ECON 173 - Intermediate Microeconomic Analysis
Drake University, Fall 2025
William M. Boal

EXAMINATION 3 ANSWER KEY
"Firms and Competition"

Version A

I. Multiple choice

(1)b. (2)b. (3)c. (4)b. (5)c. (6)a. (7)c. (8)d. (9)a. (10)b.
(11)b. (12)b. (13)d. (14)a. (15)c. (16)b.

II. Short answer

(1) a. 7 percent. b. 1 percent.

(2) a. 4 units. b. 6 units. c. $240.
d. 12 units. c. $300.

(3) a. 0 thousand (because price is below shutdown price).
b. 10 thousand (using rule P=MC to find q).
c. 7 thousand (using rule P=MC to find q).
d. $8 (because breakeven price = min(SATC)).
e. $2 (because shutdown price = min(SAVC)).

(4) a. import. b. 4 million. c. increase.
d. $7 million. e. decrease. f. $5 million.
g. increase. h. $2 million.

III. Problems

(1) [Input substitution; Returns to scale]

a. $MP_1 = 2\,x_1^{-1/3} x_w^{2/3}$. YES, there are diminishing returns to input 1, because as x_1 increases (and x_2 is held constant), MP_1 decreases.

b. $MRSP = \frac{MP_2}{MP_1} = \frac{2\,x_1^{2/3}\,x_2^{-1/3}}{2\,x_1^{-1/3}\,x_2^{2/3}} = \frac{x_1}{x_2}$. YES, this function has diminishing MRSP, because as x_1 decreases and x_2 increases, the numerator decreases and the denominator increases. Therefore, MRSP decreases.

c. Check returns to scale:

$f(ax_1, ax_2) = 3\,(a\,x_1)^{2/3}(a\,x_2)^{2/3} = a^{2/3}\,a^{2/3}\;3\,x_1^{2/3}\,x_2^{2/3}$

$= a^{4/3}\;\; q > a\,q$, for all a>1.

Thus, multiplying all inputs by the same factor (a) causes output to increase by a larger factor. So, this production function has INCREASING returns to scale.

(2) [Cost minimization]

a. Equation for isoquant: $30 = 2\,x_1^{1/2}\,x_2^{1/2}$ *or* $15 = x_1^{1/2}\,x_2^{1/2}$ *or* $225 = x_1\,x_2$.

b. $MRSP = MP_2/MP_1 = \frac{x_1^{1/2}\,x_2^{-1/2}}{x_1^{-1/2}\,x_2^{1/2}} = \frac{x_1}{x_2}$.

c. Set MRSP = w_2/w_1 = \$10/\$90 (the tangency condition) and solve jointly with $15 = x_1^{1/2}\,x_2^{1/2}$ (the isoquant) to get $x_1^*=5$ and $x_2^*=45$.

d. TC(50) = 5×\$90 + 45×\$10 = \$900.

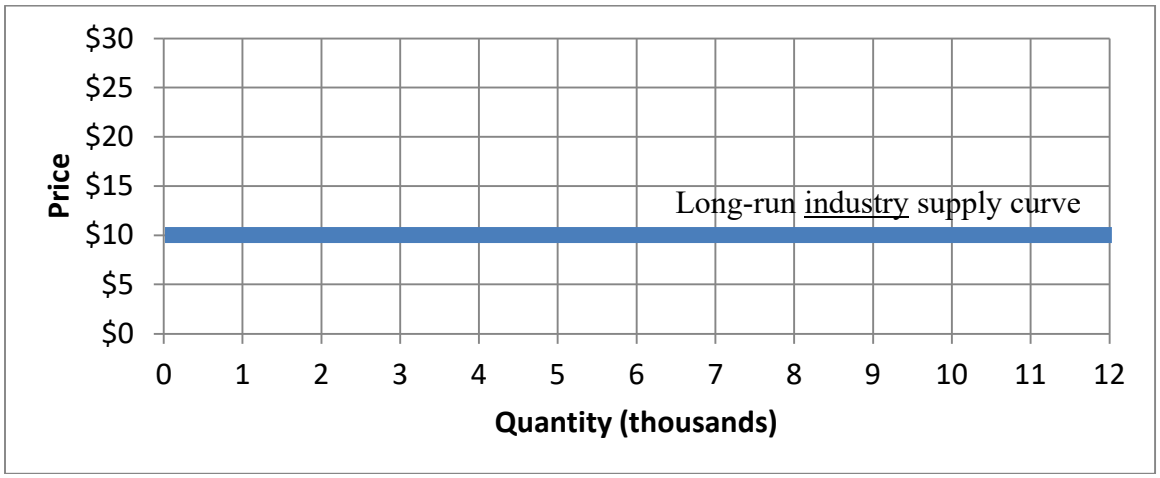
(3) [Cost curves; Long-run market equilibrium]

a. AC = TC/q = 0.01 q^2 – 0.8 q + 26.
Set 0 = dAC/dq = 0.02 q – 0.8 and solve to get q_{ES} = 40.

b. Breakeven price = minimum AC = AC(q_{ES}) = \$10.

c. A firm's supply curve shows how much the firm will produce for any given price. If P>minimum average cost, the profit-maximizing firm will choose an output level where P=MC(q), and if P<minimum average cost, it will produce nothing. So, this firm's supply curve is given by the following equations.
If P≥\$10, P = MC(q) = dTC/dq = 0.03 q^2 – 1.6 q + 26.
If P≤\$10, q = 0 (firm shuts down).

d. The long-run industry supply curve is a horizontal line at minimum AC:



(4) [Welfare effects of tax or subsidy]

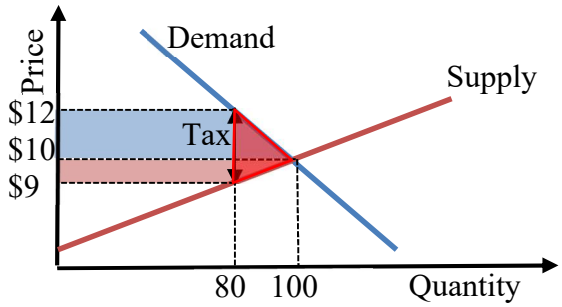
a. Set $P_D = P_S$ and solve to get P* = \$10 and Q* = 100.

b. With an excise tax of \$3, $P_D = P_S + 3$. Substituting and solving gives Q = 80. It is useful to also compute the new total price paid by buyers, including the tax (P_D = \$12), and the new net price received by sellers, excluding the tax (P_S = \$9).

c. Consumer surplus decreases by \$180, the area of the trapezoid between \$12 and \$10.

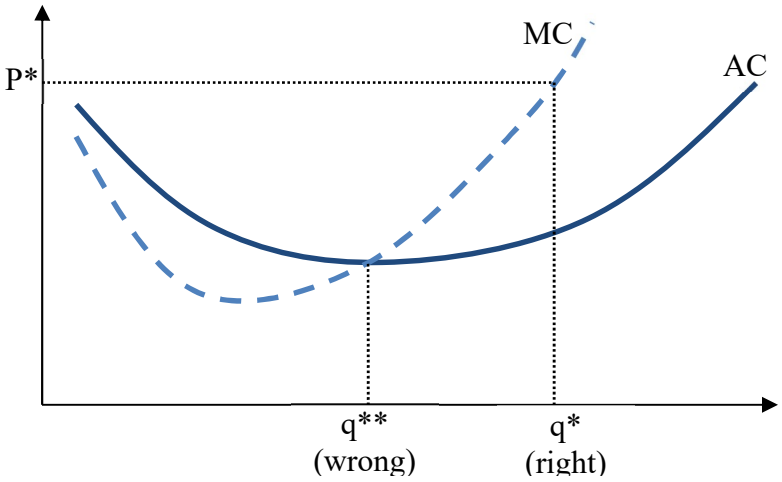
d. Producer surplus decreases by \$90, the area of the trapezoid between \$10 and \$9.

e. Although the government collects \$3×80=\$240 in tax revenue, this is less than the combined decreases of consumer and producer surplus. The loss to society as a whole (also called "deadweight loss" or "excess burden of the tax") is \$30, the area of the red triangle in the graph below.

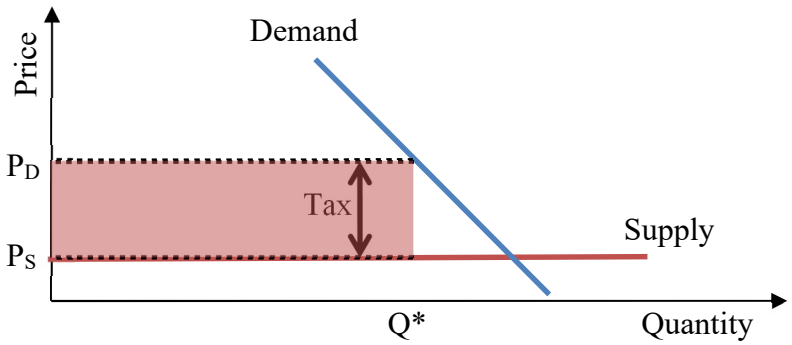


IV. Critical thinking

(1) [The following answer uses a long-run framework, where there are no fixed costs. A similar answer in a short-run framework would be acceptable.] Profit is maximized when the firm operates at the output level where *market price equals marginal cost*, provided price is greater than minimum average cost. (If price is less than average cost, total profit is maximized when the output level is zero.) Thus, the total-profit-maximizing level of output *depends on the market price*. In general, the two output levels will be different, as shown in the graph below. Here, P* is the market price, q* is the output level that maximizes total profit, and q** is the output level where average cost is lowest.



(2) To find the burden of a tax, first find the quantity traded. After a tax is imposed, the quantity traded is where the demand curve is higher than the supply curve by the amount of the tax. If supply is *perfectly elastic* (horizontal) then there is no change in the price received by the sellers (P_S) as a result of the tax. Instead, the buyers pay all of the tax. That is, the tax causes the buyers' price (P_D) to rise by the amount of the tax. Similarly, producer surplus is zero both before and after the tax, but there is a loss of consumer surplus. So, in this special case, buyers bear the entire burden of the tax, as shown in the graph below.



Version B

I. Multiple choice

(1)d. (2)c. (3)a. (4)d. (5)d. (6)c. (7)a. (8)b. (9)b. (10)a.
(11)b. (12)a. (13)a. (14)b. (15)d. (16)a.

II. Short answer

(1) a. 5 percent. b. 3 percent.

(2) a. 4 units. b. 6 units. c. \$240.
d. 3 units. c. \$300.

(3) a. 0 thousand (because price is below shutdown price).
b. 10 thousand (using rule P=MC to find q).
c. 11 thousand (using rule P=MC to find q).
d. \$6 (because breakeven price = min(SATC)).
e. \$3 (because shutdown price = min(SAVC)).

(4) a. export. b.8 million. c. decrease.
d. \$8 million. e. increase. f. \$16 million.
g. increase. h. \$8 million.

III. Problems

(1) [Input substitution; returns to scale]

a. $MP_1 = 2\,x_1^{-1/3}$. YES, there are diminishing returns to input 1, because as x_1 increases (and x_2 is held constant), MP_1 decreases.

b. $MRSP = \frac{MP_2}{MP_1} = \frac{(2/3)\,x_2^{-1/3}\,x_2^{-1/4}}{2\,x_1^{-1/3}} = \frac{x_1^{1/3}}{3\,x_2^{1/3}}$. YES, this function has diminishing MRSP, because as x_1 decreases and x_2 increases, the numerator decreases and the denominator increases. Therefore, MRSP decreases.

c. Check returns to scale:

$f(ax_1, ax_2) = 3\,(a\,x_1)^{2/3} + (a\,x_2)^{2/3} = 3\,a^{2/3}\,x_1^{2/3} + a^{2/3}\,x_2^{2/3}$
$= a^{2/3}\left(3\,x_1^{2/3} + x_2^{2/3}\right) = a^{2/3}\,q < a\,q$, for all a>1.

Thus, multiplying all inputs by the same factor (a) causes output to increase by a smaller factor. So, this production function has DECREASING returns to scale.

(2) [Cost minimization]

a. Equation for isoquant: $100 = 10\, x_1^{1/2}\, x_2^{1/2}$ *or* $10 = x_1^{1/2}\, x_2^{1/2}$ *or* $100 = x_1\, x_2$.

b. $MRSP = MP_2/MP_1 = \frac{5\, x_1^{1/2}\, x_2^{-1/2}}{5\, x_1^{-1/2}\, x_2^{1/2}} = x_1/x_2$.

c. Set MRSP = w_2/w_1 = \$10/\$40 (the tangency condition) and solve jointly with equation for isoquant to get x_1*=5 and x_2*=20.

d. TC(100) = 5×\$40 + 20×\$10 = \$400.

(3) [Cost curves; Long-run market equilibrium]

a. AC = TC/q = 0.01 q^2 – q + 40.

Set 0 = dAC/dq = 0.02 q – 1 and solve to get q_{ES} = 50.

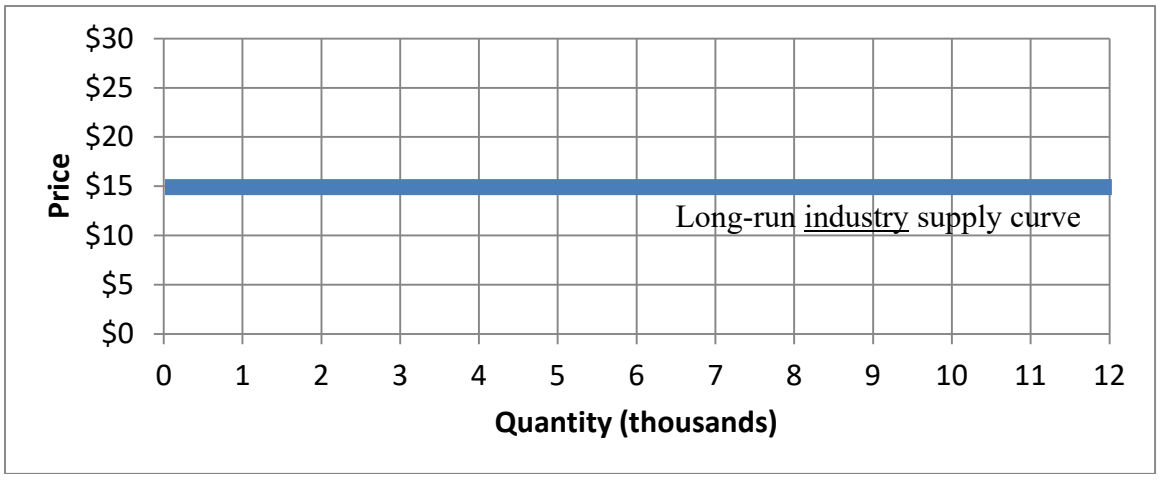
b. Breakeven price = minimum AC = AC(q_{ES}) = \$15.

c. A firm's supply curve shows how much the firm will produce for any given price. If P>minimum average cost, the profit-maximizing firm will choose an output level where P=MC(q), and if P<minimum average cost, it will produce nothing. So, this firm's supply curve is given by the following equations.

If P≥\$15, P = MC(q) = dTC/dq = 0.15 q^2 – 2 q + 20.

If P≤\$15, q = 0 (firm shuts down).

d. The long-run industry supply curve is a horizontal line at minimum AC:



(4) [Welfare effects of tax or subsidy]

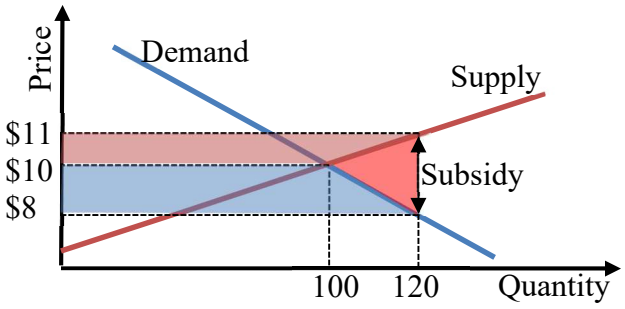
a. Set $P_D = P_S$ and solve to get P* = \$10 and Q* = 100.

b. With subsidy of \$3, $P_D + 3 = P_S$. Substituting and solving gives Q = 120. It is useful to also compute the new net price paid by buyers, excluding the subsidy (P_D = \$8), and the new total price received by sellers, including the subsidy (P_S = \$11).

c. Consumer surplus *increases* by \$220, the area of the trapezoid between \$10 and \$8.

d. Producer surplus increases by \$110, the area of the trapezoid between \$11 and \$10.

e. The government pays \$3×120=\$360 in direct cost, but this is greater than the combined increases of consumer and producer surplus. The loss to society as a whole (also called "deadweight loss") is \$30, the area of the red triangle in the graph below.



IV. Critical thinking
(Same as Version A above.)

[end of answer key]