

CLASS XI | CBSE | 2025-26

INTRODUCTORY

MICROECONOMICS

CHAPTER 7

Production Function and Returns to a Factor

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Chapter Overview

What You Will Learn:

1. Production and Production Function
2. Short run vs Long run production
3. Total Product (TP), Average Product (AP), Marginal Product (MP)
4. Law of Variable Proportions — 3 phases with diagram
5. Relationship between TP, AP and MP
6. Returns to Scale (Long Run)

Exam Importance: Law of Variable Proportions diagram + TP-AP-MP relationship = 6 marks regularly. Numericals on AP and MP = 3-4 marks. One of the highest-weight chapters!

1. PRODUCTION AND PRODUCTION FUNCTION

DEFINITION: Production

Production is the process of converting inputs (factors of production) into outputs (goods and services). It creates UTILITY.

DEFINITION: Production Function

Production Function shows the technical relationship between inputs and output. It gives the MAXIMUM output producible from a given combination of inputs with given technology. $Q = f(L, K)$

Type	Period	Factors	Feature
Short-Run Production Function	Short period	At least ONE factor FIXED (usually Capital)	Fixed plant size; only labour can vary
Long-Run Production Function	Long period	ALL factors VARIABLE (both Labour and Capital)	Can expand plant, install more machines

2. TP, AP, AND MP — MEANINGS AND FORMULAS

Concept	Definition	Formula
Total Product (TP)	Total output of ALL units of variable factor combined with fixed factor	TP = Sum of MPs of all workers
Average Product (AP)	Output PER UNIT of variable factor	AP = TP / Units of Labour (L)
Marginal Product (MP)	ADDITIONAL output when ONE MORE unit of variable factor is employed	MP = $TP_N - TP_{(N-1)} = \Delta TP / \Delta L$

TP-AP-MP Schedule:

Workers (L)	TP	AP = TP/L	MP = $\Delta TP / \Delta L$	Phase
0	0	—	—	—
1	10	10	10	Phase 1 (Increasing Returns)
2	22	11	12	Phase 1 (Increasing Returns)
3	33	11	11	Phase 1 (MR begins here, AP max)
4	40	10	7	Phase 2 (Diminishing Returns)
5	45	9	5	Phase 2
6	48	8	3	Phase 2
7	49	7	1	Phase 2
8	49	6.1	0	TP MAX (MR=0 — boundary Phase 2/3)
9	45	5	-4	Phase 3 (Negative Returns) — TP falls

3. LAW OF VARIABLE PROPORTIONS

DEFINITION: Law of Variable Proportions

"As more and more units of a variable factor (e.g., labour) are added to a fixed factor (e.g., capital/land), the Total Product initially increases at an increasing rate, then at a decreasing rate, and finally decreases." Also called: Law of Diminishing Returns (short run).

Phase	TP Behaviour	MP Behaviour	AP Behaviour	Reason
Phase 1: Increasing Returns	Rises at INCREASING rate	RISES (MP positive and rising)	RISES	Better utilisation of fixed factor; specialisation; indivisibilities
Phase 2: Diminishing Returns	Rises at DECREASING rate	FALLS (MP positive but falling)	FALLS (after reaching peak)	Fixed factor becomes limiting; law of diminishing returns sets in
Phase 3: Negative Returns	FALLS (TP declines)	NEGATIVE (MP < 0)	Falls but positive	Too many workers on fixed land/machine — they hinder each other

CRITICAL RELATIONSHIPS — Must Know for Exam:

1. When MP is RISING → TP rises at INCREASING rate (Phase 1).
2. When MP is FALLING but POSITIVE → TP rises at DECREASING rate (Phase 2).
3. When MP = ZERO → TP is at its MAXIMUM (end of Phase 2 / start of Phase 3).
4. When MP is NEGATIVE → TP is FALLING (Phase 3).
5. When MP = AP → AP is at its MAXIMUM (boundary Phase 1/2).
6. When MP > AP → AP is RISING. When MP < AP → AP is FALLING.

MEMORY TRICK

TP-AP-MP TRICK: MP = 0 → TP is MAX | MP = AP → AP is MAX MP > AP → AP rises | MP < AP → AP falls | MP negative → TP falls Phase 1: All three rising. Phase 2: TP still rises, MP and AP fall. Phase 3: TP falls, MP negative.

4. RETURNS TO SCALE (LONG RUN)

DEFINITION: Returns to Scale

Returns to Scale refers to changes in output when ALL inputs are increased proportionally in the long run.

Type	If all inputs double:	Output change	Reason	Example
Increasing Returns to Scale (IRS)	Output MORE than doubles	> 100% increase	Specialisation, indivisibilities, bulk buying economies	Small firms growing — economies of scale
Constant Returns to Scale (CRS)	Output exactly doubles	= 100% increase	Constant efficiency at this scale	Mature industries at optimal scale
Decreasing Returns to Scale (DRS)	Output less than doubles	< 100% increase	Management difficulties, resource scarcity	Very large firms — diseconomies of scale

EXAM-ORIENTED QUESTIONS

1-Mark Questions

Q1. What is Total Product?

Ans. TP is total output produced by all units of variable factor combined with the fixed factor. $TP = \text{Sum of MPs}$.

Q2. What is Marginal Product?

Ans. MP is the additional output from employing one more unit of variable factor. $MP = TPN - TP(N-1)$.

Q3. When does TP reach its maximum?

Ans. TP is maximum when $MP = 0$ (Marginal Product equals zero).

Q4. When does AP reach its maximum?

Ans. AP is maximum when $MP = AP$ (Marginal Product equals Average Product).

Q5. State the condition when TP falls.

Ans. TP falls when MP becomes NEGATIVE.

Numerical: From the following, calculate MP and AP. Also identify phases.

Workers (L)	TP
1	8
2	20
3	27
4	32
5	35
6	36
7	35

Solution:

MP: 8, 12, 7, 5, 3, 1, -1 ($TPN - TP(N-1)$)

AP: 8, 10, 9, 8, 7, 6, 5 (TP/L)

Phase 1 (Increasing): $L=1$ to 2 (MP rising: $8 \rightarrow 12$). Phase 2 (Diminishing): $L=3$ to 6 (MP positive, falling). Phase 3 (Negative): $L=7$ ($MP=-1$).

TP max at $L=6$ ($TP=36$, $MP=0$ between $L=6$ and $L=7$). AP max at $L=2$ ($AP=10=MP=12$? No: AP max when $MP=AP$, approximately at $L=2$ to 3).

CHAPTER SUMMARY

KEY POINTS:

1. Production Function: $Q = f(L, K)$. Short run = 1 factor fixed. Long run = all factors variable.
2. $TP = \text{Sum of MPs}$ | $AP = TP/L$ | $MP = TPN - TP(N-1)$.
3. Law of Variable Proportions: 3 phases — Increasing, Diminishing, Negative returns.
4. $MP=0 \rightarrow TP \text{ max}$ | $MP=AP \rightarrow AP \text{ max}$ | $MP<0 \rightarrow TP \text{ falls}$.
5. Returns to Scale: IRS (output rises more than proportionally), CRS (proportional), DRS (less than proportional).