The Implications of Pre-Existing Market Power Distortions for Electric Vehicle Tax Policies: Evidence from Colombia

Supplementary materials:

Data (folder): A complete description of the data can be found in the excel file titled "Data set description". This folder contains public data on vehicle's price in Colombia gathered from "El Motor" magazine as well as information on vehicle's specifications including emissions gather from 'https://www.carfolio.com/car-makes/' Scraped using carspecs.py code. Both the pdf files of the original magazine publication and the python code to access the data lays inside this folder.

- **El Motor Prices (folder):** El Motor files with Excel file compiling all the data.
- **Scrape NAN car specifications (folder):** Code and scraped data on vehicles specifications. We used the following websites ('https://www.carfolio.com/car-makes/' and 'https://www.tucarro.com.co/')
- **Data_prep (Junpyter notebook):** Estimation and extrapolation of nan specifications. Used when data was not available on main source (IHS data) or secondary source (scraped websites). Price where not extrapolated.
- **Validation (Junpyter notebook):** Validation of extrapolated data using observed data.

How was the dataset created?

We received information from the Colombian vehicle market from IHS Markit for the years 2015 to 2020. This data is protected by a Non-Disclosure Agreement (NDA) and is not included in the Data folder.

The dataset had several missing values, particularly for MSRP and vehicle characteristics. To address these gaps, we used public data from "El Motor" magazine to fill in the MSRP column and data from the website 'https://www.carfolio.com/car-makes/' for vehicle characteristics and emissions. Data from Carfolio was collected using web scraping techniques. The scraping script, named 'carspecs.py', is located in the "Scrape NAN car specifications" folder.

We used the script "Fill_NAN.py", located in the Data folder, to fill in missing values in the IHS data. The resulting file, "Col_data_F.xlsx", was then processed using the script titled "Data_preparation" to create dummy variables, compute market shares, add additional data (e.g., electricity costs in Colombia), and compute the outside option. This process produced the version of the data used in the Estimation code.

Model Estimation (folder): This folder contains the coding for the market equilibrium modeling. It uses a Random Coefficient Discrete Choice Model (BLP). There are two variations of the model: Demand and Supply jointly estimated and Demand only.

Demand and Supply (folder): Jointly estimated demand and supply code:

- Main (Matlab code): Runs the model. Loads the data and call functions.
- Objective function: Runs the Generalized Methods of Moments objective function.
- Contraction (Matlab code): Contraction mapping to get observed market shares.
- Markup (Matlab code): computes markup using inverse of elasticity.
- Mktshares (Matlab code): compute product market share inside a market.
- Ind_share (Matlab code): compute individual shares.
- Exp_mu (Matlab code): computes non lineal part of utility function.
- Elast_blp (Matlab code): computes blp elasticity by product
- Change_ms (Matlab code): computes changes in market share. Used in counterfactual.
- Covar (Matlab code): Compute variance – covariance matrix for estimated parameters.
- Getranddraw (Matlab code): get random draws for random coefficients.
- ‘Table_1_Descriptive_stats’ (Results Table): Table 1
- 'Random_Coef_demand.txt' (Results Table): Table 4
- 'Random_Coef_supply.txt' (Results Table): Table 5

Demand only (folder): Assuming perfect competition:

- Main_DO (Matlab code): Runs the model. Loads the data and call functions.
- Objective function: Runs the Generalized Methods of Moments objective function.
- Contraction (Matlab code): Contraction mapping to get observed market shares.
- Mktshares (Matlab code): compute product market share inside a market.
- Exp_mu (Matlab code): computes non lineal part of utility function.
- Elast_blp (Matlab code): computes blp elasticity by product
- Covar (Matlab code): Compute variance – covariance matrix for estimated parameters.
- Getranddraw (Matlab code): get random draws for random coefficients.

Simulation: Code for scenario simulations. Contains two folders: Oligopolistic competition and Perfect competition**.**

Monopolistic Competition (folder): Code for scenario simulation (no incentives, sale tax exception only, import tariffs exception only, sales tax plus import tariff exceptions, constant fiscal expenditure on import tariffs, carbon taxes.).

- Main_sim (Matlab code): Runs the model. Loads the data and call functions.
- Markup (Matlab code): computes markup using inverse of elasticity.
- Mktshares (Matlab code): compute product market share inside a market.
- Ind_share (Matlab code): compute individual shares.
- Exp_mu (Matlab code): computes non lineal part of utility function.
- Getranddraw (Matlab code): get random draws for random coefficients.
- New_eq (Matlab code): New equilibrium for no-incentives scenario, sales tax only and import tariffs only.
- New_pr (Matlab code): Code that computes the equilibrium prices for counterfactual scenarios.
- New_eq_sj: New equilibrium using fiscal cost target.
- New_sj: compute new prices and quantities for counterfactual scenarios while keeping target fiscal expenditure.
- New_eq_CT: Compute new equilibrium for carbon tax scenario.
- New_sj_CT: compute new prices and quantities for carbon tax scenarios.
- New_eq_CT_2: Compute new equilibrium for carbon tax scenario with target fiscal cost.
- New_sj_CT_2: compute new prices and quantities for carbon tax scenarios while keeping target fiscal expenditure.
- Figure 1 Market Shares of Electric and Hybrid Vehicles and Shares of Available Electric and Hybrid Vehicles in Total Vehicles: Figure showing the market share evolution for Electric and Hybrid vehicles.
- Figure 2 Average vehicle prices by fuel type: Figure showing the average price of vehicles.
- Table 2: Summary statistics for the top 5 vehicles with highest sales by fuel type.

Perfect competition (folder): Code for scenario simulation (no incentives, sale tax exception only, import tariffs exception only, sales tax plus import tariff exceptions, constant fiscal expenditure on import tariffs, carbon taxes.).

- Main_sim_PC (Matlab code): Runs the model. Loads the data and call functions.
- Mktshares (Matlab code): compute product market share inside a market.
- Exp_mu (Matlab code): computes non lineal part of utility function.
- Getranddraw (Matlab code): get random draws for random coefficients.
- New_eq_tt (Matlab code): New equilibrium for no-incentives scenario, sales tax only and import tariffs only.

- New_eq_TT2 Compute new equilibrium for carbon tax scenario with target fiscal cost.

How to replicate the code:

Tu run the demand estimation, just open the **Main** file and run. The necessary data and function will be called by this file. The **Main** data run will gather results for the Monopolistic competition model. **Main_DO** runs the perfect competition model.

The file **Main_sim** will run the scenario-simulation. This file will upload the result from the market modeling (**'results_final.mat'**).

To run the scenario-simulation counterfactuals Assuming perfect competition, please execute the file named **Main_sim_DO**. This file will call all the necessary functions as well as the results from the perfect competition model.

Please, reach out to the authors to discuss access to the data, given that a substantial part of the data related to prices and quantities for vehicles sold in Colombia are covered by a Non-Disclosure Agreement.

Estimated time to run the code:

Data processing:

1. **Data scraping:** between 19 and 21 hours using an average internet connection (about 120 Mbps).
2. **Data processing:** 52 minutes using a machine with a 16GB or RAM, and an Intel(R) Core(TM) i7-6560U CPU @ 2.20GHz 2.21 GHz processor.
3. **Demand estimation[1]:**

Function Name	Calls Total	Total Time (seconds)	Self Time (seconds)*
Main	1	8280.062	249.229
computey	369	7834.757	7.567
fmincon	2	7676.339	0.364
objective_fun	355	7673.91	152.367
contraction	26568	7439.647	98.083
mktshares	2694299	7215.871	637
mean	3667225	858.759	858.759
markup	26568	387.543	182.858
covar	2	269.496	0.275
expmu	53143	252.395	252.395
ind_shares	26573	58.75	58.75
marginal_effect	3	1.993	0.836
elast_blp	2	1.549	0.665

[1] This estimate is for the demand and supply model. Running time for the perfect competition model yields lower running times.

*Self time is the time spent in a function excluding the time spent in its child functions. Self time also includes overhead resulting from the process of profiling.

4. **Simulations[2]:**

Function Name	Calls Total	Total Time (seconds)	Self Time (seconds)*
Main_sim	1	27509.716	188.769
new_eq_CT	1	20327.972	0.023
new_eq_sj_CT	1	4429.995	0.02
new_eq_CT_2	4	2073.81	0.153
new_eq_sj_CT_2	1	475.18	0.02
New_pr	1	749.22	0.05
New_sj	1	639.48	0.04
CS	7	7.063	4.772
expmu	16	4.717	4.717
getranddraw	8	0.081	0.029
mktshares	9	1.466	1.316

*Self time is the time spent in a function excluding the time spent in its child functions. Self time also includes overhead resulting from the process of profiling.

Table Index:

From the manuscript:

- **Figure 1:** Market Shares of Electric and Hybrid Vehicles and Shares of Available Electric and Hybrid Vehicles in Total Vehicles. The figure was generated in between lines 419 and 424 of the Main_sim file. The file is named *Figure1 Market share evolution by vehicle type.* The file is located in the Monopolistic Competition folder.
- **Figure2:** Average price of electric vehicles between 2019 and 2020. The figure was generated in between lines 425 and 429 of the Main_sim file. The file is named *Figure 2 Average vehicle prices by fuel type.* The file is located in the Monopolistic Competition folder.
- **Table 1:** Descriptive statistics for vehicle characteristics. Table is saved in lines 294 to 296 in the Main file in the Demand and Supply folder.
- **Table 2:** 5 top-selling models by fuel type. The table is generated between lines 893 and 944 of the Main_sim file. Is located in the Monopolistic Competition folder.

[2] This estimate is for monopolistic competition model simulations. Running the simulations for the perfect competition model yields similar running times.

- **Tables 4 and 5:** Results from Random Coefficient model is saved in lines 487 and 488 of the Main file in the Demand and Supply folder. The name of the file is: 'Random_Coef_demand.txt', 'Random_Coef_supply.txt'
- **Table 6**: Elasticities, mark ups and men profit by vehicle type are saved in line 573 of the Main file in the Demand and Supply folder. The name of the file is: 'Elast_Mark_up.txt'
- **Table 7:** Elasticities by fuel type are saved in line 631 of the Main file in the Demand and Supply folder. The name of the file is: 'Elast_Gas_type.txt'
- **Tables 8 and 11:** Welfare results for different policies and for different policies controlling for fiscal costs are saved between lines 793 and line 833 in the Main_sim file. These tables are saved as 'Table_8_11_year_2019.txt', 'Table_8_11_year_2020.txt'
- **Tables 9 and 14:** Emissions and cost-effectiveness are created and saved between lines 826 and 862 the Main_sim file. These tables are saved as 'Table_9_14_year_2019.txt', 'Table_9_14_year_2020.txt'
- **Tables 10 and 13:** Consumer surplus changes by vehicle price quintiles controlling for fiscal costs are saved in lines 869 to 890 in the Main_sim file. These tables are saved as 'Table_10_13_year_2019.txt', 'Table_10_13_year_2020.txt'.

- **Table 12:** Welfare results for different policies controlling for fiscal costs are saved between lines 768 and line 813 in the Main_sim_PC file. These tables are saved as 'Table_12_year_2019.txt', 'Table_12_year_2020.txt'