You can work by group of two or alone. You must provide the code and a short report that explains the approach and presents the results in tables and/or figures. Please send those files by email to `isis.durrmeyer@tse-fr.eu` before December 17$^{\text{th}}$. If you send compressed files, make sure to use the **zip** format.

Data

You have fake data on the French automobile market. This dataset is in csv. You observe the following variables (in order):

year: between 2003 and 2008
num_manuf: identification number for each manufacturer (labeled from 1 to 21)
num_brand: identification number for each brand (labeled from 1 to 40)
price: in €10,000
cylinder: the cylinder capacity (in 1,000cm^3)
weight: in 1,000 kg
horsepower: the fiscal horsepower
fuel_cost: in €/100 km
nb_households: total number of households (market potential)
sj: market shares
co2: CO_2 emissions (in gram per kilometer, g/km)
i1b_poids_vide-i3b_euro_km: standard BLP instruments (sum of other product characteristics)

If working with a random coefficient model is too complicated, use a simple logit model without unobserved individual heterogeneity.

1 Estimation of the model

1) Estimate a random coefficient logit model with a random coefficient on the fuel cost. We assume the fuel cost coefficient is uniformly distributed. *(Note: to approximate the integral, use 100 uniform draws and set the random number generator to "2021").* We specify the utility function as linear in all the car characteristics (intercept, price, cylinder, weight, horsepower and fuel cost). We use the standard BLP instruments that are already constructed. Interpret the coefficients. Do they have the expected signs? Represent graphically the distribution of the fuel cost sensitivities.

2) Estimate the same random coefficient logit model with brand fixed effects. Compare the estimated parameters. We will use these parameters for the counterfactual simulations.

3) Recover the vector of marginal costs for the year 2008 and compute the average mark up rate of the industry, the total industry profits and the total consumer surplus (both in million euros).

2 Counterfactual simulations

For the counterfactual simulation part, you should use the year 2008 only and the parameters estimated in question 2).

Question 1: Welfare impacts of a CO_2 tax

We consider a purchase tax based on the level of carbon emissions of the cars. Specifically, we introduce a tax of €10 per gram of CO_2 emissions. For instance, if the car emits 140 g/km, the buyer has to pay $140 \times 10 =$ €1,400 in addition to the posted price at the time of the purchase.

1) Write the condition that characterizes the optimal price set by firms under the tax.

2) Solve for the new equilibrium outcomes under the tax. [*Hint 1: be careful about the price and tax units!*
Hint 2: be careful to the difference between the price paid by consumers and the posted price.]

3) Calculate the new average mark up rate of the industry, the total industry profits, the total consumer surplus and the total tax revenue (all three in million euros). Is the tax globally welfare improving?

Question 2: Is there a Laffer curve for the carbon tax?

1) Give the definition of a Laffer curve.

2) Define a grid of possible tax rates between 0 and €100 per g/km. For each possible value of the tax rate, compute the total tax revenue generated. [*hint: define the step according to your computer performance and the efficiency of your method to solve for the equilibrium. I use a step of 5 g/km but take a larger one if necessary.*]

3) Plot the tax revenue as function of the tax rate. Is there a Laffer curve? Interpret the result.