EMPIRICAL INDUSTRIAL ORGANIZATION (ECO 310)

Fall 2022 – Victor Aguirregabiria

PROBLEM SET 2

Due on Sunday, November 20, before 11:59pm via Quercus

INSTRUCTIONS. Please, follow these instructions for the submission of your completed problem set.

1. Write your answers electronically in a word processor.
2. For the answers that involve coding in STATA, include in the document the code in STATA that you have used to obtain your empirical results.
3. Convert the document to PDF format.
4. Submit your problem set in PDF online via Quercus.
5. You should submit your completed problem set by **Sunday, November 20, 11:59pm**.
6. You can discuss about the problem set with you classmates, but your answers and code should be written individually.

The total number of marks is 200.

To answer the Questions in this Problem Set, you need to use the datafile `datafile_problemset_02_2022.dta` that you can download from the course website in Quercus. Use this dataset to implement the estimations described below. Please, provide the STATA code that you use to obtain the results.

This dataset contains information on the retail wine industry in a Canadian province. It is a panel dataset with three dimensions: wine product, retail store, and month. It includes $11,033$ wine products, 623 stores, and 12 months, and a total of $6,180,915$ product-store-month observations.

The following Table provides a brief description of all the variables in this dataset.

Description of datafile datafile_problemset_02_2022.dta	
Variable name	**Description**
product	Wine Product ID Number
store	Store ID Number
period	Month count: from 1 to 12
qunit	Quantity (750ml bottles) sold of product in store and month
price_750ml	Price of Product per 750ml bottle
alc	Alcohol percentage points of Wine Product
sugar_gpl	Sugar (gram per litter) of Wine Product
redwine	Dummy for Red Wine
whitewine	Dummy for White Wine
num_country	Country of origin of Wine Product
ontario	Dummy for Ontario origin of Wine Product
winerack	Dummy for Wine Product belongs Wine Rack Brand
wineshop	Dummy for Wine Product belongs Wine Shop Brand
otherontario	Dummy for Ontario Wine other than Wine Rack or Wine Shop
local_msize	Market size (in bottles of wine) at store-month

For the rest of this problem set, we use the following subindexes: j for product, m for store (local market), and t for month.

Consider the following Logit Demand Model:

$$\ln\left(\frac{s_{jmt}}{s_{0mt}}\right) = -\alpha\, p_{jt} + \mathbf{x}_j\, \boldsymbol{\beta} + \xi_{jmt} \tag{1}$$

Variable s_{jmt} is the market share of product j in store m and month t, that is, $s_{jmt} = \frac{qunit}{localmsize}$. Variable p_{jt} represents the price of product j at month t, that is, $p_{jt} = price750ml$. Note that, in this province, the price of a product is the same across all the local markets (stores). Finally, vector $\mathbf{x}_j$ contains the following product characteristics:

$$\mathbf{x}_j = (alc,\ sugargpl,\ redwine,\ whitewine,\ winerack,\ wineshop,\ otherontario,\ Country\ dummies)$$

QUESTION 1. [20 points]. (A) Construct market shares s_{jmt} and s_{0mt}, and variable $y_{jmt} = \ln(s_{jmt}/s_{0mt})$. (B) Present a figure with the histogram of y.

QUESTION 2. [20 points]. Obtain the OLS estimates of parameters α and $\boldsymbol{\beta}$ in equation (1). In this regression, include store fixed effects and month fixed effects. When reporting your table of estimation results, please do not include estimated coefficients for store dummies and month dummies.

QUESTION 3. [20 points]. Based on your estimates in Question 2, provide an estimate of the willingness to pay (in dollars per 750ml bottle) of the average consumer for the following changes.

a. A reduction in alcohol content of 1 percent point.

b. An increase in sugar content of 1 gram per liter.

c. Switching from a white wine to a read wine.

d. Switching from "otherontario" wine to "wineshop" wine.

e. Switching from a French wine to a Canadian wine.

QUESTION 4. [10 points]. Based on the estimates in Question 2, obtain a variable with the estimated own-price demand elasticity $-\frac{ds_{jmt}}{dp_{jmt}} \frac{p_{jmt}}{s_{jmt}}$ for every observation (j, m, t) in the data. Present the mean and median of this variable, and a figure with its histogram.

QUESTION 5. [20 points]. Suppose that ξ_{jmt} follows an AR(1) process: $\xi_{jmt} = \rho\, \xi_{jm,t-1} + a_{jmt}$. Obtain the OLS Cochrane-Orcutt estimates of parameters ρ, α, $\rho\alpha$, and $(1-\rho)\boldsymbol{\beta}$. In this regression, include store fixed effects and month fixed effects. Do not report coefficients for store dummies and month dummies.

QUESTION 6. [10 points]. Based on the estimates in Question 5, obtain a variable with the estimated own-price demand elasticity $-\frac{ds_{jmt}}{dp_{jmt}} \frac{p_{jmt}}{s_{jmt}}$ for every observation (j, m, t) in the data. Present the mean and median of this variable, and a figure with its histogram.

QUESTION 7. [10 points]. Taking into account potential endogeneity, interpret the different estimates of α and of the corresponding demand elasticities in Questions 2 and 5. Based on this interpretation, select between one of these two demand estimations. Justify your choice.

For the remaining questions, we consider the following assumptions.

A. Each wine product is produced by a single manufacturer, and that each manufacturer produces only one wine product. Therefore, j indexes both products and firms.

B. Firms (i.e., wine manufacturers) compete in prices a la Nash-Bertrand.

C. Each store m is a separate geographic market where firms (i.e., wine manufacturers) compete with each other.

D. Every firm can choose a different for its wine product at each store.

E. The marginal cost of product j in market m at month t, MC_{jmt}, is constant: that is, MC_{jmt} does not depend on the amount of output q_{jmt}.

QUESTION 8. [10 points].

a. Obtain the expression for the first order condition of profit maximization for firm j in market m at month t.

b Based on this condition, obtain a "pricing equation" for price p_{jmt} in terms of MC_{jmt} and a price-cost margin term that depends only on α and s_{jmt}.

c. Define the price-cost margin PCM_{jmt} as $\frac{p_{jmt}-MC_{jmt}}{p_{jmt}}$. Obtain an expression for the price-cost margin in terms only of α, s_{jmt}, and p_{jmt}.

QUESTION 9. [20 points]. Use the expressions in Question 8 to obtain estimates of MC_{jmt} and of PCM_{jmt} for every observation (j, m, t). Use your favorite estimate of α. Obtain the mean and median of PCM. Present a histogram of the estimated PCMs.

For Question 10 below, take into account the equation for market share in a demand logit model:

$$s_{jmt} = \frac{a_{jmt}\ \exp\{-\alpha\ p_{jmt} + w_{jmt}\}}{1 + \sum_{i=1}^{J} a_{imt}\ \exp\{-\alpha\ p_{imt} + w_{imt}\}} \tag{2}$$

where $a_{jmt} \in \{0, 1\}$ is a binary variable that indicates whether product j is available in store m at month t. i.e., a_{jmt} is the indicator of $q_{jmt} > 0$. Variable w_{jmt} is equal to $\mathbf{x}_j\ \boldsymbol{\beta} + \xi_{jmt}$, and it can be interpreted as an index of product quality. Also, note that in the logit demand model, taking into account equation (1), we can obtain w_{jmt} using the following equation:

$$w_{jmt} = \ln\left(\frac{s_{jmt}}{s_{0mt}}\right) + \alpha\ p_{jt} \tag{3}$$

QUESTION 10. [60 points]. Given your estimates of demand parameters and MCs, we are interested in evaluating the effects on quantities, prices, firms' profits, and consumer welfare of a hypothetical (counterfactual) increase in the tax of alcohol. Suppose that the tax increase is equal to 1 cent of a dollar per percentage of alcohol in the product, i.e., $taxchange_j = \$0.01 * alc_j$.

a. **[5 points]** Calculate new variable `taxchange` with $taxchange_{jmt}$ for every observation (j, m, t). Add `taxchange` to the estimated marginal cost to obtain the new (counterfactual) marginal cost for every observation (j, m, t).

b. **[5 points]** Using equation (3), calculate a new variable `wquality` with w_{jmt} for every observation (j, m, t).

c. **[20 points]** Obtain an approximation to the new (counterfactual) equilibrium prices and market shares using the following iterative procedure.

Step 1. Use the pricing equation in Question 8(b) to obtain new prices, say $p_{jmt}^{ITER\,1}$, using the new MCs, your estimate of α, and s_{jmt} in the data.

Step 2. Use equation (2) for market shares, your estimates for product qualities w_{jmt}, and new prices $p_{jmt}^{ITER\,1}$ to calculate new market shares, say $s_{jmt}^{ITER\,1}$.

Step 3. Similar as Step 1 but using market shares $s_{jmt}^{ITER\,1}$ instead of the shares in the data. Let $p_{jmt}^{ITER\,2}$ be the prices you obtain after applying this iteration.

Step 4. Similar to Step 2 but using prices $p_{jmt}^{ITER\,2}$ instead of $p_{jmt}^{ITER\,1}$. Let $s_{jmt}^{ITER\,2}$ be the shares you obtain after applying this iteration.

d. **[30 points]** Suppose that $p_{jmt}^{ITER\,2}$ and $s_{jmt}^{ITER\,2}$ are prices and market shares after the implementation of this counterfactual tax change. Calculate the following statistics at the aggregate annual and province level:

- Median price change.
- Change in annual sales of wine in this province.
- Government annual revenue from this tax increase.
- Change in total annual firms' profits in this province.
- Change in annual Consumer Surplus in this province.
- Annual Deadweight Loss of this tax: Change in consumer surplus + Change in firms' profits + Change in government revenue.

Interpret the results.

Hint to obtain the change in Consumer Surplus. You can approximate the change in consumer surplus applying the following formula for each observation (j, m, t). Let (p^{data}, q^{data}) be price and quantity in the data, and let (p^{tax}, q^{tax}) be price and quantity after the tax. Define the change in price as $\Delta p \equiv p^{tax} - p^{data}$, and the change in quantity as $\Delta q \equiv q^{tax} - q^{data}$. Then, the change in consumer surplus can be obtained using the following triangular approximation:

$$\Delta CS \equiv CS^{tax} - CS^{data} = -\Delta p\; q^{tax} + \frac{1}{2}\Delta p\; \Delta q \tag{4}$$