

Figure 13.A. The Production Function

Number of Workers	Total Product (TP)	Marginal Product	Average Product	
0	0	-----	-----	
1	5	$5 - 0 = 5$	$5 / 1 = 5$	Stage I
2	20	$20 - 5 = 15$	$15 / 2 = 7.5$	
3	30	$30 - 20 = 10$	$30 / 3 = 10$	Stage II
4	35	$35 - 30 = 5$	$35 / 4 = 8.75$	
5	32	$32 - 35 = -3$	$32 / 5 = 6.4$	Stage III

Figure 13.B. The Production Function

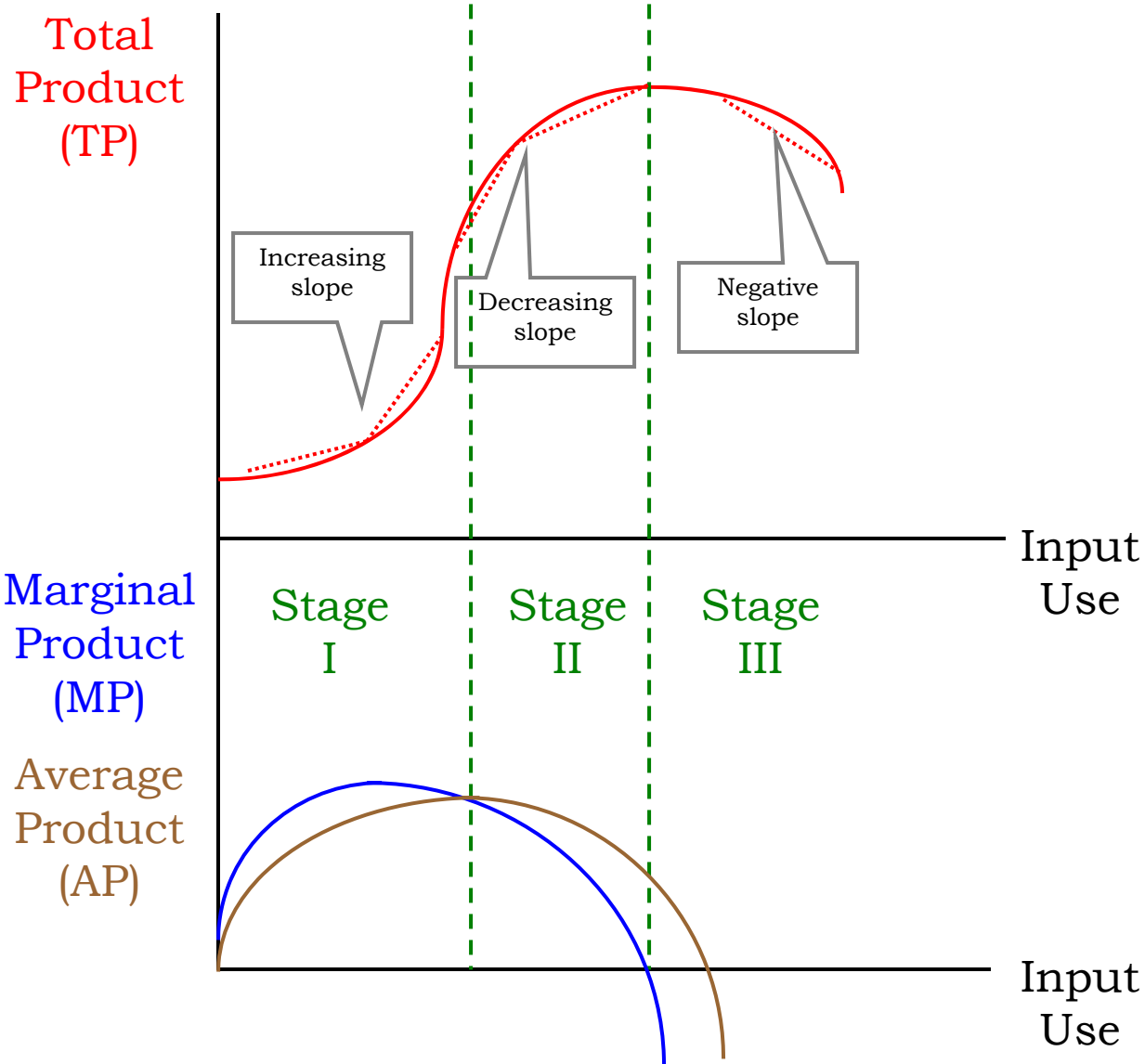


Figure 13.C. The Production Function for Oklahoma Wheat

lbs Nitrogen Per Acre	Wheat Yield (Total Product) <i>bushels / acre</i>	Marginal Product of Nitrogen	Average Product of Nitrogen
0	23.0	-----	-----
20	30.5	$(30.5-23.0)/(20-0) = 0.375$	$32 / 20 = 1.525$
40	35.0	$(35.0-30.5)/(40-20) = 0.225$	$37 / 40 = 0.875$
60	37.0	$(37.0-35.0)/(60-40) = 0.100$	$40 / 60 = 0.617$
80	37.8	$(37.8-37.0)/(80-60) = 0.040$	$43 / 80 = 0.473$

Figure 13.D. Marginal Value and Cost of Input Use

lbs Nitrogen Per Acre	Wheat Yield (Total Product) <i>bushels / acre</i>	Marginal Product of Nitrogen <i>bushels / acre</i>	Average Product of Nitrogen <i>bushels / acre</i>	Marginal Value of Nitrogen (Wheat Price = \$3.25 / bu) \$ / acre	Marginal Cost of Nitrogen (Nitrogen Price = \$0.15 / lb N)
0	23.0	-----	-----	-----	-----
20	30.5	0.375	1.53	0.375*3.25 =\$1.22	\$0.15
40	35.0	0.225	0.88	\$0.73	\$0.15
60	37.0	0.100	0.62	\$0.33	\$0.15
80	37.8	0.040	0.47	\$0.13	\$0.15

Figure 13.E. Solving for the Optimal Number of *Days on Feed*

Set Marginal Value of Input = Input Price

Assume output price = $P_{LC} = 0.75$; Input Price = $p_{DOF} = 1.41$

$$P_{LC}[4.36 - 0.0157(\text{DOF}^*)] = p_{DOF}$$

$$0.75[4.36 - 0.0157(\text{DOF}^*)] = 1.41$$

$$\text{DOF}^* = (3.27 - 1.41) / 0.013775 = 158 \text{ days on feed}$$

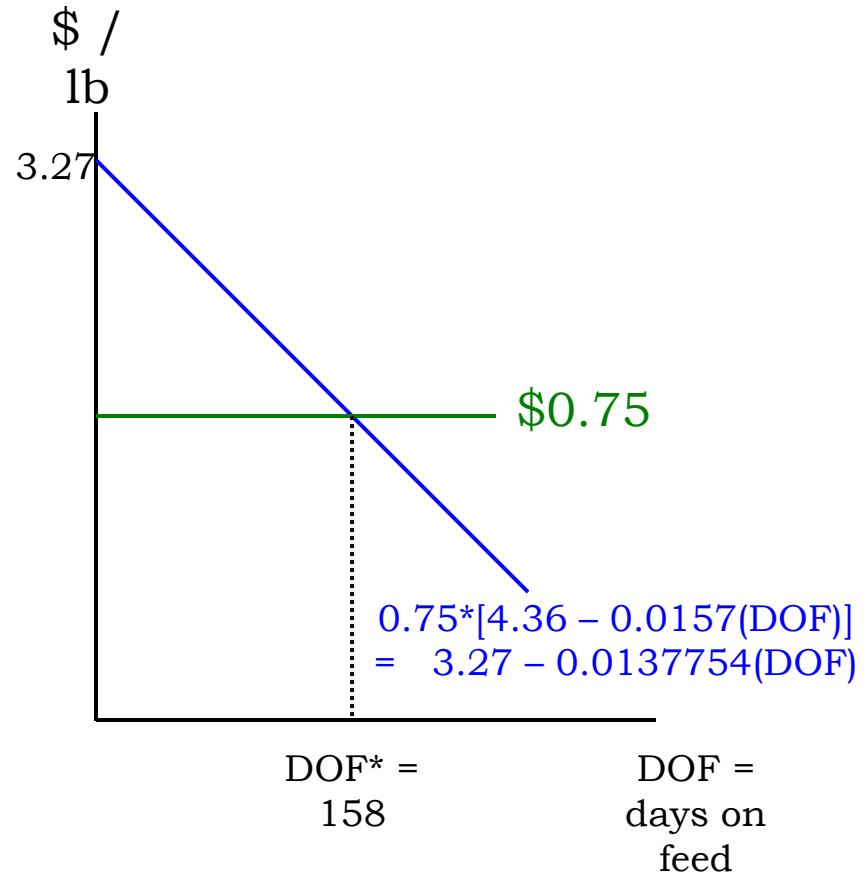
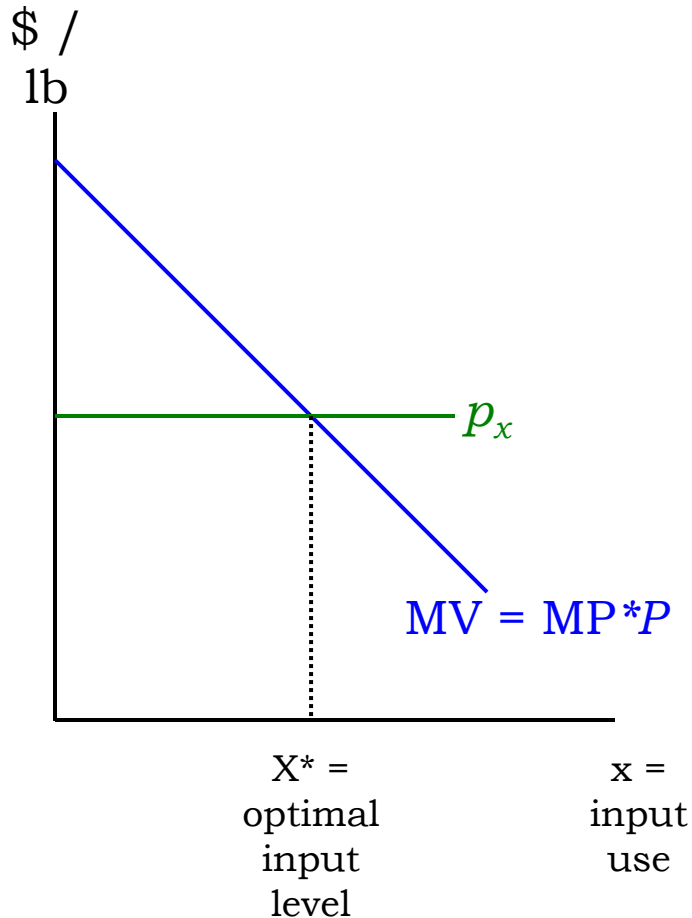
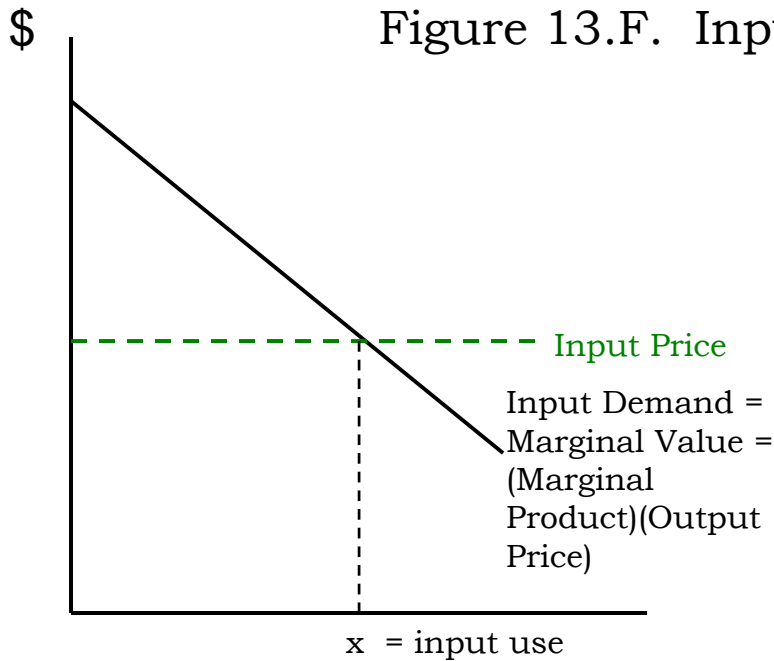


Figure 13.F. Input Demand



An increase (decrease) in the input price decreases (increases) input use by the firm.

An increase (decrease) in marginal product or output price increases (decreases) input use by the firm.

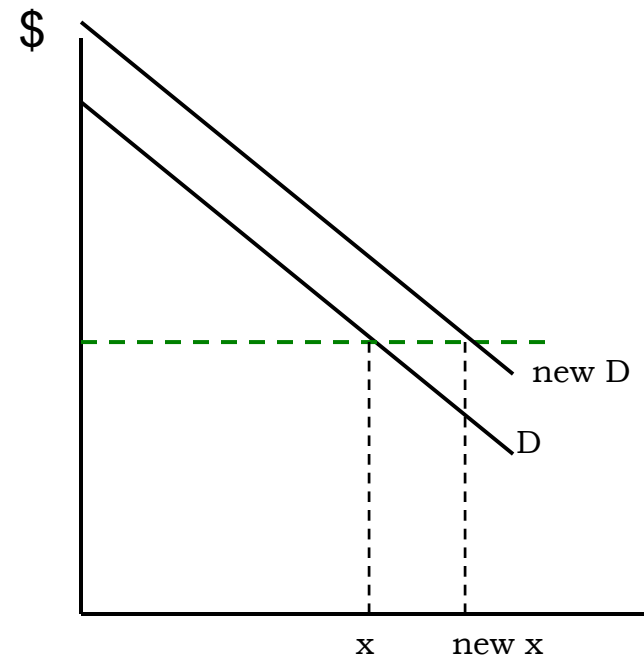
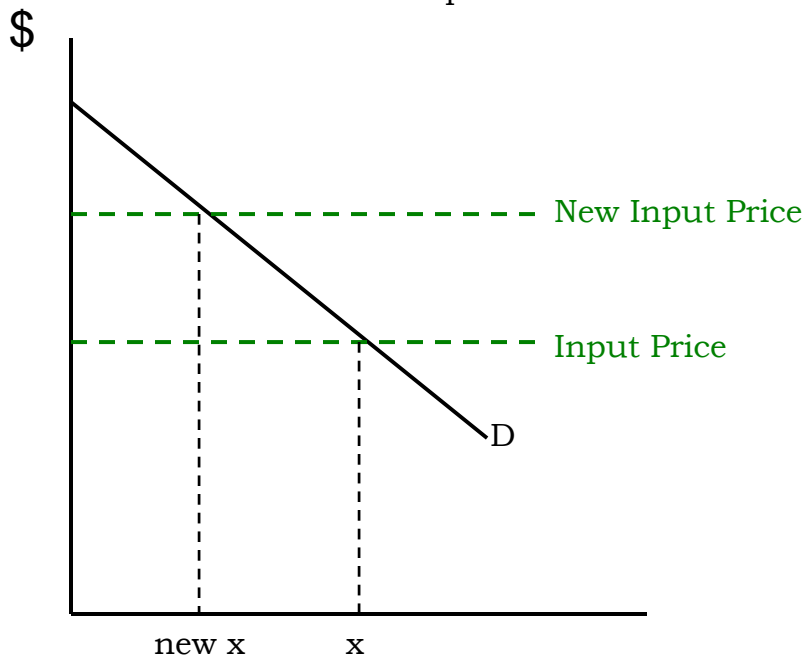


Figure 13.G. Marginal and Average Cost Curves

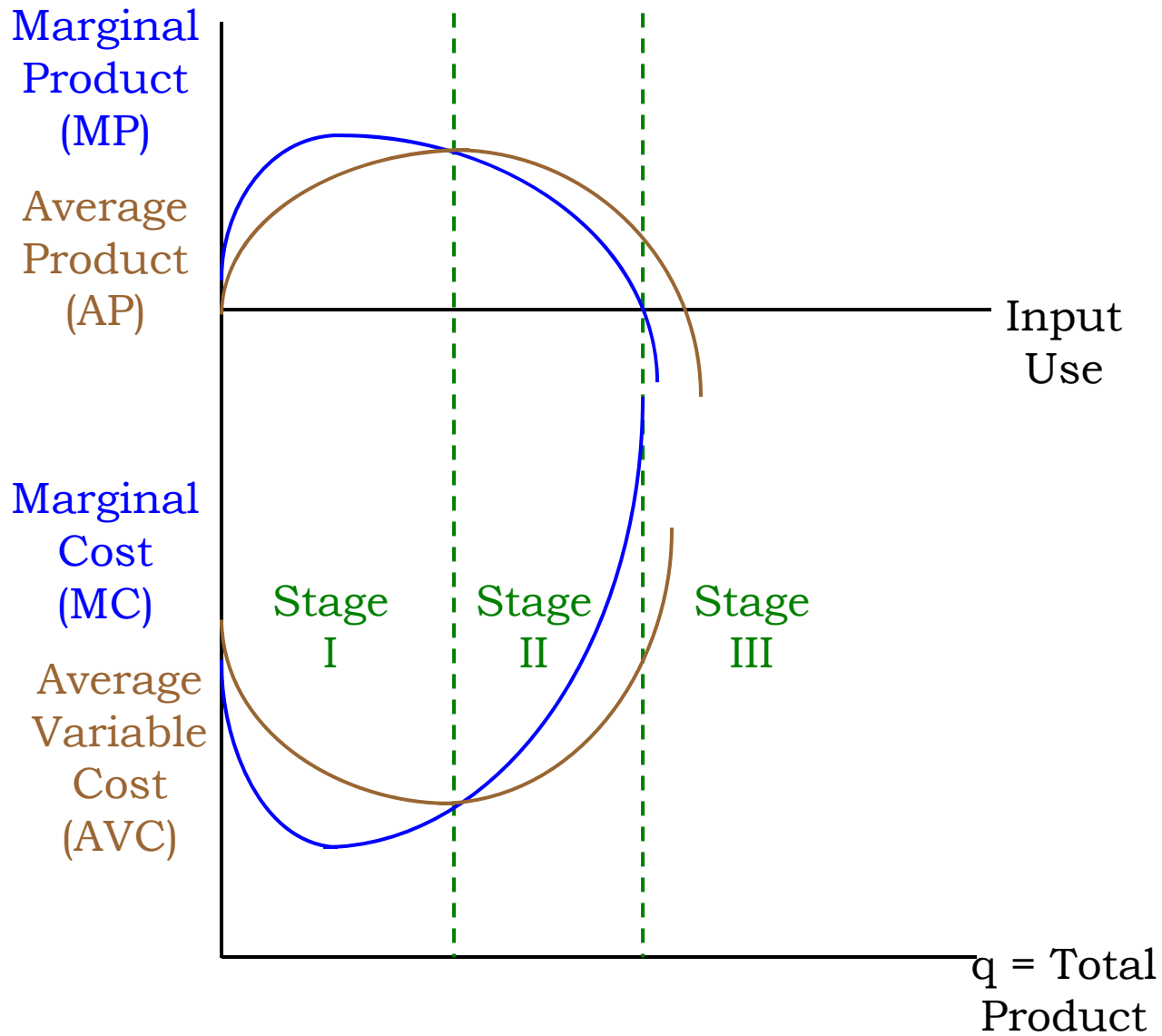


Figure 13.H. Marginal and Average Cost Curves

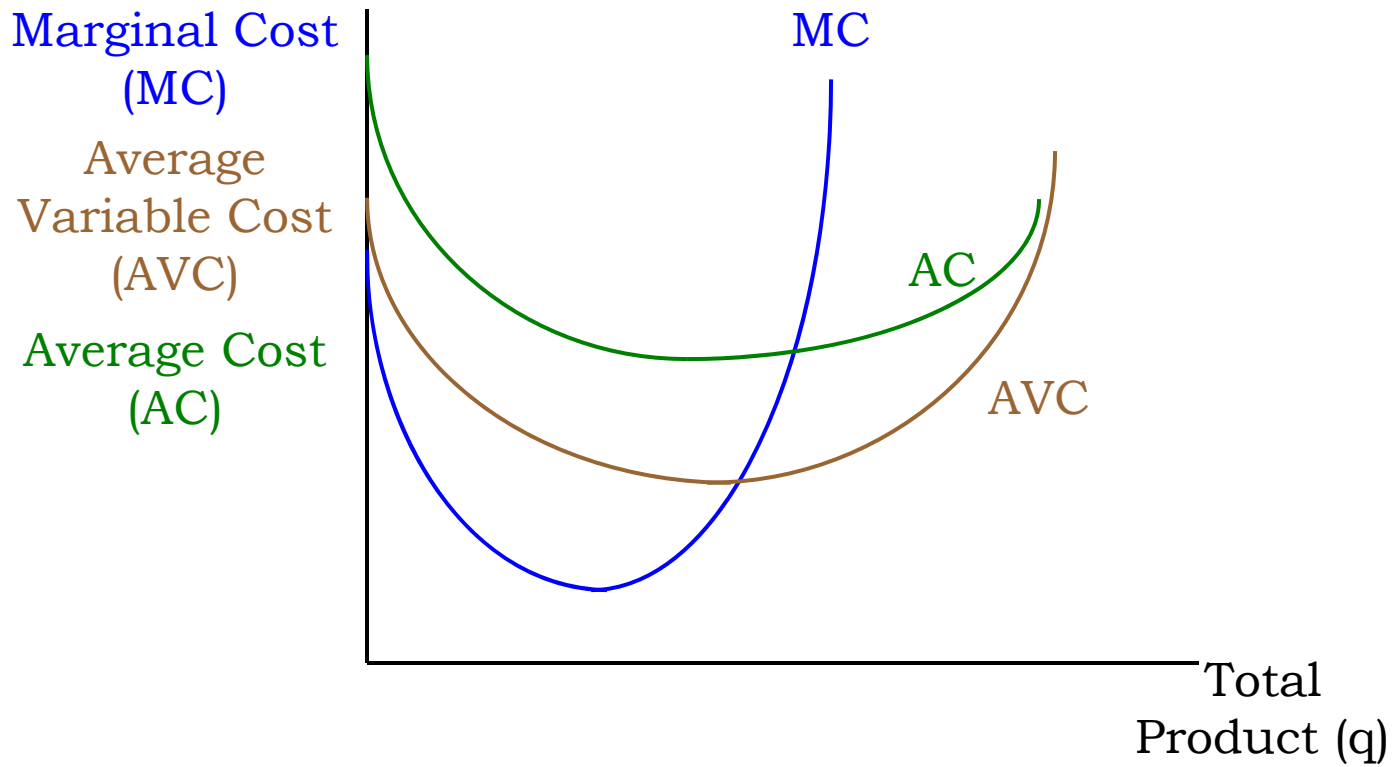


Figure 13.I. Hypothetical Firm (cost per worker = \$10; fixed costs = \$15)

Number of Workers	Total Product (TP)	Variable Costs	Fixed Cost	Total Costs	Marginal Cost	Average Variable Cost	Average Cost
0	0	\$0	\$15	\$15	-----	-----	-----
1	5	\$10	\$15	\$25	$(\$25 - \$15) / \$ (5 - 0) = \2	$\$10 / 5 = \2	\$5
2	20	\$20	\$15	\$35	\$0.66	\$1	\$1.75
3	30	\$30	\$15	\$45	\$1	\$1	\$1.5
4	35	\$40	\$15	\$55	\$2	\$1.14	\$1.57
5	32	\$50	\$15	\$65	-----	\$1.56	\$2.03

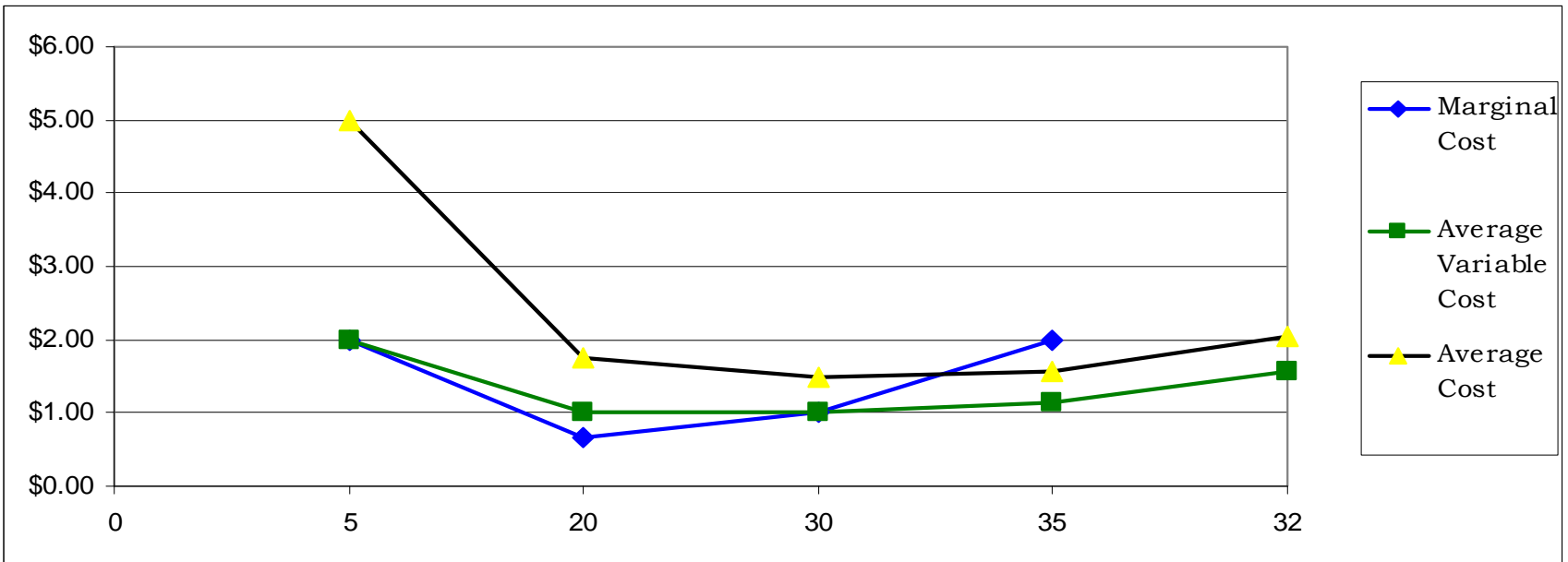
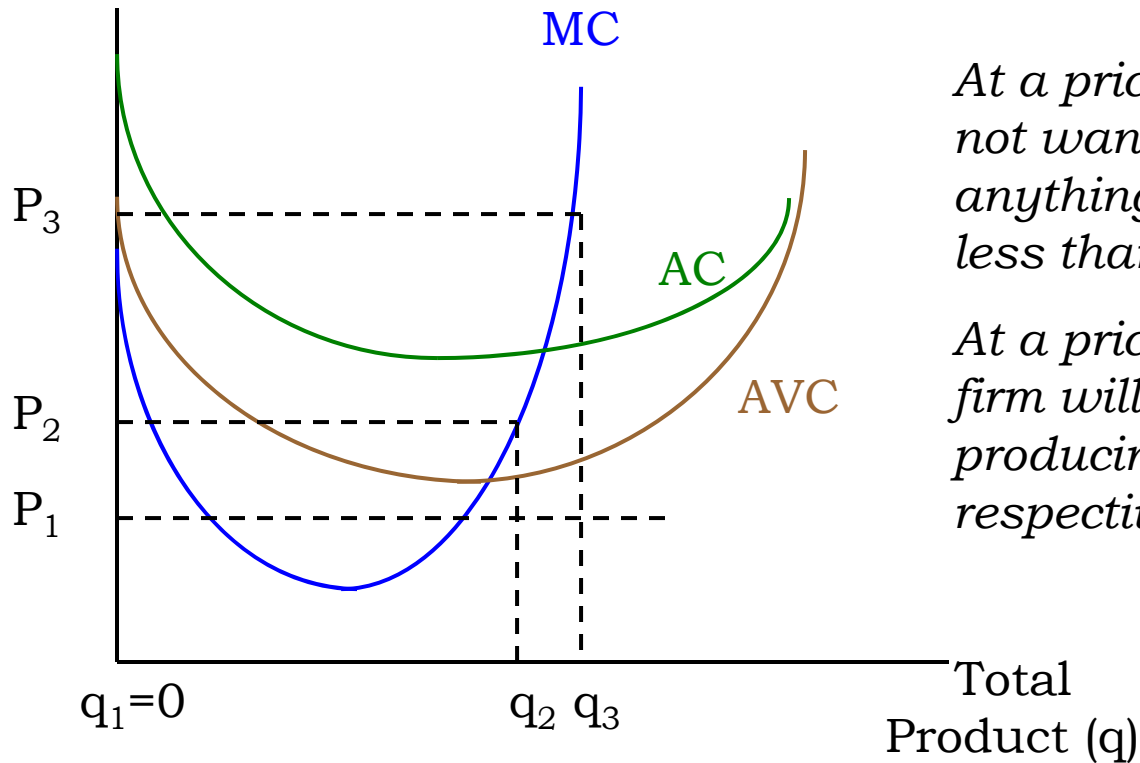


Figure 13.J. The Firm's Production Decision



At a price of P_1 , the firm will not want to produce anything because price is less than AVC .

At a price of P_2 and P_3 , the firm will maximize profits by producing q_2 and q_3 , respectively.

Figure 13.K. Firm Costs in the Long-Run

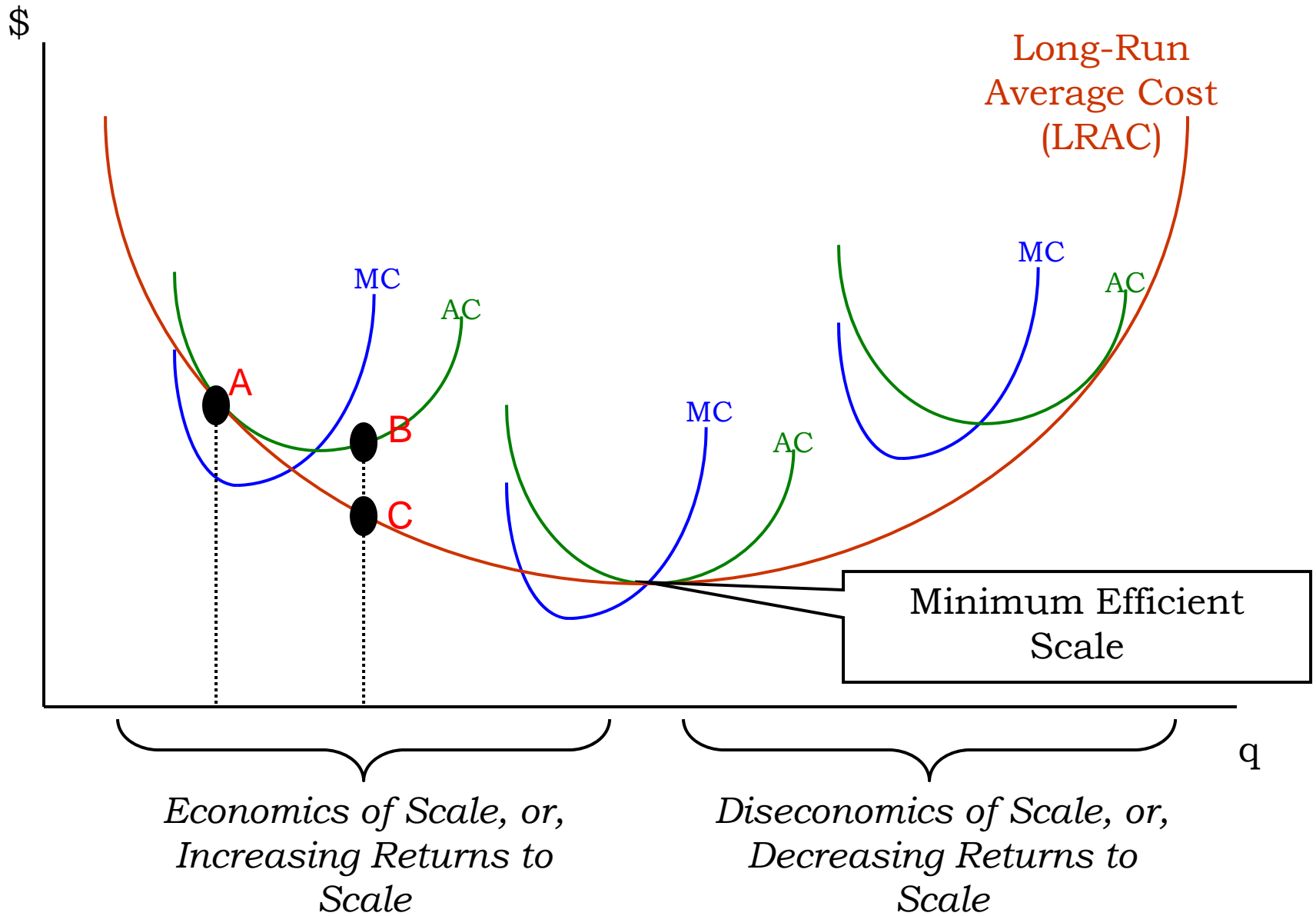


Figure 13.L. Economies of Scale and Number of Brewers in the U.S. Brewing Industry

Year	Minimum Efficient Scale (millions of barrels)	Number of Mass-Producing Brewing Companies
1950	0.1	350
1970	8.0	75
2000	18.0	24

Source: Tremblay and Tremblay