Module 3

Lecture 17

Topics

3.2 The Marginalist Revolution II

3.2.1 Product Exhaustion Theorem

3.2 The Marginalist Revolution II

- The emergence of marginal theory made the use of mathematics possible which opened doors to new analytical tools.

- The second generation marginalists expanded the scope of mathematics for economics. Economists from both sides of Atlantic contributed in the process.

- The flagship of the second generation marginalists was the use of marginalists theory for production. Ricardo can be seen as a early pre-cursor who assumed diminishing return to land.

- It took 75 more years to extend the theory for other factors of production. Major contributions in this field came from Wieser (1851-1926), Bohn Bawerk (1851-1914) (both from Austria), J.B.Clark (1847-1938; U.S.),Knut Wicksell (1851-1926; Sweden), Wicksted (1844-1927) and Edgeworth (1845-1926) (both from England)

- The second generation marginalist theories culminated into the neoclassical doctrines which was proposed by Alfred Marshall in 1890. We will have a separate lecture on Marshall.

- The principle of diminishing return tells us that if one factor is increased keeping other factors constant output first increases at an increasing rate and then increases at a decreasing rate and then it decreases. This is also known as the law of variable proportion. The following table represents this law:

Labour	TP	AP	MP
1	10	10	10
2	21	10.5	11
3	33	11	12
4	46	11.5	13
5	58	11.6	12
6	68	11.3	10
7	75	10.7	7
8	80	10	5
9	83	9.2	3
10	83	8.3	0
11	80	7.3	-3

Table 1: Law of Variable Proportion

- In the table TP represents total product, AP represents average product and MP represents marginal product.

- Average product is defined as $AP_L = \frac{Q}{L}$ and marginal product is defined as $MP_L = \frac{\Delta Q}{\Delta L}$

- From the production it can be readily deduced that a factor is employed to the level such that

$$w_L = MP_L . P \qquad (1)$$

- Let us now elaborate this condition. The left hand side of the equation gives the amount of money the entrepreneur needs to spend to hire one extra unit of labor. In equilibrium, this should be equal to the value of the extra product it produces.

- This equation shows that wage (or any factor price) must be equal to the value of the marginal product. For a production with n factors of production this can be extended to

$$\frac{MP_1}{p_1} = \frac{MP_2}{p_2} = \frac{MP_3}{p_3} = \cdots = \frac{MP_n}{p_n} \qquad (2)$$

Where MP_i represents the marginal product of factor i and p_i represents the price of factor i.

- The term $\frac{MP_1}{p_1}$ represents the marginal physical product from spending the last rupee on factor 1. In equilibrium this must be same for all inputs. If not, i.e. say if $\frac{MP_i}{P_i} > \frac{MP_j}{P_j}$ then the firm owner should reallocate the resources by spending one less rupee on factor j, and spend that one rupee on factor i as the resultant increase in output is greater than the resultant decrease.

3.2.1 Product Exhaustion Theorem

- The product exhaustion theorem implies that paying each factor its marginal product should exhaust the total product.

- J.B Clark stated the same but did not offer any formal proof. Mathematically, this should look like this

$$Q = MP_L \times L + MP_K \times K \qquad (3)$$

- Wicksteed mentioned the same point and tried to offer a formal proof. He failed to prove the result but maintained that there must be competition for this result to hold.

- We know that an easy proof exists that uses Euler theorem. However, Euler theorem states the result is only true if the production function is homogeneous of degree one. But if the production function is homogeneous of degree one that means that it must show constant returns to scale.

- A production function is said to show constant returns to scale if output increases by 1% in response to 1% rise in all inputs. The function shows to decreasing return to scale if output rises by mess than 1% and increasing return to scale if it rises by more than1%.

- If the production function shows decreasing returns to scale then factor payment is less than total output, and in case of increasing return to scale total factor payment is more than the total output.
- Hence, product exhaustion theorem is only consistent with constant returns to scale production function.

- Wicksell argued that each firm goes through all three returns to scale. He developed the concept of inverted U shaped long run cost curve. In Wicksel's solution the production function need not be showing only constant return to scale. In the long run the firm must operate at the minimum point of the average cost curve implying zero profit. Technically we can say that at the minimum point CRS operates.

- Wicksel argued that perfectly competitive market would produce the zero profit result and product exhaustion result would hold true.

- Product exhaustion theorem was not just any other mathematical result. It bears some important ethical implication.

- This result shows that total product is distributed among all the factors according to their contribution (measured by marginal productivity) to the production.

- The ethical point was first raised by John Bates Clark who sitting in America independently developed the idea of marginal productivity and utility.

- The ethical implication of production exhaustion theorem drew attention of the scholarly people. Because in a way this provides argument against the Marxian exploitation theory.

- However, the ethical arguments also drew many criticisms. One obvious criticism is whether marginal product or average product is a factor's true contribution to the society. Note that in product exhaustion theorem each factor is paid its marginal product.

- Moreover, even if a factor earns its marginal product that does not mean the individuals get a just income. If the factors are distributed unjustly, individuals will not get the just share of income. This argument can be extended to raise the question why the productivity of a machine should be the just earning of the owner.