ECON 433
Final: Dynamic Oligopoly, Patents, and Mergers

Kevin Hasker

This exam will start at 9:30 and finish at 11:10.

Answer all questions in the space provided. Points will only be given for work shown.

1. *(18 points)* Please read and sign the following statement:

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   _

2. *(10 points)* Is price fixing common, rare, or somewhere in between? Is it a significant factor in the economy or not? Give an example of an important industry that has been found guilty of price fixing in this century.

3. *(8 points total)* Consider an oligopolist who maximizes over quantity with the cost function $c_i(q) = c_i q_i$, price is set to clear the market using the inverse demand curve $P(Q)$, where $Q = \sum_{i=1}^{n} q_i$ is the total quantity and $P'(Q) < 0$. Show that the optimized profit function can be written as $\pi_i^* = |P'(Q^*)| (q_i^*)^2$, where q_i^* is i's optimal quantity and Q^* is the equilibrium total quantity. You may assume that the second order conditions are met and **may use this in the rest of the exam even if you can not show it.**

4. *(44 points total)* Consider a quantity maximizing Duopoly. Firm 1 has the cost function $c_1(q) = 2q_1$, firm 2 has the cost function $c_2(q) = 5q_2 + F$, where F will change during the course of the question. Price is set to clear the market according to the inverse demand curve of $P = 35 - 3Q$, where $Q = q_1 + q_2$.

   (a) *(18 points total)* Assume that $F = 0$ and consider the game where both firms set their quantities simultaneously (Cournot).

      i. *(4 points)* Set up the objective functions of both firms.

      ii. *(8 points)* Find the best responses of both firms.

      iii. *(4 points)* Find the equilibrium quantities of both firms.

iv. *(2 points)* Find the profits of firm 2 in equilibrium. (HINT: Read the last question.)

(b) *(14 points total)* Assume that $F = 0$ and consider the game where first firm one sets their quantity and then firm 2 sets their quantity (Stackelberg).

i. *(4 points)* Without any calculation find the best response of firm 2 and explain why you know this is correct.

ii. *(2 points)* Set up the objective function of firm 1 in this game.

iii. *(4 points)* Find the optimal quantity of firm 1 and their profits in this game. (HINT: You may not use the last question to find the profits.)

iv. *(4 points)* Find the equilibrium quantity of firm 2 and their profits in this game. (HINT: Read the last question.)

(c) *(12 points total)* Now $F = 3$.

i. *(3 points)* Set up the profits of firm 2 assuming they are best responding to the quantity of firm one (it should be a function of q_1).

ii. *(3 points)* Find the quantity of firm one that will cause firm two to shut down, call it q_1^{sd}.

iii. *(3 points)* Consider the Stackelberg game, show that now the equilibrium will be $q_1 = q_1^{sd}$, $q_2 = 0$.

iv. *(3 points)* Consider the Cournot game, show that the equilibrium does not change when firm 2 has these fixed costs.

5. *(20 points)* About strategic substitutes and strategic compliments.

   (a) *(8 points)* Define strategic substitutes and strategic compliments.

(b) *(8 points)* Give two examples of how the difference between strategic substitutes and compliments result in different predictions in the models we have looked at. You may assume full generality of the models we have looked at in class.

(c) *(4 points)* Given that we can not be sure whether firms are using strategic substitutes or compliments, what general lesson does this illustrate about Industrial Organization (or Industrial Economics as it is known at Bilkent.)

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3. *(8 points total)* Consider an oligopolist who maximizes over quantity with the cost function $c_i(q) = c_i q_i$, price is set to clear the market using the inverse demand curve $P(Q)$, where $Q = \sum_{i=1}^{n} q_i$ is the total quantity and $P'(Q) < 0$. Show that the optimized profit function can be written as $\pi_i^* = |P'(Q^*)| (q_i^*)^2$, where q_i^* is i's optimal quantity and Q^* is the equilibrium total quantity. You may assume that the second order conditions are met and **may use this in the rest of the exam even if you can not show it.**

4. *(44 points total)* Consider a quantity maximizing Duopoly. Firm 1 has the cost function $c_1(q) = 25q_1$, firm 2 has the cost function $c_2(q) = 26q_2 + F$, where F will change during the course of the question. Price is set to clear the market according to the inverse demand curve of $P = 36 - \frac{1}{2}Q$, where $Q = q_1 + q_2$.

   (a) *(18 points total)* Assume that $F = 0$ and consider the game where both firms set their quantities simultaneously (Cournot).

      i. *(4 points)* Set up the objective functions of both firms.

      ii. *(8 points)* Find the best responses of both firms.

      iii. *(4 points)* Find the equilibrium quantities of both firms.

iv. *(2 points)* Find the profits of firm 2 in equilibrium. (HINT: Read the last question.)

(b) *(14 points total)* Assume that $F = 0$ and consider the game where first firm one sets their quantity and then firm 2 sets their quantity (Stackelberg).

i. *(4 points)* Without any calculation find the best response of firm 2 and explain why you know this is correct.

ii. *(2 points)* Set up the objective function of firm 1 in this game.

iii. *(4 points)* Find the optimal quantity of firm 1 and their profits in this game. (HINT: You may not use the last question to find the profits.)

iv. *(4 points)* Find the equilibrium quantity of firm 2 and their profits in this game. (HINT: Read the last question.)

(c) *(12 points total)* Now $F = 2$.

i. *(3 points)* Set up the profits of firm 2 assuming they are best responding to the quantity of firm one (it should be a function of q_1).

ii. *(3 points)* Find the quantity of firm one that will cause firm two to shut down, call it q_1^{sd}.

iii. *(3 points)* Consider the Stackelberg game, show that now the equilibrium will be $q_1 = q_1^{sd}$, $q_2 = 0$.

iv. *(3 points)* Consider the Cournot game, show that the equilibrium does not change when firm 2 has these fixed costs.

5. *(20 points)* About strategic substitutes and strategic compliments.

   (a) *(8 points)* Define strategic substitutes and strategic compliments.

(b) *(8 points)* Give two examples of how the difference between strategic substitutes and compliments result in different predictions in the models we have looked at. You may assume full generality of the models we have looked at in class.

(c) *(4 points)* Given that we can not be sure whether firms are using strategic substitutes or compliments, what general lesson does this illustrate about Industrial Organization (or Industrial Economics as it is known at Bilkent.)

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3. *(8 points total)* Consider an oligopolist who maximizes over quantity with the cost function $c_i(q) = c_i q_i$, price is set to clear the market using the inverse demand curve $P(Q)$, where $Q = \sum_{i=1}^{n} q_i$ is the total quantity and $P'(Q) < 0$. Show that the optimized profit function can be written as $\pi_i^* = |P'(Q^*)| (q_i^*)^2$, where q_i^* is i's optimal quantity and Q^* is the equilibrium total quantity. You may assume that the second order conditions are met and **may use this in the rest of the exam even if you can not show it.**

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   (a) *(18 points total)* Assume that $F = 0$ and consider the game where both firms set their quantities simultaneously (Cournot).

      i. *(4 points)* Set up the objective functions of both firms.

      ii. *(8 points)* Find the best responses of both firms.

      iii. *(4 points)* Find the equilibrium quantities of both firms.

iv. *(2 points)* Find the profits of firm 2 in equilibrium. (HINT: Read the last question.)

(b) *(14 points total)* Assume that $F = 0$ and consider the game where first firm one sets their quantity and then firm 2 sets their quantity (Stackelberg).

i. *(4 points)* Without any calculation find the best response of firm 2 and explain why you know this is correct.

ii. *(2 points)* Set up the objective function of firm 1 in this game.

iii. *(4 points)* Find the optimal quantity of firm 1 and their profits in this game. (HINT: You may not use the last question to find the profits.)

iv. *(4 points)* Find the equilibrium quantity of firm 2 and their profits in this game. (HINT: Read the last question.)

(c) *(12 points total)* Now $F = 32$.

i. *(3 points)* Set up the profits of firm 2 assuming they are best responding to the quantity of firm one (it should be a function of q_1).

ii. *(3 points)* Find the quantity of firm one that will cause firm two to shut down, call it q_1^{sd}.

iii. *(3 points)* Consider the Stackelberg game, show that now the equilibrium will be $q_1 = q_1^{sd}$, $q_2 = 0$.

iv. *(3 points)* Consider the Cournot game, show that the equilibrium does not change when firm 2 has these fixed costs.

5. *(20 points)* About strategic substitutes and strategic compliments.

   (a) *(8 points)* Define strategic substitutes and strategic compliments.

(b) *(8 points)* Give two examples of how the difference between strategic substitutes and compliments result in different predictions in the models we have looked at. You may assume full generality of the models we have looked at in class.

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4. *(44 points total)* Consider a quantity maximizing Duopoly. Firm 1 has the cost function $c_1(q) = 21q_1$, firm 2 has the cost function $c_2(q) = 22q_2 + F$, where F will change during the course of the question. Price is set to clear the market according to the inverse demand curve of $P = 32 - \frac{1}{3}Q$, where $Q = q_1 + q_2$.

   (a) *(18 points total)* Assume that $F = 0$ and consider the game where both firms set their quantities simultaneously (Cournot).

      i. *(4 points)* Set up the objective functions of both firms.

      ii. *(8 points)* Find the best responses of both firms.

      iii. *(4 points)* Find the equilibrium quantities of both firms.

iv. *(2 points)* Find the profits of firm 2 in equilibrium. (HINT: Read the last question.)

(b) *(14 points total)* Assume that $F = 0$ and consider the game where first firm one sets their quantity and then firm 2 sets their quantity (Stackelberg).

i. *(4 points)* Without any calculation find the best response of firm 2 and explain why you know this is correct.

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iv. *(4 points)* Find the equilibrium quantity of firm 2 and their profits in this game. (HINT: Read the last question.)

(c) *(12 points total)* Now $F = 3$.

i. *(3 points)* Set up the profits of firm 2 assuming they are best responding to the quantity of firm one (it should be a function of q_1).

ii. *(3 points)* Find the quantity of firm one that will cause firm two to shut down, call it q_1^{sd}.

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