

# Charging drivers by the pound: The effect of the VED system in the UK

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- Transportation sector: 25% of GHG emissions
- Vehicle taxes: sale taxes or **annual registration taxes** linked to CO<sub>2</sub> emission rates (g/km)
- Widely adopted (France, Sweden, Germany, Spain, **UK**...)
- Declared goal: tackling climate change, encouraging switch to cleaner cars (UK Budget 2000)
- Current literature:
  - Structural: D'Haultfoeuille et al. 2014, Alberini and Bareit 2015, Konishi and Meng 2015, Stitzing 2015, Grigolon et al. 2015
  - Reduced form: Ciccone 2015, Klier and Linn 2015



- What is the effect of registration taxes on vehicle sales?
- Impact of different structures of a registration tax?
- Consider miles driven in addition to emission rates (carbon tax)?



- Exploit variation in registration taxes across emission rates and time in the UK between 2005 and 2010
- Use a model of vehicle sales
- Predict and compare the effect of various policy instruments
  - Registration tax, tax bands based only on emission rates, not based on mileage (existing policy)
  - Registration tax proportional to emission rates (not based on mileage)
  - Carbon tax (based both on mileage and emission rates)
  - Carbon tax requires a model of miles driven

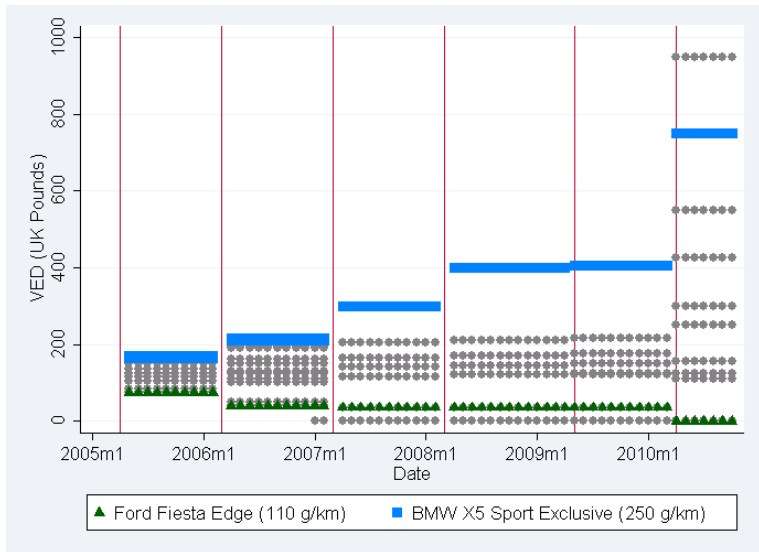


# UK Vehicle Excise Duty (VED)

- Annual vehicle registration tax based on CO<sub>2</sub> emission rates (g/km), started in 2001
- Vehicles grouped in CO<sub>2</sub> bands
  - E.g. all vehicles between 100 g/km and 120 g/km
- Different VED amount for each band
- Changes in VED over time:
  - More bands
  - VED increase for very polluting vehicles, decrease for cleaner vehicles



# VED amounts over time



- R.L. Polk & Co data on monthly new passenger vehicle registrations (2005-2010) at model-trim-variant level
  - Info on CO<sub>2</sub>, price, fuel cost per km, various vehicle characteristics
  - Reconstruct tax with official UK Budget documents
  - Aggregate at policy periods (VED unchanged), roughly one year
- UK National Travel Survey (NTS), 2005-2010
  - Info on mileage per year, vehicle characteristics, age of vehicle
  - Multi-year cross-sectional data



# Summary statistics (registration-weighted)

	Mean	Std dev.	Max
Monthly registrations	28.7	85.2	4465
CO <sub>2</sub> emission rate (g/km)	159.4	35.7	697
Real VED tax (2005 £ per year)	129.5	64.4	831
Fuel consumption (Liters/100 km)	6.42	1.5	26.2
Real sale price (2005 £)	11,606.97	6,164	240,549
N. variants per model	50.16	43.6	213





$$\ln(\text{Reg}_{imt}) = \alpha + \beta X_{imt} + \beta_1 P_{imt} + \beta_2 FC_{imt} + \beta_3 \text{VED}_{imt} + \xi_{mt} + \epsilon_{imt}$$

- Polk data, following Berry (1994), Klier and Linn (2015)
- Dependent variable: log new registrations for vehicle variant  $i$ , with model  $m$ , at time  $t$
- Time is policy period (VED amounts do not change)
- Control for real price  $P$ , real fuel cost  $FC$ , vehicle characteristics  $X$
- Identification: variation in VED within make-model at same time



# Results vehicle registration model

	(1)	(2)	(3)	(4)	(5)
<b>Fuel cost</b> (£/100 km)	-0.196*** (0.056)	-0.212*** (0.046)	-0.182*** (0.060)	-0.172*** (0.053)	-0.267*** (0.063)
<b>VED tax</b> (£100s)	-0.261*** (0.057)	-0.244*** (0.053)	-0.259*** (0.053)	-0.269*** (0.051)	-0.238*** (0.057)
Observations	55,811	55,811	55,811	50,705	53,448
	Model by time FE	Make by time FE	No price	No top 1% best selling make- models	No months before VED changes



- Predict mileage using NTS data
  - Dependent variable: log of annual km in survey year
  - Regressors: engine size, fuel cost, vehicle age
  - Separate regressions for diesel and gasoline vehicles
  - Use coefficients to predict lifetime mileage for vehicles in Polk database
  - Assuming vehicle lifetime of 14 years (Source: SMMT)

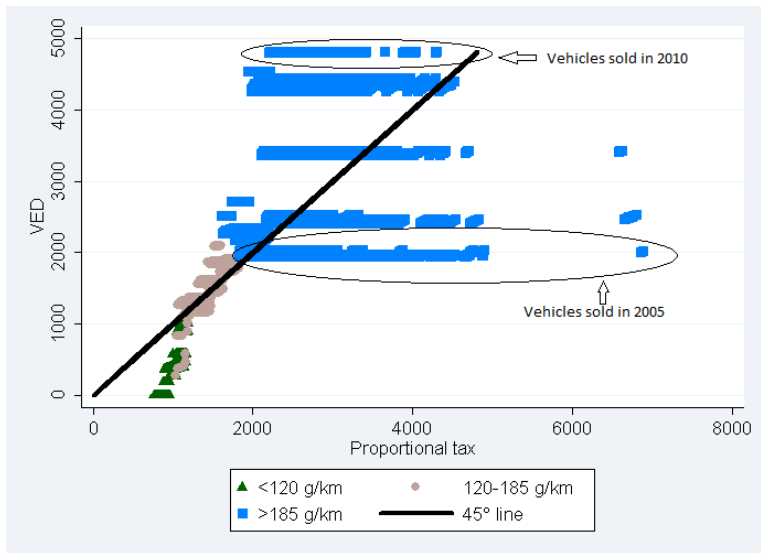


# Comparing VED and alternative policies

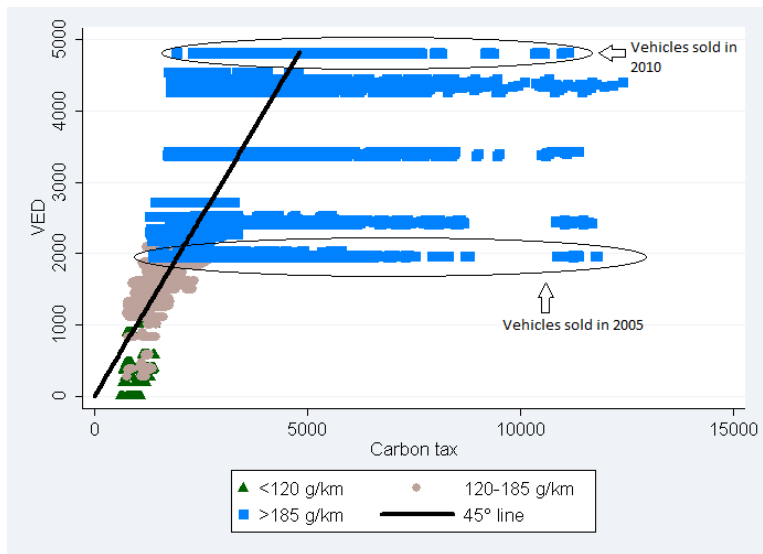
- Use registration and mileage models to predict effect on registrations and carbon emissions
  - Proportional tax: £0.83 per gCO<sub>2</sub>/km
  - Carbon tax: £72 per ton CO<sub>2</sub>
  - Tax rate generate same revenue of the VED (14.23 billion pounds)
  - Predicted registrations normalized at the model by time level



# Total VED tax and proportional tax (vehicle lifetime)



# Total VED tax and carbon tax (vehicle lifetime)



# Predictions: lifetime carbon emissions from new vehicles

VED bands g CO <sub>2</sub> /km	VED	Emissions (million tons CO <sub>2</sub> )		
		Proportional tax	Carbon tax	Carbon tax (same mileage)
<b>Total</b>	<b>252.32</b>	<b>252.62</b>	<b>242.97</b>	<b>251.40</b>
% change		+0.12%	-3.71%	-0.36%

Remember: revenue is the same for the three policies



- Consumers respond to the VED in terms of registrations
- Different policies tax differently high and low polluting vehicles
- VED and tax proportional to emission rates equivalent for effect on emissions
- Carbon tax more effective than VED...
- ...but only through effect on mileage

