Industrial Organization II (ECO 2901)

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Problem Set #1.

Due on Thursday, March 10, 2011

Context. At the end of year 2002, the federal government of the Republic of Greenishtan introduced a new environmental regulation on the cement industry, one of the major polluting industries. The most important features of this regulation is that new plants, in order to operate in the industry, should pass an environmental test and should install new equipment that contributes to reduce pollutant emissions. Industry experts consider that this new law increased the fixed cost of operating in this industry. However, these experts disagree in the magnitude of the effect. There is also disagreement with respect to whether the new law affected variable costs, competition, prices, and output. You have been hired by the Ministry of Industry as an independent researcher to study and to evaluate the effects of this policy on output, prices, firms' profits, and consumer welfare.

Data. To perform your evaluation, you have a panel dataset with annual information on the industry for the period 1998-2007. The Stata datafile `eco2901_problemset_01_2011.dta` contains panel data from 200 local markets (census tracts) over 10 years (1998-2007) for the cement industry in the Republic of Greenishtan. The local markets in this dataset have been selected following criteria similar to the ones in Bresnahan and Reiss (1991). This is the list of variables in the dataset:

Variable name		**Description**
`market`	:	Code of local market
`year`	:	Year
`pop`	:	Population of local market
`income`	:	Per capita income in local market
`output`	:	Annual output produced in the local market
`price`	:	Price of cement in local market
`pinput`	:	Price index of intermediate inputs in local market
`nplant`	:	Number of cement plants in local market at current year

Model. To answer our empirical questions, we consider a model in the spirit of the model by Bresnahan and Reiss that we have seen in class. The main difference with respect to that model is that we specify the demand function and the cost function in the industry and make it explicit the relationship between these primitives and the profit of a plant.

Demand of cement in market m at period t. We assume that cement is an homogeneous product and consider the following inverse demand function:

$$\ln P_{mt} = \alpha_0^D + \alpha_1^D \ln POP_{mt} + \alpha_2^D \ln INC_{mt} - \alpha_3^D \ln Q_{mt} + \varepsilon_{mt}^D$$

where $\alpha^{D\prime}s$ are demand parameters, Q_{mt} represents output, POP_{mt} is population, INC_{mt} is per capita income, P_{mt} is price, and ε_{mt}^D is a component of the demand that is unobserved to the researcher.

Production costs. Let q_{mt} be the amount of output of a cement plant in market m and period t. The production cost function is $C_{mt}(q_{mt}) = FC_{mt} + MC_{mt}\ q_{mt}$, where FC_{mt} and MC_{mt} are the fixed cost function and the marginal cost, respectively. We consider the following specification for FC_{mt} and MC_{mt}:

$$\begin{aligned} FC_{mt} &= \exp\left\{X_{mt}\ \alpha^{FC} + \varepsilon_{mt}^{FC}\right\} \\ MC_{mt} &= \exp\left\{X_{mt}\ \alpha^{MC} + \varepsilon_{mt}^{MC}\right\} \end{aligned}$$

where X_{mt} is the vector $(1,\ln POP_{mt},\ln INC_{mt},\ln PINPUT_{mt})$, where $PINPUT_{mt}$ is the index price of inputs (energy and limestone); α^{FC} and α^{MC} are vectors of parameters; and ε_{mt}^{FC} and ε_{mt}^{MC} are components of the fixed cost and the marginal cost, respectively, that are unobserved to the researcher. The main reason why we consider an exponential function in the specification of FC_{mt} and MC_{mt} is to impose the natural restriction that costs should be always positive.

Entry costs and scrapping value. For simplicity, we consider a static model and therefore we assume that there are not sunk entry costs.

Unobservables. Let ε_{mt} be the vector of unobservables $\varepsilon_{mt} \equiv (\varepsilon_{mt}^D,\ \varepsilon_{mt}^{MC},\ \varepsilon_{mt}^{FC})$. We allow for serial correlation in these unobservables. In particular, we assume that each of these unobservables follows an AR(1) process. For $j \in \{D,\ MC,\ FC\}$:

$$\varepsilon_{mt}^j = \rho^j\ \varepsilon_{mt-1}^j + u_{mt}^j$$

where $\rho^j \in [0,1)$ is the autorregressive parameter, and the vector $u_{mt} = (u_{mt}^D,\ u_{mt}^{MC},\ u_{mt}^{FC})$ is i.i.d. over markets and over time with a joint normal distribution with zero means and variance-covariance matrix Ω.

Question 1 [20 points]. **(a)** Propose an estimator of the demand parameters and explain the assumptions under which the estimator is consistent. **(b)** Obtain estimates and standard errors. **(c)** Test the null hypothesis of "no structural break" in demand parameters after year 2002.

Question 2 [20 points]. **(a)** Describe how to use the Cournot equilibrium conditions to estimate the parameters in the marginal cost function. Explain the assumptions under which the estimator is consistent. **(b)** Obtain estimates and standard errors. **(c)** Test the null hypothesis of "no structural break" in the variable cost parameters after year 2003.

Question 3 [30 points]. Assume that $\rho^{FC} = 0$. **(a)** Describe how to estimate the parameters in the fixed cost function. Show that these costs are identified in dollar amounts (i.e., not only up to scale). Explain the assumptions under which the estimator is consistent. How does the estimation of fixed costs change if $\rho^{FC} \neq 0$? Explain. **(b)** Obtain estimates and standard errors. **(c)** Test the null hypothesis of "no structural break" in the fixed cost parameters after year 2003.

Question 4 [30 points]. Now, we use our estimates to evaluate the effects of the policy change. Suppose that we attribute to the new policy the estimated change in the parameters of the cost function, but not the estimated change in the demand parameters.

(a) [10 points] Given the estimated parameters "after 2002", calculate the equilibrium values of the endogenous variables $\{P_{m,2003}, Q_{m,2003}, N_{m,2003}\}$ for every local market in 2003, i.e., for every value of the exogenous variables $(X_{m,2003}, \varepsilon_{m,2003})$. Obtain also firms' profits, consumer welfare, and total welfare.

(b) [10 points] Now, consider the counterfactual scenario where demand parameters are the ones "after 2002" but cost parameters are the ones "before 2003". For this scenario, calculate the "counterfactual" equilibrium values of the endogenous variables $\{P^*_{m,2003}, Q^*_{m,2003}, N^*_{m,2003}\}$ for every local market in 2003. Also obtain the counterfactual values for firms' profits, consumer welfare, and total welfare.

(c) [10 points] Obtain the effects of the policy one the number of firms, output, prices, firms' profits, consumer welfare, and total welfare. Comment the results. Present two-way graphs of these effects with the logarithm of population in the horizontal axis and the estimated on a certain endogenous variable in the vertical axis. Comment the results. What are the most important effects of this policy?