Problem Set 3

Cement Monopoly

Due: 11PM Eastern Time on Sunday, September 22

Econ 316: Industrial Organization

To turn in this problem set:

- Email submit.io.psets@gmail.com, attaching (1) a pdf with your answers and (2) your .ipynb file.

Honor code

I am allowed to discuss the problem sets with others. However, I will write everything I submit, such as code, mathematical derivations, and final answers. I will not copy others. When I receive advice from others, I will cite them in my problem set.

For example, if student named Juana Diaz gave you advice on a line of code, you should write "(Received advice from Juana Diaz)" on that line. Receiving advice does not affect your grade or how the grader thinks of you.

Question 0

0A: I followed the honor code on this problem set. (Answer Yes or No.)

0B: How much time did you spend on this problem set?

Question 1: Cement monopolies

(You should review the Intro II lecture slides before doing this problem set.)

There are 107 large cement plants in the U.S. Because it is expensive to transport cement long distances, plants sell locally. But economies of scale in cement production mean that local areas can become natural monopolies. In this problem, we assume that the 107 plants are monopolists over local demand. We want to calculate the deadweight loss from monopoly pricing.

Assume that demand around plant i is

$$Q_i = \beta_0 + \beta_1 P_i + U_i,$$

where P_i is the price, β_1 is a scalar, and U_i is an *unobserved* demand shock.
"Unobserved" means that the econometrician (i.e. you) does not know it. However, the plant manager does know it, and uses it to set prices.

Each plant sets prices to maximize profits:

$$max\pi_i(P_i) = Q_i(P_i) \cdot (P_i - c_i),$$

where $Q_i(P_i)$ is the demand function from above, and c_i is the (constant) marginal cost.

1A: Derive a formula for the profit-maximizing price P_i^* as a function of $(\beta_1, \beta_0, c_i, U_i)$.
1B: Derive a formula for the profit-maximizing quantity Q_i^* as a function of $(\beta_1, \beta_0, c_i, U_i)$.

In the dropbox folder for this problem set, you will find cement_data.csv, a csv file containing (simulated) data on prices P_i^* , marginal costs c_i , and quantities sold Q_i^* at the 107 US plants. You will also find a template python notebook called PS2_Template.ipynb. Download both, and modify PS2_Template.ipynb as needed to answer the below questions.

1C: Report a scatterplot of the $\{P_i^*$, $Q_i^*\}$ pairs in the 107 markets.
1D: Is the slope of the relationship between price and quantity an unbiased estimate of the β_1 parameter in the demand function above? Why or why not?

1E: Report a scatterplot of the $\{P_i^*$, $c_i^*\}$ pairs in the 107 markets.
1F: Report a scatterplot of the $\{Q_i^*$, $c_i^*\}$ pairs in the 107 markets.
1G: Using OLS, regress price on marginal cost. Report the coefficient on marginal cost. (Note that this is an estimate of the slope of your scatterplot in 1E.)
1H: Using OLS, regress quantity on marginal cost. Report the coefficient on marginal cost. (Note that this is an estimate of the slope of your scatterplot in 1F.)
1I: Divide your answer in 1H by your answer in 1G and report the result. As we discussed in lecture, this is an estimate of β_1.
1J: Confirm the estimate of β_1 by running a formal instrumental variables regression. You should get the same coefficient as in 1I (up to rounding error) and can use this to check your work.

1K: Notice that the elasticity of demand at the equilibrium $\{P_i^*$, $Q_i^*\}$ can be written as

$$\eta_i = \frac{dQ}{dP}\frac{P_i^*}{Q_i^*} = \beta_1 \frac{P_i^*}{Q_i^*}.$$

Create the vector of 107 values of η_i, using your estimate of β_1. Report the minimum, maximum, and mean.
1L: Are these cement plants pricing on the elastic ($\eta < -1$) or inelastic ($\eta > -1$) portion of their demand functions? Is this what you would expect given our discussion of the inverse elasticity markup rule? (Hint: If you put $\eta > -1$ into the inverse elasticity markup rule, you get an equation that doesn't make any sense. So the monopolist will always set price at a point on the demand curve where $\eta < -1$.)

1M: Imagine now that states regulate all cement plants and force them to sell all cement at marginal cost c_i. In each market, there would now be a new equilibrium quantity Q_i^{pc}. Create the vector of 107 values of Q_i^{pc}. Report the mean.
1N: Write the formula for the deadweight loss (DWL) from monopoly pricing relative to marginal cost pricing in market i, as a function of $\left(Q_i^{pc}, Q_i^*, P_i^*, c_i\right)$. (Hint: this is just a triangle, as in the lecture slides.)
1O: Create the vector of 107 DWLs. Report the sum of this vector. This is the estimated nationwide DWL from cement monopolies.