

Industrial Organization and Data Science

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Course Assignments & Reading

Course assignments should be printed and turned in at the start of class unless otherwise noted. Feel free to work in groups but everyone is required to turn in their own work with answers written in your own words. In both calculations and complex ideas, write down each step of logic used in reaching your conclusion. Keep in mind that in most cases a good answer is one precise sentence; quality is heavily favored over quantity. This will be graded on a full credit, half credit and no credit basis. All work must be typed

Week 9, due November 23

Assignment to be turned in. Please turn in typed out answers. Math with pen/pencil OK.

- 1) For this question assume that two firms are competing Bertrand in prices.
 - a. What is the BR of firm 2 if firm 1 charges a price P ?
Firm 2 should set price to $P - 0.01$ if $P > MC_2$.
 - b. What is the BR of firm 1 if firm 2 charges $P = MC_1 < MC_2$?
Firm 1 should also charge $p = MC_1$.
 - c. What are NE profits of a high cost firm when competing on prices?
I am assume it is asking for net profit, the net profit should be $(P - MC)M$ if the firm has lower price, for M is the market size. If the firm has higher price, the net profit is 0. If the prices are the same, it should be $(P - MC)0.5M$.
- 2) Assume that there are two types of consumers for your product: high demand (type H) and low demand (type L). Specifically, for a given level of quality, type H consumers are always willing to pay more. There are two qualities for which you can produce a good, bad (B) and good (G). It costs \$3 to make a B good and \$5 to make a G good. Consumers will only buy one good (type B or G). The following chart lists valuations for each good for each type of consumer:

	G	B
H	10	6
L	5	4

Assume that **consumer type is not observable**, that first degree price discrimination is impossible, and there are 20 low type and 10 high type consumers.

- a. What is the optimal price and profits if you only sell the type G good?
Price should be 10, and the profit would be $(10 - 5)10 = 50$.
- b. What are the optimal prices and profits if you sell both goods? What is your profit?
Set price of G good to 10 and price of B good to 4, the total profit would be $50 + 20 = 70$.

- c. Assume you can degrade the value to the bad version by \$1 to both the high and low value customer. Assume you save \$2 on production costs by doing this. Assume that you price optimally in that case, are you willing to service/sell to both markets now?

I am willing to sell both markets, as it will get $(10 - 5)10 + (3 - 1)20 = 90$ profit. But if we only sell B good, the maximum profit will be $(3 - 1)30 = 60$, which is lower than 90.

- 3) Assume that we're in a Hotelling linear city model but that firm 1 is located at location .25 rather than location 0. Assume that the "neighbor" firm on the RHS is charging P_n . Find the optimal price of firm 1 given they have some cost c .

$$U_i = \begin{cases} v - t \cdot (x - 0.25) - P_i & \text{Firm 1 purchase} \\ v - t \cdot (1 - x) - P_n & \text{Neighborhood firm purchase} \\ 0 & \text{No purchase.} \end{cases}$$

$$\text{Let } v - t \cdot (x' - 0.25) - P_i = v - t \cdot (1 - x') - P_n$$

$$-tx' + 0.25t - P_i = -t + tx' - P_n$$

$$1.25t - P_i + P_n = 2tx'$$

$$\frac{1.25t - P_i + P_n}{2t} = x'$$

$$\Rightarrow D_i(P_i, P_n) = Nx'$$

$$\max_{P_i} (P_i - c) \cdot Nx' = (P_i - c) \cdot N \cdot \frac{1.25t - P_i + P_n}{2t} = f(P_i)$$

$$f'(P_i) = -(P_i - c) \cdot N \cdot \frac{1}{2t} + N \cdot \frac{1.25t - P_i + P_n}{2t} = 0$$

$$\Rightarrow -P_i + c + 1.25t - P_i + P_n = 0.$$

$$c + 1.25t + P_n = 2P_i$$

$$\frac{1}{2} \cdot (c + 1.25t + P_n) = P_i$$

- 4) Coding up Double ML.

- a. Use the Double ML algorithm to estimate the own price elasticity for Tropicana, Minute Maid and Dominick's using all available lagged features in the ML models including feat as a predictor. You'll estimate three separate regressions one for each brand for the final stage OLS residuals regression.

- I suggest using a random forest for P and Q.
- I also suggest using store and week fixed effects in your model.

- iii. I also suggest using the interaction of important lagged price and quantity variables interacted with sociodemographic characteristics.
- b. Now do the same thing but estimate the full 3x3 elasticity matrix. Remember that for the OLS regression you'll have residual log sales on the left and residual log price dom, residual log price MM and residual log price trop on the RHS and you'll estimate three separate regressions one for each brand.