Chapter Four
FACTOR PRICING AND INCOME DISTRIBUTION

4.1 INTRODUCTION

What are the determinants of income distribution in an economy? Ownership of resources and their prices are major determinant of money income. They also determine allocation of resources to various uses and firms. In this chapter, we examine how prices of productive resources are determined. The economy's income is distributed in the markets for the factors of production. The four factors of production are labor, capital, land and entrepreneurship. These factors of production are, respectively, compensated with, wage, interest, and profit. Such income distribution between the factors of production is called functional income distribution; and the theory of factor prices is popularly known as the theory of distribution.

How much the factors receive depends on the demand for them, which is derived demand that comes from firms that use the factors to produce goods and services. Competitive, profit maximizing firms hire each factor up to point at which the value of the marginal product of the factor equals its price. The price paid to each factor adjusts to balance the supply and demand for the factor. Because factor demand reflects the value of the marginal product of that factor, in equilibrium each factor is compensated according to its marginal contribution to the production of goods and services and hence revenue.

In this chapter, we analyze factor demand by considering how a competitive, profit maximizing firm decides how much of any factor to buy. We begin our analysis by examining the demand for labor, which is the most important factor of production. In modern economies, workers receive most of the national income, which makes labor the most important factor of production. Later, we introduce the supply side and analyze the wage and employment determination under different market conditions. Once we assure comprehensive understanding of the principles governing labor, we will make applications of the lessons learnt therein to the market for other factors of production. Finally we analyze income distribution with emphasis on factor substitution and technical progress.

Chapter Objectives

At the end of this chapter, you should be able to:

- Analyze the labor demand under perfect and imperfect product and labor markets
- Learn why equilibrium wages equal the value of the marginal product of labor
- Derive and identify the short run and long run demand for labor
- Consider how the other factors of production-land and capital are compensated.
- Examine the determinants of distributive income share of factors

Chapter Outline

4.2 DEMAND OF A FIRM FOR FACTORS OF PRODUCTION

Although in many ways factor markets resemble the goods markets you have analyzed in parts of your previous Module and the present one, they are different in one important way. That is the demand for a factor of production is a derived demand. A firm's demand for a factor of production is derived from its decision to supply a good in another market.

For example, *ceteris paribus*

- The demand for brick layer is closely tied to the demand for houses.
- The demand or apple pickers is derived from the demand for apple.

- To add an example form service, the demand for tourist guide is derived from the demand for the service.

4.2.1 Optimum Input Use with One Variable Input

We begin by reviewing production theory which was discussed in your Module Two of Microeconomics I, and then bridge you to the main parts of the chapter. Suppose that a firm uses labor (L) and capital (K) inputs and the production function is $TP = f(L, K)$. If we are not able to vary both input in the short run, the change in TP occurs due to change in the variable factor only. For instance, if capital is kept constant the production function becomes $TP = f(L, \overline{K})$. It can be recalled that, among the stages of production, the technically feasible level of employment of a variable input is the range where its marginal productivity is positive and the average productivity is falling. Since information conferred by MP_L (along with relative prices of inputs) is crucial for profit maximizing firms, we give it equally important weight in deriving demand for labor. Now important questions come to be: can we get useful information from a production function in order to derive demand for labor? If so how? In order to answer this question we first mathematically present the relationship between demand for labor and MP_L. Then we depict the relationships with the use of graphs.

According to our marginal principle (which is clearly known so far) a profit maximizing firm optimizes at the equality of marginal revenue and marginal cost of an extra unit of product:

$$MC = MR$$

It can be recalled that MC is addition to total cost of a firm in producing a unit of extra output. Using an equation,

$$MC = \frac{\Delta TC}{\Delta Q}.$$

Since dividing both the numerator and denominator in the right hand side by ΔL does not change the equality, the above equation becomes:

$$MC = \frac{\Delta TC / \Delta L}{\Delta Q / \Delta L}$$

$\Delta TC / \Delta L$ =***w.*** This means, if the labor market is perfectly competitive and a firm employs labor at a given market wage, the change in total cost due to extra labor unit is just the wage rate.[1] The numerator of the above equation is clearly equal to marginal productivity of labor: $\Delta Q / \Delta L = MP_L$

Substituting and rearranging, we get:

$MC = \frac{w}{MP_L}$, meaning $\frac{w}{MP_L}$ gives the change in total cost per unit increase in output.[2]

Restating our initial points: to maximize profit, the firm must use the optimal or least-cost input combination to produce the best level of output. The best level of output for a perfectly competitive firm is the output at which. $MC = MR$

Thus it follows that to maximize profit,

$$\frac{w}{MP_L} = MC = MR\ .$$

By cross multiplication and rearranging the terms, we get:

$w = MR \times MP_L$ Marginal Revenue Product of labor (MRP_L)

if P=MR (Perfectly competitive product market),

$w = P \times MP_L$ Value of Marginal Product of labor (VMP_L)

Therefore, MRP_L or VMP_L is the demand for labor.

[1] *We will show later that marginal labor cost can be greater than the wage rate when the firm does have monopsony power in the labor market.*

[2] *Similarly,* $\frac{r}{MP_K} = MC$

Dear Learner, we have jut shown demand for labor is the ***marginal revenue product in general.***

Give your own definition to marginal Revenue product of a resource in general.

(Hint: $MRP = MR \times MP = \frac{\partial TR}{\partial L}$)

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Answer: In general, ***Marginal Revenue Product*** of a resource is a measurement of the change in the firm's total revenue from selling the extra or marginal physical product that results from employing one additional unit of a resource together with other fixed resources

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The profit maximizing rule is that

- The firm should hire until the marginal product of labor *times* the firm's marginal revenue or price of the commodity equals the wage rate.
- Similarly, the firm should rent capital until the marginal product of capital *times* the firm's marginal revenue or price of the product is equal to the rental price of capital.

To maximize profits, the same rule holds for all inputs that the firm uses.

Whereas the optimum is attained at the equality, the right hand side terms of the above equations represent the derived demand. Just focusing on labor, its demand is represented by *the change in the firm's total revenue from selling the extra or marginal physical product that results from employing one additional unit of labor together with other fixed resources*. This derived demand is commonly called *Marginal Revenue Product of labor* (MRP_L). In the case where the product market is perfectly competitive and MR=P, the demand for labor is called *Value of Marginal Product of labor* (VMP_L).

☺ ***Check Your Progress 1***

A firm sells its product at a given price of $10 per unit in a competitive market. In the first two columns of the table below, the short run technical relations between labor and output are given. Fill the remaining columns.

Labor (L)	***Quantity Produced (Q)***	***MP_L***	***TR***	***VMP_L***
0	0	-	-	-
1	100			
2	180			
3	240			
4	280			
5	300			

Alternatively way to derive Demand for Labor

Given capital, an the optimum level of labor is the level which maximizes profit, $\frac{\partial \pi}{\partial L} = 0$.

$$\pi = TR - TC$$
$$Q = Q(L, \overline{K})$$
$$TR = P(Q(L, \overline{K})) \times Q(L, \overline{K})$$
$$TC = wL + r\overline{K}$$
$$\pi = P(Q(L, \overline{K})) \times Q(L, \overline{K}) - [wL + r\overline{K}]$$

We initially begin with the assumption that w is function of L and P is function of Q. We will refine later where these are so or not.

The first order condition of the general function will be:

$$\frac{\partial \pi}{\partial L} = \underbrace{\frac{\partial}{\partial L}\left[P(Q(L, \overline{K})) \times Q(L, \overline{K})\right]}_{\frac{\partial TR}{\partial L} = MRP_L} - \underbrace{\frac{\partial}{\partial L}\left[w(L) \times L + r\overline{K}\right]}_{\frac{\partial TC}{\partial L} = MLC} = 0$$

$$\frac{\partial \pi}{\partial L} = \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial L}Q + P\frac{\partial Q}{\partial L} - \left[\frac{\partial w}{\partial L}L + \frac{\partial L}{\partial L}w\right] = 0$$

Rearranging and collecting identical terms,

$$\frac{\partial Q}{\partial L}\left[\frac{\partial P}{\partial Q}Q + P\right] = \left[w + \frac{\partial w}{\partial L}L\right];$$ Notice that $\frac{\partial P}{\partial Q}$ is negative while $\frac{\partial w}{\partial L}$ is positive

(See Table 4.1 and 4.2 for more clarification).

From the equation, we do have

$$\frac{\partial Q}{\partial L} = MP_L \quad \text{and} \quad P - \left|\frac{\partial P}{\partial Q}\right|Q = MR$$

Generally, we will have equilibrium condition

$$\underbrace{MP_L\left[P - \left|\frac{\partial P}{\partial Q}\right|Q\right]}_{\substack{Marginal\ Revenue\ Product \\ \Downarrow \\ Demand\ for\ labor}} = \underbrace{\left[w + \frac{\partial w}{\partial L}L\right]}_{\text{Marginal Labor Cost}}$$

The left hand side of the above equation represents demand for labor (Marginal Revenue Product). It can be written as:

$MRP_L = p(1 - \left|\frac{1}{\varepsilon_p}\right|)MP_L$, *where* ε_p *is price elasticity of the product demand.*

As $|\varepsilon_p|$ rises, demand for labor becomes more elastic. At the extreme when $|\varepsilon_p|$ is infinite (the firm's product demand is perfectly elastic), $(1 - \left|\frac{1}{\varepsilon_p}\right|)$ becomes zero and the demand for labor becomes its Value of Marginal Product (VMP_L)

$VMP_L = PMP_L$

The interpretations of the foregoing mathematical treatments can be summarized in the table 4.1 and Figure 4.1. From our equations above do have also the marginal factor cost which stands for the supply side. However, for the sake of convenience in exposition, we will not treat the supply side until *section 4.4 and 4.5*. Therefore *Table 4.1* and *Figure 4.1* summarize only the demand side regardless of the equilibrium outcomes.

Table 4.1 ***Summary of the Firm's***

Short Run Demand for Labor

Product Market Condition	***Demand for Labor***
Perfect: A firm sells as much as needed at a given price. Hence, MR is equal to price. $\frac{\partial P}{\partial Q}Q = 0$	***Value of Marginal Product (VMP$_L$)*** $\underbrace{MP_L P}_{VMP_L}$
Imperfect: A firm with monopoly power sells more by reducing price. If so, $\frac{\partial P}{\partial Q}Q < 0$. Hence, MR<P	***Marginal Revenue Product (MRP$_L$)*** $MP_L MR$ *Labor is paid less than the value of its Marginal product due to Monopolistic power*

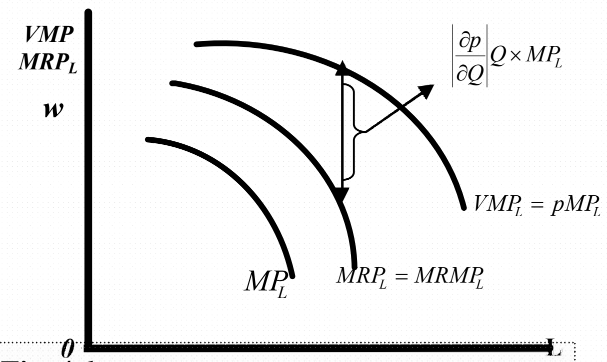


Fig 4.1. Derived Short Run Labor Demand Curves in with Perfect and Imperfect Product Market conditions.
On the vertical axis are VMP$_L$,, MRP$_L$ and w.
As wage declines and more labor is demanded, the firm moves along the VMP$_L$ or MRP$_L$

☺***Check Your Progress 2***

Suppose that the market product demand for an industry of 100 identical, *perfectly competitive* firms is $Q = 350 - 5p$ and the individual supply is $Q = 2 + 0.05p$.

The firms in the industry employ homogeneous workers, whose marginal productivity is $MP_L = 8 - 0.5L$.

Required: Based on the above,

Determine the function of demand for labor of a perfectly competitive firm in this industry. (Graphical aid is useful)

4.2.2 Optimum Input Employment With Two Variable inputs

Suppose that a firm uses labor (L) and capital (K) inputs and the production function is $Q = f(L, K)$. The firm maximizes profit subject to a given outlay (B), $B = wL + rK$, where ***w*** is wage rate and ***r*** is rental price of capital. The least input combination of a firm will be

$$\frac{MP_L}{w} = \frac{MP_K}{r}$$

where MP refers to the marginal (physical) product.

The above equation indicates that to minimize production costs, the extra output or marginal product per dollar spent on labor must be equal to the marginal product per dollar spent on capital. Another way of expressing this is that at optimum resource utilization, the ratio of marginal productivities of the resources is equal to the ratio of their prices:

$$\frac{MP_L}{MP_K} = \frac{w}{r}$$

This is depicted in *Figure 4.2* by the use of isocost line and iscost curves.

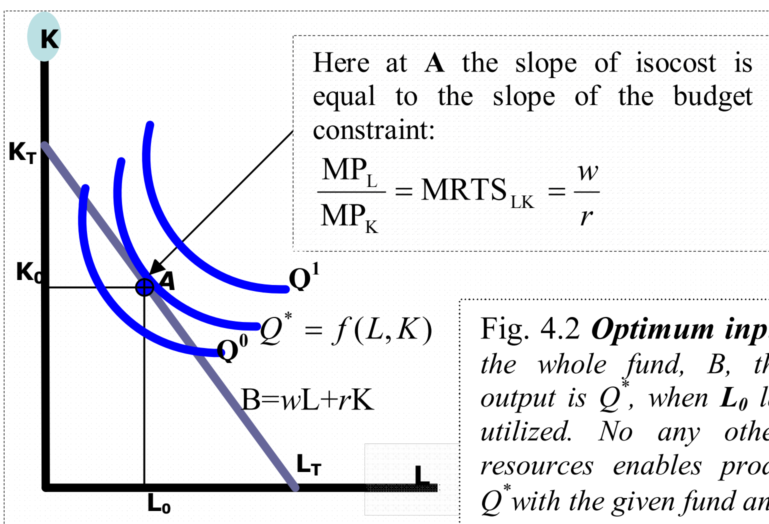


Fig. 4.2 ***Optimum input Combination***. *Using the whole fund, B, the maximum attainable output is Q^*, when **L_0** labor and **K_0** capital are utilized. No any other combination of the resources enables production of as much as Q^* with the given fund and input prices.*

Check Point↘:

(i) ***If MP_L=8, MP_K=10 and wage rate and rental price of capital are equal, is it least cost combination? If not what could be done?***

The answer is clearly No! If w=r, the inequality becomes $\frac{MP_L(=8)}{w} < \frac{MP_K(=10)}{r}$, *meaning the firm is getting more extra output for a dollar spent on capital than on labor. Remember that the factor prices are given. What the firm can do is changing the input combination. To minimize cost, therefore, the firm would have to hire more capital and less labor. As the firm does this, MP_K falls and MP_L increases (because of diminishing returns). The process would have to continue until equality is attained.*

(ii) ***If MP_L=8, MP_K=10 and w=4 and r=5, is it least cost combination?***

Now, the answer is ***yes*** *it is least cost combination since* $\frac{8}{4} = \frac{10}{5} = 2$. *Meaning the firm is getting equal extra output for a dollar spent on each factor.*

☺***Dear learner****, this exercise is meant to remind and reinforce what you have learnt in Microeconomics I and bridge you to the present.*

Now, if relative price of the inputs changes and the firm varies both labor and capital, what will the demand for labor look like? In *section 4.2.1* we have assumed that as wage declines and more labor is demanded, the firm moves along the VMP_L or MRP_L. This assumption is valid in the short run because in drawing the demand curve of labor, the fixed cooperating factors in the production process such as capital are given and constant. Therefore, in searching answer for the preceding question, we build on the foregoing analysis of isocost-isoquant approach we have just made. Assume that both labor and capital are variable. Specifically speaking, we analyze how the optimum input combination changes. Then we trace these points of equilibria over various input relative prices. To do so, let us assume that the rental price of capital, *r* remains constant and wage rate, *w* falls (and hence $\frac{w}{r}$ falls). Using Fig.4.3, the budget constraint rotates outward with the center at K_T, the optimum being reached at higher isoquant where at least more of the cheaper input, labor will be employed.

Let's conceptualize the effect of relative input price change before we use our simple model. Intuitively, if wage falls while rental price of capital is kept constant, the firm can produce the previous level of output but by using more of the cheaper input-labor- and less of the relatively expensive one-capital. In other words, less of the available fund can be used and the same level of output can be maintained, but with different combination of inputs. On the other hand, if the whole available fund is used, it is plausible to make further use of additional inputs (even including complementary capital input) and produce more. That is, in the long run a firm would make appropriate adjustment in the amount of capital employed when the amount of labor used changes in response to changes in wage rate. Considering that the two factors, labor and capital are complementary, the increase in the amount of labor used, when wage rate declines would lead the firm to adjust the quantity of capital (and other fixed factors) in the long run.

Let us make a long pause here and give you an activity.

Activity: ***Using your previous knowledge***

In your ***Microeconomics I***, *Theory of Consumer Demand chapter*, you were able to decompose the price effects into income and substitution effects. Recall of the case of two normal goods, X_1 and X_2. Draw a graph where you have X_1 and X_2, respectively, on the horizontal axis and vertical axis. Using well behaved indifference curves of a consumer and budget constraint, show an optimum combinations of the good. Later, assume price of X_1 falls while that of X_2 remains unchanged. Show the new equilibrium and decompose the price effects into substitution and income effects. Remember that you are doing this for two normal goods. (You can refer to Fig. 2.27 on page 64 of Module I of Microeconomics I).

Well, now use this analogy for complementary (also substitute to some degree) labor and capital inputs, where you now use ***isocosts*** instead of the consumer budget constraints, ***isoquants*** instead of indifference curves, and fall in price of labor instead of that of commodity X_1..

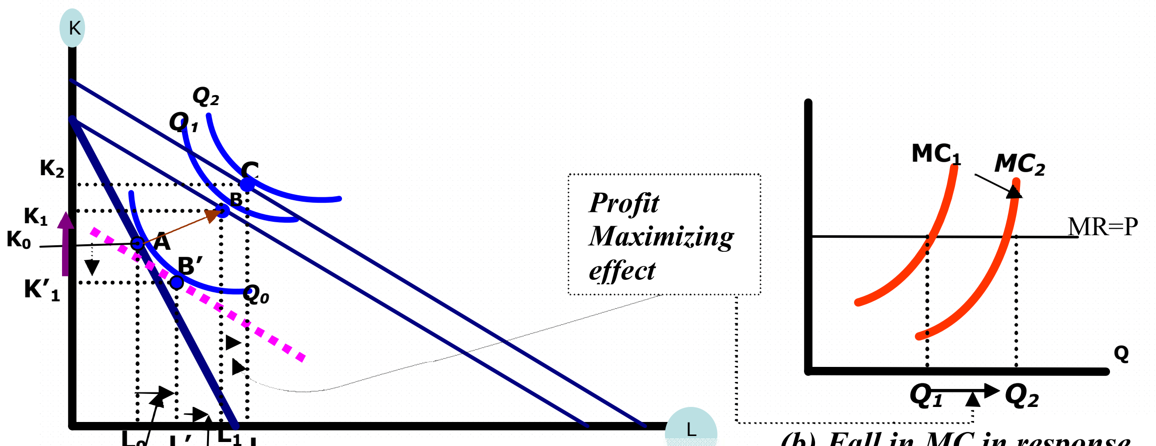
If you have properly done this, the movement on the isoquant curve is, indeed analogously, the ***substitution effect***. The other effect on both of these inputs is the ***output effect***, which is positive alike the income effect in your previous example. What is left? There is even further effect which we will see together.

Switching to Fig. 4.3, Panel (***a***), the firm was initially at *point A*, producing Q_0 by employing L_0 and K_0. Due the wage decline, the new equilibrium will be at *C*, where Q_2 is produced by optimum utilization of L_2 and K_2 units of the inputs. In decomposing this wage decline effect we will have the following components.

1. *Price effect: A to B*
   - *Substitution effect: A to B'*
   - *Output effect: B' to B*
2. *Profit maximization effect: B to C.*

1. **Price effect**. Consider 4.3 Panel (A), the fall in price of labor (*w*) results in flatter isocost, showing the decline in relative price. If we conceive, however, that the firm is made produce only the previous level, Q_0, at the new input relative prices, the movement will be from A to B. this is ***Substitution effect***. That is, some of labor whose price has fallen substitutes capital. If so, unambiguously more of the former and less of the latter will be used to produce as much as what had been produced before.[3] When the output is kept constant with the new prices, the total outlay will not be fully used. If the firm uses full of it, more of both inputs will be employed to produce more generating **Output Effect,** which is the movement from B' to B in the figure.

[3] You are advised to analogously use the concept of compensated budget line in your Module One of Microeconomics I, section 2.6 page 64.



(a) Wage change and input use adjustment

(b) Fall in MC in response to decline in wage rate

***Fig.4.3 Price and Profit Maximization Effects** (i) **A to B′ is Substitution effect**. Relative input price change has resulted in input substitution. That is, labor whose price has fallen substitutes capital and movement is along the same isoquant (ii)* **B' to B is Output effect**. *where more of both inputs are employed to produce more by using the whole fund. (iii)* **B to C is Profit Maximizing effect**, *where even additional fund can be used to maximize profit by producing Q_2 in response to fall in MC (panel b)*

2. Profit Maximizing effect. It can be recalled that the profit maximizing point for firm is the level of output where MC=MR. When wage declines, total cost and unit costs will be less at a given level of output. Hence, profit maximizing levels of output and employment will be greater (see Panel (B) in Fig. 4.3) If greater fund is used and profit is to be maximized, Q_2 will be produced instead of Q_1. The effect on both factors will be positive.

So far we have discussed how adjustment of the inputs utilization is made in the long run in response to relative price change. The next step is deriving the demand for a factor (labor in our example). Considering labor, whose price is assumed to change and using the foregoing discussion, we will derive the firm's long run demand for labor.

The adjustments in capital, we have seen above, make it appealing that in the long run decline in wage will cause only movement on the short run demand curve depicted in Fig. 4.1. Rather, the demand curve becomes more elastic in the long run. Before we show this, let us briefly revise the production theory of our previous Module I using Fig. 4.4.

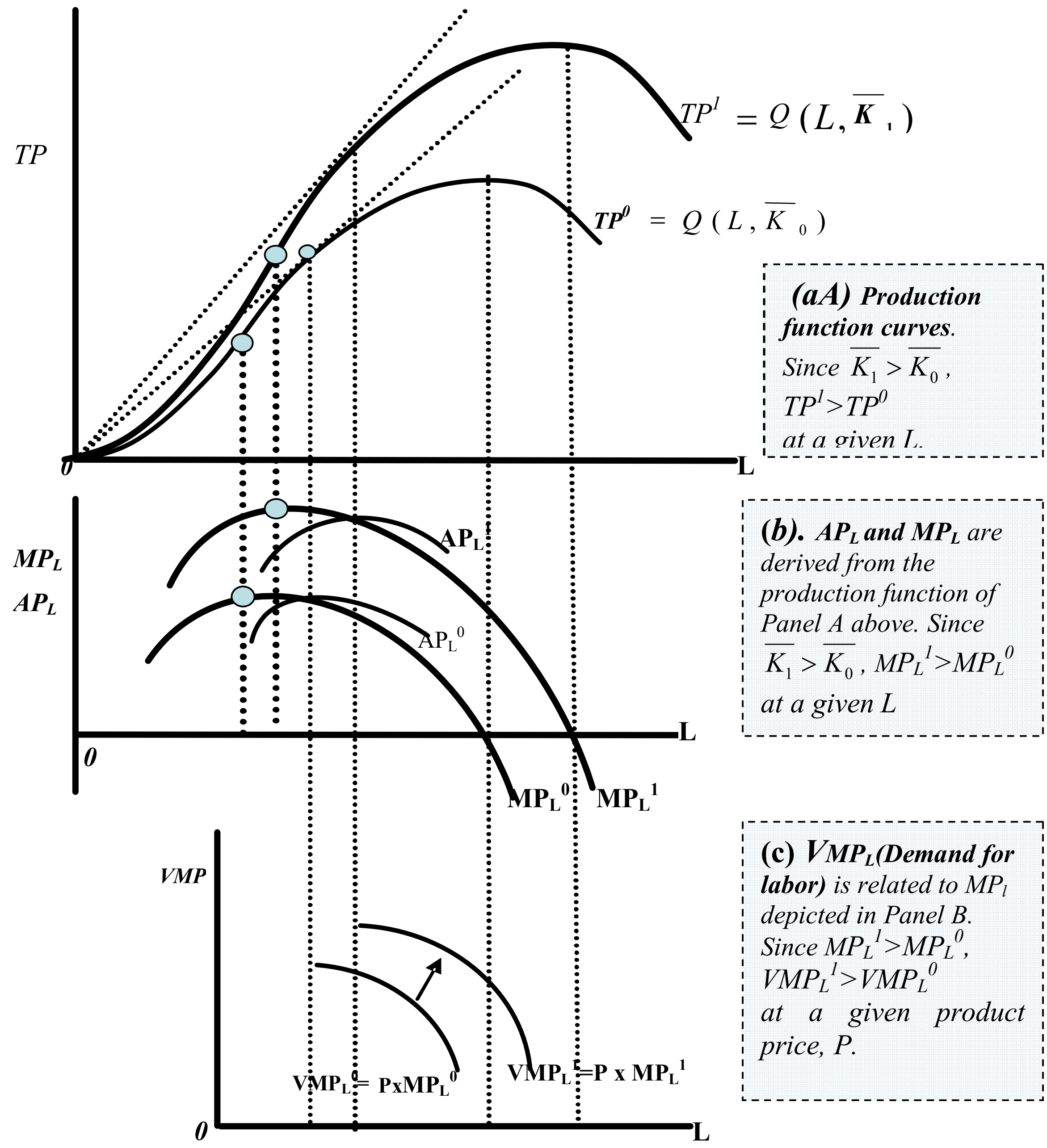


Fig. 4.4 ***Production Function, Change in Capital and Demand for Labor***: *MP_L of labor is the change in TP (Total Product) as a result of an extra unit of labor input. The relevant portion of MP_L is the positive range beyond the maximum of AP_L (that is technically feasible part of the production function). The product of MP_L over relevant portion and product price, P gives demand for labor (called Value of Marginal Product, VMP) curve. Given product demand, rise in labor productivity due to higher level of capital, leads to higher demand for labor. This is depicted in the figure where the shifts in TP in* ***Panel (a)*** *and unit product curves in* ***panel (b)*** *are followed by shift in the Value of Marginal Product curve in the same direction (****panel (c)****).*

Consider the three panels in Fig. 4.4, in which we do have (***a***) total product curve and (***b***) unit products curves followed by (***c***) demand for labor curves. Initially, the firm was employing fixed capital, $\overline{K_0}$ and the total product curve corresponding to this level of capital with variable labor is TP^0. However, if the firm gets appropriate adjustment time and raises capital to $\overline{K_1}$, the total product curve becomes TP^1, which lies above the previous one at each level of labor input. Besides, the corresponding unit product curves in panel (*b*) shift upward and to the right. Of our main focus is MP_L which closely determines the demand for labor. When capital is raised from $\overline{K_0}$ to $\overline{K_1}$, marginal productivity of labor increases, as can be seen in panel (***b***) of Fig 4.4, where MP_L^0 shifts to MP_L^1. As a consequence of increased productivity, the demand for labor increases, in turn, shown in panel (***c***). The reason is that the demand for labor is the product of marginal productivity and marginal revenue (or price for competitive firms), as we have seen in our previous short run treatments.

It can be learnt from the foregoing revision of production function, as labor is used with more capital its productivity increases and hence, VMP_L shifts up rightwards.

We have already been convinced that:

> ***As wage declines, not only more of labor is used, but also output and profit maximization effects lead to utilization of more capital.***

Now, we have come to the point of deriving long run demand for labor. Let's switch to Fig. 4.5 for illustration. If we begin from w_0, the short run demand for labor is VMP_L^0. Decline in wage leads to shift in VMP_L in the long run. The greater the wage decline, the greater will the shift in VMP_L be. If you assume various wage rates, like w_1', w_1'' and w_1 and connect the intersections of various ***w's*** and corresponding VMP_L's with a curve, this curve will be the long run demand for labor, as can be seen in Fig. 4.5. The long run labor demand curve traces the locus of various wage rates and optimum units of labor when the firm makes adjustment for labor and other cooperating factors.

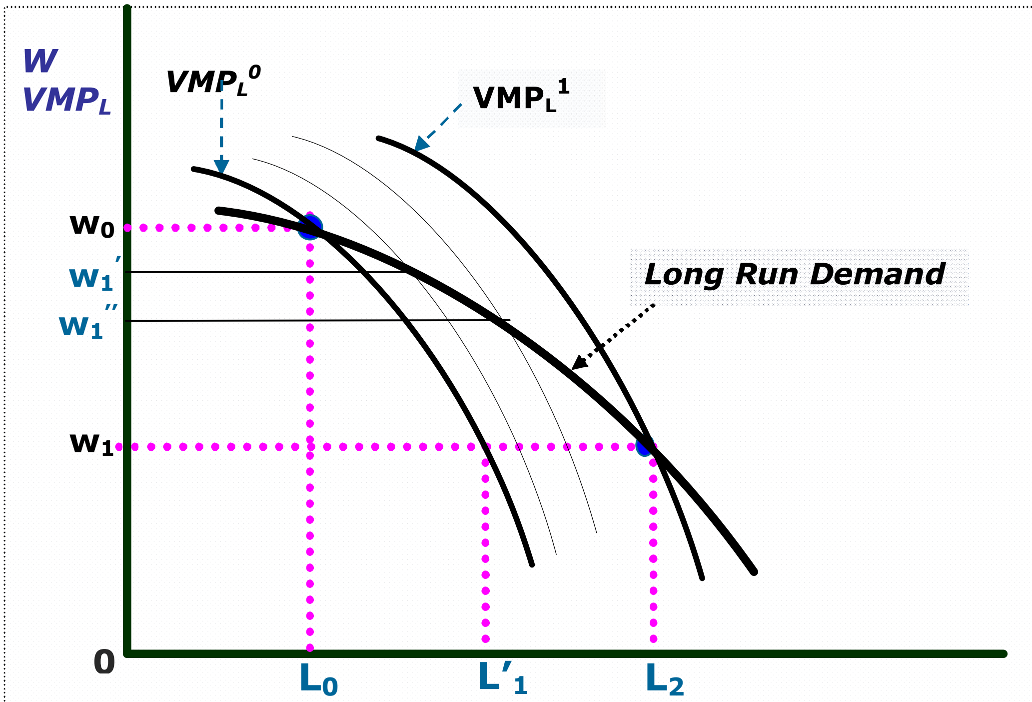


Fig. 4.5 ***Long Run Demand Curve***

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4.3 COMPETITIVE INDUSTRY'S DEMAND FOR LABOR

Wage and employment are determined by the interaction of aggregate demand and supply. So far, we have derived the individual firm demand for labor both when labor is the only variable input as well as when capital is also variable. In this section, we derive the aggregate demand for labor.

Dear student, suppose that the level of employment at w_o in Figure 4.5 abve is 100. After wage falls to w_1, it becomes 200. Besides, suppose that there are 100 identical *perfectly competitive* firms producing homogeneous product. Given these, how do you find the employment level at w_1 at aggregate? Is it just *200 per individual firm times 100 individual firms*? Or is there some other consideration?

Well, the aggregate demand is the horizontal summation of the individual demand. That is what we have been doing in the product market so far. However, in the demand for labor we have to make a particular consideration. It is that, when wage falls all the identical small firms respond by employing more and then produce more to be sold in the same market. If so, such response of all the firms will result in decrease in product price. Expressed in other way, it is a single firm in a perfectly competitive industry that is too small to affect the product market price rather than the industry as a whole.

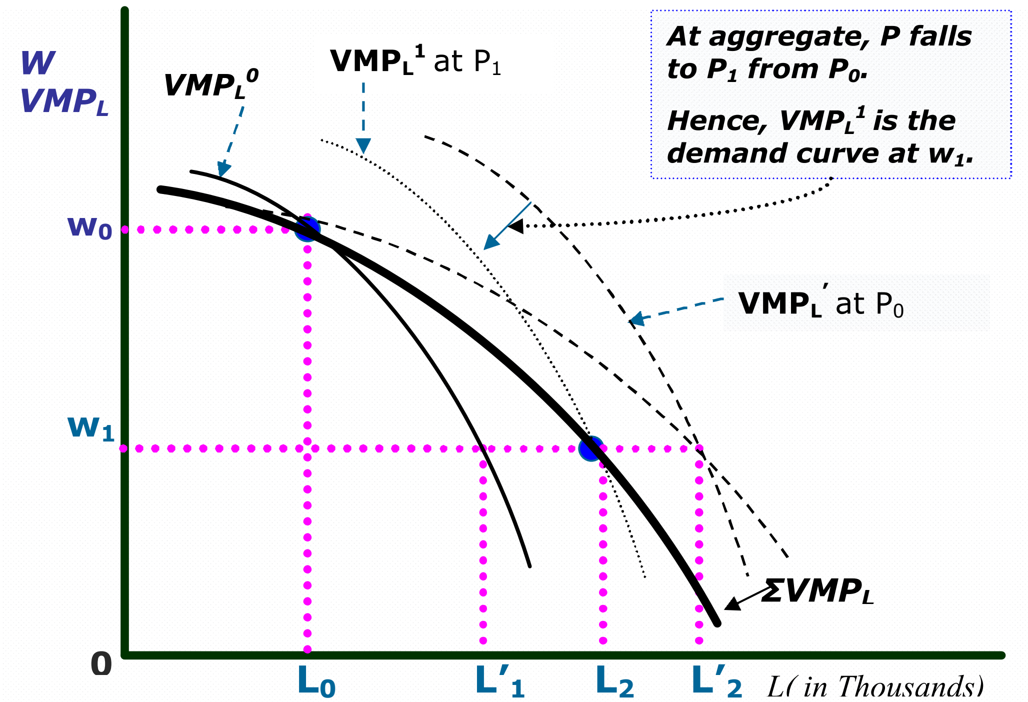


Fig 4.6. Competitive Industry's Demand for Labor

Finally, an important consideration you have to make is that the complementarity and substitutability examples we have been using between labor and capita, can similarly apply to the case of between different classes of labor itself. Another consideration is that although most of our analyses have been about labor in this chapter, it has to be notices that we can we apply the lessons to all others with minor modifications when required.

4.4 SUPPLY OF FACTORS OF PRODUCTION

The short run supply curve of an input (like the supply curve of a final commodity) is generally upward sloped, indicating that a greater quantity of the input is supplied per unit of time at higher input prices. However, while the other inputs are supplied by firms, and their and their supply curves are generally positively sloped, labor is supplied by individuals and their supply curve may be backward bending.

4.4.1 Short Run Individual Labor Supply

One of the most important decisions made by any individual is how to allocate time between activities in the market and all other activities. Time in the market yields income, perhaps also some intrinsic satisfaction. Call this "work". Time at home also produces satisfaction. Call this "leisure". This typically doesn't yield income. But only a fixed amount of time is available.

How to allocate time between these uses? The answer to this question is thought of as "labor supply".

The Work – Leisure Decision: Basic Model

Two set of information are necessary to determine the optimal distribution of an individual's time between work and leisure.

1st. ***Subjective (psychological) information*** concerning the individual's work-leisure preferences. This information is embodied in *indifference curves*.

2nd. **O*bjective (market) information,*** which is reflected in *budget constraints*.

Order of Analysis

(i) Short run individual labor supply

(a) Preferences
(b) Constraints
(c) Optimal Choices
(d) Effect of wage change on equilibrium individual labor hours
(e) Decomposing the effect of wage change on equilibrium individual labor hours into substitution and Income effects

(ii) Long run and aggregate labor supply

Assumptions

- Utility of an individual depends on leisure time *(l)* and goods and services consumed (*c*):

$U = U(\underset{+}{l}, \underset{+}{c})$; both MU_l and MU_c are positive, meaning that the utility is increasing function of l and c.

- Both l and c are normal goods: as income of an individual increases, *ceteris paribus*, more of them are consumed.
- The total available time (T) is allocated between non labor time (leisure, l) and labor (h) at free choice of an individual: $T=l+h \Rightarrow h=T-l$
- The individual uses his labor income and (possibly non-labor) income for goods and services (c)

  c= $y=wh+y_u$; where y is total income; w is wage rate per hour; h is hours worked; y_u is non-labor (unearned) income.

  Assuming that y_u zero and substituting h *with* $(T-l)$

  $\Rightarrow c=w(T-l)$

Preferences, budget constraints and optimal choice

When applied to the work leisure decision, an indifference curve shows the various combinations of real income and leisure time which will yield some specific level of utility or satisfaction to the individual.

In panel (a) and (b) of fig 4.7 the vertical axis represents consumption of goods and services, c in real terms. the horizontal axis represents leisure, l from left to right (0 to total time, T). Since h is T minus l, it increases from right to left. In panel (a) the indifference curves represent U(l,c). As usual, higher indifference curve represents higher utility, whereas utility is constant on an indifference curve with different combinations of (l,c). The indifference curves are downward sloped reflecting that if one of the variables is reduced, more of the other has to be consumed to maintain the same level of utility. For example, if c is foregone, the individual has to increase l in order to maintain the utility level. In our usual way of expression, $\left|\frac{dc}{dl}\right|$ (which equals the absolute slope of indifference curve) stands for the maximum amount of c an individual willingly foregoes to consume *a unit* of l to remain neither worse off nor better off (that is to remain on the same indifference curve)[4]. However, since the diminishing marginal utility commonly operates, the amount of *c* you are willing to forego to get a unit of *l* decreases as you have more of the former and less of the latter. Hence, $\left|\frac{dc}{dl}\right|$ become smaller and smaller as you move down to the bottom-right, resulting in convex indifference curve. It is worth mentioning that preferences vary from individual to individual; some are leisure lovers and have extremely steep indifference curves; others value the labor income and do have very flat indifference curve. The indifferences we use for exposition in this section are of intermediate ones.

Whereas panel (a) of Fig. 4.7 depicts the subjective information, panel (b) depicts the objective information. Labor time (*h)* is measured from right to left. If income, which is entirely used for consumption, *c* is gained from labor service one sells at given wage (*w*), *c*=*wh* increases as more *h* is supplied. At the absence of non-labor income, the budget constraint line originates at *h=0* and extends to *c-intercept* where *h=T*. Since *w* is given and constant, the change in *c* is entirely due to change in *h (hours supplied)*.

⇨ $\frac{\Delta c}{\Delta h}(=\frac{\Delta y}{\Delta h}) = w$, meaning that the slope of the budget constraint line is a given constant wage rate, *w.* If wage increases the budget constraint line becomes steeper.

At this stage of discussion, it is appropriate to make theoretical prediction of the optimum (*l*, c*)* by bringing together preference and budget constraint of a typical individual. To do so, we make use of Fig. 4.8

---

4 On an indifference curve the total change in utilty is zero: $dU(l,c) = \frac{\partial U}{\partial l}dl + \frac{dU}{dc}dc = 0$

$$\Rightarrow \frac{\partial U}{\partial l}dl = -\frac{dU}{dc}dc \Rightarrow \frac{MU_l}{MU_c} = -\frac{dc}{dl}$$

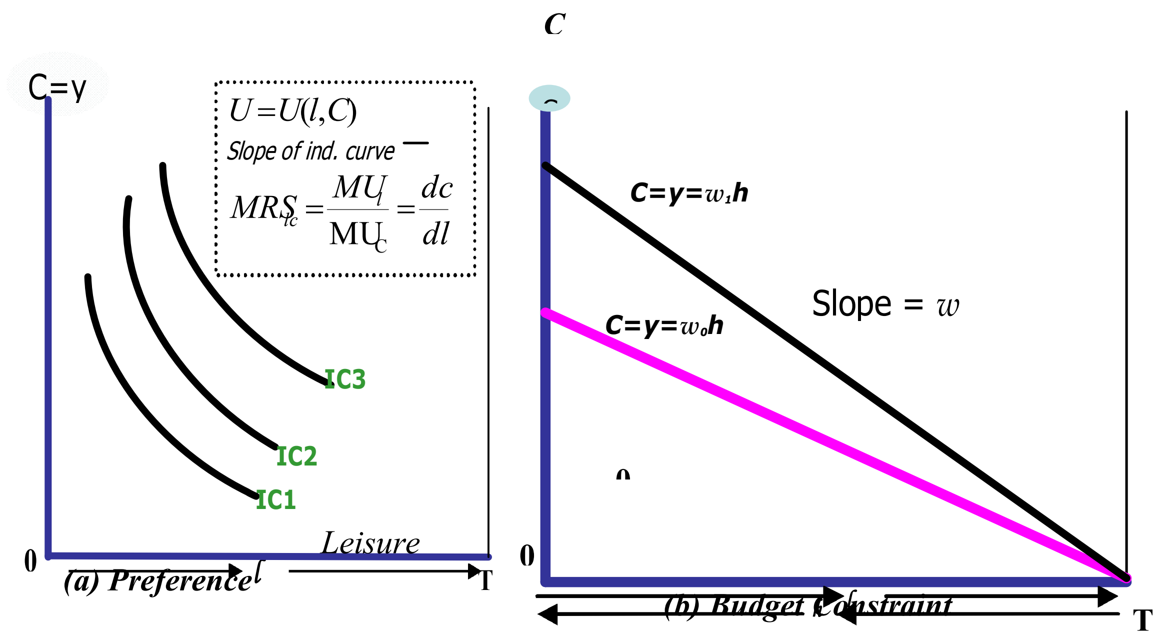


Fig. 4.7 ***l-c indifference map*** **and Budget Constraint**

It can be recalled that one of our assumptions was that individuals do have freedom of allocating the available time between work and leisure. Given this, the optimum time is determined by finding the *l* and *c* that maximize utility. Once *l* is determined, *h* is clearly *T-l*. Below, we will use graphical and mathematical treatments to det

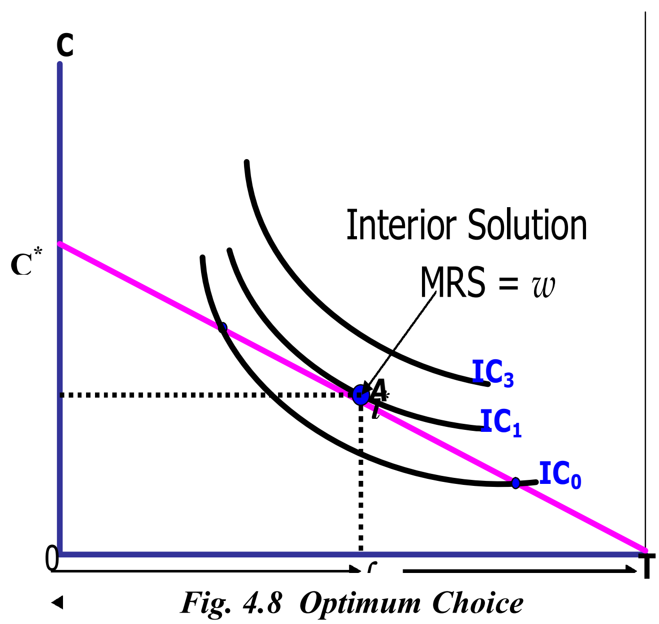


Fig. 4.8 Optimum Choice

$\max U(l,c)$ subject to c= wT-wl.

Changing into Lagrangean:

$\mathcal{L}=U(l,c) - \lambda(c - wT + wl)$ and finding FOC,

$$\frac{\partial L}{\partial l} = \frac{\partial U}{\partial l} - \lambda w = 0 \Rightarrow MU_l = \lambda w$$

$$\frac{\partial L}{\partial c} = \frac{\partial U}{\partial c} - \lambda = 0 \Rightarrow MU_c = \lambda$$

$$\frac{\partial L}{\partial \lambda} = c - wT + wl = 0$$

Using the first two FOC equations, we get:

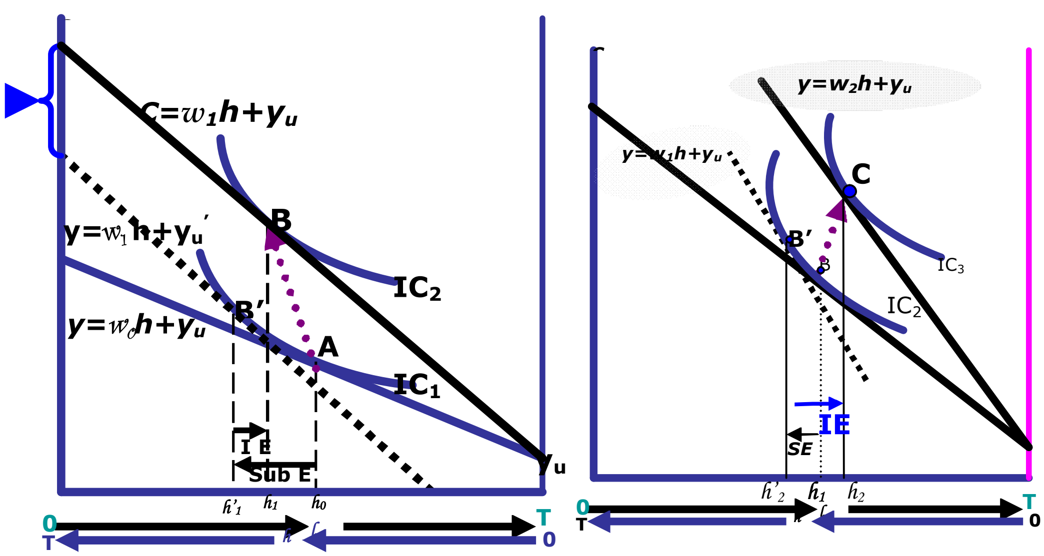
$$\underbrace{\frac{MU_l}{MU_c} = MRS_{lc}}_{\text{Subjective rate}} = \underbrace{w}_{\text{objective rate}}$$

Meaning that the individual chooses *l** and *c** levels at which the subjective rate he/she is willing to exchange *l* for labor market income (and hence *c*) is equal to the market wage rate.

Labor Supply Response to wage Change

What will the work leisure decision of an individual be as the wage rate changes (say, in creases)? Will the individual choose to work more or fewer hours as the wage rate increases? **It depends**. The effect of a wage rate change on labor supply (or hours of work) is decomposable into a *substitution* and *income effects*. When the wage rate changes, these two effects tend to alter one's utility-maximizing position.

Income effect: the income effect refers to the change in the desired hours of work resulting from a change in income. This effect is conceptually decomposed by keeping an individual on the previous satisfaction level when wage increases, such as, the imaginary position, *B'* in panel (a) of Fig. 4.9. In this Fig. when wage increases from w_0 to w_1, the observable movement is from is from *A* to *B*. However, if you 'compensate' the individual (in negative sense here), you keep him/her on the old indifference curve. In other words, it is as if we "remove" some of the individual's real income until the new budget constraint is tangent to the old indifference curve at the new higher wage (eg. Keeping at imaginary position, B' instead of *B* in panel (a) of Fig 4.9).



(a) Greater Substitution Effect ***(b) Greater Income Effect***

Fig.4.9 Substitution and Income Effects of Wage Change.

Notice that the broken line tangent to IC_1 at *B'* is parallel to the new budget line reflecting the same wage rate, w_1 and different y_u.

If you give back the conceptually 'removed' $(y_u - y_u^{'})$, the individual moves from *B'* to *B*. This is the income effect component of wage rise.

To further conceptualizing this effect, a rise in wage rate means that a larger money income is obtained from a given number of hours of work. We would expect an individual to use a part of this increased income to buy goods and service. But if we make a reasonable assumption that leisure is a normal good [a good of which more is consumed as income rises], then we can expect that part of ones expended income might be used to 'purchase' leisure. Consumers do not derive utility from goods alone, but from combination of goods and non market time (leisure).

How does one purchase leisure or non market time? In a unique way: *by working fewer hours.* This means that when wage rate rise and leisure is a normal good, the income effect results in a reduction in the desired number of hours.

Substitution effect: The substitution effect indicates the change in the desired hours of work resulting from a change in the wage rate, keeping utility constant. When wage rate increases the relative price of leisure is altered. Specifically, an increase in the wage rate raises the 'price' or opportunity cost of leisure. Because of higher wage rate, one must now forego more income for each hour of leisure consumed. The basic theory of economic choice implies that an individual will purchase less of any normal good when it becomes relatively more expansive. In brief, the higher price of leisure motivates one to consume less leisure (or to work in market).

The substitution effect merely tells us that when wage rates rise and leisure become more expensive, it is reasonable to substitute work for leisure. For a wage increase, the substitution effete results in the person desiring to work more hours. In panels (a) and (b) of Fig. 4.9, the substitution effects are, respectively, from *B'* to *B* and from *B'* to *C*.

Net effect: The over all effect of an increase in the wage rate on the number of hours an individual wants to work depend on the relative magnitudes of these two effects. Economic theory does not predict the net outcome unambiguously.[5]

[5]Net Effect = Sub Effect + Income Effect $= [\partial h / \partial w] = \underbrace{[\partial h / \partial w]}_{+ve}{}_{\text{u=const}} + \underbrace{[\partial h / \partial y]}_{-ve} h_{\text{w=constant}}$

The left hand side is the net change in hours of work. The first expression in the right hand side is pure substitution effect while the second is pure income effect. In other words, $[\partial h / \partial w]_{u=cons}$ is about the tangency point of the new wage rate with the previous indifference curve.

If the substitution effect dominates the income effect, the individual will choose to work more hours when the wage rate rises (as shown in panel (a) of Fig. 4.9). But if the income effect is larger than the substitution effect, a wage increase will induce the individual to work fewer hours (as shown in panel (b) of Fig. 4.9)

Table 4.2 Summary of the effect of the relative size of the substitution and income effect on the desired hours of work.

Relative Size of effect	**Impact on hours of work**		**Slope of labor supply curve**
	a)wage rate increase	b)wage rate decrease	
Substitution effect exceeds income effect	Increase	Decrease	Positive
Income effect equal substitution effect	No change	No change	Vertical
Income effect exceeds substitution	Decrease	Increase	Negative

The Backward Bending Labor supply curve

As the wage rate increases, the budget line rotates up along the vertical axis; i.e. the income that the individual earns increases and hence the *c intercept* increases $\Rightarrow$ the budget constraint gets steeper. From the Fig. 4.10 below, we observe that for the wage rate increase the budget line gets steeper. Initially, we find that individual chooses fewer hours of leisure and more hours work. Later, wage increase causes a further reduction in hours of work.

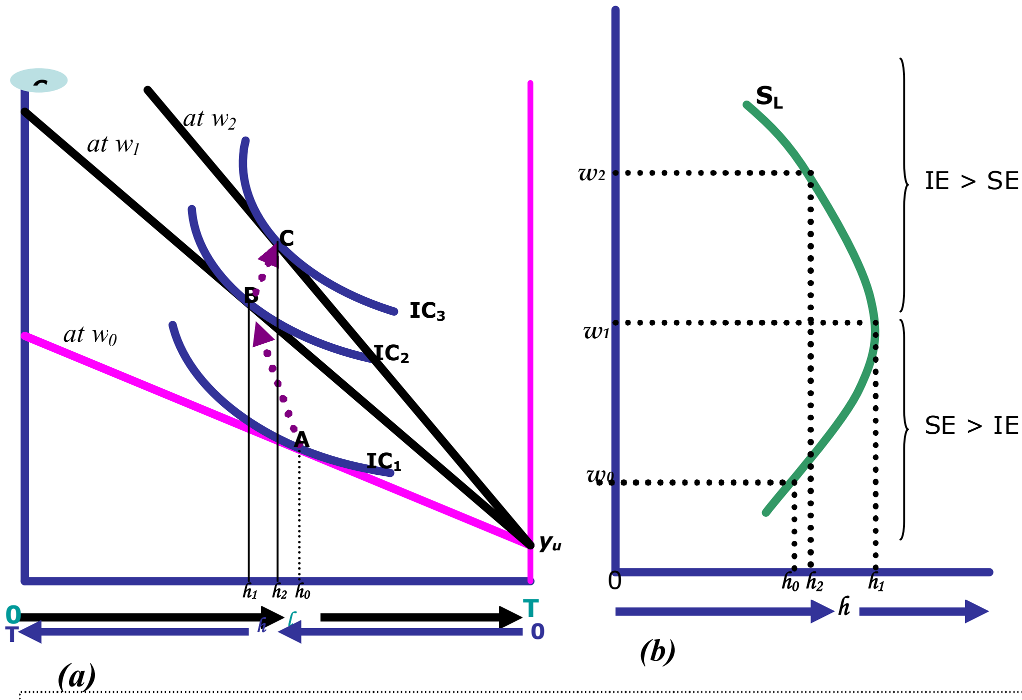


Fig. 4.10 Backward Bending Demand Curve

This analysis suggests that for specific person, hours of work may for a time increase as wage rate rise, but beyond some point, further wage increase may lead to fewer of labor being supplied.

The labor income- leisure figure can be transformed into a diagram which has traditional axis measuring wage rates on the vertical axis and hours of labor supplied left to right on the horizontal axis. In so doing, we find that this individual's labor supply curve is forward rising for a time and then backward bending.

This curve is known as *a backward bending supply curve*, the forward rising portion being expected or taken for granted. We can envision an individual labor supply curve for each person in the Economy. But keep in mind that each individual's preference for work versus leisure is unique and hence the exact location, shape, and point of the backward bend of the curve vary from person to person.

Finally, the backward bending supply curve we have seen above does not apply to every person. In other words, not all people reduce hours of work in response to higher wage.

4.4.2 Aggregate and Long Run Labor Supply

The supply curve of labor of a group of individuals or of the whole working force in the economy can be derived by summing up horizontally the supply curves of individuals. It is generally believed that when the wage rate rises from initially low level to a sufficiently good level, the total supply of labor to the economy as a whole increases.

In the case of supply of workers to a particular occupation, if wages go up, some persons from other similar occupations would be attracted to it and thus the supply of labor to that occupation will increase. Especially, the elasticity is higher for non-specialized labor.

Particularly in the long run, the labor supply curve is upward sloping even for specialized skills for which the short run individual labor supply may be backward bending. In the long run, besides occupational shifts in the in the present labor force, new entrants to the labor market can also adopt that occupation by getting training for it.

4.5 FACTOR PRICING IN PERFECT COMPETITIVE AND IMPERFECT MARKETS

So far, we have analyzed both the demand and supply sides of factors of production. The factor price and employment are determined by the interaction of demand and supply. In this section, we analyze the wage and employment determination under different market characteristics. For this purpose, the previously derived general FOC equation: $MP_L\left[\frac{\partial P}{\partial Q}Q + P\right] = \left[w + \frac{\partial w}{\partial L}L\right]$ can be used. The equilibrium conditions are summarized under Table 4.3 below.

Table 4.3 ***Summary of the Firm's Demand for Labor and Equilibrium Conditions under Different Market Situations***

Labor Market Characteristics / **Product Market Characteristics**	**Perfect:** A single firm cannot affect the market wage. It employs as much as needed without raising wage rate. If so, $\frac{\partial w}{\partial L}L = 0$. Hence, MC_L is equal to the wage rate (w).	**Imperfect:** A single firm does have the power to affect the market wage. At extreme, we do have a single buyer of labor service (monopsonist). In this case, it is required to raise wage to attract more labor. If so, $\frac{\partial w}{\partial L}L > 0$. Hence, Marginal Labor Cost (***MLC***) is greater than wage rate (w) by $\frac{\partial w}{\partial L}L$. →The new higher wage applies to all.
Perfect: A firm sells as much as needed at a given price. Hence, MR is equal to price. $\frac{\partial P}{\partial Q}Q = 0$ ***Value of Marginal Product (VMP_L) is Demand curve.***	*Equilibrium Condition* $\underbrace{MP_L P}_{VMP_L} = \underbrace{w}_{MLC}$ • *Labor is paid value of its Marginal product*	*Equilibrium Condition* $\underbrace{MP_L P}_{VMP_L} = \underbrace{w + \frac{\partial w}{\partial L}L}_{MLC}$ • *Labor is paid less than the value of its Marginal product due to Monopsonistic exploitation.*
Imperfect: A firm with monopoly power sells more by reducing price. If so, $\frac{\partial P}{\partial Q}Q < 0$. Hence, MR<P ***Marginal Revenue Product (MRP_L) is Demand curve.***	*Equilibrium Condition* $MP_L MR = w$ • *Labor is paid less than the value of its Marginal product due to Monopolistic exploitation.*	*Equilibrium Condition* $MP_L MR = w + \frac{\partial w}{\partial L}L$ • *Labor is paid less than the value of its Marginal product due to both monopolistic and Monopsonistic exploitations.*

It can be seen that employment of and reward for a factor of production is affected by imperfections both in the product and labor markets. This is shown in Fig. 4.11 which is closely related to the summary in Table 4.3.

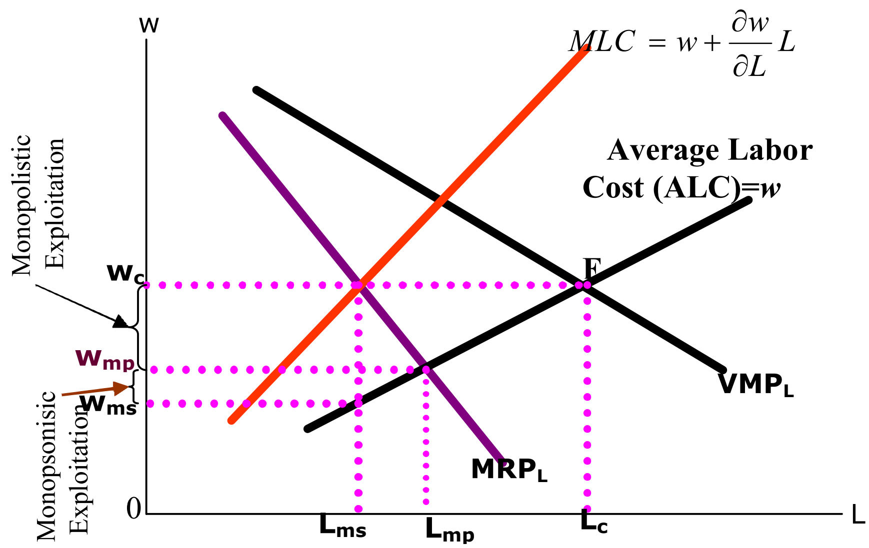


Fig 4.11 Wage and Employment Determination under Perfect and Imperfect Markets

When both the product market and the labor market are perfect, both employment (L_c) and wage (w_c) are the maximum. Wage rate less than w_c is considered an exploitation. Firstly, the portion, w_c-w_{mp} in Fig. 4.11 is attributed to monopolistic power in the product market. It is known as monopolistic exploitation. Secondly, a firm may be a single buyer of labor service, called monopsony. The portion, w_{mp}-w_{ms} is attributed to such monopsonistic power.

☺Check Your Progress 3

The Labor Demand of a monopolist is given by $MRP_L = 20 - L$, which could have been $VMP_L = 20 - 0.5L$ had it been a competitive industry. This firm is also a monopsonist (single buyer of labor service) and the Average Labor Cost (ALC) it faces is given by $w = 2L$.

Required: Find out the following and Graphically show on a single Plane:

(a) The competitive level of employment and wage

(b) The monopolistic level of employment and wage, regardless of monopsonistic power.

(c) The monopsonistic level of employment and wage

(d) The monopolistic and monopsonistic exploitation

Bilateral Monopoly

In the previous section we have seen that wage rate is very small at the presence of both monopoly and monopsony power. Suppose that now there is organized labor union that bargains for higher wage by acting as a single seller. This results in bilateral monopoly. Bilateral monopoly, in our case, is a market from where a monopolist, a single seller of a labor service (labor union), sells to the monopsonist who is the single buyer of the labor service. Here under collective bargaining, we will not easily determine a particular wage rate. Rather, we determine the upper and the lower limits. The lower limit is the monpsonist wage rate (similar to w_{ms} in Fig. 4.11.

In order to settle the range of wage rates within the particular wage rate lies, we will use Fig. 4.12. Notice that MR_U in the figure is the union's marginal revenue which shows how much additional income or revenue the union will obtain when more labor is hired. In nutshell, it is marginal to MRP_L. At the absence of collective bargaining, the profit maximizing level of employment would be determined at the equality of MLC and MRP_L. At this point, L_{ms} units of labor are employed at w_{ms} wage rate.

> ⇨ w_{ms} is the minimum limit below which wage rate cannot fall. It is the rate the monopsonist would wish to set if left free of collective bargaining.

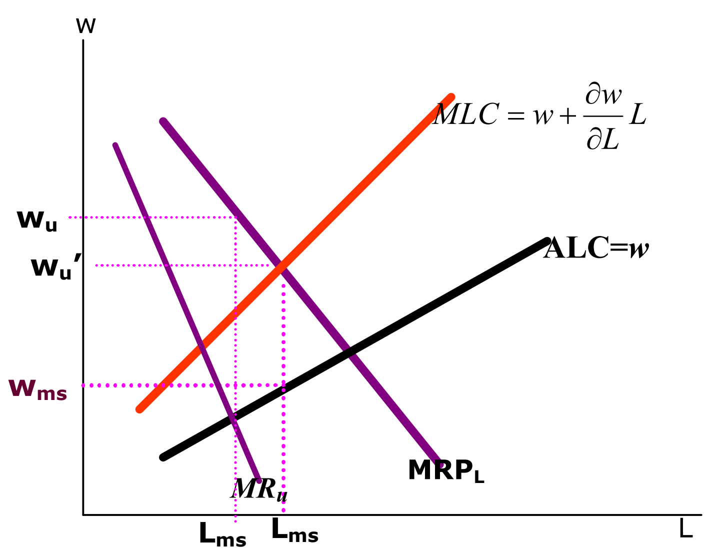


Fig. 4.12 Wage Determination under Bilateral Monopoly
MR is marginal to MRP_L.

On the other hand the labor union aims at maximizing its net revenue (i.e. revenue over and above opportunity costs of labor which is maximum at w_u.

> ⇨ w_u is the maximum limit above which wage rate cannot be raised. It is the rate the union would wish to set.

Finally, whereas the range of the wage lies between w_{ms} and w_u, a particular one depends on bargaining power of the two parties.

Economic Rent

In ordinary sense of the term, rent means a payment for hiring of any fixed asset such as house, machines, vehicles, etc. In economics, however, rent is the difference between the payment made to a factor of production and the minimum amount to keep the a factor of production in its present occupation in an industry under equilibrium state.

So far we have seen how wage is determined under different situations. If we take a further step, we will identify that part of labor income is an economic rent. For example, if the equilibrium wage is w in Fig. 4.11, part of the area of the rectangle, OL_cEw_c above the ALC curve (labor supply) is Economic Rent. Generally, the lower the elasticity of labor supply curve, the larger the economic rent will be. For example, land which is relatively of fixed supply, is highly inelastic and its economic rent is consequently high.

4.6 INCOME DISTRIBUTION, ELASTICITY OF FACTOR SUBSTITUTION AND TECHNOLOGICAL PROGRESS

4.6.1 Marginal Productivity Theory of Income Distribution

According to marginal productivity theory, *all factors* can be assumed to be variable and get the reward equal to their marginal product. Thus labor gets real wage rate equal to marginal product, capital gets rate of interest equal to its marginal product, land gets rent equal to it marginal product. The total *absolute* share of a factor is determined by its marginal product *(i.e.,* remuneration in real terms) multiplied by the amount of the factor used. Thus, the absolute share of labor in the national income is determined by the amount of labor used (L) in production multiplied by its marginal product (or real wage rate), and so on.

$$\text{Absolute Share of Labor} = L \times MP_L$$

$$\text{Absolute Share of Capital} = K \times MP_K$$

The relative share of labor (α) in the national income is the absolute share divided by the total national product (Q).

$$\text{Relative Share of Labor} = \alpha = \frac{L \times MP_L}{Q}$$

Likewise, The relative share of capital (β) in the national income is the absolute share divided by the total national product (Q).

$$\text{Relative Share of Capital} = \beta = \frac{K \times MP_K}{Q}$$

It should be noted that in neo-classical marginal productivity theory, all factors are regarded as substitutes of each other, though to varying degrees. With the given and fixed supplies of factors, the marginal products of the various factors are known from the production function. With the knowledge of these marginal products of factors (equal to which real rewards for factors are determined), the absolute and relative shares of the factors can be found out. A better understanding can be made by rewriting Equations of the relative shares above by substituting:

MP_L with $\frac{\Delta Q}{\Delta L}$ and

MP_K with $\frac{\Delta Q}{\Delta K}$

and then rearranging, we will obtain a better expression.

$$\alpha = \frac{L \times MP_L}{Q} = \frac{L \times \frac{\Delta Q}{\Delta L}}{Q} = \frac{\Delta Q}{\Delta L} \times \frac{L}{Q} = \frac{\Delta Q}{Q} \div \frac{\Delta L}{L}$$

$$\Rightarrow \alpha = \underbrace{\frac{\Delta Q}{Q}}_{\substack{\text{Relative change} \\ \text{in production}}} \div \underbrace{\frac{\Delta L}{L}}_{\substack{\text{Relative change} \\ \text{in Labor}}} = \underbrace{\frac{\Delta Q}{Q} \div \frac{\Delta L}{L}}_{\text{Labor Elasticity of production}}$$

This means that the relative share of labor in national income is equal to the elasticity of production with respect to labor input. In a numerical terms, if 2% change in the quantity of labor brings about a 80% change in production, then labor's share in national product will be 40% (α =0.4).

In the same manner, relative share of capital (β) is

$$\beta = \frac{K \times MP_K}{Q} = \frac{K \times \frac{\Delta Q}{\Delta K}}{Q} = \frac{\Delta Q}{\Delta K} \times \frac{K}{Q} = \underbrace{\frac{\Delta Q}{Q} \div \frac{\Delta K}{K}}_{\text{capital Elasticity of production}}$$

Thus, the relative share of capital (β) is equal to the elasticity of production with respect to capital. In a numerical terms, if 1% change in the quantity of capital brings about a 60% change in production, then capital's share in national product will be 60% (β =0.6).

Activity: Given the Cobb-Douglas Production Function of an economy, $Q = AL^{\lambda}K^{\mu}$, where $\lambda + \eta = 1$

Verify that the relative income share of labor is equal to λ and that of capital is equal to μ .

The change in Factor Share of Income depend on

- Elasticity of Factor Substitution
- Technological Progress

4.6.2 Elasticity of Factor Substitution

Elasticity of Factor Substitution shows proportional change in input ratio in response to proportionate change of the factor price ratio. As shown above, in neo-classical theory factor rewards are equal to their marginal products which are equal to their real prices:

MP_L=real wage ,w

MP_L=real interest, r

From the previous relative share equations, can be rewritten as:

$$\alpha = \frac{L \times w}{Q} \text{ and } \beta = \frac{K \times r}{Q}\text{, respectively.}$$

The ratio of these relative shares is called distributive share which becomes:

$$\frac{\text{relative shares of labor}}{\text{relative share of capital}} = \frac{\alpha}{\beta} = \frac{wL}{rK} = \frac{(L / K)}{(r / w)} = \frac{(K / L)}{(w / r)}.$$

Changing both the numerator and the denominator of the above into proportional changes, we get Elasticity of Factor Substitution.

$$\text{Elasticity of Factor Sub.}, \sigma = \frac{\Delta(K/L) \div (K/L)}{\Delta(w/r) \div (w/r)}$$

If relative price of labor rises, that is $\frac{w}{r}$ increases, this will induce the substitution of capital for labor and as a result capital-labor ratio (K/L) will increase. If the elasticity of substitution is less than one, say equal to 0.5, then 10% increase in wage-rental ratio $\frac{w}{r}$ will lead to the increase in capital-labor ratio by only 5%. Thus, given that the elasticity of factor substitution is less than unity (inelastic), then a given percentage increase in $\frac{w}{r}$ ratio will not cause the substitution of capital for labor in the same proportion. If the elasticity is unity, a given percentage increase in $\frac{w}{r}$ ratio will cause the substitution of capital for labor in the same proportion. Whereas when it is greater than unity (elastic), greater percentage change in capital-labor ratio is caused by a given percentage change in $\frac{w}{r}$.

Dear learner, (i) does the information about elasticity of factor substitution tell us anything about the change in distributive income share of labor and capital in response to change in $\frac{w}{r}$? ____Verify.___________________________________

____

____.

(ii) If the elasticity is already known to be greater than unity (elastic) and our objective is to increase the distributive share of labor, which policy should we support: policy that raises $\frac{w}{r}$ or reduces it?_________________

Explain.____

____

__.

Well! For the first question, Yes, it does! One way of verifying this is as follows.

From above we can rewrite as,

$$\frac{\text{relative shares of labor}}{\text{relative share of capital}} = \frac{(w/r)}{(K/L)} = \frac{wL}{rK}$$

Using this equation,

(a) If the factor substitution is inelastic, a given percentage change in (w/r) is followed by smaller percentage change in (K/L) ratio and hence,

$\Rightarrow \frac{(w/r)}{(K/L)} = \frac{wL}{rK} < 1$, meaning that rise in (w/r) favors the distribution share of labor.

(b) If the factor substitution is unitary elastic, a given percentage change in (w/r) is followed by the same percentage change in (K/L) ratio and hence,

$\Rightarrow \frac{(w/r)}{(K/L)} = \frac{wL}{rK} = 1$, meaning that rise in (w/r) does not cause distribution share.

(c) If the factor substitution is elastic (greater than unity), a given percentage change in (w/r) is followed by greater percentage change in (K/L) ratio and hence,

$\Rightarrow \frac{(w/r)}{(K/L)} = \frac{wL}{rK} > 1$, meaning that rise in (w/r) favors the distribution share of capital.

Briefly responding to the second question, if the factor substitution is elastic our objective of raising distributive share of labor is will be achieved when $\frac{w}{r}$ decreases (otherwise, its rise favors capital as shown in (c) above).

Note that the elasticity of factor substitution depends on production function of the economy, for which we will provide illustrative example next.

Illustrative Example: Cobb-Douglas production function and distributive share of labor and capital

Cobb-Douglas production function is a popular function. According to Ahuja (2005:867), Cobb-Douglas production function proved to be ideal for explaining the constancy of labor's share in the national income, which for long time economists believed to be empirically true.

$$Q = AL^{\alpha}K^{1-\alpha}$$

where L and K are, respectively, labor and capital. Q stands for production. A and α are constant. $\alpha + (1-\alpha) = 1$ means that Cobb-Douglas production function represents constant returns to scale, that is increase in the scale of production has no effect on productivity. In an activity, you were asked to verify that the exponents of the factors in the Cobb-Douglas production function represent the relative income shares. Likewise, here *α and $(1-\alpha)$ represent relative shares of labor and capital, respectively, as can be verified along the way.*[6]

$$\text{Given } Q = AL^{\alpha}K^{1-\alpha},$$

$$MP_L = \alpha AL^{\alpha-1}K^{1-\alpha} = \alpha \frac{AL^{\alpha}K^{1-\alpha}}{L}$$

$$\Rightarrow MP_L = \alpha \frac{Q}{L}$$

$$MP_K = (1-\alpha)AL^{\alpha}K^{-\alpha} = (1-\alpha)\frac{AL^{\alpha}K^{1-\alpha}}{K}$$

$$\Rightarrow MP_K = (1-\alpha)\frac{Q}{K}$$

$$\text{Elasticity of Factor Sub.}, \sigma = \frac{\Delta(K/L) \div (K/L)}{\Delta(w/r) \div (w/r)},$$

---

[6] *Rearranging* $MP_L = \alpha \frac{Q}{L}$, *we obtain* $\alpha = \frac{MP_L \times L}{Q}$ *= relative share of labor. Similarly, rearranging* $MP_K = (1-\alpha)\frac{Q}{K}$, we obtain $(1-\alpha) = \frac{MP_K \times K}{Q}$ *= relative share of capital*

substituting $\dfrac{\alpha(Q/L)}{(1-\alpha)(Q/K)}$ *for w/r,*

$$\text{Elasticity of Factor Sub.}, \sigma = \frac{\Delta(K/L) \div (K/L)}{\Delta\left(\dfrac{\alpha(Q/L)}{(1-\alpha)Q/K}\right) \div \dfrac{\alpha(Q/L)}{(1-\alpha)Q/K}}$$

$$\text{Elasticity of Factor Sub.}, \sigma = \frac{\Delta(K/L) \div (\overline{K}/\overline{L})}{\dfrac{\alpha}{(1-\alpha)}\Delta\left(\dfrac{K}{L}\right) \div \dfrac{\alpha}{(1-\alpha)}\left(\dfrac{K}{L}\right)}$$

$$\text{Elasticity of Factor Sub.}, \sigma = 1$$

For an economy characterized by Cobb-Douglas production function, the elasticity of factor substitution is unity, and hence a given percentage of relative price change causes the same percentage response (change) in factor ratio. For example, if w/r increases by 10% K/L increases by 10% and $\dfrac{wL}{rK}$ remains constant.

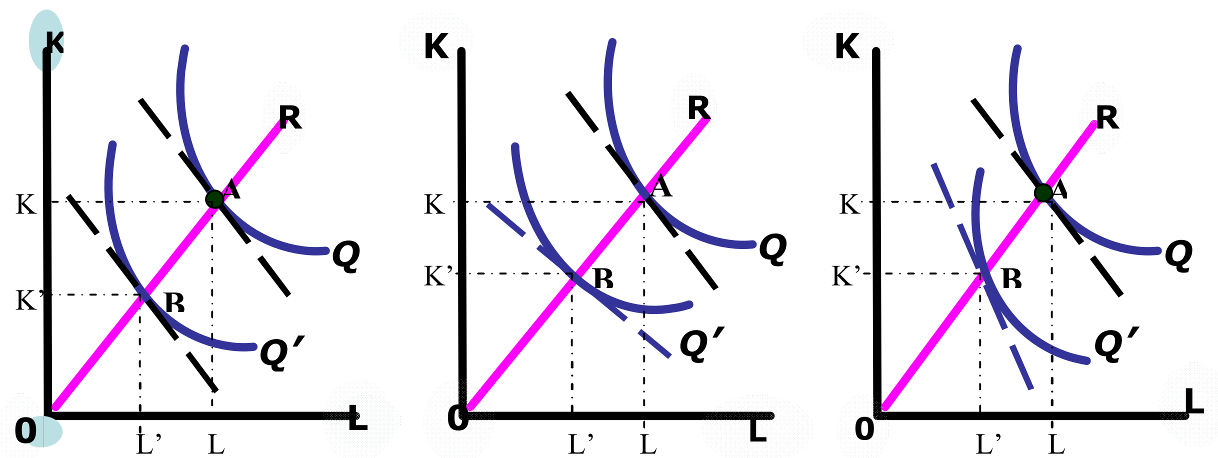
To briefly summarize the discussion of this sub section, firstly, according to the marginal productivity theory, all factors can be assumed to be variable and get the reward equal to their marginal product. Secondly, the distributive share of a factor is determined by both *how much of it is employed* and *how much it is paid*. Raising its price does not necessarily increase its relative distribution since there is possibility of high response in substituting it with relatively cheaper factors. In other words change in distributive share in response to relative price change depends on how responsive the economy is in substituting factors, which is measured by elasticity of factor substitution. This in turn depends on the production function of the economy.

4.6.3 Technological Progress

Being concerned with static analysis of factor shares we have so far assumed that production function remains constant over a period of time. However, in real life change in technology is continuously taking place which causes a shift in the production function and thereby brings about a change in marginal products of factors and therefore in marginal rate of technical substitution between labor and capital. Due to its effect on $MRTS_{LK}$ (or ratio of MP_L/MP_K) the technological change affects income distribution or relative shares of factors.

Technological changes has been classified by J. R. Hicks (cited in Ahuja, 2005) into the following categories:

- Capital using technological change
- Neutral and technological change
- Labor-using technological change



(A) Neutral Technological Progress

(B) Capital using Technological Progress

(C) Labor using Technological Progress

Fig.4.13 Different Types of Technological Progress. *Initially the firm produces Q units of output by utilizing L and K units of labor and capital, respectively. Due technological progress, the same units of output, Q' can be produced by using less of the factors.* OR *is a linear ray from the origin representing constant capital-labor ratio equal to its slope.*

It may be noted that technological advancement implies that a given level of output can be produced with smaller quantities of factors and therefore isoquants shift downward as a result of this. Technological change is said to be neutral if at a given and constant capital-labor ratio, marginal rate of technical substitution (MPL/MP_K) remains the same when, due to the progress in technology, isoquants representing production function shift downward. This is illustrated in *panel (a) of Fig. 4.13.*. Initially the firm is at isoquant Q producing level of output Q. OR is a linear ray from the origin representing constant capital-labor ratio equal to its slope. Now, as a result of neutral technological progress isoquant representing level of output *Q* shifts downward to the new position *Q'* and along the ray of constant capital-labor ratio *(K/L),* the firm reaches at point *B.* It will be found that the slope of the tangent drawn at point *B* on the new isoquant, indicating $MRTS_{LK}$ *is* the same as at point *A* of the ray *OR* on the initial isoquant *Q.* This occurs when the nature of technological change is such that it equally increases the marginal products of both labor and capital so that $MRTS_{LK}$ which is equal to the ratio of MP_L/MP_K remains the same.

***Capital-Using Technological Progress**. T*echnological progress is capital-using (or capital deepening) if it raises the marginal product of capital relative to labor. This means that with the shift of the isoquants representing production function due to capital biased technological change, the $MRTS_{LK}$ ($=MP_L/MP_K$) will decrease as can be seen in panel (*b*) of Fig. 4.13. Here, the linear ray *OR* from the origin depicting-a given constant capital-labor *(K/L)* ratio intersects the initial isoquant *Q* at point *A* and the new isoquant *Q'* at point *B* after its downward shift due to the technological advancement. A glance at panel *(b)* will reveal that the slope of the tangent depicting $MRTS_{LK}$, drawn at point B on the isoquant *Q'* is less than at point *A* on the initial isoquant Q. This implies that $MRTS_{LK}$ has declined as a result of technological change showing that this is the case of capital-deepening technological progress.

***Labour-Using Technological Change**.* Lastly, labour-using technological change occurs when it leads to the increase in marginal product of labor relative to marginal product of capital so that $MRTS_{LK}$ at the constant capital labor *(K/L)* ratio increases, as can be seen in panel *(c)* of Fig 4.13. With the improvement of technology and consequent downward shift in isoquant representing a given level of output shifts from Q to Q'. It will be seen on the ray *OR* and at point *B* that the shope of the new isoquent *Q',* is greater than at *point A* on the initial isoquant Q which means that $MRTS_{Lk}$ has increased with the change in technology, capital-labor ratio remaining constant. Thus, panel *(c)* represents the case of labor-using technological progress.

Technological Change and Relative Factor Shares

The nature of technological progress, whether it has capital-using or labor-using bias, has an important bearing on the income distribution between labor and owners of capital.

Consider the following three points to show the effect of each type of technical progress on relative share:

(a) As we know at equilibrium, $\frac{MP_L}{MP_K} = MRTS_{LK} = \frac{w}{r}$.

(b) Technological progress that affects $\frac{MP_L}{MP_K}$ also affects $\frac{w}{r}$ in the same direction since factors are rewarded according to their marginal productivities.

(c) For technological progress to cause change in distributive share, $\frac{wL}{rK}$ should be affected.

(i) When technological progress is ***neutral***, relative shares of labor and capital ($\frac{wL}{rK}$) will remain constant, as will be explained below.

- The isoquant shifts down and $MRTS_{LK}$ remains the same at constant K/L ratio.
- If so, the ratio of factor prices (w/r) which in equilibrium equals $MRTS_{LK}$ will remain the same.
- Thus, if w/r remains constant at constant K/L, $\frac{wL}{rK}$ remains constant, meaning that neutral technological progress does not cause change in distributive share.

(ii) When technological progress is ***capital deepening***, relative shares of labor declines while that of capital increases ($\frac{wL}{rK}\uparrow$) as will be explained below.

- The isoquant shifts down and $MRTS_{LK}$ decrease at constant K/L ratio.
- If so, the ratio of factor prices (w/r) which in equilibrium equals $MRTS_{LK}$ will also decrease. Specifically, r increases relative to wage since MP_K increases.
- Thus, if w/r decreases at constant K/L, $\frac{wL}{rK}$ decreases, meaning that capital deepening technological progress causes change in distributive share in favor of capital.

It is desirable to mention here that the assumption of constant K/L ratio is not without criticism, since such technological progress can lead to rise in K/L ratio.

(iii) When technological progress is ***Labor-using***, relative shares of labor rises while that of capital decreases ($\frac{wL}{rK}\downarrow$) as will be explained below.

- The isoquant shifts down and $MRTS_{LK}$ increases at constant K/L ratio.
- If so, the ratio of factor prices (w/r) which in equilibrium equals $MRTS_{LK}$ will also increase.
- Thus, if w/r increases at constant K/L, $\frac{wL}{rK}$ increases, meaning that labor-using technological progress causes change in distributive share in favor of labor.

4.7 CHAPTER SUMMARY

1. The demand for resources is derived from the demand for the commodities that require the resource in production. The greater the demand for the commodity and the more productive the resource, the greater the price that firms are willing to pay for the resource.
2. The marginal revenue product (MRP) measures the increase in the firm's total revenue from selling extra product that results from employing one additional unit of the resource. As additional units of the variable resource are used with fixed inputs, the extra unit, or marginal physical product (MPP), falls due to diminishing returns.
3. A firm that is perfect competitor in the resource market maximizes profit when its Value of marginal product from the variable resource equals the resource price. Thus, the firm's Value of marginal product schedule is the firm's demand schedule for the variable resource.
4. If the firm is an imperfect competitor in the commodity market, its marginal revenue product declines both because the marginal physical product from the

variable input declines and because the firm must lower the commodity price in order to sell more units of the commodity.

5. A firm's demand for productive resource increases if the demand for the product increases, if productivity of the resource rises, if the price of a substitute resource rises, or price of the price of a complementary resource falls
6. If the firm is an imperfect competitor in resource market, the firm maximizes total profits by hiring each resource until the value of marginal product from each resource equals the marginal resource cost. The marginal resource cost is equal to the increase in the firm's total cost for hiring each additional unit of the resource.
7. According to the marginal productivity theory of distribution factors are rewarded according to their marginal productivity.
8. Both product and factor market imperfections lead to both lower employment and factor prices.
9. Distributive factor share of income is influenced by production function, elasticity of factor substitution, factor prices and technological progress.

4.8 QUESTIONS FOR REVIEW

1 What do we mean by derived demand for a factor?

2 What is the difference between Value of Marginal Product and Marginal Revenue product?

3 How does imperfection in the product market affect the demand for labor?

4 Explain how the following affect demand for a factor of production

- Demand for the product
- Marginal physical productivity of the product
- Price of other factors
- Adjustment period

5 Explain the relationship between income distribution, production function, factor substitution and technological progress

Chapter Five
GENERAL EQUILIBRIUM ANALYSIS

5.1 INTRODUCTION

Before we turn to the detailed study of general equilibrium analysis, it will be helpful for the proper understanding of the subject if we first make the distinction between ***partial equilibrium*** and ***general equilibrium analyses***. So far, both in the first module and the previous chapters of this module of your Microeconomics, we have examined the behavior of individual decision making units and the workings of individual markets for commodities and inputs under various market structures. We have adopted a partial equilibrium approach, concentrating on decisions in a particular segment of the economy in isolation of what was happening in other segments, under *ceteris paribus assumption*.

How are the individual pieces-individuals as consumers of commodities and suppliers of inputs, and firms as employers of inputs and producers of commodities- are integrated? Such an examination of how the various individuals fit together to form an integrated economic system has generally been missing from our presentations. However, you are advised to appreciate the great importance of *ceteris paribus* assumption and partial equilibrium analyses so far. They have, indeed, created convenience in analysis by reducing complexities to manageable set of variables.

In this chapter, we take up the topic of interdependence or relationship among the various decision-making units and markets in the economy. This allows us to trace both the effect of a change in any part of the economic system on every other part of the system, and the repercussions from the latter on the former. We begin the chapter by distinguishing between partial equilibrium analysis and general equilibrium analysis and by examining the conditions under which each type of analysis is appropriate. Then, we discuss the conditions required for the economy to be in general equilibrium of exchange, production, and production and exchange simultaneously, and we examine their welfare implications.

Chapter objectives

At the end of this chapter, you should be able to:

- Distinguish between partial equilibrium and general equilibrium
- Describe the contract curve in Edgeworth exchange box diagram
- Determine the conditions for general equilibrium in consumption and production
- Show the points of general equilibrium in a competitive output market using Production Possibility Frontier (PPF) and Edgeworth exchange box diagram.
- Explain Pereto optimality in exchange, consumption and production
- Derive welfare implications of general equilibrium

Chapter Outline

5.1 Introduction

5.2 *Partial versus general equilibrium analysis*

5.3 *General equilibrium of exchange and production*

5.3.1 *General equilibrium of exchange*

5.3.2 *General equilibrium of production*

5.4 General equilibrium of production and exchange and Pareto optimality

5.4.1 General equilibrium of production and exchange simultaneously

5.4.2 Marginal conditions for economic efficiency and Pareto optimality

5.5 Perfect competition, economic efficiency, and equity

5.6 Chapter summary

5.7 Activities for review

5.2 *PARTIAL VERSUS GENERAL EQUILIBRIUM ANALYSIS*

While conducting partial equilibrium analysis, we studied the behavior of individual decision-making units and individual markets viewed in isolation. We examined how an individual maximizes satisfaction subject to his or her income constraint; how a firm efficiently allocates resources and maximizes profit under a certain market structure; how the price and employment of input is determined, etc. In doing so, we have abstracted from all the interconnections that exist between the market under study and the rest of the economy (the ceteris paribus assumption). In short, we have shown how demand and supply in each market determine the equilibrium price and quantity in that market independently of other markets.

However, a change in any market has spillover effects on other markets, and the change in these other markets will, in turn, have repercussions or feedback effects on the original market. These effects are studied by general equilibrium analysis. That is, general equilibrium analysis studies the interdependence or interconnections that exist among all markets and prices in the economy and attempts to give a complete, explicit, and simultaneous answer to the questions of what, how, and for whom to produce.

Suppose that a country domestically produces automobiles. The industry uses steel, glass, rubber and other inputs. Besides, a number of workers are employed here and they generate income for their living. Assume that these domestically produced automobiles are high-petroleum-consuming ones compared to imported automobiles. Now if oil price increases, demand for domestic automobiles will decrease, since consumers shift to oil efficient imported automobiles. This results in reduction in price of the domestic automobiles. Consequently, new equilibrium will be established at lower price and quantity.

We could have completed the analysis had we been studying partial equilibrium analysis!

On the other hand, the analysis goes on if we adopt general equilibrium analysis since there are further *spill over* and *feedback* effects of the initial oil price change. A change in the demand and price for domestically produced automobiles will immediately affect:

- The demand and price of steel, glass, and rubber (the intermediate inputs of automobiles),
- The demand, wages, and income of auto workers and of the workers in the related other industries.
- The demand and price of gasoline and of public transportation (as well as the wages and income of workers in these industries) are also negatively affected.

When does the effect end? These affected industries do have spillover effects on still other industries, until the entire economic system is more or less involved, and all prices and quantities are affected. This is like throwing a rock in a pond and examining the ripples emanating in every direction until the stability of the entire pond is affected. The size of the ripples declines as they move farther and farther away from the point of impact. Similarly, industries further removed or less related to the automobile industry are less affected than more closely related industries.

What is important is that the effect that a change in the automobile industry has on the rest of the economy will have repercussions (through changes in relative prices and incomes) on the automobile industry itself. This is like the return or feedback effect of the ripples in the pond after reaching the shores. These repercussions or feedback effects are likely to significantly modify the original partial equilibrium conclusions (price and output) reached by analyzing the automobile industry in isolation (see Fig. 5.1).

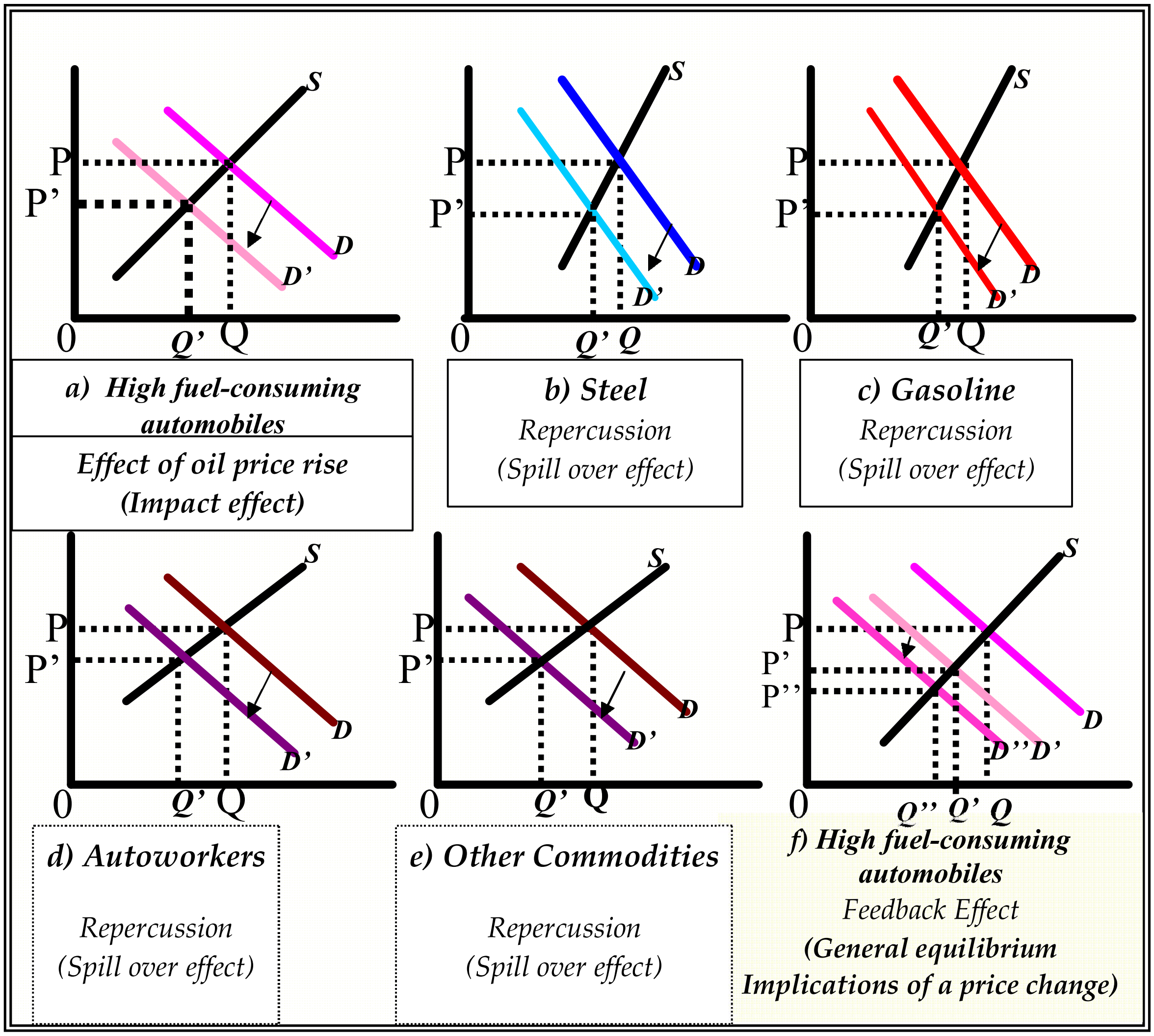


Fig.5.1 **General Equilibrium Implications of a price change: USA example.**
The impact or partial equilibrium effect of a reduction in the demand for new domestically produced automobiles is to reduce price from P to P’ and quantity from Q to Q' [panel (a)] This reduces the demand for (and price and quantity of) steel [panel (b)] and gasoline [panel (c)] and the demand for (and wages and employment of) workers in the automobile [panel (d)] and other affected industries This, in turn, has spillover effects on the market for other commodities [panel (e)] and feedback effects on the domestic automobile industry itself [panel (f)]

Source: Adapted from USA example (1973-1980) in Salvatore (2003:p570).

The illustration in Fig. 5.1 is adapted from Salvatore (2003:p570). To have clear understanding of this example, start from panel (a), where the effect of oil price rise begins. Had it been just partial equilibrium analysis, the model would have predicted new equilibrium at (Q’, P’) in response to the shift in demand for high fuel-consuming automobiles. However, considering (b) to (e) show how this initial change in (a) production of directly or indirectly related industries and income of individuals that can have feedback effect to (a) by further reducing the demand for these automobiles. As can be seen in (f), the feedback effect further reduces the equilibrium quantity and price to (Q'', P''). This later consideration is made by general equilibrium analysis.

When (as in the automobile example) the repercussions or feedback effects from the other industries are significant, partial equilibrium analysis is inappropriate. By measuring only the impact effect on price and output, partial equilibrium analysis provides a misleading measure of the total.

On the other hand, if the industry in which the original change occurs is small and the industry has few direct links with the rest of the economy, then partial equilibrium analysis provides a good first approximation to the results sought.

The logical question is why not use general equilibrium analysis all the time and immediately obtain the total, direct, and indirect results of a change on the industry (in which the change originated) as well as on all the other industries and markets in the economy? The answer is that general equilibrium analysis, dealing with each and all industries in the economy at the same time, is by its very nature difficult, time consuming, and expensive. Happily for the practical economist, partial equilibrium analysis often suffices. In any event, partial equilibrium analysis represents the appropriate point of departure, both for the relaxation of more and more of the ceteris paribus or "other things equal" assumptions, and for the inclusion of more and more industries in the analysis, as required.

The first and simplest general equilibrium model was introduced in 1874 by the great French economist, Leon Walras. This model and subsequent general equilibrium models are necessarily mathematical in nature and include one equation for each commodity and input demanded and supplied in the economy, as well as market clearing equations. More recently, economists have extended and refined the general equilibrium model theoretically and proved that under perfect competition, a general equilibrium solution of the model usually exists with all markets simultaneously in equilibrium. Our analysis in this chapter is based on the assumption of perfect competition and follows a very simple model.

5.3 *GENERAL EQUILIBRIUM OF EXCHANGE AND PRODUCTION*

In this section, we examine separately general equilibrium of exchange and of production, and we derive the production-possibilities frontier. In the next section, we then examine how both equilibria are achieved simultaneously and the conditions for maximum economic efficiency.

5.3.1 *General Equilibrium of Exchange*

Let us begin by examining general equilibrium of exchange for a very simple economy composed of only

- Two individuals (A and B),
- Two commodities (X and Y),
- The tastes and welfare of individuals A and B are described by the following two utility functions.

  $U_A = U(X_A, Y_A)$

  $U_B = U(X_B, Y_B)$

  Theses functions are represented by the indifference curves in Fig5.2 and 5.3.
- No production.

This allows us to present the general equilibrium of exchange graphically. Initially, let us present preferences of the individuals for the two commodities (Fig 5.2 (A) and (B)). It does not matter if we rotate Pannel B 180^0, to Pannel C.

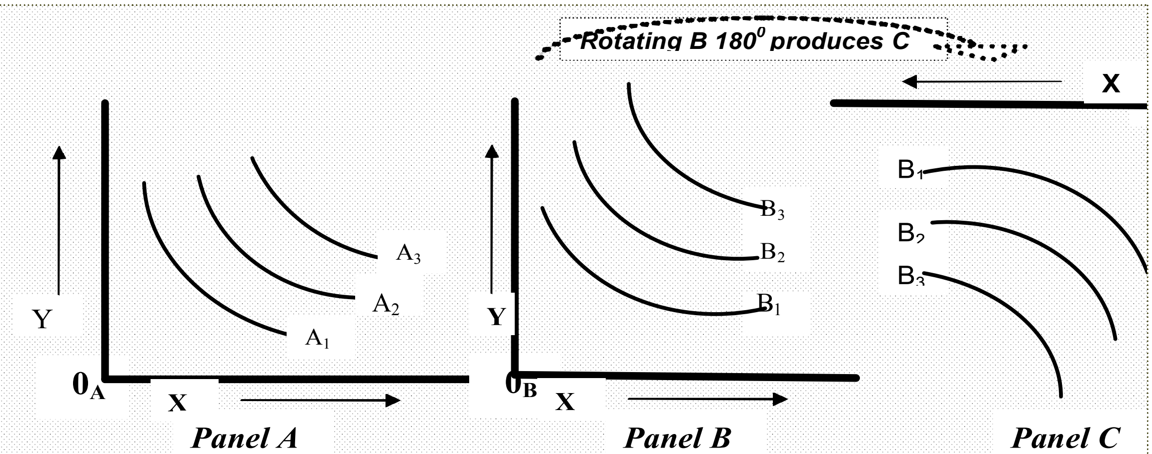


Fig.5.2 **Indifference map of.** A's indifference curves (A_1, A_2, and A_3) are convex to O_A, while B's indifference curves (B_1,B_2, and B_3) are convex to O_B, respectively in Panel A and Panel B. Panel C is just a rotated version of Panel B.

If you join Panels (A) and (B) of fig 5.2, you will get the Edgeworth box of figure 5.3. The *Edgeworth box diagram for exchange* shown in Figure 5.3 is obtained by rotating the indifference diagram for individual B by 180 degrees (so that origin 0_B appears in the top right-hand comer) and superimposing it on the indifference diagram for individual B (with origin 0_B) in such a way that the size of the box refers to the total amount of X and Y available to the two individuals (10X and 8Y).

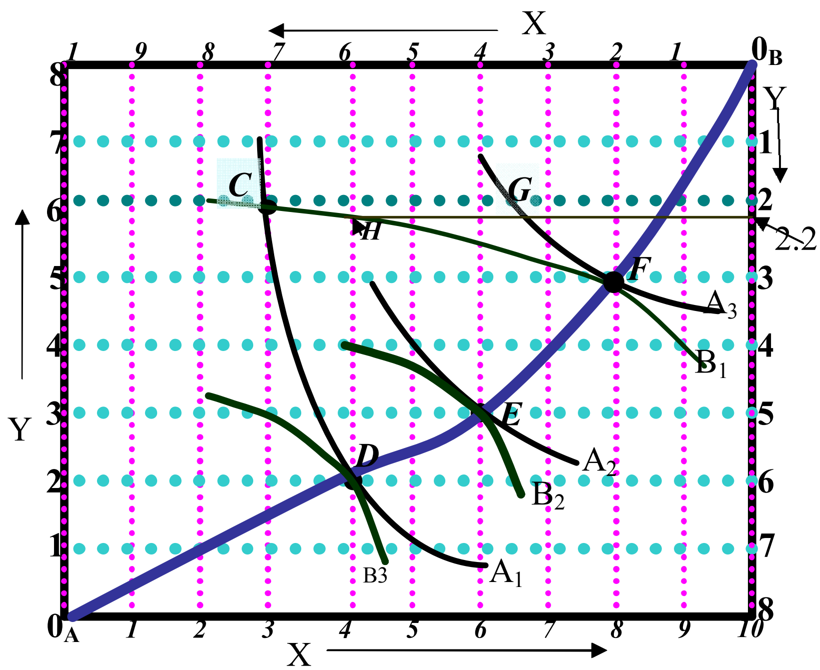


Fig.5.3 **Edgeworth Box Diagram for Exchange.**

Quick self check on Edgeworth Box

Q1. Can *A* achieve A_3? By moving from C to G?

No, B is not willing to exchange that way since it puts him on lower indifference curve than B_1.

Q2. Can *A* achieve A_3 by moving from C to F?

Possibly yes, since B is not affected

Q3. Can both benefit by moving from C through Exchange?

Yes, if they move to some point between D and F.

We can read from the edgeworth diagram that

- The economy does have 10X and 8y totally:
- $$X = 10 = X_A + X_B$$
  $$Y = 8 = Y_A + Y_B$$
    - Eg. A point such as **C** indicates that *individual A* has 3X and 6Y (viewed from origin 0_A), while *individual B* has 7X and 2Y (viewed from origin 0_B) out of the total of 10X and 8Y.

- Curve $O_A DEFO_B$ is the ***contract curve for exchange***. It is the locus of tangencies of the indifference curves (at which the MRS_{xy} are equal) for the two individuals where the economy is in general equilibrium of exchange.
- Starting from any point not on the contract curve, both individuals can gain from exchange by getting to a point on the contract curve.

Suppose that point C *in Fig 5.3* represents the original distribution of commodities X and Y between individuals A and B. Since at point C, indifference curves A_1 and B_1 intersect, their slope or marginal rate of substitution of commodity X for Y (MRSxy) differs. Starting at point C, individual A is willing to give up 4Y to get additional 1X (and move to point D on A), While individual B is willing to accept only 0.2Y in exchange for one unit of X (and move to point H on B_1). Because A is willing to give up much more Y than necessary to induce B to give up 1X, there is a basis for exchange that will benefit either or both individuals. This is true whenever, as at point C the MRSxy for the two individuals differ. For example, starting from point C, if individual A exchanges 4Y for 1X with individual B, A moves from point C to point D along indifference curve A_1, while B moves from point C on B, to point D on B_3. Thus, individual B receives all of the gains from exchange while individual A gains or loses nothing (since A remains on A_1). At point D, A_1 and B_3 are tangent, so that their slopes (MRSxy) are equal, and there is no further basis for exchange.

Alternatively, if individual A exchanged 1Y for 5X with individual B, individual A would move from point C on A_1 to point F on A_3, while individual B would move from point C to point F along B_1. Then, A would reap all of the benefits from exchange while B would neither gain nor lose. At point F, MRS_{xy} for A equals MRS_{xy} for B and there is no further basis for exchange. Finally, if A exchanges 3Y for 3X with B and gets to point E, both individuals gain from exchange since point E is on A_2 and B_2. Thus, starting from point C, which is not on line DEF, both individuals can gain through exchange by getting to a point on line DEF between D and F. The greater A's bargaining strength, the closer the final equilibrium point of exchange will be to point F, and the greater will be the proportion of the total gains from exchange going to individual A (so that less will be left over for individual B).

Along the ***contract curve for exchange***, the marginal rate of substitution of commodity X for commodity Y is the same for individuals A and B, and the economy is in general equilibrium of exchange. Thus, for equilibrium,

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

Starting from any point not on the contract curve, both individuals can gain from exchange by getting to a point on the contract curve. Once on the contract curve, one of the two individuals cannot be made better off without making the other worse off. For example, a movement from point D (on A_1 and B_1) to point E (on A_1 and B_1) makes individual A better off but individual B worse off. Thus, the consumption contract curve is the locus of general equilibrium of exchange. For an economy composed of many consumers and many commodities, the general equilibrium of exchange occurs where the marginal rate of substitution between every pair of commodities is the same for all consumers consuming both commodities.

5.3.2 *General Equilibrium of Production*

In the preceding section we have examined general equilibrium in a pure exchange economy with no production. We turn to *general equilibrium of production* in a simple economy in which no exchange takes place.

To examine general equilibrium of production, we deal with a very simple economy that produces only two commodities (X and Y) with only two inputs, labor (L) and capital (K).

Suppose that the technological relationships in the economy are as follows:

$$X = X(L_X, K_X)$$

$$Y = Y(L_Y, K_Y)$$

These two functions are represented by the isoquants in Fig 5.4

Where, X and Y are the annual outputs. L and K are, respectively, labor and capital whose subscripts indicate the corresponding output for which they are used.

If $\overline{L}$ is the total (say, annual) available labor services and $\overline{K}$ is the (say, annual) available capital services, then this condition can be written as follows:

$$\overline{L} = L_X + L_Y$$

This is horizontal distance 5.4

$$\overline{K} = K_X + K_Y$$

This is vertical distance 5.4

L_X, L_Y, K_X, and K_Y are variables with values to be solved in the general equilibrium model. $\overline{L}$ and $\overline{K}$ are assumed to be in fixed supply.

Productive efficiency

Productive efficiency exists if it is not possible to reallocate inputs in to alternative uses in such a manner as to increase the output of anyone good without reducing the output of some alternative good.

If productive resources are presumed to be always fully employed, then it must follow that:

$$L_X = \overline{L} - L_Y$$
$$K_X = \overline{K} - K_Y$$

Next, we construct an Edgeworth box diagram for production from the isoquants for commodities X and Y in a manner completely analogous to the Edgeworth box diagram for exchange of Figure 5.3. This is shown in Figure 5.4, accounting for the above equations.

The *Edgeworth box diagram for production* shown in Figure 5.4 is obtained by rotating the isoquant diagram for commodity Y by 180 degrees (so that origin 0y appears in the top right-hand comer) and superimposing it on the isoquant diagram for commodity X (with origin 0x) in such a way that the size of the box refers to the total amount of L and K available to the economy (l2L and 10K). Any point inside the box indicates how the total amount of the two inputs is utilized in the production of the two commodities. For example, Point R indicates that 3L and 8K are used in the production of X_1 of Commodity X and the remaining 9L and 2K are used to produce Y_1 of Y. Three of X's isoquants (convex to origin 0_X) are X_1, X_2 and X_3. Three of Y's isoquants (convex to origin 0_Y) are Y_1, Y_2 and Y_3.

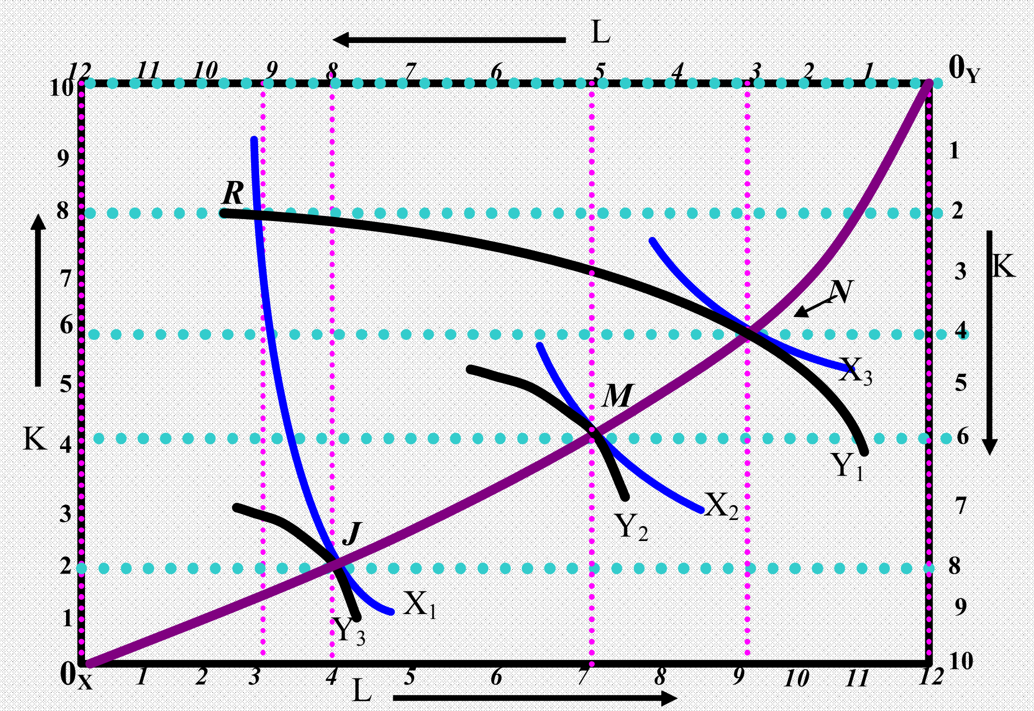


Fig.5.4 **Edgeworth Box Diagram for Production.** A point such as **R** indicates that 3L and 8K (viewed from origin Ox) are used to produce X_1 of commodity X, and the remaining 9L and 2K (viewed from origin Oy) are used to produce Y_1 of Y The isoquants for X (X_1, X_2, and X_3) are convex to Ox, while the isoquants of Y (Y_1, Y_2, andY_3) are convex to Oy Starting from point R, where X_1 and Y_1, intersect, the economy can produce more of X, more of Y, or more of both by moving to a point on JMN. Curve $OxJMNO_y$ is the contract curve for production. It is the locus of tangencies of the isoquants (at which the $MRTS_{LK}$ are equal) for both commodities, and the economy is in general equilibrium of production.

If this economy was initially at point R, it would not be maximizing its output of commodities X and Y because, at point R, the marginal rate of technical substitution of labor for capital ($MRTS_{LK}$) in the production of X (the absolute slope of X_1) exceeds the $MRTS_{LK}$ in the production of Y (the absolute slope of Y_1). By simply transferring 6K from the production of X to the production of Y and lL from the production of Y to the production of X, the economy can move from point R (on X_1 and Y_1) to point J (on X_1 and Y_3) and increase its output of Y without reducing its production of X.

Alternatively, this economy can move from point R to point N (and increase its output of X from X_1 to X_3 without reducing its output of Y_1) by transferring 2K from the production of X to the production of Y and 6L from Y to X. Or, by transferring 4K from the production of X to the production of Y and 4L from Y to X, this economy can move from point R (on X_1 and Y_1) to point M (on X2 and Y2), and increase its output of both X and Y. At points J, M, and N, an X isoquant is tangent to a Y isoquant so that the $MRTS_{LK}$ in the production of X equals $MRTS_{LK}$ in the production of Y.

Curve 0xJMNOy is ***the contract curve for production***. It is the locus of tangency points of the isoquants for X and Y at which the marginal rate of technical substitution of labor for capital is the same in the production of X and Y. That is, the economy is in general equilibrium of production when

$$MRTS^{X}{}_{LK} = MRTS^{Y}{}_{LK}$$

Thus, by simply transferring some of the given and fixed amounts of available L and K between the production of X and Y, this economy can move from a point not on the contract curve for production to a point on the curve and increase its output of either or both commodities. Once on its production contract curve, the economy cannot increase the output of either commodity unless it reduces the output of the other. For example, by moving from point J (on X_1 and Y_3) to point M (on X_2 and Y_2), the economy increases its output of commodity X (by transferring 3L and 2K from the production of Y to the production of X), but its output of commodity Y falls. For an economy of many commodities and many inputs, the general equilibrium of production occurs where the marginal rate of technical substitution between any pair of inputs is the same for all commodities and producers using both inputs.

Derivation of Production Possibility frontier (PPF)

So far we have determined the conditions for equilibrium in exchange and production separately. Our general objective of this chapter is to determine the conditions for simultaneous equilibrium in both exchange and production. In order to do so we

- Derive the Production Possibility Frontier (PPF) from Edgeworth contract curve for production
- Bring the PPF and Edgeworth Box for exchange.

PPF shows the alternative combinations of commodities that the economy can produce by fully utilizing all of its resources with the best technology available to it. From the production contract curve, we can derive the corresponding production-possibilities frontier or transformation curve by simply plotting the various combinations of outputs directly. For example, if isoquant X_l in Figure 5.4 referred to an output of 4 units of commodity X and isoquant Y_3 referred to an output of 13 units of commodity Y, we can go from point **J** (X_l, Y_3) in Figure 5.4 to point **J** (4X, 13Y) in Figure 5.5. Similarly, if isoquant X_2 referred to an output of l0X and isoquant Y_2 to an output of 8Y, we can go from point M (X_2, Y_2) in Figure 5.4 to point M (l0X, 8Y) in Figure 5.5.

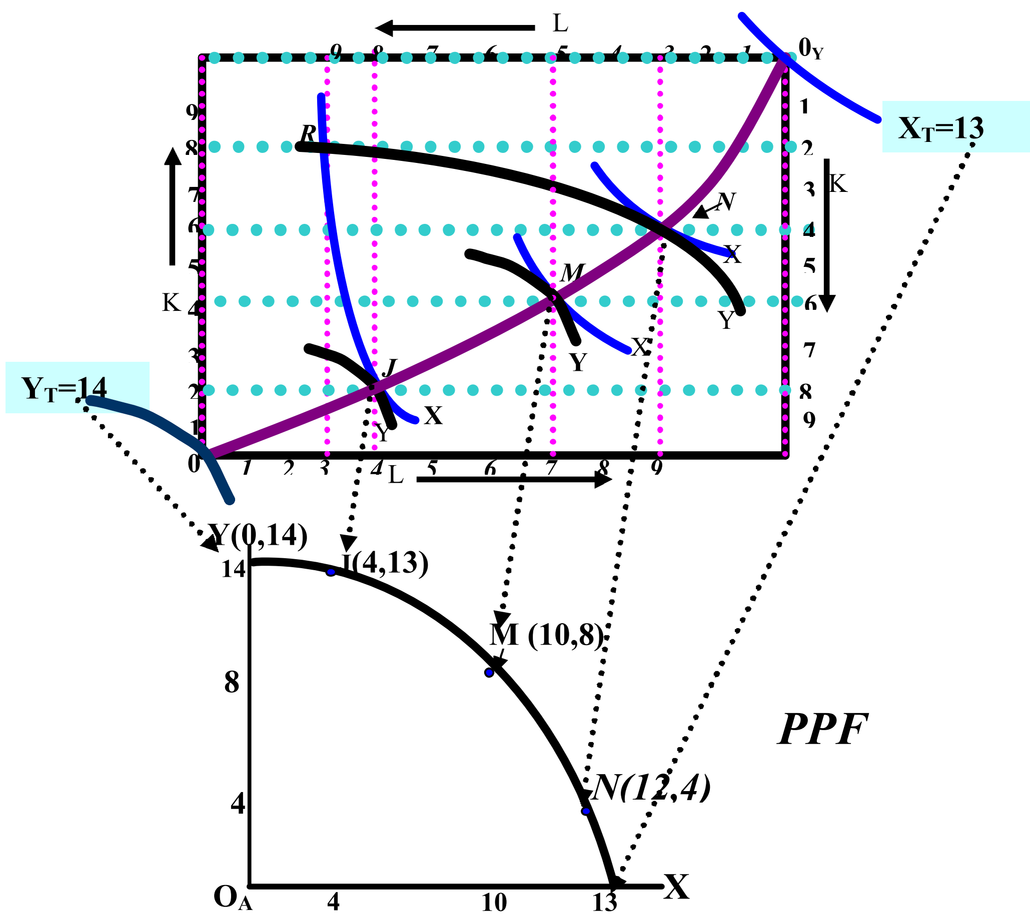


Fig. 5.5 Deriving PPF from Edgeworth Box for Production

Finally, if $X_3 = 12X$ and $Y, = 4Y$, we can plot point N (X3, Y_1) from Figure 5.4 as point N (l2X, 4Y) in Figure 5.5. By joining points JM N and other points similarly obtained, we derive the production possibilities frontier or transformation curve of X for Y as shown in Figure 5.5. *Thus, the production-possibilities frontier is obtained by simply mapping or transferring the production contract curve from input space to output space.*

The production-possibilities frontier or transformation curve shows the various combinations of commodities X and Y that the economy can produce by fully utilizing all of the fixed amounts of labor and capital with the best technology available. Since the production contract curve shows all points of general equilibrium of production, so does the production-possibilities frontier. That is, the production-possibilities frontier shows the maximum amount of either commodity that the economy can produce, given the amount of the other commodity that the economy is producing. Once on the production-possibilities frontier, the output of either commodity can be increased only by reducing the output of the other.

The absolute value of the slope of the PPF measures the amount of Y foregone in order to produce one extra unit of X. It is called the ***marginal rate of transformation*** of X for Y (MRT_{XY}). Clearly, transformation of X for Y is made by releasing enough amount resources from production of Y that enables production of an extra unit of X. In other words, marginal rate of transformation is equal to the ratio of marginal cost of X to marginal cost of Y: $MRT_{XY} = \dfrac{MC_X}{MC_Y}$.

For example, at M if $MRT_{XY} = 1.5$,

or $\dfrac{MC_X}{MC_Y} = 1.5$, meaning that the economy gives up 1.5 amount of Y in order to produce an extra unit of X.

The more costly it becomes to produce an extra unit of X, the more resources are released from production of Y, meaning that more units of Y have to be given up. This is reflected in the shape of PPF that the absolute value of its slope increases as we move down the curve. The reason for this is that, as the economy reduces its output of Y (in order to produce more of X), it releases labor and capital in combinations that become less and less suited for the production of more X. Thus, the economy incurs increasing MC_x in terms of Y. It is because of this imperfect input substitutability between the production of X and Y (and rising MC_x in terms of Y) that the production-possibilities frontier is concave to the origin.

5.4 GENERAL EQUILIBRIUM OF PRODUCTION AND EXCHANGE AND PARETO OPTIMALITY

In this section, we examine general equilibrium of production and exchange and define the concept of Pareto optimality, which summarizes the marginal conditions for economic efficiency.

5.4.1 General Equilibrium of Production and Exchange Simultaneously

We now can use the production-possibilities frontier and the contract curve for exchange to examine how our very simple economy composed of two individuals (A and B), two commodities (X and Y), and two inputs *(L* and *K)* can reach *simultaneously* general equilibrium of production and exchange. This equilibrium is shown in Figure 5.6. The production-possibilities frontier of Figure 5.6 is that of Figure 5.5, which was derived from the production contract curve of Figure 5.4. Thus, every point on production possibilities frontier is a point of general equilibrium of production. Suppose that this economy produces l0X and *8Y,* given by point *M* on production-possibilities frontier in Figure 5.6. By dropping perpendiculars from point *M* to both axes, we can construct in Figure 5.6 the Edgeworth box diagram for exchange between individuals A and B of Figure 5.3. Note that the top right-hand comer of the Edgeworth box diagram for exchange of Figure 5.3 coincides with point *M* on PPF in Figure 5.6. Given the indifference curves of individuals A and B and the output of *l0X* and 8 *Y,* we derived contract curve $O_A DEF O_B$ for exchange in Figure 5.3. This curve is reproduced in Figure 5.6.

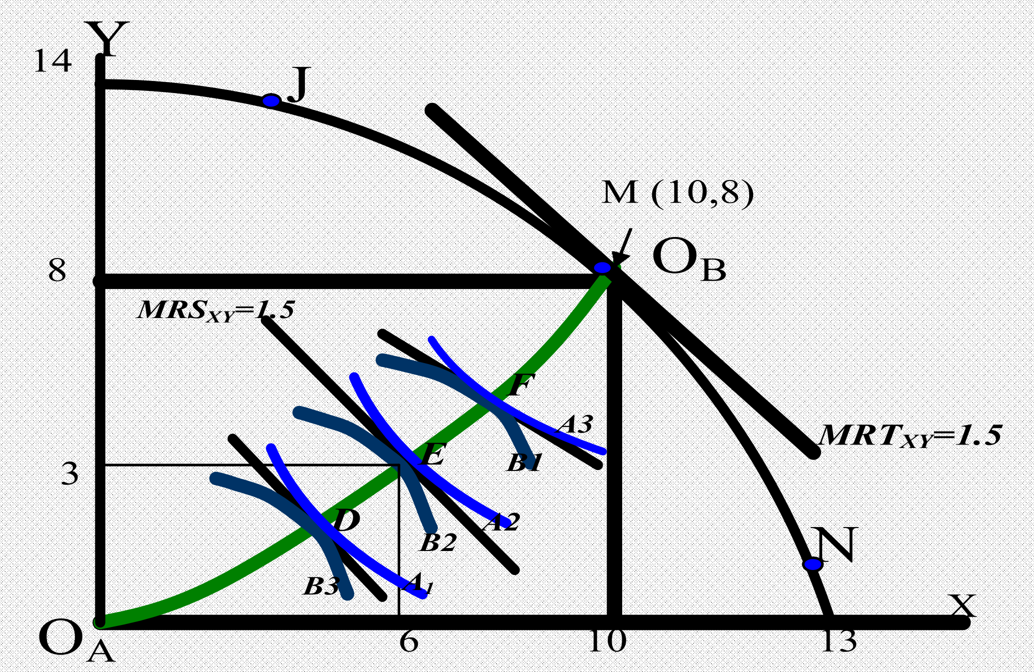


Fig.5.6 ***Derived PPF.***
The PPF or transformation curve is derived by mapping the production contract curve of Figure 5.4 from input to output space. The absolute slope or MRT_{xy} = 3/2 at point M, means that 3/2 of Y must be given up to produce one additional unit of X. MRT_{xy} increases as we move down the frontier. For example, at point N, MRT_{xy} = 3.

Every point on the contract curve for exchange in Figure 5.6 is a point of general equilibrium of exchange.

Thus in Figure 5.6,

- Every point on PPF is a point of general equilibrium of production, and
- Every point on the contract curve for exchange is a point of general equilibrium of exchange: $MRS^{A}{}_{XY} = MRS^{B}{}_{XY}$
- To be *simultaneously* in general equilibrium of production and exchange, the marginal rate of transformation of commodity X for commodity *Y* in production must be equal to the marginal rate of substitution of commodity X for commodity *Y* in consumption for individuals A and B. That is,

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

Geometrically, this equation corresponds to the point on the contract curve for exchange at which the common slope of an indifference curve of individual A and individual B equals the slope of PPF at the point of production. **In** Figure 5.6, this occurs at point *E,* where

$$MRS^{A}{}_{XY} = MRS^{B}{}_{XY} = MRT_{XY} = 1.5$$

Thus, when producing l0X and *8Y* (point *M* on PPF*),* this economy is simultaneously in general equilibrium of production and exchange when individual A consumes 6X and 3 *Y* (point *E* on his/her indifference curve *A_2)* and individual B consumes the remaining 4X and *5Y* (point *E* on his/her indifference curve *B_2).*

If the above condition did not hold, the economy would not be simultaneously in general equilibrium of production and exchange. For example, suppose that individuals A and B consumed at point *D* on the contract curve for exchange rather than at point *E* in Figure 5.6. At point *D,* the $MRS^{A}{}_{xy}$ $MRS^{B}{}_{xy} = 3$. This means that individuals A and B are willing (indifferent) to give up 3 *Y* to obtain one additional unit of X. Since in production only 1.5 *Y* needs to be given up to produce an additional unit of X, society would have to produce more of X and less of *Y* to be simultaneously in general equilibrium of production and exchange. That is, if $MRS_{xy} = 3$, this society would not have chosen to produce at point *M,* but would have produced at point *N (12X* and *4Y),* where

$$MRS_{xy} = MRT_{xy} = 3.$$

The opposite is true at point *F.* That is, at point *F,* $MRS_{xy} = 1/2$. Since $MRT_{xy} = 1.5$ at point M, more of *Y* needs to be given up in production to obtain one additional unit of X than individuals A and B are willing to give up in consumption. If this were the case, this society would have chosen to produce at point *J (4X* and *13Y) where*$MRS_{xy} = MRT_{xy} = 1/2$, rather than at point *M.*

Only by consuming at *pointE* will $MRT_{xy} = MRS_{xy}$ for both individuals, and society will be simultaneously in general equilibrium of production and exchange when it produces at point *M'.*

5.4.2 Marginal Conditions for Economic Efficiency and Pareto Optimality

With general equilibrium of production and exchange, economic efficiency is maximum and we have Pareto optimality. According to this concept, *a distribution of inputs among commodities and of commodities among consumers* is *Pareto optimal or efficient if no reorganization of production and consumption* is *possible by which some individuals are made better off (in their own judgment) without making someone else worse off.* Any change that improves the well-being of some individuals without reducing the well-being of others clearly improves the welfare of society as a whole and should be undertaken. This will move society from a Pareto nonoptimal position to Pareto optimum. Once at Pareto optimum, no reorganization of production and exchange is possible that makes someone better off without, at the same time, making someone else worse off. To evaluate such changes requires interpersonal comparisons of utility, which are subjective and controversial.

In a very simple economy of two individuals, two commodities (X and *Y),* and no production, the contract curve for exchange (along which the MRS_{xy} is the same for both individuals) is the locus of Pareto optimum in exchange and consumption. A movement from a point off the contract curve to a point on it improves the condition of either or both individuals, with the given quantities of the two commodities. Once on the contract curve, the economy is in general equilibrium or Pareto optimum in exchange, in the sense that either individual can be made better off only by making the other worse off. In an economy of many individuals and many commodities, Pareto optimum in exchange requires that the marginal rate of substitution between any pair of commodities be the same for all individuals consuming both commodities.

In a very simple economy of two commodities, two inputs *(L* and *K),* and no exchange, the production contract curve (along which the $MRTS_{LK}$ is the same for both commodities) is the locus of Pareto optimum in production. A movement from a point off the production contract curve to a point on it makes it possible for the economy to produce more of either or both commodities, with the given inputs and technology. Once on the production contract curve, the economy is in general equilibrium or Pareto optimum in production in the sense that the economy can increase the output of either commodity only by reducing the output of the other. In an economy of many commodities and many inputs, Pareto optimum in production requires that the marginal rate of technical substitution between any pair of inputs be the same for all commodities and producers using both inputs.

Finally, Pareto optimum in production and exchange simultaneously in an economy of many inputs, many commodities, and many individuals requires that the marginal rate of transformation in production equals the marginal rate of substitution in consumption for every pair of commodities and for every pair of individuals consuming both commodities. In the case of a very simple economy composed of only two commodities and two individuals (A and B), Pareto optimality in production and consumption requires that $MRT_{XY} = MRS^{A}{}_{XY} = MRS^{B}{}_{XY}$, where production and consumption are economically efficient and society maximizes welfare.

5.5 PERFECT COMPETITION, ECONOMIC EFFICIENCY, AND EQUITY

In this section we show why perfect competition leads to economic efficiency or Pareto optimum, but not necessarily to equity.

Perfect Competition and Economic Efficiency

With perfect competition in all input and commodity markets, the three marginal conditions for economic efficiency or- Pareto optimum in production and exchange are automatically satisfied. This is the basic argument for perfect competition. We can easily prove that perfect competition leads to economic efficiency.

Consumer maximizes utility or satisfaction when he or she reaches the highest indifference curve possible with his or her budget line. This occurs where an indifference curve is tangent to the budget line. At the tangency point, the slope of the indifference curve (the $MRSxy$) is equal to the slope of the budget line (Px/P_y). Since P_x and P_y, and thus P_x/P_y, are the same for all consumers under perfect competition, the MRS_{xy} is also the same for all consumers consuming both commodities. This is the ***first marginal condition for economic efficiency*** or ***Pareto optimum*** in exchange. In the foregoing analysis we do have assumed equilibrium to be at $MRS_{XY} = P_x/P_y = 1.5$

It can be recalled from your previous lessons that efficiency in production requires that the $MRTS_{LK} = w/r$ (the ratio of the input prices given by the absolute value of the slope of the isocost line). Since w and r, and thus w/r, are the same for all producers under perfect competition, the $MRTS_{LK}$ is also the same for all producers using both inputs. This is ***the second marginal condition for economic efficiency*** or ***Pareto optimum*** in production. In the foregoing analysis we do have assumed equilibrium to be at $MRTS_{LK}=w/r=1.5$

At Equilibrium

- Perfectly competitive firms produce where $MCx = P_x$ and $MC_y = P_y$.

  ⇨ $MC_x/ MC_y = P_x/ P_y$

- $MRTxy=MCx/MC_y$,(Section 5.3.2)

⇨Therefore, $\boxed{MC_x/ MC_y = P_x/ P_y = MRT_{xy}.}$

Since we have also seen above that under perfect competition $MRT_{xy} = P_x/ P_y$ for all consumers consuming both commodities, we conclude that $MRT_{xy} = MRS_{xy}$ for all consumers consuming both commodities. This is ***the third marginal condition for economic efficiency*** and Pareto optimum in production and exchange.

The output of *10X* and 8 *Y* at point *M* in Figure 5.6 is based on a particular distribution of inputs (income) between individuals A and B and on their tastes. A different distribution of income and/or tastes for individuals A and B would lead to a different combination of goods X and *Y* demanded. This would result in a different P_x/ P_y, different quantities of X and Y produced, and different levels of satisfaction for A and B. For example, suppose that individuals A and B demanded 12X and *4Y* (point *N* in Figure 5.6). Then, general equilibrium of production and exchange or Pareto optimality requires that

$$MRT_{xy} = P_x /P_y = MRS^{A}xy = MRS^{B}xy = 3.$$

This involves constructing an Edgeworth box diagram from point *N.* In a purely exchange economy (i.e., one in which there is no production), the equilibrium $Pxl\ P_y$ is the one that exactly matches the desired quantity of X and *Y* that each individual wants to exchange. If B wants more of X for a given amount of *Y* than A is willing to exchange, then $Pxl\ P_y$ will rise until the demand for the quantities of X and *Y* to be exchanged match. Similarly, if B wants less of X for a given amount of Y than A is willing to exchange, Px/P_y will fall until equilibrium is reached.

Efficiency and Equity

According to the **first theorem of welfare economics,** an equilibrium produced by competitive markets exhausts all possible gains from exchange, or that equilibrium in competitive markets is Pareto optimal.

There is also a **second theorem of welfare economics**, which postulates that when indifference curves are convex to their origin, every efficient allocation (every point on the contract curve for exchange) is a competitive equilibrium for some initial allocation of goods or distribution of inputs (income).

Activity: by now, you must have clearly understood that any point on the contract curve for exchange is efficient, regardless of the position of individual A or B. Now, the question is: is any point on the contract curve for exchange equitable as well? Why? ____

____
____.

Efficient outcomes are not necessarily equitable. The significance of the second welfare theorem is that the issue of equity in distribution is logically separable from the issue of efficiency in allocation. This means that whatever the redistribution of income that society wants would lead to the exhaustion of all possible gains from exchange under perfect competition. Pareto optimality does not, therefore, imply equity: Society can use taxes and subsidies to achieve what it considers to be a more equitable distribution of income. These may discourage work, however, and show that there is usually a trade-off between efficiency and equity.

For economic efficiency and Pareto optimum to be reached, there should be no market failure.

To show that imperfect competition in the product market leads to economic inefficiency and Pareto nonoptimality, remember that a profit-maximizing firm always produces where marginal revenue *(MR)* equals marginal cost *(MC).* If commodity Y is produced in a perfectly competitive market,

$$P_y = MR_y = MC_y.$$

On the other hand, if commodity X is produced by a firm with monopoly power,

$P_x > MR_x$ *and* $P_x > MC_x$.

Then, $MRT_{XY} = \dfrac{MC_X}{MC_Y} = \dfrac{MR_X}{MR_Y} < \dfrac{P_X}{P_Y}$

But $\dfrac{P_X}{P_Y} = MRS_{XY}$. If so, $MRT_{xy} < MRS_{xy}$,

Therefore, the third condition for Pareto optimum and economic efficiency is violated.

To show that imperfect competition in the input market leads to economic inefficiency and Pareto nonoptimality, remember that in Chapter Four of this Module it was shown that a profit maximizing firm always produces where the Value of Marginal product *(VMP)* of each input equals the marginal resource cost *(MRC)* for the input. If P_I is the price of the input, and the input market is perfectly competitive, $VMP = MRC = P_I$. Otherwise, $VMP = MRC > P_I$.

Now suppose that all markets in the economy are perfectly competitive, except that the firm producing commodity X is a monopsonist in its labor market (i.e., it is the sole employer of labor in its labor market).

Therefore, $VMP = MRC > P_I$ in the production of X, while

$VMP = MRC = P_I$ in the production of *Y. (Notice our assumption that the only producer of X does have monopsony power).*

That is, $MRTS^X_{LK} > MRTS^Y_{LK}$ so that the first of the conditions for Pareto optimum and economic efficiency is violated. In other words, the maximizing behavior of producers and consumers no longer acts to achieve efficiency automatically. For this reason, monopoly (and monopsony) power is considered undesirable by normative economists.

Finally, note that perfect competition leads to efficiency and Pareto optimum in production and exchange *at a particular point in time.* Over time, tastes, the supply of inputs, and technology change; what is most efficient at one point in time may not be most efficient over time. In short, perfect competition leads to *static, but not necessarily to dynamic, efficiency.*

5.6 CHAPTER SUMMARY

1. This chapter has been devoted to general equilibrium analysis by assuming perfect competition for which the general equilibrium exists.

2. With its advantage of convenience, partial equilibrium analysis studies the behavior of individual decision-making units and individual markets, viewed in isolation. General equilibrium analysis studies the interdependence that exists among all markets in the economy. Only when an industry is small and has few direct links with the rest of the economy is partial equilibrium analysis appropriate.

3. A simple economy of two individuals (A and B), two commodities (X and *Y),* and two inputs *(L* and *K)* is in general equilibrium of exchange when the economy is on its contract curve for exchange. This is the locus of tangency points of the indifference curves (at which the MRS_{xy} are equal) for the two individuals. The economy is in general equilibrium of production when it is on its production contract curve. This is the locus of the tangency points of the isoquants (at which $MRTS_{LK}$ are equal) for the two commodities. By mapping or transferring the production contract curve from input to output space, we derive the corresponding productionpossibilities frontier.

4. For the economy to be simultaneously in general equilibrium of production and exchange, the marginal rate of transformation of X for *Y* in production must be equal to the marginal rate of substitution of X for *Y* in consumption for individuals A and B. That is, $MRT_{xy} = MRS^{A}_{XY} = MRS^{B}_{XY}$. Geometrically, this corresponds to the point on the contract curve for exchange at which the common slope of the indifference curve of the two individuals equals the slope of the production-possibilities frontier at the point of production. A distribution

of inputs among commodities and of commodities among consumers is Pareto optimal or efficient if no reorganization of production and consumption is possible by which some individuals are made better off without making someone else worse off. Thus, the conditions for Pareto optimality are the conditions for general equilibrium of production and exchange.

5. Under perfect competition in all input and output markets. All the conditions for Pareto optimum are automatically satisfied. This is the basic argument in favor of perfect competition and proof of Adam Smith's law of the invisible hand. The first theorem of welfare economics postulates that equilibrium in competitive markets is Pareto optimal. The second theorem of welfare economics postulates that equity in distribution is logically separable from efficiency in allocation. Perfect competition leads to maximum economic efficiency only in the absence of market failures.

Chapter Six
INFORMATION ASYMMETRY:INTRODUCTION

Information imperfections are pervasive in the economy: indeed, it is hard to imagine what a world with perfect information would be like. ...different people know different things [asymmetries of information]: workers know more about their ability than does the firm; the person buying insurance knows more about his health, whether he smokes and drinks immoderately, than the insurance firm; the owner of a car knows more about the car than potential buyers; the owner of a firm knows more about the firm that a potential investor; the borrower knows more about his risk and risk taking than the lender.

JOSEPH E. STIGLITZ , "Information and the Paradigm in Economics" Prize Lecture, December 8, 2001, PP: 17

6.1 INTRODUCTION

Information is a valuable economic resource. It makes difference if you know where to buy high-quality goods, if you know how much effort your employees are exerting, if you know how careless a driver your customer is. Most economic analysis assumes that buyers and sellers are both perfectly informed about the quality of the goods being sold in the market. If it is not costly to tell which goods are high-quality goods and which are low-quality goods, then the prices of the goods will simply adjust to reflect the quality difference. On the other hand if information about quality is costly to obtain, then it is no longer plausible that buyers and sellers have the same information about goods involved in transactions. In the real world, in many markets it may be very costly or even impossible to gain accurate information about the quality of the goods being sold. Such difference in access to relevant knowledge is called *information asymmetry*.

While analyzing choice under uncertainty in Chapter III of your Microeconomics I, we have assumed that individuals know the probability distributions over outcomes and on what outcomes would be observed in each state of the world. In reality, these assumptions are likely to be violated. First, individuals may have private information about their true probabilities of suffering losses. Second, they may be able to take unobservable actions which can either affect the probability of a loss or affect the size of any loss that might occur.

Although information asymmetry is applicable to wider areas, this introductory chapter delimits itself to the use of the famous, 'market of the lemon'.

Chapter Objectives

At the end of this chapter, you should be able to:

- Define information Asymmetry
- Explain how lower quality products drive high quality goods in the presence of asymmetric Information
- Measure the loss to society due to Information Asymmetry

Chapter Outline

6.2 PROPERTIES OF INFORMATION

Why, do you think, is market mechanism may fail to perfectly allocate resources to information provision and acquisition? The answer to this question becomes clear once we look at the following properties of information.

Properties of information:

- Information is not a homogeneous good.
- It is hard to quantify the amount of information obtainable from various actions.
- Information is a durable good.
- Information is a pure public good. It is non-rival (others may use at zero cost) and non-excludable (no individual can prevent others from using the information).
- The cost of acquisition of information varies significantly among individuals. Some individuals may possess specific skills relevant to information acquisition.

Thus, the level of information may differ among the participants in market transactions.

Sortly, these properties of information imply that market mechanism may often operate imperfectly in allocating resources to information provision and acquisition.

We will further see how information asymmetry causes market failure. We will start by discussing two types of problems raised by differences in information. *Adverse selection* refers to situation where one side of the market cannot observe the type of quality of goods on the other side of the market. For his reason, it is sometimes called hidden information problem. In contrast, moral hazard refers to situation where one side of the market cannot observe the actions of the other. For this reason, it is sometimes called *hidden action* problem.

6.3 THE MIXED MARKETS FOR USED CARS

The common example of a market with imperfect information is the market for used cars. Suppose that prospective buyers cannot distinguish between low quality cars (lemons) and high quality cars (plums). Although a buyer can get some information about a particular car by looking at the car and taking it for a test drive, this information is not sufficient to indicate whether the car is a lemon or a plum. There is *asymmetric information* in a market if one side of the market has better information than the other. In other words, information asymmetry refers to the fact that the buyer and the seller of a product may have different amounts of information about that product's attributes.

For example, the sellers of used cars know more than the buyers. Because buyers cannot distinguish between lemons and plums, there will be a single market for the two types of used cars. Lemons and plums will be sold together in a mixed market for the same price.

We start our discussion of the used car market with an extreme case, a market in which all the cars on the market will be lemons. This extreme case is unrealistic, but it provides a useful starting point for a discussion of the implications of asymmetric information. It shows that one possibility is the disappearance of the market for high quality good. As we will see later, the more realistic case is a situation in which most-but not all-the used cars are lemons, so there is a small chance that a buyer will get high-quality good.

6.4 IGNORANT CONSUMERS AND KNOWLEDGEABLE SELLERS

How much is a consumer willing to pay for a used car that could turn out to be either a lemon or plum? To determine price in mixed market, we must answer three questions:

i. How much is a consumer willing to pay for a plum (a high-quality car)?
ii. How much is a consumer willing to pay for a lemon (a low-quality car)?
iii. What is the chance that a used car purchased in the mixed market will turn out to be a lemon?

Suppose that a typical buyer is willing to pay $14,000 for a plum and $10,000 for a lemon. In addition, suppose that a consumer has neutral expectations about the used car market: he assumes that half the used cars are lemon and the other half are plums, so there is a 50% chance of being a lemon. How much is he willing to pay for a car that has a 50% chance of being a lemon? A reasonable assumption is that he is willing to pay the average value of the two types of cars, that is, $12,000.

In contrast to buyers, the sellers of the used cars are knowledgeable. The current owner of the used car knows from experience whether his car is a lemon or a plum. Given a single market price for all used cars- lemons and plums alike-each current owner must decide whether or not to sell his car. We can use the supply curve for lemon and plums to show how many plums and lemons will be supplied at a particular price.

Figure 6.1 shows two hypothetical supply curves: one for plums and another for lemons. The minimum price for plums is $10800, below which no plum will be supplied. AS shown by the plum supply curve, as price increases, the number of plums supplied increases. For example, five plums will be supplied at price of $12000 (*point n*). The minimum price for lemons is $4000, below which no lemon will be supplied. Lemons do have a lower minimum price because they are worth less to their current owners. As shown by the lemon supply curve the number of lemons supplied also increases as price increases. For example, 20 lemons will be supplied at price of $12000 (*point m)*.

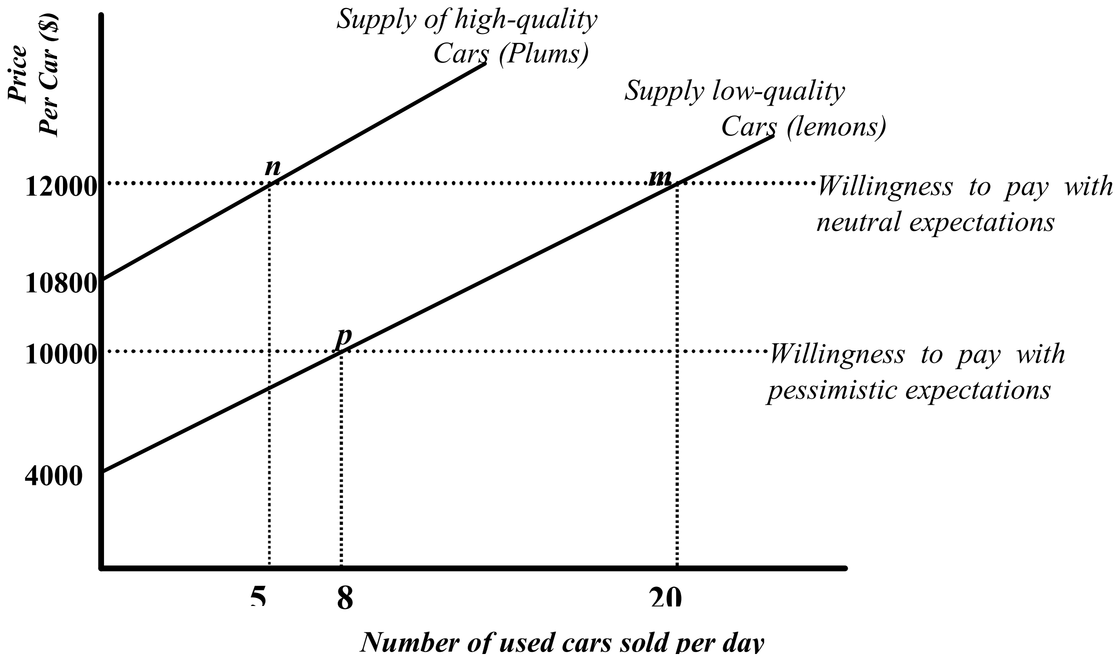


Fig. 6.1 Mixed Market and Information Asymmetry

6.5 EQUILIBRIUM IN THE MIXED MARKET

We do have two scenarios for our hypothetical used car markets: with neutral expectations and pessimistic expectations. These are summarized in Table 6.1. If consumers assume that half the used cars on the market are lemons and half are plums, the typical buyer will be willing to pay $12,000 for a used car. At this price, 5 plums and 20 lemons will be supplied. So, 80% of the used cars (20 of 25) are lemons. In this case, consumers underestimate the chance of getting a lemon.

What will consumers do when they realize that they have underestimated the chance of getting a lemon? They certainly won't be willing to pay $12,000 for a used car. In general, the greater the chance of getting a lemon, the smaller the amount that consumers are willing to pay. As a result, the price of used cars will decrease. Consequently, the market is not in equilibrium since there is pressure to change the price. Therefore, ***the neutral expectations scenario is not equilibrium.***

Suppose that after observing the outcome in the first scenario, buyers become very pessimistic and assume that all the used cars on the market are lemons (chance of 100%).

Table 6.1 Equilibria in the Mixed Mixed Market

	Neutral expectations	***Pessimistic expectations***
Assumed chance of lemon	***50%***	***100%***
Willingness to pay for lemon	\$10,000	\$10,000
Willingness to pay for plums	\$14,000	\$14,000
Willingness to pay for used car (average)	\$12,000	\$10,000
Number of lemon supplied	20	8
Number of plum supplied	5	0
Total number of used cars	25	8
Actual chance of lemon	***80%***	***100%***

Under this assumption, the typical consumer will be willing to pay only\$10,000 (the value of a lemon) for a used car (average). This price is less than the minimum price for plum (10,800), so *plums will disappear from the used car market*. This is shown in figure 6.1: at price of 10,000, the quantity of plums supplied is zero, but the quantity of lemons is eight (*point p*). In other words, all the used cars will be lemons, and consumers' pessimism is justified. Because consumers' expectations are consistent with their actual experiences in the market, equilibrium prices of used cars is \$10,000 where eight lemons and zero plums are sold per day. No plums are sold and bought! Every buyer will get a lemon.

The above analysis has clearly shown the domination of the used car markets by the lemons. Such domination is an example of ***adverse selection problem***. The uninformed side of the market (buyer in this case) must choose from an undesirable or adverse selection of goods (used cars).

The asymmetric information in the market generates a ***downward spiral of price and quantity***:

> *A decrease in price decreases the quantity of high-quality cars supplied, depressing the price even further when buyers realize the lower average quality of cars on the market, which leads to even fewer high-quality cars on the market.*

On the extreme case, this downward spiral continues until all the cars on the market are lemons where every buyer gets a lemon.

6.6 *MEASURING LOSS DUE TO INFORMATION ASYMMETRY*

When an individual decides to try to sell a bad car, he affects the *purchasers' perceptions* of the quality of the average car on the market. This lowers the price that people are willing to pay, and hurts those who want to sell good cars. This externality creates the market failure. As Akerlof points out, in some cases, buyers will only purchase lemons because they will not be willing to pay a premium for goods (cars in Akerlof's example) which are represents as high-quality, but which might be lemons. *If buyers express demand only for lemons, only lemons will be sold, even though both buyers and sellers of good quality cars would be better off if high-quality goods could be identified and sold for high price.* This is *market failure*.

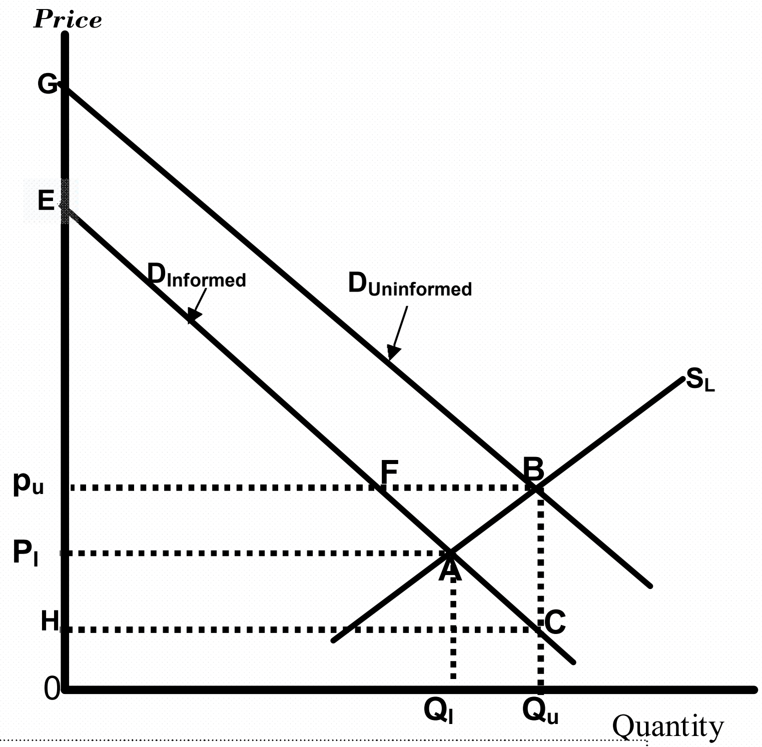


Fig. 6.2. Lemon Market and Loss due to Information Asymmetry

In Fig. 6.2 D_U and D_I represent the consumer's demand schedule in, respectively, the absence and presence of perfect information about its quality: they are, respectively, the consumer's 'uninformed' and 'informed' demands. The quantity actually purchased is Q_U and this is greater than Q_I, the quantity the consumer would have bought had he been fully informed. The gain in producer's surplus from 'over-consumption' is $PuBAP_I$. The loss in consumer's surplus from over-consumption is:

$$AP_IE - (OECQ_U - OP_uBQ_u) = AP_{\mathbf{I}}E - (P_{\mathbf{u}}EF - FBC) = AP_{\mathbf{I}}P_uF + FBC.$$

So, the ***net loss to society*** from 'overconsumption' is loss in consumer's surplus less gain in producer's surplus $= AP_{\mathbf{I}}P_uF + (AFB + ABC) - (Ap_{\mathbf{I}}p_uF + AFB)$

$$= \mathbf{ABC}.$$

☺Check Your Progress 1

Suppose that due to asymmetric information, consumers in a town are not able to exactly distinguish between *original, high quality* (plum), MP3 song collections and the *duplicated, low quality* (lemon) MP3. The consumers do perceive the average quality. Indeed, through time the lemons have driven out the plums out of markets. As a result, only the former exist and the town is served with the lemon market, where the supply function is

$N = 20 + p$; N is the number of MP3 per week.

Had the consumers been informed, the demand in the town could have been

$$N_{Inf} = 38 - 2p$$

However, the existing demand is uninformed one given by:

$$N_{un\inf} = 50 - 2p \text{ .}$$

Required: *With the use of graphical aid (mandatory),*

i. Find the equilibrium numbers MP3 CDs sold per week and corresponding prices.

a. With uninformed demand

b. Had demand been informed

ii. Show your results on your graphs. ***(Hint: Use graphs similar to Fig 6.2)***

iii. Due to the information asymmetry, how much is:

a. gain in producer surplus?

b. consumer surplus loss?

c. net loss to the society?

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