth Box

### **Academic Script**

### **1.** Partial Equilibrium and General Equilibrium Analysis

Partial equilibrium analysis is the study of equilibrium in one market in isolation. Therefore it focuses on explaining the determination of price and quantity in a given product or factor market when one market is viewed as independent of other markets. On the other hand, general equilibrium analysis deals with explaining simultaneous equilibrium in all markets when price and quantities of all products and factors are considered as variables. Thus in general equilibrium analysis the interrelationship among markets of all products and factors are explicitly taken into account to determine the market prices of several goods.

### 2. Edgeworth Box

### **Edgeworth Box**

Edgeworth box is a graphical representation of the exchange problem faced by the parties in a two good, two individual exchange economies.

## Edgeworth Box: General Equilibrium of Exchange and Consumption

A common tool in general equilibrium analysis is the Edgeworth box which allows the study of the interaction of two individuals trading two different commodities. This type of analysis draws on the use of indifference curve analysis to analyze this trading behavior.

Edgeworth Box diagram has been used to explain the general equilibrium of distribution of two goods between two individuals.

Edgeworth Consumption Box shows the indifference curves of the two individuals A and B describing their scale of preferences for the two goods. As we move upward from bottom-left to top right, individual a moves to the higher indifference curves and individual B moves to the lower indifference curves.

Fig.1 show that the general exchange equilibrium would lie somewhere on the contract curve, that is, the curve QT that passes through the tangency points of indifference curves of the two individuals. At these tangency points,  $MRS_{XY}$  of individual A equals the  $MRS_{XY}$  of individual B, which indicates the occurrence of the general equilibrium of exchange between the two individuals. Since the equality of  $MRS_{XY}$  of the two individuals exists at all points of the contract curve it is not possible to know at which specific point the general equilibrium of exchange will be reached.



Fig.1 General Equilibrium of Exchange

However, if the initial distribution of two goods X and Y between the two individuals A and B is known, it will be possible to find the boundaries within which the general equilibrium of exchange would lie. Thus, in fig.1 if the initial distribution of X and Y, between A and B is represented by point C then individual A has XA1 amount of good X and YA1 amount of good Y. The remaining quantity of good X, that is, X0 - XA1 = XB1 would be allocated to individual B and the remaining YB1 quantity of good Y would go to individual B. At this level of distribution, the indifference curves of the two individuals are intersecting.

But, the at point C cannot be the position of equilibrium for the two individuals, since both of them can gain or become better off if they exchange some quantities of the goods possessed by them and move to the contract curve. If through exchange of goods they move to point R on the contract curve, individual B reaches on higher indifference curve B4 that makes him better off while individual A is no worse off as he remains on the same indifference curve A2. On the other hand if they move to point S on the contract curve, individual A becomes better off and individual B is no worse off as compared to the initial position C. However, if they move to any point between R and S on the contract curve both the individuals will gain, as they will be reaching at higher indifference curves.

Where exactly on the contract curve, their equilibrium position of exchange will lie depends upon the bargaining power of each individual. With almost equal bargaining power of each individual the equilibrium position of exchange on the contract curve may lie at point E where both of them will gain almost equally. At point E on the contract curve individual A will exchange CK amount of commodity X for KE amount of commodity Y. Since point E lies on the contract curve which is the locus of the tangency points of indifference curves of the two individuals, marginal rate of substitution between the two goods (MRS<sub>XY</sub>) of individual A equals marginal rate of substitution between the two

goods (MRS<sub>XY</sub>) of individual B. Thus exchange of CK amount of commodity X for KE amount of commodity Y has will be settled between them at the equilibrium position E.

- 1. The general equilibrium of exchange attained at point E on the contract curve has the following important features:
- 2. The individuals maximize their satisfaction.
- 3. The exchange of goods between the two individuals implies that the quantity sold of each good equal the quantity purchased of the good.
- 4. The general exchange equilibrium also determines the exchange rate (i.e. relative prices of the two goods).
- The general equilibrium of exchange does not lead to the determination of absolute prices of goods but only relative prices of goods.
- 6. In Edgeworth Box the general equilibrium of exchange of the goods must lie on contract curve otherwise their  $MRS_{XY}$  will differ from each other.

# 3. Edgeworth Box: General Equilibrium of Exchange and Production

Factors of production are required to produce goods and the level of production depends upon the allocation of resources. Two goods and two factors analysis of general equilibrium considers four markets of which two are product markets and two are factor markets. Any change in the use of one factor for the production of goods X and Y will also affect the use of other factor. Thus the general equilibrium analysis determines the pattern of relative prices and quantities of the goods and factors at which all markets clear together and the four markets attain equilibrium simultaneously. The analysis is based on the certain assumptions:

- All units of labour are homogeneous and receive equal wages. Similar assumption is made for capital.
- 2. Availability of labour and capital is fixed and both of them are fully employed and utilized in the economy.
- 3. Production function allows transfer of labour and capital from one good to the other.
- 4. Technology is given which together with the factor endowments limits the production possibilities.

# Edgeworth Production Box and General Equilibrium of Production:

Dimensions of the Edgeworth Production Box represent the available fixed quantities of the two factors, labour and capital. In Fig.2, the horizontal axis measure the quantity of labour and the vertical axis measure the quantity of capital. For products X and Y, various isoquants are drawn in the box. For good X, the isoquants that represent successively higher levels of output like  $X_0$ ,  $X_1$ ,  $X_2$ ,  $X_3$  etc. are drawn with the bottom left hand corner  $O_X$  as their origin. Similarly for good Y, the isoquants that represent successively higher levels of as the represent successively higher levels that represent successively higher levels of output like Y<sub>0</sub>, Y<sub>1</sub>, Y<sub>2</sub>, Y<sub>3</sub> etc. are drawn with the isoquants that represent successively higher levels of output like Y<sub>0</sub>, Y<sub>1</sub>, Y<sub>2</sub>, Y<sub>3</sub> etc. are drawn with the top right hand corner O<sub>Y</sub> as the origin.



Fig.2 General Equilibrium of Production

Fig.2 shows that points R, M, Q, N, H are the tangency points of different isoquants of good X and Y. A curve RH joining the tangency points of isoquants is called the production contract curve. The general equilibrium of production under competitive conditions in the factor markets would lie somewhere on this production contract curve.

Various points in the box represent alternative allocations of factors between the two goods. For example, point T in the box shows that  $O_XL_1$  (or  $K_1T$ ) amount of labour and  $O_XK_1$  (or  $L_1T$ ) amount of capital are allocated to produce X and the remaining amount of labour TF and the remaining amount of capital TC are allocated to produce good Y.

But point T does not represent equilibrium position because from point T, the economy can move to a point M or N on the contract curve by re-allocating resources between the two goods where the output of one good increases without the reduction in output of other good. By reallocation of factors, if the economy moves to any point between M and N on the contract curve, say to point Q, the outputs of both the goods X and Y would be higher than at T. Thus, resource allocation implied by a point on the contract curve leads to greater output than those not on the contract curve.

Since the slope of an isoquant measures the marginal rate of technical substitution between the two factors labour and capital (MRS<sub>LK</sub>), at various points on the contract curve, the MRTS<sup>X</sup><sub>LK</sub> = MRTS<sup>Y</sup><sub>LK</sub>. The general equilibrium of production would lie at the efficient points on the contract curve.

In Fig.2, given initial factor allocation at point T, if general equilibrium of production occurs at point Q on the contact curve RH, it will determine the allocation of factors between the two goods and also the equilibrium production of the two goods. Thus, the general equilibrium of production at point Q, states that output X<sub>2</sub> of good X and Y<sub>2</sub> of good Y is determined. Besides, the general equilibrium of production also determines the ratio of factor prices i.e. the exchange rate of labour for capital. Thus at point Q, TS amount of labour will be exchanged for QS amount of capital.

However, on the production contract curve, the exact point at which the general equilibrium of production occurs depends upon the demand for goods X and Y. If the demand for good X is relatively higher than that of good Y, the equilibrium of production would take place on the upper point like N on the contract curve RH where a larger quantity of good X and smaller quantity of good Y are produced. On the other hand, for low demand for X and high demand for Y, the production equilibrium will occur at a lower point on the contract curve which indicates smaller output of X and larger output of Y. Thus, the exact point of equilibrium on the contract curve depends upon the specific consumer' demand for goods X and Y which in turn depends on the initial ownership of factors and the factor prices.

Thus the general equilibrium of production requires the simultaneous equilibrium of the two factor markets that determine the allocation of resources for the production of two goods. For an economy with many goods and many factors, the general equilibrium of production requires that the marginal rate of technical substitution between any pair of factors is the same for all goods and all producers are using the same pair of factors.

## 4. General Equilibrium of Production and Exchange

There are several points on the transformation curve. Each point indicates a different price ratio of the two goods and also a different production equilibrium that states a different output-mix of the two goods. The general equilibrium of production can occur at any of the points on the given transformation curve depending upon the prevailing price ratio of the two goods.

General equilibrium level of price ratio  $P_X/P_Y$  or the marginal rate of transformation  $MRT_{XY}$  will be the one at which the profits of firms and also consumer satisfaction is maximum. To analyze the general equilibrium of output-mix, consumer preference pattern or demand for goods is introduced. If the  $MRS_{XY}$  of the consumers is not equal to the  $MRT_{XY}$  in production, the consumer satisfaction will not be maximized due to which further changes in the price ratio of the two goods and output-mix will tend to occur.

Since  $MRT_{XY}$  shows the rate at which one good is 'transformed' into another in the production process and marginal rate of substitution measures the rate at which consumers are willing to exchange one good for the other, equilibrium cannot be reached unless the two rates are equal. In a free market economy, the forces of competition would ensure the adjustment in the outputmix of the two commodities such that,  $MRS_{XY}$  equals  $MRT_{XY}$ .

General equilibrium of production together with the general equilibrium of exchange (or consumption) requires that the marginal rate of transformation ( $MRT_{XY}$ ) must be equal to the marginal rate of substitution ( $MRS_{XY}$ ) of the consumers and also the  $MRS_{XY}$  of the two consumers must be equal to each other. Thus, for the achievement of general equilibrium of production and exchange simultaneously

 $MRT_{XY} = MRS^{A}_{XY} = MRS^{B}_{XY}$ 

Overall general equilibrium of production and exchange is explained using Fig.3 and Fig.4. In Fig.3 a production transformation curve TT' is drawn. Consider point L on the curve TT' at which OM of good X and ON of good Y are produced. With the given preference pattern and resource endowments of the two consumers, their indifference curves are drawn within the box which are tangent to each other at point S and their  $MRS_{XY}$  is indicated by the slope of the tangent line kk'.



Fig.3: General Disequilibrium (MRT<sub>XY</sub>  $\neq$  MRS<sub>XY</sub>)

Fig.3 shows that the  $MRS_{XY}$  of consumers at point S is less than  $MRT_{XY}$  of producers at point L indicating that production pattern is inconsistent with the consumer preferences. Thus the system is in disequilibrium because the firms produce relatively greater quantity of X and smaller quantity Y is being produced than demanded by the consumers. In response to this disequilibrium situation and to maximize profits, the producers tend to produce more of Y and less of X and the process of adjustment in outputmix will continue until the  $MRT_{XY}$  in production is brought into equality with  $MRS_{XY}$  of consumers. With this equality, general equilibrium of production and exchange (consumption) will be attained which is presented in Figure 4.

At point Q' on production transformation curve TT' in Fig.4, OX2 level of output of X and OY2 level of output of Y are produced and MRT<sub>XY</sub> at point Q' equals MRS<sub>XY</sub> at point E (slopes of JJ' and PP' are equal). Producers are in equilibrium because at Q' the marginal rate of transformation MRT<sub>XY</sub> equals the price ratio  $P_X/P_Y$ as measured by the slope of PP'. There is general equilibrium of exchange or consumption as  $MRS_{xY}$  of the two individuals are the same (their indifference curves being tangent to each other at point E).



Fig.4 General Equilibrium ( $MRT_{XY} = MRS_{XY}$ )

There is joint equilibrium of production and exchange as the  $MRT_{XY}$  which determines the price ratio  $P_X/P_Y$  at point Q' also equals the  $MRS_{XY}$  of the two individuals at the consumption equilibrium point E. Thus, with point Q' on transformation curve TT' and point E on the consumption contract curve drawn in the Edgeworth Box made from point Q', the following condition of general equilibrium of production and consumption is fulfilled

$$MRT_{XY} = (P_X/P_Y) = MRS^{A}_{XY} = MRS^{B}_{XY}$$

General equilibrium of production determines total output  $X_2$  of commodity X and total output  $Y_2$  of commodity Y. It is with  $OX_2$ and  $OY_2$  as the dimensions, the Edgeworth Box is drawn and indifference curves of two individuals depicting their scale of preferences are drawn with CC' as the contract curve. Consumption equilibrium point E reveals that out of total output  $X_2$  of good X the amount  $X_A$  is being consumed by individual A and the remaining amount of X goes to individual B for consumption. Out of total output  $Y_2$  of commodity Y, the amount  $Y_A$  is consumed by A and the remaining amount by the individual B.

#### **5. General Equilibrium Determines Only Relative Prices**

The micro-economic theory is concerned with the analysis of factors that determine relative prices and not absolute prices. Relative price is the price of a good or factor when compared with the price of another good or a factor. In other words, relative price is the ratio of prices of goods. The analysis of general equilibrium shows that factor prices is the ratio of the price of labour to the price of capital (w/r), which is measured by the common slope of the isoquants at the tangency points of the relevant isoquants that was determined. Likewise, in general equilibrium of exchange it was explained how general equilibrium determined the ratio of the prices of two goods i.e., (Px/Py).

General equilibrium in Fig.4 is established at point Q' on the transformation curve TT' where  $MRT_{XY} = MRS^{A}_{XY} = MRS^{B}_{XY}$ . This yields the relative prices of goods X and Y, indicated by the ratio Px/Py which is measured by the slope of the transformation curve at that the equilibrium point Q'. It is important to note that it is the relative prices and not the absolute prices that from the general equilibrium analysis show. Therefore if all the prices change by a common multiplier (like doubling or halving of all the prices), then the relative prices will remain the same and hence there will not be any change in the equilibrium position.

For example, suppose the relative prices Px/Py of two goods X and Y, as measured by the marginal rate of transformation at point Q' in Fig.4 is 2/1 and the relative price of labour and capital (w/r) as measured by the slope of the isoquants at point Q, in Fig.2 is 3/1.Further suppose price of good X is Rs. 20 and the price of good Y is 10, so that relative product prices are 20/10 =2/1 and the price of labour (w) is Rs. 30 and the price of capital (r) is Rs. 10. So the relative factor prices w/r (30/10) equals 3/1. Now, if all prices are doubled, Px = 40 and Py = Rs. 20, and w =Rs. 60 and r = Rs. 20, then the relative prices of products Px/Py= 40/20 = 2/1 and relative factor prices w/r = 60/20 = 3/1. Since the relative prices have remained unchanged despite a change in their absolute levels, the position of general equilibrium would remain unaltered. In real terms nothing would change. Consumers would receive twice the payments or income but would buy exactly the same quantities of goods X and Y. Each firm would earn double the total revenue than before but would buy and employ the same amounts of factors at the double rate of factor prices. Thus microeconomic theory lays stress on the determination of relative prices because they are critical in the determination of the real outcome

#### 6. Summary

General equilibrium analysis is used to explain simultaneous equilibrium in all the markets when price and quantities of all products and factors are considered as variables. Edgeworth box is an important method for the analysis of general equilibrium. Edgeworth box allows the study of the interaction of two individuals trading two different commodities. This type of analysis draws on the use of indifference curve analysis to examine this trading behavior. The analysis of general equilibrium is used to determine the relative prices of goods or factors of production.