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Cars and emissions in Portugal: policies, macroeconomic impacts and cities

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**ISCTE-IUL, Lisboa

Daniel Magueta, Mara Madaleno, Marta Ferreira Dias, Monica Meireles (2018). New cars and emissions: Effects of policies, macroeconomic impacts and cities characteristics in Portugal. Journal of Cleaner Production, 181, 178-191. <https://doi.org/10.1016/j.jclepro.2017.11.243>

Encontro com a ciência e a Tecnologia em Portugal, 2-4 julho 2018, Centro de congressos Lisboa



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Background

- In Portugal, in 2013, the transport sector was responsible for 33.3% of energy consumption with the road transport accounting for 95% of this percentage.
- Furthermore, the transport sector was also responsible for 34.7% of CO₂ emissions, a value highly concentrated in the major cities.
- To improve significant reductions on emissions in the transport sector, the Government has introduced several energy efficiency measures.
- In this paper it is analysed the effectiveness of Portuguese fiscal policies in encouraging the purchase of lower carbon cars.



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Goal and contribution

- Using a completely unexplored database of sales regarding new cars sold in Portugal during the period of 2002 and 2016 we have explored the evolution of average CO₂ emissions and sales considering different types of new cars sold (gasoline, diesel and electrical) in terms of descriptive statistics.
- We have also applied multiple regression models using macroeconomic variables able to justify changes in terms of both sales and emissions.
- Results demonstrate that including macroeconomic effects, household characteristics and city specificities are important for both emissions and sales explanatory behaviour that allow inferring how policy makers should redirect attention when formulating new policies regarding environmental performance.



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Data

- We present a description on the evolution of sales in the Portuguese new cars market for the period between 2002 and 2016, with a special focus on the data related to the years of 2006 and 2013, when significant changes in the legislation had occurred.
- All data comes from ACAP (Associação Automóvel de Portugal – Portuguese Automobile Association; www.acap.pt).
- The database contains information with respect to monthly sales of new cars in Portugal including models, engine size, power, car characteristics, among others, except the region of sales.
- Macroeconomic variables: Eurostat.

Table 2
Descriptive statistics – new car market – 2006.

	n° Models	% Models	Engine Pwr (cc)		CO ₂ Emissions		Horse Pwr (hp)		Sales	
			Mean		mean	Std. Dev.	mean		n° cars	Share (%)
2006 - All										
Berlina 3D	467	13.10%	1467.20		140.29	22.54	72.04		12,288	6.31%
Berlina 5D (B5)	869	24.37%	1517.61		144.60	23.02	73.36		92,705	47.61%
Cabrio	150	4.21%	2011.65		182.31	65.57	117.59		2466	1.27%
S. Weagon (SW)	529	14.83%	1921.36		165.28	32.80	100.68		41,821	21.48%
Commercial	34	0.95%	1437.38		151.21	15.65	57.91		1394	0.72%
Coupe	173	4.85%	2573.92		210.55	91.32	160.75		3681	1.89%
CUV	30	0.84%	2204.67		189.47	47.22	113.23		546	0.28%
MonoVolume	469	13.15%	1727.28		164.41	28.09	83.96		17,454	8.96%
Roadster	59	1.65%	2401.12		205.59	62.03	144.90		986	0.51%
Sedan	581	16.29%	2241.62		180.61	46.34	122.60		16,405	8.43%
4 × 4 (off-road)	205	5.75%	2553.90		232.66	54.95	129.84		4956	2.55%
Total	3566	100.00%	1867.68		166.87	47.76	97.38		194,702	100.00%
2006 - Gasoline										
Berlina 3D	241	16.35%	1378.95		151.32	23.19	71.68		6358	9.46%
Berlina 5D (B5)	421	28.56%	1384.53		153.06	22.05	69.88		49,437	73.53%
Cabrio	106	7.19%	2078.37		196.73	70.29	125.92		1130	1.68%
S. Weagon (SW)	143	9.70%	1832.77		182.55	42.64	102.82		3484	5.18%
Commercial	9	0.61%	1329.11		171.78	10.81	56.67		223	0.33%
Coupe	113	7.67%	2808.11		238.68	97.98	186.05		1632	2.43%
CUV	8	0.54%	2375.63		205.38	57.11	124.13		140	0.21%
MonoVolume	110	7.46%	1432.15		166	18.61	71.68		1929	2.87%
Roadster	57	3.87%	2421.6		207.49	62.04	146.51		832	1.24%
Sedan	212	14.38%	2384.35		208.15	55.34	140.34		1752	2.61%
4 × 4 (off-road)	54	3.66%	2895.2		258.31	75.75	168.81		316	0.47%
Total	1474	100.00%	1833.98		180.59	57.89	103.38		67,233	100.00%
2006 – Diesel										
Berlina 3D	226	10.90%	1561.32		128.52	14.42	72.42		1910	1.56%
Berlina 5D (B5)	448	21.60%	1642.67		136.66	21	76.63		43,268	35.44%
Cabrio	43	2.07%	1870.74		148.56	32.11	98.6		1336	1.09%
S. Weagon (SW)	382	18.42%	1956.99		158.69	25.49	100.06		38,326	31.39%
Commercial	25	1.21%	1476.36		143.8	9.16	58.36		1171	0.96%
Coupe	58	2.80%	2171.98		159.47	40.27	115.21		2049	1.68%
CUV	22	1.06%	2142.5		183.68	41.58	109.27		406	0.33%
MonoVolume	359	17.31%	1817.72		163.92	30.4	87.72		15,525	12.72%
Roadster	2	0.10%	1817.5		151.5	27.5	99		154	0.13%
Sedan	360	17.36%	2151.83		165.06	29.93	111.48		13,956	11.43%
4 × 4 (off-road)	149	7.18%	2428.88		223.83	41.73	115.5		3984	3.26%
Total	2074	100.00%	1889.86		157.23	35.98	92.93		122,085	100.00%
2006 - Electric and Hybrid										
Cabrio	1	8.33%	999		105	0	52		2	1.82%
Coupe	2	16.67%	999		103	0	52		4	3.64%
Sedan	8	66.67%	2530.88		147.25	48.15	153.38		69	62.73%
4 × 4 (off-road)	1	8.33%	3311		192	0	200		35	31.82%
Total	12	100.00%	2212.92		140	46	131.917		110	100.00%

Source: Own calculations based on ACAP sales database.

Table 3
Descriptive statistics new car market – 2013.

	n° Models	% Models	Engine Pwr (cc)	CO ₂ Emissions	Horse Pwr (hp)		Sales	
			Mean	Mean	Std. Dev.	Mean	n° cars	Share (%)
2013 – All								
Berlina 3D	463	13.07%	1434.75	118.7	22.67	82.603	5672	5.42%
Berlina 5D (B5)	993	28.03%	1455.9	116.6	20.4	78.751	52,332	49.97%
Cabrio	132	3.73%	1935.6	147.1	49.24	127.56	1128	1.08%
S. Weagon (SW)	535	15.10%	1858.8	131.7	24.2	109.46	19,840	18.94%
Commercial	41	1.16%	1548	130.3	23.54	72.585	426	0.41%
Coupe	150	4.23%	2783.4	180.4	75.02	205.35	2690	2.57%
CUV	194	5.48%	1647.2	139	20.73	93.139	8102	7.74%
MonoVolume	280	7.90%	1634.8	134.4	22.72	89.1	4078	3.89%
Roadster	32	0.90%	2682.4	182.6	47.57	178.33	108	0.10%
Sedan	475	13.41%	2194.3	139.2	34.99	139.47	5582	5.33%
4 × 4 (off-road)	248	7.00%	2284.9	167.2	43.84	137.06	4771	4.56%
Total	3543	100.00%	1783.4	133	36.17	105.77	104,729	100.00%
2013 – Gasoline								
Berlina 3D	264	21.78%	1314.1	124.7	23.84	81.51	2658	9.51%
Berlina 5D (B5)	439	36.22%	1266.4	123.1	18.19	73.70	20,607	73.69%
Cabrio	68	5.61%	2072.2	163.9	57.41	150.28	444	1.59%
S. Weagon (SW)	102	8.42%	1607.6	142.6	37.14	105.65	1460	5.22%
Commercial	0	0.00%	–	–	–	–	0	0.00%
Coupe	90	7.43%	3202.1	213.2	77.06	245.97	1058	3.78%
CUV	57	4.70%	1529.9	147.1	15.83	93.75	1059	3.79%
MonoVolume	48	3.96%	1292.8	136.4	16	78.94	315	1.13%
Roadster	26	2.15%	2887.5	195	45.98	193.27	43	0.15%
Sedan	83	6.85%	2396.2	168.9	52.07	168.16	204	0.73%
4 × 4 (off-road)	35	2.89%	2647.5	200.5	52.9	178.69	116	0.41%
Total	1212	100.00%	1659.9	142.6	46.14	108.39	27,964	100.00%
2013 – Diesel								
Berlina 3D	195	8.78%	1620.7	111.7	14.86	83.944	2999	3.99%
Berlina 5D (B5)	502	22.59%	1635.6	113.2	15.1	84.062	30,543	40.66%
Cabrio	62	2.79%	1848.2	133.3	18.68	105.31	679	0.90%
S.Weagon (SW)	430	19.35%	1917.2	129.6	18.91	110.13	18,307	24.37%
Commercial	41	1.85%	1547.9	130.34	23.54	72.6	426	0.57%
Coupe	53	2.39%	2294.6	138.87	17.89	150.72	1580	2.10%
CUV	136	6.12%	1696.7	135.36	21.49	92.97	7017	9.34%
MonoVolume	228	10.26%	1705.8	134.39	23.69	91.1	3742	4.98%
Roadster	6	0.27%	1920.6	136.29	9.91	122.86	65	0.09%
Sedan	361	16.25%	2135.3	135.06	21.50	129.44	5134	6.83%
4 × 4 (off-road)	208	9.36%	2214.8	162.9	38.86	128.79	4633	6.17%
Total	2222	100.00%	1855.95	129.53	25.98	104	75,125	100.00%
2013 - Electric and Hybrid HyHybridHybrid								
Berlina 3D	2	2.47%	647	6.5	6.5	125	10	0.81%
Berlina 5D (B5)	28	34.57%	1430.8	66.25	43.25	81.5	442	35.99%
Cabrio	2	2.47%	0	45	10	0	5	0.41%
S. Weagon (SW)	7	8.64%	1932.6	101.3	9.735	123.43	377	30.70%
Coupe	8	9.88%	1310.1	85.63	69.09	110.38	52	4.23%
MonoVolume	3	3.70%	1798	97.67	2.357	100	17	1.38%
Sedan	30	37.04%	2407.1	107.6	51.92	184.73	324	26.38%
4 × 4 (off-road)	1	1.23%	2554.7	126.3	44.84	174.43	1	0.08%
Total	81	100.00%	2207.9	110.2	35.24	150.25	1228	100.00%

Source: Own calculations based on ACAP sales database.

Table 5

Least Squares estimation results considering as dependent variables average monthly sales and average monthly CO₂ emissions by type of fuel/car and all new car sold: January 2002–December 2016.

		Dependent variable							
		Av. All CO ₂	Av. All Sales	Av. Gasol. CO ₂	Av. Gasol. Sales	Av. Diesel CO ₂	Av. Diesel Sales	Av. Electrical CO ₂	Av. Electrical Sales
Regressors	Av. CO ₂ emissions		2.3675**		4.7621***		3.5300**		-0.0514
	Av. Sales	0.0136**		0.0145***		0.0100**		-0.2215	
	Av. Eng. Size	0.8422***	-5.4611***	0.8735***	-4.5244**	0.7265***	-8.9166***	-0.0707	-0.0180
	Av. Power	-0.3695***	-1.9213*	-0.1178**	-6.0747***	0.0088	0.4064***	0.0750	0.4747***
	Long Term Int. Rate	-0.0019	0.0066	0.0073	-0.3260**	0.0098*	-0.0584	0.6456	-0.2105
	Unemploy. Rate	-0.0518***	-0.2883	-0.0692***	-1.0101***	0.0162	-0.1156	-5.2941***	-0.7154
	Dummy law	-0.0031	0.1023***	-0.0102***	0.1099**	-0.0023	0.0657*	0.3383	0.4376***
	Av. Gasoline fuel prices	-0.0353	1.9775**	-0.0220	0.4857	-0.1764***	1.3452	5.3700	5.3617**
	Av. Diesel fuel prices	-0.3216***	-0.2233	-0.1917***	-1.5846*	-0.0750**	-0.9196	2.5114	-1.1762
	Net Disp. Income PT	0.0187	-9.8858**	0.1359	-27.6765***	1.8107***	-20.6056***	43.3978	-57.6453***
	Net Disp. Income Lisbon	1.2357***	4.3256	0.9035***	10.4348**	1.3682***	3.2749	-21.2942	28.1763***
	Net Disp. Income Porto	0.4571*	1.5543	-0.1514	16.0708***	-1.4372***	12.2642***	-37.7162**	10.4447
	Employment rate PT	-1.3572**	5.1567	-0.2518	-32.8254***	1.6993***	-7.8082	20.3656	27.0948
	Employment rate Lisbon	-3.8518***	15.5144***	-2.7958***	28.9807***	-5.2141***	20.7922**	50.7025**	21.9685*
	Employment rate Porto	5.0913***	-15.8027**	3.2585***	-3.2219	3.9315***	-9.1030	-92.9670***	-33.57,595***
	Pop. Density PT	-19.0938***	85.5933***	-13.1185***	132.5694***	-24.9661***	105.5765**	125.5337	278.1467***
	Pop. Density Lisbon	4.2423***	-24.5211***	3.8278***	-34.8278***	5.8198***	-29.8841***	-83.3737***	-10.3447
	Pop. Density Porto	9.2900***	-36.0244*	4.8536***	-54.3865**	11.4194***	-43.0574*	40.6155	-205.9291***
	Adj. R ²	0.9934	0.7750	0.9940	0.8506	0.9959	0.6970	0.4637	0.9228

Method: Least Squares; Sample: 2002M01 2016M12; Included observations: 180.

Note: Av. stands for average, Gasol. stands for gasoline, Disp. is disposable, PT is Portugal, Pop. denotes population. *, **, *** represent coefficients statistically significant at 10%, 5% and 1%, respectively. The presented values are regression coefficient estimates. Av. CO₂ emissions and average sales as regressions change depending on the type of fuel/car (all new sales, gasoline, diesel and electrical) respectively for each of the considered dependent variables.



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Conclusions

- Environmental consciousness of population is needed because lower emissions or higher sales of electrical vehicles observed may be due to the effect of the introduced laws and not to the individual efforts to decrease global warming.
- This shows that we may have legislation imposing willingness to achieve the emissions level but not consumers' willingness to achieve it, as desired.
- This also leaves space for a higher intervention concerning population awareness for emission reduction needs and for the importance of choosing cars that should help achieving the emission reduction targets and consequently global warming reduction effects.



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Conclusions

- ▶ Results demonstrate that including macroeconomic effects, household characteristics and city specificities is important for both emissions and sales behaviour. When long-term interest rates increase, the gasoline car sales decrease.
- ▶ However only in this category, a significant impact was found. Including the population density effect by considering high urban areas in Portugal (Lisbon and Porto), we observe that there is a positive and significant correlation between emissions of new cars sold (for all, gasoline and diesel) and population, leading us to the conclusion that higher concentration of persons increases emissions, by increasing the circulation of vehicles by squared km.
- ▶ As such, accounting for cities specificities allows us to observe different impacts and to consider city characteristics when designing policies regarding CO₂ abatement effects associated to new car sales.



Thanks for your attention!

Questions?

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