

Vivek Ghosal: Economics of Biotechnology and Medical Innovations

Sample Questions ONE Fall 2024

* Below are various practice problems based on materials related to slides BM1, BM2 and corresponding class discussions

** You **do not** have to submit them. Please work through the problems sequentially. I will ask students to provide answers during class and discuss.

*** These problems are **similar to questions that will be on tests**. We will apply them more specifically to various biopharma markets and related settings. Therefore, it is important that you work through the problems on your own.

1. Demand, Costs, Competition, Monopoly

1.A. Consider the following starting information

1. Q =total market quantity produced; q =one firm's quantity produced; P =market price; MR =firm's marginal revenue; TC =total cost; AC =average cost; MC =marginal cost; and π =firm's total profit.

2. Market demand function: $Q = 1,000 - 1.5P$

3. Total cost function: $TC = 5q$

Questions:

(a) Given the TC function, what are total fixed costs equal to?

(b) What are AC and MC equal to?

(c) For a firm in a competitive market, what is MR equal to?

(d) If the market had a monopolist, what is the MR function?

(e) For the competitive market equilibrium, what are P and Q ?

(f) Calculate total profits if the market were competitive.

(g) If the market had a monopoly, what are P and Q ?

(h) Calculate total profits if the market had a monopoly.

** Aside from answering the numerical parts, draw diagrams for each market equilibrium.*

1.B. Change in cost function – Part One

1. Items from A.1 and A.2 are same.

2. $TC = 100 + 0.5q$

(a) Given the TC function, what are total fixed costs equal to?

(b) What are AC and MC equal to?

(c) For a firm in a competitive market, what is MR equal to?

(d) If the market had a monopolist, what is the MR function?

(e) For the competitive market equilibrium, what are P and Q ?

(f) Calculate total profits if the market were competitive.

(g) If the market had a monopoly, what are P and Q ?

(h) Calculate total profits if the market had a monopoly.

** Aside from answering the numerical parts, draw diagrams for each market equilibrium.*

1. C. Change in cost function – Part Two

1. Items from A.1 and A.2 are same.

2. $TC = 100 + 0.5q + 0.1q^2$

(a) Given the TC function, what are total fixed costs equal to?

(b) What are AC and MC equal to?

(c) For a firm in a competitive market, what is MR equal to?

(d) If the market had a monopolist, what is the MR function?

(e) For the competitive market equilibrium, what are P and Q?

(f) Calculate total profits if the market were competitive.

(g) If the market had a monopoly, what are P and Q?

(h) Calculate total profits if the market had a monopoly.

** Aside from answering the numerical parts, draw diagrams for each market equilibrium.*

2. Change in costs

2.A. Consider 1.B information on demand and costs

A new FDA regulation imposes an additional \$150 of fixed-costs on the firm. These costs are due to, say, new testing and trials related regulations. This is the only change from 1.B.

Re-answer questions (a)-(h) noted in 1.B.

** Aside from answering the numerical parts, draw diagrams for each market equilibrium.*

2.B. Change in coefficients for ‘q’

The new FDA regulation noted in 2.A above had imposed \$150 of fixed-costs on the firm. Now, suppose the coefficients attached to ‘q’ change as follows: $0.6q + 0.2q^2$

Question: What rationale can you give for the coefficients attached to the ‘q’ terms changing?

3. Monopoly Numerical

Below is a numerical to work out the monopoly equilibrium and think through some issues.

Earlier we had worked out examples in class – please keep those in mind. The monopolist in this case would be a branded/patented pharma for a particular therapy.

(a) Consider this scenario as a starting market-based outcome. Let the fixed cost (consider all aspects such as R&D, labs, scientists who specifically work on drug development, testing, clinical trials, etc.) of bringing a drug to market be \$5billion. Post-FDA approval, let the unit cost of producing a pill be constant at \$50. For the specific therapy the drug is used for, let there be 5 million individuals in the country. Finally, the monopolist’s survey shows that at a price of \$750 per pill, there will be zero demand for the product. Calculate the price the monopolist will set, quantity sold, and total profits. Draw a diagram to show the outcomes.

(b) Now consider a scenario where there is health insurance. Due to the copay/reimbursement structure, consumers have to pay only a small fraction of the price per pill. The monopolist’s

survey now shows that at a price of \$1,500 per pill, demand would be zero. Calculate the price the monopolist will set, quantity sold, and total profits. Draw a diagram to show the outcomes.

(c) If the treatment period for the therapy was 20 weeks, what would be the total national healthcare expenditures under scenarios (a) and (b)?

(d) What measures can healthcare payers (think health insurance company for simplicity, or private insurance, and others like Medicare and Medicaid) undertake to alter the total costs they incur for the specific therapy? Briefly indicate each strategy, and indicate:

- (i) what parameters of the demand and/or cost functions might be affected;
- (ii) any other dynamics in the market that might alter the therapy costs; and
- (iii) overall, indicate how the total therapy costs would be affected under each scenario you note above.

4. Bertrand Competition – General Framework

Consider two pharma firms, A and B, each producing a single drug in the same broad therapeutic class. Assume A's marginal costs (MC) is greater than B's. They produce differentiated products. Therapies can vary on multiple attributes such as effectiveness, level of toxicity, side effects, duration of treatment, and inconvenience (e.g., taking a pill a day versus self-injecting twice a day). Due to these, each drug has a differentiated product demand function (see the Bertrand notes).

(a) Consider an initial equilibrium. Draw a diagram. You can use materials in the slides to illustrate representative outcomes. Describe the initial equilibrium prices, quantities sold, and profits. This is the initial market equilibrium.

(b) Now consider a rule change by the FDA. The new rules increase the stringency of clinical trials and manufacturing standards. Draw a diagram to show the pre-and-post rule change equilibrium prices and quantities sold. Describe how profits would change.

(c) Due to the costs associated with the new rules, the pharma companies A and B consider altering their clinical trials and manufacturing protocols so that the regulatory hurdles can be cleared more efficiently. They need to become more innovative and efficient. However, firms A and B have differences in their resource base (scientific personnel, capital assets, knowledge base, history, etc.), and may pursue different paths to attaining the innovations and cost efficiencies with different degrees of success. Consider two scenarios:

- (1) both A and B end up attaining symmetric efficiencies; and
- (2) B's efficiency gains are relatively more than A's.

Under each scenario, draw diagram to illustrate new equilibrium outcomes (prices and quantities), and note how profits would change.

5. Bertrand Competition – Numerical

Refer to the branded versus store brand example (Loratadine/Claritin v store brand) in the posted Bertrand slides, BM2. I am giving this out as a sample problem so that you can work out all the steps and details, and be familiar with the mechanics of the problem.

(a) Work through that example fully to obtain the two price response equations from the demand and cost information given to you. All the details are laid out in the slides, so go through the materials to make sure you can obtain the two price functions. Solve the two price equations to

get the equilibrium prices. Once you have the prices, calculate each firm's quantity sold, and profits.

(b) Suppose the FDA imposes new manufacturing process guidelines for mass production to improve purity and quality control of the pharma pills. As a result of this, let each firm face a equal-percentage increase in their marginal costs. In a diagram (fully labeled), show how the price-response functions will change. Briefly discuss the relative effects of the FDA manufacturing process mandates on the two firms.

(c) How would the market equilibrium change if the FDA mandate had a higher percentage effect on the store brands MC. Draw a diagram to show the effects and new equilibrium.

6. Bertrand Competition Numerical

Consider the following demand and cost functions for two firms A and B.

$$Q_A = 10,000 - 1.5P_A + 2.5P_B$$
$$TC_A = 20Q_A$$

$$Q_B = 15,000 - 2P_B + 1.0P_A$$
$$TC_B = 25Q_B$$

Questions:

(i) In the above system, we consider market-based rules – that is, there is no health insurance plan. Calculate: (a) equilibrium prices; (b) equilibrium quantities; (c) profits.

(ii) Given the above functions, what would be the simplest way to introduce the effects of a new health insurance plan to this market? What would be the anticipated effects on prices, quantities, and profits?

(iii) Given the above functions, how would you introduce a new stricter manufacturing quality control regulation by the FDA? What would be the anticipated effects on prices, quantities, and profits?

** Aside from solving the numerical parts, draw diagrams to show the outcomes. Label all axes and equilibrium outcomes properly.*

IMPORTANT: In class I have emphasized the importance of drawing fully labeled diagrams. Please note that in the above problems, you are expected to draw diagrams. All axes and equilibrium outcomes need to be fully labeled in the diagram. On the test, you will be required to solve numerical problems (like above) as well as draw complete diagrams. Incomplete, inadequately labeled diagrams will lead to points deduction. I am mentioning this now to make expectations clear and that you practice accordingly.

Please make sure that you take notes on what we do in class on the whiteboard – solving problems, diagrams, explanations. There will be a lot of details we do on the whiteboard. All of this is important and relevant for tests.