A Green Switch in Time Saves Nine

Assessing the Environmental Damage of the European Truck Cartel

Ilona Dielen[§] Patrice Bougette* Christophe Charlier*

Economics and Sustainability Workshop - Paris
October 5th, 2026

Available in *Environ Resource Econ* 89, 19 (2026)
https://doi.org/10.1007/s10640-026-01073-6

[§] Université Paris-Est Créteil, ERUDITE
* Université Côte d'Azur, CNRS-GREDEG

Outline

Framing

Outline

Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

What comes next

Turning the lens around

- This morning we studied the question of *ex ante* assessment of environmental benefits.
- Here, we adopt a symmetric approach and propose an *ex post* assessment of the environmental damage caused by a restriction of competition.
- Our case is an antitrust practice where collusion is built on the timing of environmental standards themselves.

This raises the question of how collusion can hinder policies meant to protect the environment and public health

The study case of the European truck cartel AT.39824

Six manufacturers, accounting for around **90% of the market**, colluded for **14 years** (1997-2011).

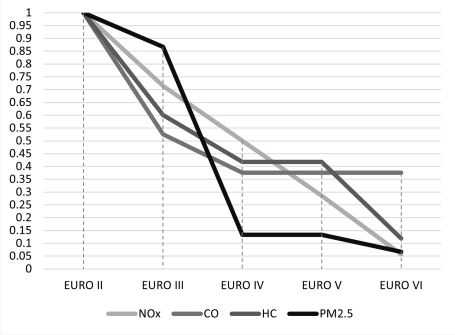
- Notable for its scale and for the record cartel fine it resulted in (€3.8Bn).
- The originality : they coordinated the adoption schedule of successive EURO standards.
- Yet this reveals a paradox in that the trucks formally complied with environmental law at all times.

It falls in a **regulatory grey zone**, compliant for the environmental regulator yet beyond the reach of competition enforcement.

How EURO standards work and why timing is the margin

Standard	Applies (ref. text)	NO_x	CO	HC	$PM_{2.5}$
			(g/kWh)		
EURO 0	1990 (88/77)	14.4	11.2	2.4	—
EURO I	1993 (91/542 A)	9	4.9	1.23	0.36
EURO II	1996 (91/542 B)	7	4	1.1	0.15
EURO III	2001 (1999/96)	5	2.1	0.66	0.13
EURO IV	2005 (2005/55/CE)	3.5	1.5	0.46	0.02
EURO V	2009 (2005/55/CE)	2	1.5	0.46	0.02
EURO VI	2013 (595/2009)	0.4	1.5	0.13	0.01

Levels and dates from the EURO directives (Table A2).



Emission limits relative to EURO II, by pollutant (Fig. B4).

Outline

Framing

Outline

Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

What comes next

The question, and a two-step strategy

Objective : assess the environmental and health impact through "avoidable" emissions.

1. A *But-For Analysis* adapted to emissions
   - Two decades of data : vehicle registrations, weight, EURO standard, lifespan, mileage (ACEA, CNR, EEA).
   - Fleet modelling and construction of counterfactual scenarios.

2. Estimating the health impact on respiratory hospital admissions
   - Fixed-effects panel over 199 European subregions (NUTS 2), 2000–2018.
   - Admissions by age group : under 1, 1–4, total population (Eurostat).
   - Admissions attributable to "avoidable" emissions under the counterfactual scenarios.

Outline

Framing

Outline

Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

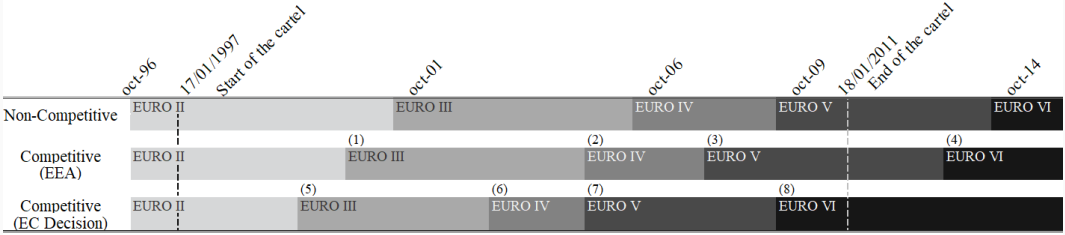
What comes next

How we built the counterfactual

Same *but-for* principle : we compare the observed fleet with an earlier-adoption fleet.

Two plausible competitive timelines bracket the result :

- EC scenario - adoption once the technology was available (Commission findings).
- EEA scenario - adoption at the first observed market entry of compliant trucks.



Standard	Implementation		Simulation from EEA		Simulation from EC-Decision
EURO III	oct-01	(1)	jan-00	(5)	apr-98
EURO IV	oct-06	(2)	jan-05	(6)	apr-03
EURO V	oct-09	(3)	jan-08	(7)	may-05
EURO VI	oct-13	(4)	jan-13	(8)	sept-09

Headline result on emissions

- The cartel generated about **119 thousand tonnes** of excess $PM_{2.5}$.
- The effect outlives the cartel because trucks sold up to 2011 keep emitting until 2017.

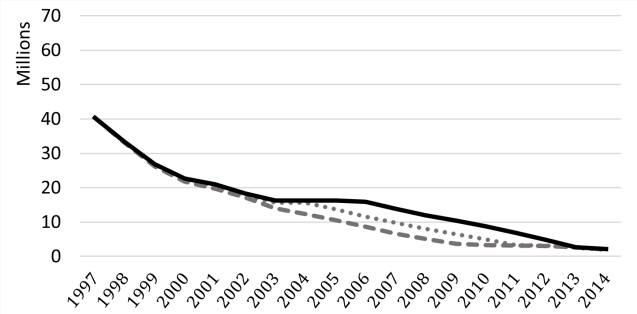


Figure : PM2.5 volume (in metric tonnes) under the cartel (black line) and under counterfactual scenarios (dots and dashed lines) over Europe

Outline

Framing

Outline

Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

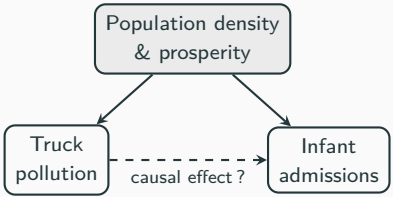
What comes next

Why we cannot just correlate pollution and hospitalisations

Dense, prosperous regions drive both :

- more traffic/admissions
- better healthcare
  = correlation that is not causal.

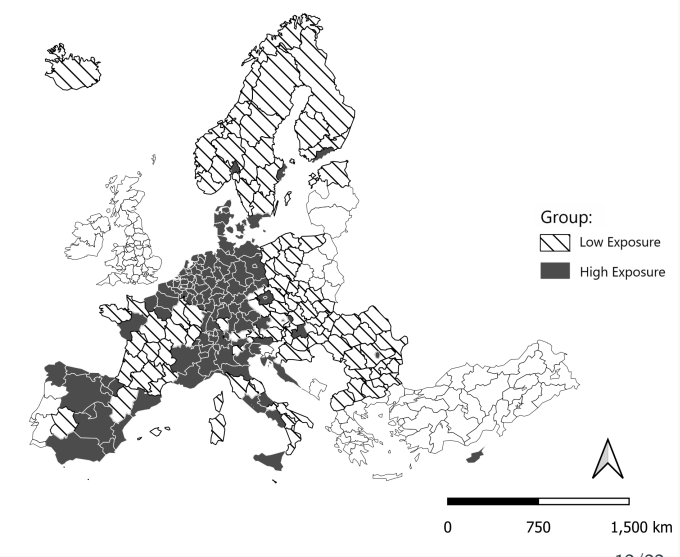
$\Rightarrow$ We need variation in emissions unrelated to local conditions : an instrumental strategy.



The confounder opens a non-causal path ; the instrument isolates the dashed arrow.

The shift-share instrument : independent variation from local characteristics

- Cross two ingredients :
  - The *share*- structural exposure to traffic (pre-2000 highway density, set by geography).
  - The *shift* - EU-wide tightening of EURO standards, acting on emissions per vehicle.
- Same shock everywhere, but it bites only where pre-2000 infrastructure exposes.



The “share” : high- vs low-exposure NUTS 2 regions

What the instrument delivers

A 1% rise in truck emissions

$\Downarrow$

about 0.12% more infant respiratory admissions

(see Annex 1)

A clear, positive effect :

- Stable when the top 1%, 5% or 10% most-affected regions are removed.
  (see Annex 2)
- Specific to infants under one (no effect on the general population)
  (see Annex 3)
- Echoed by a parallel effect on infant mortality.
  (see Annex 4)

Outline

Framing

Outline

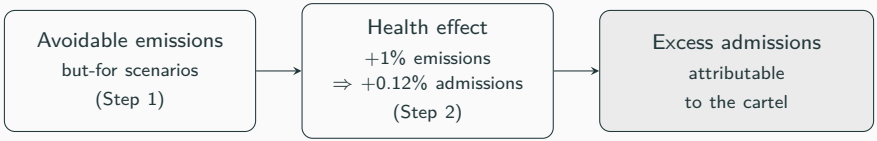
Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

What comes next

From coefficient to health damage



For each region-year, the share of emissions due to the cartel, applied to predicted admissions, then scaled by cohort size.

12 to 18

avoidable infant respiratory admissions per 1,000 births / year

Outline

Framing

Outline

Step 1 - Avoidable emissions

Step 2 - From emissions to health

The damage

What comes next

Paper 2 : From a plausible counterfactual to an equilibrium one

We investigate :

- Why would a firm anticipate a standard that will become mandatory anyway ?
- Which regulatory transitions are exposed to this behaviour ?

What the theory paper unlocks

Turning our exogenous counterfactual into an equilibrium one :

- Under competition, firms can anticipate the standard (H1).
- The number of trucks sold differs in the counterfactual (H2).
- Dates and market shares become endogenous (H3).

$\Rightarrow$ From measuring the damage to explaining the behaviour that produced it.

A collective output : the special issue

- A special issue of the *Revue d'économie industrielle* will be dedicated to competition economics and sustainability (submissions accepted until 30 Oct. 2026)

Coordinated by :

Patrice Bougette, patrice.bougette@univ-cotedazur.fr
Christophe Charlier, christophe.charlier@univ-cotedazur.fr
Frédéric Marty, frederic.marty@univ-cotedazur.fr

Thank you

ilona.dielen@u-pec.fr

Annex 1 : OLS and IV estimates of pollution on infant respiratory admissions

Estimator	OLS	IV
	(1)	(2)
Emission	0.014	0.116**
	(0.006)	(0.053)
GDP per capita	-0.045	-0.275
	(0.111)	(0.213)
Median Age	-0.229	-0.505
	(0.603)	(0.644)
Stock Vehicles	-0.244***	-0.472***
	(0.090)	(0.131)
Number of Births	0.703***	0.811***
	(0.111)	(0.164)
Observations	2,924	2,924
R-squared	0.086	0.05
FE (r, t)	Yes	Yes
Number of NUTS 2	199	199

Note : This table reports in (1) coefficients from fixed-effects OLS estimates without instrumenting emissions and in (2) IV coefficient of emission. Standard errors are clustered at the NUTS 2 level. Year and region fixed effects are included.

Annex 2 : Sensitivity of IV estimates to regions with the most hospital admissions

	(1)	(2)	(3)	(4)
Outliers dropped	None	1%	5%	10%
Emission	0.116**	0.118**	0.118**	0.117**
	(0.053)	(0.055)	(0.055)	(0.055)
GDP per capita	-0.275	-0.305	-0.305	-0.335
	(0.213)	(0.224)	(0.224)	(0.233)
Median Age	-0.505	-0.163	-0.163	-0.063
	(0.644)	(0.664)	(0.664)	(0.682)
Stock Vehicles	-0.472***	-0.449***	-0.449***	-0.438***
	(0.131)	(0.143)	(0.143)	(0.146)
Number of Births	0.811***	0.830***	0.830***	0.829***
	(0.164)	(0.172)	(0.172)	(0.178)
Observations	2,924	2,879	2,749	2,646
R-squared	0.057	0.057	0.057	0.054
FE(r,t)	Yes	Yes	Yes	Yes
Number of NUTS 2	199	198	189	180

Note : This table reports the robustness of the main IV estimate to excluding regions with the most hospital admissions of infants. Columns (2)-(4) progressively remove regions in the top 1%, top 5%, top 10% of the distribution. All specifications use the full IV model with fixed effects, robust and NUTS 2-clustered standard errors. Coefficients on emission remain positive and broadly stable across specifications, indicating that results are not driven by a small number of extreme regions. ***, *, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Annex 3 : Heterogeneous effects of traffic-related emission on hospital admissions by age group

Ages :	(1) 0-1 YO	(2) 1-4 YO	(3) 0-65 YO
Emission	0.116**	-0.025	-0.052
	(0.053)	(0.063)	(0.044)
GDP per capita	-0.275	0.360*	0.350
	(0.213)	(0.187)	(0.234)
Median Age	-0.505	-0.759	-0.421
	(0.644)	(0.943)	(0.562)
Stock Vehicles	-0.472***	-0.318***	-0.265**
	(0.131)	(0.111)	(0.110)
Number of Births	0.811***	0.319*	0.168
	(0.164)	(0.186)	(0.168)
Observations	2,924	2,052	2,640
R-squared	0.05	0.322	0.071
EF (c, t)	Yes	Yes	Yes
Number of NUTS 2	199	154	180

Note : All regressions are estimated using 2SLS with region fixed effects, year fixed effects, and clustered standard errors at the NUTS 2 level. The endogenous variable Emission is instrumented using the full set of shift-share instruments. Column (1) corresponds to infants aged 0-1, column (2) to children aged 1-4, and column (3) to the full population aged 0-65. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Annex 4 : Emission effects across alternative health outcome

Dep. variable :	(1) Hospital Admission	(2) Birth Mortality
Emission	0.116**	0.069 .
	(0.053)	(0.045)
GDP per capita	-0.275	-0.421***
	(0.213)	(0.158)
Median Age	-0.505	0.274
	(0.644)	(0.433)
Stock Vehicles	-0.472***	-0.246*
	(0.131)	(0.127)
Number of Births	0.811***	0.647***
	(0.164)	(0.123)
Observations	2,924	2,924
R-squared	0.05	0.203
EF (c, t)	Yes	Yes
Number of NUTS 2	199	199

Note : This table reports 2SLS fixed-effects estimates of the impact of truck-related particulate emissions on one alternative health outcome. Column (1) shows respiratory hospital admissions among infants under age one,and column (2) shows infant mortality. Emissions are instrumented using shift-share variables based on EURO emission standards. All models include NUTS 2 and year fixed effects and control for log GDP per capita, log median age, log lorry stock, and log births. Standard errors are clustered at the NUTS 2 level. ' . ', *, **, *** denote significance at the 15%, 10%, 5%, and 1% levels, respectively.