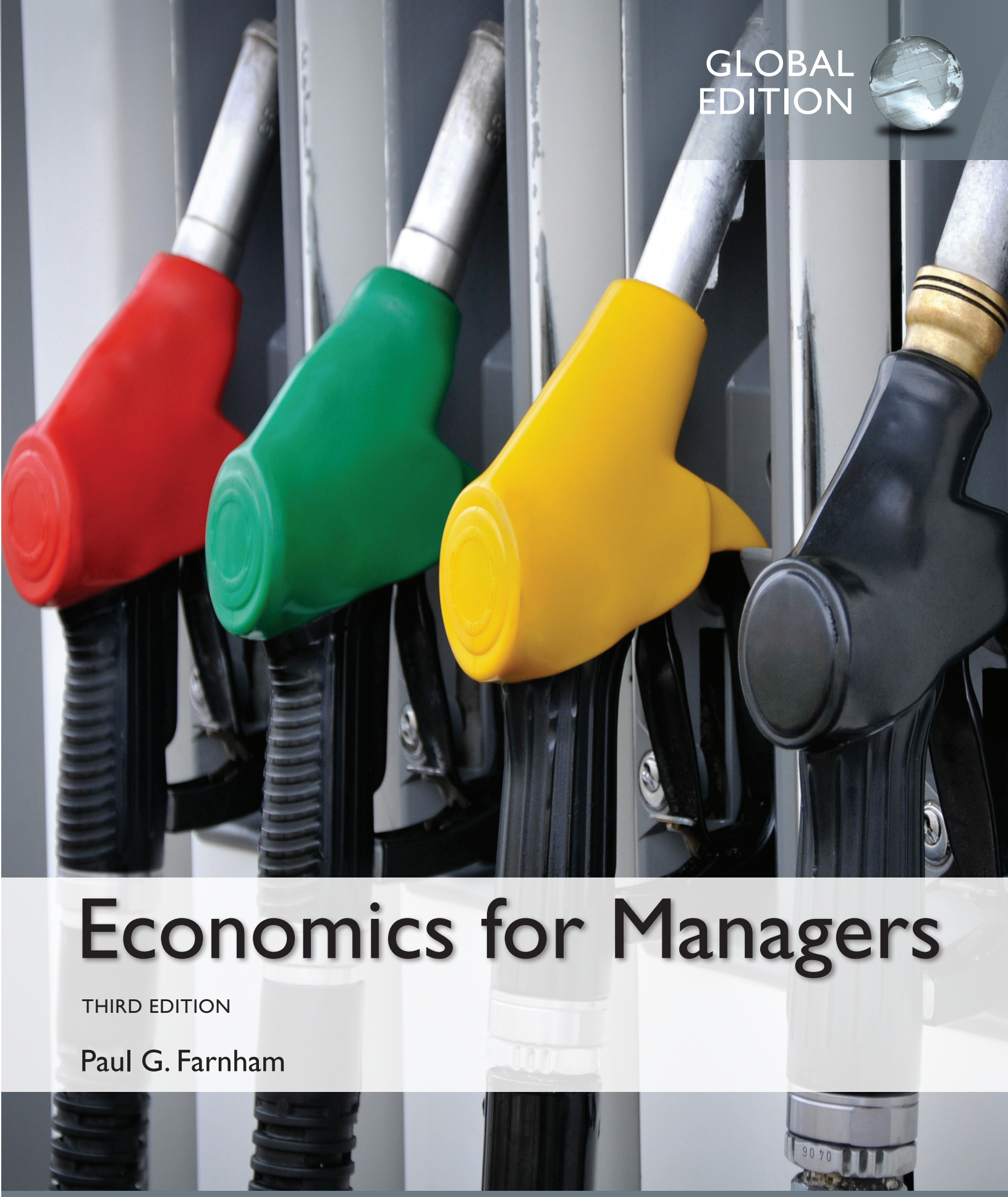

Economics for Managers

THIRD EDITION

Paul G. Farnham

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Economics for Managers

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data. These studies examined data sets where the plant, equipment, and technology were relatively constant over the data period analyzed. Jack Johnston estimated cost functions for British electric generating plants, road passenger transport, and a multiproduct food processing firm. From both his own estimation work and a comprehensive survey of existing studies, Johnston concluded that a constant marginal cost and declining average total cost best characterized the cost-output data for a wide variety of firms.

More recent studies have used much more sophisticated econometric techniques and have estimated cost structures in the context of larger decisions such as inventory management. Analyzing the food, tobacco, apparel, chemical, petroleum, and rubber industries from 1959 to 1984 and the automobile industry from 1966 to 1979, one researcher found evidence for declining marginal costs of production.[31] To determine whether these results were related to the use of industry-level data, this researcher reestimated cost equations for 10 divisions of the automobile industry and still found evidence of declining marginal costs. Other researchers[32] developed elaborate models of firm pricing behavior that are consistent with a constant marginal cost of production.

Survey Results on Cost Functions

Although some early work used a survey or questionnaire approach to make inferences about firms' cost functions, most of the more recent research studies have been econometric analyses. One notable exception is the survey by Alan Blinder and his colleagues at Princeton University in the early 1990s.[33] Blinder and his colleagues drew a sample of 333 firms in the private, unregulated, nonfarm, for-profit sector of the economy, 200 of which participated in the survey.

The researchers asked officials in these companies a series of structured questions designed to test alternative theories about why firms do not change prices regularly in response to changing economic conditions. Although the main goal of the survey was to test hypotheses about price stickiness, the researchers included a number of questions about the firms' cost structures.

Officials in firms responding to the survey reported on average that 44 percent of their costs were fixed and 56 percent were variable. If these results can be generalized to the entire economy, fixed costs appear to be more important to firms than is shown in the standard cost curves of economic theory (see Figure 5.2b). Fixed costs were less important in wholesale and retail trade (mean of 33 percent) and construction and mining (mean of 29 percent) and more important in transportation, communications, and utilities (mean of 53 percent) and services (mean of 56 percent). The researchers found that many executives did not think in terms of fixed versus variable costs. Eighteen executives, or 9 percent of the sample, did not answer the question.

The researchers also had difficulty asking whether marginal cost varied with production because many executives were not familiar with this concept. The researchers had to frame the question in terms of the "variable costs of producing additional units." The researchers often had to repeat, rephrase, or explain the question to executives who did not understand the concept. Even with this effort, 10 interviewees were unable to provide an answer. The responses to this question were quite surprising in light of standard economic theory.

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[31]Valerie A. Ramey, "Nonconvex Costs and the Behavior of Inventories," *Journal of Political Economy* 99 (1991): 306–34.

[32]Robert E. Hall, "Market Structure and Macroeconomic Fluctuations," *Brookings Papers on Economic Activity* 2 (1986): 285–322; Robert E. Hall, "The Relation Between Price and Marginal Cost in U.S. Industry," *Journal of Political Economy* 96 (1988): 921–47.

[33]Alan S. Blinder, Elie R. D. Canetti, David E. Lebow, and Jeremy B. Rudd, *Asking About Prices: A New Approach to Understanding Price Stickiness* (New York: Sage, 1998).

Forty-eight percent of the respondents indicated that their marginal costs were constant, 41 percent said they were decreasing, and only 11 percent responded that their marginal costs were increasing. Although some, if not many, respondents may have confused marginal and average costs and may really have been reporting that their average costs were decreasing, this survey response indicates that business executives do not perceive the textbook U-shaped marginal cost curve to be relevant in many situations.

Constant Versus Rising Marginal Cost Curves

Some of this discrepancy between textbook U-shaped cost curves and real-world constant or declining marginal cost curves can be explained by the fact that economic theory shows the range of possibilities for the cost relationships, not what actually exists in different firms and industries. Econometric estimation based on real-world data and surveys of executives may show constant or declining marginal cost for the range of output that the firm is actually producing. Even if firms are currently producing with constant marginal cost, they will, at some point, reach the capacity of their fixed inputs, which will cause marginal cost to increase.

Another explanation for the discrepancy regarding the shapes of the cost curves relates to the differences between agricultural and manufacturing production.[34] The concept of diminishing returns and rising short-run marginal cost—with its emphasis on the fixed, indivisible factors of production, such as land, and on the variable, divisible factors, such as labor, which change in proportion to the use of the fixed factors—was derived from agricultural settings. That producers experience diminishing returns is very plausible when adding additional amounts of labor, capital equipment, seed, and fertilizer to a fixed amount of land. There is no need to distinguish between the *stock* of the fixed input, land, and the *flow* of services derived from it. The land provides services continuously and is not turned off at night.

However, this model may be less appropriate in manufacturing and industrial settings. Much research has indicated that inputs in these settings are likely to be used in fixed proportions up to the capacity of the plant. Although the stock of a fixed input is fixed, the flow of services from that stock may be varied and combined with the services of a variable input in fixed proportions. The size of a machine may be fixed, but the number of hours it is put in operation can be varied. Both capital and labor *services* are variable in the short run and can be changed together in fixed proportions, thus preventing diminishing returns and rising marginal costs from occurring in many manufacturing operations.

In manufacturing assembly operations, the normal work period of the plant is used to adjust the level of output in the short run. For example, automobile assembly plants use a relatively fixed number of employees per shift and a preset speed for the flow of materials and components through the line. Output can be adjusted by changing the length of existing shifts or adding additional shifts in the face of changing demand. Other assembly operations, such as a collection of sewing machines in clothing manufacturing, are organized around workstations rather than a rigid assembly line. Output is varied in these operations by changing the duration and intensity of the work period at the individual workstations.

[34]This discussion is based on Carol Corrado and John J. Mattey, "Capacity Utilization," *Journal of Economic Perspectives* 11 (1997): 151–67; Richard A. Miller, "Ten Cheaper Spades: Production Theory and Cost Curves in the Short Run," *Journal of Economic Education* 31 (Spring 2000): 119–30; and Richard A. Miller, "Firms' Cost Functions: A Reconstruction," *Review of Industrial Organization* 18 (2001): 183–200.

In continuous processing operations, such as oil refineries, steel mills, cement plants, and paper mills, plants operate nearly 24 hours per day, 7 days per week, given the large shutdown and start-up costs. Output is typically varied by shutting down part or all of the plant. In all of these cases, output is adjusted by increasing or decreasing the amount of capital and labor services in constant proportion so that diminishing returns do not occur and a constant marginal cost can be maintained.

There may be areas other than manufacturing where this type of production technology is applicable. For example, even though the size of a restaurant is fixed, managers may shut down part of the table space, given a lack of demand. Once again, the services of the fixed input are varied even though the stock is constant. These services can then be used in a fixed proportion with other variable inputs, such as labor, to avoid the problem of rising marginal cost.

Implications for Managers

Costs play an important role in determining an effective competitive strategy, particularly if a firm does not have much control over the price of its product. The distinction between fixed and variable costs is important, as is the concept of marginal cost. However, as noted in the survey by Blinder and his colleagues, many executives and managers are not familiar with these concepts. Cost accounting systems often focus more on management, control, and Internal Revenue Service considerations than on concepts useful for decision making. It may also be more difficult for managers to cut costs when firms are profitable than when they are not because it may be less obvious that competitors are catching up.[35]

Lack of knowledge about costs is not a recent phenomenon. Even though Henry Ford pioneered the use of mass production and the assembly line as a cost-cutting measure, he disliked bookkeepers and accountants. Shlomo Maital tells the following story:

> Once, walking into a room, Henry Ford asked an aide what the white-collar workers in the room do. Told they were accountants, he ordered, "I want them all fired. They're not productive, they don't do any real work." The result was chaos, as Arjay Miller (who later became president) discovered. Miller was asked to obtain a monthly estimate of Ford company profits. Doing so required estimates of revenues and costs. Sales projections were fairly straightforward. But Miller was amazed to learn that the Ford Motor Co. estimated its costs by dividing its bills into four piles (small, medium, large, extra-large), guessing at the average sum of the bills in each pile, *then measuring the height of each pile* and multiplying the height in inches by average bill size. The system was not unlike that used 20 years earlier; when piles of bills were not quite so unwieldy, the understaffed accountants had weighed them.[36]

Maital also relates how Akio Morita, the founder of Sony Corp., made a better strategic decision for his company based on his knowledge of the costs of production. In 1955, Morita was trying to market a small, cheap, practical transistor radio in the United States. Several buyers asked for price quotes on 5,000, 10,000, 30,000, 50,000, and 100,000 units. Because Sony's current capacity was less than 1,000 radios per month, Morita knew that the entire production process would have to be expanded to fill these large orders and that this would impact the costs of

[35]This insight is drawn from Maital, *Executive Economics*, 76.
[36]Ibid., 69.

production. Morita essentially drew the economist's U-shaped average cost curve showing that he would charge the regular price for 5,000 units and a discount for 10,000 units, but successively higher prices for 30,000, 50,000, and 100,000 units. These higher prices reflected increased short-run average and marginal costs of production.[37]

Summary

We have discussed and illustrated short-run production and cost in this chapter. The discussion has focused on production functions where there is at least one fixed input. These production functions all eventually incur diminishing returns when increased units of the variable inputs are used relative to the amount of the fixed inputs and the additional amount of output produced begins to decline. Diminishing returns are fundamental to all short-run production processes.

We then illustrated the impact of the production function on the costs of production. Diminishing returns in production cause short-run marginal cost to increase for a producer. We saw how the U-shaped cost curves of economic theory show the full range of outcomes in a production process, but that real-world cost curves may have different shapes. Marginal cost may be constant over a wide range of output as managers take steps to prevent diminishing returns from occurring immediately. We also discussed the concept of opportunity cost, which measures the value of any resource in terms of its next best alternative use. Economists use this concept when discussing cost, and managers should use it for correct decision making. The latter do not always do so, given the problems in correctly measuring opportunity costs.

Later we examine long-run production and cost, where all inputs in a production function are variable. This discussion focuses on input substitution and the shape of the long-run average cost curve. All of these issues are fundamental to the discussion of pricing and other competitive strategies.

Key Terms

accounting profit, p. 157
average fixed cost, p. 159
average product, p. 148
average total cost, p. 159
averaged variable cost, p. 159
cost function, p. 156
economic profit, p. 157
explicit cost, p. 156
fixed input, p. 146
historical cost, p. 157
implicit cost, p. 156
increasing marginal returns, p. 151
law of diminishing marginal returns or law of the diminishing marginal product, p. 151
long-run production function, p. 147
marginal cost, p. 160
marginal product, p. 148
negative marginal returns, p. 151
opportunity cost, p. 156
production function, p. 146
profit, p. 157
short-run cost function, p. 159
short-run production function, p. 147
total cost, p. 159
total fixed cost, p. 159
total product, p. 148
total variable cost, p. 159
variable input, p. 146

[37] Ibid., 66–68.

Exercises

Technical Questions

1. The following table shows data for a simple production function.

Capital (*K*)	Labor (*L*)	Total Product (*TP*)	Average Product (*AP*)	Marginal Product (*MP*)
10	0	0	—	—
10	1	5		
10	2	15		
10	3	30		
10	4	50		
10	5	75		
10	6	85		
10	7	90		
10	8	92		
10	9	92		
10	10	90		

   a. From the information in the table, calculate marginal and average products.
   b. Graph the three functions (put total product on one graph and marginal and average products on another).
   c. For what range of output does this function have diminishing marginal returns?
   d. At what output is average product maximized?

2. The following table shows data for a simple production function.

Capital (*K*)	Labor (*L*)	Total Product (*TP*)	Average Product (*AP*)	Marginal Product (*MP*)
10	0		—	—
10	1			25
10	2			75
10	3			120
10	4			83
10	5			54
10	6			35
10	7			22
10	8			10
10	9			4
10	10			1

   a. From the information in the table, calculate total and average products.
   b. Graph the three functions (put total product on one graph and marginal and average products on another).
   c. For what range of output does this function have diminishing marginal returns?
   d. At what output is average product maximized?

3. Jim is considering quitting his job and using his savings to start a small business. He expects that his costs will consist of a lease on the building, inventory, wages for two workers, electricity, and insurance.
   a. Identify which costs are explicit and which are opportunity (implicit) costs.
   b. Identify which costs are fixed and which are variable.

4. Suppose Marcus is operating a bookstore, and he made zero economic profit last year.
   a. What was Marcus's accounting profit likely to be?
   b. If the implicit costs had increased, what would be the effect on Marcus's economic and accounting profits?

5. The following table shows data for the simple production function used in Question 1. Capital costs this firm $20 per unit, and labor costs $10 per worker.

K	*L*	*TP*	*TFC*	*TVC*	*TC*	*AFC*	*AVC*	*ATC*	*MC*
10	0	0							
10	1	5							
10	2	15							
10	3	30							
10	4	50							
10	5	75							
10	6	85							
10	7	90							
10	8	92							

   a. From the information in the table, calculate total fixed cost (*TFC*), total variable cost (*TVC*), total cost (*TC*), average fixed cost (*AFC*), average variable cost (*AVC*), average total cost (*ATC*), and marginal cost (*MC*).
   b. Graph your results, putting *TFC*, *TVC*, and *TC* on one graph and *AFC*, *AVC*, *ATC*, and *MC* on another.
   c. At what point is average total cost minimized? At what point is average variable cost minimized?

6. The following table shows data for the simple production function used in Question 2. Capital costs this firm $50 per unit, and labor costs $20 per worker.

K	L	MP	TFC	TVC	TC	AFC	AVC	ATC	MC
10	0	—				—			—
10	1	25							
10	2	75							
10	3	120							
10	4	83							
10	5	54							
10	6	35							
10	7	22							
10	8	10							
10	9	4							
10	10	1							

   a. From the information in the table, calculate total fixed cost (*TFC*), total variable cost (*TVC*), total cost (*TC*), average fixed cost (*AFC*), average variable cost (*AVC*), average total cost (*ATC*), and marginal cost (*MC*). (Note that in this case, you are starting from *MP*, not *TP*, and, thus, you should calculate *TP* first if you didn't already do that in Question 2.)
   b. Graph your results, putting *TFC*, *TVC*, and *TC* on one graph and *AVC*, *ATC*, and *MC* on another.
   c. At what point is average total cost minimized? At what point is average variable cost minimized?

7. Consider the shape of the production and cost functions for two different firms.
   a. For Firm 1, workers have constant marginal product. That is, each worker produces exactly the same amount as the previous worker. Use this information to graph the approximate shape of the firm's short-run product and cost curves.
   b. For Firm 2, workers have diminishing marginal returns everywhere. That is, each worker always produces less than the previous worker. Use this information to graph the approximate shape of the firm's short-run product and cost curves.
8. Does an increase in rent lead to the same effect on a firm's average fixed cost (AFC), average variable cost (AVC), average total cost (ATC), and marginal cost (MC) as an increase in wage rates does?
9. Suppose that a firm's only variable input is labor. When 50 workers are used, the average product of labor is 50, and the marginal product of the 50th worker is 75. The wage rate is $80, and the total cost of the fixed input is $500.
   a. What is average variable cost? Show your calculations.
   b. What is marginal cost? Show your calculations.
   c. What is average total cost? Show your calculations.
   d. Is each of the following statements true or false? Explain your answer.
      1. Marginal cost is increasing.
      2. Average variable cost is increasing.
      3. Average total cost is decreasing.

Application Questions

1. In the fast-food industry case that opened this chapter, describe how diminishing returns set in for the production process and how management responded to this situation.
2. In order to promote animal welfare, Taiwan's government has set a minimum standard for free-range eggs. If the egg producers provide each hen an indoor space of no less than 8 square meters, they will receive certification that distinguishes their animal-friendly eggs from other battery-cage eggs.[38]

   Suppose you are an egg producer currently producing battery-cage eggs in Taiwan and decide to start producing free-range eggs next year. In order to provide more space for the hens, you will have to expand your farm.

   a. What will be the effect of expanding the farm on your total, average and marginal costs?
   b. Does your answer in question (a) give you enough information to decide whether to produce free-range eggs next year?

[38] "Taiwan sets standards for humane production of eggs," *WantChinaTimes*, February 11, 2014.