14.01 Problem Set 5

Due at 5pm on November 3th, 2023
Late problem sets are **not** accepted.

1 Short Questions (15 Points)

1. *(5 Points)* Show mathematically why the marginal revenue curve of a monopolist is always below the demand curve.

2. *(5 Points)* Show mathematically that a monopolist will always want to be on the elastic portion of the demand curve.

3. *(5 Points)* Show mathematically that the markup is decreasing on the absolute value of the demand elasticity.

2 True or False (20 Points)

Decide whether the following statements are True or False. Explain your answers.

1. *(5 Points)* In Cournot duopoly, if one firm decreases its output then it is optimal for the other firm to also decrease its output.

2. *(5 Points)* Bertrand competition always results in zero economic profits in the long run.

3. *(5 Points)* Competitive markets are always preferable to monopoly.

4. *(5 Points)* Government regulation can improve welfare under noncompetitive markets.

3 Cournot Competition and Cartels (65 Points)

The global Oil market is considered to be a Cournot industry. The largest oil producing countries control a significant fraction of the world's oil production. These countries make decisions about how much oil to produce, taking into account the decisions of the other nations. In these countries, oil is very easy to extract, so we will assume throughout the exercise that it can be extracted at a constant marginal cost equal to one. Suppose that the world's demand for oil is given by

$$Q_D = 2 - p$$

1. *(5 Points)* If the market for oil was perfectly competitive, what would be the equilibrium price and quantity of oil? What is the consumer, producer, and total surplus?

Suppose there is only one country producing in this market: Saudi Arabia, so there is a monopoly. Saudi Arabia can produce oil at a constant marginal cost of one.

2. *(5 Points)* What price does the monopolist charge, and what quantity do they produce? What is the consumer surplus, producer surplus and deidweight loss?

3. *(5 Points)* Graph the marginal revenue, marginal cost, and demand curves in the same graph. Identify the equilibrium quantity and price, as well as the consumer surplus, producer surplus and deadweight loss. How do they differ from their counterparts under a competitive equilibrium? Provide an economic intuition.

Now suppose a new country, the UAE, enters the market. Both countries can produce at a constant marginal cost of one. Suppose the firms compete a la Cournot. Let q_S denote the quantity produced by Saudi Arabia and q_U denote the quantity produced by the UAE.

4. *(5 Points)* What is each firm's best-response function? How much will each firm produce in a Nash equilibrium?

5. *(5 Points)* Graph the two firms' best-response function in a graph with q_S on the x axis and q_U on the y axis. Indicate the Nash equilibrium.

6. *(5 Points)* What are the consumer and producer surplus? How large is the loss of efficiency in this market?

Most of the major oil-producing nations in the world are members of the Organization of the Petroleum Exporting Countries (OPEC). The primary goal of OPEC is to coordinate and manage the production and pricing of oil to stabilize oil markets. OPEC try to manage oil prices by regulating their production levels. We can interpret OPEC's production decisions as forming a cartel. Suppose Saudi Arabia and the UAE, the sole producers of oil in this economy, are member of OPEC and decide to form a cartel.

7. *(5 Points)* How much would the equilibrium price and quantity compare with the monopoly and duopoly cases? Assuming both countries produce the same quantity when they form a cartel, how much would each firm produce in this case? Let $\hat{q}$ denote such quantity. How does this quantity compare with the quantity under a Cournot equilibrium? Provide an economic intuition.

Suppose that the firms have agreed to produce quantities $\hat{q}$. Then, each firm can individually decide to choose one of the following two actions:

- **Follow (F)** the decision made in the meeting and produce $\hat{q}$.
- **Defect (D)** and produce the quantity that is the best response to $\hat{q}$.

8. *(5 Points)* If country s chose D, what quantity would they chose to produce? Provide an economic intuition.

9. *(10 Points)* Write out a game-theory payoff matrix representing the profits that each country makes depending on the strategies chosen by each country.

10. *(5 Points)* What is the Nash Equiibrium of this game?

The US Strategic Petroleum Reserve (SPR) is the world's largest supply of emergency crude oil, established to reduce the impact of disruptions in supplies of petroleum products. The stocks are owned by the Federal Government, and are stored in huge underground caverns. SPR oil is sold competitively when the US President finds that a sale is required (Note: the SPR actually exists, you can find more about it here).

Suppose in response to Saudi Arabia and the UAE colluding to increase oil prices, the President of the US decides to use the SPR. In particular, let q_{US} denote the amount they decide to offer to the market.

11. *(5 Points)* Write down the problem of the OPEC members, taking the supply from the US as given.

12. *(5 Points)* What is the equilibrium price and quantity, as a function of q_{US}?

13. *(5 Points)* What would happen to the equilibrium price and quantity if the size of the government intervention was equal to $q_{US} = \frac{1}{3}$? Provide an economic intuition.

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