Problem Set #3: Entry models

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This exercise will exploit MATLAB skills and you will get further practice using the software by replicating the algorithm in Berry (1992).

Problem 1- Understanding Berry 1992. In this exercise you will have to understand a watered down version of the algorithm created by Berry (1992). We will use the same setting and data as in BR(1991b)[1]. The dataset is "brdata.mat". The variables are the same name as in the paper, so look at the paper for more information on the setting and data. The dataset includes markets with 0, 1, 2, 3, 4, 5 and +5 entrants. We will assume that the expected profit takes the following functional form:

$$\overline{\Pi}_{im} = S_m(\mathbf{Y}, \lambda)V_m(\mathbf{Z}, \alpha_n, \beta) - F_m(W, \gamma).$$

where $S_m(\mathbf{Y}, \lambda)$ measures the size of the market and it is a function of local population demographics $\mathbf{Y}$. $V_m(\mathbf{Z}, \alpha_n, \beta)$ is a measure of per-capita demand, which depends on demand shifters, Z. $F_m(W, \gamma)$ is a measure of fixed costs, which depend on costs shifters. Assume the following functional forms:

$$\begin{aligned}
S_m(\mathbf{Y}, \lambda) &= tpop + \lambda_1 opop + \lambda_2 ngrw + \lambda_3 pgrw + \lambda_4 octy, \\
V_m(\mathbf{Z}, \alpha_n, \beta) &= \alpha_n + \beta_1 eld + \beta_2 pinc + \beta_3 lnhdd + \beta_4 ffrac, \\
F_m(W, \gamma) &= \gamma_n + \gamma_L landv.
\end{aligned}$$

We will introduce firm heterogeneity in the following way:

$$\Pi_{im} = S_m(\mathbf{Y}, \lambda)V_m(\mathbf{Z}, \alpha_n, \beta) - F_m(W, \gamma) + \epsilon_{im}.$$

where ϵ_{im} is an error term specific to firm i and n is the number of firms in market m. We assume that the errors are i.i.d., and follow a standard normal distribution (i.e., N(0,1)). Firm i is willing to enter if $\overline{\Pi}_{im} \geq 0$ which implies that $\epsilon_{im} \geq -(S_m V_m(n) - F_m(n))$.

Let's consider only markets where there are at most 4 firms. Then, let's assume: (1) that the number of potential entrants is equal to 4; (2) the parameters of the profit function equal

[1] Please read the Bresnahan and Reiss 1991b paper to know more about the data.

the estimated values from the BR estimation above; (3) the ϵ_{im} are i.i.d. across firms and markets and are distributed following a standard normal distribution. For each market m, approximate by simulation the expected number of firms:

$$E[n_m|Y_m, Z_m, \hat{\theta}] = \int \cdots \int n_m^*(\epsilon_{1m}, \ldots, \epsilon_{4m}|Y_m, Z_m, \hat{\theta})\phi(\epsilon_{1m}, \ldots, \epsilon_{4m})$$

where $\hat{\theta}$ are the estimated parameters from the BR setting, ϕ is the multivariate standard normal density. Assume that in each market m, the most profitable entrant moves first, followed by the second most profitable, the by the third most profitable, and finally by the least profitable entrant.

The following steps are taken in order to proceed with the approximation of $E[n_m|Y_m, Z_m, \hat{\theta}]$ for each $m = 1, \ldots, M$:

1 Set the number of simulations to $S = 1000$

2 For each draw $s = 1, \ldots, S$, generate a vector of four independent standard normal variables $(\epsilon_{1m}^s, \epsilon_{2m}^s, \epsilon_{3m}^s, \epsilon_{4m}^s)$ per market.

3 For each vector $(\epsilon_{1m}^s, \epsilon_{2m}^s, \epsilon_{3m}^s, \epsilon_{4m}^s)$, compute the number of firms $n_m^*(Y_m, Z_m, \hat{\theta})$ using

$$n_m^{*,s}(\epsilon^s, \hat{\theta}) = \max\left(0 \leq n \leq N \Big| \sum_{i=1}^{N} 1\{\epsilon_{im} \geq -(S_m V_m(n) - F_m(n))|Y_m, Z_m, \hat{\theta}\} \geq n\right)$$

In calculating it, follow the assumed order of move.

4 Compute the average $S^{-1}\sum_{s=1}^{S} n_m^*(Y_m, Z_m, \hat{\theta})$ to approximate $E[n_m|Y_m, Z_m, \hat{\theta}]$ in each market m.

Construct your own code following steps 1 to 4.