Lecture No 11.

Equi-marginal returns and Opportunity cost - comparative advantage

v) Opportunity cost and Marginal criterion for Resource Allocation: Maximum revenue from a limited amount of input was shown to occur when,

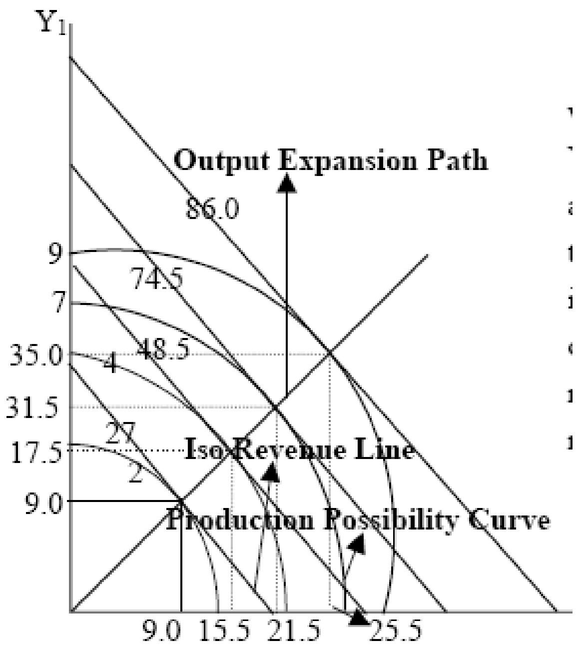

Fig.12.7 Output Expansion Path

where ΔY_1 isnegative. But the decrease inY_1could only be caused by shifting someamount of input, X, from enterprise (Y_1)to enterprise Y_2. Denote the amount ofinput shifted by 'ΔX'. Dividing both sidesof the above expression by ΔX andmultiplying both sides of the equality byminus

$$Py_2 \frac{\Delta Y_2}{\Delta X} = Py_1 \frac{\Delta Y_1}{\Delta X} \; ;$$

$$Py_2 \,.\, MPPxy_2 = Py_1 \,.\, MPPxy_1 ;$$

$$VMPxy_2 = VMPxy_1$$

Thus, revenue from the limited amount of input, X, will be a maximum when the value of the marginal product of the input is the same in each enterprise. (The notation, $MPPxy_1$ and $VMPxy_2$, is used to denote the MPP of X on Y_1 and VMP of X used on Y_2 respectively). Equating the VMP's of the input in the two enterprises leads to the identical solution obtained from the production possibility curve. The two criteria are compared in Table 12.1 (a) and 12.1 (b) below:

Table 12.1(a) Comparing the Marginal Criteria for Resource Allocation and Production Possibility Curve

Variable Input (X)	Output (Y_1)	MPP_{XY1}	VMP_{XY1} @Py_1= Re.1/unit	Variable Input (X)	Output (Y_2)	MPP_{XY2}	VMP_{XY2} @Py_2= Rs.2/unit
0	0	-	-	0	0	-	-
1	12	12	12	1	7	7	14
2	22	10	10	2	13	6	12
3	30	8	8	3	18	5	10
4	36	6	6	4	22	4	8
5	40	4	4	5	25	3	6

For two units of input, one to Y_1 where it would earn Rs.12 and the second to Y_2 for an earning of Rs.14, the total revenue would be Rs.26. The second unit could also go to Y_2 and the earning would be unchanged. From the production possibility curve for 2 units of input, in Fig.12.7, maximum revenue combination

Table 12.1(b) Comparing the Marginal Criteria for Resource Allocation and Production Possibility Curve

Units of Inputs Available	Solution Equating VMP			Solution using Production Possibility Curve		
	Y_2	Y_1	TR	Y_2	Y_1	TR
2	7	12	26	9	9	27.0
4	13	22	48	15.5	17.5	48.5
7	22	30	74	21.5	31.5	74.5
9	25	36	86	25.5	35.0	86.0

Py_1 = Re.1; Py_2 = Rs.2.

of outputs is 9 each of Y_1 and Y_2 and the total revenue is Rs.27 which is slightly more than the allocation using “average” marginal criteria. The numbers 2, 4, 7 and 9 given the fig.12.7 are input levels of production possibility curves. The numbers 27, 48.5, 74.5 and 86 are revenue levels of iso revenue lines. Thus, the geometric approach is more accurate. This allocation of inputs between products can also be viewed in terms of opportunity cost. It demonstrates the cost in terms of the value of an alternative product that is given up rather than the purchase price of variable input. As long as VMP in one enterprise, that is sacrificed, equals the VMP in the other enterprise, that is gained, the opportunity costs for both enterprises are equal and total returns are maximum.

B. EQUI - MARGINAL PRINCIPLE

In input-output relationship, MC=MR is the economic principle used to determine the most profitable level of variable input. But it is under the assumption of unlimited availability of variable input. Such an assumption of unlimited resources is unrealistic. So, in real world situations, the equi-marginal principle is useful in determining how to allocate limited resources among two or more alternatives. The principle says: If a scarce resource is to be distributed among two or more uses, the highest total return is obtained when the marginal return per unit of resource is equal in all alternative uses.

i) One Input - Several Products: Suppose, there is a limited amount of a variable input to be allocated among several enterprises. For this, the production function and product prices must be known for each enterprise. Next, the VMP schedule must be computed for each enterprise. Finally, using the opportunity cost principle, units of input are allocated to each enterprise in such a way that the profit earned by the input is a maximum. Profit from a limited amount of variable resource is maximized when the resource is allocated among the enterprises in such a way that the marginal earnings of the input are equal in all enterprises. It can be stated as: $VMPxy_1 = VMPxy_2 = ... = VMPxyn$ where, $VMPxy_1$ is the value of marginal product of X used on product Y_1; $VMPxy_2$ is the value of marginal product of X used on product Y_2; and so on.

Table 12.2 Allocation of Limited Variable Input among Three Enterprises

Enterprise I (Maize) Y_1			Enterprise II (Sorghum) Y_2			Enterprise III (Ragi) Y_3		
X	Y_1	VMP_{XY1}	X	Y_2	VMP_{XY2}	X	Y_3	VMP_{XY3}
0	0	-	0	0	-	0	0	-
1	10	20	1	18	18	1	7	14
2	18	16	2	31	13	2	13	12
3	24	12	3	42	11	3	18	10
4	29	10	4	51	9	4	22	8
5	33	8	5	58	7	5	25	6
6	36	6	6	64	6	6	27	4

(Py_1 = Rs2; Py_2 = Rs 1; Py_3 = Rs 2)

Suppose that the farmer has five units of X. According to the opportunity cost principle, he will allocate each successive unit of input to the use where its marginal return, VMP, is the largest; i.e., first unit of X used in I earns Rs.20; second on first unit of II earns Rs18; third on second unit of I earns Rs.16; fourth on first unit of III earns Rs.14; and fifth on second unit of II earns Rs.13. Two units of inputs go on I, two on II and one on III. Used in this manner, the five units of inputs will earn Rs.81. No other allocation of the five units among the three enterprises will earn as much. What is the maximum amount of input needed for enterprises I, II and III? To find out this, the manager must determine the most profitable amount of input for each enterprise. When input cost is Rs.6.5 per unit, the optimum amounts are 5 for I, 5 for II and 4 for III. Cost is Rs.91 (5+5+4=14) (6.5)=Rs 91. Thus, the manager would never use more than a total of 14 units of inputs on I, II and III, no matter how many units of inputs he could afford to buy.

ii) Algebraic Example

Corn response to nitrogen production function is: $C=65.54+1.084NC – 0.003N_C^2$ . . .(1)

Sorghum response to nitrogen function is: $S = 68.07+0.830N_S – 0.002 N_S^2$ . . . . . . (2)

Assume that the farmer has 100 kgs of nitrogen available for 2 acres- one acre to be used for corn and one to be used for sorghum and that the price of corn is Rs.3 per kg and the price of grain sorghum is Rs2.50 per kg.

The allocative equations would be $VMP_{NC} = VMP_{NS}$ (or) P_c MPPnc $= P_s$ MPPns

VMP N_c =(1.084 – 0.006 Nc) (3) = Rs. (3.252 – 0.018 Nc)

VMP Ns = (0.830 – 0.004 Ns) (2.50) =Rs. (2.075 – 0.01 Ns)

Substituting Ns = 100 – Nc, we get, 3.252 – 0.018Nc = 2.075 – 0.01 (100 – Nc), and Ns = 100 – 77.8 = 22.2.

$C = 65.54 + 1.084\ Nc + 0.003\ Nc^2$ = 131.71668 x 3 = Rs.395.15

$S = 68.07 + 0.83\ Ns – 0.002\ Ns_2$ = 85.51o32 x 2.5 =Rs. 213.78

Thus, the corn would get 77.8 kgs of nitrogen and sorghum would get 22.2 kgs. This allocation equates the value of marginal products and assures the largest return from 100 kgs of nitrogen. Substituting 77.8 Kgs of nitrogen into VMPNc equation and 22.2 Kgs into VMPNs equation, demonstrates that the VMP’s are equal to Rs.1.85.

iii) Two inputs - Two outputs: Consider the case in which two inputs X_1 and X_2 can be used to produce two products, Y_1 and Y_2. When the inputs are used in the first enterprise, the equi-marginal principle dictates the following equality:

Thus, the marginal earnings of each input must be the same per unit cost, even within a specific enterprise. When both ratios equal one, the optimum has been reached. The same condition must hold for the use of the two inputs in the second enterprise.

Marginal returns per rupee spent on input must be same for both inputs in enterprises. Thus, the general condition is: