ECON 173 - Intermediate Microeconomic Analysis
Drake University, Fall 2021
William M. Boal

EXAMINATION #3 ANSWER KEY
"Firms and Competition"

Version A

I. Multiple choice

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

II. Short answer

(1) a. 4%. b. 3%.

(2) a. 0 thousand (because price is below shutdown price).
b. 11 thousand (using rule P=MC to find q).
c. 8 thousand (using rule P=MC to find q).
d. \$6 (because breakeven price = min(SATC)).
e. \$2 (because shutdown price = min(SAVC)).

(3) a. import. b. 6 million pounds. c. increase.
d. \$14 million. e. decrease. f. \$8 million.
g. increase. h. \$6 million.

III. Problems

(1) [Production functions]

a. $MP_1 = 6\, x_1^{-1/4}$. Yes, there are diminishing returns to input 1, because as x_1 increases (and x_2 is held constant), MP_1 decreases.

b. $MRSP = MP_2/MP_1 = \frac{(3/4)\, x_2^{-1/4}}{6\, x_1^{-1/4}} = \frac{1}{8}\left(\frac{x_1}{x_2}\right)^{1/4}$. Yes, this function does have diminishing MRSP, because as x_1 decreases and x_2 increases, MRSP diminishes.

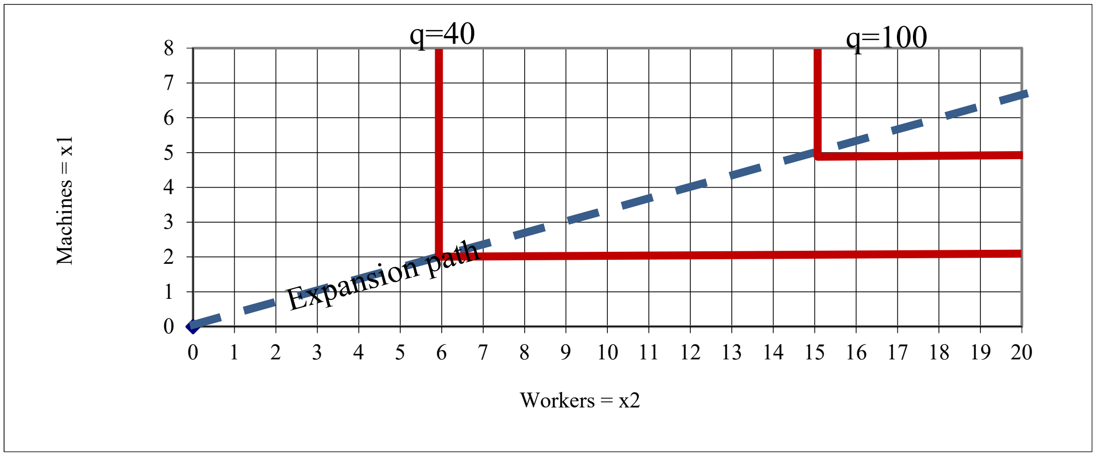
c. Check returns to scale:

$f(ax_1, ax_2) = 8\,(ax_1)^{3/4} + (ax_2)^{3/4} = 8\, a^{3/4}\, {x_1}^{3/4} + a^{3/4}\, {x_2}^{3/4}$
$= a^{3/4}\left(8\, {x_1}^{3/4} + {x_2}^{3/4}\right) = a^{3/4} q < aq$, 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) [Fixed-proportions technology]

a. $x_1 = (x_2/3)$. b. $q = 20\, x_1$. c. $q = (20/3)\, x_2$.
d. $q = \min\{20\, x_1, (20/3)\, x_2\}$.
e.



(3) [Cost minimization]

a. Equation for isoquant: $60 = 4\,x_1^{1/2}\,x_2^{1/2}$ or $15 = x_1^{1/2}\,x_2^{1/2}$ or $225 = x_1 x_2$.

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

c. Set MRSP = \$18/\$2 and solve jointly with $60 = 4\,x_1^{1/2}\,x_2^{1/2}$, to get x_1*=45 and x_2*=5.

d. TC(60) = 45×\$2 + 5×\$18 = \$180.

(4) [Long-run profit maximization and supply]

a. AC = TC/q = 0.01 q^2 – q + 35.

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

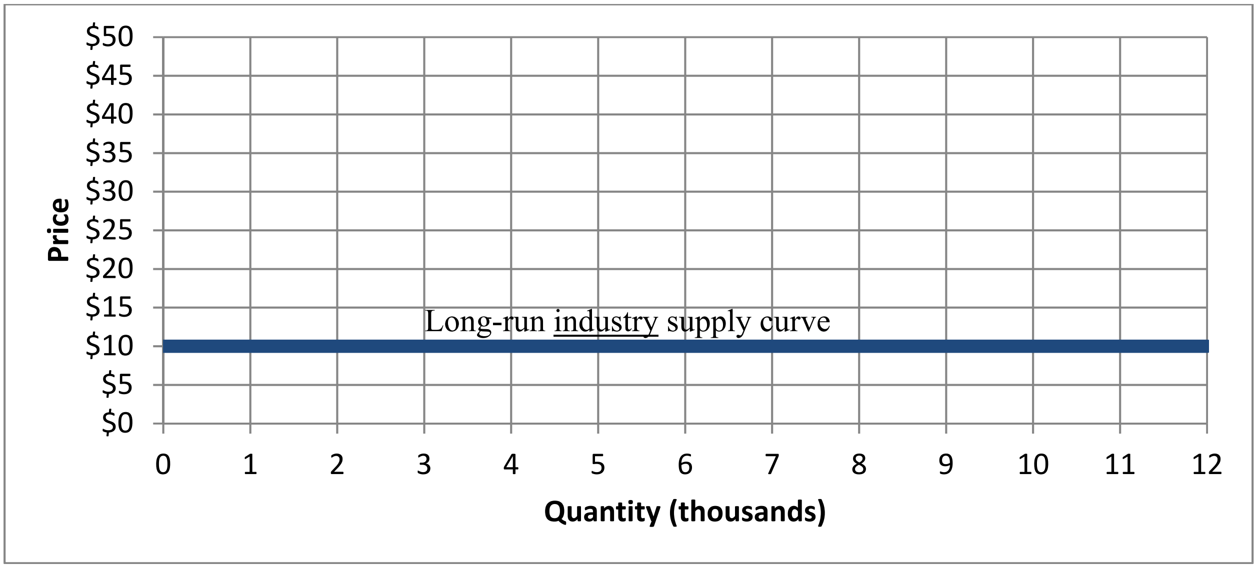
b. Breakeven price = minimum AC = AC(q_{ES}) = \$10.

c. A supply curve shows how much will be produced 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 the firm's supply curve is given by the following equations.

If P≥\$10, P = MC(q) = dTC/dq = 0.03 q^2 – 2 q + 35.

If P≤\$10, q=0 (firm shuts down).

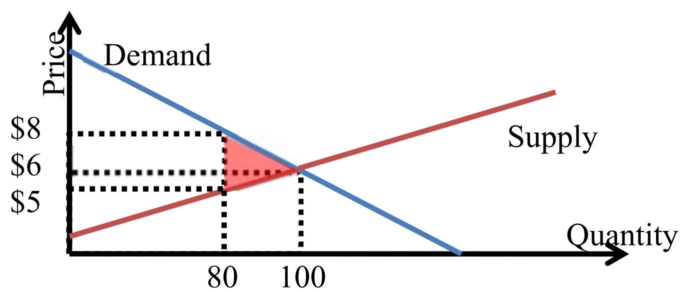
d. The long-run industry supply curve is a horizontal line at minimum AC:



(5) [Welfare effects of tax or subsidy]

a. Set $P_D = P_S$ and solve to get $P^* = \$6$ 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 ($P_D = \$8$), and the new net price received by sellers, excluding the tax ($P_S = \$5$).



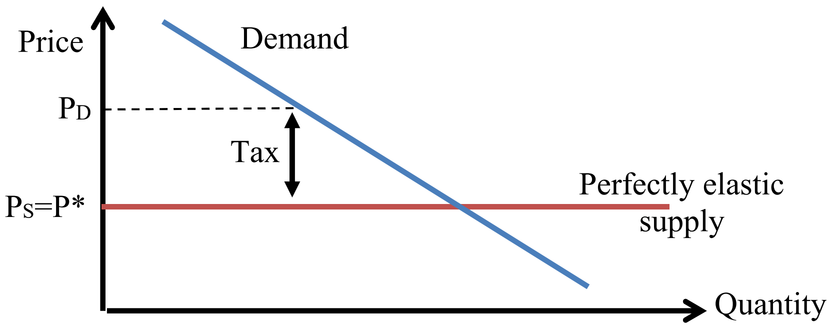
c. Consumer surplus decreases by \$180, the area of the trapezoid between \$6 and \$8.

d. Producer surplus decreases by \$90, the area of the trapezoid between \$6 and \$5.

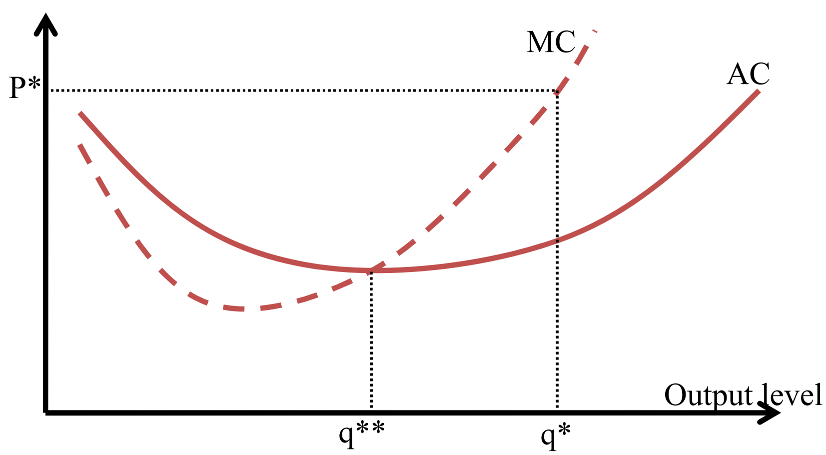
e. Although the government collects \$3×80=\$240 in tax revenue, this is less than the combined decreases of consumer and producer surplus. The loss to society as a whole (also called "deadweight loss" or "excess burden of the tax") is \$30.

IV. Critical thinking

(1) If supply is perfectly elastic (horizontal) then only buyers bear the burden of the tax. The tax inserts a wedge between demand and supply, but only the buyers' price (P_D) moves. The sellers' price (P_S) remains the same as before the tax.



(2) [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.] It is true that *per-unit profit* is maximized when the firm operates at the output level where average cost is lowest. However *total 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.



Version B

I. Multiple choice

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

II. Short answer

(1) a. 3%. b. 4%.

(2) a. 7 thousand (using rule P=MC to find q).
b. 9 thousand (using rule P=MC to find q).
c. 0 thousand (because price is below shutdown price).
d. $7 (because breakeven price = min(SATC)).
e. $4 (because shutdown price = min(SAVC)).

(3) a. export. b. 6 million pounds. c. decrease.
d. $10 million. e. increase. f. $16 million.
g. increase. h. $6 million.

III. Problems

(1) [Production functions]

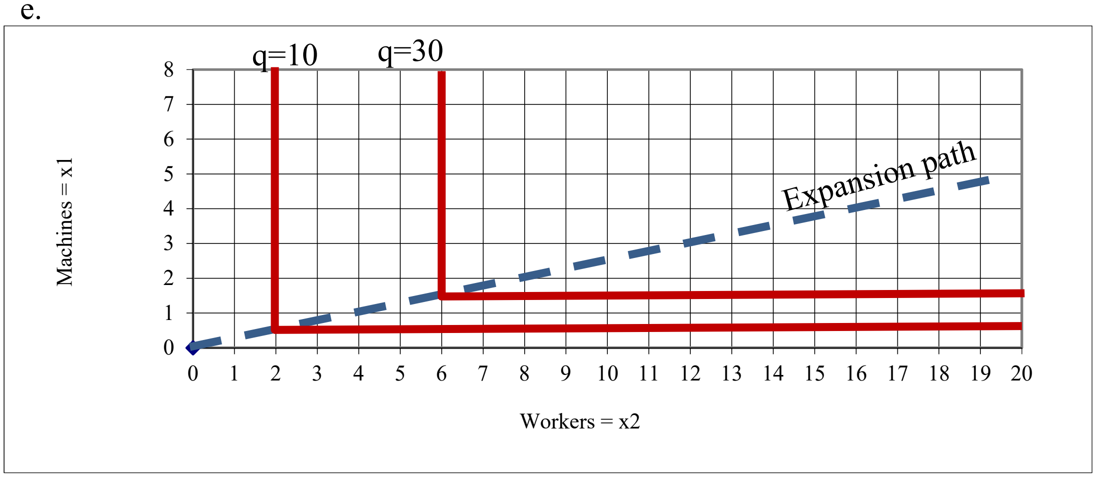
a. $MP_1 = 6\, x_1^{-1/4}\, x_2^{3/4}$. Yes, there are diminishing returns to input 1, because as x_1 increases (and x_2 is held constant), MP_1 decreases.

b. $MRSP = MP_2 / MP_1 = \frac{6\, x_1^{3/4}\, x_2^{-1/4}}{6\, x_1^{-1/4}\, x_2^{3/4}} = \frac{x_1}{x_2}$. Yes, this function does have diminishing MRSP, because as x_1 decreases and x_2 increases, MRSP diminishes.

c. Check returns to scale:
$f(ax_1, ax_2) = 8\,(ax_1)^{3/4}\,(ax_2)^{3/4} = 8\,a^{3/4}\,{x_1}^{3/4}\,a^{3/4}\,{x_2}^{3/4}$
$= a^{3/4}\;a^{3/4}\;\left(8\,{x_1}^{3/4}\,{x_2}^{3/4}\right) = a^{3/2}\,q > aq,$ 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) [Fixed-proportions technology]

a. $x_1 = (x_2/4)$. b. $q = 20\, x_1$. c. $q = (20/4)\, x_2$.
d. $q = \min\{20\, x_1, (20/4)\, x_2\} = \min\{20\, x_1, 5\, x_2\}$.
e.



(3) [Cost minimization]

a. Equation for isoquant: $30 = 5\, x_1^{1/2}\, x_2^{1/2}$ or $6 = x_1^{1/2}\, x_2^{1/2}$ or $36 = x_1 x_2$.

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

c. Set MRSP = \$20/\$5 and solve jointly with $30 = 5\, x_1^{1/2}\, x_2^{1/2}$, to get x_1*=12 and x_2*=3.

d. TC(30) = 12×\$5 + 3×\$20 = \$120.

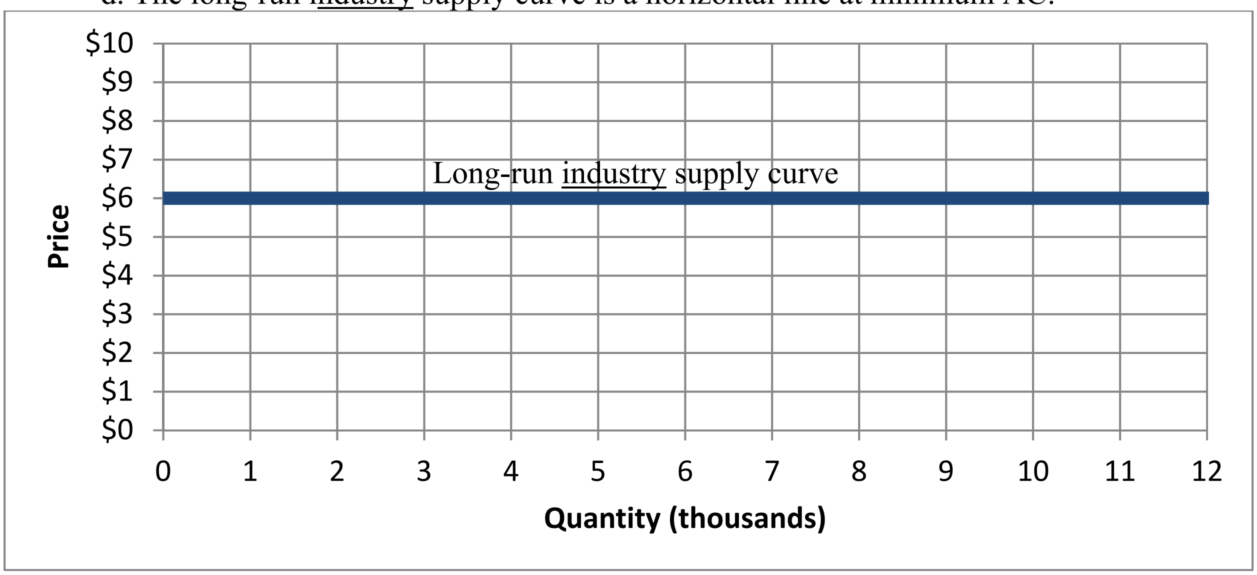
(4) [Long-run profit maximization and supply]

a. AC = TC/q = 0.01 q^2 – 0.8 q + 22.
Set 0 = dAC/dq = 0.02 q – 0.8 and solve to get q_{ES} = 40.

b. Breakeven price = minimum AC = AC(q_{ES}) = \$6.

c. A supply curve shows how much will be produced 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 the firm's supply curve is given by the following equations.
If P≥\$6, P = MC(q) = dTC/dq = 0.03 q^2 – 1.6 q + 22.
If P≤\$6, q=0 (firm shuts down).

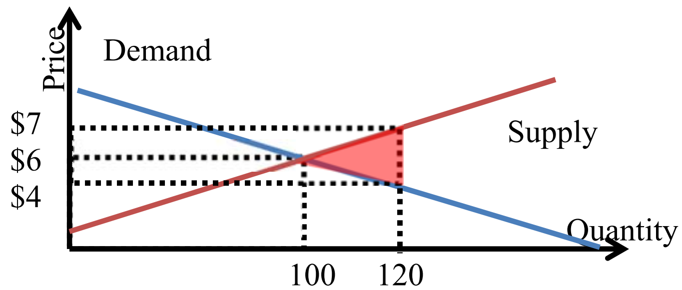
d. The long-run industry supply curve is a horizontal line at minimum AC:



(5) [Welfare effects of tax or subsidy]

a. Set $P_D = P_S$ and solve to get P* = \$6 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 = \$4), and the new total price received by sellers, including the subsidy (P_S = \$7).



c. Consumer surplus increases by $220, the area of the trapezoid between $6 and $4.
d. Producer surplus increases by $110, the area of the trapezoid between $6 and $7.
e. The government pays $3×120=$360 in tax revenue, but this is less than the combined increases of consumer and producer surplus. The loss to society as a whole (also called "deadweight loss") is $30.

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

[end of answer key]