The impact of emission-based taxes on the retirement of used and inefficient vehicles: The Swiss case

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In short

- Impact evaluation (DID) of two bonus/malus schemes

- Outcome variable is age to retirement of used and inefficient cars

- Policy is **retroactive** : earlier scrappage

- Policy **only on new vehicles** : delayed scrappage

- Relevance: e.g. 60% Swiss fleet has been on the road at least 6 years but they are not subject to most bonus/malus policies here or elsewhere.

Emission-based taxes as a strategy to tackle CO2 emissions

- CO2 emissions important cause of climate change

- Developed countries: 1/3 of CO2 emissions generated by transportation sector

- Emission-based taxes are becoming popular among developed countries

  - Emission-linked taxes — Germany, Finland, Ireland, and Norway

  - Bonus/malus or feebates — Sweden, France, Canada and Switzerland

- Goal: increase the share of fuel efficient vehicles

Our research and goals

- Imposing bonus/malus schemes on new cars must have an impact on the market for used cars and scrappage rates ...

- ... so we examine whether emissions-based annual registration fees impact lifetime (and scrappage rates) of existing cars. Are there any unintended consequences (Gruenspecht, 1982)?

- Quasi-experiment in Switzerland (Alberini and Bareit, 2016)

- Focus on two cantons that implemented a bonus/malus in 2009 and 2010, respectively.

- Identification strategy: difference-in-difference with hazard of retirement

Bonus/malus schemes under study

Canton	Policy	Year	Malus			Bonus		
			Criteria	Retroactive	Amount	Criteria	Retroactive	Amount
Obwalden	Bonus/Malus	2009	Label G	Yes	+ CHF 60	Labels A and B	No	- 100 %
Geneva	Bonus/Malus	2010	> 200 g CO_2/km	No	+ 50 % of tax	< 121 g CO_2/km	No	- 50%

Study design

Policy	Treatment	Treatment group	Control group	Have data before and after the treatment for both groups?
Bonus for low emitters and Malus for high emitters in Obwalden (used and new)	Bonus/Malus	Used high emitters in Obwalden	Used high emitters in Uri	Yes
Bonus for low emitters and Malus for high emitters in Geneva canton (new only)	Bonus/Malus	Used high emitters in Geneva	Used high emitters 9 cantons with no policy	Yes

Control vehicles and cantons

- Control cantons with similar vehicle fleets (vintage, CO2 emissions, and weight)

- Control vehicles are identical make-model-trim (up to body type, engine size, horsepower, fuel type, transmission and number of doors)

Econometric models

- Survivial analysis model

- Dep. Var.: lifetime of a car

- Weibull proportional hazard (PH) model

- Right censoring

Data

- Vehicle fleet in Switzerland from 2005 to 2013

- Individual car registration data, but no owner characteristics

- Municipality variables (distance to closest city and altitude)

Weibull proportional hazard function, Obwalden

Treated canton: Obwalden	Control canton: Uri							
	Time Invariant + Obwalden dummy (II)		Time Invariant + Post 2009 dummy (III)		(II) + Post 2009 dummy (IV)		(IV) + Treatment effect dummy (V)	
	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio
Policy evaluation variables								
Post 2009 (A)			-1.075***	0.341	-1.299*	0.273	-1.450**	0.235
(1/0)			(0.133)		(0.668)		(0.684)	
Obwalden (B)	-1.110				-1.088***	0.337	-1.269***	0.281
(1/0)	(0.684)				(0.133)		(0.147)	
Treatment effect (A*B)							0.513***	1.670
(1/0)							(0.152)	

Treatment effects in non-linear DID (Puhani, 2012)

$$\tau(T = 1, M = 1, X, trim)$$
$$= \lambda^1(T = 1, M = 1, u, trim, X)$$
$$- \lambda^0(T = 1, M = 1, u, trim, X)$$
$$= \alpha u^{\alpha-1} \exp(\beta_0 + \beta_T + \beta_M + \beta_{TM} + \beta_{trim} trim + \beta_x X)$$
$$- \alpha u^{\alpha-1} \exp(\beta_0 + \beta_T + \beta_M + \quad\quad \beta_{trim} trim + \beta_x X)$$

Weibull proportional hazard function, Obwalden
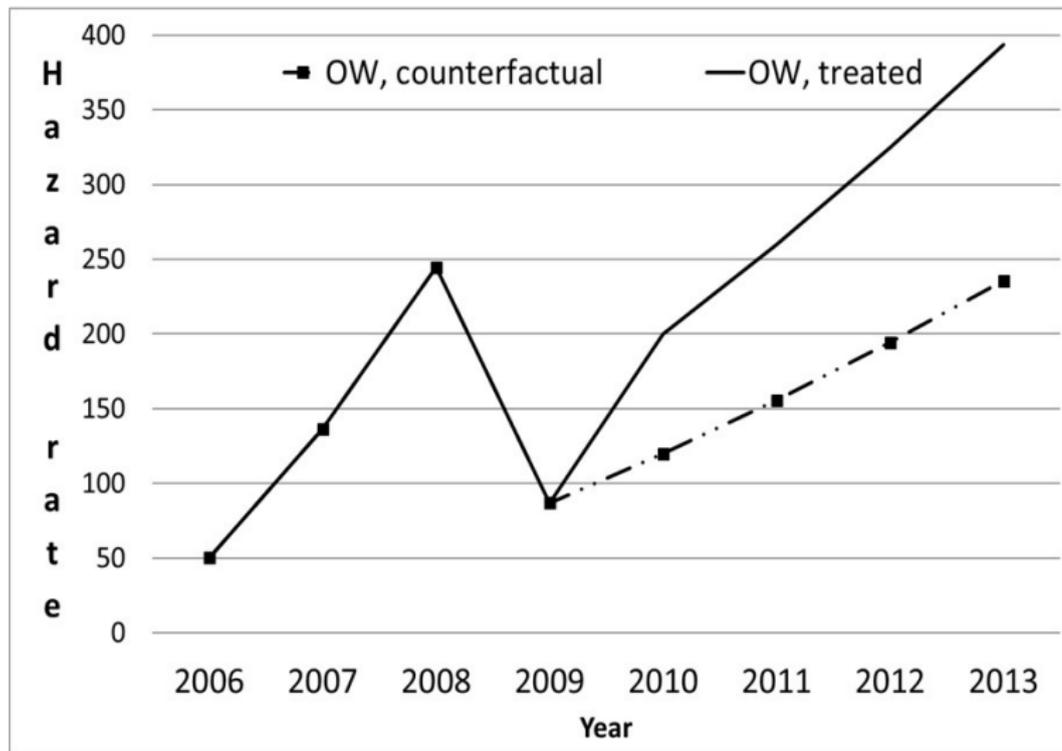
Weibull proportional hazard function, Geneva

Treated canton: Geneva	Control Canton: all 9 cantons							
	Time invariant + Geneva dummy (II)		Time invariant + Post 2010 dummy (III)		(II) + Post 2010 dummy (IV)		(IV) + Treatment effect dummy (V)	
	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio	Coeff (std errors)	Hazard ratio
Policy evaluation variables								
Post 2010 (A)			-0.405***	0.667	-0.405***	0.667	-0.391***	0.676
(1/0)			(0.0125)		(0.0125)		(0.0140)	
Geneva (B)	-0.738***	0.478			-0.760***	0.468	-0.713***	0.490
(1/0)	(0.164)				(0.162)		(0.161)	
Treatment effect (A*B)							-0.141***	0.868
(1/0)							(0.023)	

Weibull proportional hazard function, Geneva
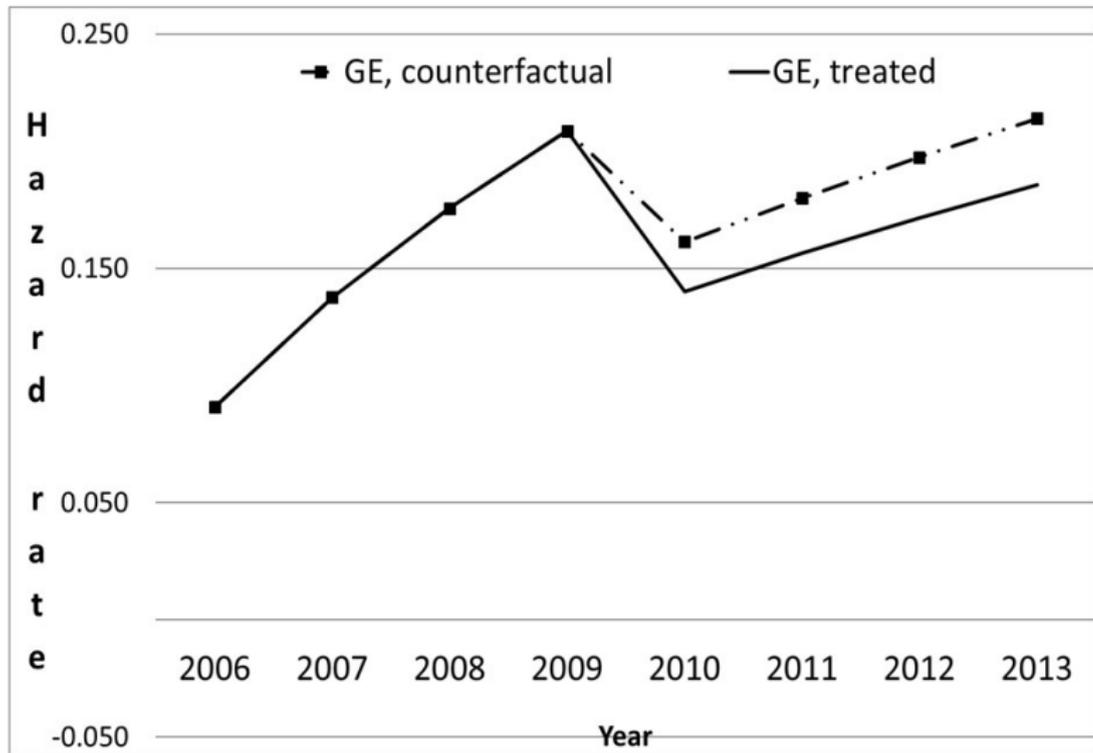
Impacts on time to retirement

Vehicle	Age to retirement (years)			95% C.I. of differencea	
	Counterfactual	Treated	Difference	Lower Bound	Upper Bound
Obwalden					
Toyota Corolla	10.26	9.45	0.81	0.75	0.87
Toyota RAV	10.55	9.68	0.87	0.80	0.93
Hyundai Santamo	8.51	8.03	0.48	0.44	0.51

Conclusions

- Bonus/malus scheme has opposite effects in the two cantons

- Obwalden: bonus/malus accelerates scrappage

- Geneva: bonus/malus extends lifetime

- Results for Geneva are consistent with previous studies in which changes in prices of new vehicles are due to
  - fuel economy standards (Goulder et al., 2012)
  - changes in gasoline prices (e.g. Jacobsen and van Benthem, 2015; Li et al., 2009; Bento et al., 2013)

Previous evaluations

- **Ex-ante impacts on simulated markets that have not experienced a feebate** (e.g.Habibi et al., 2015; Zazhariadis and Clerides, 2015; Adamou et al., 2014; and Adamou et al., 2012)

- **Ex-post evaluations without access to a proper control** (e.g. Klier and Linn, 2015; Stitzing, 2015; Ciccone, 2015; Rivers and Schaufele, 2014, and Rogan et al., 2011; Klier and Linn, 2015; D'Haultfoeuille et al., 2013, Huse and Lucinda, 2013)

- **Focus on registration or sale of new efficient vehicles and impacts on CO2 emissions, consumer welfare, public revenues, and firm profits**

Swiss fleet

		2005	**2009**	**2012**
Registrations	Millions	3.86	4.01	4.25
CO2	g/km	204.00	194.00	185.00
FE, gasoline	l/100 km	8.70	8.30	8.00
FE, diesel	l/100 km	6.90	6.80	6.60
Shares				
0-2	%	17.95	18.40	20.17
3-5	%	22.60	19.07	19.13
6-8	%	20.14	19.63	17.36

In comparison

	< 5 years	6 or more
Finland	21.87	78.13
Germany	29.57	70.43
France	25.87	74.13