Industrial Organization II (ECO 2901)
Winter 2016. Victor Aguirregabiria

Problem Set
Due in class on Friday, March 10th, 2017

PROBLEM 1 [PRODUCTION FUNCTION]

The Stata datafile `data_mines_eco2901_2017.dta` contains annual information on output and inputs from 330 copper mines for the period 1992-2010 (19 years). The following is a description of the variables.

Variable name		**Description**
`id`	:	Mine identification number
`year`	:	Year [from 1992 to 2010]
`active`	:	Binary indicator of the event "mine is active during the year"
`prod_tot`	:	Annual production of pure copper of the mine [in thousands of tonnes]
`reserves`	:	Estimated mine reserves [in thousands of ore]
`grade`	:	Average ore grade (in %) of mined ore during the year (% copper / ore)
`labor_n_tot`	:	Total number of workers per year (annual equivalent)
`cap_tot`	:	Measure of capital [maximum production capacity of the mine]
`fuel_cons_tot`	:	Consumption of fuel (in physical units)
`elec_cons_tot`	:	Consumption of electricity (in physical units)
`materials_tot`	:	Consumption of intermediate inputs / materials (in $ value)

Note that some variables have a few missing values even at years when the mine is actively producing.

Question 1.1. Consider a Cobb-Douglas production function in terms of labor, capital, fuel, electricity, and ore grade. Use this dataset to implement the following estimators:

- OLS
- Fixed-Effects
- Arellano-Bond estimator with non-serially correlated transitory shock
- Arellano-Bond estimator with AR(1) transitory shock
- Blundell-Bond estimator with non-serially correlated transitory shock
- Blundell-Bond estimator with AR(1) transitory shock
- Olley-Pakes (Using the first difference in cap_tot as investment)
- Levinshon-Petrin

Question 2.1. Suppose that these mines are price takers in the input markets. Consider that the variable inputs are labor, fuel, and electricity.

(a) Derive the expression for the Variable Cost function for a mine (i.e., the minimum cost to produce an amount of output given input prices).
(b) Let $\ln MC_{it}$ be the logarithm of the realized Marginal Cost of mine i at year t. I have not included data on input prices in this dataset, so we will assume that mines face the same prices for variable inputs, and normalize to zero the contribution of these input prices to $\ln MC_{it}$. Calculate the quantiles 5%, 25%, 50%, 75%, and 95% in the cross-sectional distributions of $\ln MC_{it}$ at each year in the sample. Present a figure with the time-series of these five quantiles over the sample period. Comment the results.
(c) For a particular sample year, say 2005, calculate the contribution of each component of $\ln MC_{it}$ (i.e., total factor productivity, capital, ore grade, and output) to the cross-sectional variance of $\ln MC_{it}$. Present it in a table. Comment your results.
[Note: To measure the contribution of each component, use the following approach. Consider $y = \beta_1 x_1 + \beta_2 x_2 + ... + \beta_K x_K$. A measure of the contribution of x_j to $var(y)$ is $\rho_j \equiv \dfrac{var(y) - var(y \mid x_j = constant)}{var(y)}$. Note that $\rho_j \in (0, 1)$ for any variable x_j. However, in general, $\sum_{j=1}^{K} \rho_j$ can be either smaller or greater than one, depending the sign of the covariances between the components.]
(d) Consider the balance panel of mines that are active in the industry every year during the sample period. Repeat exercises (b) and (c) for this balanced panel. Compared your results with those in (c) and (d). Comment the results.

PROBLEM 2 [DEMAND OF DIFFERENTIATED PRODUCTS]

The STATA datafile `eco2901_problemset_01_2012_airlines_data.dta` contains a panel dataset of the US airline industry in 2004. A market is a *route* or directional city-pair, e.g., round-trip Boston to Chicago. A product is the combination of route (m), airline (f), and the indicator of stop flight or nonstop flight. For instance, a round-trip Boston to Chicago, non-stop, with American Airlines is an example of product. Products compete with each other at the market (route) level. Therefore, the set of products in market m consists of all the airlines with service in that route either with nonstop or with stop flights. The dataset contains $2,950$ routes, 4 quarters, and 11 airlines (where the airline "Others" is a combination of multiple small airlines). The following table includes the list of variables in the dataset and a brief description.

Variable name		Description
`route_city`	:	Route: Origin city to Destination City
`route_id`	:	Route: Identification number
`airline`	:	Airline: Name (Code)
`direct`	:	Dummy of Non-stop flights
`quarter`	:	Quarter of year 2004
`pop04_origin`	:	Population Origin city, 2004 (in thousands)
`pop04_dest`	:	Population Destination city, 2004 (in thousands)
`price`	:	Average price: route, airline, stop/nonstop, quarter (in dollars)
`passengers`	:	Number of passengers: route, airline, stop/nonstop, quarter
`avg_miles`	:	Average miles flown for route, airline, stop/nonstop, quarter
`HUB_origin`	:	Hub size of airline at origin (in million passengers)
`HUB_dest`	:	Hub size of airline at destination (in million passengers)

In all the models of demand that we estimate below, we include time-dummies and the following vector of product characteristics:

{ `price, direct dummy, avg_miles, HUB_origin, HUB_dest, airline dummies` }

In some estimations we also include market (route) fixed effects. For the construction of market shares, we use as measure of market size (total number of consumers) the average population in the origin and destination cities, in number of people, i.e., `1000*(pop04_origin + pop04_dest)/2`.

Question 2.1. Estimate a Standard Logit model of demand: (a) by OLS without route fixed effects; (b) by OLS with route fixed effects. Interpret the results. What is the average consumer willingness to pay (in dollars) for a nonstop flight (relative to a stop flight), ceteris paribus? What is the average consumer willingness to pay for one million more people of hub size in the origin airport, ceteris paribus? What is the average consumer willingness to pay for Continental relative to American Airlines, ceteris paribus? Based on the estimated model, obtain the average elasticity of demand for Southwest products. Compare it with the average elasticity of demand for American Airline products.

Question 2.2. Consider a Nested Logit model where the first nest consists of the choice between groups "Stop", "Nonstop", and "Outside alternative", and the second nest consists in the choice of airline. Estimate this Nested Logit model of demand: (a) by OLS without

route fixed effects; (b) by OLS with route fixed effects. Interpret the results. Answer the same questions as in Question 2.1.

Question 2.3. Consider the Nested Logit model in Question 2.2. Propose and implement an IV estimator that deals with the potential endogeneity of prices. Justify your choice of instruments, e.g., BLP, or Hausman-Nevo, or Arellano-Bond, ... Interpret the results. Compare them with the ones from Question 2.2.

Question 2.4. Given your favorite estimation of the demand system, calculate price-cost margins for every observation in the sample. Use these price cost margins to estimate a marginal cost function in terms of all the product characteristics, except price. Assume constant marginal costs. Include also route fixed effects. Interpret the results.

Question 2.5. Consider the route Boston to San Francisco ("BOS to SFO") in the fourth quarter of 2004. There are 13 active products in this route-quarter, and 5 of them are non-stop products. The number of active airlines is 8: with both stop and non-stop flights, America West (HP), American Airlines (AA), Continental (CO), US Airways (US), and United (UA); and with only stop flights, Delta (DL), Northwest (NW), and "Others". Consider the "hypothetical" merger (in 2004) between Delta and Northwest. The new airline, say DL-NW, has airline fixed effects, in demand and costs, equal to the average of the fixed effects of the merging companies DL and NW. As for the characteristics of the new airline in this route: `avg_miles` is equal to the minimum of `avg_miles` of the two merging companies; `HUB_origin = 45`; `HUB_dest = 36`; and the new airline still only provides stop flights in this route.

(a) Using the estimated model, obtain airlines profits in this route-quarter before the hypothetical merger.
(b) Calculate equilibrium prices, number of passengers, and profits , in this route-quarter after the merger. Comment the results.
(c) Suppose that, as the result of the merger, the new airline decides also to operate non-stop flights in this route. Calculate equilibrium prices, number of passengers, and profits , in this route-quarter after the merger. Comment the results.