Impact of Low-Emission Zones on Spatial and Economic Inequalities using a Dynamic Transport Simulator

THEMA
théorie économique, modélisation et applications

AICC Poster
2023-09-29

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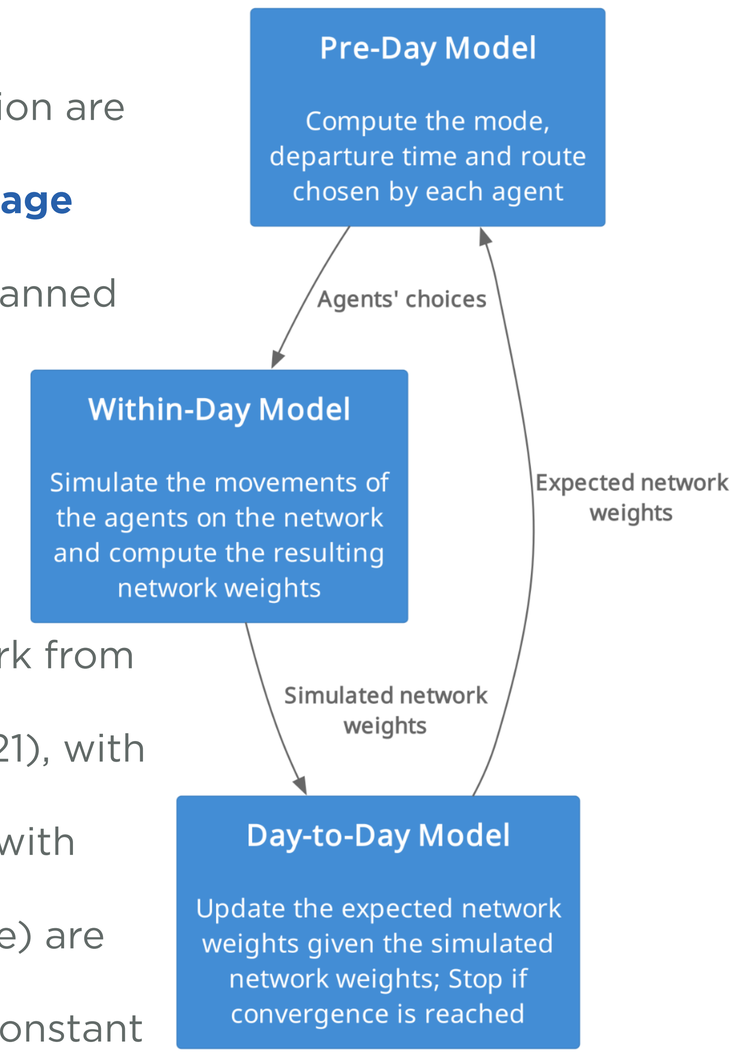
Ile-de-France's Low-Emission Zone (LEZ)

- More than 40% of inhabitants and 10% of roads of the region are inside the LEZ
- All vehicles are classified according to their **fuel type** and **age** (Crit'Air system)
- Starting in 2025, vehicles with Crit'Air 3 or worse will be banned (32% of today's fleet)
- Goal of the policy: improve **air quality** in the region

Transport Simulation (METROPOLIS)

- Ile-de-France, **morning peak** (3h-10h), **three modes** (car, public transit, walk), all purposes
- Road network from **OpenStreetMap**, public-transit network from **GTFS** file
- **Synthetic population** simulated using Hörl and Balac (2021), with car type and fuel (6.29M agents)
- Agents minimize their **generalized cost** (Vickrey formula with Nested Logit)
- Iterative process: choices (mode, departure time and route) are simulated until the expected congestion converges
- **Short term model:** car ownership and OD pairs are kept constant



LEZ Traffic Impact

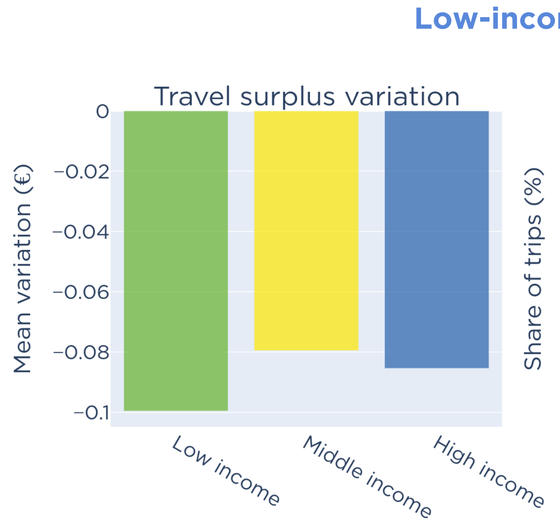
- Agents with banned cars need to switch to public transit or walk if they want to enter the LEZ
- Agents with clean cars might face less congestion

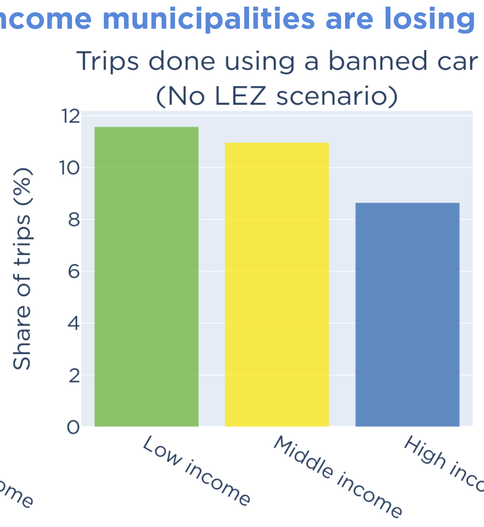
- **Car use** decreases by 220k (-10 %)
- **Vehicle-kilometer** decreases by 2.8M km (-9 %)
- **Congestion index** decreases from 32 % to 27 %
- **Average surplus** by agent decreases by 0.09 €

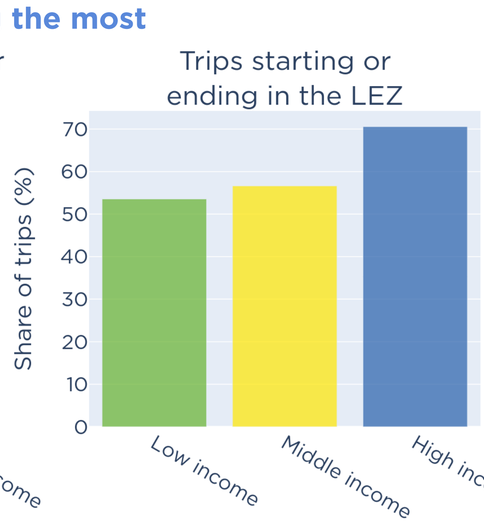
Main **mode shifts**:

- Car to Public transit (for banned cars), 3.8 %
- Car to Walk (for banned cars), 1.1 %
- Public transit to car (for clean cars), 1.3 %
- Walk to car (for clean cars), 0.1 %

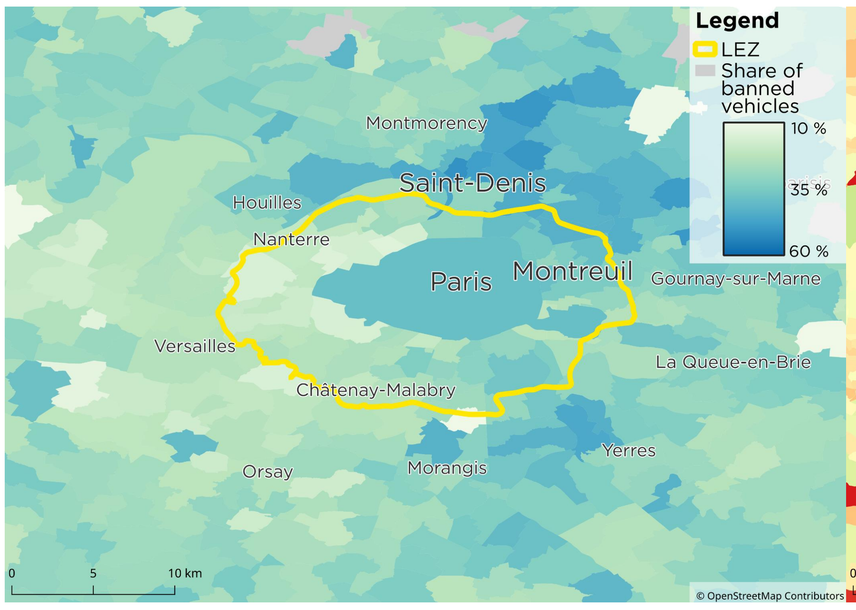
Low-income municipalities are losing the most



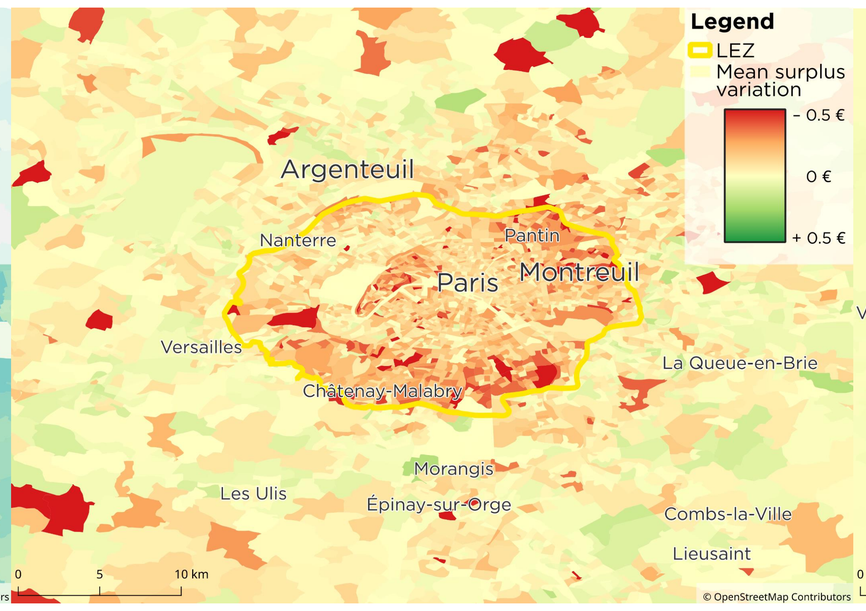




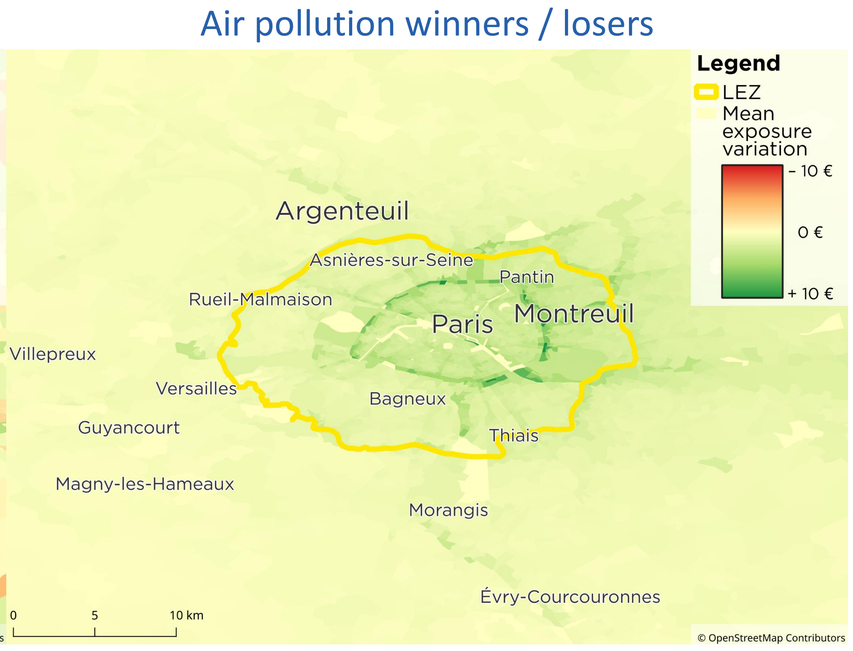
Share of banned vehicles



Traffic winners / losers

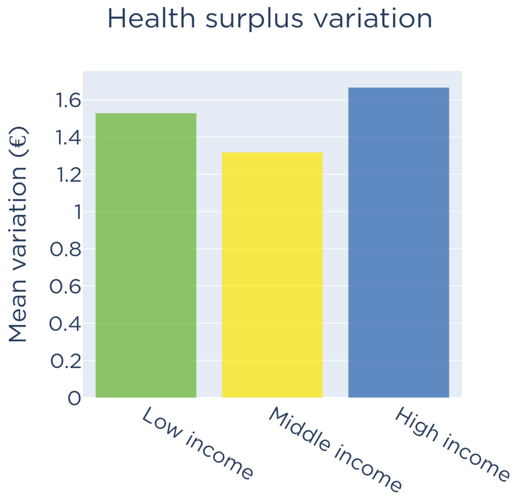


Air pollution winners / losers



LEZ Air Pollution Impact

- **NO_x**, **$PM_{2.5}$** and **CO** emissions, dispersion and population exposure are computed using **METRO-TRACE** (Le Frioux, de Palma, Blond, 2023)
- **Emissions** decrease by 21 % (NO_x), 14 % ($PM_{2.5}$), 33 % (CO)
- Health impact of **population exposure** to pollutants decrease by 33 % (NO_x), 18 % ($PM_{2.5}$), 56 % (CO) [value of statistical life: 7.4 M €]
- **CO_2 emissions** decrease by 9 %



LEZ Cost-Benefit Analysis
(values are for a single morning peak)

Travel surplus	**– 565 k €**
(inc. owners of banned cars)	(– 1 010 k €)
(inc. owners of clean cars)	(+ 445 k €)
Health surplus	**+ 16 921 k €**
(inc. exposure to NO_x)	(+ 14 596 k €)
(inc. exposure to $PM_{2.5}$)	(+ 1 988 k €)
(inc. exposure to CO)	(+ 337 k €)
Environmental surplus (CO_2 emissions)	**+ 95 k €**
Total surplus	**+ 16 451 k €**

Estimated surplus increase over 1 year: 8.2 billion €