In this problem set, you will build upon your work from the first assignment to analyze a hypothetical buyout of a local craft brewery by a large corporate brewery. A market is denoted by t and a brewery is denoted by j. The matrix below shows an example of a region with 25 markets (or counties). Local breweries are spread throughout the region, and each market can have no more than one local brewery. A county that has a local brewery is marked in red.

$$\begin{matrix} \color{red}{1} & 2 & 3 & 4 & 5 \\ 6 & 7 & 8 & 9 & 10 \\ 11 & \color{red}{12} & 13 & \color{red}{14} & 15 \\ 16 & 17 & 18 & 19 & 20 \\ 21 & 22 & \color{red}{23} & 24 & 25 \end{matrix}$$

There are three corporate breweries: AB, MC, BB. Corporate breweries serve all markets. In addition, AB and MC each owns a craft beer brand acquired through a past buyout. These subsidiaries of AB and MC also serve all markets and are denoted by $AB2$ and $MC2$ for convenience.

Let $\mathcal{J}_t$ denote the choice set of consumers in market t. The outside option of not purchasing beer is denoted by $j = 0$. Consumers in market t have access to beers produced by: (1) the local brewery of the home market; (2) the local breweries that are no more than r market away; and (3) the corporate brewery and their subsidiaries. For example, if $r = 1$, consumers in market 3 would only be served by the corporate breweries and their subsidiaries so that $\mathcal{J}_3 = \{0, AB, AB2, MC, MC2, BB\}$. On the other hand, if $r = 2$, the choice set would be expanded to include nearby local breweries: $\mathcal{J}_3 = \{0, 1, 12, 14, AB, AB2, MC, MC2, BB\}$.

The conditional indirect utility of consumer i in market t from buying beer j is specified as random, with the usual BLP form:

$$\begin{aligned} u_{ijt} &= \delta_{jt} + \eta_{ijt} \quad j \neq 0 \\ u_{i0t} &= \eta_{i0t}. \end{aligned}$$

When a corporate brewery acquires a local brewery through a buyout, the product characteristics of the acquired local brewery do not change, but consumers experience an additional disutility when buying from that brewery since it is now associated with a corporate brand. On the other hand, the acquired local brew can be sold in all markets using the acquiring brewery's distribution network.

Let $\sigma_{jt}(x_t, \xi_t, p_t)$ denote brewery j's market share in county t. Let c_{jt} denote the constant marginal cost of producing brew j in county t.

1. Suppose BB acquires one of the local breweries through a buyout. Let's denote that acquired local brewery as $BB2$. Provide a brief intuitive argument why this buyout may result in higher prices for some brew in some counties but lower prices in other counties.

2. Could the home market prices of $BB2$ have fallen after the buyout in this model? Comment on our assumption that the product characteristics do not change after the buyout.[1]

3. Suppose $BB2$ is able to adopt BB's cost structure so that $c_{BB2} = c_{BB}$. How would this affect your argument in the previous question?

4. Generate a data set using a simple version of the BLP model. You don't have to use the parameter values suggested below; feel free to experiment with different values and document what you use.

(a) Expand the set of markets to 14×14 matrix or larger.

(b) Set $r = 4$ and allocate local breweries so that there are at least two local beers available in each market.[2]

(c) Let x_j consist of:

  (i) Three dummy variables: $1\{j \text{ local}\}$, $1\{j \text{ corporate}\}$, $1\{j \text{ corporate subsidiary}\}$.[3]

  (ii) Alcohol percentage as an iid draw from U(0,1); this is zero if $j = 0$.

  (iii) Bitterness as iid draw from U(0,1); this is zero if $j = 0$.

(d) Let each of the three dummy variables have random coefficient $\beta_{it}^k = \beta_0^k + \beta_1^k \nu_{it}^k$ where $k = 1, 2, 3$ and v_{it}^k is an iid draw from N(0,1).

(e) Let the two quality measures have constant (non-random) coefficients β^4, β^5.

(f) Let $(\beta_0^1, \beta_1^1) = (1.25, 0.8)$, $(\beta_0^2, \beta_1^2) = (0.75, 0.8)$, $(\beta_0^3, \beta_1^3) = (1, 0.8)$, $\beta^4 = 1, \beta^5 = 1$.

(g) Let ξ_j be an iid draw from N(0,1).

(h) Specify constant marginal cost of each brewery as

$$c_{jt} = \gamma \exp\left(\frac{w_{jt}}{8}\right) \exp\left(\frac{\omega_{jt}}{10}\right),$$

where w_{jt} and ω_{jt} are iid draws from N(0,1). For simplicity, we leave the product characterstics out of the marginal cost. For corporate breweries, let $\gamma = 0.85$, and for local breweries, let $\gamma = 1$ to reflect relative cost efficiencies of the large breweries. You can also try making home market costs lower than away market costs to reflect transportation costs.

[1] `https://www.nytimes.com/2017/10/05/dining/leinenkugel-beer-wisconsin.html`

[2] It may be easy to first start with a smaller matrix like in the example and smaller r.

[3] `https://www.brewersassociation.org/independent-craft-brewer-seal/`

(i) For each market t, calculate the matrix of (simulated) own and cross price derivates of market shares $(\frac{\partial s_j}{\partial p_k})$ implied by the true model. To do this:

  (i) Write the choice probability s_j as a weighted average (integral) of choice probabilities conditional on the value of i's random coefficients.

  (ii) Derive the analytical expression for the derivative of the integrand above with respect to p_k.

  (iii) Use the expression in (ii) and simulation of the random coefficients to approximate the integral in (i).

(j) Let prices be set according to firms' first-order conditions, assuming Nash equilibrium in a complete information simultaneous price setting game. You will use the derivatives you calculated above. To construct these prices for one of your markets, start from a guess at the price vector, calling this p^0, and find the prices that solve each firm's first-order conditions assuming the other firms price as in p^0. Then iterate: starting with $l = 0$, take the prices p^l you just obtained, compute the new best-response prices p^{l+1}. Continue iterating until "convergence" (i.e., until the overall price vector changes very little). Note: you can probably do this for all markets at once instead of in a loop over markets.

5. Now estimate the demand model but do so using a nested logit specification where the nests are the outside good, local brewery, and corporate brewery. Estimate the model by 2SLS using all the excluded cost shifters w_{jt} as instrument for market-t prices and "within-group shares" (you may want to review the discussion in Berry (1994) of the nested logit).

6. Without referencing your results, discuss the extent to which the nested logit model is mis-specified.

7. Calculate the matrix of own and cross price derivatives of market shares implied by your estimates. (Use the chain rule and the derivative of the nested logit choice probability with respect to the mean utility. No simulation is needed here.) Provide some useful summary statistics describing the match to the results in 4i and discuss the results.

8. Using the estimated model, simulate the post-buyout prices, treating firms' marginal costs as known (in practice you would estimate these). Show results with and without assuming that $BB2$ adopts BB's cost structure. Provide a helpful set of summary statistics regarding the predicted price changes and discuss them.