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ASSESSING THE EFFECT OF ENVIRONMENTAL FEEBATE OF PRIVATE CARS ON ECONOMIC WELFARE

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with

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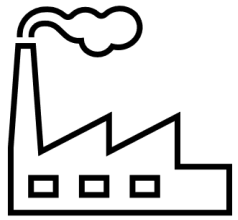
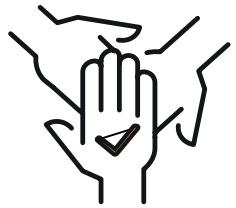
Introduction

- Private cars contribute about 20% of total CO_2 emissions (IEA, 2019)
- Many countries pledge to reach net zero emissions over the coming decades (IEA, 2021; European Commission, 2019; Government of the USA, 2021)
  - and implement policies design to decrease pollution from cars

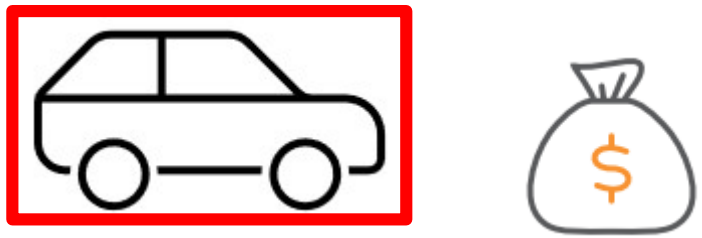


regulating manufacturers

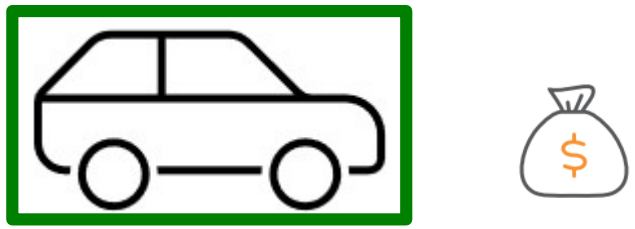


incentivizing consumers to buy cleaner cars

What is an environmental feebate?



Polluting cars → High purchase tax



Less polluting cars → Rebates or subsidies

- A frequently used policy measure to encourage consumers to buy less polluting cars
- Programs introduced in the US, France, Sweden, Japan, etc.

Do feebates help decrease pollution from car fleets?

Good for consumers?

Good for car manufacturers?

Environmental feebate programs

- **Japan 2009** - Substantial **economic surplus**, despite only minor changes in energy efficiency of the car fleet (Konishi and Zhao 2017)
- **Germany 2008** – Effect on environment cannot counterbalance the **decrease in welfare** (Adamou et al. 2014)
- **Sweden 2007 – Decreased emissions but extremely cost inefficient.** Transition to high-efficiency cars would have taken place regardless (Huse and Lucinda (2014)
- **France 2008 –**
  - Decrease in emissions but 2025 national targets will not be met (Kessler et al. 2023).
  - Negative impact on the environment (D'Haultfœuille et al. 2014)
  - Consumers shifted to cars emitting less CO_2, CO, and THC, but more hazardous pollutants - NOx and PM (Durrmeyer 2022)

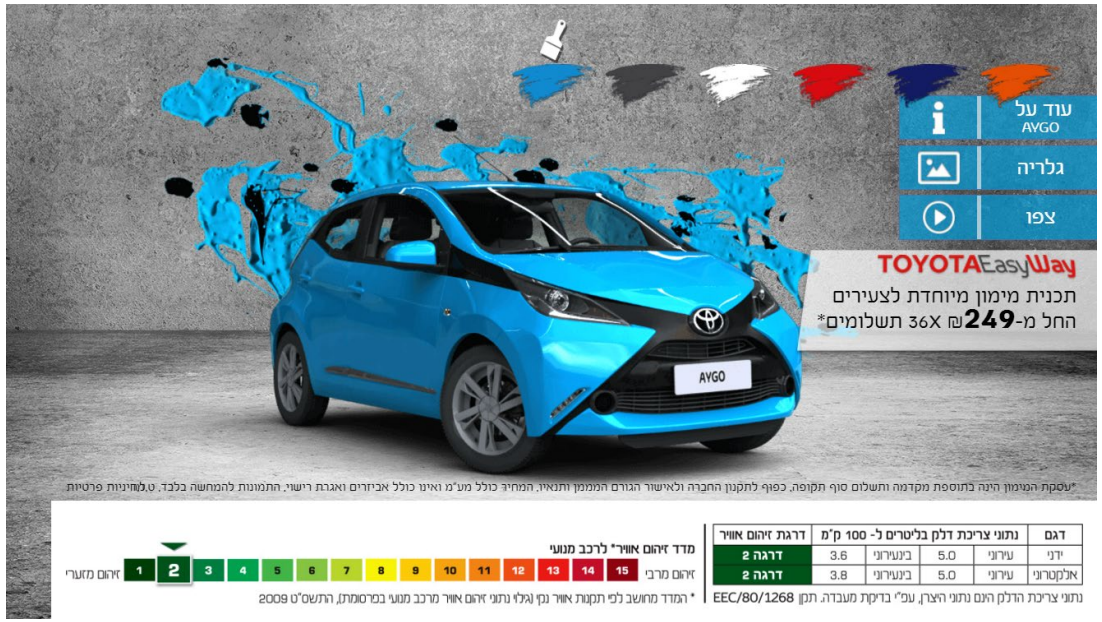
Research context

- Feebate program implemented in Israel in 2009
- The only feebate program in the world to include all 5 key pollutants:

  CO_2, CO, THC, NOx and PM
- A pollution score was calculated for each new car model:

$$Pollution\ score = \frac{30 * CO_2 + 500 * CO + 10{,}000 * NO_X + 900 * THC + 20{,}000 * PM}{30}$$

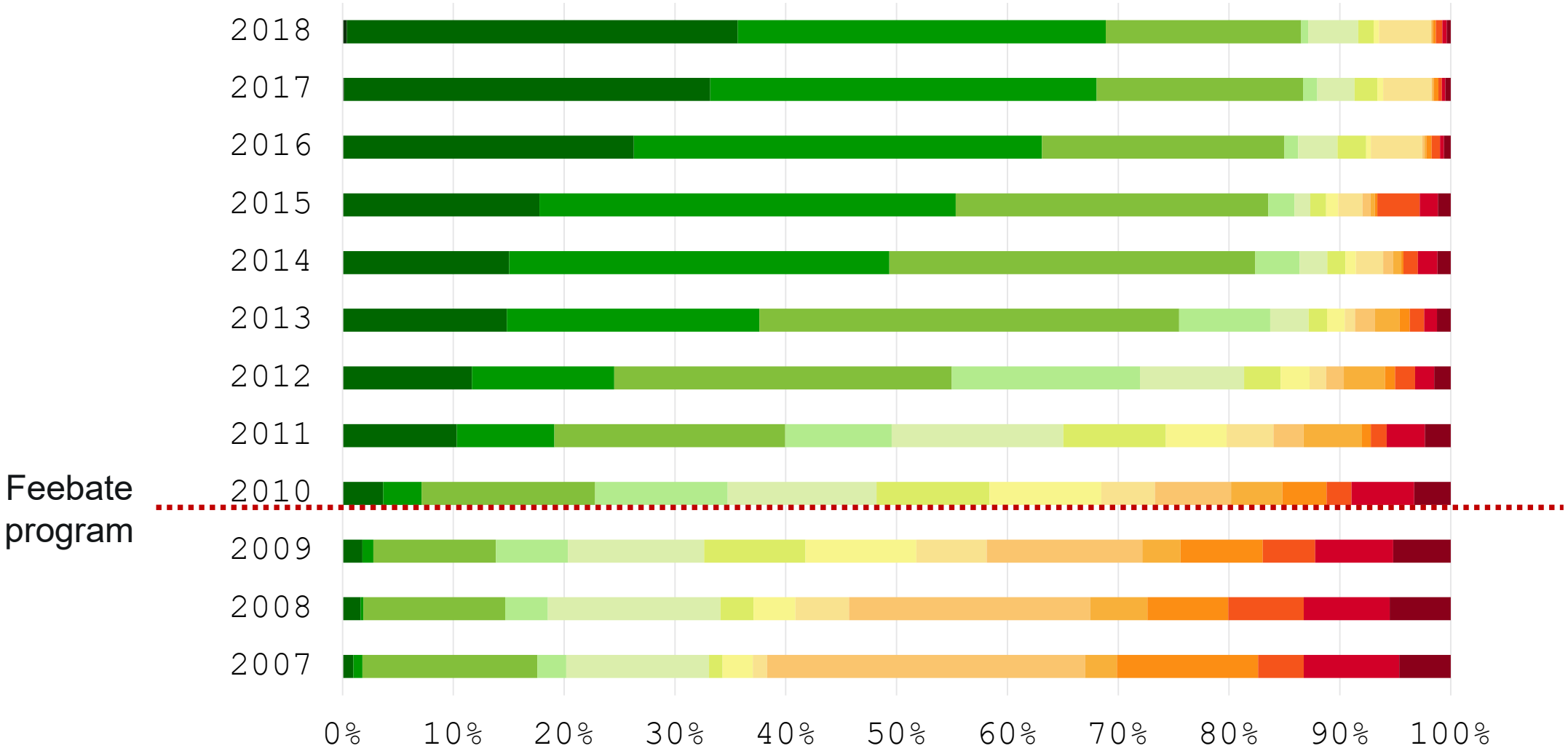
The feebate in Israel



Pollution level	Pollution score	Tax rate	Rebate (NIS, in 2015 values)
1 (Emission free)	0-50	10%	
2 (Plug-in hybrid)	0-100	20%	
2 (Hybrid)	21-130	30%	
2	51-130	83%	16,238
3	131-150		14,885
4	151-170		12,991
5	171-175		11,368
6	176-180		10,013
7	181-185		8,931
8	186-190		7,848
9	191-195		7,036
10	196-200		5,955
11	201-205		5,413
12	206-210		4,331
13	211-220		3,518
14	221-250		2,165
15	251-400		-

What can be observed before vs. after the feebate?

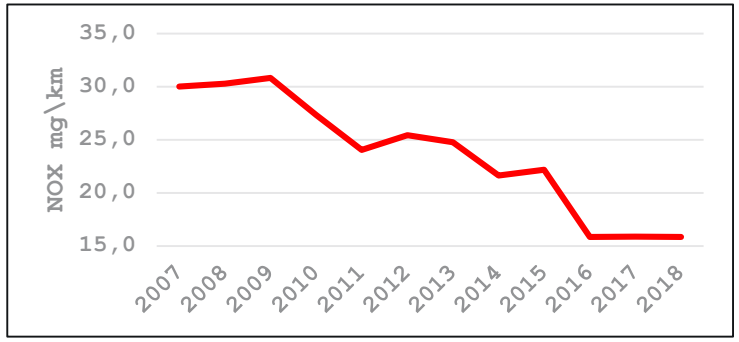
Distribution of new cars by pollution level

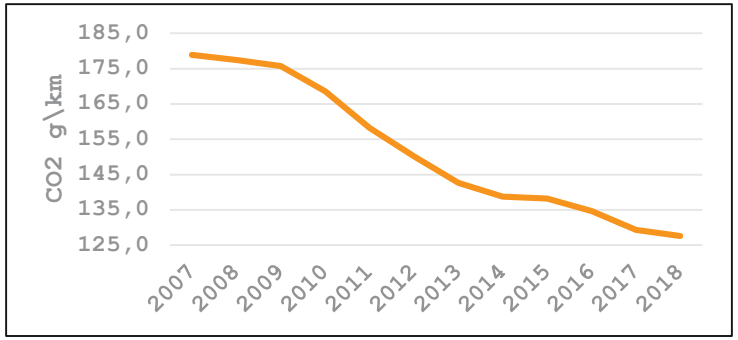


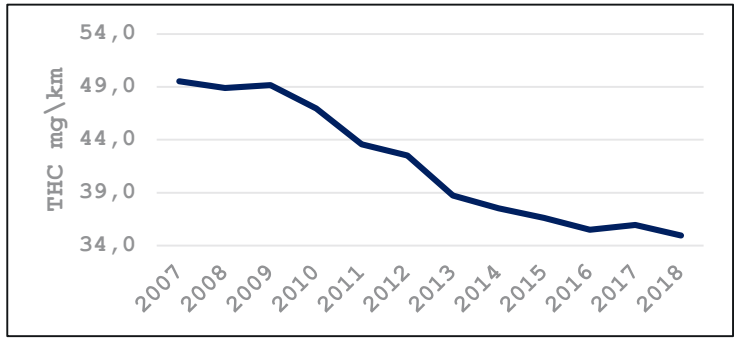
Authors' calculations based on data from the Israel Ministry of Transport and Road Safety

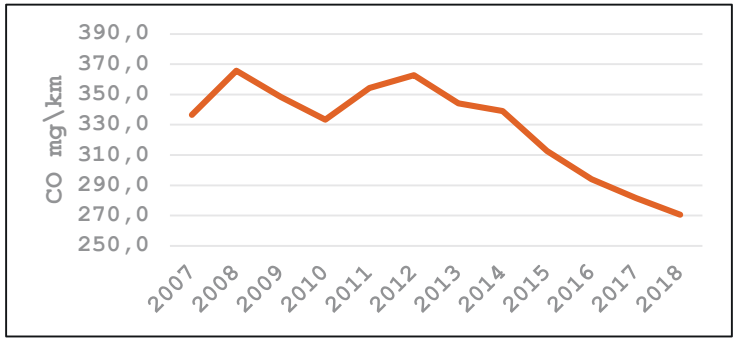
Least polluting | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Most polluting

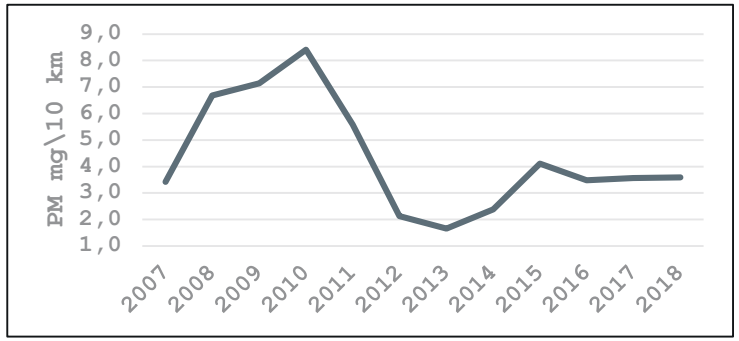
Average per-kilometer emission profile of the fleet of new cars











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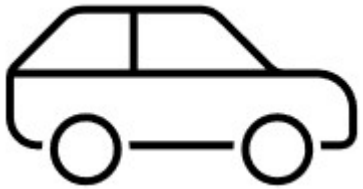
Data

Census – new car sales
2007 - 2018
(Ministry of Transport and Road Safety)



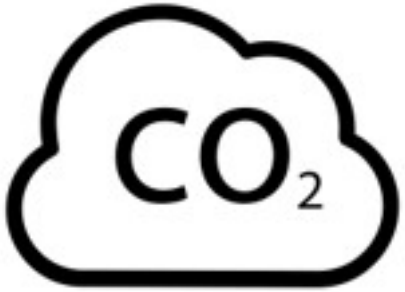
Subaru XV 2018 → 1995cc
Subaru XV 2018 → 1600cc

At least 100 annual unit sales

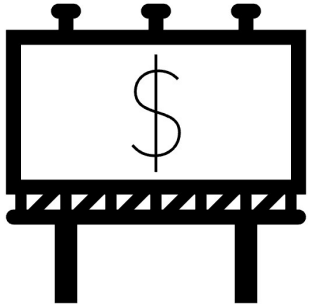
3,252 car models representing 1,803,800 car units sold

Data

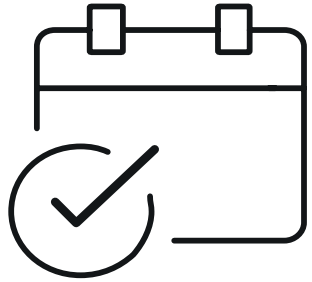
Emission data
(Ministry of Transport and Road Safety)



Advertising expenditure
(‘Ifat’-Market Research)



Household survey data
(Central Bureau of Statistics)



Differentiated goods model

- Concentrated structure of car markets (Berry, 1994; Fershtman and Gandal, 1998; Verboven, 1996; Kessler et al., 2023)

Differentiated goods model

Concentrated structure of car markets (Berry, 1994; Fershtman and Gandal, 1998; Verboven, 1996; Kessler et al., 2023)

$$(1)\quad ln(S_{jt}/S_{0t}) = x_{jt}\beta - \alpha p_{jt} + \sigma\, ln(\bar{S}_{j/gt}) + \xi_{jt}$$

$$(2)\quad \frac{p_{jt}}{1+T_{jt}} = w_{jt}\gamma + \frac{(1-\sigma)}{\alpha(1+T_{jt})\left[1-\sigma\sum_{k\epsilon f_{gt}} q_{kt}/Q_{gt} - (1-\sigma)\sum_{k\epsilon f_{gt}} q_{kt}/\mathrm{M}\right]} + v_{jt},$$

costs

markup

S_{jt} share of car j in market M

S_{0t} share of consumers choosing not to buy a new car

x_{jt} car characteristic

w_{jt} cost characteristic

p_{jt} retail price of car j

$\bar{S}_{j/gt}$ share of car j in category g

T_{jt} tax rate of car j

q_{kt}/Q_{gt} share of firm f in category g

q_{kt}/M share of firm f in market M

GMM estimation

Variables	Demand	Pricing
Car size (engine size / car weight)	0.000918***	40.51***
	(0.000137)	(1.580)
Automatic gear	0.702***	8,614***
	(0.0714)	(562.0)
Diesel	0.245***	4,757***
	(0.0818)	(1,168)
Four-wheel drive	0.0579	12,606***
	(0.0942)	(1,193)
Air bags	0.0831***	1,738***
	(0.0176)	(256.4)
Sunroof	0.263***	9,205***
	(0.0717)	(804.9)
Magnesium wheels	-0.238***	4,067***
	(0.0382)	(426.7)
Pollution level	-0.0176***	
	(0.00492)	
Exchange rate		-1.497***
		(0.0977)
Car category fixed effects	✓	
Year fixed effects		✓
Alpha	1.91e-05***	
	(2.86e-06)	
Sigma	0.116**	
	(0.0536)	
Constant	-8.278***	-51,363***
	(0.344)	(5318)
Observations	3,252	

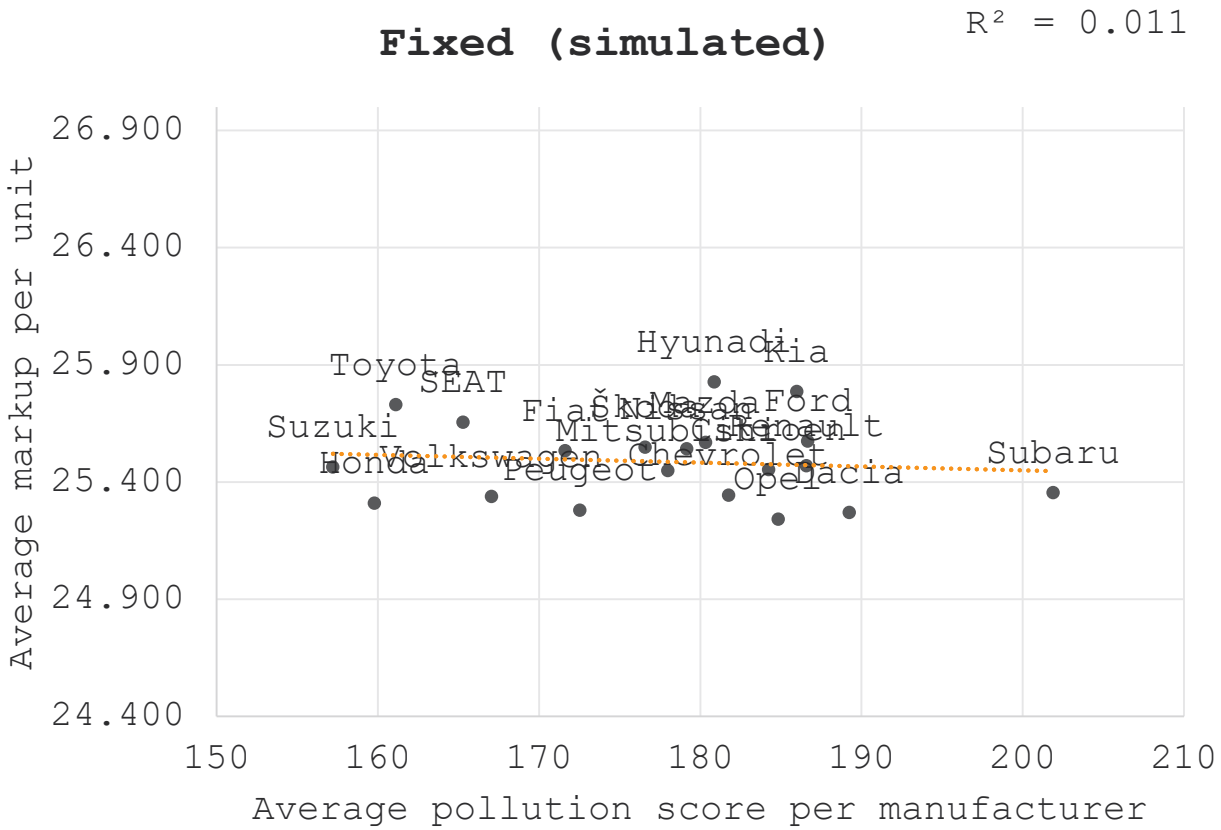
Simulations procedure

- Solving a demand and pricing equations for each car model/year.
- Calculating emissions for each car model/year and their cost using average km traveled by each car model.
- Calculating emissions of the outside-option.

Manufacturers' average pollution score and markup
feebate vs. fixed tax

Top 20 manufacturers, with more than 10K car units sold during the entire period (98% of market share).

Manufacturers' average pollution score and markup **feebate** vs. fixed tax



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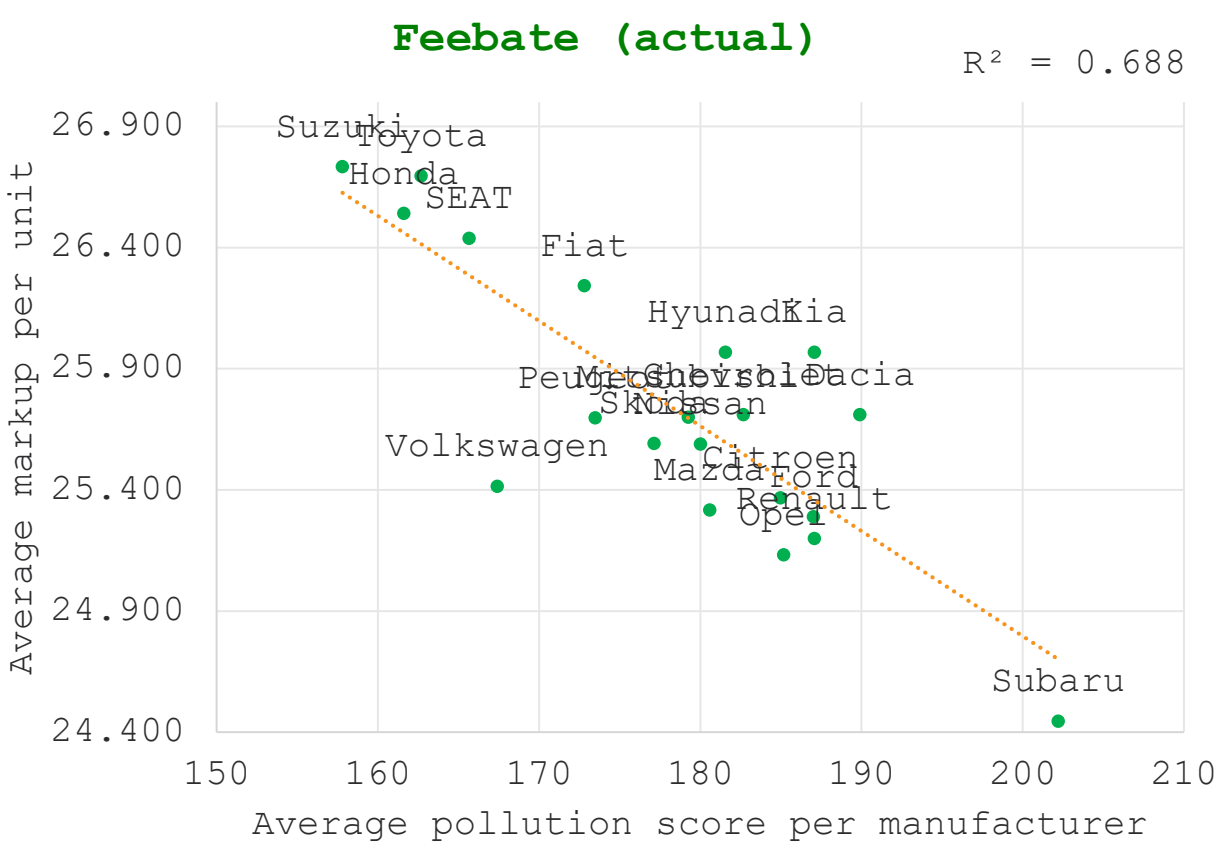

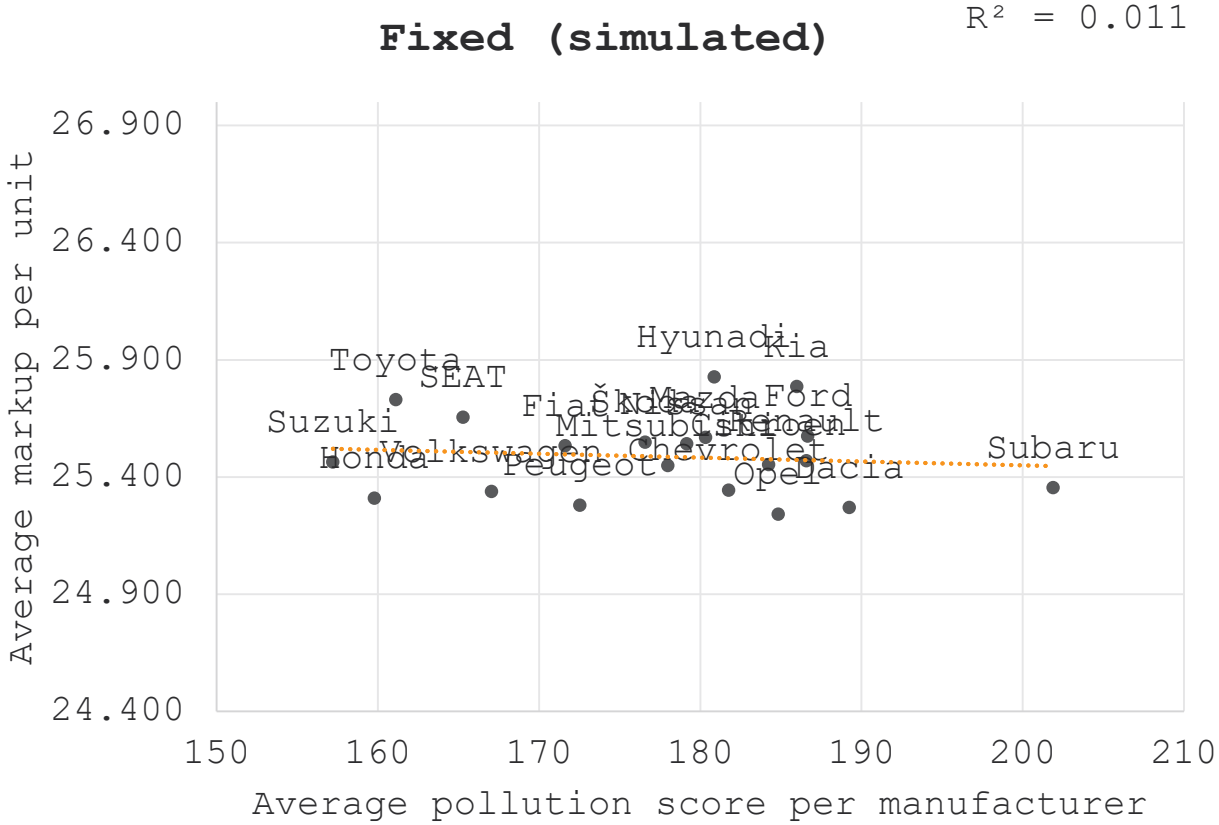

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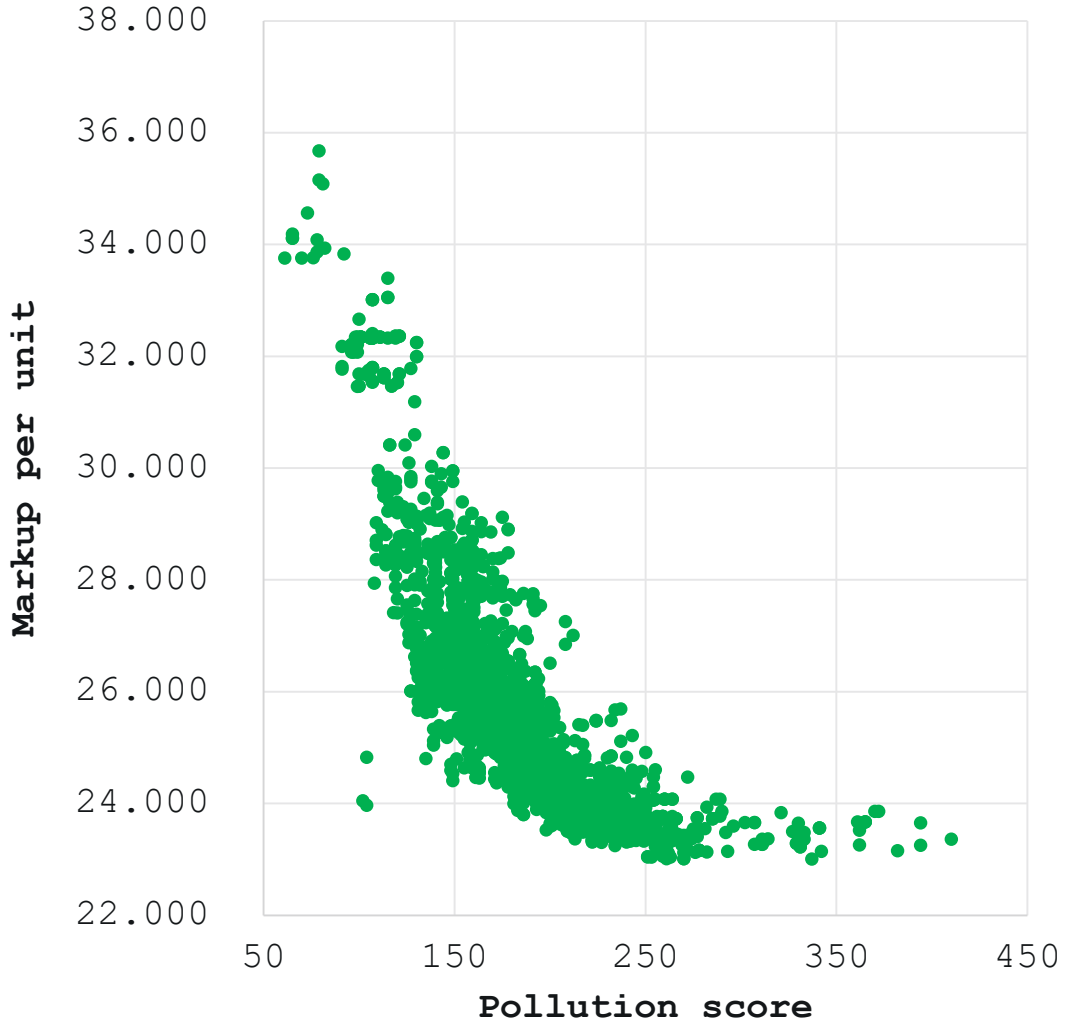
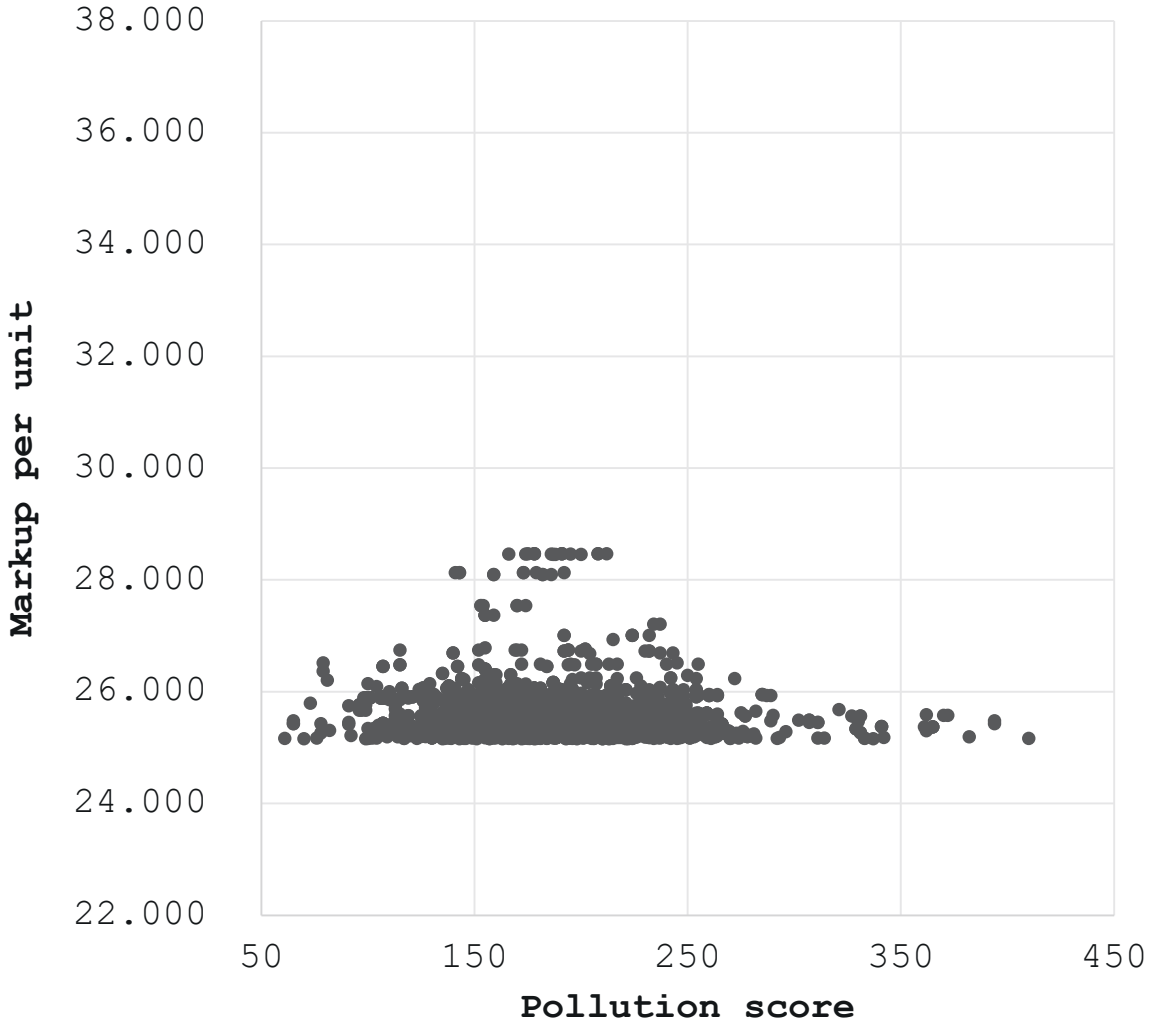
Car model pollution score and manufacturers' average markup - feebate vs. fixed tax





Change in sales, average retail price, tax revenue, and manufacturer markup

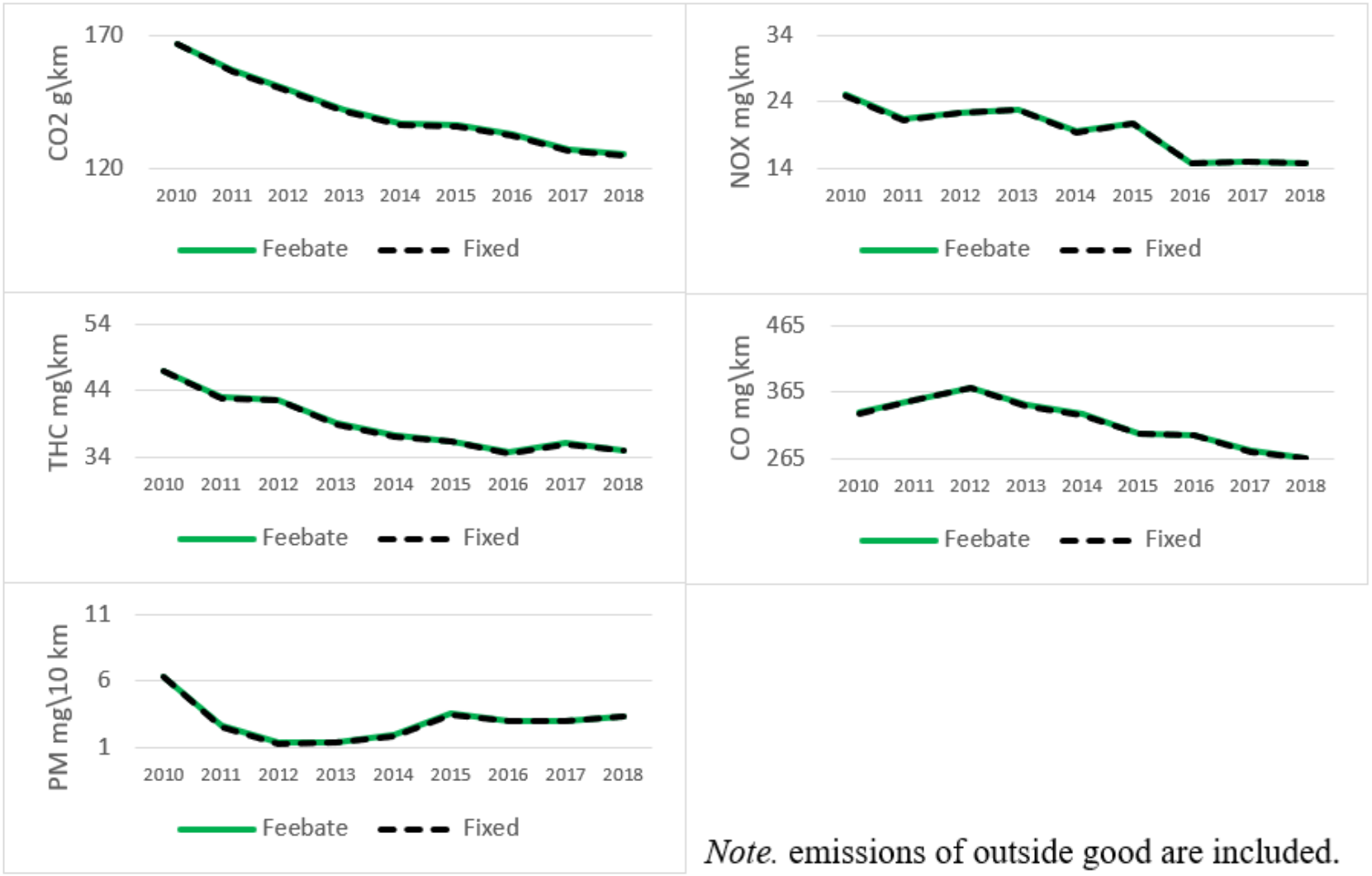
Car category	Δ Sales	Δ Retail price	Δ Tax revenue	Δ Markup
Family	-0.39%	0.23%	-0.77%	0.71%
Mini	-2.89%	2.37%	-4.41%	5.94%
SUV	1.84%	-0.53%	4.18%	-3.83%
Executive	1.61%	-0.58%	3.08%	-3.35%
Minivan	0.83%	-0.10%	2.31%	-1.78%
Commercial	1.58%	-0.55%	3.43%	-3.19%
Sports	-0.29%	0.34%	-0.15%	0.54%
Luxury	-4.27%	0.67%	-8.70%	7.52%

Total emissions
feebate vs. fixed tax

Average annual total emissions (tons)	Feebate (actual)	Fixed tax (simulated)	Δ (in %)
CO_2	605,493.69	601,878.45	0.60%
NO_X	104.33	103.56	0.75%
THC	164.34	163.87	0.28%
CO	1,340.07	1,325.96	1.06%
PM	1.89	1.88	0.99%

Note. emissions of outside good are included.

Average emissions per kilometer
feebate vs. fixed tax



Note. emissions of outside good are included.

Welfare effects (millions NIS) (2010-2018)
feebate vs. fixed tax

	Feebate (actual)	Fixed tax (simulated)	Δ in NIS	Δ in %
Manufacturer surplus	46,657	46,429	228	0.49%
Consumer surplus	70,240	70,632	-391	-0.55%
Emissions cost (outside option included)	755	750	5	0.62%
Government revenue	88,855	88,948	-93	-0.1%

Summary

- The policy in Israel is similar to policies in other countries (US, France, Sweden, and Japan)
- The first one to include all 5 pollutants
- Because of the market power of car manufacturers they were able to react to the feebate
  - affected the success or failure of the feebate program
- The decrease in emission levels would likely have taken place regardless of the feebate policy, probably because of the evolution of technology and CAFE standards
- Information regarding the pollution level of the car affects demand above and beyond price

Policy implications

- Feebates may not be effective under imperfect competition
- Policymakers should consider other regulatory tools

Thank You.

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