Cost-Benefit Analysis of Low Emission Zones

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The Problem:

Many cities in EU, including Paris, exceed the guidelines for ambient air quality (especially $PM_{2.5}$, NO_2, O_3)

A Solution:

Restrict the use of older, more polluting vehicles (especially diesel) inside low emission zones (LEZ)

Such zones have been created in many cities in many countries of the EU, but so far not in France

Do the benefits justify the costs?

… and who bears the costs?

CBAs as justification of LEZs: current practice

In most cases no CBA at all

e.g. many LEZ in Germany, without any CBA

whereas the Swiss decided that LEZ would be too costly, also without any CBA

Internet search of CBAs for LEZs: Only three CBAs

London [2003]

Antwerp [2012]

Ile de France [Paris 2012]

Effects evaluated: Health benefit for population,

Cost for owners of excluded vehicles,

Administrative costs (*negligible*)

Paris [2012] also evaluated many other effects, e.g. cost of change in trip duration (large)

London 2003. The London Low Emission Zone Feasibility Study A Summary of the Phase 2 Report to the London Low Emission Zone Steering Group 2003. http://www.tfl.gov.uk/assets/downloads/roadusers/lez/phase-2-feasibility-summary.pdf

TML 2012. "Haalbaarheidsstudie voor invoering en beheer van lage emissiezone(s) in de stad Antwerpen" (Feasibility study for the introduction and management of low-emission zone(s) in the city of Antwerp). Transport & Mobility Leuven Diestsesteenweg 57, 3010 Leuven, Belgium. http://www.tmleuven.be

Paris 2012. "ZAPA Etude d'impact socio-économique". Rapport final, juillet 2012. Atelier Parisien d'Urbanisme. www.apur.org

Conclusions of these CBAs

London [2003]:

Benefits comparable to costs

Antwerp [2012]:

Benefits much larger than costs

But error in calculation of lifetime benefits

(assumes infinite duration, but really duration = survival time of excluded vehicles; ***with correct calculation LEZ not justified****)*

Ile de France [Paris 2012]:

Effects evaluated for 9 different restriction levels/geographic extents**:**

- health benefit for population (using literature values for €/kg of $PM_{2.5}$ and NO_2)
- cost for owners of excluded vehicles
- administrative costs (*negligible*)
- *also evaluated many other effects, e.g. cost of change in trip duration (large)*

Concludes that all these LEZ justified,

but cost for owners of excluded vehicles grossly underestimated

and discounting not correct.

New CBA for Ile de France [2014]

(large multidisciplinary project with detailed atmospheric modeling by LSCE and AIRPARIF, review of health effects by V. Nedellec, evaluation of costs by A. Rabl)

Only for 1 restriction level/geographic extent:

No more diesel with emissions before Jan 2006,

within A86 (= large ring, Ø ≈ 30 km)

Main difficulties:

i) **costs for owners of excluded passenger cars and light utility vehicles**

(because no particulate filter retrofits, unlike trucks and buses)

ii) **Survival of vehicles** (because benefit = avoided pollution from vehicles that would still be running in absence of LEZ)

Since 2000 no more data of vehicles in circulation

use fit to survival times by Jéger [2001]

lognormal distribution with **median survival time ~ 13 yr**

Jéger F. 2001. « Une estimation du parc automobile à l'aide des durées de vie des véhicules ». Notes des Synthèse du SES, janvier – février 2001.

Cost for Owners of Excluded Vehicles

Number of PC	Loss per PC	cost M€
583000	4000	2332
Number of LDV	Loss per LDV	
152000	8000	1216
Number of HDV	Loss per HDV	
56000	4000	224
Number of M2W	Loss per M2W	
572000	2500	1430
	Total Cost	**5202 M€**

Benefits during first year of LEZ

Review of exposure-response functions by V. Nedellec
monetary values of ExternE

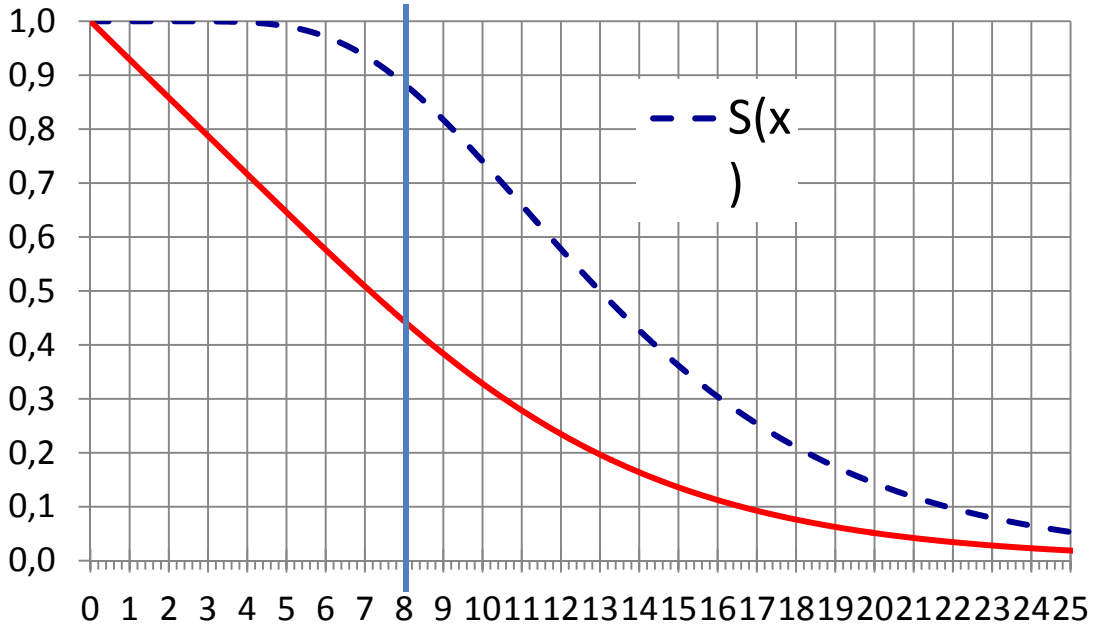
BC = black carbon $PM_{2.5}$ by vehicles

Mortality, long term	**Deaths**	*Confidence Interval*	**Value, at 1.5 M€/death**
NO_2 (no LEZ)	11126	*(3445, 17794)*	
NO_2 (with LEZ)	10663	*(3280, 17147)*	
Benefit of LEZ, NO_2	**463**		**695 M€**
BC from traffic (no LEZ)	1656	*(488, 2724)*	
BC from traffic (with LEZ)	1313	*(382, 2182)*	
Benefit of LEZ, BC	**343**		**515 M€**
Total 1st yr Benefit of LEZ, NO_2+BC ?	**806 ?**		**1209 M€ ?**

OK to add NO2 and BC?

To find **total lifetime benefit**, need to consider the rate at which old vehicles disappear naturally from vehicle fleet

Survival of vehicles S(x) and fraction T(x) of fleet older than x



$$\frac{total\ benefit}{benefit\ first\ year} = \frac{1}{T(x)} \sum_{i=0}^{\infty} \frac{T(x+i)}{(1+\tau)^i}$$

with τ = discount rate = 4% and x = 2014 – 2006 (for exclusion of vehicles built before 2006)

Total benefit/benefit 1st yr = 4.8

Total benefit = 4.8 * 1209 M€ = 5800 M€

Result and Conclusion

For LEZ with restriction level: **No more diesel with emissions before Jan 2006**,
and extent: **within A86** (= large ring, Ø ≈ 30 km)

Benefit = 5800 million € ≈≥? Cost = 5200 million €

But Benefit/Cost probably much better
if only the most polluting vehicles are excluded (built before 2000)
or only trucks and buses
(because particulate filter retrofit available and not too expensive, ≈4000 €)
See **CBA of particle filter** by Masse [2003]:
Very cost effective for buses and trucks, but marginal for cars (if even available)

Large uncertainties ⇒ assumptions and results can be manipulated by pressure groups

Benefit of avoiding EU penalty for exceeding air quality guidelines?

Importance of equity: who gains, who looses?
Owners of old vehicles tend to be poorer,
many living further from public transportation

MASSE Emmanuel 2003. "Analyse économique de la rentabilité des filtres à particules sur les véhicules diesels neufs". Direction des Etudes Economiques et de l'Evaluation Environnementale. Série Etudes N° 03-E08.