

Problem Set 3

Econ 1: Problem Set 3--due Feb 24/25

Several hundred miles north of the metropolis of Esseph in the state of Euphoria is the city of Chief Joseph, home of the Miniflexible company, monopoly provider of operating systems to desktop personal computers. Variable costs for Miniflexible are zero: operating systems are distributed for free over the internet. The annual amortized costs of writing and maintaining the operating system are:

$$FC = \$3,000,000,000$$

1) Suppose that annual demand for desktop personal computers is given by:

$$P = \$200 - 0.000001Q$$

That is: Miniflexible has to cut the price by \$1 in order to sell an extra one million operating systems a year. The demand curve thus has a y-intercept of \$200 (the maximum willingness-to-pay of any potential purchaser) and an x-intercept of 200,000,000/year (the number of potential purchasers who would receive any benefit at all from the commodity—who have a positive willingness-to-pay).

a) What is the profit-maximizing quantity for Miniflexible to sell its customers?

The marginal revenue curve is: $MR = \$200 - 0.000002Q$. The marginal costs to the monopoly are zero. So the profit-maximizing quantity is where the MR curve hits the x-axis—where marginal revenue is zero. That is at $Q_m = 100,000,000$ /year (where “ Q_m ” stands for “Q-monopoly”).

b) What is the profit-maximizing price for Miniflexible to charge its customers?

At a profit maximizing quantity $Q_m = 100,000,000$, the demand curve $P = \$200 - 0.000001Q$ tells us that the monopoly market equilibrium price will be $P_m = \$100$.

c) How much consumer surplus do purchasers receive?

With a maximum willingness-to-pay of \$200 and a price of \$100, the average willingness-to-pay of those who purchase is \$150. There is thus a \$50 average

wedge between willingness-to-pay and market price: that is the average surplus received by purchasers. There are 100,000,000 purchasers a year. Thus consumer surplus $CS_m = \$5,000,000,000/\text{year}$.

d) How much in monopoly profits does Miniflexible make?

With zero variable costs, Miniflexible's operating surplus is the same as its total revenue. It sells 100,000,000 units a year at a price of \$100/unit: that's \$10,000,000,000/year of revenue. Subtract the \$3,000,000,000/year of amortized fixed costs it incurs, and learn that Miniflexible's profits are $PS_m = \$7,000,000,000/\text{year}$.

2) Suppose that Al Gore had been elected President and had made it a priority for the government to not just fund the creation of the Internet but also to write and distribute the operating system for desktop computers.

a) How much in extra taxes would the government have to raise a year to fund this additional government program—this Computer Operating System Taskforce—if the U.S. government's operations were only 60% as efficient as those of the private profit-seeking sector?

It takes \$3B/year in amortized fixed costs for the private-sector Miniflexible to build and maintain an operating system. If the government's operations are 60% as effective, it would take the government \$5B/year.

b) How much should the government charge for the operating system?

$P_{us} = \$0$ ("Pus" meaning "P under socialism"). Since there are no variable costs associated with creating an extra unit of the program, my getting a copy of the program imposes no reduction in the resources available for the rest of society. Thus from a utilitarian societal-welfare perspective there is no reason to charge a price for it.

c) How much consumer surplus will users of the operating system then receive?

If the operating system is given away for free, then since the maximum willingness-to-pay is \$200 the average willingness to pay is \$100. 200,000,000/year units will be given away. That is consumer surplus CS_s \$20B/year—four times what was provided by Miniflexible.

d) How would you evaluate, from a societal-welfare point of view, the relative merits of (a) monopoly provision by Miniflexible, and (b) socialism in the form of public provision for free?

Socialism uses up \$5B/year of society's resources each year in programmer time and other costs that could be used to produce other valuable commodities. It produces \$20B/year of consumer surplus. Net benefit: \$15B/year. Monopoly uses up \$3B/year of society's resources each year in programmer time and other costs that could be used to produce other valuable commodities. It produces (a) \$5B/year of consumer surplus and (b) \$7B/year of monopoly profits for Miniflexible shareholders and executives like Bill Walls and Steve Batmer. Net benefit: \$12B/year if the average dollar received by Walls and Batmer boosts societal well-being by as much as the average dollar received by anyone else, and by less if it is boosted by less.

3) Suppose that Elizabeth Warren were elected President and made it a priority for the government to regulate monopolies like Miniflexible. She names Berkeley Professor Dan Rubinfeld to run the new Computer Regulatory Analysis Fact-finding Taskforce and to set a price at which Miniflexible can sell its operating system. The mandate of CRAFT is that it must (a) maximize consumer surplus without either (b) making Miniflexible unprofitable or (c) requiring that public tax money be spent.

a) What should Dan Rubinfeld set as the amount Miniflexible should be allowed to charge for its operating system? (Either write down the equation for revenue as a function of price and quantity and then use the quadratic formula to figure out at what P/Q pair revenue is equal to costs; or simply set up a spreadsheet and do an exhaustive search—start with the price at the maximum willingness to pay and march down the page, with each line calculating revenue and costs for a different price, and see how low you can push the price before Miniflexible starts losing money and can no longer cover its costs. I would do the second myself.)

Since the amortized annual per-unit costs of Miniflexible are \$3B/Q, Dan Rubinfeld should set the price such that Miniflexible covers its costs: $P = \$3B/Q$ with $P = \$200 - 0.000001Q$,

One way to do it is by looking for the quantity Q_r (“ Q_r ” standing for “ Q -regulatory”) at which revenue equals costs via the quadratic formula. That means:

$$\$200 - 0.000001Q = \$3,000,000,000/Q$$

$$\$200Q - 0.000001Q^2 - \$3,000,000,000 = 0$$

$$Q^2 - \$200,000,000Q + \$3,000,000,000,000 = 0$$

$$Q_r = \{183,666,003, 16,333,997\}$$

The second of these roots of the quadratic—16,333,997—is indeed a quantity produced at which selling that quantity at the market price just covers Miniflexible’s amortized fixed costs. It is associated with a price $P_r = \$183.67$. But this would make no sense as a regulatory decision: cutting the price below \$183.67 would (i) increase consumer surplus and (ii) give Miniflexible positive prices. What this root tells us is that the monopoly’s charging a price above \$183.67 would be so counterproductive and market-restricting that even a monopoly seller would lose money at such price.

The first of these roots of the quadratic— $Q_r = 183,666,003$ —is the one we want. It corresponds to a price $P_r = \$16.33$. That is the price that allows Miniflexible to cover its costs while providing a lot of value for consumers.

c) How much consumer surplus will users of the operating system then receive?

If the operating system is sold at a price of \$16.33, then since the maximum willingness-to-pay is \$200 the average willingness to pay is \$108.17. 183,666,003/year units will be sold. That is consumer surplus of \$16,866,600,329/year.

d) How would you evaluate, from a societal-welfare point of view, the relative merits of (a) monopoly provision by Miniflexible, (b) socialism in the form of public provision for free, and (c) the regulated monopoly where Miniflexible is allowed to cover its costs?

Socialism uses up \$5B/year of society’s resources each year in programmer time and other costs that could be used to produce other valuable commodities. It produces \$20B/year of consumer surplus. Net benefit: \$15B/year. Monopoly uses up \$3B/year of society’s resources each year in programmer time and other costs that could be used to produce other valuable commodities. It produces (a) \$5B/year of consumer surplus and (b) \$7B/year of monopoly profits for Miniflexible shareholders and executives like

Bill Walls and Steve Batmer. Net benefit: \$12B/year if the average dollar received by Walls and Batmer boosts societal well-being by as much as the average dollar received by anyone else, and by less if it is boosted by less. Regulated monopoly produces \$0 of monopoly profits and \$16.87B of consumer surplus: it is in the middle—although, in this particular situation, much closer to the societal optimum than to monopoly.

4) Is there anything else you might want to try if you were in charge of designing market structure for the operating-systems-for-desktops industry?

The natural thing would be to ask Miniflexible and a couple of competitors to bid for the government contract of writing and maintaining an operating system that the government would then give away for free, and hoping to get a bid less than the \$5B/year it would cost the government to produce and maintain the operating system itself.

5) Suppose that software piracy is rampant: suppose that 75% of potential purchasers—with no pattern as to their relative willingness-to-pay—pirate the software and download it for free. How would this change your analysis?

With 75% of its potential customers pirating the software for free, Minifilter can only collect \$2.5B/year in revenue. That isn't enough to support its business. The monopoly equilibrium—and the regulatory equilibrium—disappear. The private market cannot provide this commodity. Either the government has to aggressively step up copyright enforcement to discourage software piracy, or socialism becomes the only option.

The possibility of software piracy means that the commodity at issue—the operating system—is no longer what economists would call *excludible*: it is not possible for the supposed owner of the commodity to exclude others from acquiring and making use of it. Markets work best only when commodities are perfectly rival and perfectly excludible. And without sufficient excludability markets cannot work at all.

6) Suppose that software piracy is less rampant: that 50% of potential purchasers—with no pattern as to their relative willingness-to-pay—pirate the software and download it for free. How would this change your analysis?

Minifilter can operate its monopoly business model—at its profit-maximizing price $P_m = \$100$ it sells 50,000,000 units/year, collects \$5B/year in revenue,

and makes a comfortable \$2B/year in monopoly profits. However, consumer surplus goes up relative to monopoly. We have 50,000,000 units/year sold and 100,000,000 units/year pirated for free, for not the \$5B of consumer surplus under monopoly but rather for \$12.5B/year of consumer surplus, and \$14.5B/year of societal surplus (if wealth flowing to Bill Walls, etc....) The monopoly market works better with (some) software piracy!

7) Suppose that it is a well-established norm in the software industry that if there is more than one producer in the business, you charge what you would charge if you were the monopolist, and you thus share the market. In the absence of government regulation or socialistic public provision for free, if anyone can make an operating system for an amortized cost of \$3B/year, how many producers would you expect to see in the operating-system market? What would your welfare analysis be?

If even competing producers each and all charge the monopoly price $P_m = \$100$, then you would expect to see three producers in the market. Each would incur \$3B/year of fixed costs. Each would sell 33.33M copies of the operating system and collect \$3.33B/year of revenue. Each would make \$333M/year of monopoly profits. And consumers would collect their \$5B of monopoly consumer surplus. This market structure would produce only \$6B/year of societal surplus. This structure of monopolistic competition would be, substantially, the worst outcome. It would then cost the market \$9B/year to provide what the (inefficient) government could have provided for \$5B/year. And the market would only have produced \$15B instead of \$20B of total value for purchasers.