Stranded to be?
Diesel ban and used car markets

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Abstract

After promoting their development for two decades, European governments are pulling back their support to diesel cars. While those engines were supposed to be cleaner than gasoline ones, by consuming less and emitting less CO_2, their emissions of local air pollutants are much higher. In response to increasing awareness on air quality, Low Emissions Zones (LEZs) are gradually implemented by some cities, announcing a progressive ban on diesel cars which could also turn those vehicles into stranded assets for households. This is a thorny issue in France where 50% of vehicles are diesel-fueled. Investigating nearly a million of used cars ads across France, we find that diesel vehicle sellers located within ongoing and planned LEZs anticipate this change of regulation and lower their asking price for those cars. This effect is robust to the introduction of an air pollution indicator for cities.

JEL Classification: Q52, Q53, R48

Keywords: Low Emission Zones, Air pollution.

1 Introduction

The Diesel-gate scandal revealed the need for stronger environmental regulations in the road transport sector. It contributed to accelerate announcements on the ban of petrol - particularly diesel - cars that have been made by European countries and cities over the last few years (Plötz et al., 2019). Indeed road transport is major producer of environmental externalities with greenhouse gases[1] and air pollutants[2]. Alongside European and national policies, cities develops local clean air programs. Low Emission Zones (LEZs) are among the most ambitious cities programs for clean air, and spread quickly across the Member States[3]. A LEZ is an area where restrictions are put on the road vehicles which can circulate, according to their air pollutants emissions. Such programs often enable cities to tighten national targets on their territory[4]. Nevertheless, a major obstacle to diesel bans lies in the important share diesel cars in the vehicles fleets of several European countries, such as Germany or France. Although more expensive at purchase, diesel cars benefitted both from a competitive advantage towards gasoline cars, as they consume less, and from a favorable tax system (Hivert, 2013). This last point also roots in the specialization of several European car makers in diesel engines.

This paper investigates the impact of diesel ban announcements by French cities on used cars market. More precisely, we determine if ongoing and planned LEZs impact prices posted by used cars sellers. Our analysis rely on scraped data containing about one million adds of used cars from online car dealers and market-places. We find that that posted prices for diesel cars are significantly smaller in both ongoing and planned LEZs. This impact is about three times larger for ongoing LEZs compared to planned ones. Several robustness checks confirm these results.

We relate to two main strands of literature. The first one is the economic analysis of

[1]Road transport contributed 21% of CO_2 emissions in Europe in 2016. Source: https://ec.europa.eu/clima/policies/transport/vehicles_en

[2]According to the European Environment Agency, road transport produces up to 30% of fine particles and NO_2.

[3]There were more than 230 cities with LEZs in 2019 in Europe.

[4]For instance, the ambition of several French cities, including Paris, is to prohibit entrance to diesel cars by 2030, while national target aims at phase out new diesel cars in 2040 (Plötz et al., 2019).

LEZs. Due to their recent implementation, there are few studies on the effectiveness of LEZs in Europe. Nevertheless European LEZs have much in common with other driving restriction policies developed in other parts of the world. Such policies in Latin America (Colombia, Mexico, Ecuador, Chile...) and China have also brought attention of scholars. Studies mainly focused on the effect of LEZs and other driving restrictions on air quality and health on the one hand, and on the local vehicle fleets composition, congestion and transport modes on the other hand. (Wolff, 2014) analyses the effect of German LEZs. The author find an average 9% decrease of PM emissions in LEZs. He also underlines a significant effect on the renewal of the car fleet near LEZs with more recent low-emission vehicles. Gehrsitz (2017) find that significantly improves air quality, but this improvement does not reflect on infant health. Some Latin American cities - as Mexico, Bogota - developed driving restrictions based on licence-plated digits, mostly independently from pollution levels and strong. Several studies such as (Davis, 2008; Zhang et al., 2017) have shown that these policies at best did not improved air quality or decreased congestion. Main reason is that due to the design of the policy gave incentives for drivers to buy a second car, generally older and more polluting. Oppositely, the driving restriction policy of Quito, applied only at peak hours and with a strict enforcement by the local police, showed a 9-11% decrease in carbon monoxide emissions (Carrillo et al., 2016).

The second interesting strand of literature covers empirical studies studying the determinants of used-cars prices. However their results are diverse regarding the rationality of consumers. While Sallee et al. (2016) showed that used cars buyers have consistent anticipations regarding energy costs, Lacetera et al. (2012) showed that they rely on heuristics when buying used cars, suffering from a bias in the process of odometer values. Regarding consumers anticipations regarding regulatory changes, the more recent paper Asplund et al. (2019) makes an interesting contribution by showing how a credible political announcement shifted substantially car buyers behaviors.

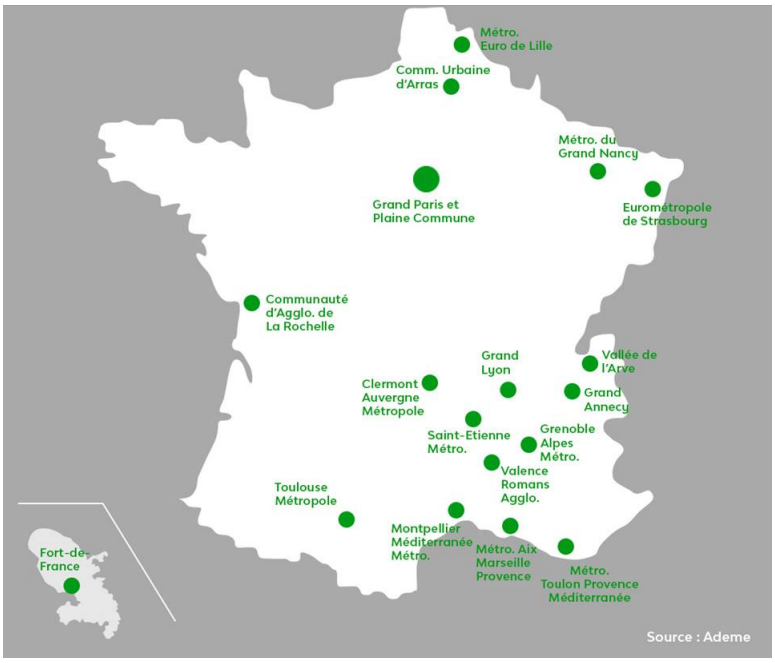

Figure 1: Map of French Low Emission Zones that are in place or will be in 2020.

2 Methods

2.1 Background

Since the 1990's, France has developed an important share of diesel cars in its national fleet[5]. For consumers, diesel were more expensive at purchase but with less costly fuel expenses. This trend has been stimulated, among other, by a fiscal advantage of diesel fuel over gasoline and by the industrial know-how of French makers in diesel engines (Hivert, 2013). This trend was reversed in the middle of the 2010's. In 2019, new registration of diesel cars dropped to 30% while national share of diesel dropped to 50% in the vehicle fleet.

Four LEZs were in place in 2019 in France[6], and nineteen in 2020 [7]. Cities implementing LEZs are shown on figure 1. These LEZs consist in excluding most polluting cars from delimited areas that can cover from simply the city center to the whole agglomeration. Air

[5]In 2013, share of diesel was 75% for new car sales and 60% in the whole fleet.

[6]In Paris, Paris agglomeration (with a less stringent restriction), Grenoble and Strasbourg.

[7]https://www.ecologique-solidaire.gouv.fr/zones-faibles-emissions-19-collectivites-sengagent-qualite-lair

pollutants of vehicles are classified according to their Air Quality Certificate, named *Crit'Air*. Those certificates are differentiated according to the fuel type and the Euro emission norm of the vehicle (see Table 3). Euro norm are mandatory norms on local pollutants emissions (PMs, CO, NO_x) which car makers must comply from a certain year. Nevertheless, approval generally starts one year before the year of enforcement of the norm. The part of the fleet labeled 4 and above was around 20% in 2019 [8]. In January 2020, only the Paris metropolitan area had an ongoing LEZ by restricting access to diesel car labeled Crit'air 4 and more.

2.2 Data

Our main data comes from scraped data of online car adds. Adds are recovered from the website leparking.fr, which aggregates used car adds from more than fifty online car dealers and market places. From a single recovery from 2019, we collected more than 900,000 unique adds. As a reference, there are about seven million transactions of used cars each year in France. Each add contains the selling price, the vehicle mileage, technical characteristics, zip-code and nature of the seller (professional dealer or private individual). Technical characteristics include the vehicle maker, model and version, body type, fuel type and gearbox type.

Web scraped data, and more generally big data sources, are a data source of growing interest in the economic research and have been used in diverse fields such as macroeconomics, housing or digital economics (Edelman, 2012).

We build an LEZ indicator that differentiate cities between (i) cities with an ongoing LEZ that already restrict city access of some diesel cars (ii) cities with planned LEZ (as Marseille, Lyon) or ongoing LEZ without restriction on diesel light-duty vehicles (such as Strasbourg or Grenoble) and (iii) cities with no planned LEZ.

We build a variable on local air pollution from data from a ranking of more about 300 French cities with highest PMs concentrations.

[8] https://www.statistiques.developpement-durable.gouv.fr/une-voiture-sur-deux-est-eligible-la-vignette-critair-1-ou-2?list-chiffres=true

2.3 Descriptive statistics

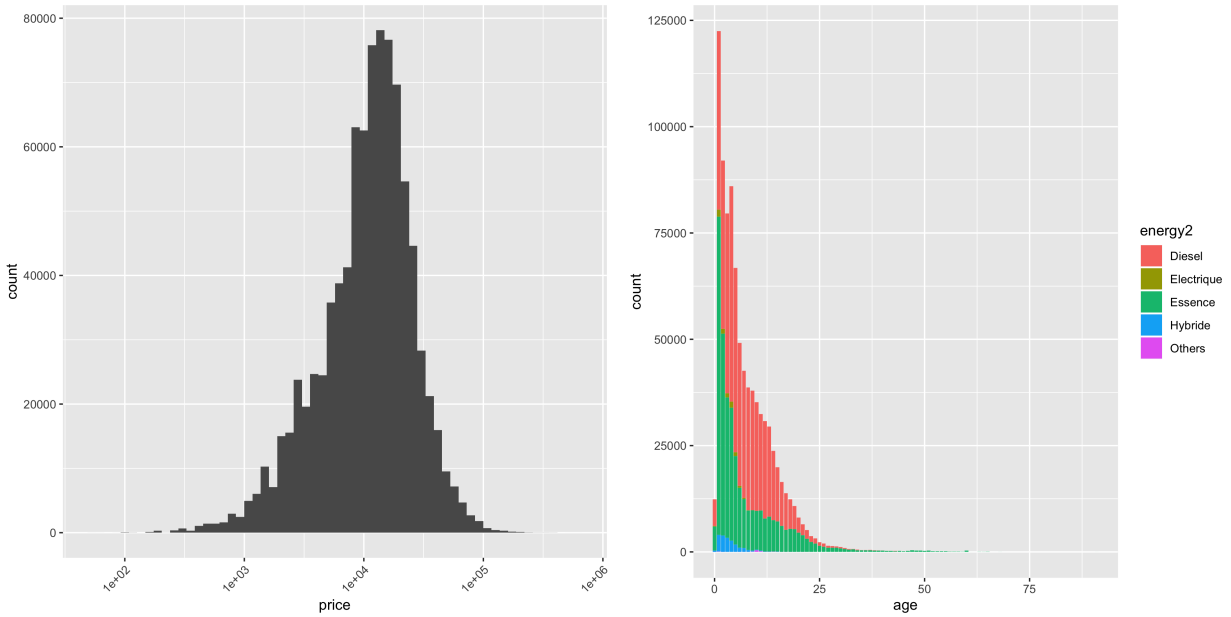

Figure 2: Distribution of price, and age with fuel type

Fuel type	Amount	Frequency
Diesel	512780	57%
Gasoline	360325	40%
Hybrid	18764	2%
Full electric	7178	0.8%
Others	1300	0.2%
Total	900347	100%

Table 1: Repartition of fuel types of used cars

Table 1 and Figure 2 shows the main descriptive statistics from our data sets on used car adds. Diesel are much more represented than gasoline, and even more for vehicles aged from 5 to 15 years. This is consistent with the historic trends of the French fleet mentioned earlier. Full electric and other fuel types (Gnv, Gpl) are in very low quantities, which is due to their very low share in new cars sales. For ease of understanding, we discard them of our our analysis.

2.4 Model

Our econometric estimation relies on a simple hedonic model. Hedonic model are commonly used to estimate market valuation of single attributes ref. The variable of interest is the crossed effect of fuel type with the LEZ indicator. We control age, mileage and seller types. We also control for technical characteristics with fixed effects on makers and body types.

Our model is :

$$\log(Price)_i = aage_i + bage^2 + cX_i$$
$$+dLEZ_i + eLEZ_i * FUEL_i + fPOL_i + gPOL * FUEL_i \quad (1)$$

We choose the following references for categorical variables: gasoline for fuel types, sedan for body shapes, French maker Renault for makers, professional for seller types, automatic for gearbox types. We control for unobserved local policies on air quality with a pollution level variable, as cities with more alarming pollution levels may have implemented complementary policies and not necessarily LEZs to decrease the share of diesel cars within the city (such as pedestrianisation of the city centre, development of bike lanes, etc.).

3 Results

Main regressions are shown in Table 2. Our econometric model has a strong explanatory power of about 85%. Most controls are highly significant and their effects are easily interpretable. As expected, results indicate that age and mileage have decreasing effects on the car posted price. Significativity of age^2 coefficient indicates a "vintage" effect for old vehicles which are highly represented in our data set. We find that both hybrid and diesel car are more expensive than gasoline cars. As discussed earlier, this result is understandable as new diesel car are generally more expensive than the gasoline equivalent. Financial advantage of diesel remain in its lesser consumption of fuel. Similarly, hybrid cars sales represent a premium segment of the new car markets and are also more expensive. LEZs seem to have a positive effects on posted prices. However its magnitude is small, and its sign does not seem robust to our checks. The central result is that the crossed effect of LEZs and diesel

Table 2: Regression results

	Dependent variable:
	log(price)
age	-0.114^{***}
	(0.0002)
age^2	0.002^{***}
	(0.00000)
mileage	-0.004^{***}
	(0.00001)
Body type	YES
Maker	YES
gearbox-Manual	-0.248^{***}
	(0.001)
seller-Professional	0.061^{***}
	(0.001)
pollution level	-0.0003^{***}
	(0.0001)
fuel type - Diesel	0.107^{***}
	(0.001)
fuel type - Hybrid	0.114^{***}
	(0.005)
LEZ - ongoing	0.043^{***}
	(0.003)
LEZ - planned	-0.007^{***}
	(0.002)
pollution level : Diesel	-0.0001
	(0.0001)
pollution level : Hybrid	0.001
	(0.0004)
Diesel:LEZ - ongoing	-0.064^{***}
	(0.004)
Hybrid:LEZ - ongoing	0.027^{***}
	(0.010)
Diesel:LEZ - planned	-0.020^{***}
	(0.003)
Hybrid:LEZ - planned	0.007
	(0.011)
Constant	10.317^{***}
	(0.004)
Observations	889,842
R^2	0.850
Adjusted R^2	0.850
Residual Std. Error	0.351 (df = 889767)
F Statistic	$67{,}937.020^{***}$ (df = 74; 889767)
Note:	*p<0.1; **p<0.05; ***p<0.01

engine is negative and highly significant. This indicates that car sellers located within cities with a LEZ program anticipate the future effect of these policies - a progressive diesel ban - and lower their posted price compared to the ones for the same car in cities without a LEZ. The effect is three times higher in the ongoing LEZs than in the planned LEZs with 6.4% against 2%.

The pollution level does have an impact on the general price of cars (potentially confirming our hypothesis that this variable is a proxy for policies reducing the place of cars within cities) but do not have crossed significant effect with the energy variable on the price.

These results are robust to several checks. First, re-sampling of the LEZ variable show that there is no placebo effect. We also introduce a third class of French large cities that did not plan the implementation of an LEZ program We did not find significative effect of the price of diesel cars. We do not find either the evidence of a general "large city" effect on diesel used car prices.

4 Discussion and conclusion

From the average posted price of diesel cars in ongoing and planned LEZs, back of the envelope calculations can give the absolute depreciation caused by the implementation of LEZ programs. We find a average depreciation of diesel cars of 1150€ for ongoing LEZs and 260€ for planned LEZs.

Such results indicates that as the implementation should create stranded assets for diesel car owners. Future works should elaborate those results may translate into sensitive distributional effects. Furthermore, this study indicate that current French subsidy policies on old vehicle scrappage and on low-emission vehicle promotion.

These evidenced depreciations should also be analyzed to the current policy of There are reasons to think that LEZ program may have significant spatial spillovers in local car markets. A main future development of this study will be to include more precise geographic specifications in a spatial econometrics framework.

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A Additional information on French LEZs

Crit'Air label	Gasoline	Diesel	Hybrid	Full electric
0				All
1	Euro 5 and above (>2011)		All	
2	Euro 4 (2006-2010)	Euro 5 and above (>2011)		
3	Euro 2&3 (1997-2005)	Euro 4 (2006-2010)		
4		Euro 3 (2001-2006)		
5		Euro 2 (1997-2000)		
Non-ranked	Euro 1 and below (<1996)	Euro 1 and below (<1996)		

Table 3: Definition of "Crit'Air" air quality certificates for light duty vehicles.

B Additional descriptive statistics

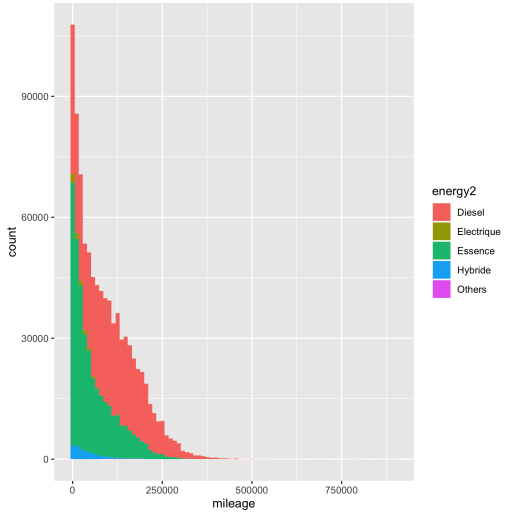

Figure 3: Distribution of mileage of used cars with their fuel type.