Problem Set #2

The goal of this problem set is twofold. First, we will explore how the use of different instruments affects robustness to misspecification. Second, we will estimate a model of entry and exit, and look at its consequences for estimating welfare.

The delivery should be a self-contained pdf with both questions and answers written down in LaTeX. You should also submit a zip file with the codes and the data inside. Make sure to use relative paths so that your code will run completely and at once from any computer. Inside the zip file, you should include a `README.txt` file with clear instructions on how to run the code. The solution needs to be submitted through the portal in bCourse. No late submissions will be accepted. Start early. Don't leave the problem set for the last week.

Through the problem set, you will use the same data from Problem Set 1, stored in `data_yoghurt.csv`. To estimate the model, you can use the codes from Problem Set 1, or you can use the python library `pyBLP` (this can be a good opportunity to learn how to use the library).

1. Excluded and Included Instruments (40%)

In this section, we will explore how the estimates of the own-price elasticity vary under misspecification. The true data generating process corresponds to the model from Section 5 of Problem Set 1. That is, consumer i's utility be given by

$$u_{ijct} = -\alpha p_{jct} + \tau_j + \tau_c + \tau_t + \beta_i(X_j^s - \bar{X}^s) + \xi_{jct} + \epsilon_{ijct} \tag{1}$$

where $\epsilon_{ijct} \sim^{iid} EVI$, $\beta_i = \bar{\beta} + \sigma v_i$, X_j^s is the sugar content per gram of product of product j, and $\bar{X}^s = \frac{1}{J}\sum_{j=1}^{5} X_j^s$ is the average sugar content in city 1 and month 1. We will define two types of instruments: excluded and included instruments. As excluded instruments, we will use the distance between each city and each product's closest distribution center interacted with diesel prices. As internal instruments, we will use the number of products available in each market.

1. Explain under what assumptions are both instruments valid when the model is correctly specified.

2. Give an intuition for why using included instruments can be less robust to misspecification.

3. Estimate the true model using excluded and included instruments: To identify σ, use the sum of the sugar content per gram of each product in the market.

4. Estimate the following model using external and internal instruments

$$u_{ijct} = -\alpha p_{jct} + \tau_j + \tau_c + \tau_t + \beta_i X_j^s + \xi_{jct} + \epsilon_{ijct} \tag{2}$$

where $\epsilon_{ijct} \sim^{iid} EVI$, $\beta_i = \bar{\beta} + \sigma v_i$, X_j^s is the sugar content per gram of product of product j. To identify σ, use the sum of the sugar content per gram of each product in the market.

5. Estimate the following model using external and internal instruments

$$u_{ijct} = -\alpha p_{jct} + \tau_j + \tau_c + \tau_t + \beta_i X_j^p + \xi_{jct} + \epsilon_{ijct} \tag{3}$$

where $\epsilon_{ijct} \sim^{iid} EVI$, $\beta_i = \bar{\beta} + \sigma v_i$, X_j^p is the protein content per gram of product of product j. To identify σ, use the sum of the protein content per gram of each product in the market.

6. Estimate the following model using external and internal instruments

$$u_{ijct} = -\alpha p_{jct} + \tau_j + \tau_c + \tau_t + \xi_{jct} + \epsilon_{ijct} \tag{4}$$

where $\epsilon_{ijct} \sim^{iid} EVI$. Use only the instrument for prices (plus the fixed effects).

7. Calculate the average own-price elasticity from each estimated model using both excluded and included instruments and plot them in the same figure. Do excluded instruments do better?

2. Entry and Exit (60%)

In Problem Set 1, you estimated the impact on consumer welfare of allowing a merger between Chobani and Dannon. An important assumption from the previous analysis is that the number of competitors was fixed in the counterfactuals with and without the merger. After attending some lectures in the Industrial Organization class at UC Berkeley, you are worried that the merger might affect entry/exit decisions and, therefore, your welfare estimates might be biased.

To account for potential changes in market structure, you write down the following two-stage model. In the first stage, firms observe all product characteristics X, the values of the product, city, and month fixed effects, the marginal cost of production c_{jct} for all firms, and a fixed cost of entering the market, F_{jct}, that is drawn from a random log-normal distribution $\log \mathcal{N}(\mu_F, \sigma_F)$. In deciding whether to enter, firms solve for the equilibrium by setting $\xi_{jct} = 0$ and assuming all firms enter every market. Then, firm j decides to enter in market ct if $\Pi_{jct} \geq F_{jct}$, where Π_{jct} are the profits that the firm would get in market ct if all firms enter the market and $\xi_{jct} = 0$. In the second stage, demand shocks, ξ_{jct}, are realized and firms compete a la Nash-Bertrand in each market.

8. Explain what would you like to expect to happen to entry and exit after the merger happens.

9. To solve the model, we need to start from the second stage. Estimate the demand model presented in Section 5 of Problem set 1 (you already estimated it in the previous section of this problem set) and recover each product's marginal cost.

10. Use your demand estimates and calculate firms' profits, Π_{jct}, when all products are available in every market and $\xi_{jct} = 0$ for each product. This requires solving for a new equilibrium.

11. Denote by $Y_{jct} = 1$ the cases when you see that product j entered in market ct and by $Y_{jct} = 0$ when not. Estimate μ_F and σ_F by MLE using the following likelihood function:

$$\log \mathcal{L}(\theta) = \sum_{ct} \sum_{j} \left(Y_{jct} \Pr(\Pi_{jct} \geq F_{jct}) + (1 - Y_{jct}) \Pr(\Pi_{jct} < F_{jct}) \right)$$

    Report the parameters in a table.

12. Use your demand estimates and calculate firms' profits, Π_{jct}, when all products are available in every market and $\xi_{jct} = 0$ for each product when Chobani and Dannon merge.

13. Calculate the probability that each firm enters into city 1 and month 1 in the counterfactuals with and without the merger. How do the probabilities compare? How do you think this affects your conclusions from Problem Set 1?