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Problem Set #7

Due November 30, 2022

1. Consider the following two period model of learning-by-doing. In each of two periods, the demand for a nondurable good is given by $P(Q) = 4 - Q$ where Q is the total quantity of the good produced.

In the first period, firm 1 (a monopolist) produces quantity q_1^1 of a good at a constant marginal cost of 2. After the first period, firm 2 has the opportunity to pay a sunk cost of E and enter the market. If firm 2 enters, then in the second period firm 1 and firm 2 compete as Cournot duopolists (otherwise firm 1 is again a monopolist). Firm 2 has a constant marginal cost of 2. Because of the experience it gained in the first period, however, firm 1 can produce the good at at a lower marginal cost. Write $MC(q_1^1)$ for the second period *marginal cost* of firm 1 when its first period output was q_1^1 and assume that $MC(q_1^1) \in [1, 2]$.

(a) What are the firms' outputs and profits in the second period as a function of $MC(q_1^1)$.

(b) Assume that the function relating first period output and second period marginal cost is

$$MC(q_1^1) = \begin{cases} 2 & \text{if } q_1^1 \leq 1 \\ 2\frac{1}{2} - \frac{1}{2}q_1 & \text{if } q_1^1 \in [1, 3] \\ 1 & \text{if } q_1^1 > 3. \end{cases}$$

Assume also that firm 2 observes q_1^1 before making its entry decisions and choosing its second period output. Show that if $E = \frac{16}{81}$ it is not optimal for firm 1 to choose a q_1^1 which is sufficiently large so as to deter entry.

(c) Again suppose $E = \frac{16}{81}$ (or any other value which is such that firm 1 wants to "accomodate" entry) and that firm 2 observes q_1^1 before choosing its second period output. What output level does firm 1 choose?

(d) Suppose now that firm 2 is unable to observe q_1^1. Without doing the calculations, how would you expect firm 1's first period output to differ from the answer to part (c)? Would you expect it to be greater than or less than one? How would the answers to the qualitative parts of this question change if the firms engaged in price competition instead of Cournot competition?

2. Consider the following four stage game involving two firms. Initially firm 1 is a monopolist. In the first stage, it sets price p_1 and receives profits $\pi_1^1 = (p_1 - c)D(p_1)$. The demand function is initially unknown to the firms. They share a common prior, believing that demand is $\overline{\theta}d(p)$ with with probability q and $\underline{\theta}d(p)$ with probability $1 - q$. Assume $\overline{\theta} > \underline{\theta}$. Demand is the same in both periods of the game. Firm 1 learns the true value of θ after the first stage. Firm 2, however, does not observe firm 1's demand.

In the second stage firm 1 has the option of bulding a fire with \$100 bills so that he may reduce his profits to any level he likes. At the end of the second stage firm 1 is required by law to disclose its remaining profits (but not the amount of money it burned).

In the third stage firm 2 may enter the market at a cost of $E > 0$.

Finally in the fourth stage the firms compete earning profits $\pi_1^m(\theta)$ and 0 if firm 2 didn't enter and $\pi_1^D(\theta)$ and $\pi_2^D(\theta)$ if firm 2 did enter.

(a) If $q\pi_2^D(\overline{\theta}) + (1-q)\pi_2^D(\underline{\theta}) > E$, show that there is no perfect Bayesian equilibrium where firm 1 burns $(\overline{\theta} - \underline{\theta})d(p_1^*)(p_1^* - c)$ in the high demand state to pretend that it is low demand state.

(b) Find sufficient conditions for the existence of a separating PBE where firm 1 burns money only when demand is low. How does the welfare analysis of such an equilibrium differ from that of Fudenberg and Tirole's signal-jamming model.

3. The first half of Chevalier's paper, "Capital Structure and Product Market Competition: Empirical Evidence from the Supermarket Industry," is an event study which estimates a regression of the form

$$R_{it} = \alpha_i + \beta_i Rm_t + \sum_j (\gamma_j x_{ij} + \delta_j(1 - x_{ij}))D_{jt} + \epsilon_{it},$$

where R_{it} is the return on a stock, Rm_t is the return on the stock market, D_{jt} is a dummy variable set equal to one for the thirty day period prior to a supermarket firm j announcing that it was undertaking an LBO, and x_{ij} is a measure of whether firms i and j are competitors.

(a) What assumptions about stock market valuations are necessary for this event study methodology to identify the effects of an LBO on a firm's rivals?

(b) What assumptions is Chevalier making about the equality of certain coefficients to avoid the problem of having only one data point on the return of each rival chain every time an LBO occurs? Why does she interact D_{jt} with x_{ij} and $1 - x_{ij}$? Can you suggest controls that would work better than her x_{ij} and $1 - x_{ij}$?

(c) In her event study Chevalier finds that two of the four $\hat{\gamma_j}$ are positive and significant and interprets this as evidence that LBO's soften competition. Why might one argue that one should be testing whether $\hat{\gamma_j} - \hat{\delta_j}$ is significant? Would such a test have provided significant results?

4. Consider a variant of the standard competition-on-a-line model with loss averse consumers. Firms 1 and 2 are located at the opposite endpoints of $[0, 1]$ and have a constant marginal cost of c. A unit mass of consumers have types θ uniformly distributed on $[0, 1]$. Assume that consumers expect to buy from the closest firm and feel a loss if they buy a product they like less. Specifically, for each type θ, the reference point is the utility from the good located closest to θ. For $\theta \in [0, 1/2]$, the reference point is $v - t\theta$, and for $\theta \in [1/2, 1]$, the reference point is $v - t(1-\theta)$. So, for instance, if a consumer of type $\theta \in [0, \frac{1}{2}]$ gets utility $f(0) - p_1$ if she buys from firm 1 at price p_1, utility $f((v - t(1-\theta)) - (v - t\theta)) - p_2$ if she buys from firm 2, and utility $f(-(v - tx))$ if she does not buy, where

$$f(x) = \begin{cases} x & \text{if } x > 0 \\ 2x & \text{if } x \leq 0 \end{cases}$$

(a) Suppose firm 1 sets a price of $p_1 > p_2$. For which values of θ do consumers prefer buying from firm 1 to buying from firm 2.

(b) When v is sufficiently large this model has a symmetric pure strategy NE where both firms set a price of p^*. Find p^*.

EXTRA PROBLEM NOT TO BE HANDED IN

5. Consider the following model of brand proliferation. A continuum of consumers (of mass 1) are located around a circle of circumference one. In the first period, firm 1 has the opportunity to introduce any number N of brands and position them anywhere it likes around the circle. The cost of doing this is NE_1. Firm 2 then chooses whether to enter, in which case it introduces and positions a single brand at a cost of E_2. If firm 2 enters, assume that there is differentiated product price competitions with consumers having value $v - td^2 - p$ for a product located at a distance d from them.

(a) If firm 1 introduces two brands at points which are opposite each other on the circle, and firm 2 introduces a single brand half way between two of these show that the equilibrium prices and profits are $p_1 = 7t/48$, $p_2 = 5t/48$, $\pi_1 = 49t/576 - 2E_1$, $\pi_2 = 25t/576 - E_2$. Explain intuitively why firm 1 chooses a higher price than firm 2.

(b) Find values of v, t, E_1, and E_2 for which firm 1 would choose $N = 1$ if entry were not possible, but "overinvests" in brand proliferation and chooses $N = 2$ in this model to deter entry.

(c) Suppose we added a third stage to this game where firm 1 could withdraw any of its brands if it desired before price competition occurs (but not get back the sunk costs of introducing the brands). Given the parameter values from part (b) show that if firm 2 were to introduce a brand located in exactly the same place as one of firm 1's brands, then firm 1 would in equilibrium withdraw that brand. What does this imply about the feasibility of entry deterrence through brand proliferation?

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