L6 – Theory of the Firm:

It is possible for firm owners to have different goals, but the one motive that makes the most accurate prediction about how firms behave is the based on the assumption of **profit maximization**.

I. Profit Maximization

$$Total\ Revenue = Price \times Quantity$$

$$Total\ Cost = Market\ Value\ of\ the\ Inputs\ used\ in\ Production$$

$$Profit = Total\ Revenue - Total\ Cost$$

Note: total revenue is driven by demand.

Firm's Decisions:
- How much to produce? (What is the quantity q?)
  - When to shutdown?
- Given q, how much input to use?

The answers depend on whether the time horizon is short-run or long-run.

	Short-run	Long-run
In the Firm	Some inputs are fixed.	All inputs are variable.
In the market	The Number of firms is fixed.	Firms may exit or enter the market.

II. Production Function

❖ A **production function** shows the relationship between the quantity of inputs used to produce a good and the quantity of output of that good.

❖ It can be represented by a table, equation, or graph.

e.g. $Q = Af(KL) = A\sqrt{KL}$
where A is the productivity factor, K is the capital, and L is the labor.
Productivity = Production per capita. The social productivity determines the standard of living.

III. Short-run Production: One Variable and One Fixed Input

- In the short-run: Capital input is fixed, only labor input varies.

$$q = f(\bar{K}L)$$

- As the amount of input used increases, the ***marginal product*** of that input (i.e. the increase in output that arises from an additional unit of input) falls.

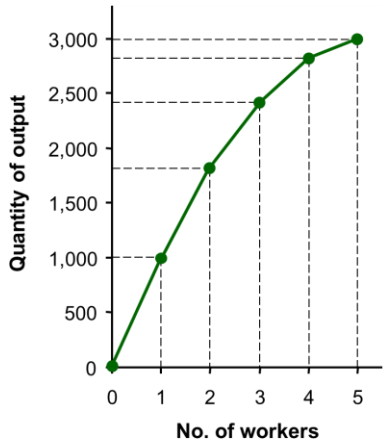
  Examples:
  ΔQ = change in output, ΔL = change in labor

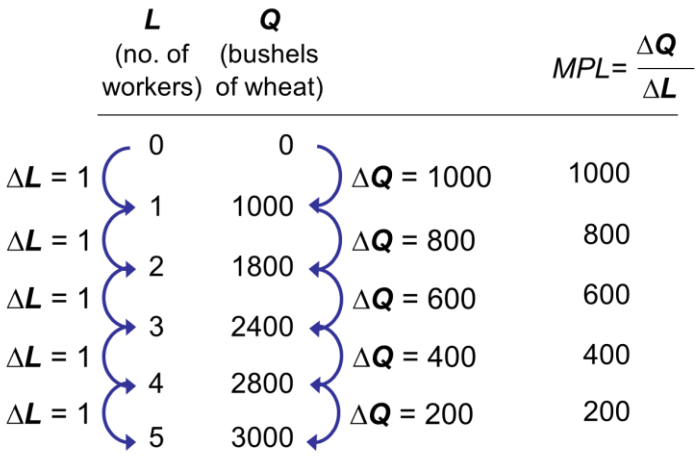
  Marginal product of labor (MP_L) = ΔQ/ΔL

  ➔ **Marginal product is diminishing** (i.e. the MP of an input declines as the quantity of that input increases, holding other inputs constant).

Example 1:
Farmer Jack grows wheat.
He has 5 acres of land
(limited space, limited output).
He can hire as many workers as he wants.

L (no. of workers)	*Q* (bushels of wheat)
0	0
1	1000
2	1800
3	2400
4	2800
5	3000





❖ Why MP_L is important?

- When Farmer Jack hires an extra worker, his costs rise by the wage and his output rises by MP_L

- Comparing them helps Jack decide whether he would benefit from hiring the worker.

❖ Why MP_L diminishes?

- Farmer Jack's output rises by a smaller and smaller amount for each additional worker. Why?

- As Jack adds workers, the average worker has less land to work with and will be less productive.

- In general, MP_L diminishes as L rises whether the fixed input is land or capital (equipment, machines, etc.).

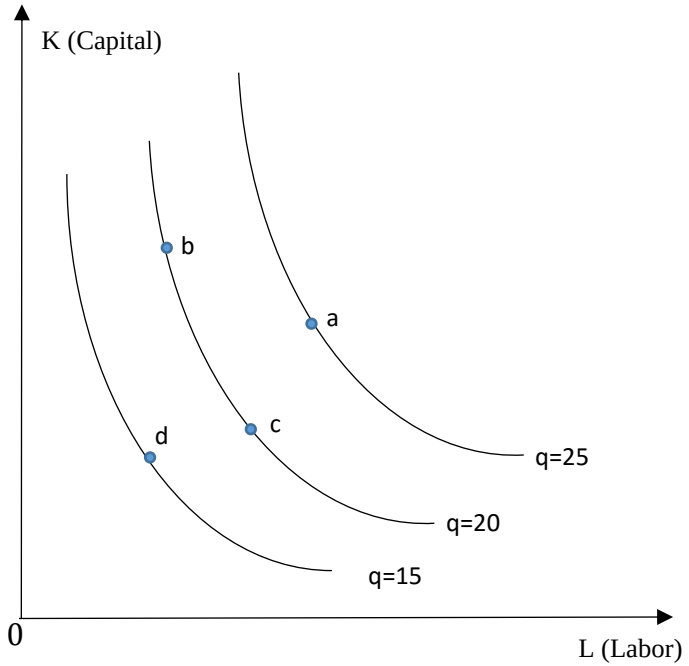
❖ Malthus Theory: starvation is unavoidable

- $Q = \sqrt{KL}$
- In the past the major capital is land, which is fixed even in the long-run.
- Population size increases + MP_L
- Solution: $Q = A\sqrt{KL}$.

IV. Long-run Production: Two Variable Inputs

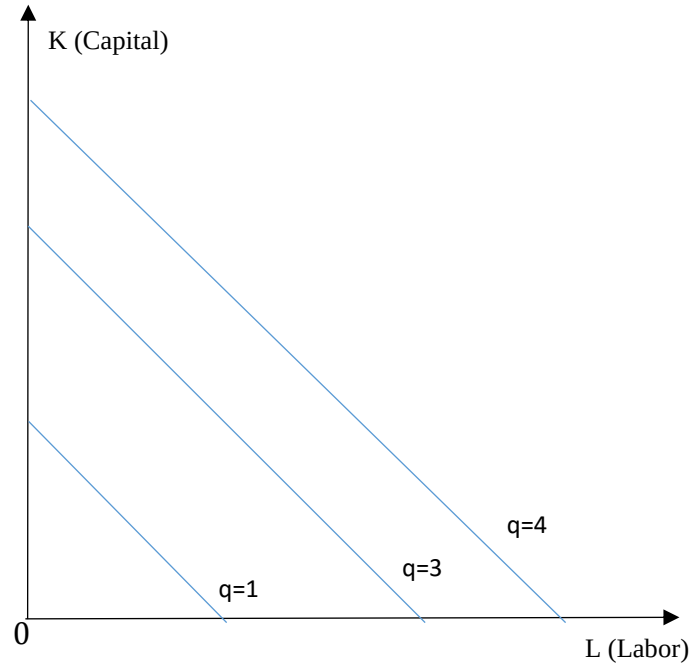
❖ ISOQUANTS: A curve that shows all combinations of L and K that can produce the same level of output.

$$\bar{q} = f(L, K)$$

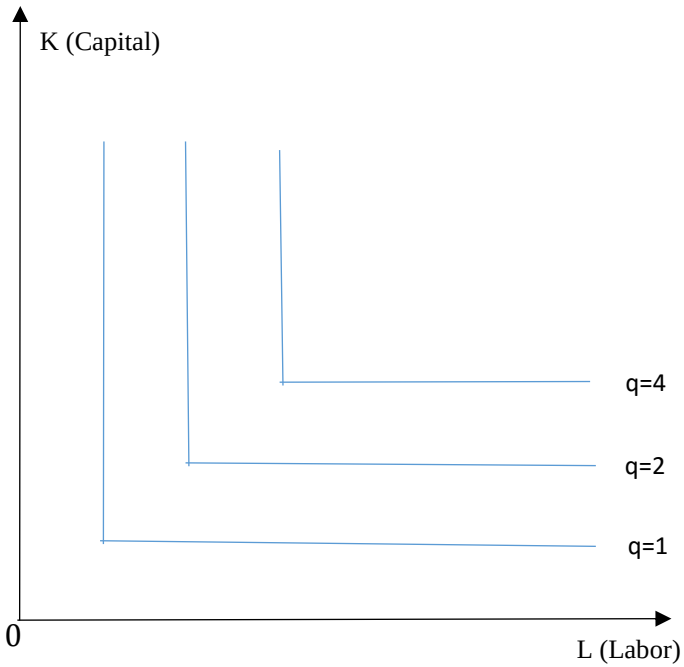


Properties of Isoquants:

- The farther an isoquant is from the origin, the greater the level of output.
- Isoquants do not cross
- Isoquants slope downward.
- Isoquants bow inward (convex).



$$q = aK + bL$$



$$q = \min(K, L)$$

Substituting Inputs

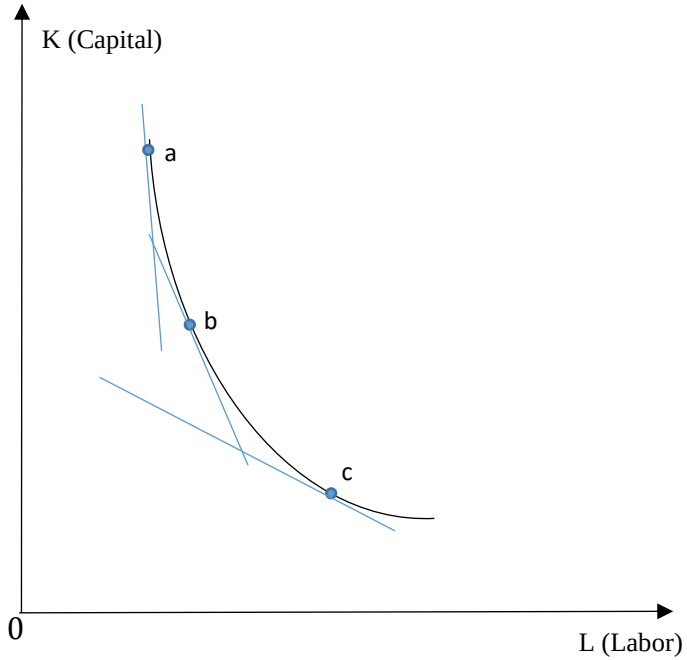
The slope of an Isoquant is called Marginal Rate of Technical Substitution (MRTS):

$$MRTS = -\frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K}$$

(Note that $MP_K \Delta K + MP_L \Delta L = 0$)

MRTS shows how many units of capital can be replaced by one more unit of labor such that the output level remains the same.

Diminishing MRTS: a result of our assumption of diminishing MP_L and diminishing MP_K.



Returns to Scale:

1. Constant Returns to Scale (CRS): $f(nK, nL) = nf(K, L)$

2. Increasing Returns to Scale (IRS): $f(nK, nL) > nf(K, L)$
   One reason: Greater specialization of labor and capital

3. Decreasing Returns to Scale (DRS): $f(nK, nL) < nf(K, L)$
   One reason: Difficulty of organizing, coordinating, and integrating activities increases with firm size.

Production Efficiency is a state in which:

a) Given a production level, cost is minimized.
b) Given a cost level, production is maximized.

Remarks:

a) and b) is like the two sides of a same coin. It can be seen as a special case of Pareto efficiency.