WHAT ARE THE EFFECTS OF INCENTIVES ON ELECTRIC VEHICLE SALES IN EUROPE?

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Motivation

- Major policy attempts world-wide to foster electric vehicle adoption
- Yet, limited quantitative empirical evidence on effect and efficiency of policies

➢ **What is the impact of direct and indirect incentives on PEV adoption?**

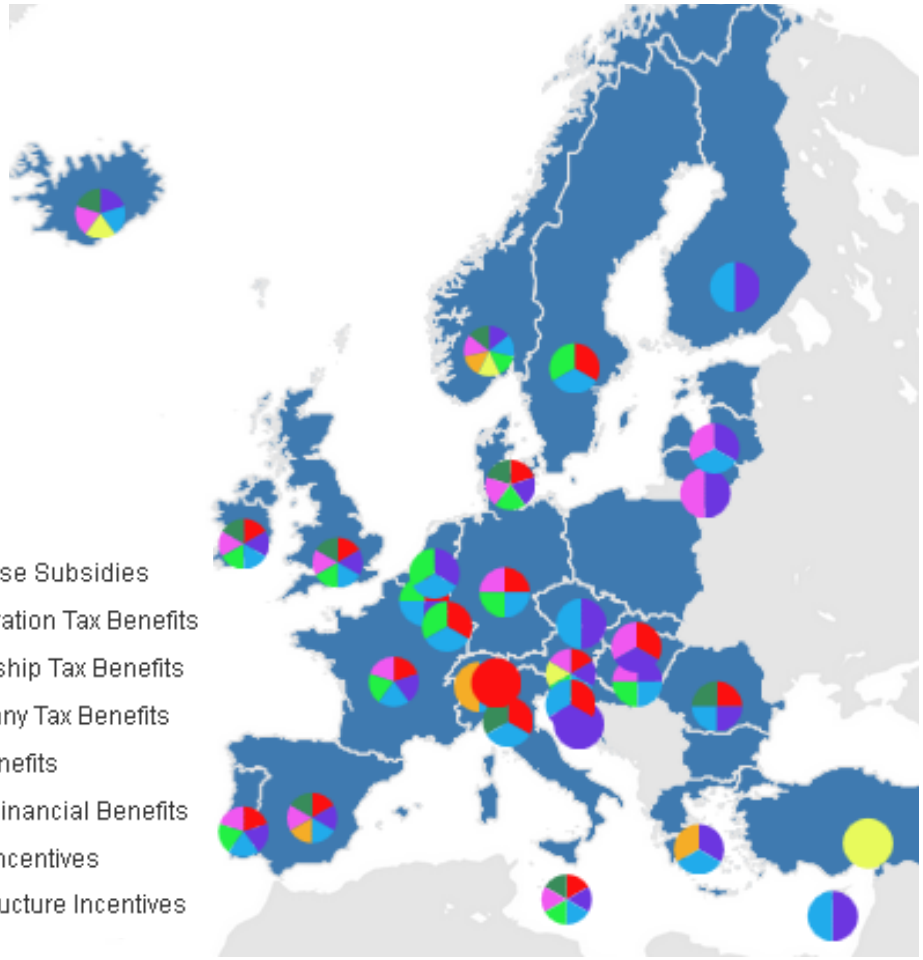

Figure source: www.eafo.eu

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Existing studies on policy measures and PEV adoption

Market studies (regression on sales shares or PEV registrations per capita):

- Clinton et al. (2015) study **BEV** incentives in US federal states (2011 – 2014):
  Incentive and tax credit have positive impact on BEV adoption (except for Tesla Model S)
  HOV lane effect unclear
- Sierzchula et al. (2014) study **PEV** markets shares in 30 national markets in 2012:
  financial incentives and charging infrastructure positively correlated with sales
- Jin et al. (2014) monetized indirect incentives for **PEV** in US states from 2013:
  subsidies, carpool lane access, and emissions testing exemptions increase sales
- Chandra et al. (2010) analyze **HEV** rebates in Canada 1989-2006:
  Rebates help HEV diffusion, but free-rider effect is strong
- Gallagher & Muehlegger (2010) study **HEV** in the US (2000 – 2006):
  feebates are effective; effects of HOV lanes unclear

➢ **Existing studies indicate positive effect of direct and indirect incentives.**

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Data from Europe and US federal states

Annual PEV sales in Europe (2010 – 2016) from www.eafo.eu

Original data sources for PEV sales: European Automobile Manufacturers' Association (ACEA) and National statistical offices

Explanatory variables include incentives, prices, taxes, income:

- *Direct incentives*: subsidy, rebate, tax exempt
  → Absolute subsidy in 1000 EURO
- *Indirect incentives*: HOV lanes, charging rate reduction, sales tax exempt, fuel tax exempt, reduced license tax, reduced registration fee
  → count total number of indirect incentives
- Prices: Gasoline and Electricity prices (Eurostat
- Median Income (Eurostat)

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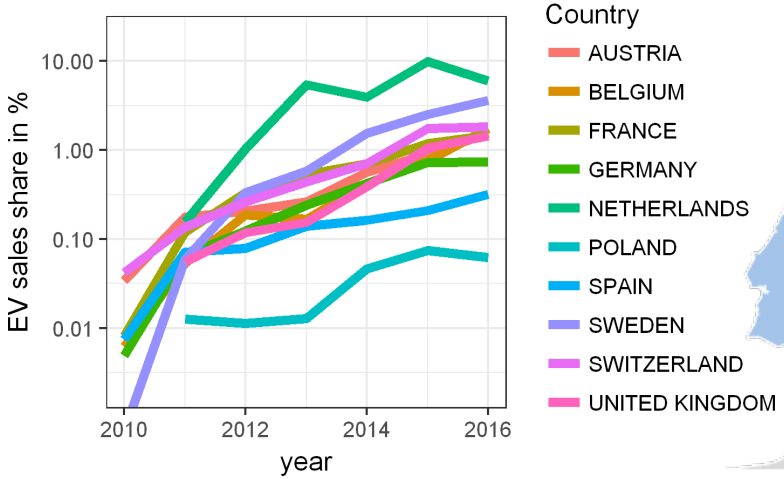
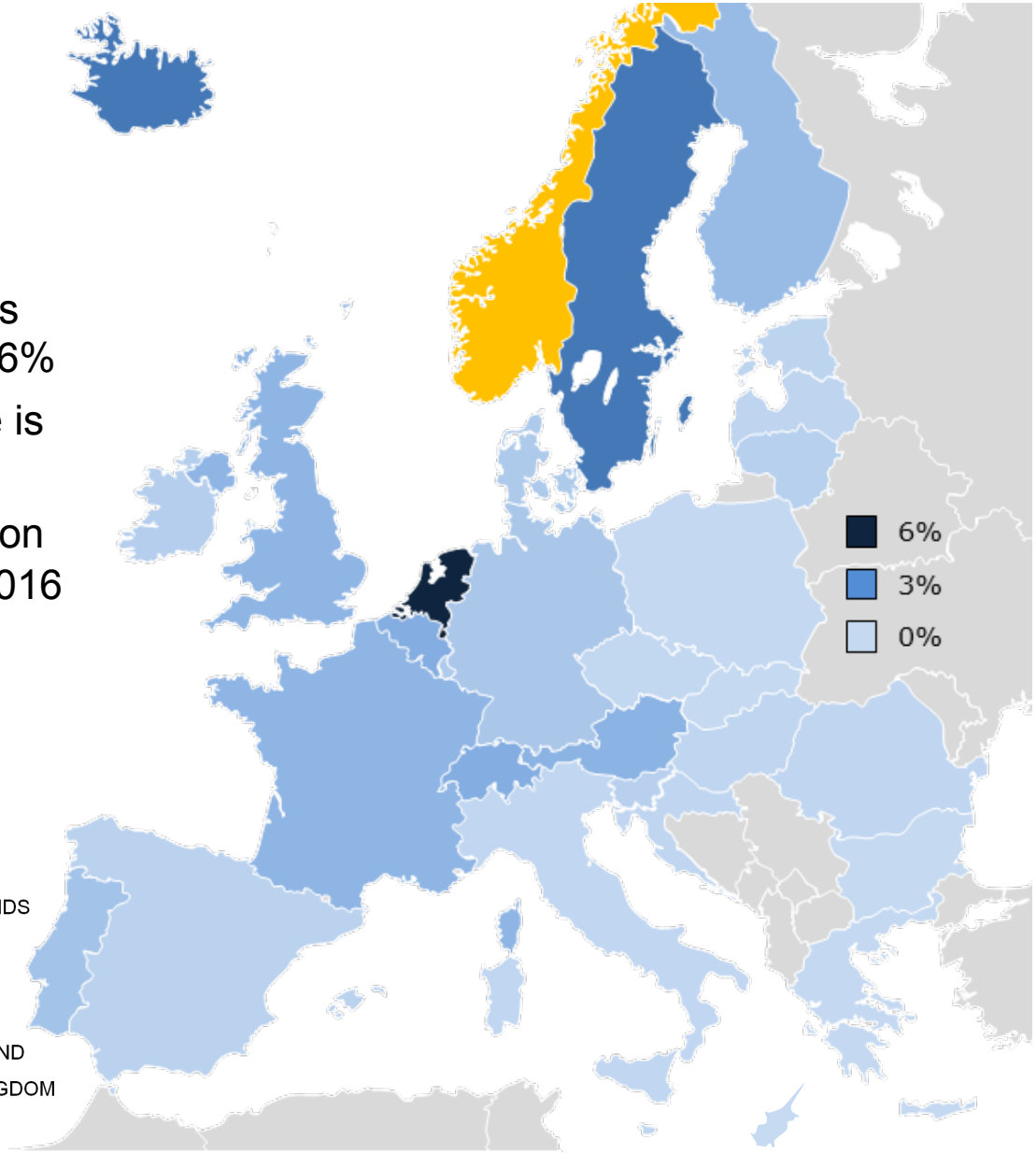
PEV Sales Data Overview

- European countries by EV sales share in 2016 ranged from 0 – 6%
- Norway with 29% market share is separated
- Similar data and policies in action for each country from 2010 – 2016





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Method: panel data regression of incentives and fuel prices on PEV sales shares

- **Panel data regression**:
  - several observations over time of market shares in countries (“panel data”)
  - include country fixed effects for unobserved country specific factors (e.g. presence of a car manufacturing industry or a certain car culture).

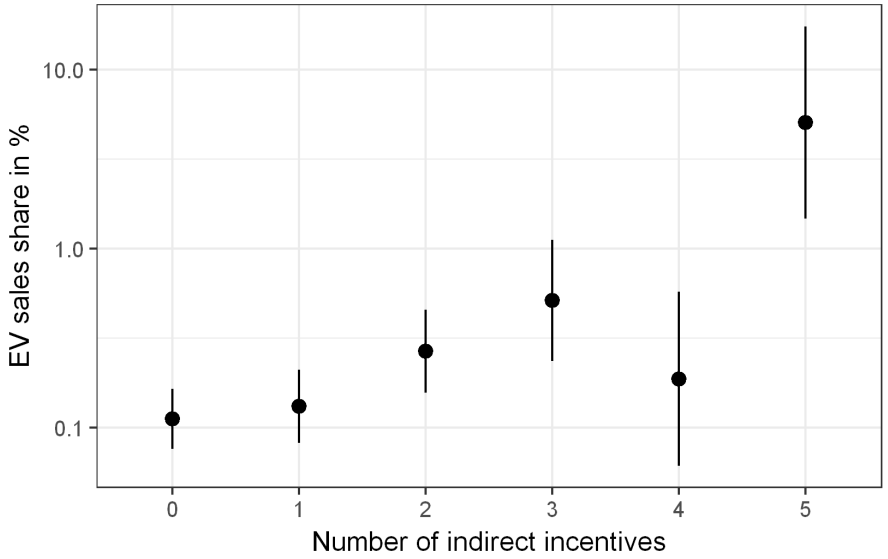
- **Panel data regression model for PEV sales**:

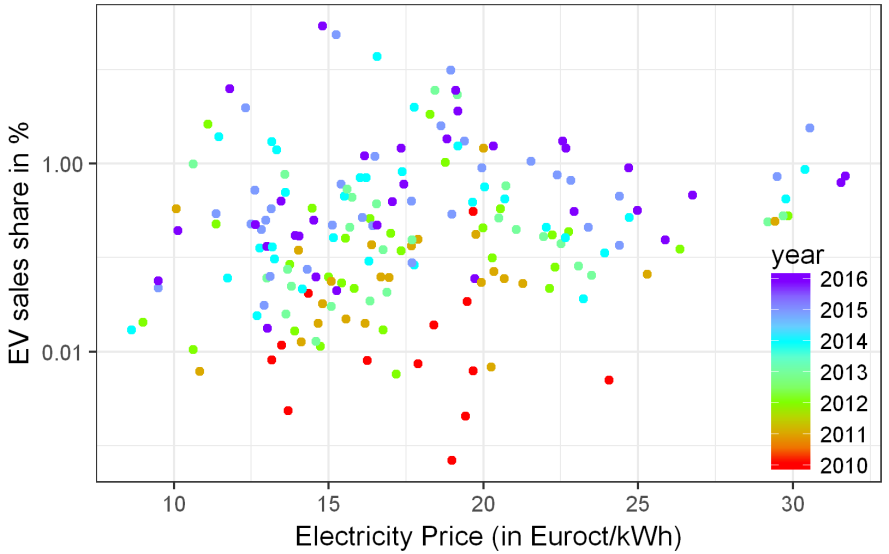
$$\log(\text{PEV sales share}_{it}) = \beta_1 \text{ Median income}_{it} + \beta_2 \text{ Gasoline Price}_{it} + \beta_3 \text{ Electricity Price}_{it} + \beta_4 \text{ Direct Incentives}_{it} + \beta_5 \text{ Indirect Incentives}_{it} + \alpha_i + \varepsilon_{it}$$

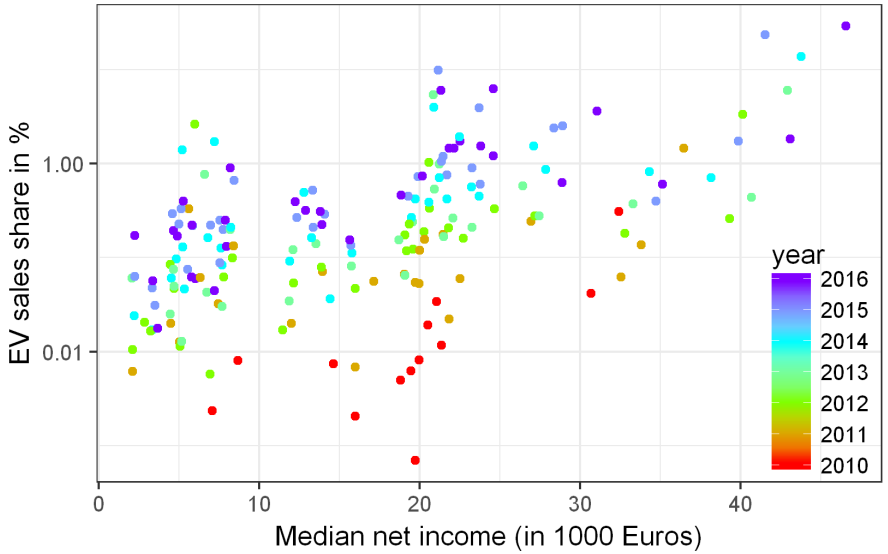
with i – Country and t – year

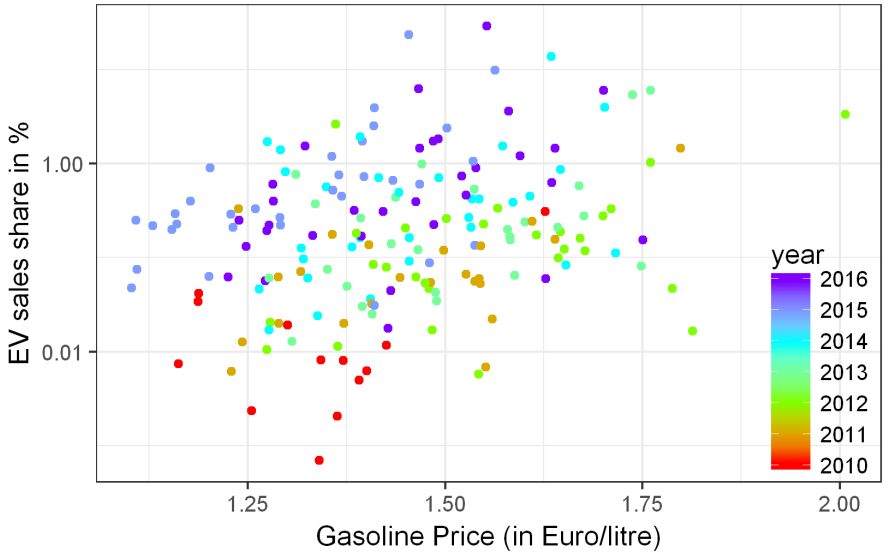
- For comparison, we also show the results from
  - ordinary least square regression (ignoring panel data structure) and
  - Panel data regression also including year fixed effects

Results: Qualitative comparison over time









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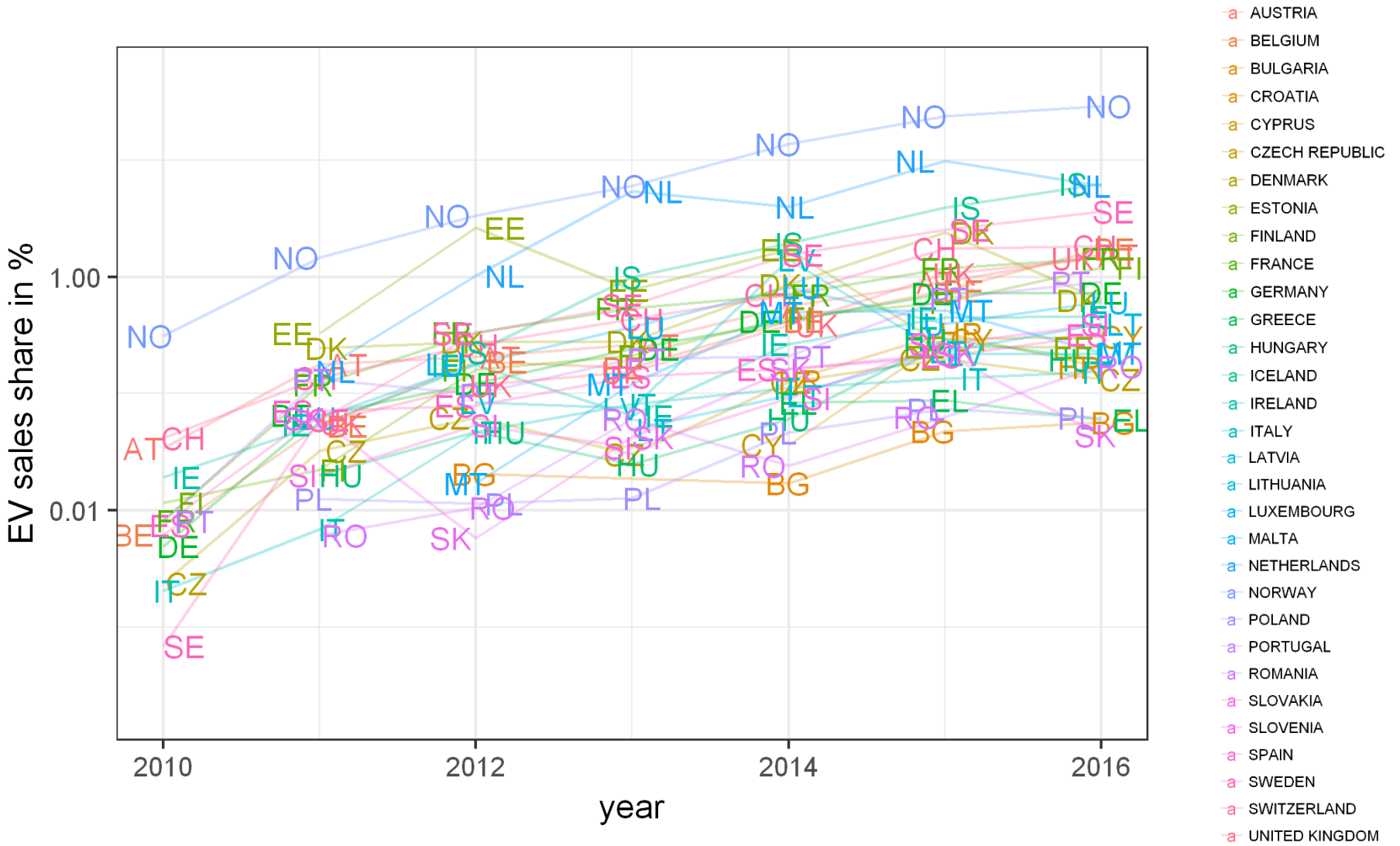
Results: Qualitative comparison over time



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Panel data regression on PEV sales shares

Model	OLS	Panel regression country FE	Panel regression country-year FE
Electricity Price (ct/kWh)	-0.031	**+0.31*** **	-0.044
Gasoline Price (in ct/litre)	+0.012	**-0.13*** **	-0.025
Diesel Price (in ct/litre)	-0.008	**+0.11*** **	+0.049***
Net income (in 1000€)	+0.075***	**+0.44*** **	+0.106*
Direct Incentive (in 1000€)	+0.052	**+0.16** **	+0.040
Indirect Incentives (#)	+0.245**	**+0.68*** **	+0.299**
Constant	-8.045***		
Observations	185	185	185
Country fixed effects	No	Yes	Yes
Year fixed effects	No	No	Yes
R^2	0.327	0.549	0.172
Adjusted R^2	0.314	0.436	0.131
F Statistic	14.402*** (df = 6; 178)	29.808*** (df = 6; 147)	4.897*** (df = 6; 141)

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

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Interpretation of results on PEV sales shares

Comparison of models:

- Panel data model with country fixed effects has highest adjusted R^2 and captures structure of the data well

Main findings:

- **+16% relative increase of PEV sales share per 1'000 € incentive**, e.g. from 0.2% to 0.23% with 1'000 € incentive (keeping all other factors fixed).
- **+68% relative increase of PEV sales share per indirect incentive**, e.g. from 0.2% to 0.33% with one more incentive (keeping all other factors fixed).
- Higher Gasoline and lower electricity prices increase PEV market shares; Higher Diesel price seems to correlate with higher PEV sales shares
- Countries with higher median income have higher PEV sales shares

➢ **Positive effect of direct & indirect incentives**

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Discussion and further work

Robustness checks:

- Left out data from 2016 as most mature year without noteworthy changes
- Additional controlling factors such as Motorisation Rate or Home Ownership Rate (as proxy for share of vehicle owners with Garages) or the Gini coefficient for the share of very high income households does not alter the findings
- Finite differences instead of panel data regression lead to similar results for control variables but effect of incentives no longer significant

Factors that could impact findings:

- Local effects and subsidies can impact results: e.g. city ban for conventional vehicles or subsidy on city level
- More models need to be tested
- Include the effect of charging stations → discuss endogeneity problem
- Treatment of indirect incentives difficult: separate categories, nominal or metric?

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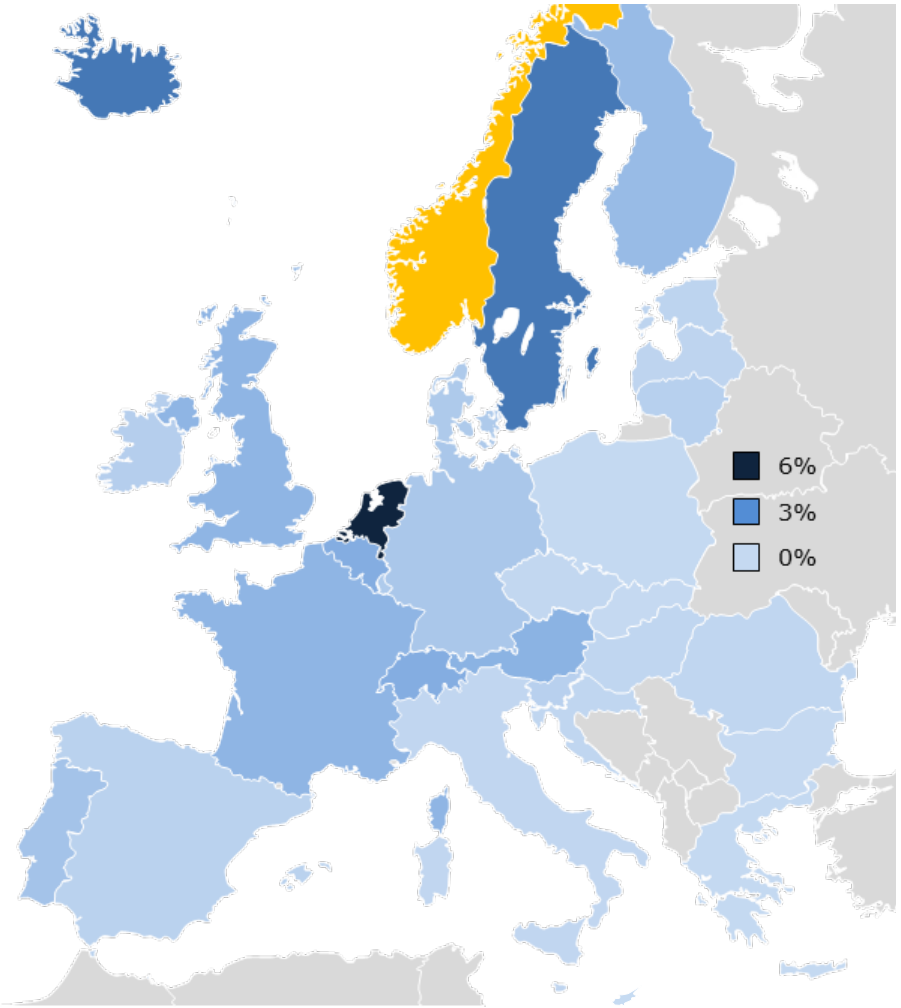
Conclusions

- Direct incentives have positive effect
- Indirect incentives difficult to treat and effect not clear
- Methodologically challenging: charging stations

Thank you for listening!



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