Economics for Managers

Session 6-8| 28-July-2019

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Today

- Continue our discussion on:
  - Preferences, utility, budget constraints & optimization
  - Price change decomposed into substitution effect and income effect

- Introduction to Production/ Costs:
  - Production function
  - Change in one input (Marginal Product)
  - Change in both inputs (Returns to Scale)

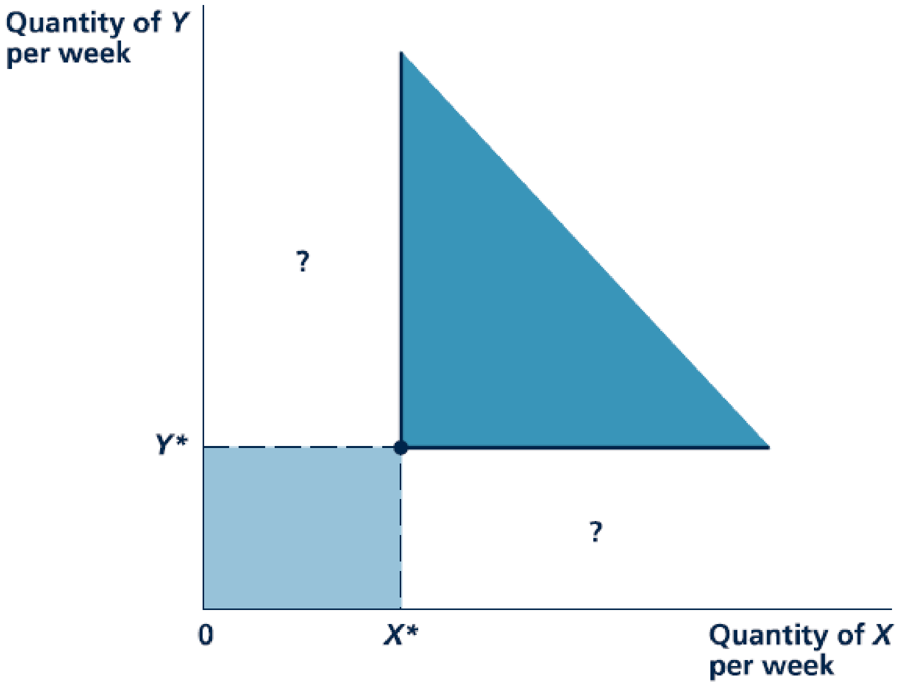
Thinking about consumer choice

- We started with law of demand (thinking about one good and its price)
  - Does the framework hold when a consumer has to consume or decide between many goods?
- For analytical ease, we restrict our framework to 2 goods
- But, how to compare goods that are dis-similar: cars vs pizzas? apples vs oranges?
- And, how does a consumer allocate his income between different goods? BUDGET
- We get satisfaction from goods
  - Use an abstract concept called UTILITY which provides a measure of satisfaction (same unit of account for satisfaction from different goods)

Thinking about consumer choice (cont.)

- Till now, we did not incorporate a consumer's PREFERENCES/ TASTES
- Assumptions about preferences of consumers (Rationality)
  - Completeness (one of the following possibilities)
    - Tea is preferred to Coffee
    - Coffee is preferred to Tea
    - Tea and Coffee are equally attractive
  - Transitivity
    - If Tea is preferred to Coffee and Coffee is preferred to Juice then Tea is preferred to Juice
  - More is Better (next slide)

More of a Good is preferred to Less

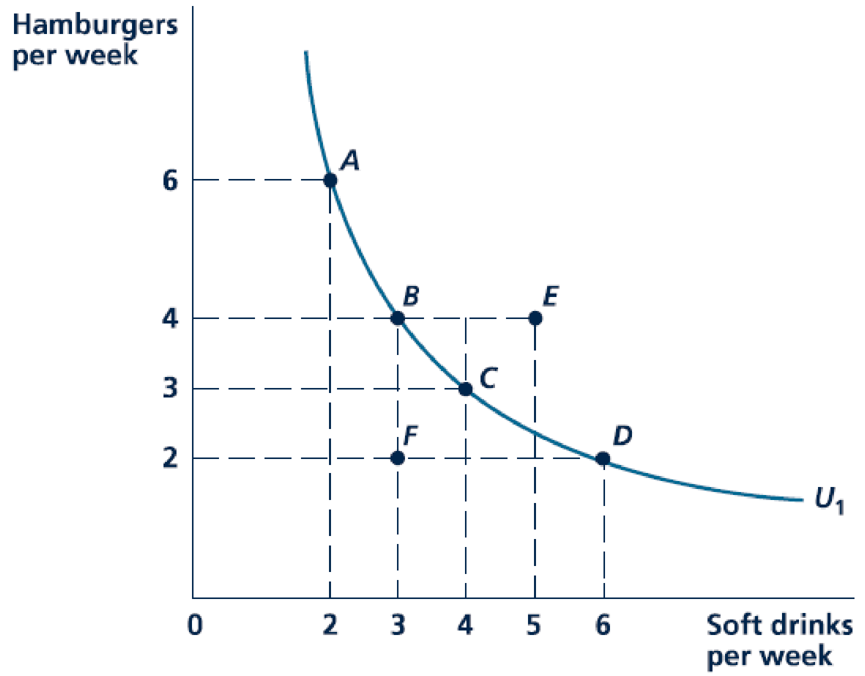


The darkly shaded area represents those combinations of X and Y that are unambiguously preferred to the combination X^*, Y^*. This is why goods are called "goods"; individuals prefer having more of any good rather than less. Combinations of X and Y in the lightly shaded area are inferior to the combination X^*, Y^*, whereas those in the questionable areas may or may not be superior to X^*, Y^*.

Utility

- Utility is used to 'measure' a consumer's preferences
- Helpful in comparing dis-similar goods: cars vs food; even apples vs oranges
- Ceteris paribus assumption ~ other things being equal
- Marginal Utility of a good (diminishing)- 1st cup of coffee vs 2nd vs third…
- Balance in consumption preferred to extremes
- Marginal Rate of Substitution (MRS) between 2 goods
    - Diminishing Marginal Rate of Substitution

Indifference Curve (IC)



The curve U_1 shows the combinations of hamburgers and soft drinks that provide the same level of utility to an individual. The slope of the curve shows the trades an individual will freely make. For example, in moving from point *A* to point *B*, the individual will give up two hamburgers to get one additional soft drink. In other words, the marginal rate of substitution is approximately 2 in this range. Points below U_1 (such as *F*) provide less utility than points on U_1. Points above U_1 (such as *E*) provide more utility than U_1.

Algebra of MRS & Slope of IC

[2] If we assume utility is measurable, we can provide an alternative analysis of a diminishing MRS. To do so, we introduce the concept of the marginal utility of a good X (denoted by MU_X). Marginal utility is defined as the extra utility obtained by consuming one more unit of good X. The concept is meaningful only if utility can be measured and so is not as useful as the MRS. If the individual is asked to give up some $Y(\Delta Y)$ to get some additional $X(\Delta X)$, the change in utility is given by

$$\text{Change in utility} = MU_Y \cdot \Delta Y + MU_X \cdot \Delta X \qquad \{i\}$$

It is equal to the utility gained from the additional X less the utility lost from the reduction in Y. Since utility does not change along an indifference curve, we can use Equation i to derive

$$\frac{-\Delta Y}{\Delta X} = \frac{MU_X}{MU_Y} \qquad \{ii\}$$

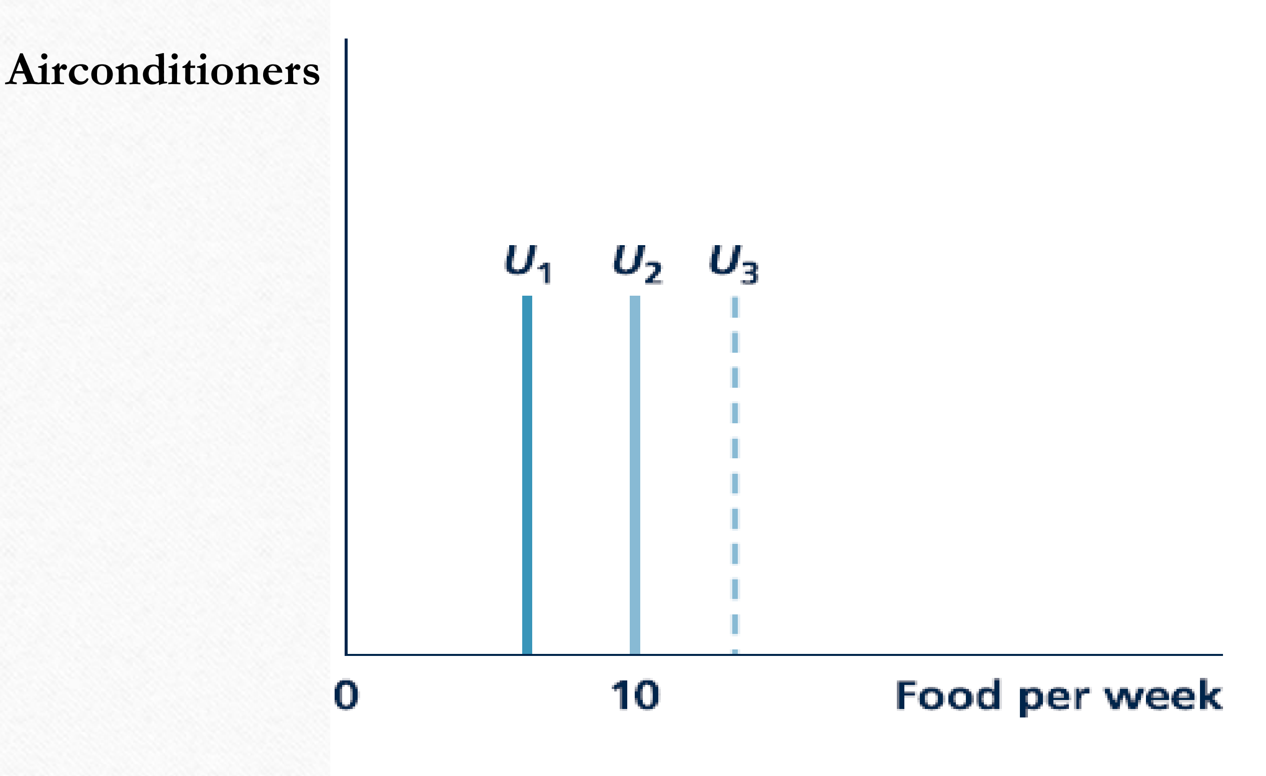
Along an indifference curve, the negative of its slope is given by MU_X/MU_Y. That is, by definition, the MRS. Hence we have

$$\text{MRS} = MU_X/MU_Y \qquad \{iii\}$$

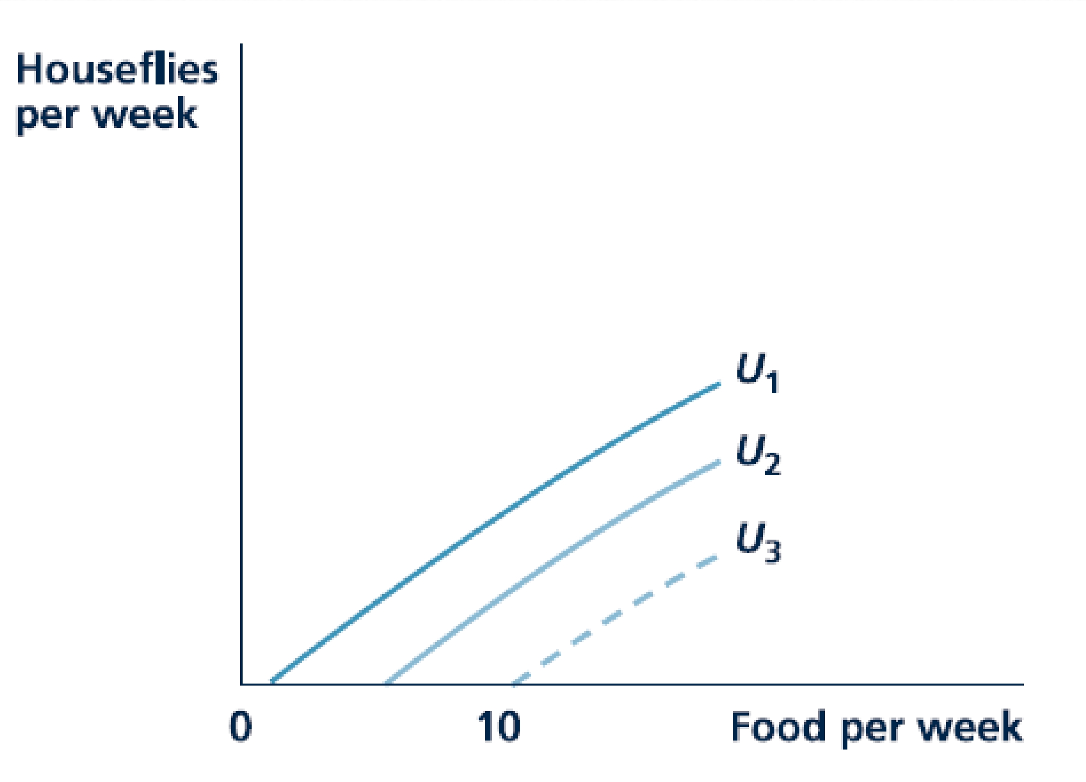
As a numerical illustration, suppose an extra hamburger yields two utils (units of utility; $MU_Y = 2$) and an extra soft drink yields four utils ($MU_X = 4$). Now MRS = 2 because the individual will be willing to trade away two hamburgers to get an additional soft drink. If we can assume that MU_X falls and MU_Y increases as X is substituted for Y, Equation iii shows that MRS will fall as we move counterclockwise along U_1.

Different Shapes of Indifference Curves

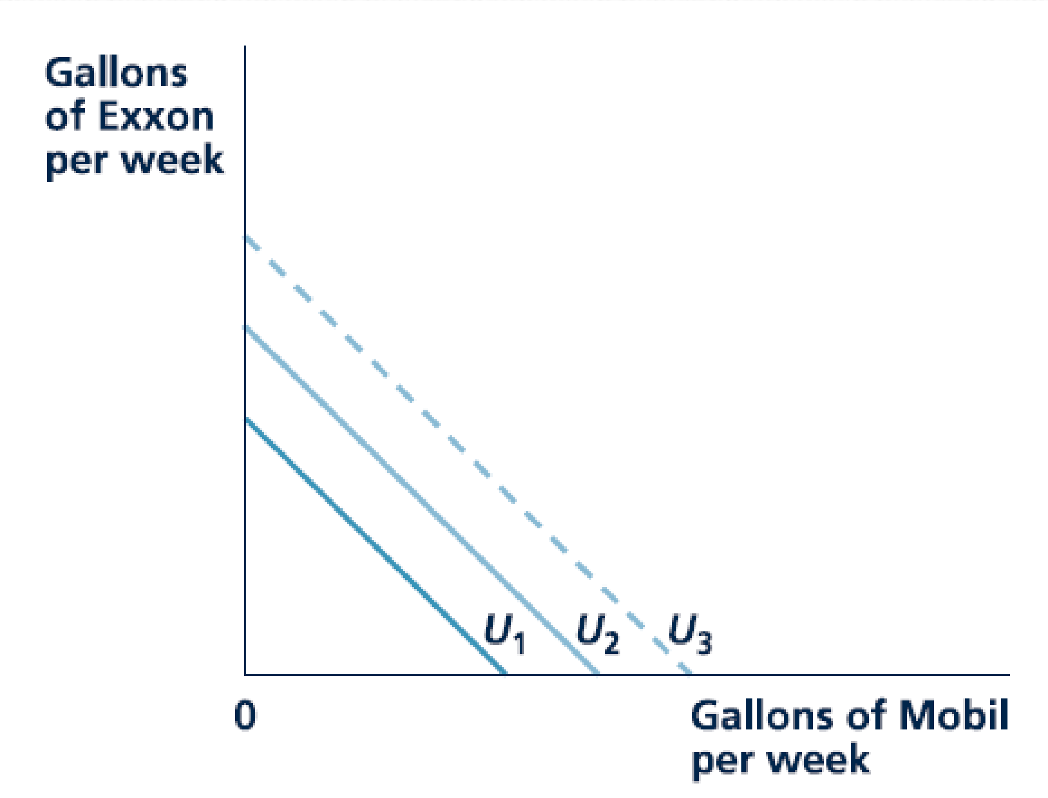
A Useless good



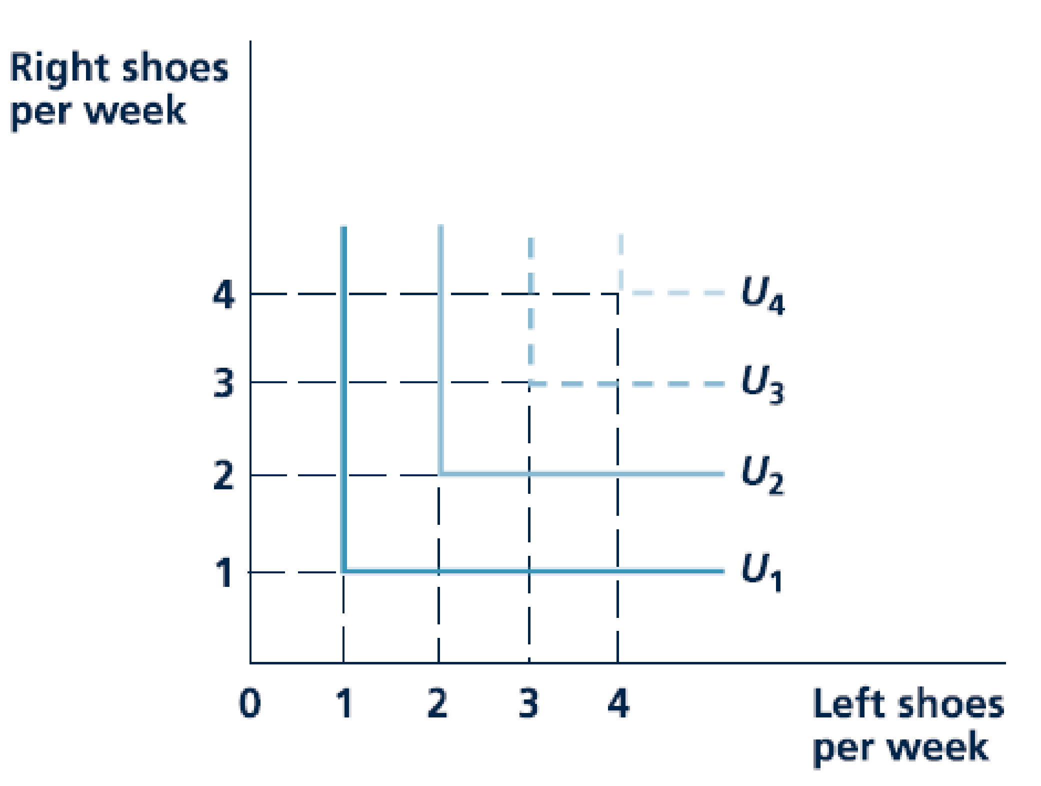
An Economic Bad



Perfect Substitutes



Perfect Complements



When is a consumer's utility maximized

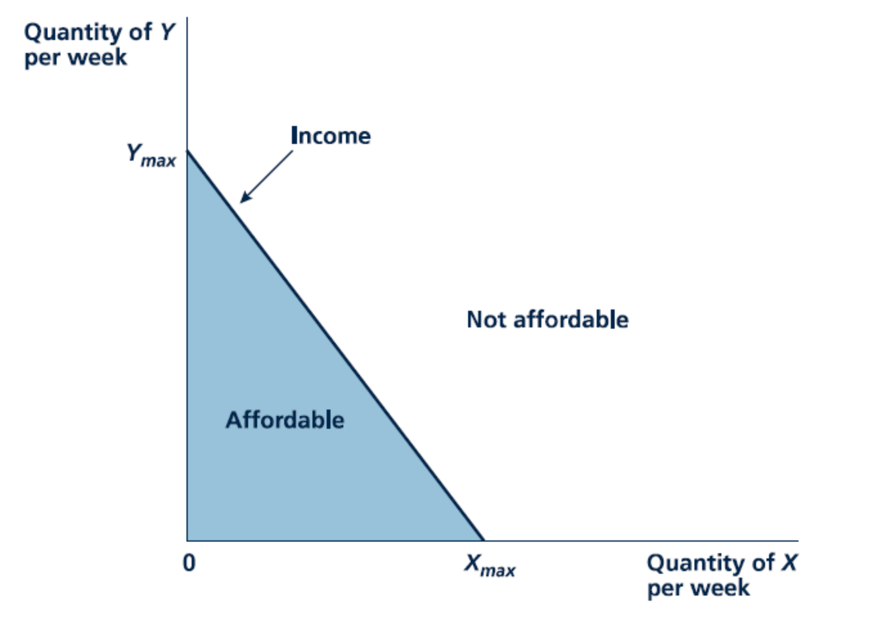
- When the entire income is spent

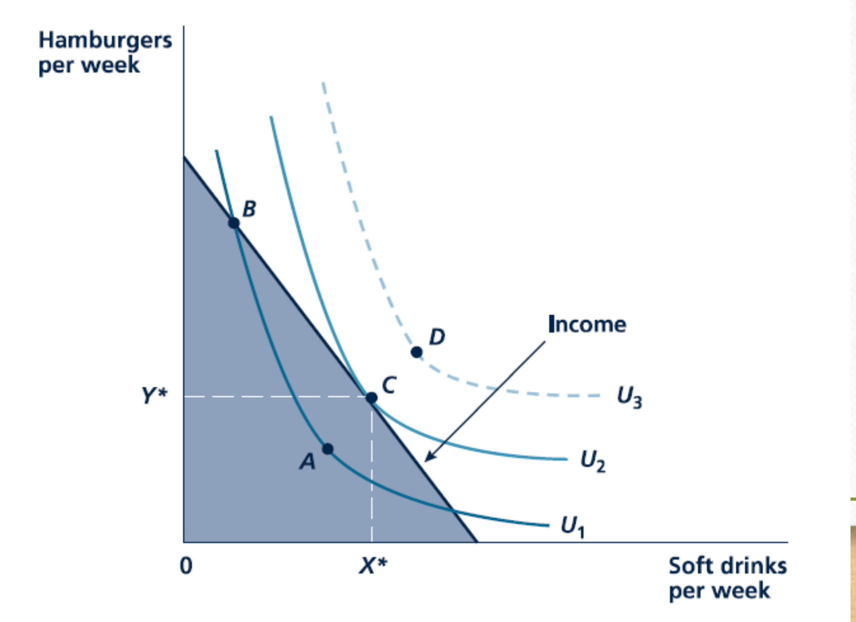
  (More is Better)

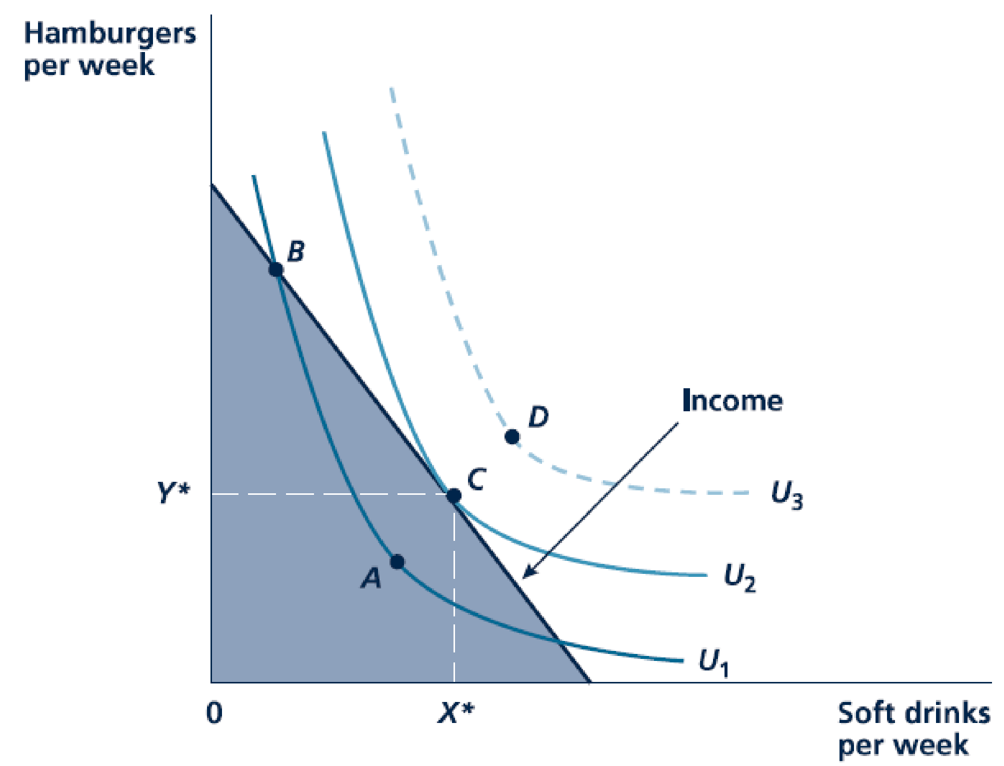
- When MRS between 2 goods

  =

  Ratio of prices of those 2 goods`





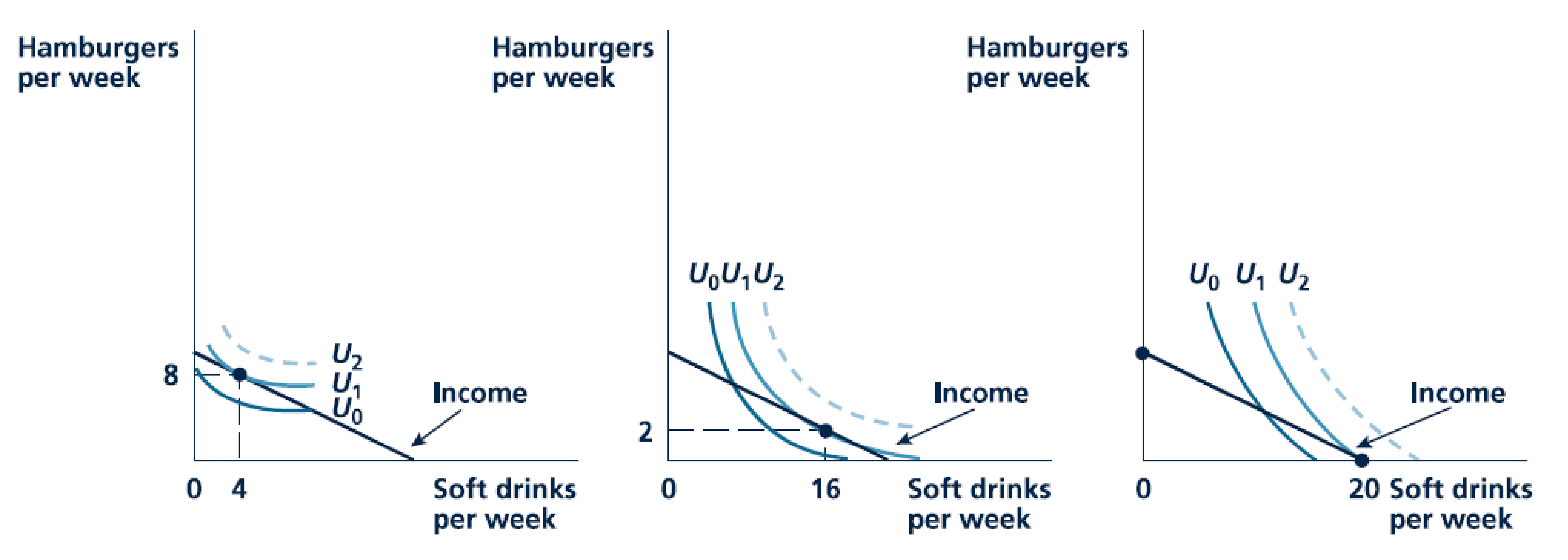


Slope of budget constraint

= Slope of indifference curve or (neglecting the fact that both slopes are negative)

$$P_X/P_Y = \mathrm{MRS}$$

Difference in preferences leading to different choices



Hungry

Thirsty

Extra-Thirsty

From a Consumer's Equilibrium to her Demand Curve

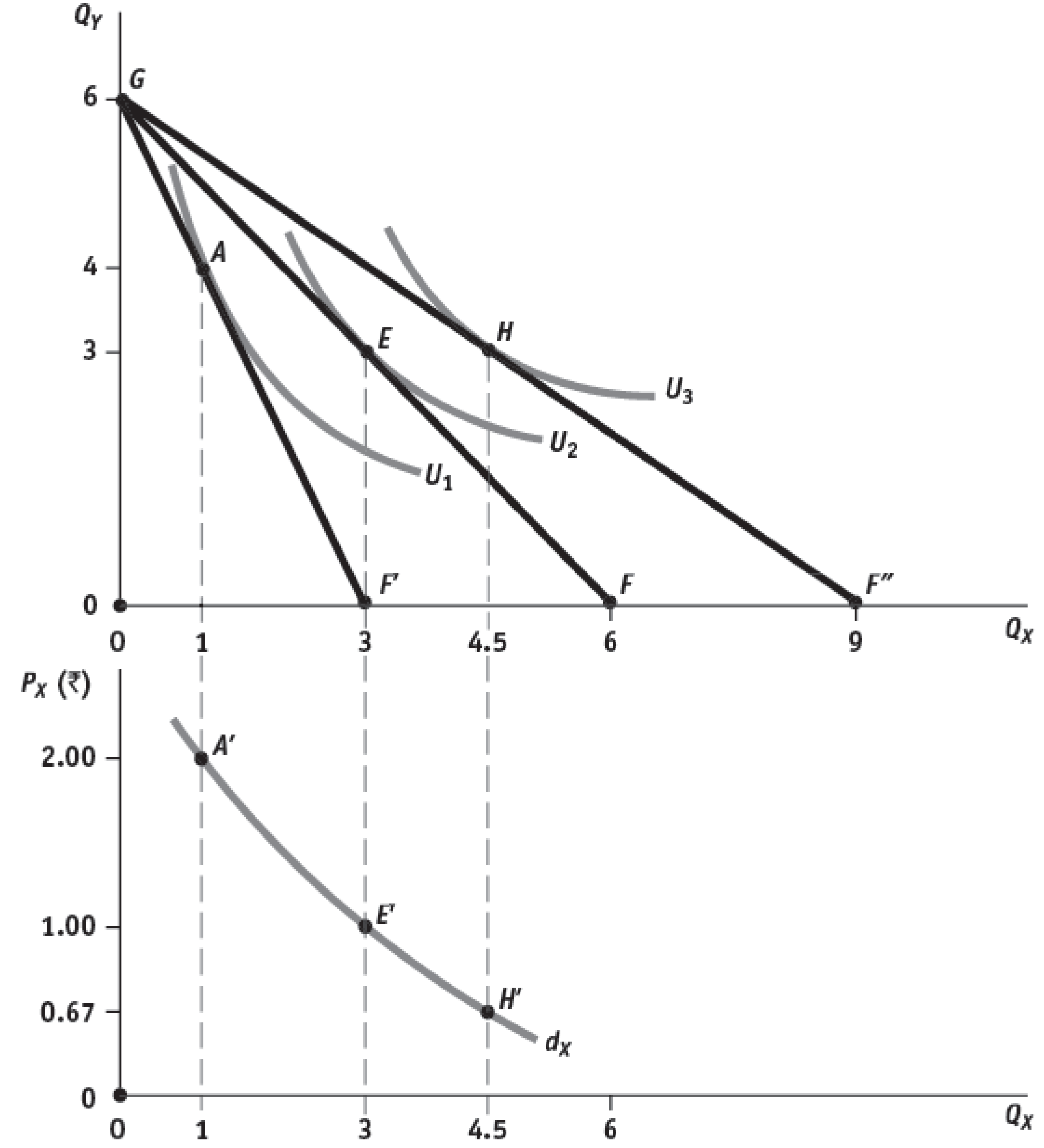


FIGURE 2-8 Derivation of the Consumer's Demand Curve The top panel shows that with $P_X = ₹2$, $P_X = ₹1$, and $P_X = ₹0.67$, we have budget lines *GF′*, *GF*, and *GF″*, and consumer equilibrium points *A*, *E*, and *H*, respectively. From equilibrium points *A*, *E*, and *H* in the top panel, we derive points *A′*, *E′*, and *H′*, in the bottom panel. By joining points *A′*, *E′*, and *H′*, we derive d_X, the consumer's demand curve for commodity *X*.

Effect of Price Change decomposed into Substitution & Income effects

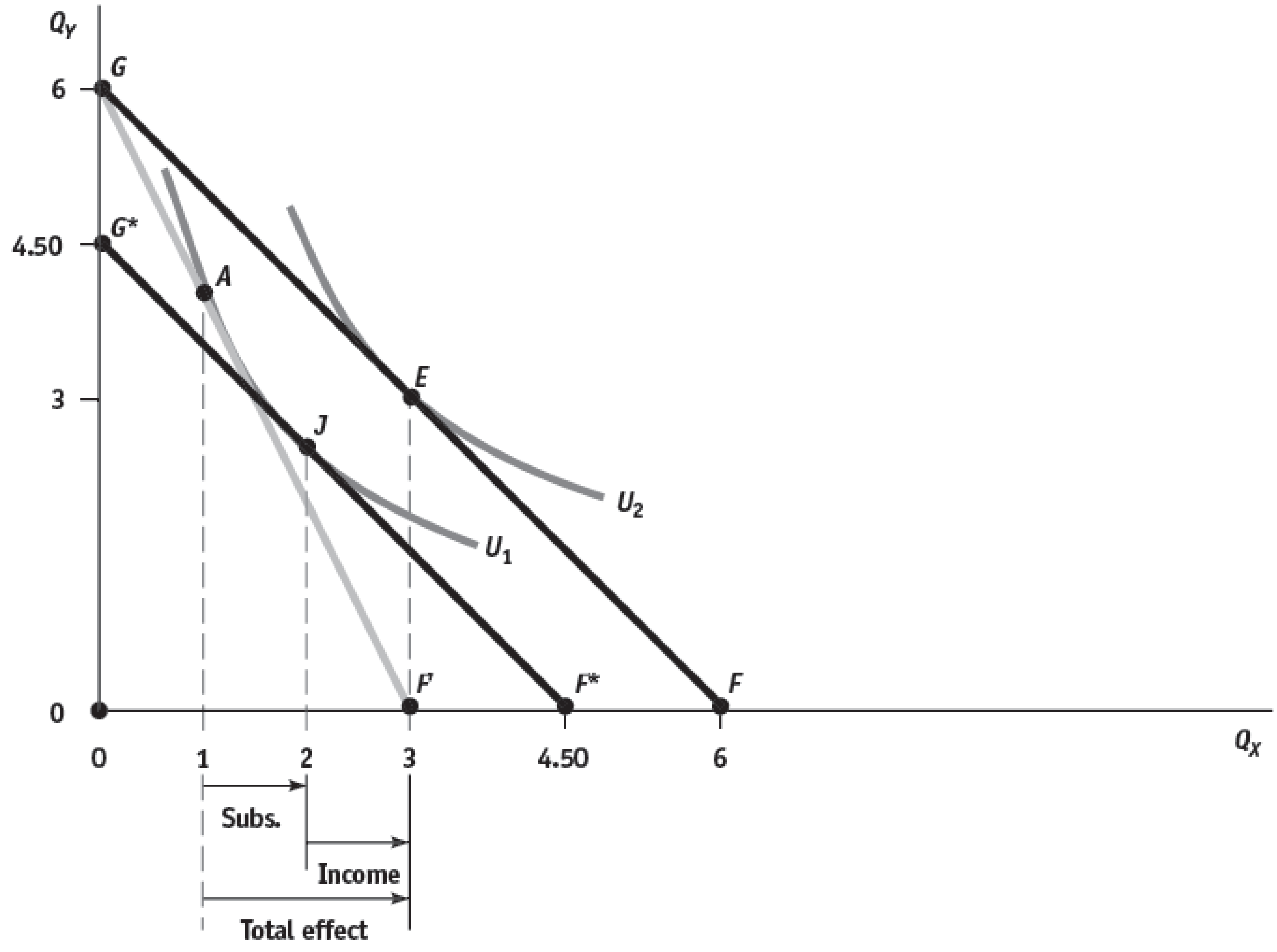


FIGURE 2-9 Separation of the Substitution from the Income Effect of a Price Change The individual is in equilibrium at point *A* with $P_X = ₹2$ and at point *E* with $P_X = ₹1$ (as in the top panel of Figure 2-8). To isolate the substitution effect, we draw hypothetical budget line *G*F**, which is parallel to *GF* and tangent to U_1, at point *J*. The movement along U_1, from point *A* to point *J* is the substitution effect and results from the relative reduction in P_X only (i.e., with real income constant). The shift from point *J* on U_1 to point *E* on U_2 is then the income effect. The total effect ($AE = 2X$) equals the substitution effect ($AJ = 1X$) plus the income effect ($JE = 1X$).

Production

Thinking about Production

- We started with the law of supply (upward sloping)
- Input costs affect a firm's supply decisions
- But, we did not look at how a firm combines inputs (like workers' time & machinery) to produce its output. Production Function
- We restrict our framework to 2 inputs (Labour & capital)
- When only one input is changed (short-run):
  - Marginal Product is relationship between output and one input (holding the other constant)
  - Marginal Product is diminishing
- Isoquants- different combinations of inputs yielding same output
- Rate of Technical substitution
  - Marginal Rate of Technical Substitution (MRTS) is diminishing
- When both inputs are changed (long-run):
  - Returns to scale

TABLE 7-1 Production Function with Two Inputs

Capital (*K*)							
	6	10	24	31	36	40	39
	5	12	28	36	40	42	40
	4	12	28	36	40	40	36
	3	10	23	33	36	36	33
↑	2	7	18	28	30	30	28
K	1	3	8	12	14	14	12
		1	2	3	4	5	6
		L →		Labor (*L*)			

Output (*Q*)

Production Function with One Variable Input

Total Product	$TP = Q = f(L)$
Marginal Product	$MP_L = \dfrac{\Delta TP}{\Delta L}$
Average Product	$AP_L = \dfrac{TP}{L}$
Production or Output Elasticity	$E_L = \dfrac{MP_L}{AP_L}$

TABLE 7-2 Total, Marginal, and Average Product of Labor, and Output Elasticity				
(1)	(2)	(3)	(4)	(5)
Labor (number of workers)	Output or Total Product	Marginal Product of Labor	Average Product of Labor	Output Elasticity of Labor
0	0	—	—	—
1	3	3	3	1
2	8	5	4	1.25
3	12	4	4	1
4	14	2	3.5	0.57
5	14	0	2.8	0
6	12	–2	2	–1

[2] The reason for the decline in *TP* when 6*L* is used will be discussed shortly.

[3] In terms of calculus, $MP_L = \partial TP/\partial L$.

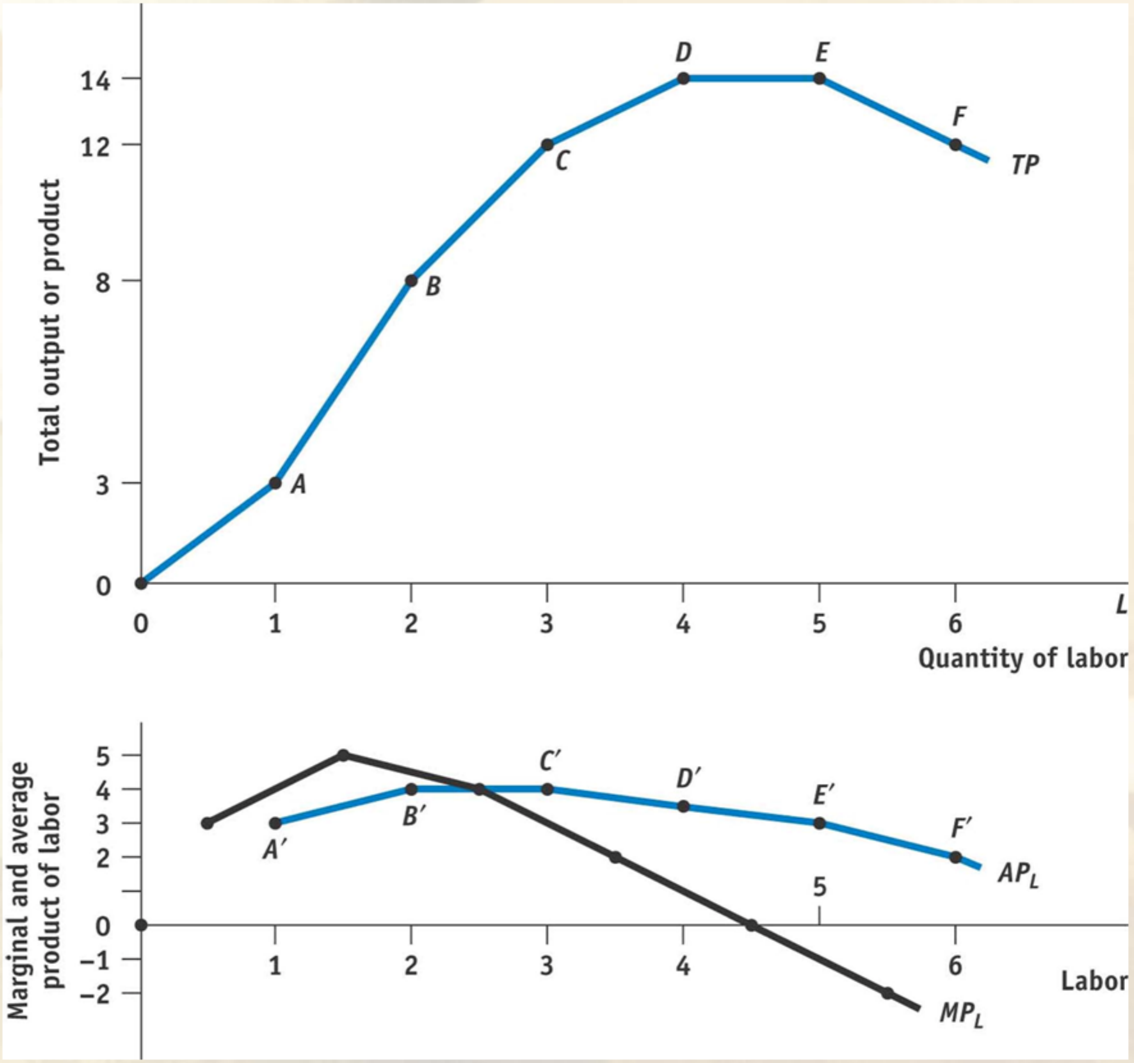


FIGURE 7-3 Total, Marginal, and Average Product of Labor Curves The top panel shows the total product of labor curve. *TP* is highest between 4*L* and 5*L*. The bottom panel shows the marginal and the average product of labor curves. The MP_L is plotted halfway between successive units of labor used. The MP_L curve rises up to 1.5*L* and then declines, and it becomes negative past 4.5*L*. The AP_L is highest between 2*L* and 3*L*.

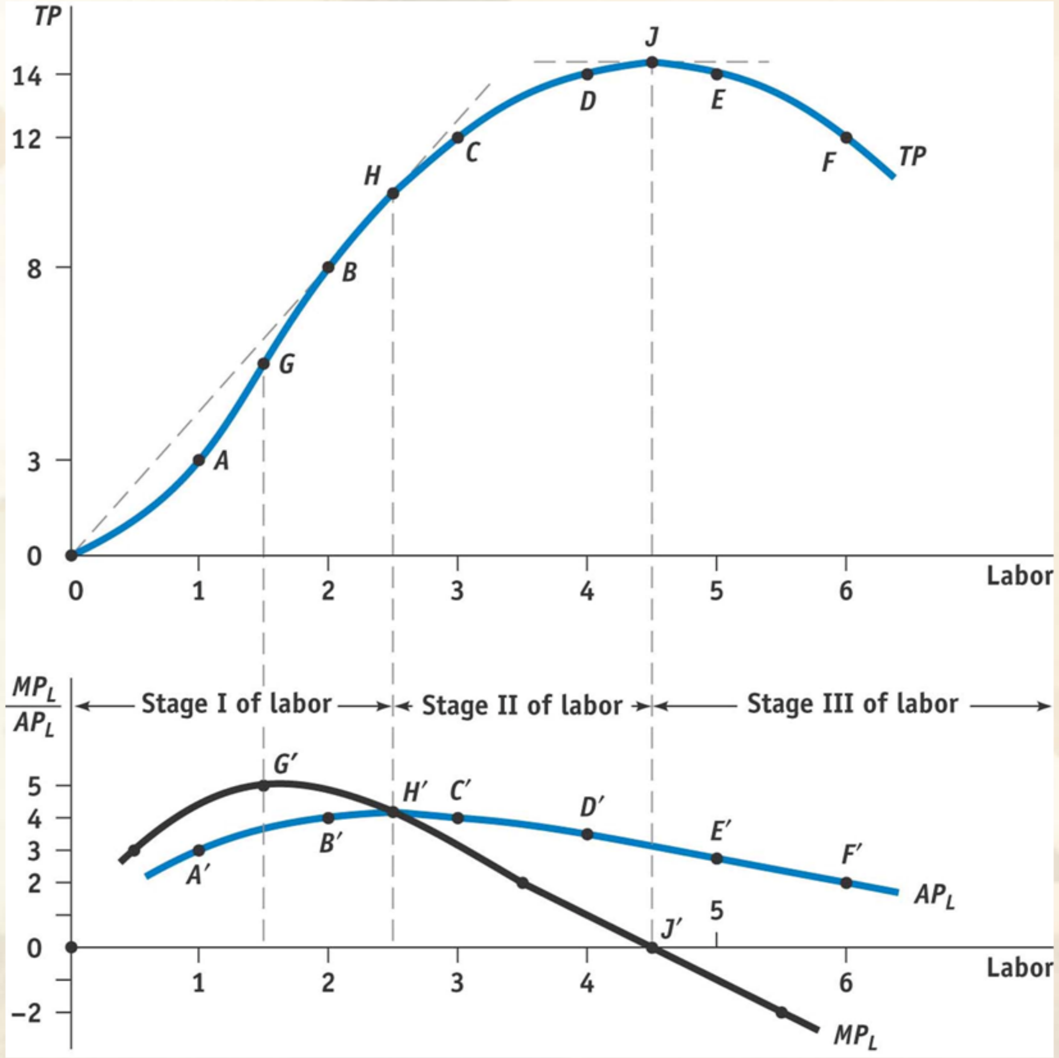


FIGURE 7-4 Total, Marginal, and Average Product Curves, and Stages of Production With labor time continuously divisible, we have smooth *TP*, *MP,* and *AP* curves. The MP_L (given by the slope of the tangent to the *TP* curve) rises up to point *G'*, becomes zero at *J'*, and is negative thereafter. The AP_L (given by the slope of the ray from the origin to a point on the *TP* curve) rises up to point *H'* and declines thereafter (but remains positive as long as *TP* is positive). Stage I of production for labor corresponds to the rising portion of the AP_L. Stage II covers the range from maximum AP_L to where MP_L is zero. Stage III occurs when MP_L is negative.

Optimal Use of the Variable Input

Marginal Revenue Product of Labor	$MRP_L = (MP_L)(MR)$
Marginal Resource Cost of Labor	$MRC_L = \dfrac{\Delta TC}{\Delta L}$
Optimal Use of Labor	$MRP_L = MRC_L$

TABLE 7-3 Marginal Revenue Product and Marginal Resource Cost of Labor

(1)	(2)	(3)	(4) = (2) × (3)	(5)
Units of Labor	Marginal Product	Marginal Revenue = *P*	Marginal Revenue Product	Marginal Resource Cost = *w*
2.5	4	$10	$40	$20
3.0	3	10	30	20
3.5	2	10	20	20
4.0	1	10	10	20
4.5	0	10	0	20

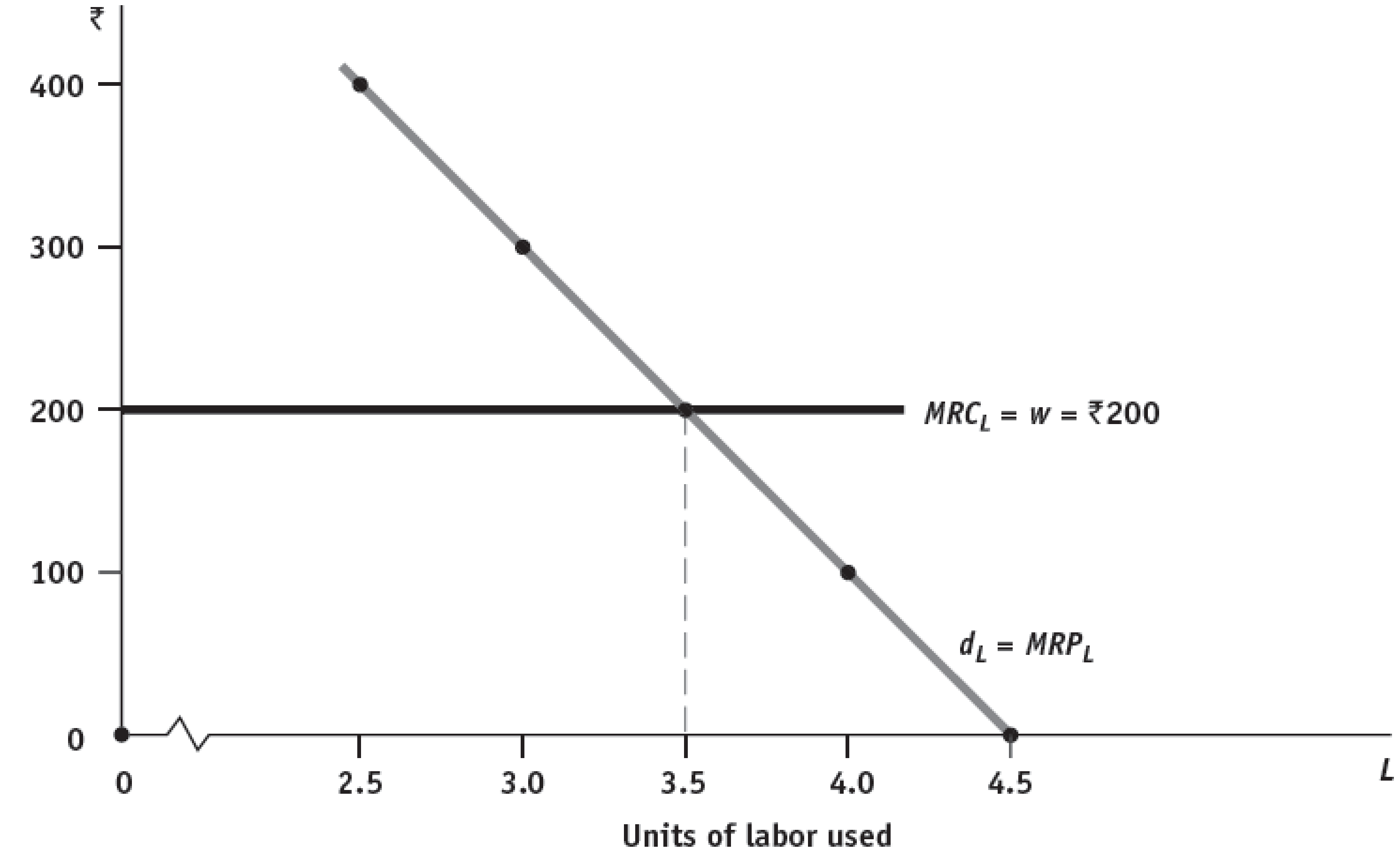


FIGURE 7-5 Optimal Use of Labor It pays for the firm to hire more labor as long as the marginal revenue product of labor (MRP_L) exceeds the marginal resource cost of hiring labor (MRC_L), and until $MRP_L = MRC_L$. With $MRC_L = w =$ ₹200, the optimal amount of labor for the firm to use is 3.5 units. At 3.5L, $MRP_L = MRC_L =$ ₹200, and the firm maximizes total profits.

Production with Two Variable Inputs

Isoquants show combinations of two inputs that can produce the same level of output.

Firms will only use combinations of two inputs that are in the economic region of production, which is defined by the portion of each isoquant that is negatively sloped.

TABLE 7-4 Production Function with Two Variable Inputs

Capital (K) ↑							Output (Q)
6	10	24	31	36	40	39	
5	12	28	36	40	42	40	
4	12	28	36	40	40	36	
3	10	23	33	36	36	33	
2	7	18	28	30	30	28	
1	3	8	12	14	14	12	
$L \rightarrow$	1	2	3	4	5	6	Labor (L)

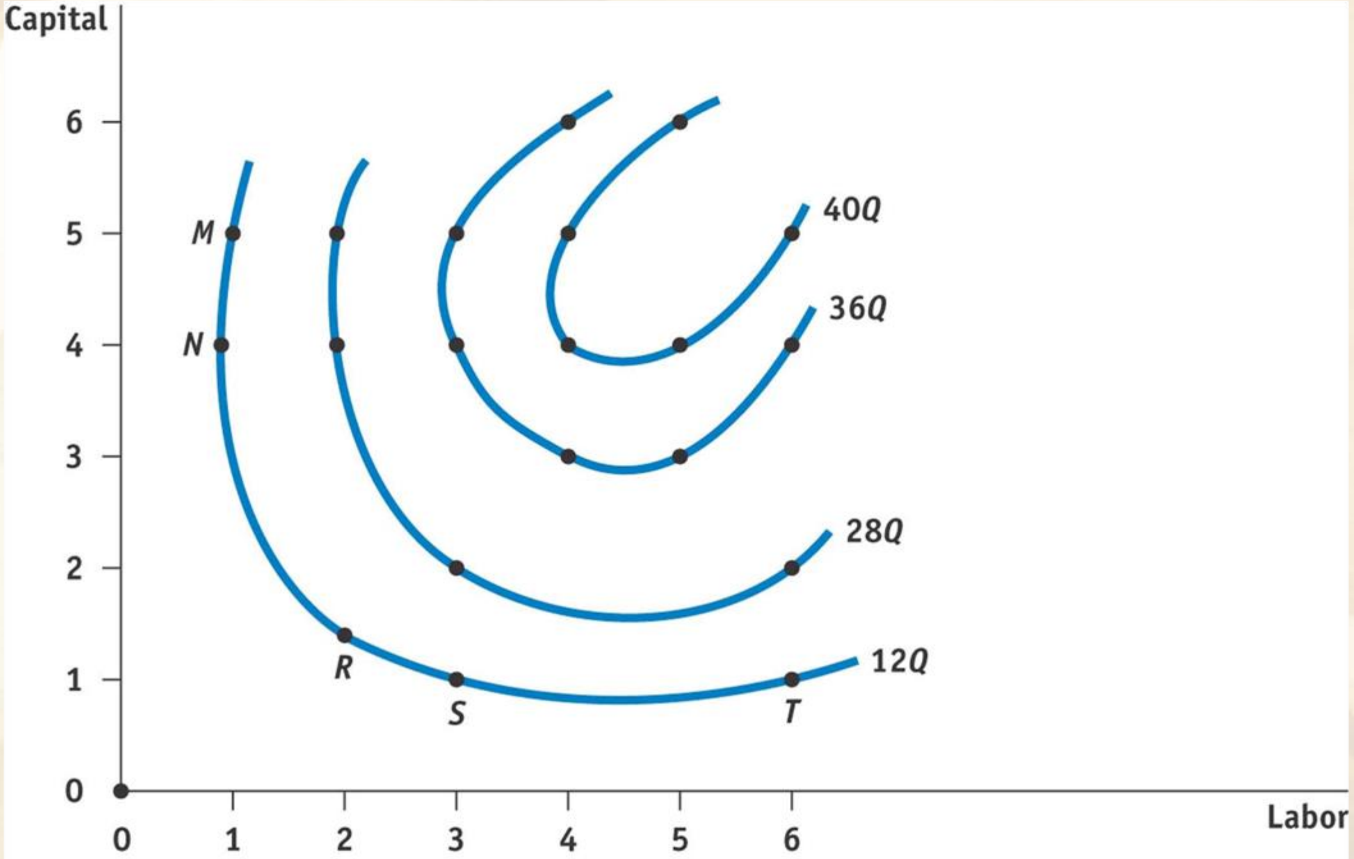


FIGURE 7-6 Isoquants An isoquant shows the various combinations of two inputs that can be used to produce a specific level of output (*Q*). From Table 7-4, we can see that 12*Q* can be produced with 1*L* and 5*K* (point *M*), 1*L* and 4*K* (point *N*), 2*L* and 1.5*K* (point *R*), 3*L* and 1*K* (point *S*), or 6*L* and 1*K* (point *T*). Higher isoquants refer to higher levels of output.

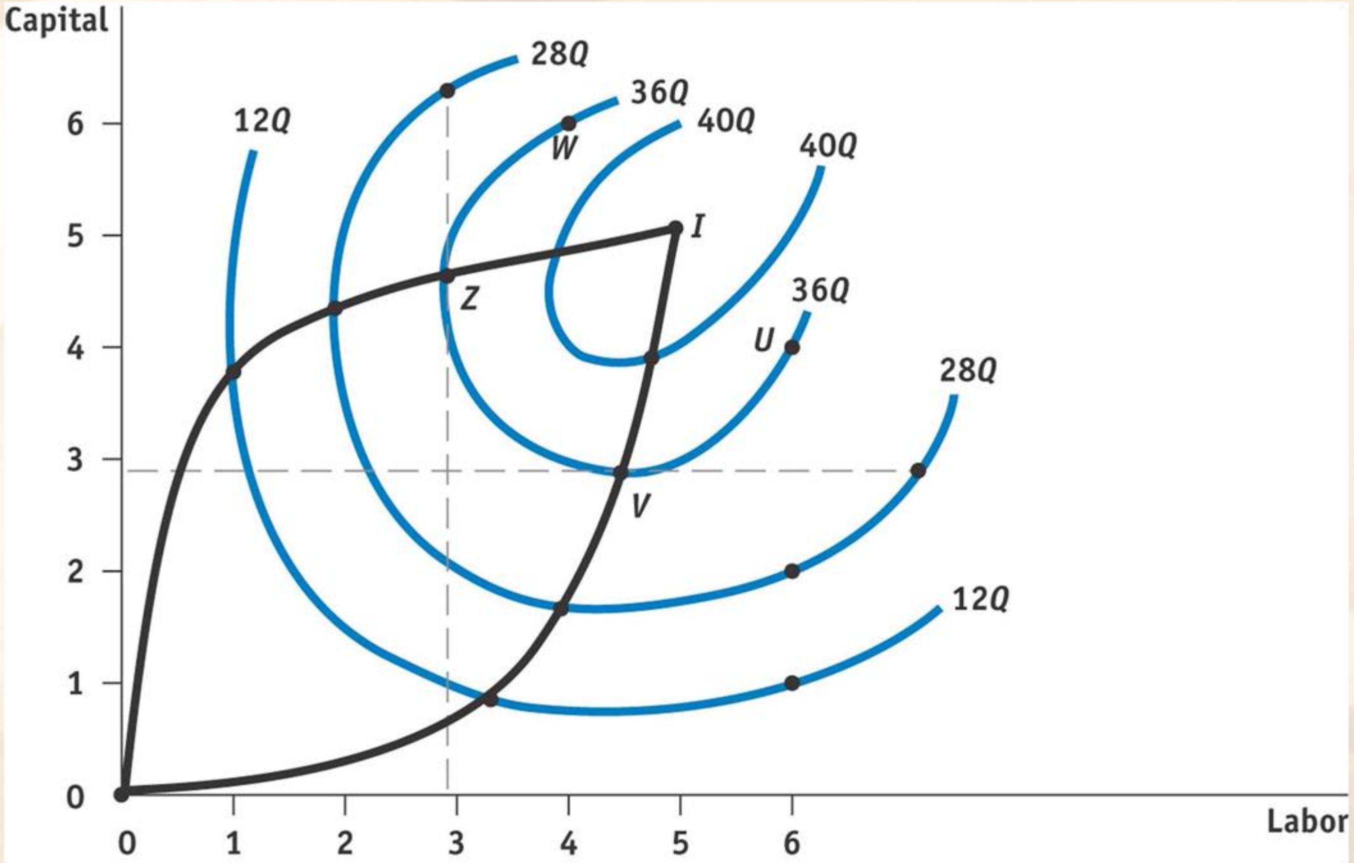


FIGURE 7-7 The Relevant Portion of Isoquants The economic region of production is given by the negatively sloped segment of isoquants between ridge lines 0*VI* and 0*ZI*. The firm will not produce in the positively sloped portion of the isoquants because it could produce the same level of output with both less labor and less capital.

Production with Two Variable Inputs

Marginal Rate of Technical Substitution

$$MRTS = -\Delta K/\Delta L = MP_L/MP_K$$

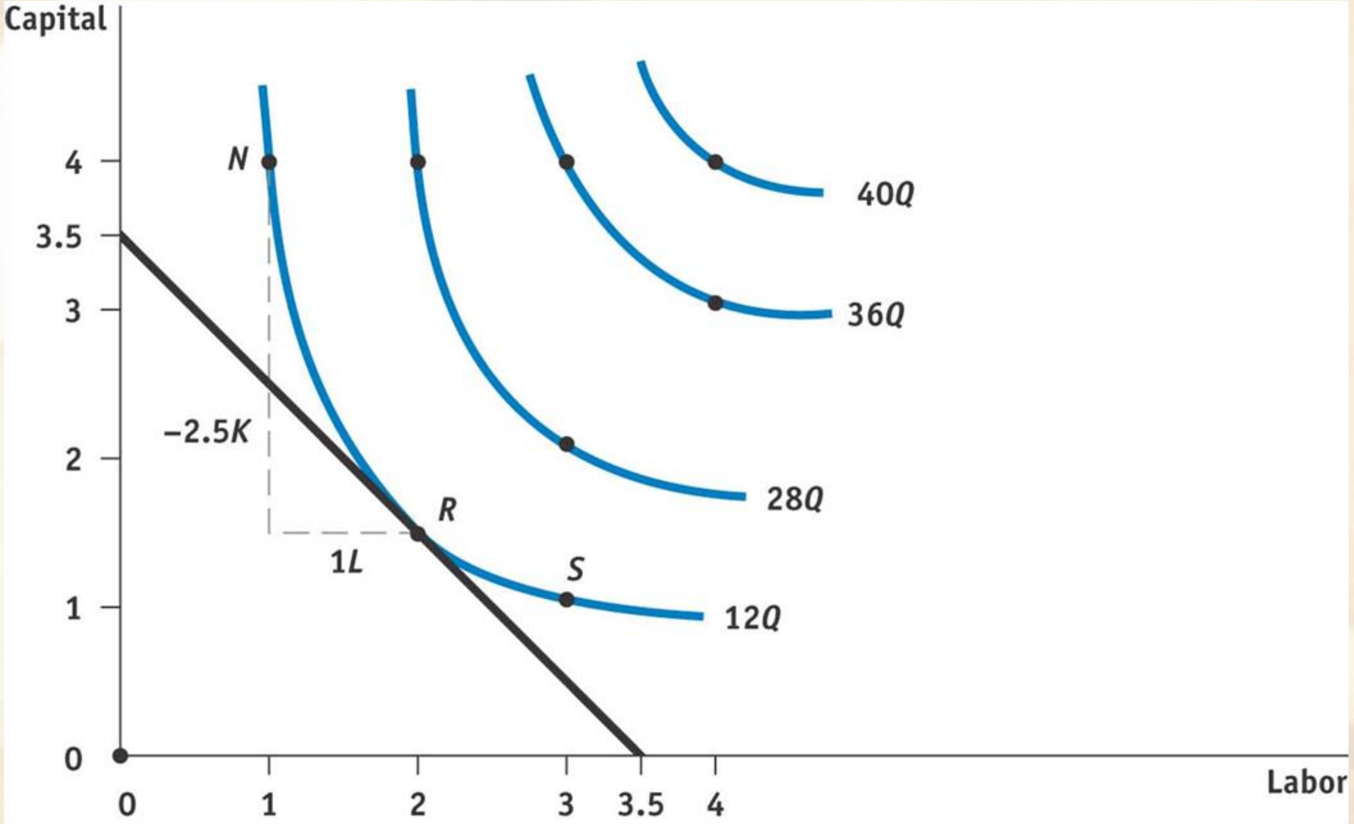


FIGURE 7-8 The Slope of Isoquants The absolute value of the slope of an isoquant is called the *marginal rate of technical substitution* (*MRTS*). Between points *N* and *R* on isoquant 12*Q*, *MRTS* = 2.5. Between points *R* and *S*, *MRTS* = $\frac{1}{2}$. The *MRTS* at any point on an isoquant is given by the absolute slope of the tangent to the isoquant at that point. Thus, at point *R*, *MRTS* = 1.

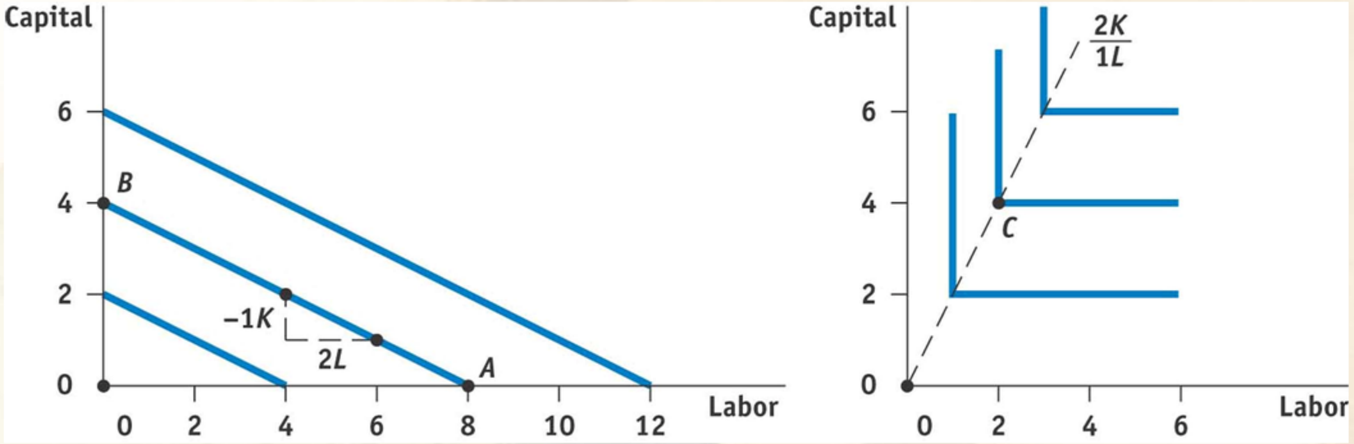


FIGURE 7-9 Perfect Substitutes and Complementary Inputs When an isoquant is a straight line (so that its absolute slope or *MRTS* is constant), inputs are perfect substitutes. In the left panel, 2*L* can be substituted for 1*K* regardless of the point of production on the isoquant. With the right-angled isoquants in the right panel, efficient production can take place only with 2*K*/1*L*. Thus, labor and capital are perfect complements. Using only more labor or only more capital does not increase output (that is, $MP_L = MP_K = 0$).

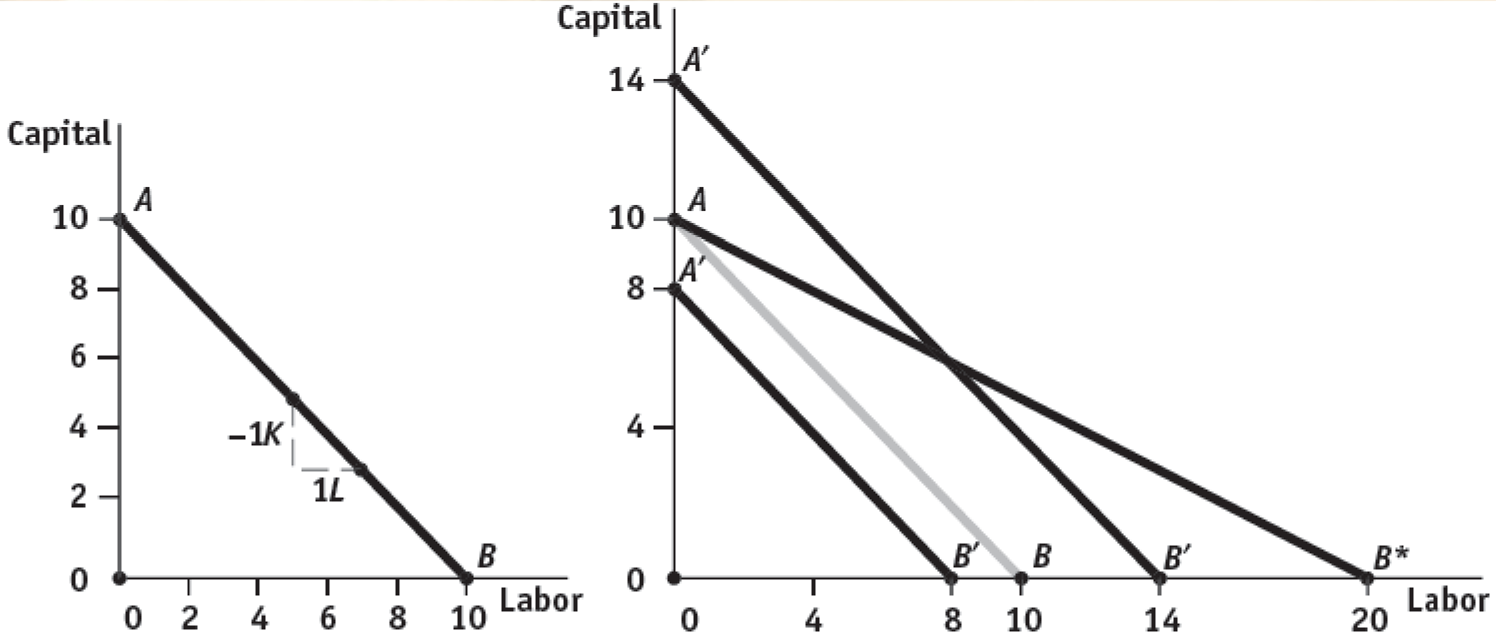


FIGURE 7-10 Isocost Lines With total cost of $C = ₹100$ and $w = r = ₹10$, we have isocost line *AB* in the left panel, with vertical intercept of $C/r = ₹100/₹10 = 10K$ and slope of $-w/r = -₹10/₹10 = -1$. With $C = ₹140$ and $w = r = ₹10$, we have isocost line $A'B'$ in the right panel. With $C'' = ₹80$ and $w = r = ₹10$, the isocost line is $A''B''$ in the right panel. On the other hand, with $C = ₹100$ and $r = ₹10$ but $w = ₹5$, we have isocost line AB^* in the right panel, with vertical intercept of $10K$ and slope of $\frac{1}{2}$.

Optimal Combination of Inputs

Isocost lines represent all combinations of two inputs that a firm can purchase with the same total cost.

$$C = wL + rK$$

$$C = Total\ Cost$$

$$w = Wage\ Rate\ of\ Labor\ (L)$$

$$K = \frac{C}{r} - \frac{w}{r}L$$

$$r = Cost\ of\ Capital\ (K)$$

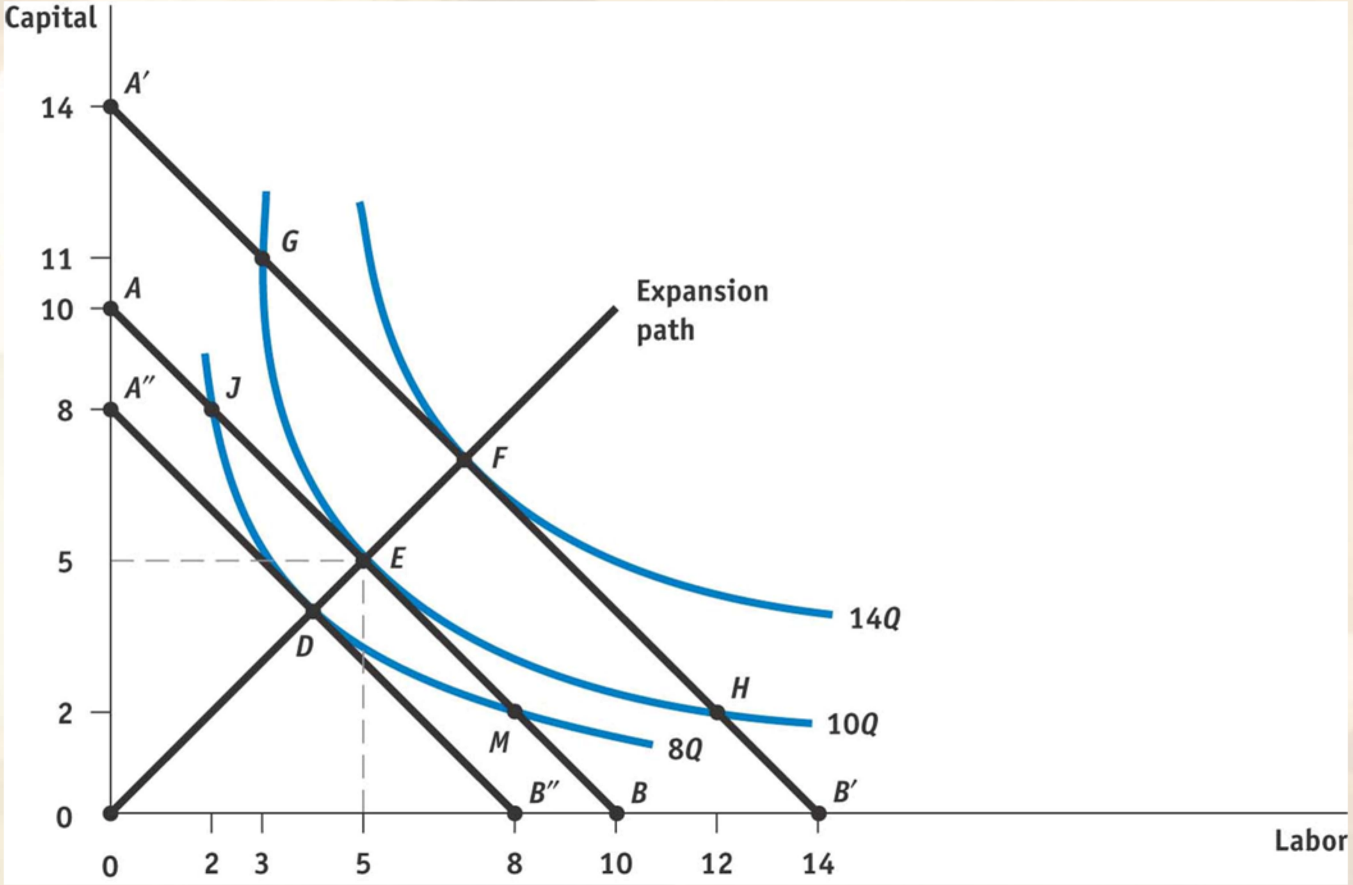


FIGURE 7-11 Optimal Input Combination The optimal input combination is given by points *D*, *E*, and *F* at which isoquants 8*Q*, 10*Q*, and 14*Q* are tangent to isocosts to *A''B''*, *AB*, and *A'B'*, respectively. By joining the origin with points *D*, *E*, and *F*, we get the expansion path of the firm. At the optimal input combinations (tangency points), the absolute slope of the isoquants ($MRTS = MP_L/MP_K$) equals the absolute slope of the isocost lines (w/r), so that $MP_L/w = MP_K/r$.

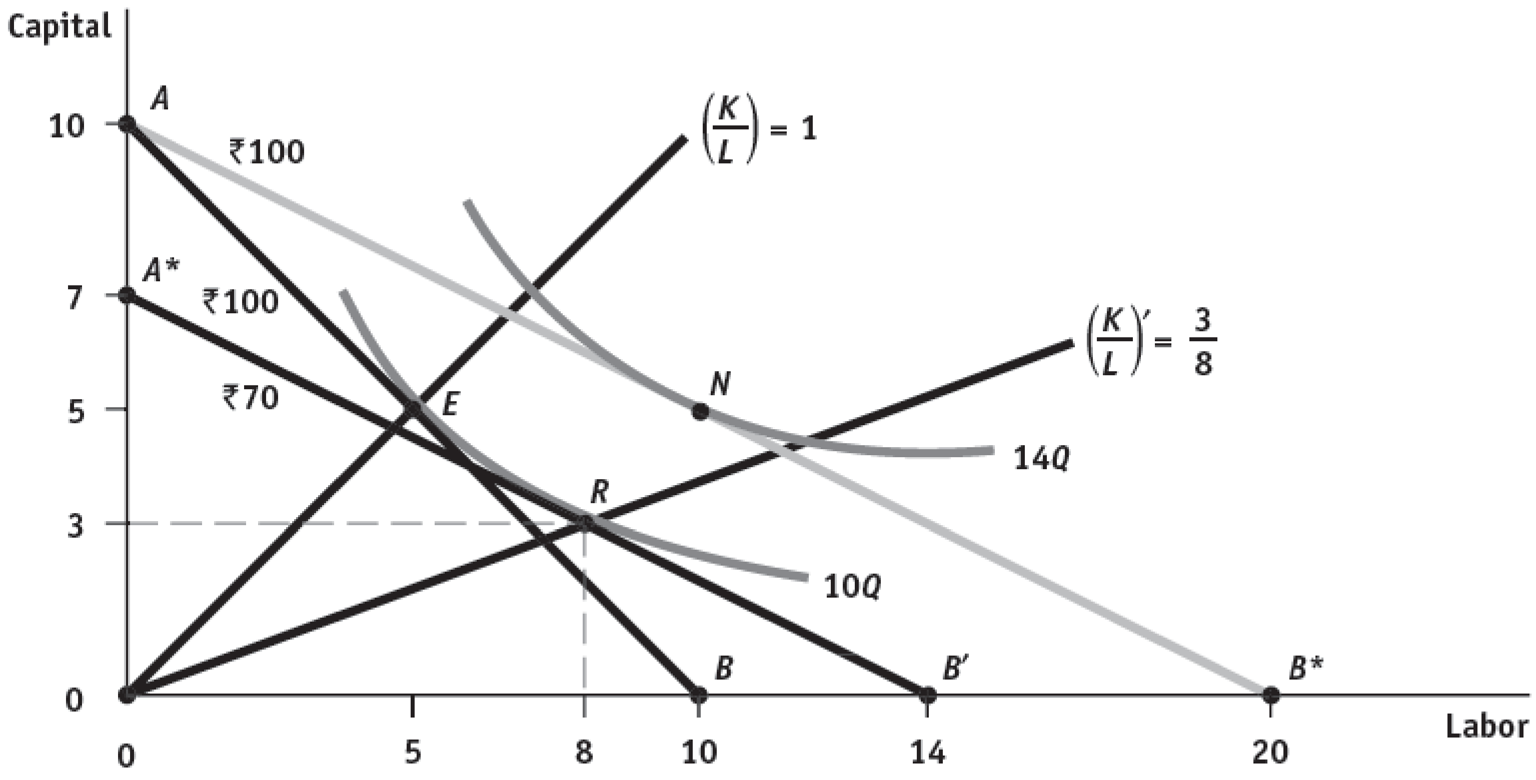


FIGURE 7-12 Input Substitution in Production With $C = ₹100$ and $w = r = ₹10$, the optimal input combination to produce 10Q is 5K and 5L (point E, where isoquant 10Q is tangent to isocost AB). At point E, $K/L = 1$. If r remains at ₹10 but w falls to ₹5, the firm can reach isoquant 10Q with $C = ₹70$. The optimal combination of L and K is then given by point R where isocost A^*B' is tangent to isoquant 10Q, and $K/L = \frac{3}{8}$.

Returns to Scale

Production Function $Q = f(L, K)$

$$\lambda Q = f(hL, hK)$$

If $\lambda = h$, then f has constant returns to scale.

If $\lambda > h$, then f has increasing returns to scale.

If $\lambda < h$, then f has decreasing returns to scale.

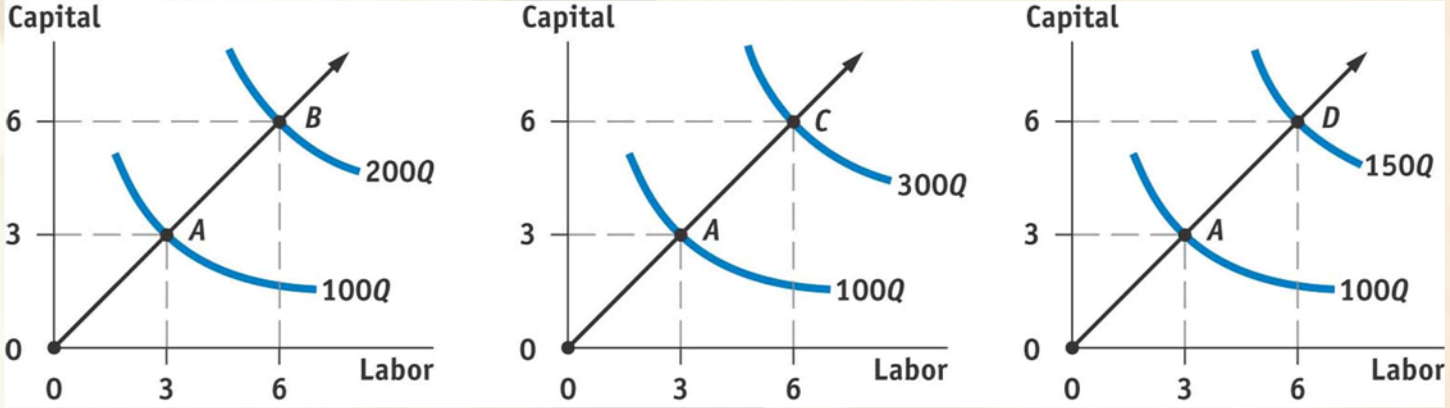


FIGURE 7-14 Constant, Increasing, and Decreasing Returns to Scale In all three panels of this figure we start with the firm using 3*L* and 3*K* and producing 100*Q* (point *A*). By doubling inputs to 6*L* and 6*K*, the left panel shows that output also doubles to 200*Q* (point *B*), so that we have constant returns to scale; the center panel shows that output triples to 300*Q* (point *C*), so that we have increasing returns to scale; while the right panel shows that output only increases to 150*Q* (point *D*), so that we have decreasing returns to scale.

Costs

The Nature of Costs

- Explicit Costs
  - Accounting Costs
- Economic Costs
  - Implicit Costs
  - Alternative or Opportunity Costs
- Relevant Costs
  - Incremental Costs
  - Sunk Costs are Irrelevant

Short-Run Cost Functions

Total Cost = TC = f(Q)

Total Fixed Cost = TFC

Total Variable Cost = TVC

TC = TFC + TVC

Short-Run Cost Functions

Average Total Cost = ATC = TC/Q

Average Fixed Cost = AFC = TFC/Q

Average Variable Cost = AVC = TVC/Q

ATC = AFC + AVC

Marginal Cost = ΔTC/ΔQ = ΔTVC/ΔQ

TABLE 8-1 Short-Run Total and Per-Unit Cost Schedules							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quantity of Output	Total Fixed Costs	Total Vari-able Costs	Total Costs	Average Fixed Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	₹6000	₹0					
1	6000	2000					
2	6000	3000					
3	6000	4500					
4	6000	8000					
5	6000	13500					

TABLE 8-1 Short-Run Total and Per-Unit Cost Schedules

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quantity of Output	Total Fixed Costs	Total Vari-able Costs	Total Costs	Average Fixed Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	₹6000	₹0	₹6000	—	—	—	—
1	6000	2000	8000	₹6000	₹2000	₹8000	₹2000
2	6000	3000	9000	3000	1500	4500	1000
3	6000	4500	10500	2000	1500	3500	1500
4	6000	8000	14000	1500	2000	3500	3500
5	6000	13500	19500	1200	2700	3900	5500

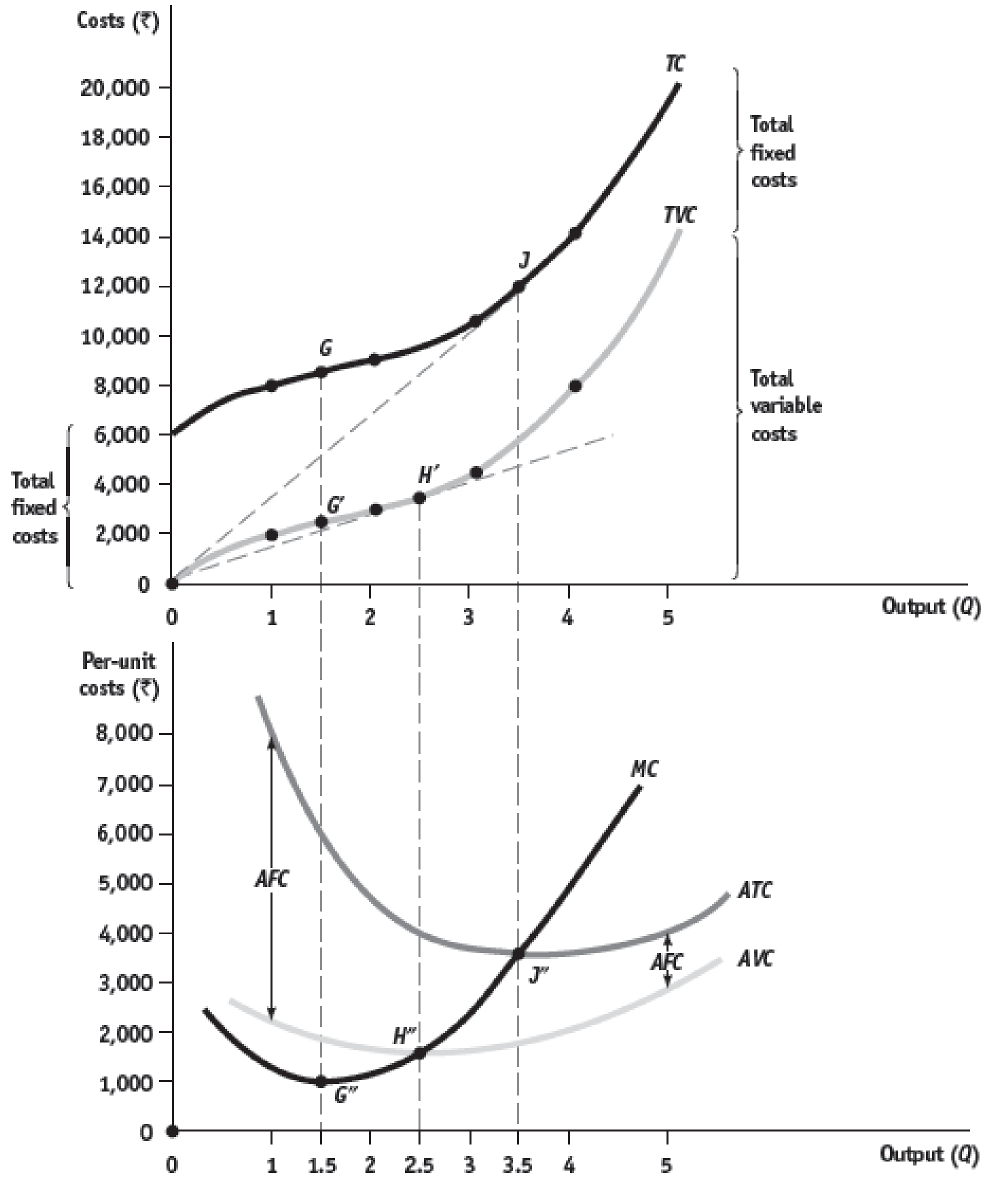


FIGURE 8-1 Short-Run Total and Per-Unit Cost Curves The top panel shows that *TVC* are zero when output is zero and rise as output rises. At point *G′* the law of diminishing returns begins to operate. The *TC* curve has the same shape as the *TVC* curve and is above it by ₹6000 (the *TFC*). The bottom panel shows U-shaped *AVC*, *ATC*, and *MC* curves. *AFC* = *ATC* – *AVC* and declines continuously as output rises. The *MC* curve reaches a minimum before the *AVC* and *ATC* curves and intercepts them from below at their lowest points.

Short-Run Cost Functions

Average Variable Cost

$$AVC = TVC/Q = w/AP_L$$

Marginal Cost

$$\Delta TC/\Delta Q = \Delta TVC/\Delta Q = w/MP_L$$

Long-Run Cost Functions

Long-Run Total Cost = LTC = f(Q)

Long-Run Average Cost = LAC = LTC/Q

Long-Run Marginal Cost = LMC = ΔLTC/ΔQ

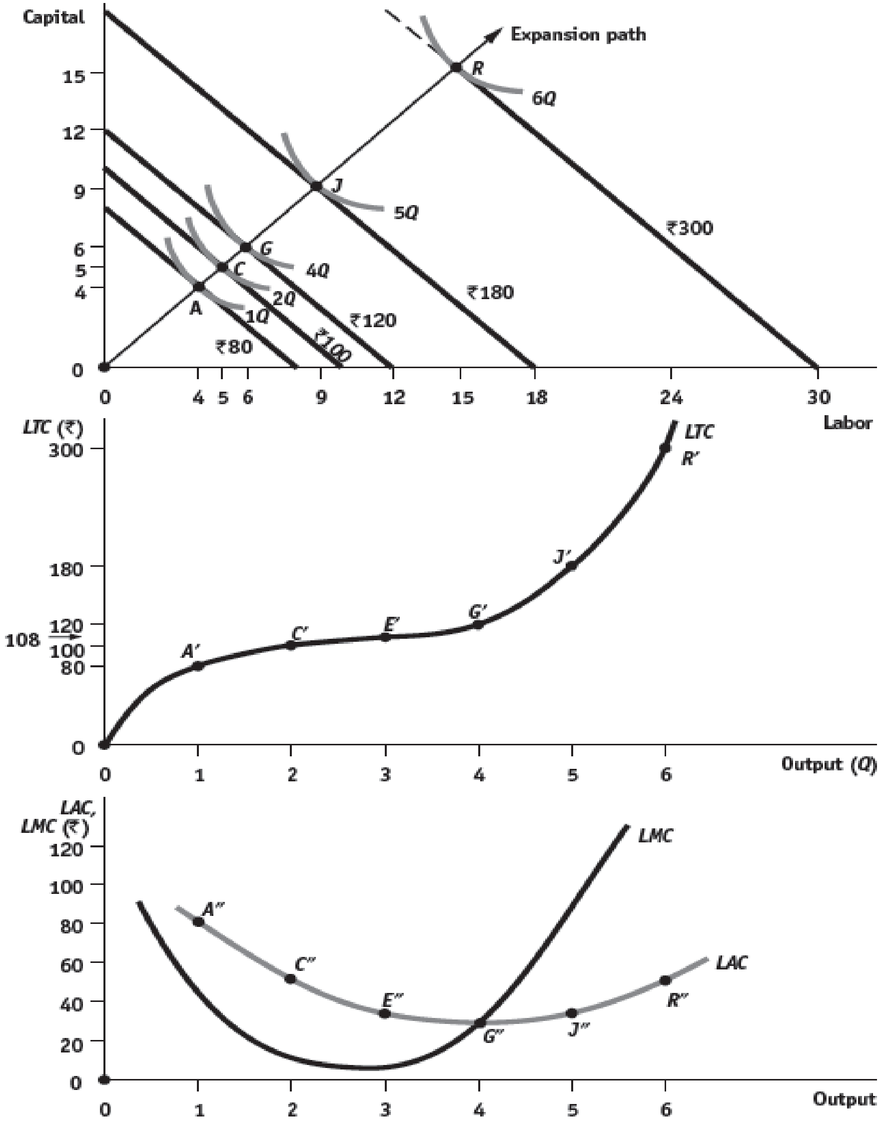


FIGURE 8-3 Derivation of the Long-Run Total, Average, and Marginal Cost Curves From point *A* on the expansion path in the top panel, and $w = ₹10$ and $r = ₹10$, we get point *A′* on the long-run total cost (*LTC*) curve in the middle panel. Other points on the *LTC* curve are similarly obtained. The long-run average cost (*LAC*) curve in the bottom panel is given by the slope of a ray from the origin to the *LTC* curve. The *LAC* curve falls up to point *G″* (4*Q*) because of increasing returns to scale and rises thereafter because of decreasing returns to scale. The long-run marginal cost (*LMC*) curve is given by the slope of the *LTC* curve and intersects the *LAC* curve from below at the lowest point on the *LAC* curve.

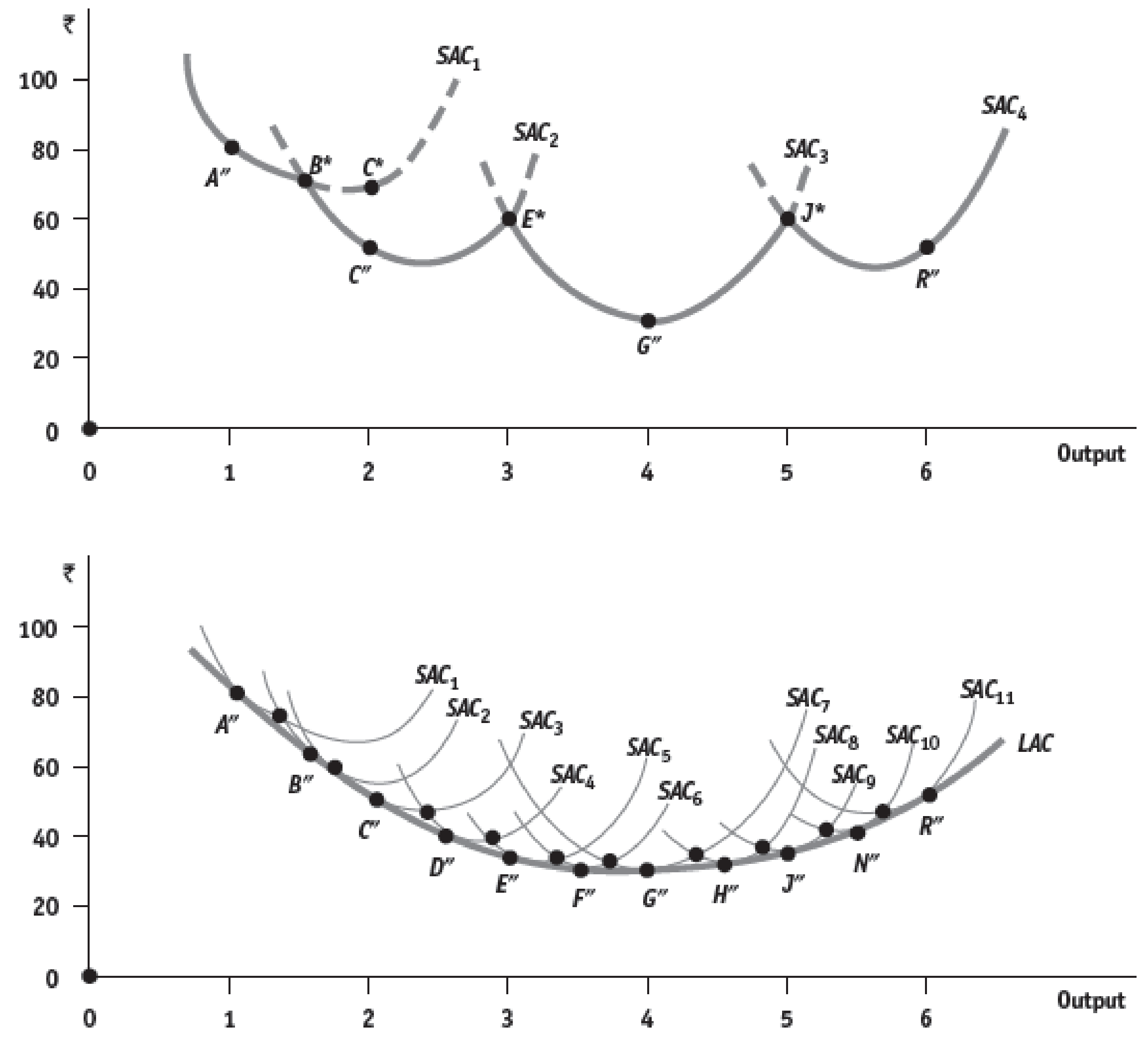


FIGURE 8-4 Relationship Between the Long-Run and Short-Run Average Cost Curves In the top panel, the *LAC* curve is given by *A″B*C″E*G″J*R″* on the assumption that the firm can build only four scales of plant (SAC_1, SAC_2, SAC_3, and SAC_4). In the bottom panel, the *LAC* curve is the smooth curve *A″B″C″D″E″F″G″H″J″N″R″* on the assumption that the firm can build a very large or infinite number of plants in the long run.

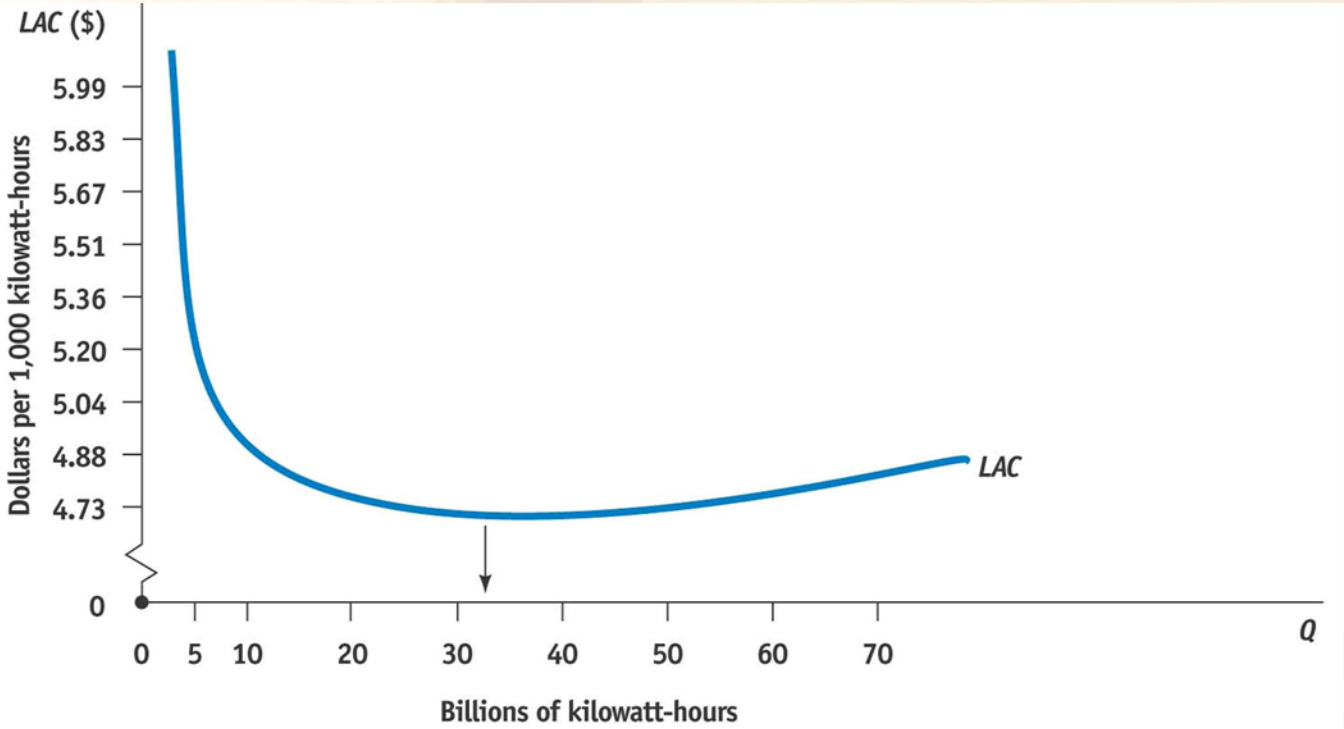


FIGURE 8-5 The Long-Run Average Cost Curve in Electricity Generation The figure shows the estimated *LAC* curve in the generation of electricity in the United States for a sample of 114 firms in 1970. The lowest *LAC* occurs at the output level of 32 billion kilowatt-hours, but the *LAC* curve is nearly L-shaped.

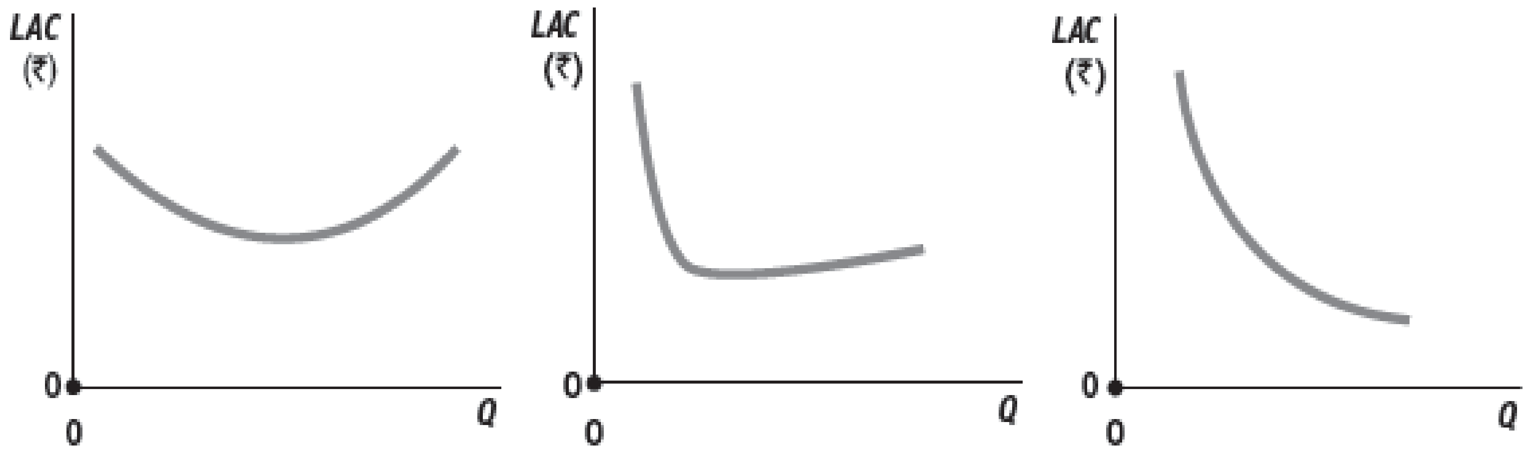


FIGURE 8-6 Possible Shapes of the LAC Curve The left panel shows a U-shaped *LAC* curve, which indicates first increasing and then decreasing returns to scale. The middle panel shows a nearly L-shaped *LAC* curve, which shows that economies of scale quickly give way to constant returns to scale or gently rising LAC. The right panel shows an *LAC* curve that declines continuously, as in the case of natural monopolies.

Cost-Volume-Profit Analysis

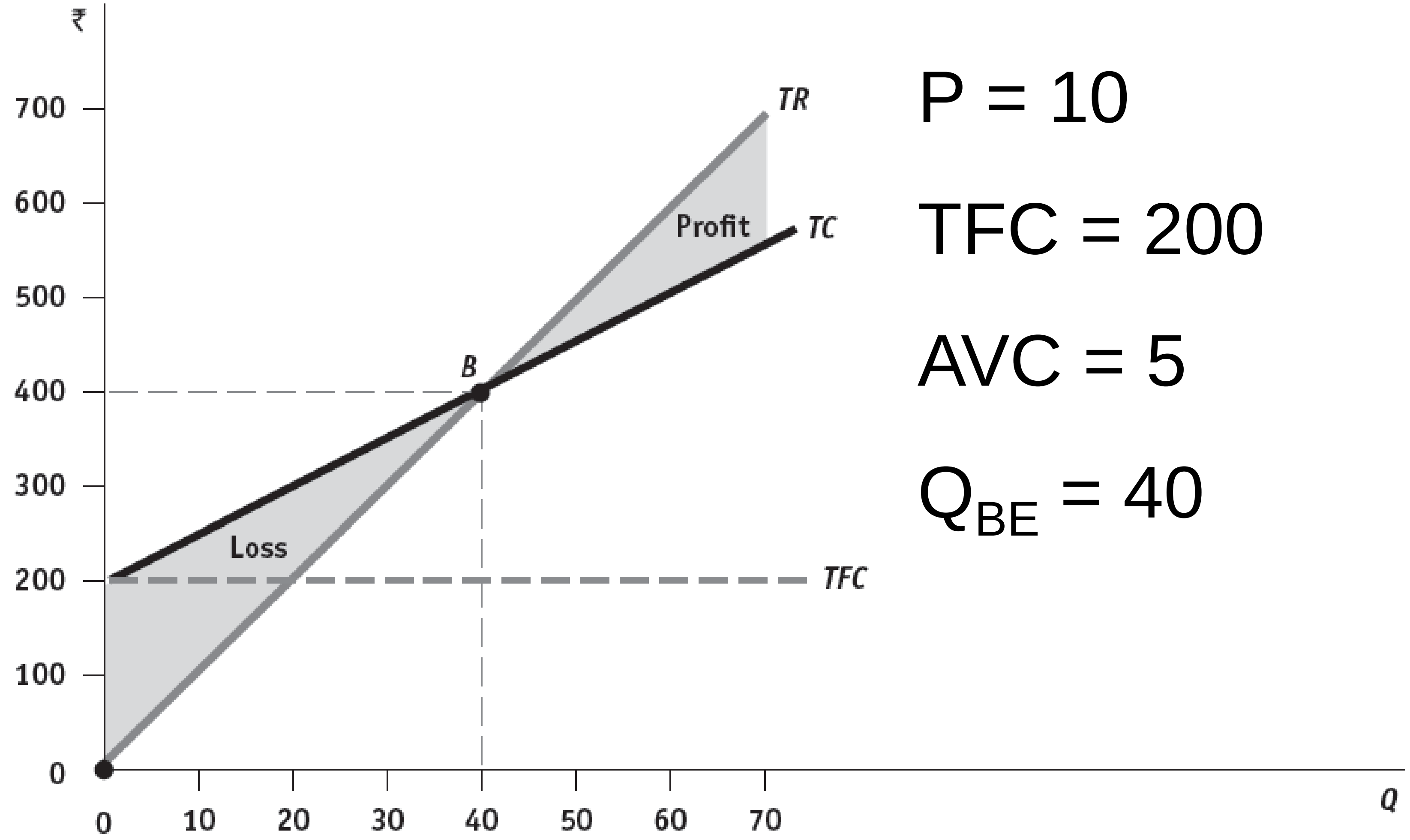
$$\text{Total Revenue} = TR = (P)(Q)$$

$$\text{Total Cost} = TC = TFC + (AVC)(Q)$$

$$\text{Breakeven Volume } TR = TC$$

$$(P)(Q) = TFC + (AVC)(Q)$$

$$Q_{BE} = TFC/(P - AVC)$$



$P = 10$

$TFC = 200$

$AVC = 5$

$Q_{BE} = 40$

FIGURE 8-8 Linear Cost–Volume–Profit or Breakeven Chart The slope of the total revenue (*TR*) curve refers to the product price of ₹10 per unit. The vertical intercept of the total cost (*TC*) curve refers to the total fixed costs (*TFC*) of ₹200, and the slope of the *TC* curve to the average variable cost of ₹5. The firm breaks even with *TR* = *TC* = ₹400 at the output (*Q*) of 40 units per time period (point *B*). The losses that the firm incurs at smaller output levels and profits at larger output levels can be read off the figure.

Operating Leverage

Operating Leverage = TFC/TVC

Degree of Operating Leverage = DOL

$$DOL = \frac{\%\Delta\pi}{\%\Delta Q} = \frac{Q(P - AVC)}{Q(P - AVC) - TFC}$$

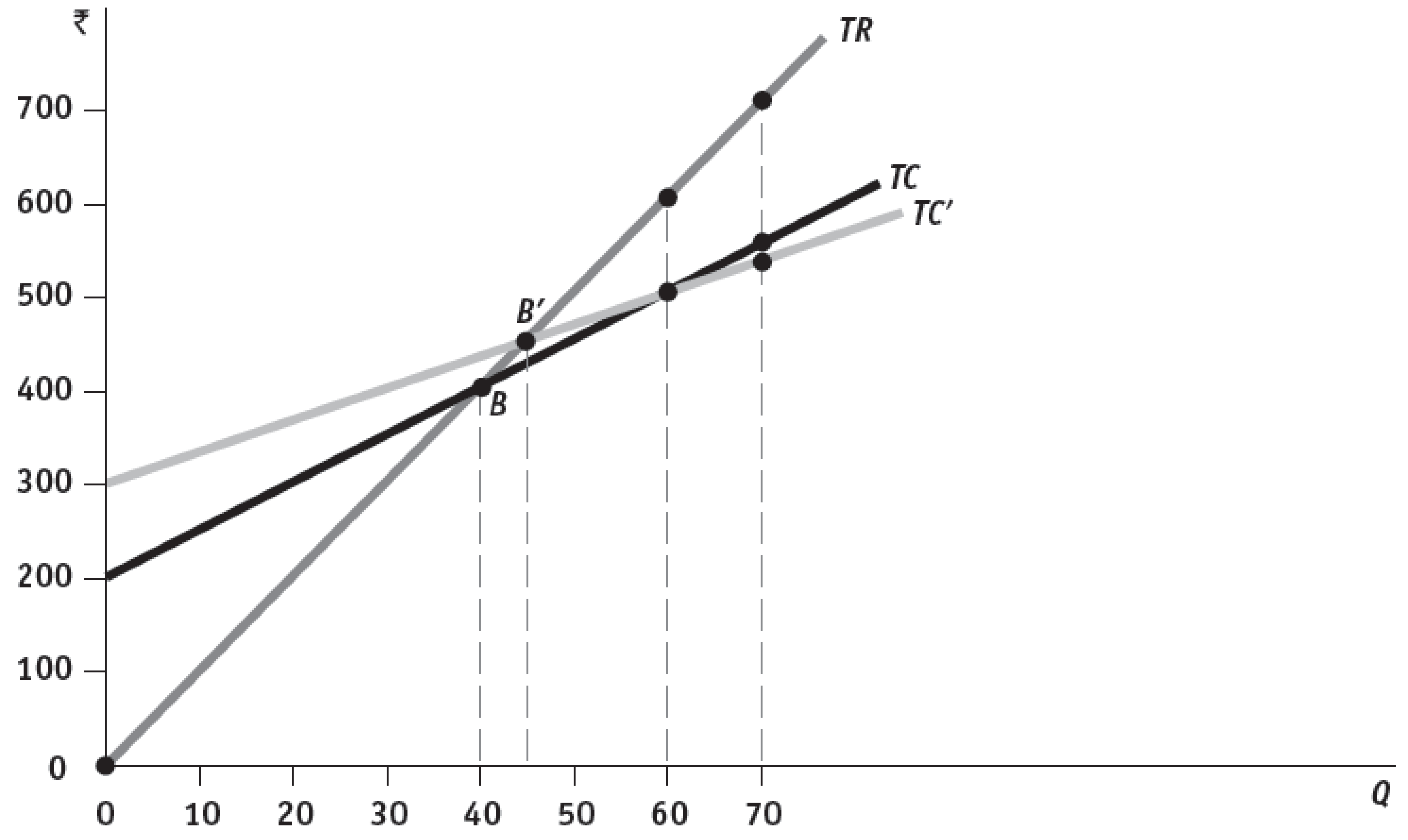


FIGURE 8-9 Operating Leverage, Breakeven Point, and Variability of Profits The intersection of *TR* and *TC* defines the breakeven quantity of $Q_B = 40$ (as in Figure 8-8). With *TC* (i.e., if the firm becomes more highly leveraged), the breakeven quantity increases to $Q_{B'} = 45$ (given by the intersection of *TR* and *TC′*). The total profits of the firm are also more variable with *TC′* than with *TC*.

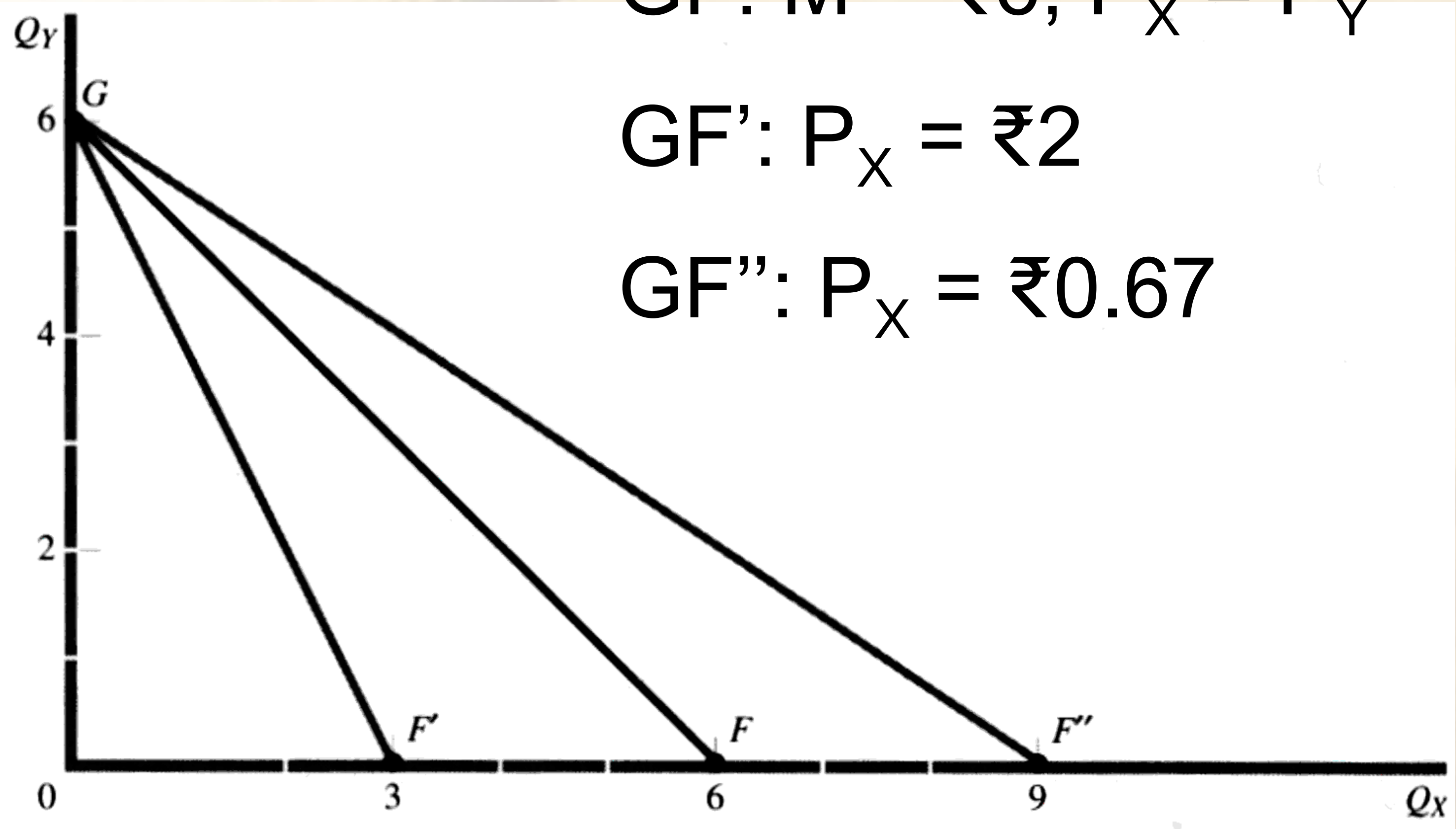
Appendix

Budget Lines: Change in Price

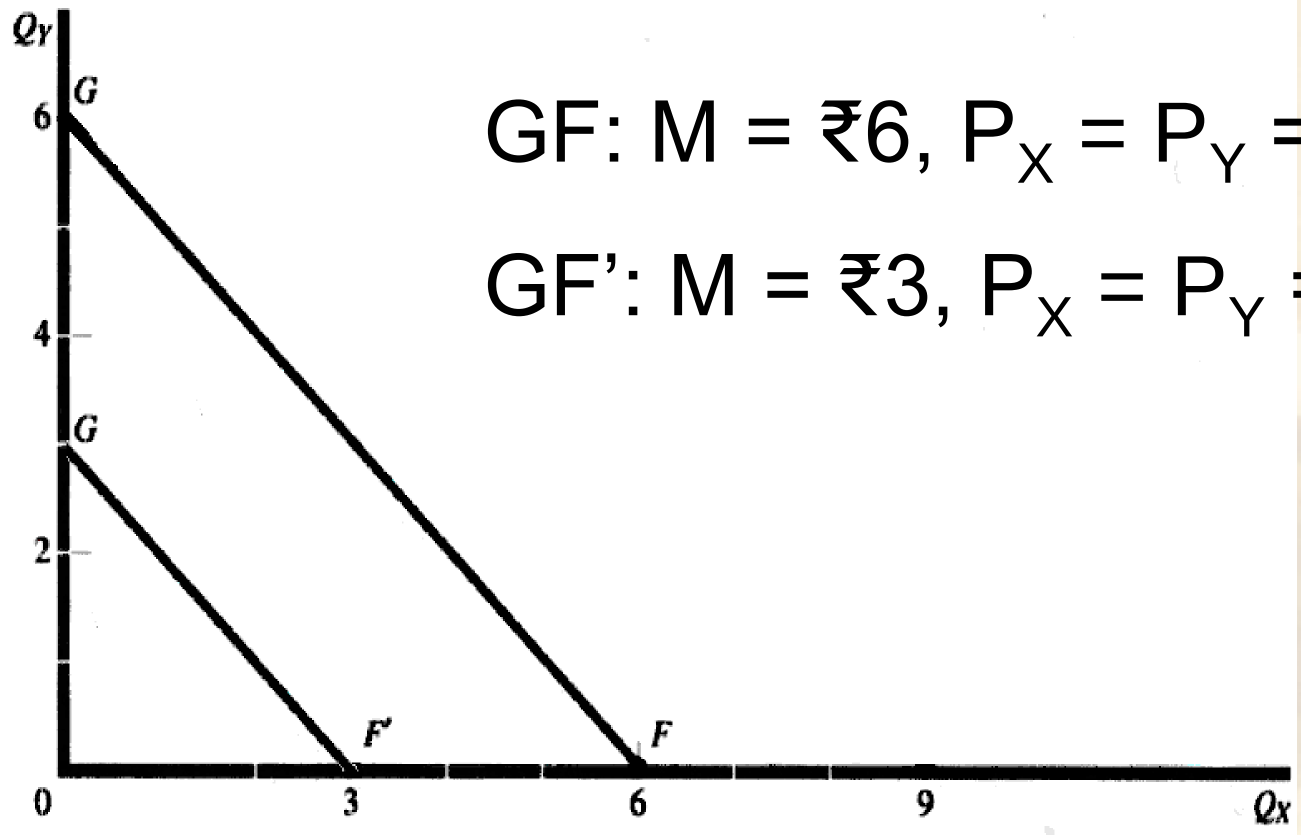
GF: M = ₹6, $P_X = P_Y$ = ₹1

GF’: P_X = ₹2

GF”: P_X = ₹0.67



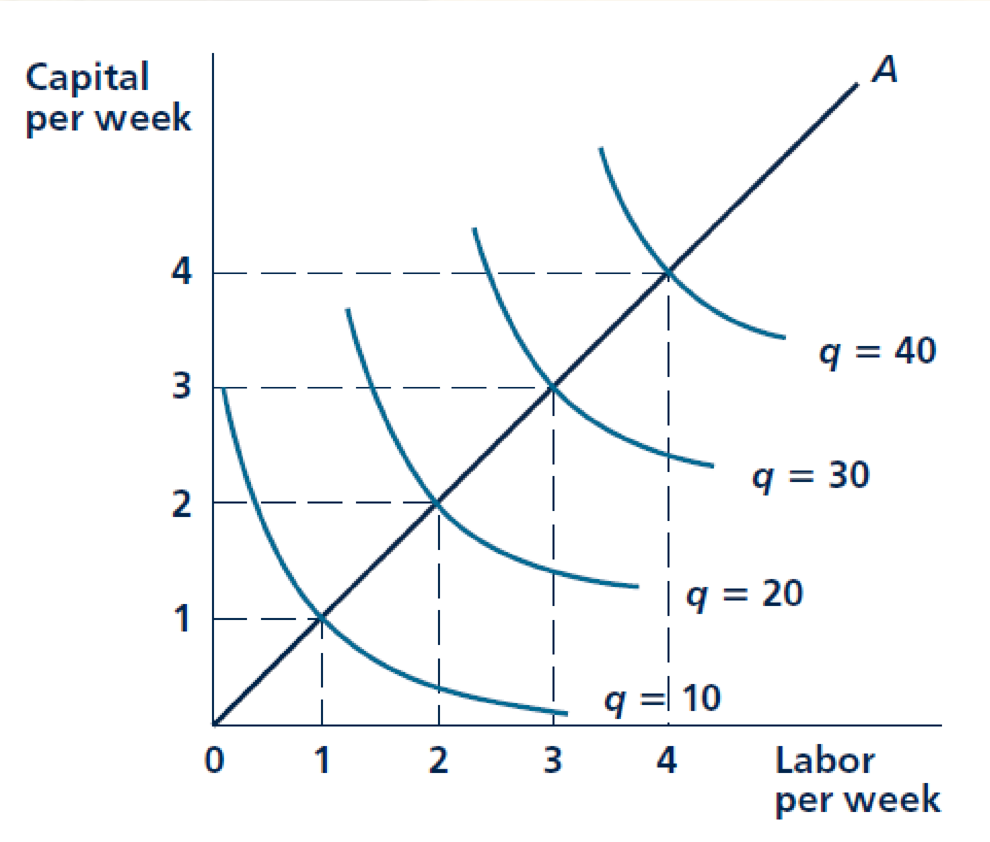
Budget Lines: Change in Income



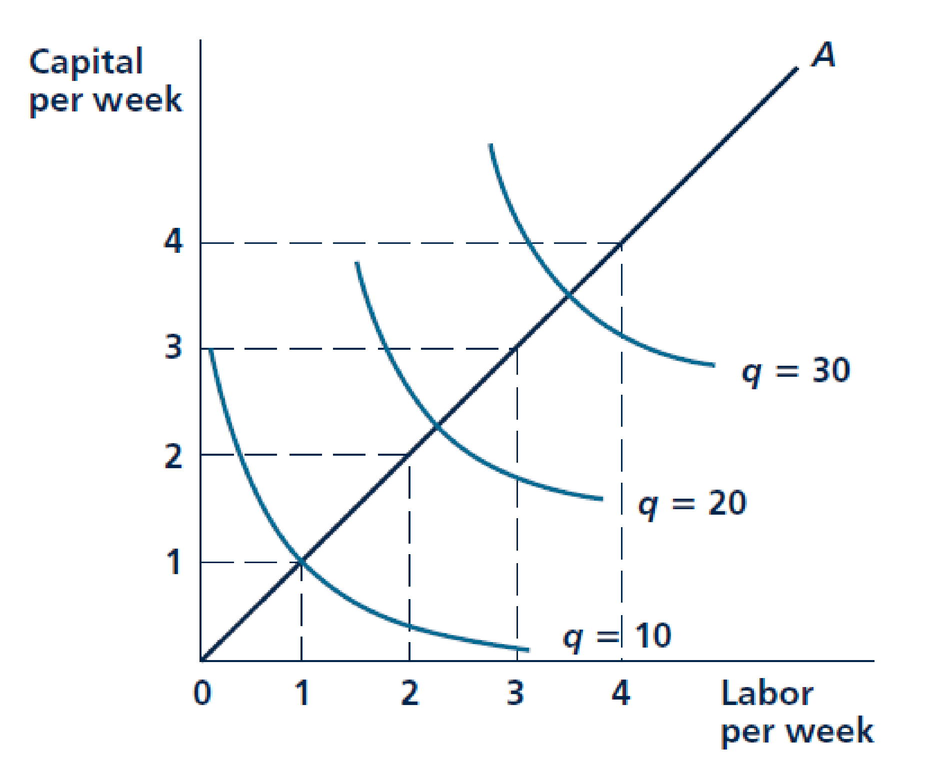
GF: M = ₹6, $P_X = P_Y$ = ₹1

GF’: M = ₹3, $P_X = P_Y$ = ₹1

Constant Returns to Scale



Decreasing Returns to Scale



Increasing Returns to Scale