

EXAMINATION #3 VERSION B
“Firms and Competition”
October 27, 2022

INSTRUCTIONS: This exam is closed-book, closed-notes. Calculators, mobile phones, and wireless devices are NOT permitted. Point values for each question are noted in brackets.

I. MULTIPLE CHOICE: Circle the one best answer to each question. Use margins for scratch work [1 pt each—11 pts total]

(1) Suppose a firm produces an output using capital and labor. The increase in output from a one-unit increase in capital input, while holding labor input constant, is called

- a. the marginal product of capital.
- b. the marginal rate of substitution in production of labor for capital.
- c. the average product of capital.
- d. the price of capital.

- a. $q = x_1 + 3x_2$.
- b. $q = x_1 + (1/3)x_2$.
- c. $q = 50 \min\{x_1, 3x_2\}$.
- d. $q = 50 \min\{x_1, (x_2/3)\}$.
- e. $q = 50 x_1 x_2^3$.
- f. $q = 50 x_1 x_2^{1/3}$.

The next two questions refer to the following information. A certain kind of machine can produce 50 units of output per hour if it is operated by 3 workers. Fewer workers cannot operate the machine and extra workers contribute nothing. Let x_1 denote the number of machines in use of this type. Let x_2 denote the number of workers assigned to operate these machines. Let q denote output per hour.

The next two questions refer to the following information. The elasticity of output with respect to labor for the US economy as a whole is about 2/3. The elasticity of output with respect to capital is about 1/3. Suppose labor input increases by 4% and capital input increases by 7%.

(2) The equation for the firm’s expansion path is

- a. $1 = 3$.
- b. $x_1 = (1/3)x_2$.
- c. $x_1 = 3x_2$.
- d. $50 = x_1 + 3x_2$.
- e. $50 = x_1 x_2^3$.

(4) Without any technical change, one would expect output to increase by

- a. 0%.
- b. 1%.
- c. 2%.
- d. 3%.
- e. 4%.
- f. 5%.
- g. 6%.
- h. 7%.

(3) The formula for the firm’s production function is

(5) If in fact output increases by 6%, then the Solow residual (that is, the increase in multifactor productivity) is

- a. 0%.
- b. 1%.
- c. 2%.
- d. 3%.
- e. 4%.
- f. 5%.
- g. 6%.
- h. 7%.

(6) Suppose that at a firm's current level of output, its marginal cost is less than its average cost. Then its average cost curve at this level of output must

- a. slope up.
- b. slope down.
- c. be horizontal.
- d. be vertical.
- e. cannot be determined from information given.

(7) If firms in an industry enjoy *constant returns to scale*, the industry will likely be eventually dominated by

- a. small firms.
- b. large firms.
- c. a mix of small and large firms.
- d. Cannot be determined.

(8) In the short run, a firm should shut down if its revenue falls below its

- a. total cost.
- b. producer surplus.
- c. fixed cost.
- d. variable cost.

(9) *Price equals average cost* in a competitive industry in long-run equilibrium because

- a. business owners have a sense of fairness.
- b. individual firms adjust their output levels using the rule "price equals average cost" to maximize profit.
- c. consumers refuse to pay more than what is reasonable.
- d. positive profits encourage entry of new firms while negative profits encourage existing firms to leave the industry.
- e. the threat of government regulation causes firms to hold prices down.

(10) Suppose there is a change in government policy affecting the automobile industry. Which of the following outcomes would be a *potential Pareto improvement*?

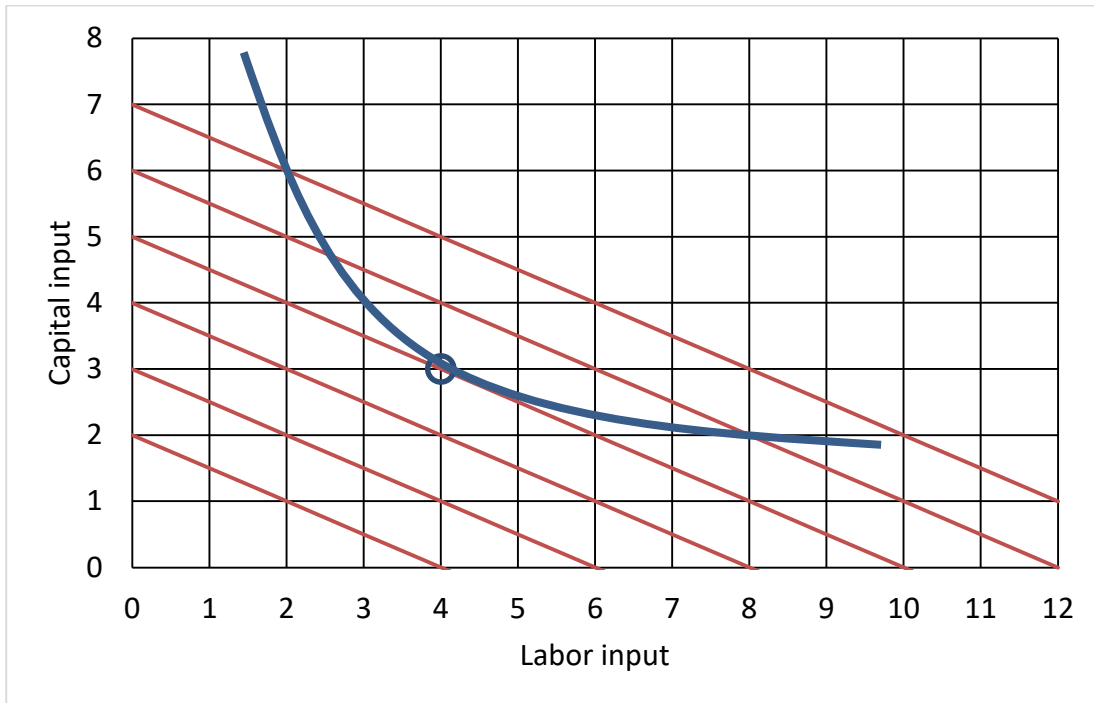
- a. Producers gain \$5 billion while consumers are unaffected.
- b. Producers gain \$5 billion while consumers lose \$10 billion.
- c. Producers gain \$10 billion while consumers lose \$5 billion.
- d. Both (a) and (c).
- e. All of the above.

(11) The price of lawnmowers would decrease if the government enacted a

- a. a quota on sellers of lawnmowers.
- b. a quota on buyers of lawnmowers.
- c. a price floor (or legal minimum price) for lawnmowers.
- d. all of the above.
- e. none of the above.

II. SHORT ANSWER: Please write your answers in the boxes on this question sheet. Use margins for scratch work.

(1) [Cost minimization; Cost in the short run: 10 pts] A firm wants to produce 50 units of output at lowest cost. This firm must pay \$10 per hour for labor and \$20 per hour for capital. The graph below shows the firm's isoquant for 50 units of output per hour and several isocost lines. The small circle marks a tangency.



First, suppose the firm can hire whatever amounts of labor and capital it wants.

- a. How many units of capital will it hire?
- b. How many units of labor will it hire?
- c. Compute the firm's total cost.

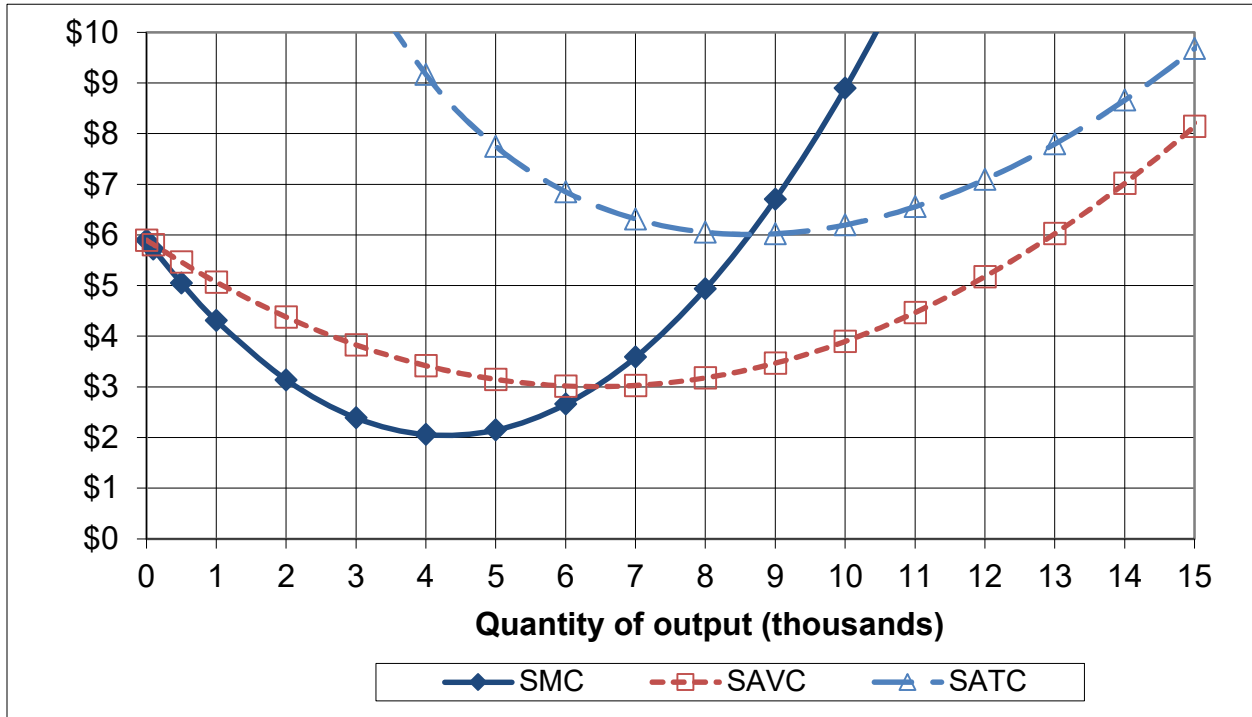
	units
	units
	\$

Alternatively, suppose the firm's capital input is fixed in the short run at 6 units, but the firm's labor input is variable. The firm still wants to produce 50 units of output.

- d. How many units of labor will it hire?
- e. Compute the firm's total cost in the short run.

	units
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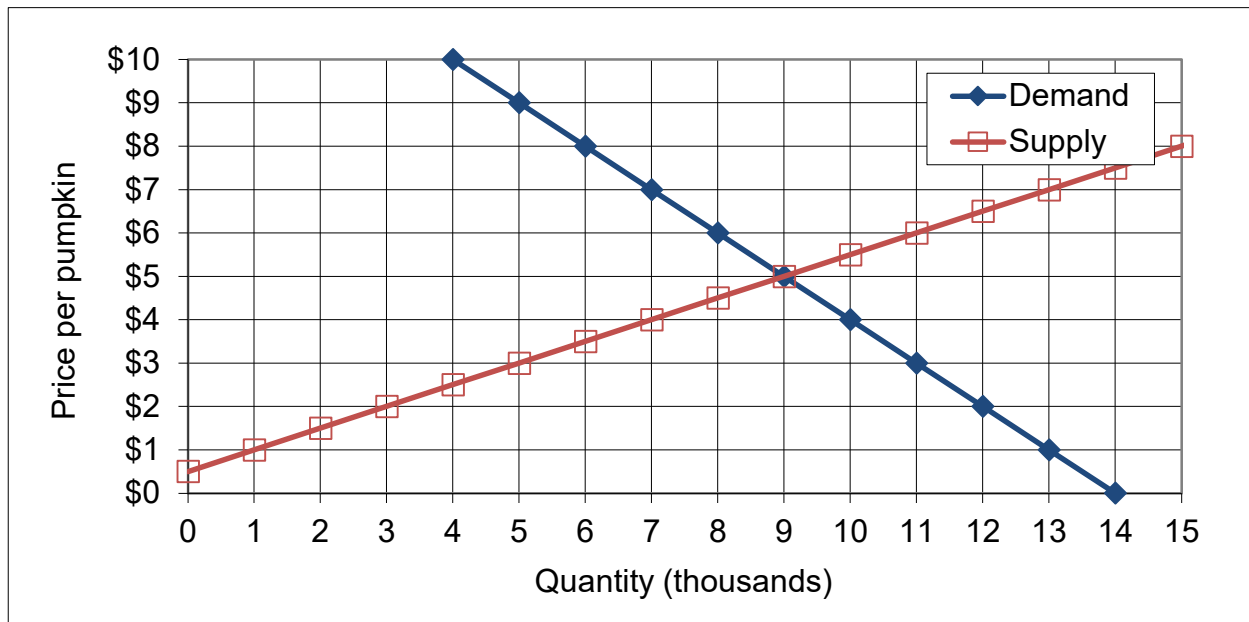
(2) [Profit maximization in the short run: 10 pts] The following graph shows ACME Manufacturing Company's short-run average total cost (SATC), short-run average variable cost (SAVC), and short-run marginal cost (SMC). Assume ACME maximizes its profit while taking the market price as given.



- If the market price is \$9, about how much output will ACME try to produce (to the nearest thousand)?
- If the market price is \$5, about how much output will ACME try to produce (to the nearest thousand)?
- If the market price is \$2, about how much output will ACME try to produce (to the nearest thousand)?
- What is ACME's *breakeven price*—that is, the lowest price at which ACME can produce output without making losses in the short run?
- What is ACME's *shutdown price*—that is, the lowest price at which ACME will continue to operate in the short run?

thousand
thousand
thousand
\$
\$

(3) [Welfare analysis of taxes and subsidies: 20 pts] The following graph shows the market for watermelons.



a. Find the equilibrium price without government intervention.

\$

Suppose the government imposes a **tax of \$ 6** per watermelon.

b. Compute the equilibrium quantity sold.

thousand

c. Compute the equilibrium total price paid by buyers (including the tax).

\$	per watermelon
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d. Compute the equilibrium net price received by sellers (excluding the tax).

\$	per watermelon
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e. Does producer surplus *increase, decrease, or remain constant* because of the tax?

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f. By how much?

\$	thousand
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g. Does consumer surplus *increase, decrease, or remain constant* because of the tax?

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h. By how much?

\$	thousand
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i. Compute the total tax revenue collected by the government.

\$	thousand
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j. Compute the deadweight social loss caused by the tax.

\$	thousand
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III. PROBLEMS: Please write your answers in the boxes on this question sheet. Show your work and circle your final answers.

(1) [Input substitution; Returns to scale: 12 pts] Suppose a production function is given by

$$q = 6x_1 + 3x_2 - 2.$$

- a. Find an expression for the marginal product of input 1. Are there diminishing returns to input 1? Justify your answer.

- b. Find an expression in terms of x_1 and x_2 for the marginal rate of substitution in production of input 2 for input 1—that is, the absolute value of the slope of an isoquant, with x_1 on the vertical axis and x_2 on the horizontal axis. Does production show a diminishing marginal rate of substitution? Justify your answer.

- c. Does this production function have *constant* returns to scale, *increasing* returns to scale, or *decreasing* returns to scale? Justify your answer.

(2) [Cost minimization: 10 pts] Suppose a firm wishes to produce 60 units of output per hour at minimum cost. The firm's hourly production function is given by $q = 10 x_1^{1/2} x_2^{1/2}$, where x_1 denotes the number of machines and x_2 denotes the number of workers. Machines cost \$20 per hour to rent and workers must be paid \$5 per hour.

- a. Give an equation for the firm's target isoquant. The variables x_1 and x_2 should be the only unknowns.

- b. Find a formula for the firm's marginal rate of substitution in production of workers for machines—that is, the slope of the firm's isoquant with machines on the vertical axis and workers on the horizontal axis. The variables x_1 and x_2 should be the only unknowns. Circle your final answer.

- c. [4 pts] Solve for the number of machines (x_1^*) and workers (x_2^*) required to produce the firm's target output at minimum cost. Circle your final answers.

- d. Compute the total cost to produce 60 units of output, $TC(60)$.

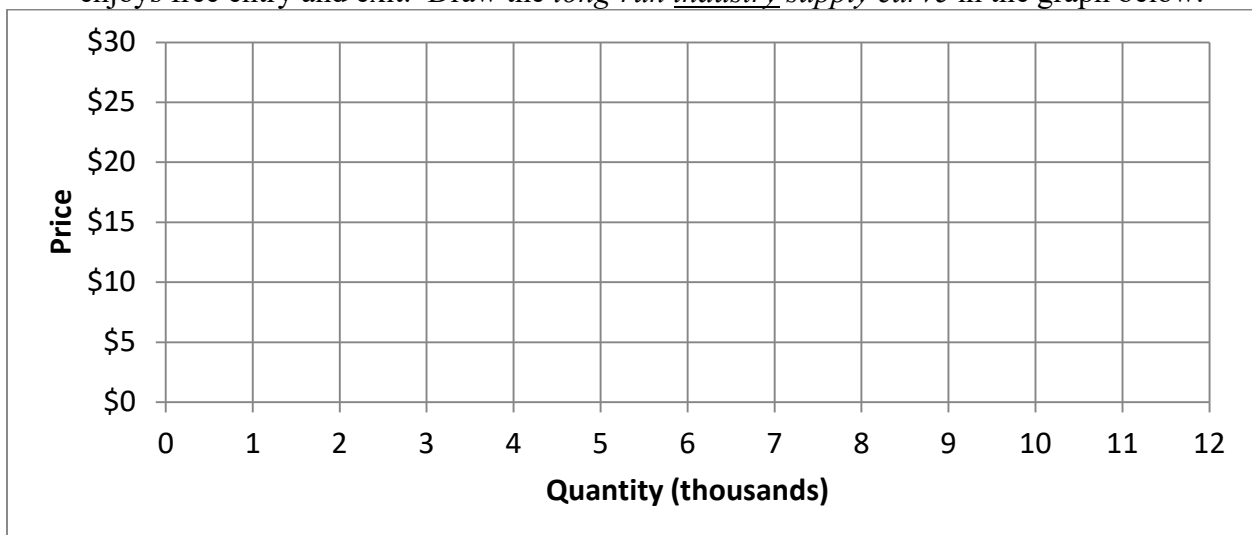
(3) [Cost curves; Long-run market equilibrium: 8 pts] Suppose a typical firm faces a (long-run) total cost function given by $TC(q) = 0.01 q^3 - q^2 + 40 q$.

a. Compute the typical firm's efficient scale q_{ES} . Show your work and circle your final answer.

b. Compute the firm's breakeven price—the minimum price at which it will avoid losses. Show your work and circle your final answer.

c. Describe with equations the *firm's supply curve*. [Hint: What happens when the market price is above the breakeven price? When the market price is below the breakeven price?]

d. Suppose all firms in this industry have the same costs, and these costs are not affected by other firms in the same industry or by total industry output. Further assume the industry enjoys free entry and exit. Draw the *long-run industry supply curve* in the graph below.



(4) [Welfare analysis of international trade: 15 pts] Suppose domestic demand and supply for a good are given by the following equations. (Use the graph at right for scratch work.)

Demand: $Q_D = 80 - 10 P$

Supply: $Q_S = 20 P - 10$



First consider the domestic market without international trade.

- a. Compute the equilibrium price and quantity without international trade.

Now suppose the market is opened to international trade, and the world price turns out to be \$2 .

- b. Does the country *import* or *export* this good? How much?

c. Does consumer surplus *increase* or *decrease* as a result of international trade? By how much?

d. Does producer surplus *increase* or *decrease* as a result of international trade? By how much?

e. Does the country as a whole (consumers plus producers) *gain* or *lose* as a result of international trade? By how much?

IV. CRITICAL THINKING: Answer just *one* of the questions below (your choice). [4 pts]

(1) Suppose a competitive producer wants to maximize profit. Should it choose a level of output where average cost is lowest, regardless of price? Why or why not? Illustrate your answer with a graph of the producer's cost curves. Label all axes and curves.

(2) Suppose a tax of \$3 is placed on calculators, and as a consequence, the number of calculators sold falls from 20 million to 16 million. Does the country's overall welfare *increase* or *decrease* as a result of this change? By how much? Sketch a graph, labeling all axes and curves. Show your work and circle your final answer.

Circle the question you are answering and write your answer below. Full credit requires good grammar, legible writing, accurate spelling, and correct reasoning.



[end of exam]