Empirical IO Homework

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Estimation of the model

Question 1

We write the utility function of consumer i, for automobile j of brand k in year t as

$$U_{ijkt} = X_{jkt}\beta + \alpha_i fc_{jkt} + \gamma p_{jkt} + \xi_{jkt} + \epsilon_{ijkt} \tag{1}$$

where X_{jkt} includes observed characteristics such as intercept, cylinder capacity, weight, horsepower; fc_{jkt} is fuel cost; p_{jkt} is the price , ξ_{jkt} is unobserved characteristics, ϵ_{ijkt} is individual taste shock and extreme value distributed as in BLP model.

Then we collect the estimates of parameters in the first column of Table 1. It can be shown that all coefficients have the expected signs.

And we present the distribution of the fuel cost sensitivities in Figure 1, which is labeled as "without brand fe".

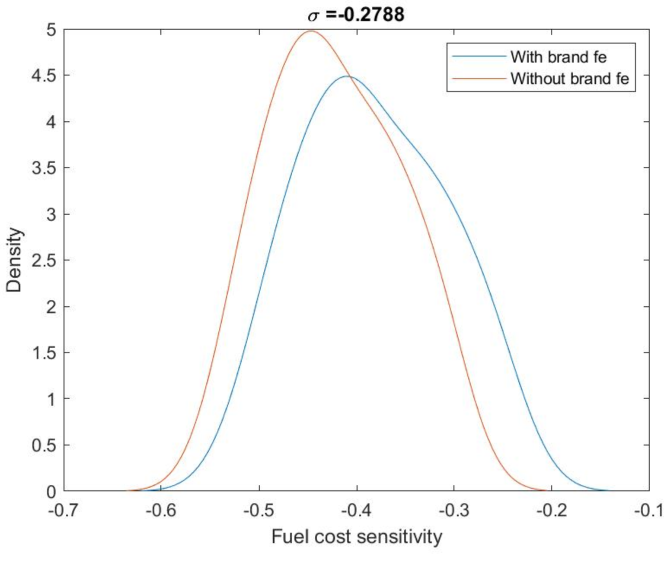

Figure 1: Sensitivity of Fuel Cost Coefficient

Question 2

After adding brand fixed effects, we collect the estimates of parameters in the second column of Table 1. The estimates of characteristics do not vary too far from the benchmark estimates. Only cylinder has a negative sign and therefore a small negative impact on utility function of consumer. And we observe mild changes in fuel cost sensitivity and heterogeneity of that, which suggest that intra-brand choice and inter-brand choices do not differ too much for consumers. This reflect the fact that fuel cost is a homogeneous engineering feature among various brands and their production line of cars. In other words, consumers, when faced with different cars of the same brand or different cars of different brand, have similar response to the feature of fuel cost.

Variable	No FE	With Brand FE	With Brand and Year FE
Intercept	-7.6796	-7.9457	1.0623
Cylinder	0.028149	-0.05213	-0.50498
Weight	0.1417	0.15704	0.18782
Horsepower	0.22185	0.19114	0.099827
Fuel Cost	-0.28759	-0.2336	0.63741
RC Fuel Cost	-0.25134	-0.27878	-9.5167
Price	-0.89675	-0.96385	-0.68003

Table 1: Coefficient Estimates from Different Regression

We also try to add year fixed effects, which is collected in the third column of Table 1. But the estimates are absurd since fuel cost has a positive impact on utility function of consumers.

And the validity of estimates of variance σ of random coefficient is supported by Figure 2 and 3.

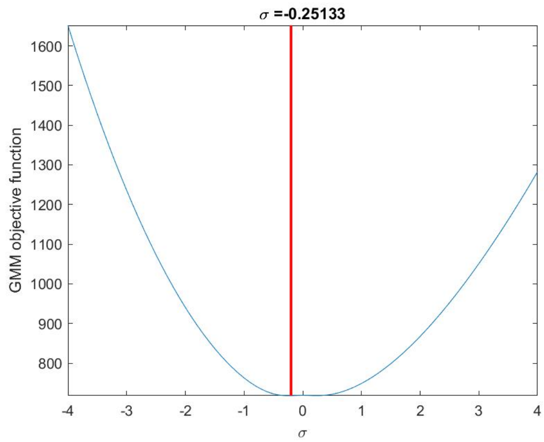

Figure 2: GMM without Brand FE

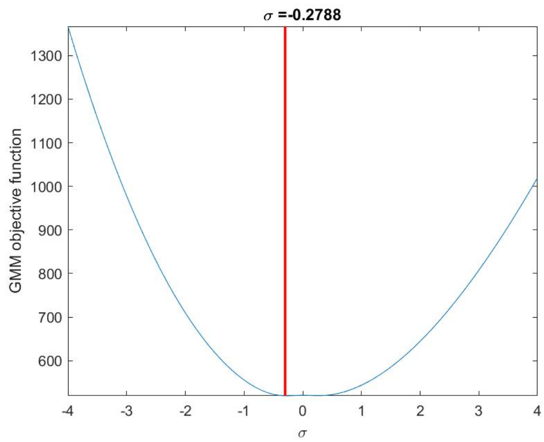

Figure 3: GMM with Brand FE

Question 3

We collect results in the first column of Table 2.

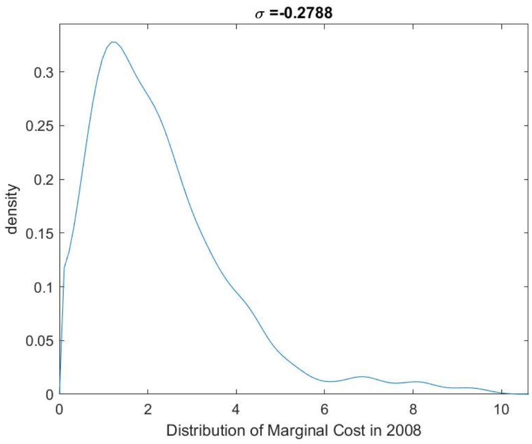

Figure 4: Distribution of Marginal Cost in 2008

Counterfactual Simulations

Question 1

Question 1.1

We define profit for firm f as

$$\Pi_f = \sum_{j \in f} (p_j - c_j)\, s_j M \tag{2}$$

where M is the market potential so that $s_j \times M$ represents the sales of product j.

Optimal pricing decisions are characterised by a collection of first order conditions as

$$s_j + \sum_{k \in \mathscr{J}_f} (p_k - c_k) \frac{\partial s_k}{\partial p_j} = 0 \quad \forall j \in \mathcal{J}_f \tag{3}$$

where $\mathscr{J}_f$ is the set of products owned by firm f.

We denote tx_{jkt} as taxation paid by consumers for automobile j of brand k in year t and therefore utility function in (1) transform into

$$U^{'}_{ijkt} = X_{jkt}\beta + \alpha_i f c_{jkt} + \gamma(p_{jkt} + tx_{jkt}) + \xi_{jkt} + \epsilon_{ijkt} \tag{4}$$

which yields new market share $s^{'}_j$ and Jacobian matrix $\left(\frac{\partial s^{'}_k}{\partial s^{'}_j}\right)_{j,k \in \{1,\ldots,F\}}$.

Question 1.2

We solve the equilibrium.

Question 1.3

We collect the results in the second column of Table 2 and find that average markup rate, total profit and consumer surplus decrease. Although total tax revenue can make up for the loss of profit, the reduction of consumer surplus is far beyond compensation since it drops for around 5,000 million euros. Tax is not globally welfare improving.

Question 2

Question 2.1

In economics, the Laffer curve illustrates a theoretical relationship between rates of taxation and the resulting levels of the government's tax revenue. The Laffer curve assumes that no tax revenue is raised at the extreme tax rates of 0% and 100%, and that there is a tax rate between 0% and 100% that maximizes government tax revenue.

Question 2.2

We compute the results and claim that when tax rate is around 83€per gram of CO_2 emissions, total tax revenue is maximized at 5585 million euros as shown in the third column of Table 2.

Table 2: Factual and Counterfactual Simulations

Variable	Tax Rate =0	Tax Rate =10	Tax Rate =83	Tax Rate =100
Average MC	2.2922	2.2922	2.2922	2.2922
Average Price	3.3462	3.3480	3.3379	3.3365
Markup (1-c/p)	0.3804	0.38072	0.37866	0.37837
Markup (p/c-1)	0.8228	0.8241	0.81591	0.81477
Total Profit	13650.9138	12251.0462	5282.0509	4360.6005
Total Consumer Surplus	42315.9300	37484.9919	15597.8359	12818.109
Total Tax Revenue	0	1574.7472	5585.4301	5485.9897

Notes: Marginal Cost, Price are in 10,000 €. Markup is a ratio between 0 and 1. Profit, Consumer Suplus and Tax Revenue are in 1,000,000 €.

Question 2.3

We find there is a Laffer curve in Figure 5. And we conclude the following

- Average price has a low sensitivity towards tax rate, but still increase with tax rate at the beginning and decrease when the tax burden becomes too heavy.
- In accordance with price, markup rate increase with tax rate at the beginning and decrease in the end since marginal cost holds constant.
- Unlike price and markup rate, the total profit of industry is decreasing all the time even though markup rate raise for mild tax rate.
- Total consumer surplus decrease all the time as well.
- Total tax revenue is as predicted by Laffer that there exist an optimal tax rate for tax revenue.

The wisdom from the Laffer curve we observe is that there are two tax rates yielding the same tax revenue and price. In other words, if the policy maker aim to implement some taxation policy to ensure certain goals, the tax rate to be chosen may well sit on the left side of the curve instead of the right side, which can also help maintain total industry profit and consumer surplus from extremely large and distortionary tax.

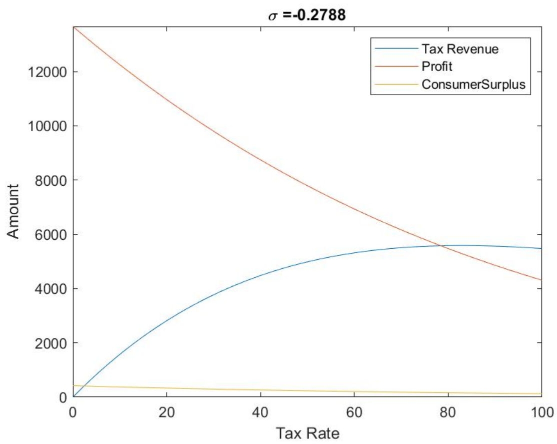

Figure 5: Caption