BT3102 Assignment 3

Mar 29 to Apr 19 2021

Q1. The sales department plans to run a large promotion. They provide you data obtained from a small trial ("hw3q1.csv"). They want to understand the effectiveness of the promotion. (Hint: the effectiveness can be different for different types of consumers.)

I. Calculate the treatment effects. Verify your results using felm. Are they the same as before-vs-after comparisons or treated-vs-non-treated comparisons?

II. The cost of the promotion is $0.8 per user. Provide specific advices to your colleague and estimate the gain (if any) from the promotion.

Q2. You are a pricing specialist in Grab's data team. You obtain prices and sales ("hw3q2.csv") for two Grab products: JustGrab ($j = 1$) and GrabShare ($j = 2$).

- $surge_j$ measures the level of machine-determined surge pricing for product j. $surge_1$ is randomized. $surge_2$ is demand-driven – when underlying demand is high, a consumer is more likely to receive higher surge pricing. The underlying demand is not recorded in the data and unobserved to you.
- Final prices p_j received by consumers are different for three reasons: (1) machine-determined surge pricing; (2) manual adjustments following revenue managers' "gut feelings" (e.g., private knowledge) about the underlying demand which are not recorded in the data and unobserved to you; (3) other factors that are considered random.
- choice = j if product j is chosen. If neither is chosen, record 0.

You think multinomial logit model is a good model in this context (i.e., $U_{ij} = \beta_0 p_j + \beta_j + \epsilon_{ij}$).

I. Estimate consumer choice model using MLE. Discuss the meaning of your estimates.

II. Discuss any potential endogeneity issue. Implement an estimation procedure that solves the endogeneity issue.

III. Calculate optimal p_j if product j is the only product in the market, or if both products are in the market. Explain why the optimal prices are different.

Q3. Three firms operate in the market. Firm 1 is evaluating an acquisition of firm 2. You are hired as their consultant to conduct merger simulations. The market consists of 10 million consumers with similar utility functions:

$$U_0 = \epsilon_0$$
$$U_1 = -0.03 \times price_1 + 2 + \epsilon_1$$
$$U_2 = -0.03 \times price_2 + 1 + \epsilon_2$$

$$U_3 = -0.03 \times \text{price}_3 + 2 + \epsilon_3$$

Pre-merger prices are determined by a simultaneous move pricing game. Producing s million products costs $C(s)$ million dollars and is the same for the three firms:

$$C(s) = (s-7)^2 + 50$$

For the merged firm, the post-merger cost of producing s_1 and s_2 is:

$$C^M(s_1, s_2) = \lambda_1 \times C(s_1) + \lambda_2 \times C(s_2)$$

Where both λ_1 and λ_2 are in [0.5,1.5] and their exact values are unknown ex ante.

I. Assume that after the merger of firm 1 and firm 2, prices of product 1 and product 2 will be reoptimized as in a multiproduct pricing problem. But firm 3's price is held constant. Assume that $\lambda_1 = \lambda_2 = 1$. Solve the post-merger market outcome (prices, sales and costs, profits). Compare them with the pre-merger equilibrium.

II. In reality, firm 3 will respond as predicted by a simultaneous move pricing game.

   a. Still assume that $\lambda_1 = \lambda_2 = 1$. Compute the post-merger market outcome and discuss how it differs from your answer in Part I.

   b. Conduct a merger analysis for different values of λ_1 and λ_2.

Q4. For this question, we will explore and understand basic concepts of dynamic programming.

I. The effect of maximum capacity on stockpiling behaviour. Set the maximum inventory capacity as 5 and 20 (keep other parameters untouched), respectively. Describe and explain what you observe.

II. The effect of discount factors on stockpiling behaviour. Set discount factors as 0.5 and 0.99 (keep other parameters untouched), respectively. Describe and explain what you observe.

III. The effect of price sensitivity on stockpiling behaviour. Change the value of price coefficient (keep other parameters untouched), respectively. Describe and explain what you observe.

IV. Note that in the slides, we assume that there are two price levels: normal price and promotion price, which is 60% discount. In this exercise, we assume that there are three price levels: normal price, 70% discount and 40% discount. The probabilities of each price levels are 0.8, 0.1 and 0.1 respectively. Please change the code correspondingly, keeping other parameters untouched. Report and briefly discuss your results.