THE EFFECTIVENESS OF TAX BREAKS IN VEHICLE TAXATION: A CASE STUDY OF POLAND

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This paper analyses the effectiveness of passenger vehicle taxation in Poland in internalizing negative environmental externalities related to CO2 emissions. It focuses on excise, which is a purchase tax with two core tax rates' bands, with recently introduced rebates for hybrid and electric vehicles. The analysis reported in the paper uses a massive dataset of primary market sales' volumes, offered prices and vehicles characteristics including their emissions. With the use of bunching analysis and econometric techniques, we verify the impact of the tax rates system on prices and vehicles' characteristics, as well as on the distribution of sales volumes.

Keywords: environmental taxation, transport taxes, pass-through

JEL Codes: H22, H23

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I. THEORETICAL BACKGROUND

Road transportation creates negative externalities that, apart from congestion, infrastructure damage and accidents, generate substantial environmental costs not included in vehicle purchase and maintenance costs. The value of negative externalities related to emissions in road passenger transportation is difficult to estimate and thus an economically and environmentally efficient allocation becomes a largely notional concept. Nevertheless, it is apparent that effective public policies have the ability to somewhat internalise the externalities related to road transport and incentivise the use of vehicles with a reduced environmental footprint, reduce mileage choices and lower the emissivity of vehicles offered by producers.

As Pigouvian taxes, apart from their fiscal objectives, vehicle purchase taxes aim to internalise negative externalities by putting a price on a car's purchase and, indirectly, on its use. The underlying goal is to meet an economically and environmentally efficient number of driven miles and characteristics of the vehicles used. Many tax systems attempt to meet this goal by differentiating the tax rates on a vehicle's purchase. The most often used criteria are engine size, horsepower, vehicle weight and retail price (Santos et al., 2010).

The differentiation of rates could create incentives or disincentives for purchase decisions, which may also have some undesired secondary impacts. Hikes in tax rates may create incentives to overuse old and polluting cars because a purchase tax is normally levied only on the primary sale (De Jong, 1990). Moreover, purchase taxes are often considered to not be well-suited to tackling externalities related to the use of vehicles, as they are better targeted at their purchase and disposal (Hayashi et al., 2001). For this reason, they may have only a minor impact on mileage choices (Johnstone and Karousakis, 1999).

Apart from potential ineffectiveness and creating inverse incentives affecting consumer choices, in larger economies, i.e. countries with a more significant impact on manufacturers' policies, purchase taxes can be avoided by changing vehicle characteristics (Johnstone and Karousakis, 1999). The effectiveness of vehicle purchase taxes may also be reduced by manufacturers' pricing policies. As noted by the growing literature on pass-through, concentrated markets are often characterised by asymmetric pass-through effects and undershifted tax rebates. The increase in competition has a positive and non-linear impact on the pass-through rate[3]. Under monopoly conditions, as shown by Genakos and Pagliero (2019), pass-through may fall even below 50 percent.

According to Yan and Eskeland (2018), registration and purchase taxes could become a powerful environmental tool but need to be complementary to other tax and non-tax measures. They also need to strike the right balance between the precision of characteristics that are used for emission correction and the costs of imposing the tax (Santos et al., 2010), i.e. administrative, compliance and enforcement costs.

Since Poland's car market accounts for a small fraction of the global market, the impact of domestic regulations on the technological aspects and customisation of offers to the local market is limited. For this reason, to be effective in reducing the environmental footprint of passenger road transport, the excise tax, which is a purchase tax levied on the primary sale of car in Poland, should be able to meet two conditions. First, the criterion for tax rate differentiation should be highly correlated with the vehicle's emissivity. Second, tax rate differentiation should translate into the price paid by consumers. In other words, it should affect consumer prices rather than producer margins. For this reason, two indicators scrutinised in this analysis are crucial for the effectiveness of the excise tax in Poland: the correlation of the tax burden with the emissivity of the vehicle and pass-through in the primary passenger vehicle market.

[3] See e.g. Weyl and Fabinger (2013), Genakos and Pagliero (2019).

II. PASSENGER VEHICLE MARKET AND TAXATION IN POLAND

We look at the passenger vehicle market in Poland to lay the groundwork for analysing the demand- and supply-side implications of tax rate differentiation. We do this as market structure and its relative size affects the effectiveness of tax policy in shaping participant decisions (Henderson, 1989). As shown by Collie (2015), the design of an effective tax policy should consider the ability of the supply side to limit the effects of the tax incidence.

In 2019, more than 561 thousand new cars were sold in Poland[4]. At the same time, sales of second-hand cars were high compared to other European Union (EU) Member States. In 2018, slightly more than 1 million used cars were registered in Poland, most of which were imported[5]. Poland is fifth in the EU in terms of number of cars per 1,000 inhabitants, significantly higher than Germany and France, for instance[6]. This should be associated with the influx of used cars from Western European countries rather than with wealth factors or the willingness of Poles to spend a larger share of their income on cars. Considering there is almost no penalty for the importation of cars not meeting the strict emission standards of new vehicles, the availability of cheap second-hand cars affects the primary market especially in lower price segments. The total value of excise income on car sales in 2019 was slightly higher than PLN 3 billion. At the same time, total excise income on fuel sales accounted for almost PLN 34 billion. It could be estimated that about 54 percent of this originates from passenger car use, which translates into more than PLN 18 billion of yearly income[7].

[4] Source: Local Data Bank, Central Statistical Office.
[5] Source: https://www.samar.pl/__/3/3.a/101659/3.sc/11/Rok-2018---ponad-1-mln-sprowadzonych-aut.html?locale=pl_PL
[6] Source: https://www.acea.be/statistics/tag/category/vehicles-per-capita-by-country
[7] The estimation is based on the combination of three data sources: fuel consumption by type of use (transport, industry and agriculture), registered vehicles by purpose (passenger cars, trucks and buses) and average distance traveled by different types of vehicles in Poland.

Market concentration measured by the widely used Herfindahl-Hirschman Index was equal to 0.138 in 2019, which is usually interpreted as a highly competitive market[8]. However, the car market is exceptionally globalised, i.e. most manufacturers operate on the global market, with only a few regional manufacturers. As a result, global corporations might be less responsive to national tax policies than their simple share of the market (especially a relatively small market such as Poland) suggests.

Currently, primary car sales in Poland are subject to two consumption taxes: VAT and excise. The ability of EU Member States to differentiate the VAT burden across goods and services is fairly limited. Individual countries are restricted to applying the standard VAT rate for vehicle purchases, which varies from 18 to 27 percent. In practical terms, VAT adjustments on vehicle purchases are limited to the rules on deducting input tax on a car's purchase and maintenance.

The main fiscal tool affecting the car market in Poland is the excise tax, in theory designed to correct market externalities by disincentivising certain types of consumption and collecting funds for the mitigation of its negative effects[9]. Current regulations concerning excise tax on the purchase of passenger cars and fuels are regulated by the Act of 6 December 2008[10]. Excise tax on passenger cars is payable on sales of new, unregistered vehicles and the introduction of imported cars into the market.

There are currently three rates of excise duty on passenger cars:

- 0 percent – applied to electric cars and cars with a plug-in hybrid drive (with an engine size up to 2000 cm3),
- 3.1 percent – for cars with an engine size up to 2000 cm3,
- 18.6 percent – for cars with an engine capacity over 2000 cm3.

[8] Source: own calculations, based on SAMAR.
[9] Source: Polish Ministry of Finance, Substantiation for the excise tax act (of 6/12/2008).
[10] Source: https://finanse-arch.mf.gov.pl/web/wp/pp/niezbednik-podatnika/akcyza

As of January 2020, new excise rules specifically for hybrid cars were introduced. Tax rates for classic hybrid (HEV) and mild hybrid (mHEV) cars were halved and amounted to 1.55 percent for cars with an engine size up to 2000 cm3 and 9.3 percent for cars with an engine size up to 3500 cm3. Cars with an engine size over the 3500 cm3 threshold were not covered by the new regulations. The reduced rate was not applied to plug-in hybrid cars (pHEV) with an engine capacity up to 2000 cm3, as they were exempted from the excise tax, whereas plug-in hybrids with a cylinder capacity over 2000 cm3 are treated the same way as HEV and mHEV.

Figure 1 presents the combined data on excise income from the sales of new and used cars in 2019 with income split by tax band (only for new cars). Although new cars account for about one-third of sales in terms of volume, the excise tax collected on these sales constitutes two-thirds of total income, which clearly indicates the price difference between these two groups. Among new car sales, the majority of tax revenue comes from the lower standard rate (60 percent) followed by the higher standard rate (30 percent). What is interesting is that in the case of reduced rates for hybrid vehicles, a reverse structure could be observed. Tax revenue from cars with an engine capacity over 2000 cm3 exceeds that of those with a smaller capacity. This means that, in practice, the new, preferential rules are applied more often to cars with larger engines, which could be implied from analysing the sales of cars without hybrid engines.

Figure 1. Tax revenue from excise on passenger vehicle sales by type and applicable rate (percent)

The design of the excise tax on passenger vehicles in Poland stands out from the solutions introduced in other EU Member States. Most countries opt for registration taxes instead of excise tax. Importantly, none of them use engine size alone as a base for tax rate cut-offs. The most common criteria for assigning an appropriate tax rate is CO2 emissivity or emission standards, often coupled with other characteristics such as fuel type or engine size. In some countries, such as Germany, there is only a small, fixed registration fee with no bands. Instead, more emphasis is placed on a recurring tax on car ownership – a yearly fee based on cylinder capacity and CO2 emissions.

Taxes on car ownership are common in the EU. Currently, only four countries[11] do not have any form this type of tax in force. According to numerous studies (see, e.g. Vance et al., 2009; Santos et al., 2010), there are clear advantages to recurring charges on ownership, even though the direct influence on consumer purchase choice is not as strong as compared with sales taxes (Runkel et al., 2018). First, this type of burden is more directly linked to the type of activity causing most of the externalities. It is not the act of the purchase but rather the continuous use of the vehicle which is responsible for pollution, congestion and accidents, among others. Second, ownership taxes incentivise owners to re-evaluate if the car is worth keeping each time the payment comes due instead of only once during the initial purchase. The incentive remains strong for cars with a low market value, while the tax on a purchase, even with a high tax rate, can be negligible for older, cheaper vehicles. This effect can, in turn, reduce the overall number of registered cars – especially those with low emission standards. This is particularly important in Poland due to its high share of used car sales.

III. TAXATION OF PASSENGE VEHICLES AND ENVIRONMENTAL EXTERNALITIES

The effectiveness of excise tax as a tool to internalise externalities evidently depends on the design of such a measure. First, effective internalisation requires that the criteria for rate differentiation are closely correlated with the size of the externalities. Second, the additional

[11] These are Poland, Estonia, Lithuania and Slovenia.

burden imposed by an effective tax system should be proportional to the externalities themselves.

The analysis illustrated in Figure 1 shows that engine size is relatively weakly correlated with fuel consumption (0.39). This relationship might have been stronger in the past, but with technological advancements in fuel efficiency, as shown by the analysis, there is no longer a straightforward linear connection between the two. Similar conclusions can be drawn by looking at the relation between cylinder capacity and CO_2 emissions. This relation is somewhat stronger and more statistically significant for engine sizes above 2000 cm3. Below this threshold, the link between the two seems very weak. A strong relationship between CO_2 emissions and fuel consumption could also be observed (slightly differentiated for petrol and diesel).

Although diesel engines emit on average more CO_2 per litre of consumed fuel, overall CO_2 emissions tend to be less compared to their petrol counterparts due to better fuel efficiency. At the same time, we are aware that CO_2 emissions do not cover the whole spectrum of environmental externalities generated by car usage, in particular that high NO_2 and particle emissions (specific to diesel engines) are far more harmful for human health. In this paper, we concentrate on CO_2 emissions only due to data constraints and for the purpose of simplicity.

Table 1. Correlation coefficients between the parameters of cars and CO2 emissions

As the excise tax aims at correcting environmental externalities, the higher correlation between CO_2 emissions and two other characteristics, i.e. horsepower and fuel consumption, signal that they are more effective criteria for tax rate differentiation. It is also important to mention that the need for CO_2 emissions proxies is no longer in place as emissions standards are currently compulsory for all new cars introduced into the common market. The Worldwide Harmonized Light-Duty Vehicle Test Procedure (WLTP) that came into force in stages starting from September 2017 requires all new car models to be tested for emissions under simulated conditions like day-to-day use.

Figure 2. Relation between CO2 emissions and other characteristics

IV. DATA CONSIDERATIONS

The main source of data used for this study comes from the Institute for Automotive Market Research SAMAR. The full database on 2019 car sales in Poland was acquired along with corresponding data on car characteristics from SAMAR’s website. It is important to note that this dataset has some limitations. Price data is limited to offered prices (including rebates applied to official price listings, but not including any others applied in the car dealership) and is not exhaustive, although the missing portion of sales data is very small. The full database contains attributes for almost 544 thousand sold passenger cars while, as previously mentioned, new car sales in Poland in 2019 amounted to 561 thousand. For the purpose of subsequent analysis for any duplicated variants of car models (identified by cylinder capacity, type of fuel, type of car body and transmission), the lowest matched price was used.

V. BUNCHING ANALYSIS

Before estimating the econometric models of pass-through, we conduct a bunching analysis. This analytical component aims at verifying the interrelation between basic vehicle characteristics and the frequency of sales or relevant number of offers.

Illustrated by Figure 3, sales of passenger cars by engine size is highly irregular. First, due to technological reasons, sales of vehicles with engine sizes below 800 cm3 and above 6000 cm3 is nearly non-existent. Second, there is considerable bunching below the mean (1603 cm3) and just below 2000 cm3, which is the threshold for higher excise tax bands. There are almost no sales of vehicles with an engine size between 2000 and 2400 cm3. Sales of vehicles above 2000 cm3 accounted for 6 percent of all volume of new passenger vehicles sold, mostly classified as upmarket.

Figure 3. Frequency of passenger car sales by engine size (2019)

We also look at horsepower and emissions to check whether the irregularities in engine size distribution across vehicles sold translates to irregularities in emissions. As shown in Figure 4, there is some evidence that the bunching in engine size results in the skewed distribution of emissions, meaning that the irregularity in the distribution could be considered as an effect of internalising environmental externalities by excise tax. In other words, an increased propensity to buy vehicles below 2000 cm3 (shown on the left-hand side) creates bunching between 140 and 150 g CO_2/km.

Figure 4. Frequency of passenger car sales by CO2 emissions for the whole sample (left) and for cars with an engine capacity between 1900-2000 cm3 (right) (2019)

We also look at the variation of price across different segments (Figure 5). We do this to observe whether the irregularities in price suggest that engine size is a good proxy of car price and thus verify whether excise tax could have positive distributional effects. We observe a non-linear relation between the segments of engine size and median price offered. For non-EV cars ("0" category), the price increases gradually with engine size until the 1800-2000 cm3 category. Despite entering a higher tax band, the median price of vehicles with an engine size in the range of 2000-2600 cm3 falls below the price offered for vehicles with slightly smaller engines. The large variation in the price of vehicles with an engine size just below 2000 cm3 may result from the fact that producers struggle to maintain an offering of vehicles below the 2000 cm3 engine-size threshold. In addition, the large variation for this and for the higher engine bands signals that engine size is also a poor proxy of car price, which limits the positive distributional consequences of excise tax bands in Poland.

Figure 5. Dispersion of car price by engine size (2019)

VI. PASS-THROUGH ANALYSIS

The bunching analysis poses a significant limitation. From a policy perspective, in Poland, the characteristics of the vehicles offered and their sales depend on other non-actionable factors. Namely, it is the global characteristic of the vehicle offering, which is only slightly differentiated within geographical regions and not adapted to local policies.

In the analysis reported in this section, we conduct a multivariate analysis, which accounts for the multiplicity of factors affecting vehicle prices. We conduct our analysis from two angles. First, we take a “static” approach, meaning that we focus on the cross-sectional variation of vehicle characteristics. The second angle is “dynamic”. Using this approach, we look at the impact of the factors that changed their value in the analysed time horizon.

A. Static hedonic price approach

The hedonic price regression is an econometric technique that has been used since Waugh (1928). Regarding its application to car prices, the hedonic regression method has featured in several papers (see e.g. Goodman, 1983; Fan and Rubin, 2010). In our analysis, the characteristics of the vehicle that affect consumer value play a secondary role as we focus on the residual effect of tax rates.

The estimated model regresses vehicle price against the vehicle characteristics that affect consumer value and the tax burden, which is uncorrelated with consumer value but correlated with mark-up. The estimated equations estimated on over 6 thousand vehicles offered on the Polish market takes the logarithmic form:

$$lnp_i = \sum_{j=1}^{N} \alpha_j lnx_{i,j} + \beta ln(1 + t_i) + \gamma d_i + \varepsilon_i$$

where p_i is the price offered for a certain specification and model of a vehicle, $x_{i,j}$ is a j characteristic of a vehicle i, t_i is the effective consumption tax rate (VAT and excise) and β is the average pass-through rate. d is a constant whereas α and γ are the remaining parameters of the model. Among the control variables, we include engine size, horsepower, type of body, transmission, brand and other vehicle-specific characteristics. The full list of variables and their characteristics is shown in Table 2 below.

Table 2. Variables used in the econometric analysis[12]

We estimate four alternative equations to verify the robustness of the model. We include all available characteristics but differentiate specifications by the inclusion of horsepower and engine size, which are to large extent collinear and cannot be included in a single equation. Moreover, we estimate the model for two time periods separately – for 2019 and 2020 – to verify whether parameter values remained stable across time

The baseline specification for 2020 (Specification #1), apart from the tax burden, includes horsepower, three dummy variables for type of engine, five dummies for type of body, automatic transmission and 44 dummies for brands included in the database, which are expected to account for intangible characteristics such as reliability, consumer value of luxury and others. The model proved to fit very well the variability of the data with R squared above 90 percent, and all exogenous variables are statistically significant at the 0.05 confidence level.

Table 3. Static models specifications[13]

According to the estimates, there is evidence of slight overshifting as the estimates of the long-run pass-through effects are larger than one in all specifications. Overall, the overshifting ranged from 4.9 to 13.4 percent across years. This observation proved to be relatively stable across the two-year period covered by the dataset (see Specification #2).

[12] For illustrative purposes, brand dummies were excluded from the table.

[13] For illustrative purposes, brand dummies were excluded from the table. Within the procedure for selecting exogenous variables aiming at minimising the problems of multicollinearity and the omitted variables, we created a correlation matrix of pre-selected variables. As this test proved, there was no case of pairwise correlation of above 0.65.

B. Difference-in-difference models

Controlling for other factors, we also analyse how the reduction in the statutory excise rate for nearly 500 versions of hybrid vehicles offered in the Polish market affected their final prices. Similar to Benedek et al. (2015), the econometric model regresses change in the log price of vehicles:

$$\Delta lnp_i = \sum_{j=1}^{N} \alpha_j lnx_{i,j} + \beta \Delta \ln(1 + t_i) + \gamma d + \varepsilon_i$$

where Δlnp_i denotes the relative change in prices between 2018 and 2019, namely when tax rebates were introduced. $x_{i,j}$ is a j characteristic of a vehicle i, t_i is the effective consumption tax rate (VAT and excise) and β is the estimated pass-through rate. d is a constant whereas α and γ are the remaining parameters of the model.

The timeframe of the analysis is approximately four months. We analyse the change in prices from November 2019 and March 2020, when all producers will have published their 2020 price lists. As the changes in rebates for hybrid vehicles were rather unexpected, prices collected in November 2019 likely do not incorporate any pre-emptive updates of vehicle prices caused by an expected change in the tax burden.

In the model, we include a wide array of characteristics to account for changes to price unrelated to tax rates. As described earlier, the change in prices might be affected, among others, by WLTP or changing tastes. Nevertheless, the inclusion of other variables related to vehicle characteristics but unrelated to the tax rate applicable has only slightly increased the model's fit[14].

[14] See characteristics of variables in Table 2.

The analysis poses a limitation as the offered price is not the transaction price. To limit the bias, we gathered information from car importers on the additional discounts applied to hybrid vehicles that were not in place in 2019. Thus, two specifications are reported. Specification #1 reports prices after the correction. Specification 2 reports prices before the correction.

Table 4. Difference-in-difference models specifications

We find that the model explaining the price corrected for special promotions explains a greater part of the price variation across time. Moreover, within the large set of available attributes, change in tax burden has the highest economic and statistical significance. The short-run pass-through (on price corrected for promotions) is slightly less than 45 percent (see Figure 2, Specification #1). If special promotions were not accounted for, the estimated pass-through would be minimal and account for 13.6 percent. The much lower value of the pass-through estimated with the difference model on hybrid vehicle observations signals that the pass-through is highly asymmetric. In other words, a decrease in the tax burden translates to the market price in a much lower percentage than an increase in the tax burden. It is also possible that that the pass-through is lower in the short term, which in this analysis is four months. For any of the two reasons, the effectiveness of the introduced tax breaks proved to be limited.

VII. CONCLUSION

The analysis of the effectiveness of a purchase tax on passenger vehicles in Poland in reducing negative externalities related to CO2 emissions yields a number of interesting observations. First, by their design, purchase taxes tackle externalities related to the purchase and disposal of cars, and only indirectly affect externalities related to their use. Moreover, engine size, which is a base criterion for tax rate differentiation in Poland, proved to be a poor proxy of a vehicle's emissions. This means that the first-order condition for the effectiveness of rate differentiation for reducing emissions is currently not met. In today's world, the criterion for differentiating rates should either be more refined or rely directly on standardised emissivity tests, which are already available for policymakers to serve as an emission proxy, for all newly produced vehicles.

The bunching analysis showed that there is considerable bunching observed around the threshold of the tax rate differentiation. Regardless of the impact of the current tax system on the bunching, it has only a minor impact on the distribution of purchased vehicles by their emissivity.

The econometric analysis of hedonic price regressions show that the basic car characteristics and tax burden explain over 90 percent of the variation in vehicle price. The impact of the tax burden proved to be more than proportional, meaning that the higher tax burden on vehicles with a larger engine size is overshifted in the long term. However, the analysis using the difference-in-difference approach showed that the recently introduced rebates for hybrid vehicles were largely ineffective as the reduction in the tax burden was primarily passed on to producers.

We conclude that in order to increase the effectiveness of purchase taxes on passenger vehicles in reducing negative externalities, the system should envisage a gradual increase in the tax burden based on reliable criteria for differentiating vehicles by the negative externalities they cause.

DISCLOSURES

The authors have no financial arrangements that might give rise to conflicts of interest with respect to the research reported in this paper.

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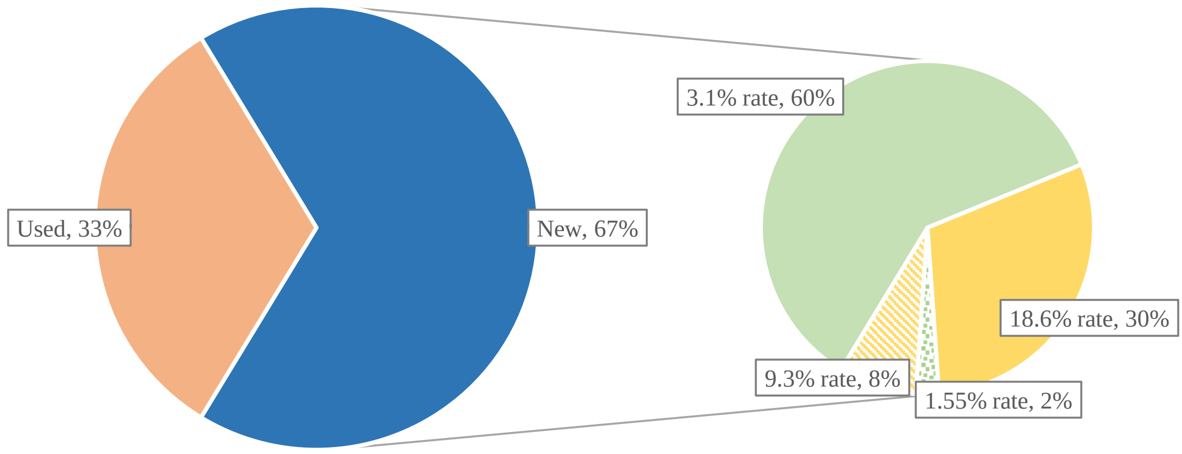
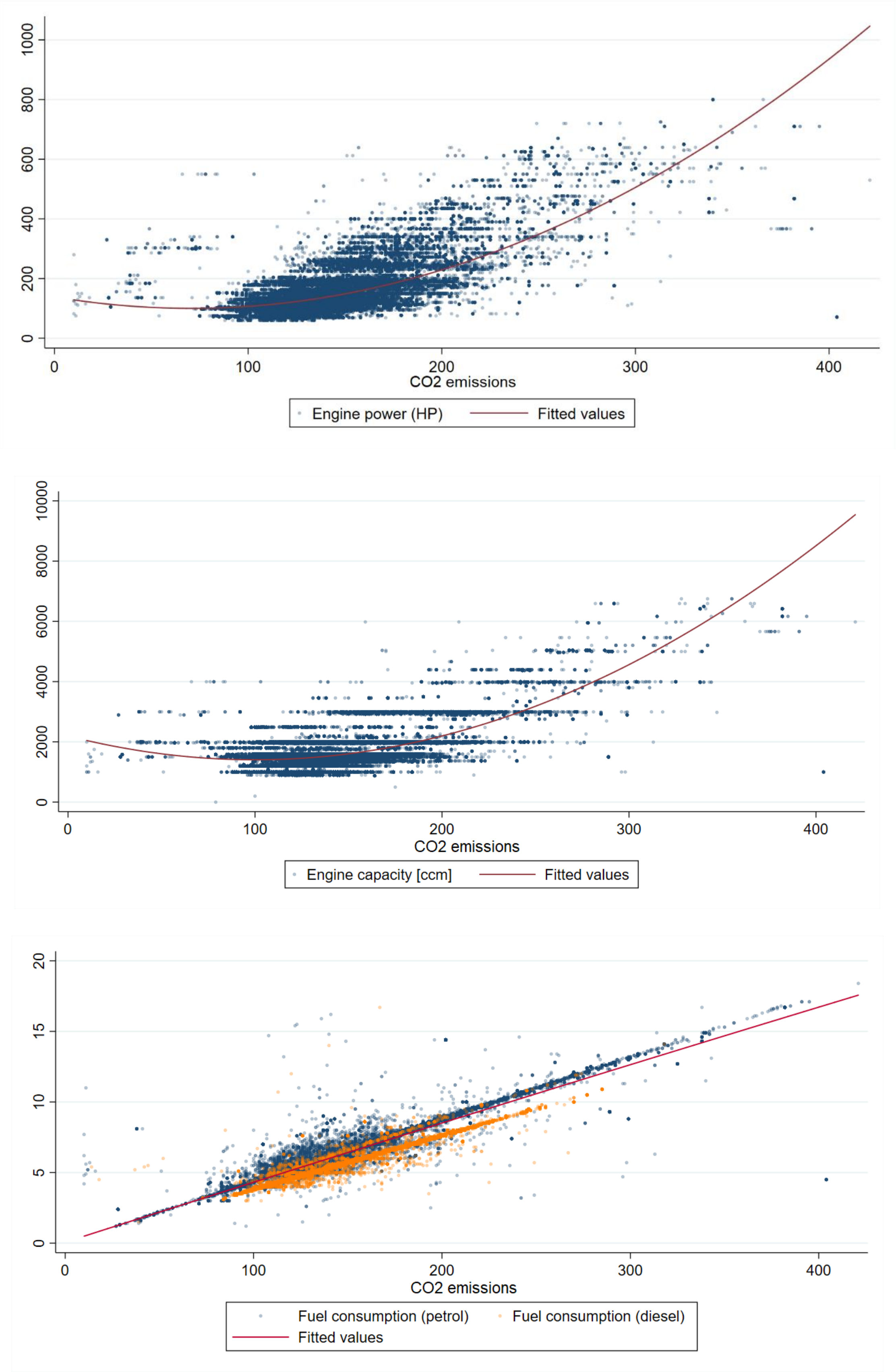
Figure 1. Tax revenue from excise on passenger vehicle sales by type and applicable rate (percent)



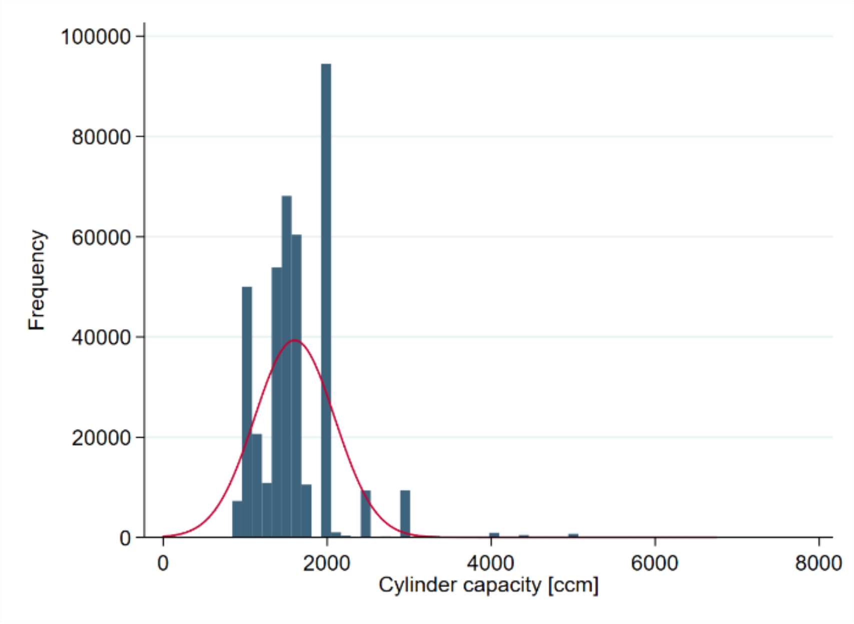
Source: Own elaboration, based on SAMAR and Ministry of Finance.

Figure 2. Relation between CO2 emissions and other characteristics



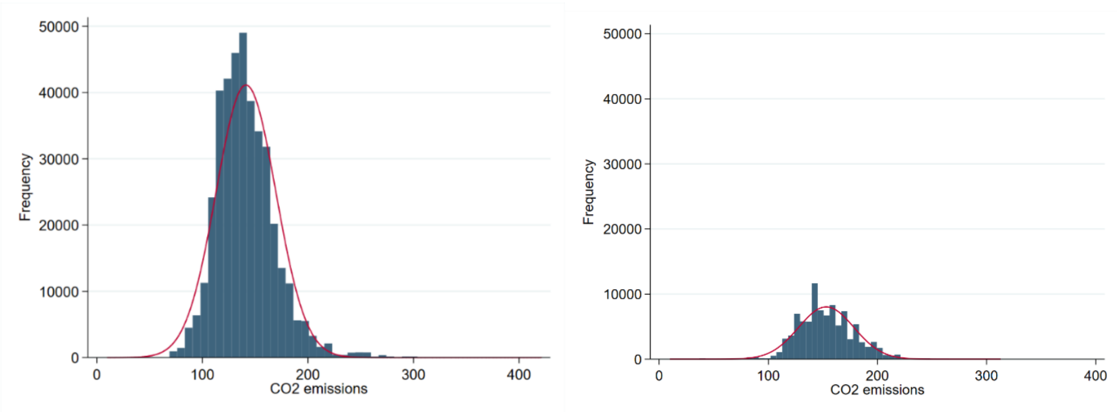
Source: Own elaboration, based on SAMAR.

Figure 3. Frequency of passenger car sales by engine size (2019)



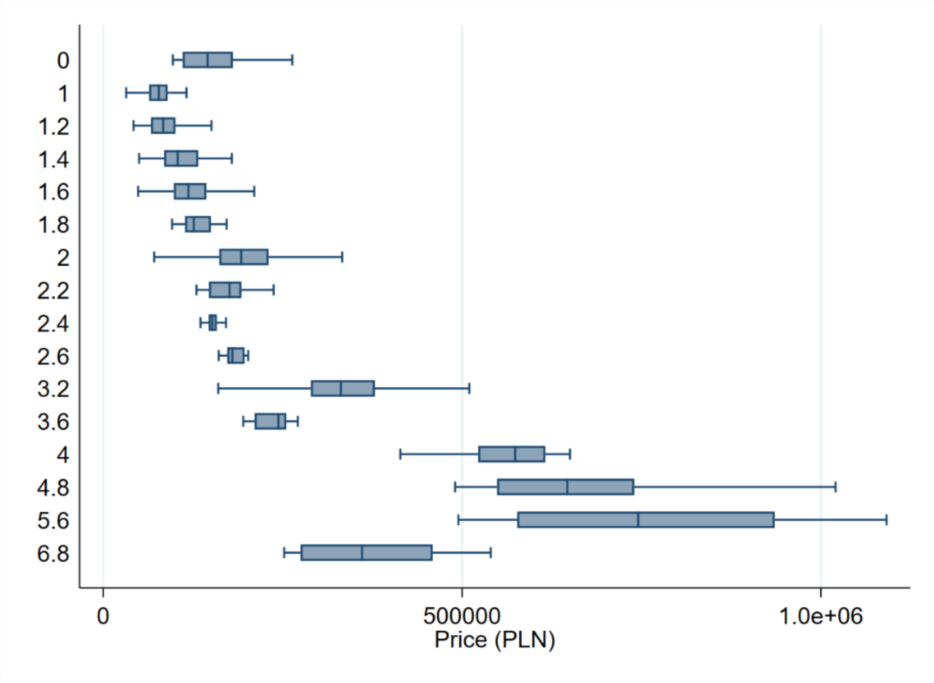
Source: Own elaboration, based on SAMAR.

Figure 4. Frequency of passenger car sales by CO2 emissions for the whole sample (left) and for cars with an engine capacity between 1900-2000 cm3 (right) (2019)



Source: Own elaboration, based on SAMAR. The overlaid red line shows a normal frequency distribution.

Figure 5. Dispersion of car price by engine size (2019)



Source: Own elaboration, based on SAMAR.

Table 1. Correlation coefficients between the parameters of cars and CO2 emissions

	Engine size	Horsepower	CO2 emission	Fuel consumption
Engine size	1.000	0.792	**0.526**	0.386
Horsepower	0.792	1.000	**0.623**	0.506
CO2 emission	0.526	0.623	1.000	0.878
Fuel consumption	0.386	0.506	0.878	1.000

Source: Own elaboration, based on SAMAR.

Table 2. Variables used in the econometric analysis

Variable	Obs	Mean	Std. Dev	Min	Max
Price (PLN)	6204	190032.9	127203.7	31900	3472690
Engine (l)	6143	1.931	0.725	0	6.8
Horsepower (PS)	6204	199.843	107.761	60	1000
Tax (1+percent)[15]	6204	1.287	0.06	1.23	1.459
HEV (dummy)	6204	0.101	0.301	0	1
Diesel (dummy)	6204	0.47	0.499	0	1
EV (dummy)	6204	0.01	0.099	0	1
SUV (dummy)	6204	0.319	0.466	0	1
SW (dummy)	6204	0.174	0.379	0	1
Convertible (dummy)	6204	0.04	0.195	0	1
Coupe (dummy)	6204	0.046	0.21	0	1
Minibus (dummy)	6204	0.086	0.28	0	1
Automatic Transmission	6204	0.668	0.471	0	1

Source: Own elaboration.

Table 3. Static models specifications

VARIABLES	(1) Baseline	(2) 2019 Specification	(3) Engine Size
ln_horesepower	0.824***	0.818***	
	(0.008)	(0.009)	
ln_engine_size			1.088***
			(0.011)
HEV	-0.004	-0.011	0.070***
	(0.011)	(0.013)	(0.013)
diesel	0.165***	0.167***	-0.063***
	(0.004)	(0.005)	(0.005)
electric	0.314***	0.340***	
	(0.021)	(0.026)	
ln_tax_2020	**1.134*** **		
	(0.057)		
ln_tax_2019		**1.049*** **	
		(0.057)	
SUV_dummy	0.061***	0.063***	0.070***
	(0.005)	(0.005)	(0.006)
wagon_dummy	0.044***	0.055***	0.060***
	(0.006)	(0.006)	(0.007)
convertible_dummy	0.152***	0.160***	0.157***
	(0.012)	(0.012)	(0.014)
coupe_dummy	0.055***	0.064***	0.074***
	(0.011)	(0.011)	(0.013)
minibus_dummy	0.319***	0.343***	0.252***
	(0.008)	(0.008)	(0.010)
transmission_dummy	0.075***	0.073***	0.135***
	(0.005)	(0.005)	(0.006)
Constant	7.026***	7.040***	11.139***
	(0.053)	(0.055)	(0.046)
Observations	7,039	7,080	6,962
R-squared	0.908	0.904	0.869

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration.

Table 4. Difference-in-difference models specifications

VARIABLES	(1) After correcting for promotions	(2) Before correcting for promotions
ln_horesepower	0.004**	0.002
	(0.002)	(0.002)
delta_ln_tax	**0.446*** **	**0.136*** **
	(0.037)	**(0.037)**
HEV	-0.007***	-0.004
	(0.002)	(0.002)
diesel	0.001*	0.002**
	(0.001)	(0.001)
electric	-0.007	-0.006
	(0.005)	(0.005)
ln_tax_2020	-0.011	0.001
	(0.011)	(0.011)
SUV_dummy	0.001	0.001
	(0.001)	(0.001)
wagon_dummy	0.001	0.001
	(0.001)	(0.001)
convertible_dummy	-0.005*	-0.004
	(0.002)	(0.002)
coupe_dummy	-0.001	-0.001
	(0.002)	(0.002)
minibus_dummy	0.011***	0.011***
	(0.002)	(0.001)
transmission_dummy	0.001	0.002*
	(0.001)	(0.001)
Constant	-0.018	-0.009
	(0.014)	(0.014)
Observations	5,852	5,852
R-squared	0.179	0.123

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Own elaboration.