REGULATIONS, TAXES AND FUEL PRICES: WHAT ARE THE DETERMINANTS OF CAR EMISSIONS RATES IN EUROPE?

Anna Alberini, AREC, University of Maryland, 301 405-1267, aalberin@umd.edu
Jose M. Eguiguren Cosmelli, AREC, University of Maryland, jmeguiguren@gmail.com
Joshua Linn, AREC, University of Maryland, linn@umd.edu

Overview

Economist often argue that pressure to reduce the CO2 emissions from new passenger vehicles comes from two main sources: Fuel prices and regulations (Anderson et al., 2011). Gasoline and diesel prices can be modified by introducing taxes. In Europe, motor fuel taxes account for relatively large shares (often in excess of 50%) of the price at the pump. The price of electricity will become an increasingly important factor as electric vehicles and plug-in hybrids are becoming widely available and adopted, and as the structure of the electricity sector changes in response to market forces and switches away from fossil fuel generation.

Regarding regulations, in addition to the "Euro" standards dictating emissions limit for specific conventional pollutants (e.g., NOx, particulate matter, etc.), since August 2012 automakers that sell cars in Europe have had to comply with a new regulatory program that obliges manufacturers to meet fleetwide CO2 emissions targets (e.g., 130 g/km for 2012-2015; all cars below 95 g/km by 2021). The emissions limits are set according to the weight of the vehicle using a limit value curve, requiring automakers to achieve the target as the fleet average emissions rate. This regulation was passed in 2009 and replaces an earlier voluntary system that was generally regarded as a failure.

Several governments seek to affect consumer purchase decisions by offering subsidies to help defray the cost of purchasing efficient, low-emissions cars. These include tax credits, direct incentives to consumers, reductions in the registration tax to be paid at the first registration of a new vehicle, and sometimes in-kind benefits and rewards (free parking, preferential use of high-occupancy lanes, free or heavily discounted access to charging facilities, etc.)

In this paper, we ask two research questions: First, are the automakers in Europe attaining the targets spelled out by European Union directive? Second, are they doing so entirely out of their own efforts, or are government policies aimed at consumers enhancing these efforts?

Methods

We use data provided by HIS-Markit. Attention is restricted to the new car market, and more specifically to gasoline, diesel, hybrid, plug-in hybrid and electric passenger vehicles. Our dataset documents monthly sales for each exact car variant in seven European Union countries from January 2011 to September 2017, but we do not have any information about the circumstances of each individual sale.[1] We merged these data with the price of gasoline and diesel at the pump, and the price of electricity to residential customers who use up to about 5000 kWh/month, for each month of our study period. We also computed the registration tax (if applicable) and the annual circulation tax (where appropriate) from the ACEA Tax Guides and government web sites. Incentives offered by the government to encourage the purchase of electric and hybrid cars come from the UK Driver and Vehicle Licensing Agency, other government websites, and eafo.eu.

We posit that at the observed prices demand equals supply. We assume that the demand function is $Q^D = Q^D(p; \boldsymbol{a}, E, \mathbf{X})$ where p is the price of the vehicle, $\boldsymbol{a}$ a vector of car attributes, E denotes the CO2 emissions rate, and $\mathbf{X}$ is a vector of other demand shifters. The latter contain taxes (to be paid at the time of the purchase or over the years) or components thereof, and proxies for demand shocks (income or taste changes). The supply function is assumed to be $Q^S = Q^S(p; \boldsymbol{a}, E, \mathbf{Z})$, where $\mathbf{Z}$ is a vector of supply shifters.

We further assume that the demand and supply function are linear in each of their arguments and include make-model fixed effects to account for unobservables. The demand shifters include anything that modifies the base registration tax and thus varies across variants within the same make and model. In France and other countries, for example, the registration tax depends on fiscal horsepower, with substantial reductions ("Bonus") for cars with low CO2 emissions rates and "penalties" ("malus") for heavy emitters.

[1] The countries are Austria, Belgium, France, Germany, Italy, Spain and the UK.

They also include the annual circulation taxes, which may make a specific car more or less attractive compared to another, and any incentives offered by the government. For example, incentives are offered sometimes to electric and hybrid vehicles or vehicles otherwise satisfying specific emissions rate or other requirements.

The supply shifters are i) the Berry, Levinsohn and Pakes (1995) instruments, a measure of the difference in attribute space between any given vehicle and the other vehicles offered by the automaker or by the competition, which presumably capture the different production costs associated with each car, and ii) a measure of the regulatory pressure that the automaker is subject to, for example the difference between the target and the actual fleetwide emissions rate attained in the previous quarter.

For our empirical analysis, we aggregate the sales to the quarter level. On equating demand and supply and solving for quantity sold, we obtain the reduced-form equation:

$$(1) \quad SalesP_{ijct} = \alpha_i + \tau_t + \boldsymbol{a}_{ijt}\boldsymbol{\beta} + \gamma \cdot E_{ijct} + \delta \cdot ANNUALFEE_{ijct} + \lambda \cdot BONUS_{ijct} + \\ + \theta \cdot MALUS_{ijct} + \pi \cdot INCENTIVE_{ijct} + BLPINSTR_{ijct}\boldsymbol{\varphi} + \omega \cdot RS_{it-1} + \varepsilon_{ijct},$$

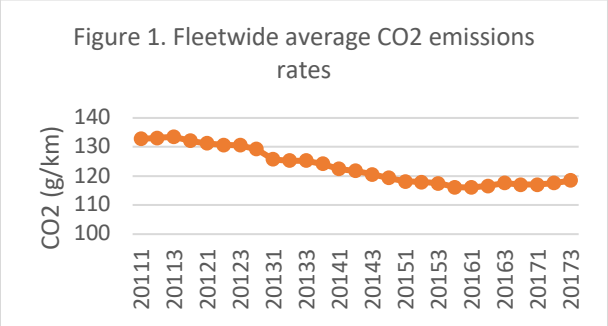
where *i* denotes the make and model (e.g., Audi Q5), *j* denotes the submodel, version and trim (e.g., version="Audi Q5 3.0 D AWD," where 3.0 refers to the engine size (in liters), "D" stands for diesel, and "AWD" means "all-wheel drive"; trim="S Line Plus"), *c* is the country where this vehicle is sold, and *t* is quarter and year.

Vector ***a*** includes car attributes, such as weight, engine size, horsepower, a proxy for acceleration (horsepower divided by weight), number of doors, body type, fuel type, range (kilometers driven on a full battery) if electric, whether transmission is automatic or manual, footprint, number of cylinders, and whether four-wheel drive. Equation (1) includes make-model fixed effects (while ***a*** and *E* capture the effects of variations within the make and model) and time fixed effects to capture the effects of regulations, global state of the economy etc. common to all countries and vehicles. The demand shifters are ANNUALFEE, the annual circulation tax, BONUS, MALUS and INCENTIVE. The supply shifters are the BLP instruments and RS, which measures regulatory pressure through the fleetwide average emissions rate for make i in the previous quarter.

Results

Figure 1 below displays the fleetwide average CO2 emissions rates, which have been clearly declining in the seven countries during our study period.

At the time of this writing, we have confirmed that bonuses, maluses, and incentives are shifters of the demand function. We are now in the process of estimating the reduced form of equation (1). The purpose of it to see whether the reductions in fleetwide average emissions—which must be due to cars being produced with lower emissions rates, or shifts in the market shares towards cars with lower emissions rates, follows from the regulations and/or is aided by the demand shifting policies, and, if so, by how much.



Conclusions

We ask two economics and policy questions: First, are automakers in Europe attaining the CO2 emissions targets spelled out in European Union directives?

Second, are they doing so entirely out of their efforts—through designing, building and marketing cleaner cars, and/or "pushing" consumers towards cleaner cars out of the mix of all cars—or can we ascribe some of the results to government policies aimed at consumers?