Empirical IO homework

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I. Question 1: Demand estimation

A. *Standard BLP model*

The utility of a consumer i is for product j at time (market) t is:

$$U_{ijt} = X_{jt}\beta + \alpha_i p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

where X_{jt} are product observable characteristics (the first variable is a constant), ξ_{jt} is the product-specific shock and ε_{ijt} is the indiosyncratic shock. Here we assume that the preferences for product characteristics β is the same for all individuals while the price sensitivity α is individual-specific. We assume that α_i is normally distributed:

$$\alpha_i = \bar{\alpha} + \sigma \nu_i$$

where $\nu_i \sim \mathscr{N}(0,1)$. Because ε_{ijt} are extreme value distributed we can compute the probability of buying product j for individual i:

$$s_{ijt} = \frac{\exp\left(\delta_{jt} + \sigma \nu_i p_{jt}\right)}{1 + \sum_{k \in \mathscr{J}_t} \exp\left(\delta_{kt} + \sigma \nu_i p_{kt}\right)}$$

where we have denoted the mean utility by:

$$\delta_{jt} = X_{jt}\beta + \bar{\alpha} p_{jt} + \xi_{jt}$$

Then we aggregate individual probabilities to get market shares:

$$s_{jt} = \int \frac{\exp\left(\delta_{jt} + \sigma \nu p_{jt}\right)}{1 + \sum_{k \in \mathscr{J}_t} \exp\left(\delta_{kt} + \sigma \nu p_{kt}\right)} \phi(\nu) d\nu$$

To approximate this integral, we draw 100 observations of ν from $N(0,1)$ and compute:

$$s_{jt} = \sum_{n=1}^{100} \frac{\exp\left(\delta_{jt} + \sigma \nu_n p_{jt}\right)}{1 + \sum_{k \in \mathscr{J}_t} \exp\left(\delta_{kt} + \sigma \nu_n p_{kt}\right)}$$

We use the standard BLP contraction to invert this equation and get $\delta_{jt}(\sigma; s_{jt})$ as a function of unknown σ and observed market share s_{jt}.

By definition:

$$\xi_{jt} = \delta_{jt} - X_{jt}\beta - \bar{\alpha} p_{jt}$$

Firstly, for a given σ and using the instruments Z_{jt} for price, we can estimate the parameters using GMM with moments:

$$\mathbb{E}[\xi Z] = 0$$

We use the 2SLS estimator, which is an efficient GMM estimator when there is no heteroskedasticity. The GMM error is now a function of σ and to be minimized as a second step.

The parameter estimates are presented in the table below.

TABLE 1—DEMAND COEFFICIENT ESTIMATES

	BLP instruments	
	coef.	sd.
constant	-7.2267***	(0.0274)
Cylinder	-0.0367	(0.0116)
Weight	0.1989***	(0.0003)
Horsepower	0.2066***	(0.0008)
Fuel cost	-0.3852***	(0.0003)
Price	-1.7938***	(0.0074)

Note: ***: 95%, **: 90% confidence of rejecting H0

The sign of the parameter estimates are as expected, except for the variable "Cylinder" (though it is not statistically significant). The price coefficient is negative and statistically significant.

B. With Fixed Effects

Assume now that the product-specific error can be written as:

$$\xi_{jt} = \xi_b + \xi_t + \Delta\xi_{jt}$$

where ξ_b is the brand fixed effect (a brand may include many products) and ξ_t is the time fixed effect. The moments become:

$$\mathbb{E}[\Delta\xi Z] = 0$$

and we estimate by including dummy variables for the fixed effects.

The estimation results are presented in the second column of the table below.

TABLE 2—DEMAND COEFFICIENT ESTIMATES

	BLP instruments		With Fixed Effects	
	coef.	sd.	coef.	sd.
constant	-7.2267***	(0.0274)	-5.0103***	(0.059)
Cylinder	-0.0367	(0.0116)	-0.2146***	(0.0114)
Weight	0.1989***	(0.0003)	0.3625***	(0.0005)
Horsepower	0.2066***	(0.0008)	0.1894***	(0.0009)
Fuel cost	-0.3852***	(0.0003)	-0.3376***	(0.0003)
Price	-1.7938***	(0.0074)	-5.0354***	(0.0143)

The signs are as before, except that the coefficient for "cylinder" is negative and statistically significant. We will use these estimates for Part 2.

Note: ***: 95%, **: 90% confidence of rejecting H0

C. 1.3. With Fixed Effects and Local Differential IVs

We use the local differential Instruments recommended by Gandhi and Houde (2020):

$$\sum_{j'} \left| d^l_{jt,j'} \right| \mathbb{1}\left(\left| d^l_{jt,j'} \right| < sd(x^l) \right) \tag{1}$$

where $d^l_{jt,j'} = x^l_{j't} - x^l_{jt}$ is the distance in characteristics l of product j and j', including price (fitted price after first step of 2SLS). The results are reported in the following table:

TABLE 3—DEMAND COEFFICIENT ESTIMATES

	BLP instruments		With Fixed Effects		With FE and Differential IV	
	coef.	sd.	coef.	sd.	coef.	sd.
constant	-7.2267***	(0.0274)	-5.0103***	(0.059)	-5.9596***	(0.0578)
Cylinder	-0.0367	(0.0116)	-0.2146***	(0.0114)	-0.1798**	(0.0112)
Weight	0.1989***	(0.0003)	0.3625***	(0.0005)	0.3074***	(0.0005)
Horsepower	0.2066***	(0.0008)	0.1894***	(0.0009)	0.1894***	(0.0008)
Fuel cost	-0.3852***	(0.0003)	-0.3376***	(0.0003)	-0.3381***	(0.0003)
Price	-1.7938***	(0.0074)	-5.0354***	(0.0143)	-3.7829***	(0.013)

Note: ***: 95%, **: 90% confidence of rejecting H0

II. Question 2: Counterfactual simulation

We consider only the data for 2008, and by computing the ownership matrix, we recover the marginal cost. Results are the following: The average markup of the industry is 0.2636. The total industry profit is 7.2774e+09 (trillion euro). The average consumer surplus is 0.3479e+04.

A. Merger and economies of scale

For the first part of this question, we compute the new ownership matrix, and by using fsolve function and help-foc we find the new prices. Also, by using the omega-share function, we find the new market shares. After the merger, the average price increases by 0.8129 percent. The markup increase by 1.5771 percent. The total profit of VOLKSWAGEN and BMW increase by 0.3319 percent. The total profit of the industry increase by 0.6589 percent. The average consumer surplus decrease by -0.3870 percent.

For the second part of this question we guess (by try and error) the cost reduction of the marginal cost should not be more than five percent. So by a "brute force" algorithm we find the minimum efficiency gain is 1.8 percent necessary for the merger to generate no decrease in the average consumer surplus.

B. Cross participation

For the first part of this question, we set 0.3 in the ownership matrix for the intersection of REN and PSA and 0 for the intersection of PSA and REN. Then, the average price increases by 0.2690 percent, the average markup increases by 1.1522 percent, the profit of PSA decreases by 27.9700 percent, the profit of REN increases by 41.8047 percent, the total profit of industry increases by 1.7635 percent, and the average consumer surplus decrease by 1.2949 percent.

For the second part, we set 0.3 for both intersections in the ownership matrix. So the maximum willingness of PSA to pay after REN bought 30 percent of PSA is 4.5463e+08. Now we set 0 in the ownership matrix for the intersection of REN and PSA and 0.3 for the intersection of PSA and REN. Hence, the maximum willingness of PSA to pay before REN buys 30 percent of PSA is 4.7720e+08. These numbers are correct if we consider only one year. The below table shows the profit of PSA in different cases.

TABLE 4—PROFIT OF PSA IN DIFFERENT CASES

	REN = 0	REN = 30
PSA = 0	2.2885e+09	1.6484e+09
PSA = 30	2.7657e+09	2.1030e+09