Practical Approaches for Correcting Car Externalities

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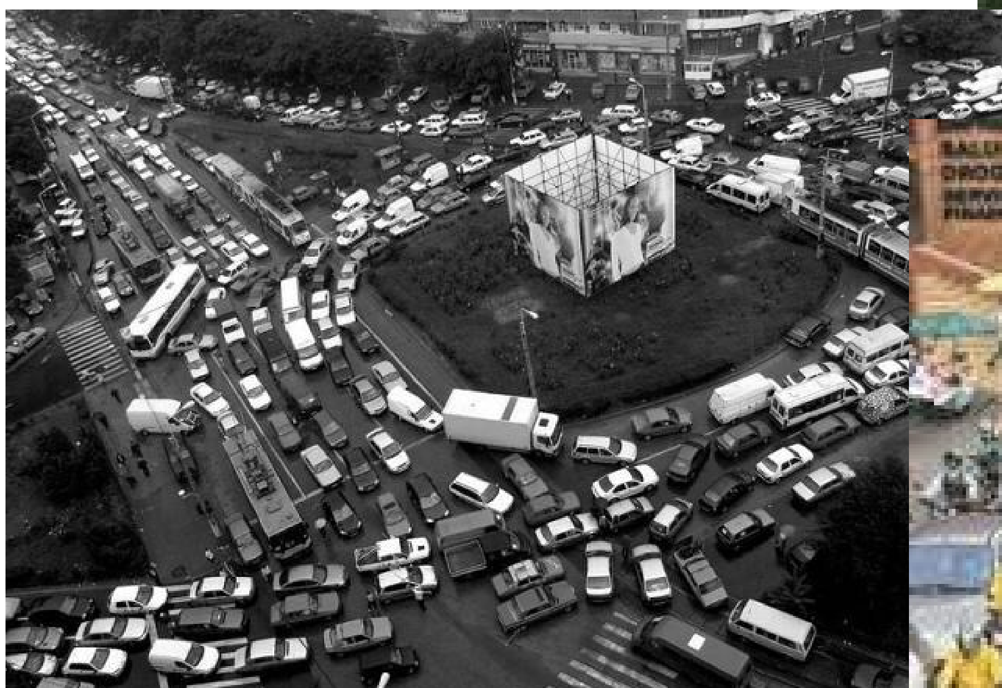
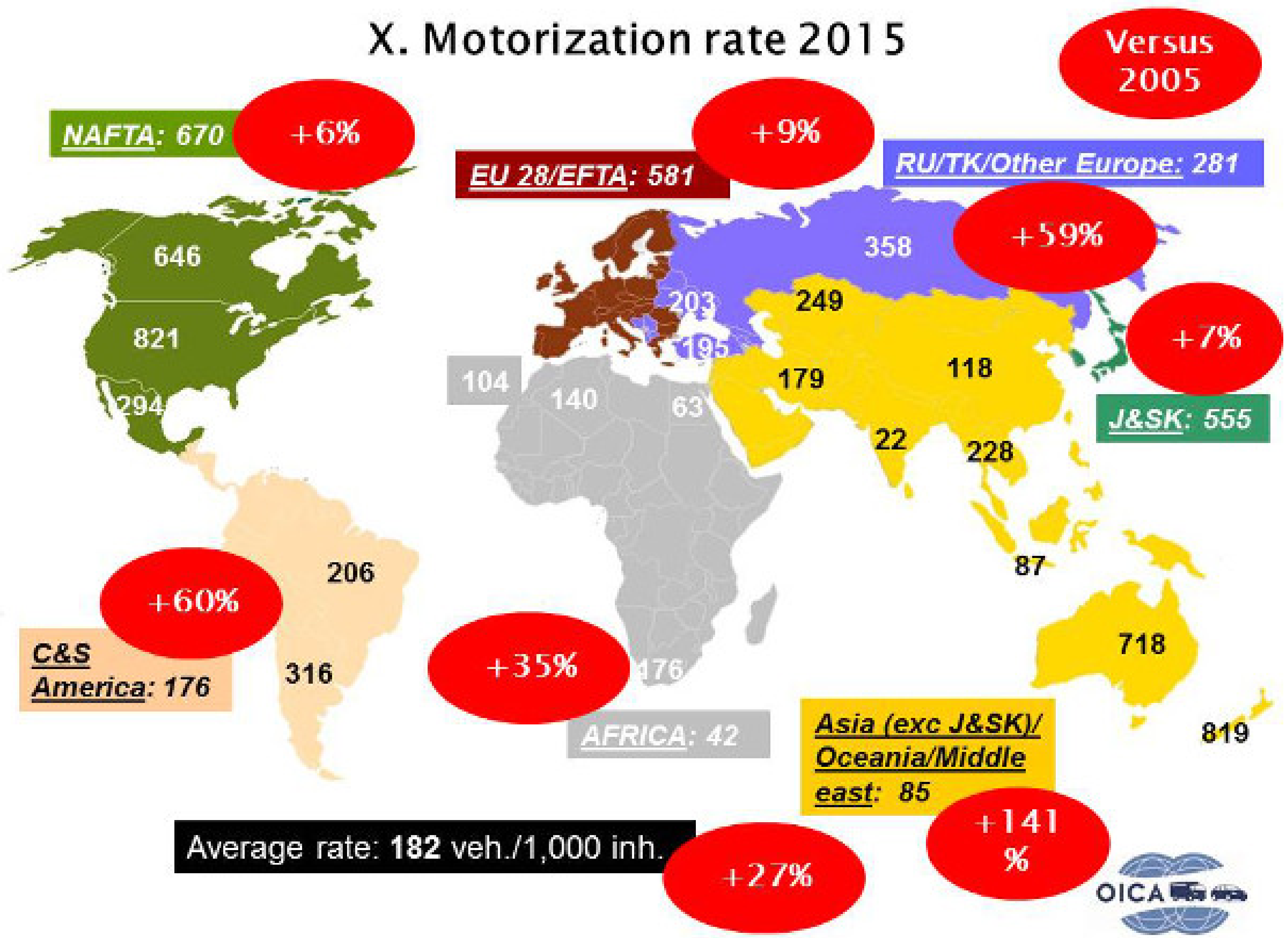
Toulouse, June 2019



Motorization rates in emerging and developing economies much to increase yet!



Different type of externalities (Parry et al, JEL 2007)

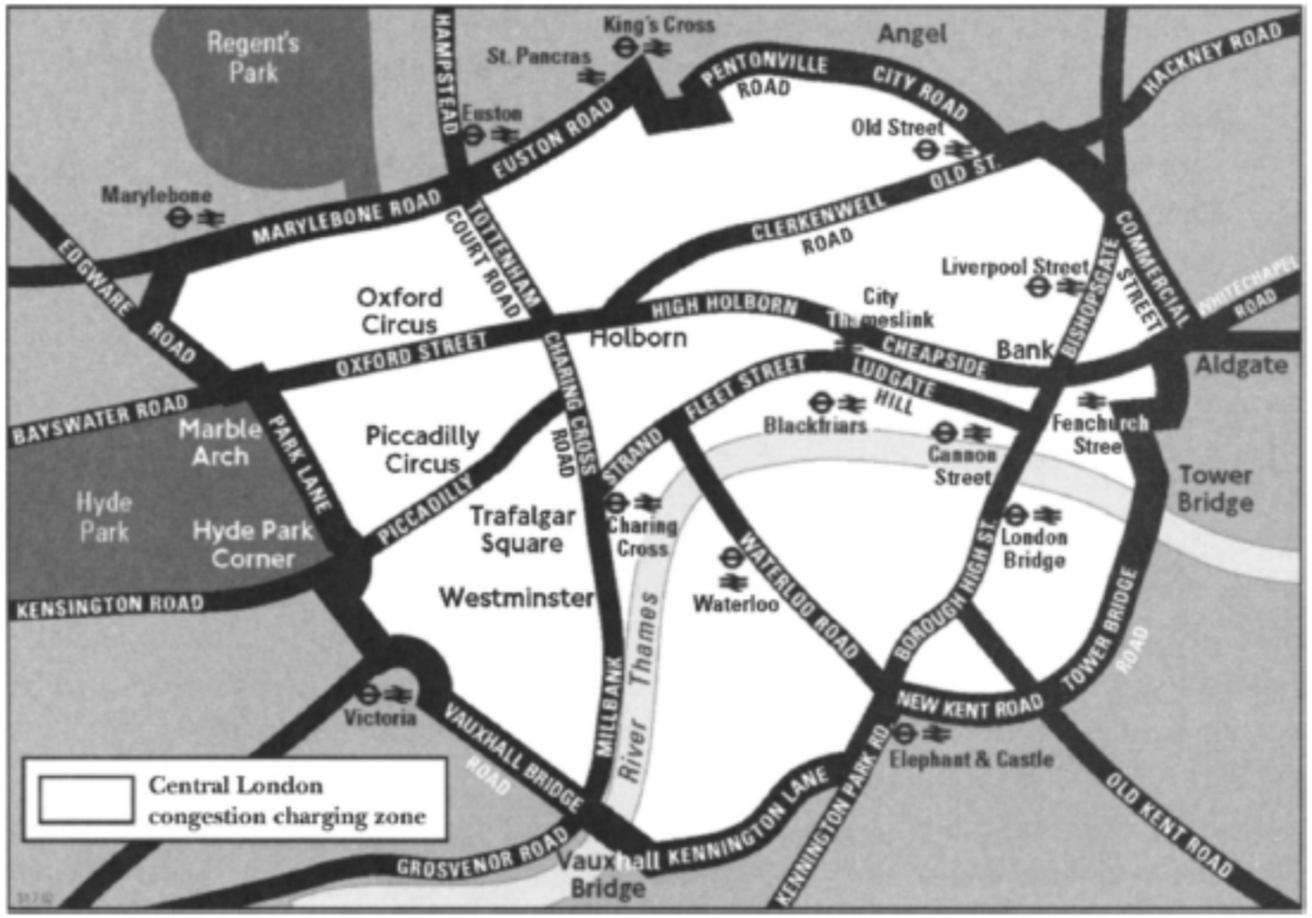
- Local air pollution (CO, NOx, HC, Particulates)
- Traffic congestion
- Global air pollution (CO_2)
- Traffic accidents
- Oil dependency
- Others (including noise and urban sprawl)

Different policy instruments being considered/discussed (Parry et al, JEL 2007)

- Fuel taxes
- Fuel economy standard for new vehicles (e.g., Corporate Average Fuel Economy or CAFE in the US)
- Emission standards (HC, NOx, CO) for new vehicles (e.g., Euro 6)
- Congestion tolls
  - identified by the authors as an emerging policy! (Singapur 1975, Bergen 1986, Oslo 1990, London 2003)
  - not much else since then (Stockholm 2007, Milan 2008, Gothenburg 2013, and New York 2020?)

Congestion pricing in London

Figure 1
The Congestion Charging Zone



Source: Transport for London, 2006.

The New York Times

Over $10 to Drive in Manhattan? What We Know About the Congestion Pricing Plan

By Winnie Hu

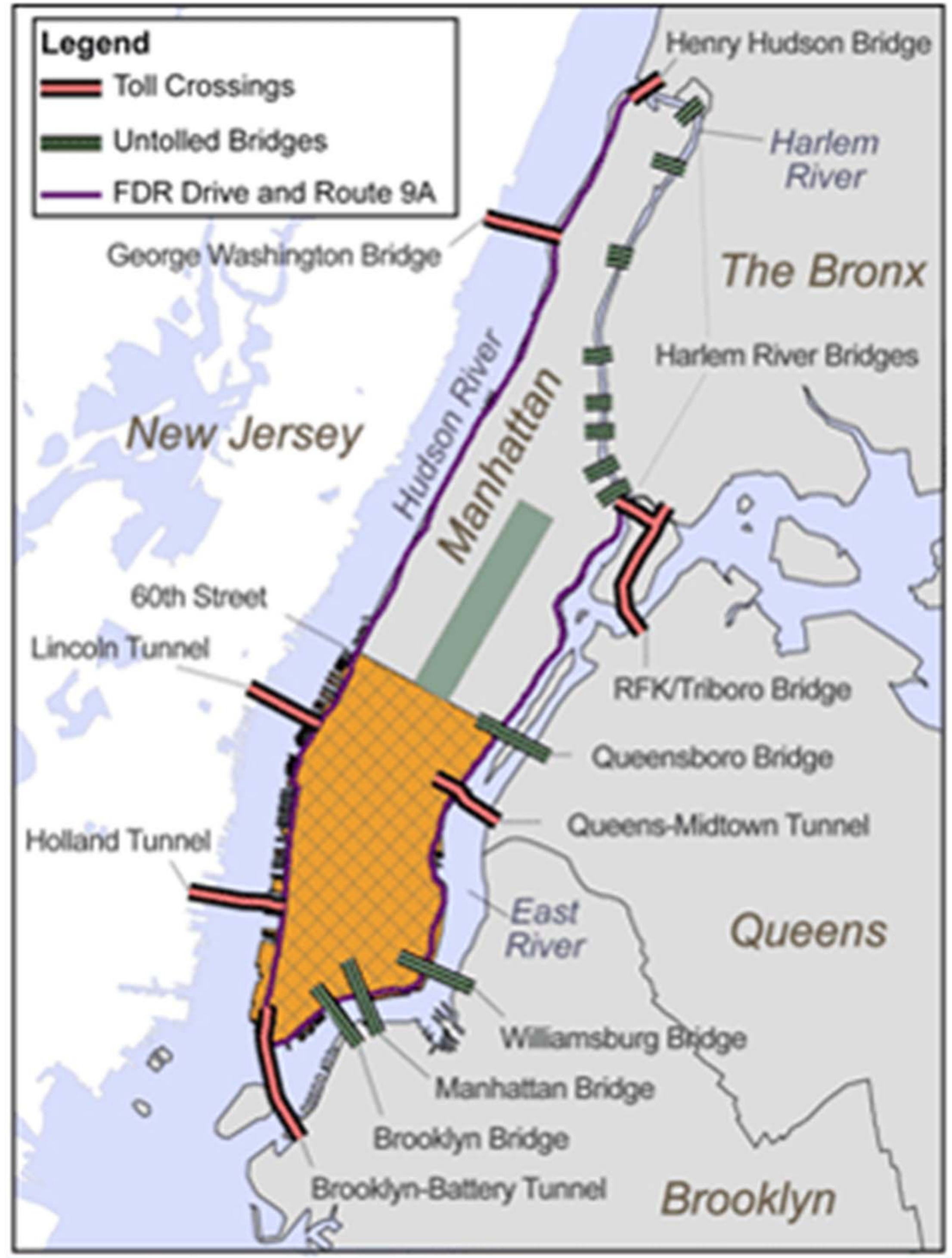
March 26, 2019

[What you need to know to start the day: Get New York Today in your inbox.]

Driving in Manhattan may never be the same again.

It will soon cost more — well over $10 — to drive into the busiest neighborhoods, from 60th Street in Midtown all the way to the Battery.

The fees are part of a groundbreaking congestion pricing plan in the new $175 billion New York State budget, which Gov. Andrew M. Cuomo and lawmakers agreed upon early Sunday morning.



In reality we observe many other policy instruments pursuing similar goals…

- High Occupancy Vehicle (HOV) Lanes (Kwon and Varaiya, TRA 2008; Hanna et al, Sc 2017)
  - highly controversial, leading to more congestion in some cases
  - Jakarta has recently eliminated them
- Carbon taxes/subsidies to new (including EV) vehicles (d'Haultfoeuille et al, EJ 2014; Durrmeyer 2019; Xing et al, NBER 2019)
  - only affect purchases of new vehicles
  - only indirectly and slowly the existing fleet
  - subsidies are expensive and suffer from self selection (ask Norway about subsidies going to EVs)
- Scrappage subsidies or cash-for-clunker programs (Adda and Cooper, JPE 2000; Mian and Sufi, QJE 2012; Hoekstra et al, AEJ-AE 2017)
  - better because they aim at old, polluting vehicles, but…
  - in place for a few months (too costly to implement)
  - and sometimes with no effect on new purchases

cont.,

- Scrappage subsidies or cash-for-clunker programs (Adda and Cooper, JPE 2000; Mian and Sufi, QJE 2012; Hoekstra et al, AEJ-AE 2017)
    - better because they aim at old, polluting vehicles, but…
    - in place for a few months (too costly to implement)
    - and sometimes with no effect on new purchases
- Pollution charges on top of congestion charges (Gibson and Carnovale, 2015)
    - The second-best instrument, because it takes care of both congestion and pollution, but…
    - we hardly see them (except in London and Milan)
- Smog checks (Hubbard RJE 1998; Oliva JPE 2015; Sanders and Sandler, NBER 2017; Barahona et al, 2020?)
    - They may suffer from corruption problems
    - Competition among inspection stations relax standards

…and more importantly!, different rationing schemes (or driving restrictions)

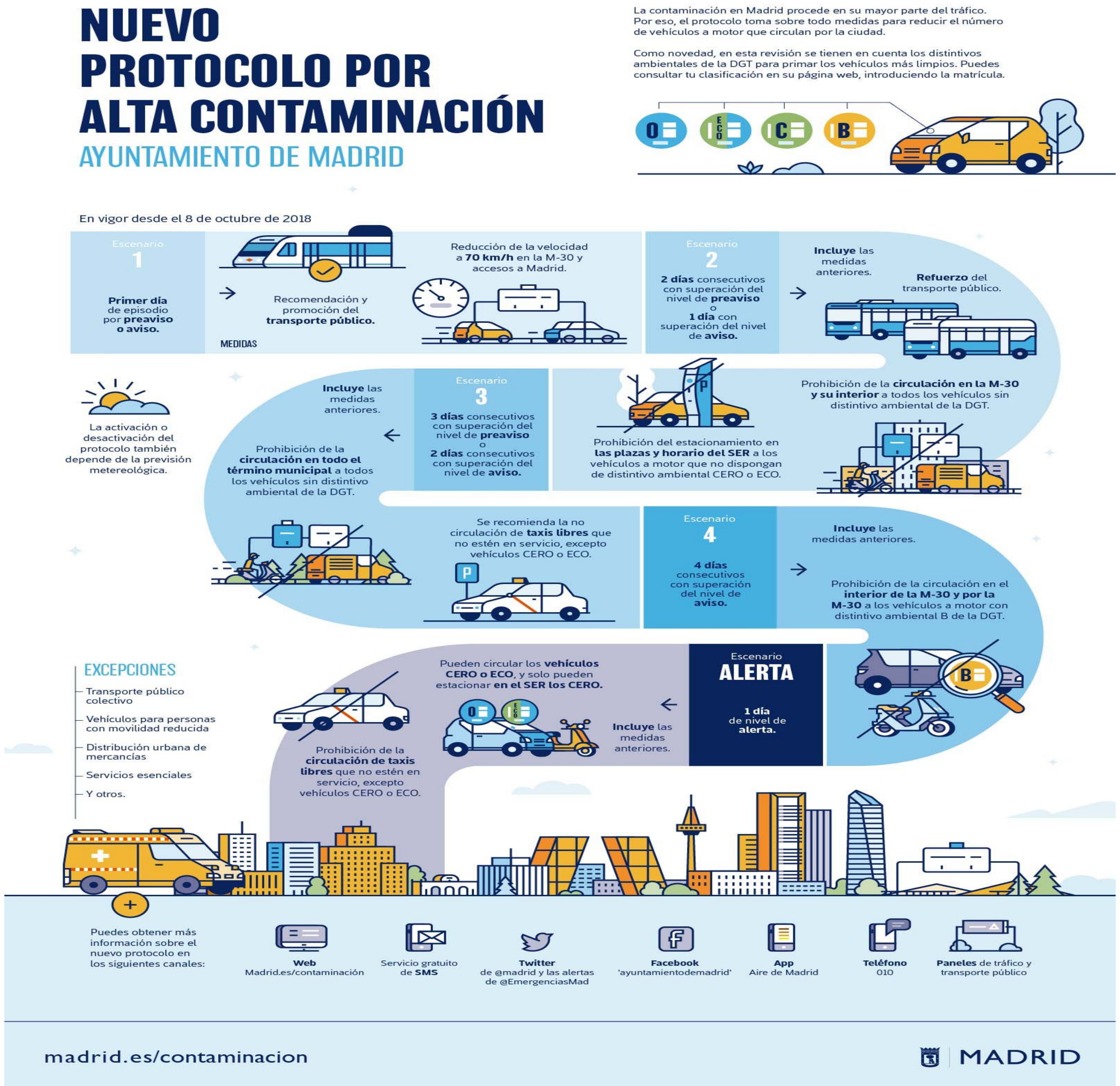
- Rationing schemes/driving restrictions – pollution
  - License plate bans (Eskeland and Feyzioglu, WBER 1997; Davis JPE 2008; Gallego et al., JPubE 2013; Viard and Fu, JPubE 2015; Barahona et al., REStud 2019)
  - Low Emission Zones (Wolf EJ 2014)
- Rationing schemes/driving restrictions – congestion (Daganzo 2000; Basso et al., 2019)

Where do we see these rationing schemes?


E
M 4775 ZX
219-WAY
SP-SAO PAULO
FWG-0202
DISCOVERY
ECUADOR
PBB-3239
BOLIVIA
L
128480
1852PHD
CLB·108
BOGOTA D.C.
京E·04589
F
AV-865-XG
93
XHS 603
PILIPINAS
TEH-94633
XH·66·40
CHILE
IND-123-34
Delhi
2019
MNT·090
MEDELLIN

Driving restrictions around the world
(* aimed primarily at reducing local air pollution)

Athens	1982
Santiago	1986
Mexico City	1989
Teheran	1991
Sao Paulo	1996
Manila	1996
Bogotá	1998
La Paz, Bolivia	2002
Medellín	2005
Cali	2005
San José, Costa Rica	2005
Berlin*	2008
Munich*	2008
Beijing	2008
Tianjin	2008
Quito	2010
Hangzhou	2011
Chengdu	2012
Nanchang	2013
Delhi (two weeks)	2016
Paris*	2016
Hamburg*	2018
Madrid*	2018


NUEVO PROTOCOLO POR ALTA CONTAMINACIÓN
AYUNTAMIENTO DE MADRID
La contaminación en Madrid procede en su mayor parte del tráfico. Por eso, el protocolo toma sobre todo medidas para reducir el número de vehículos a motor que circulan por la ciudad.
Como novedad, en esta revisión se tienen en cuenta los distintivos ambientales de la DGT para primar los vehículos más limpios. Puedes consultar tu clasificación en su página web, introduciendo la matrícula.
En vigor desde el 8 de octubre de 2018
Escenario 1
Primer día de episodio por preaviso o aviso.
MEDIDAS
Recomendación y promoción del transporte público.
Reducción de la velocidad a 70 km/h en la M-30 y accesos a Madrid.
Escenario 2
2 días consecutivos con superación del nivel de preaviso o 1 día con superación del nivel de aviso.
Incluye las medidas anteriores.
Refuerzo del transporte público.
Escenario 3
3 días consecutivos con superación del nivel de preaviso o 2 días consecutivos con superación del nivel de aviso.
Prohibición de la circulación en la M-30 y su interior a todos los vehículos sin distintivo ambiental de la DGT.
Prohibición del estacionamiento en las plazas y horario del SER a los vehículos a motor que no dispongan de distintivo ambiental CERO o ECO.
Incluye las medidas anteriores.
Prohibición de la circulación en todo el término municipal a todos los vehículos sin distintivo ambiental de la DGT.
La activación o desactivación del protocolo también depende de la previsión metereológica.
Se recomienda la no circulación de taxis libres que no estén en servicio, excepto vehículos CERO o ECO.
Escenario 4
4 días consecutivos con superación del nivel de aviso.
Incluye las medidas anteriores.
Prohibición de la circulación en el interior de la M-30 y por la M-30 a los vehículos a motor con distintivo ambiental B de la DGT.
Escenario ALERTA
1 día de nivel de alerta.
Incluye las medidas anteriores.
Pueden circular los vehículos CERO o ECO, y solo pueden estacionar en el SER los CERO.
Prohibición de la circulación de taxis libres que no estén en servicio, excepto vehículos CERO o ECO.
EXCEPCIONES
Transporte público colectivo
Vehículos para personas con movilidad reducida
Distribución urbana de mercancías
Servicios esenciales
Y otros.
Puedes obtener más información sobre el nuevo protocolo en los siguientes canales:
Web Madrid.es/contaminación
Servicio gratuito de SMS
Twitter de @madrid y las alertas de @EmergenciasMad
Facebook 'ayuntamientodemadrid'
App Aire de Madrid
Teléfono 010
Paneles de tráfico y transporte público
madrid.es/contaminacion
MADRID

A traffic sign, which bans diesel cars is pictured at the Max-Brauer Allee in downtown Hamburg, Germany, May 31, 2018.

Driving restrictions come in two forms

- Uniform restrictions upon all cars (regardless of vintage/emission rate)
    - Hoy-No-Circula in Mexico City in 1989
    - Santiago-Chile in 1986
- Vintage-specific restrictions (differentiate by vintage/emission rate)
    - Hoy-No-Circula since 1994
    - Santiago-Chile since 1993
    - Madrid Central
    - Low Emission Zones (LEZ) in Germany and China
    - Paris ban to 1997 and older vehicles
    - Diesel bans in several European cities (particularly Germany)

Do these rationing schemes work?

- When it comes to uniform restrictions (like HNC-1989) the evidence is that they don't (Eskeland and Feyzioglu, WBER 1997; Davis JPE 2008; Gallego et al., JPubE 2013; Viard and Fu, JPubE 2015)
  - they may get some reduction in the very short run (first month), but…
  - in the medium run (after 12 months) they lead to more pollution
  - not much because some people buy a second, old polluting car, but…
  - most importantly, because in the long run (after many years) these uniform restrictions delay the entry of new (cleaner) cars and extend the life of old (polluting) cars (**this is perhaps the most important insight of my entire talk!**)

CO concentration very good proxy for car use

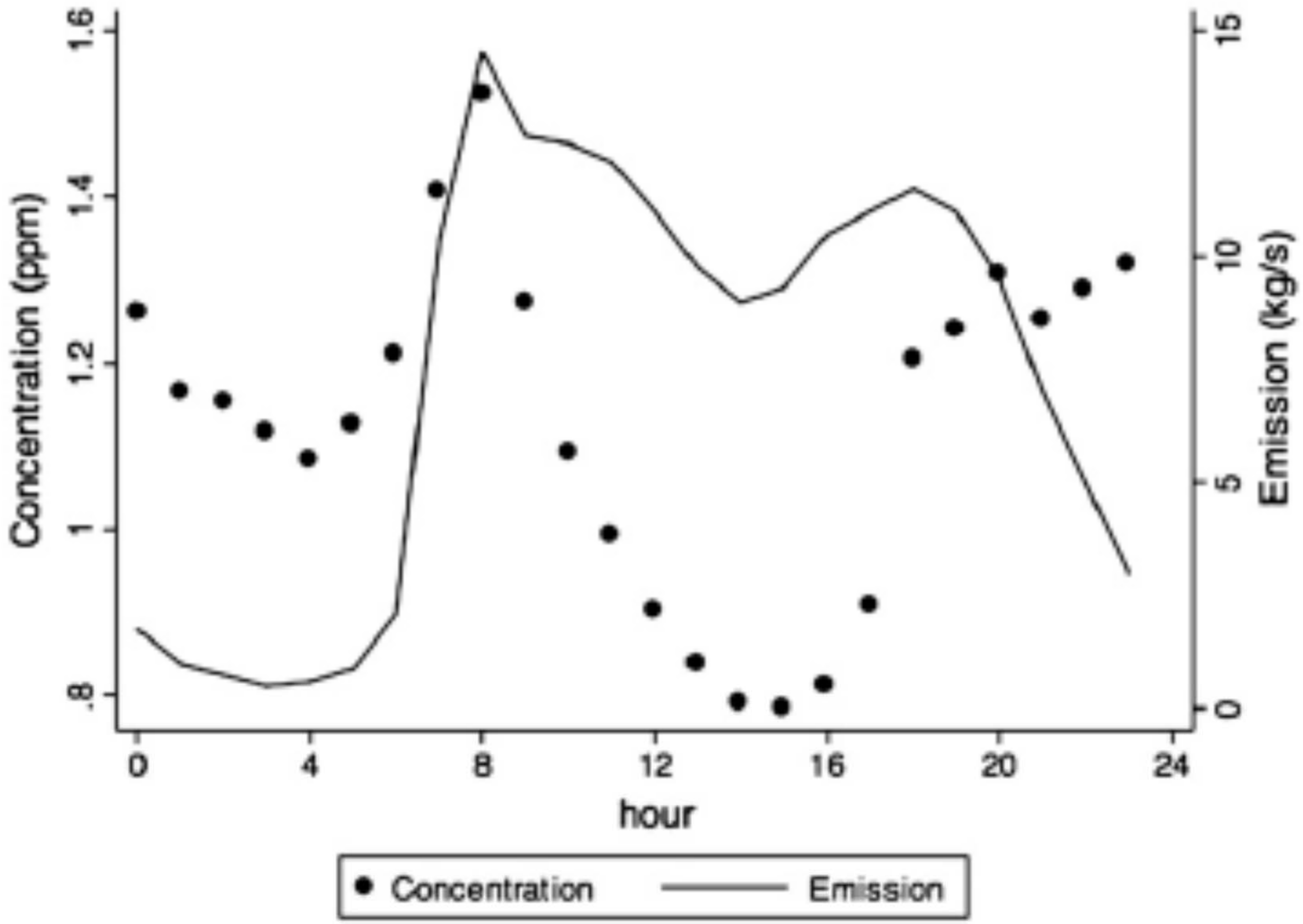


Fig. 4. CO emissions and concentrations in Santiago (January 2002).

Changes in CO concentrations: before and after

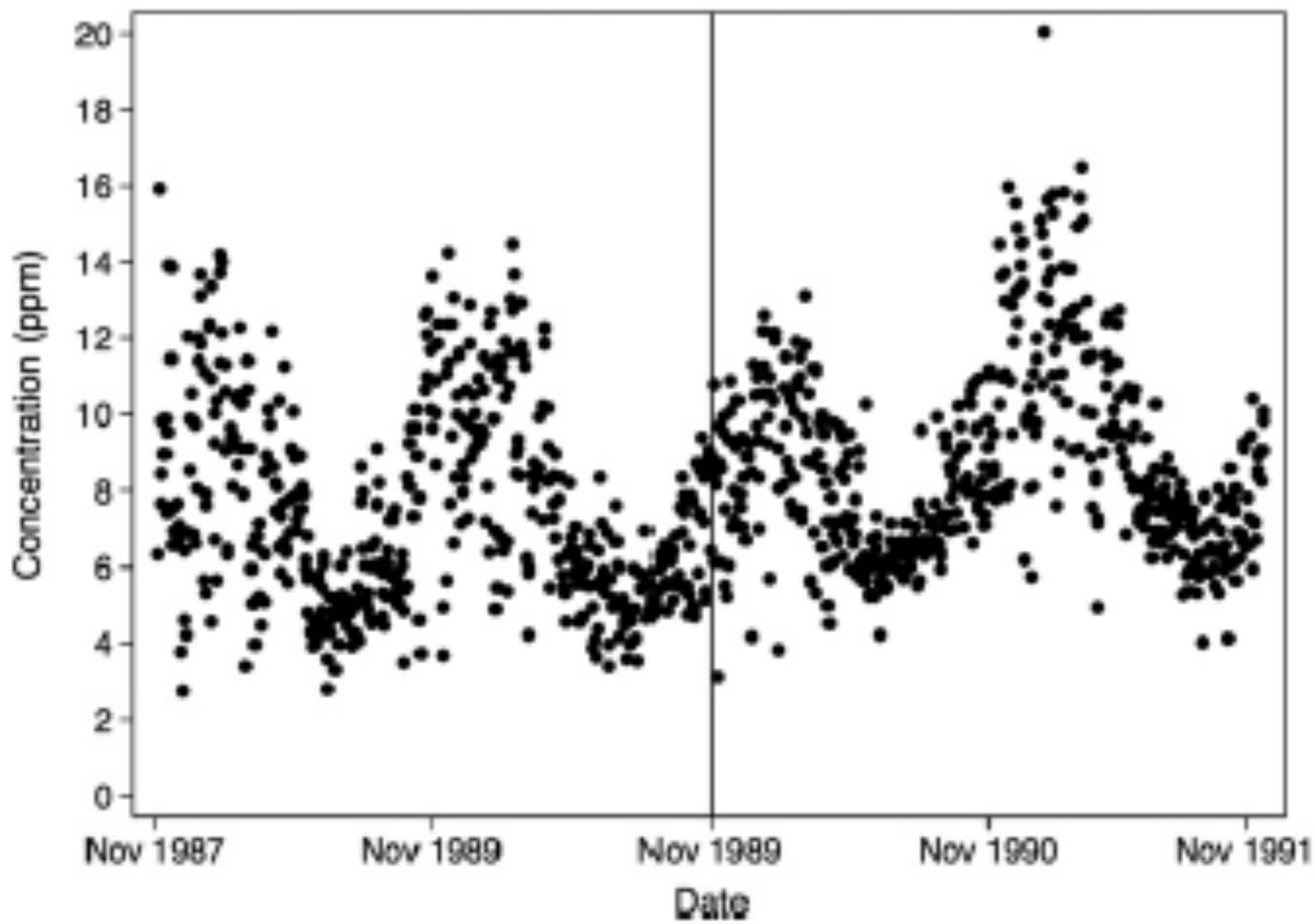


Fig. 1. Daily CO records during peak hours for HNC.

HNC impacts on CO
Gallego-Montero-Salas (JPubE 2013)

	Mexico-City (HNC)		
	short-run	long-run	T(months)
peak hours (8-9 am)	-11%	+13%	12.5
off-peak (12-2 pm)	-9%	+9%	8
sunday (8-10 am)	+2%	+19%	9.5

Mexico-City 1989 (Hoy-no-circula)

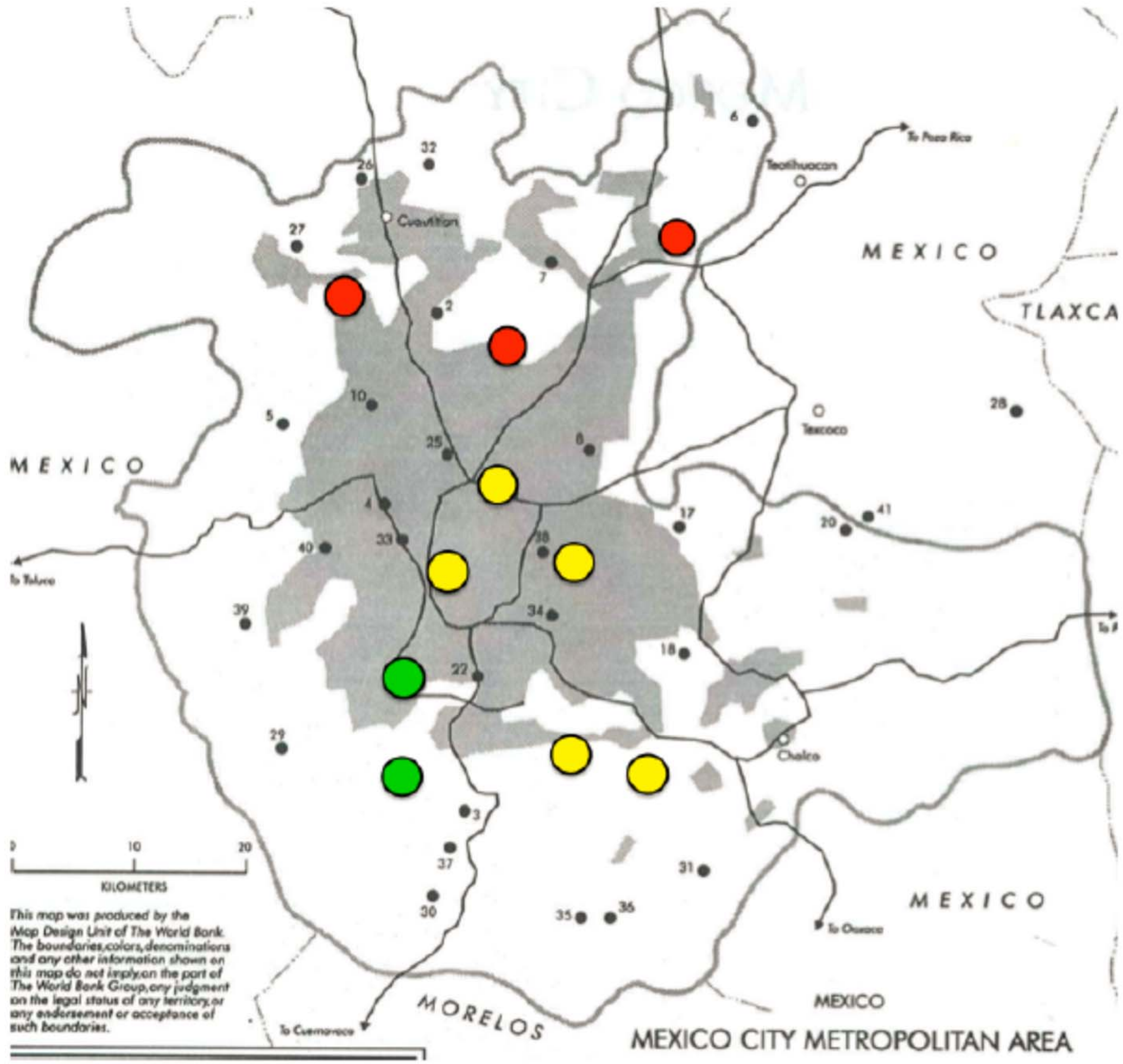


Table: Policy effects by station: HNC

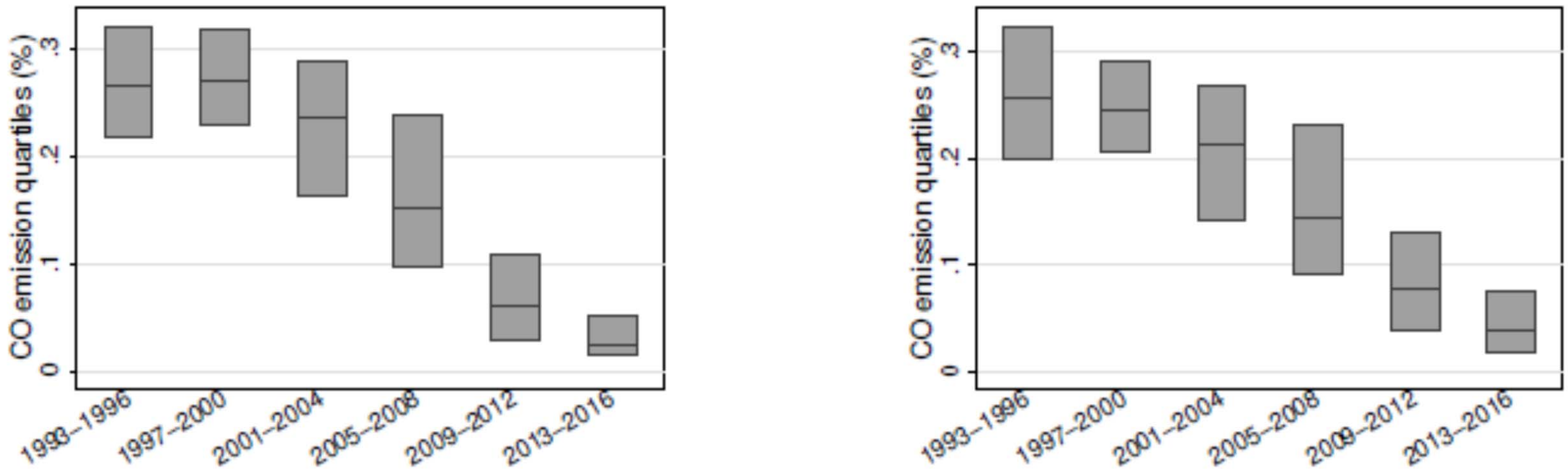
Station	Sector	Income per HH (relative to average income)	Short-run effect	Long-run effect	Difference LR-SR effects	Months of adaptation
Xalostoc	NE	0.55	11.96%	17.60%	5.64%	12.5 (6.06)
Tlalnepantla	NW	0.50[a]	-21.32%*	0.76%	22.08%*	9 (3.10)
I.M. del Petróleo	NW	0.53	-17.81%***	15.98%	33.79%***	14 (1.91)
Lagunilla	CE	0.71	-28.21%***	-6.52%	21.69%*	11 (1.78)
Merced	CE	0.84	-15.27%*	8.07%	23.34%**	12 (1.52)
M. Insurgentes	CE	0.70	-24.58%***	14.27%	38.85%***	15 (2.33)
Cerro Estrella	SE	0.54	-17.81%**	20.37%*	38.18%***	11.5 (1.51)
Taqueña	SE	1.14	-9.48%	22.55%**	32.03%***	15 (2.41)
Plateros	SW	1.99	-3.31%	-3.31%	0.00%	0 –
Pedregal	SW	1.99	-3.38%	13.78%	17.16%	10.5 (3.06)

So, can these rationing schemes ever work?

- When it comes to **vintage-specific** restrictions the evidence is that they do work (Wolf EJ 2014; Barahona et al, REStud 2019)
    - Incentives to “buy-pass” the restriction purchasing a cleaner car
    - By working through the extensive margin (type of car driven), not through the intensive margin (amount of driving), these policies can accelerate the fleet turnover toward cleaner cars
    - These policies should never be designed to affect the intensive margin (although they inevitably do) since they are equivalent to a proportional rationing rule: driving in this particular car by that particular driver is either socially efficient or not
    - Key then is that correcting for the extensive margin is relatively more important than correcting for the intensive margin
    - I want to convince you that when it comes to local pollution (with long-live fleets) it is

Older cars pollute a lot more than newer ones

(Kahn RJE 1996; Knittel and Sandler AEJ-EP 2018; Jacobsen and Salle 2019; Barahona et al 2019)



Interquartile Range of CO Emissions. The left and right figures consider emissions registered at 24[km/h] and 40[km/h] respectively. Data for 2016 is considered.

Workings of vintage-specific driving restrictions Evidence from Santiago’s 1993 program (Barahona-Gallego-Montero 2019)

6 REVIEW OF ECONOMIC STUDIES

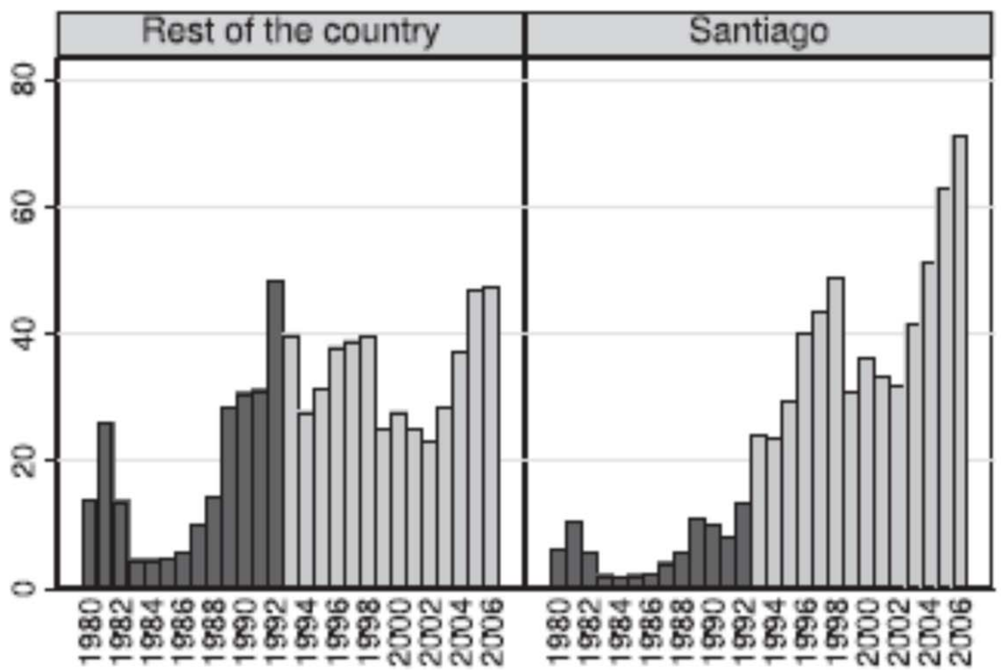


FIGURE 1

Fleets in Santiago versus the rest of country in 2006

Notes: Each bar represents number of cars (in thousands) of each vintage. Pre-1993 vintages are highlighted as darker bars.

A back of the envelope calculation indicates that emissions of CO, NOx and HC dropped by 20% in Santiago in 2006 because of the policy;

Polluting cars where exported outside Santiago where pollution was not a concern, so they were still valuable

The value of the restriction

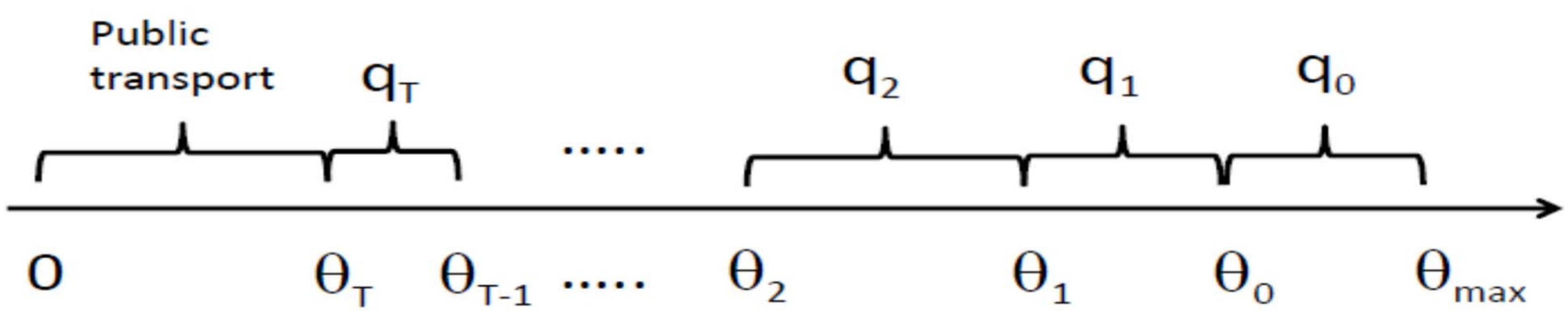
Table A.2: The effects of having a catalytic converter on the price of used cars

	(1)	(2)	(3)	(4)
FIAT	0.031***	0.027***	0.034***	0.027***
UNO	(0.006) [5220]	(0.006) [4705]	(0.007) [4705]	(0.006) [4705]
HONDA	0.127***	0.105***	0.121***	0.122***
ACCORD	(0.008) [10583]	(0.011) [3978]	(0.011) [3978]	(0.011) [3978]
HONDA	0.031***	0.069***	0.054***	0.05***
CIVIC	(0.007) [7281]	(0.007) [5655]	(0.007) [5655]	(0.007) [5655]
MAZDA	0.031***	0.054***	0.055***	0.052***
323	(0.006) [8377]	(0.005) [5576]	(0.005) [5576]	(0.005) [5576]
PEUGEOT	0.033***	0.025***	0.024***	0.021***
205	(0.007) [4285]	(0.008) [3716]	(0.008) [3716]	(0.008) [3716]
PEUGEOT	0.103***	0.138***	0.116***	0.114***
505	(0.008) [11665]	(0.009) [5115]	(0.01) [5115]	(0.01) [5115]
TOYOTA	0.094***	0.17***	0.174***	0.175***
COROLLA	(0.011) [9385]	(0.01) [6564]	(0.012) [6564]	(0.012) [6564]
Age, Model and Date f.e.	Yes	Yes	Yes	Yes
$g(\tau)$	No	Quality	Flexible line	Flexible age f.e.

Notes: The unit of observation corresponds to a car offer published in the newspaper the first Sunday of every month between 1988 and 2000. Each row corresponds to estimates of the effect of having a catalytic converter in the context of equation (3) using different specifications for different models. Standard errors clustered by ad date are presented in parentheses. The number of observations in each specification are presented in squared brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A vertical-differentiation dynamic model of the (new and secondary) car market

- It shares some elements of Gavazza et al (AER 2014), although they only consider steady states
- transitions in these car markets can take a long time (>20 years); the average vehicle age in the Mexican fleet is 14 years while in the US is less than 9 (Davis and Kahn, AEJ-EP 2010)
- We use the model to (analytically and numerically) derive the optimal vintage-specific design and to compare it to alternative instrument designs: scrappage subsidies, registration fees, gasoline taxes



Steady-state fleet composition under no intervention (two regions)

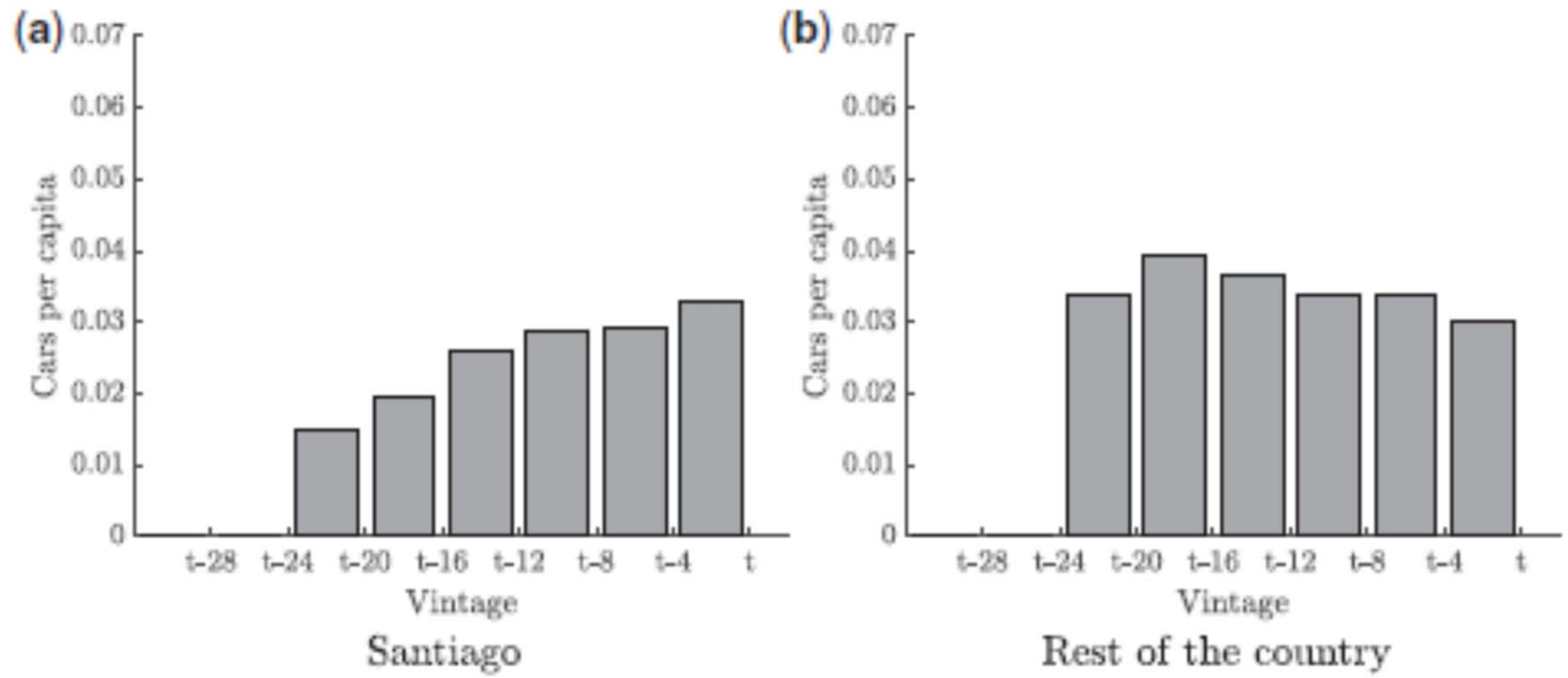


FIGURE 5

Steady-state fleet composition under no intervention

Notes: The figure shows the steady-state profile of car fleets in Santiago and the rest of the country under the no-intervention scenario. Since total population has been normalized to unity, each bar indicates the number of cars per capita for a particular vintage group.

Steady-state first-best fleet composition (under Pigouvian taxes)

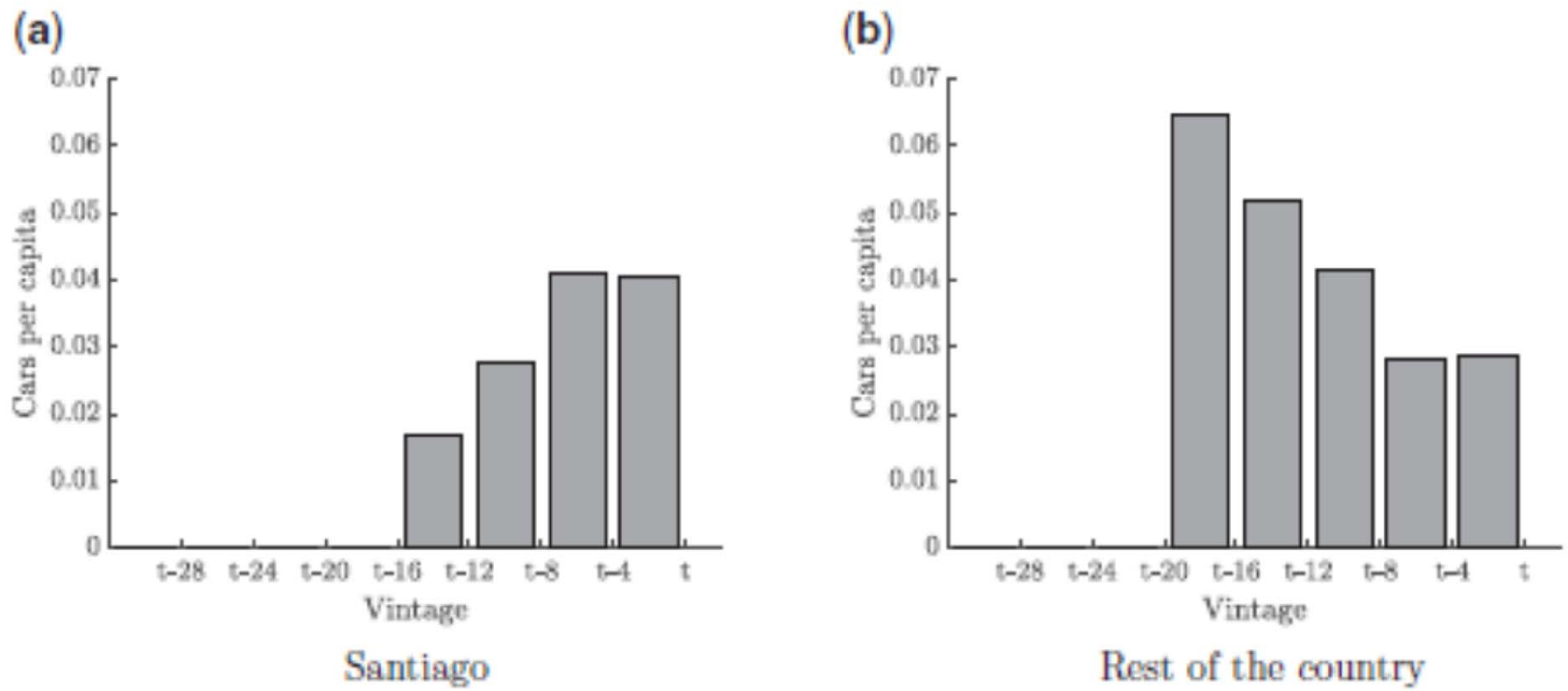
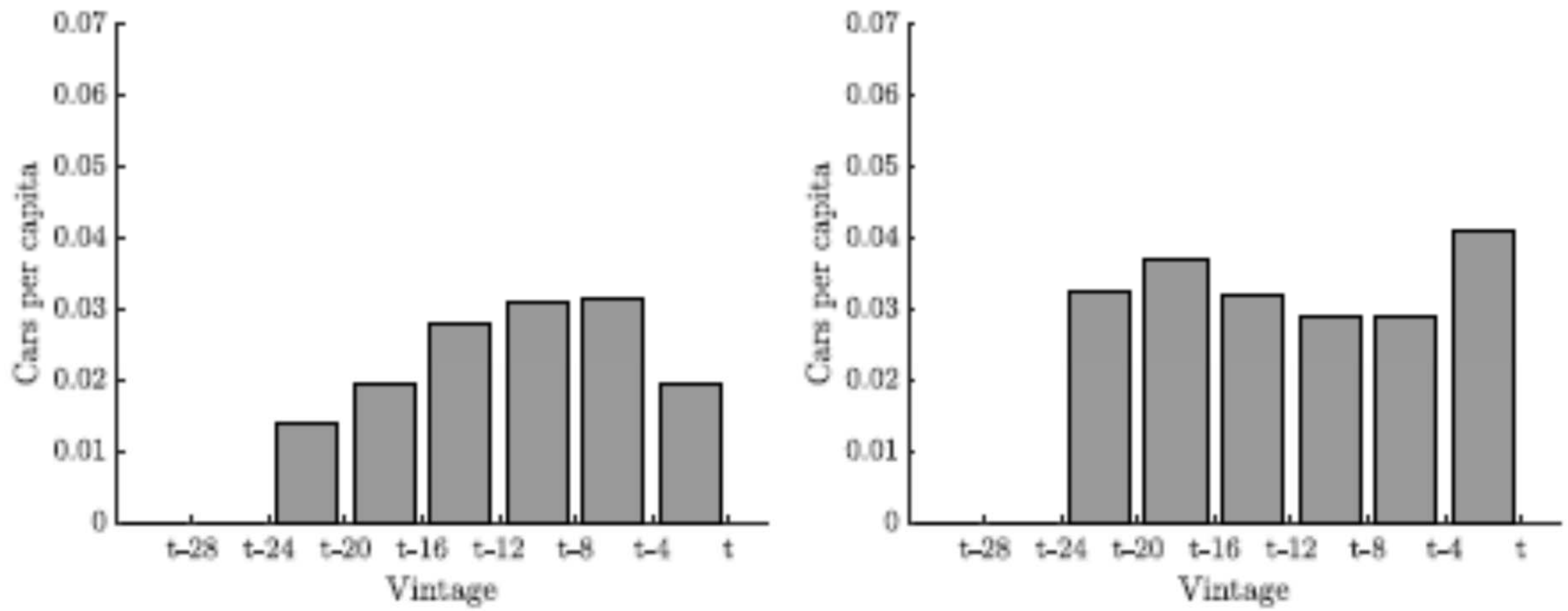


FIGURE 6

Steady-state fleet composition under the first best

Notes: The figure shows the steady-state profile of car fleets in Santiago and the rest of the country under Pigouvian taxation. Since total population has been normalized to unity, each bar indicates the number of cars per capita for a particular vintage group.

Steady-state fleet composition under uniform restriction (Mexico-City 1989); big welfare losses



(a) Santiago (b) Rest of the country

Figure E.2: Steady-state fleet composition under a uniform driving restriction

Steady-state fleet composition under an optimal vintage-specific restriction (like in Paris; recall proportional rationing); important welfare gains

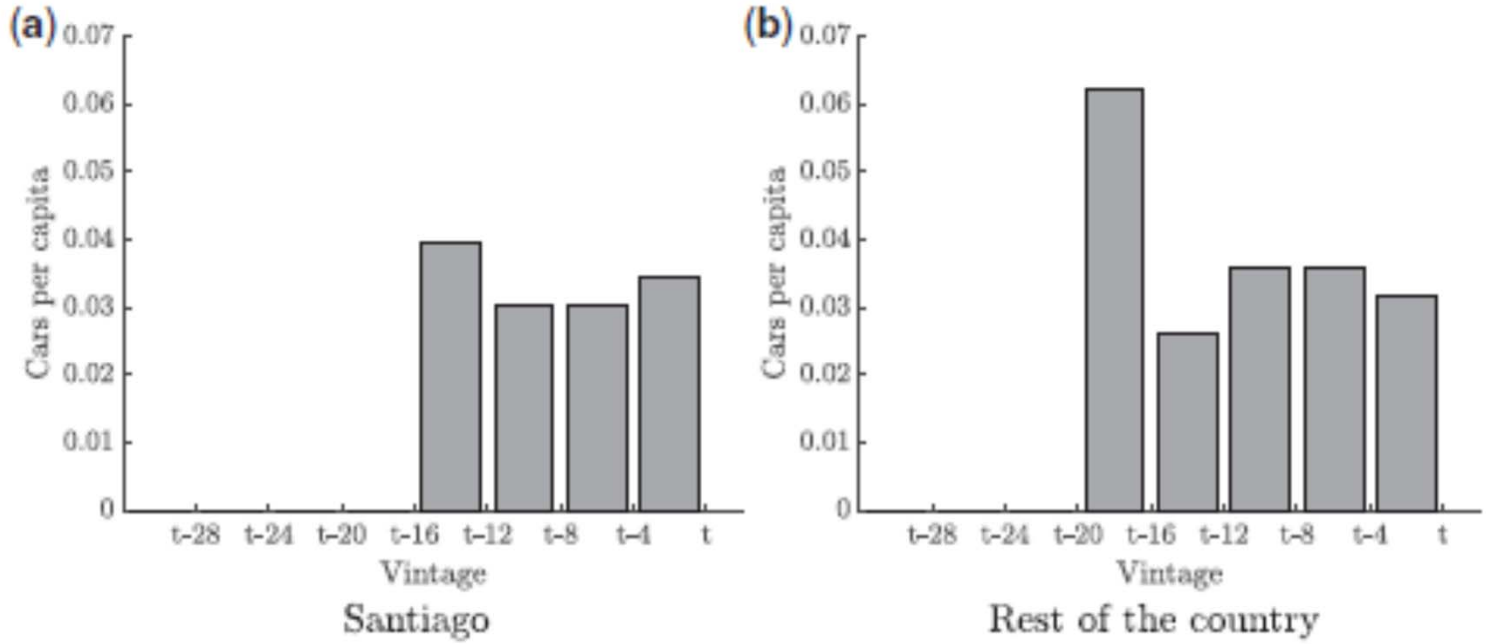


FIGURE 7

Steady-state fleet composition under a complete-ban vintage driving restriction

Notes: The figure shows the steady-state profile of car fleets in Santiago and the rest of the country under a complete-ban vintage-specific driving restriction. Since the total population in the country has been normalized to unity, each bar indicates the number of cars per capita for a particular vintage group.

Comparing different policies

TABLE 4
Welfare under various policy simulations

No.	Counterfactual	Transport surplus (in 2006 dollars)	Pollution cost (in 2006 dollars)	Welfare (in 2006 dollars)	Welfare gain /loss (relative to first-best)
1.	No intervention	5,579.6	−1,112.2	4,467.4	0%
2.	First best	5,378.9	−477.4	4,900.5	100%
3.	Driving restriction with no exemptions ($R = 0.9\ \forall\tau$)	5,192.4	−1,122.3	4,070.1	−92%
4.	Driving restriction with some exemptions ($R = 0.9$, $a \geq 3$)	5,542.7	−1,005.7	4,537.0	16%
5.	Complete-ban vintage driving restriction ($R = 0$, $a \geq 4$)	5,491.1	−800.9	4,690.2	51%
6.	Scrappage subsidy ($2,420), full arbitrage	5,276.2	−648.1	4,628.1	37%
7.	Scrappage subsidy ($3,240), no arbitrage	5,465.2	−786.4	4,678.8	49%
8.	Circulation fees	5,379.1	−571.0	4,808.1	79%
9.	Gasoline tax ($1.06 per gallon)	5,520.6	−985.9	4,534.7	16%
10.	Vintage restriction and gas tax ($R = 0$, $a \geq 4$, ¢80 per gallon)	5,456.3	−726.6	4,729.7	61%

Gasoline taxes vs vintage restrictions for local pollution

- Gasoline taxes act primarily on the intensive margin
- Vintage restrictions act primarily on the extensive margin
- In the short-run (keeping the fleet constant):
  - A US$2/gallon gasoline tax delivers 50% of the first-best gain (a bit more than in Knittel and Sandler AEJ-EP 2018)
  - (short-run optimal) vintage restriction delivers less than 30%
- In the long-run (after the fleet has adjusted to its new steady state):
  - Gasoline tax delivers 16% of the first-best gain (it delays the entry of new, cleaner (gasoline) vehicles)
  - Vintage restriction delivers 51%

CONGESTION “PRICING”: IS IT FEASIBLE?

The political economy of congestion pricing

- We don’t see congestion pricing around the world…except in London, Singapore, Stockholm, Gothenburg, Bergen, Oslo, Milan, and soon NYC (Baranzini et al, 2019)
- We don’t see pollution pricing at all, but in London and Milan: pollution charges on top of congestion fees
- (gasoline taxes not good for local pollution)
- What about driving restrictions for both congestion and local pollution?
- And to avoid drivers buying a second car, include two type of exemptions: toll and vintage exemptions
- Driving restrictions with a daily toll that exempts cars from the restriction is a first (politically feasible) step toward full congestion pricing (currently under discussion in Santiago; already in Cali since 2017)

Driving restriction with toll and vintage exemptions (Basso-Montero-Sepulveda 2019)

- Authority determines the number of days a week a car is banned from circulation (e.g., in Bogota 50% of the fleet is restricted every day),
- (for the time being we are proposing one or two days a week)
- Car owner has the option to pay a daily pass (i.e., toll) to have the car exempted from the restriction that day; however…
- …during the time of the year in which local pollution (CO, HC, NOx) is a serious problem, fall and winter, only cars above certain standard (>2000 for petrol, >2006 for diesel) have the option to pay the toll
- …and during the rest of the year all cars have such option
- logic of having vintage thresholds comes the proportional rationing rule (Barahona et al 2019)
- What to do with the toll revenues? Distributional considerations require to allocate them all to improve public transport (lower fares and better quality)

We consider five income groups:

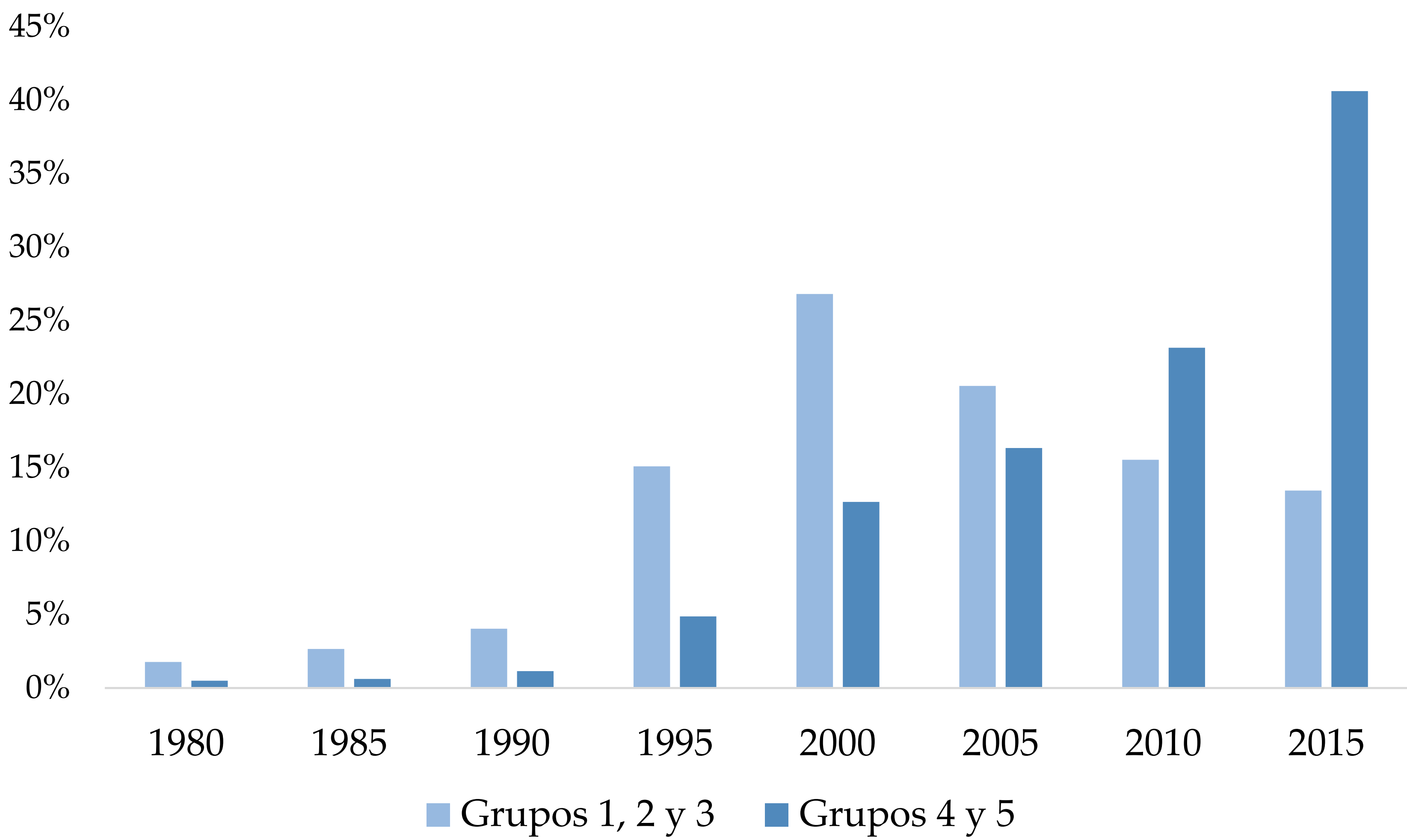
Table 4: Income groups

Income groups	Income range	Without a car	Percentage of total
Low income	[0 - $242.177]	84%	10%
Low-Middle income	[$242.177 - $484.355]	66%	22.9%
Middle income	[$484.355 - $968.710]	46%	35.5%
Middle-high income	[$968.710 - $1.937.419]	23%	23.4%
High income	[$1.937.419 - ...]	5%	8.1%

Fleet distribution among income groups by vehicle and fuel type

Model type\Inc. Group	1	2	3	4	5
Compact	**0,3%**	**0,9%**	**2,1%**	**3,9%**	**6,6%**
Gasoline	0,1%	0,7%	1,8%	3,7%	6,2%
Diesel	0,2%	0,2%	0,3%	0,3%	0,4%
Mid Size	**0,1%**	**0,1%**	**0,5%**	**1,1%**	**2,1%**
Gasoline	0,0%	0,0%	0,4%	1,0%	2,0%
Diesel	0,1%	0,1%	0,1%	0,1%	0,1%
Pickup trucks	**0,8%**	**0,9%**	**1,0%**	**1,2%**	**1,4%**
Gasoline	0,3%	0,3%	0,3%	0,4%	0,4%
Diesel	0,6%	0,6%	0,7%	0,8%	1,0%
Other vehicles	**2,1%**	**2,5%**	**3,5%**	**5,4%**	**11,3%**
Gasoline	1,7%	2,1%	3,1%	5,2%	10,8%
Diesel	0,4%	0,4%	0,3%	0,3%	0,5%
Sub compact	**2,4%**	**3,6%**	**5,8%**	**9,4%**	**14,0%**
Gasoline	1,6%	2,8%	5,1%	8,8%	13,2%
Diesel	0,8%	0,8%	0,7%	0,6%	0,8%
SUV	**0,6%**	**1,3%**	**2,5%**	**4,5%**	**8,2%**
Gasoline	0,2%	0,7%	1,7%	3,4%	6,4%
Diesel	0,4%	0,5%	0,7%	1,1%	1,9%

Fleet distribution among income groups by vintage



NOx, CO and HC emissions by vintage, vehicle type and fuel

	All		Subcompacto		Compacto		Otros autos particulares		Tamaño Medio		SUV		Camiones pequeños	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
Panel A: Monóxido de Carbono														
1985	15.26	18.21	10.94	13.06	4.52	5.39	14.51	17.32	11.79	14.07	47.81	57.06	N/A	N/A
1990	9.79	11.68	9.48	11.31	9.89	11.80	10.16	12.13	8.33	9.94	8.82	10.53	N/A	N/A
1995	0.60	0.62	0.61	0.63	0.56	0.58	0.59	0.61	0.59	0.61	0.59	0.61	0.96	1.00
2000	0.34	0.28	0.34	0.28	0.32	0.26	0.32	0.26	0.33	0.27	0.33	0.27	0.52	0.43
2005	0.09	0.06	0.09	0.06	0.09	0.06	0.09	0.06	0.09	0.06	0.09	0.06	0.15	0.10
2010	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.04	0.13
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
Panel B: NOx														
1985	0.79	0.94	1.04	1.24	0.40	0.48	0.85	1.01	0.54	0.64	0.61	0.73	N/A	N/A
1990	0.81	0.97	0.62	0.74	0.64	0.76	0.86	1.03	0.72	0.86	0.82	0.98	N/A	N/A
1995	0.49	0.51	0.44	0.46	0.42	0.44	0.52	0.54	0.48	0.50	0.58	0.60	0.63	0.65
2000	0.30	0.25	0.28	0.23	0.27	0.22	0.31	0.25	0.29	0.24	0.39	0.32	0.38	0.31
2005	0.08	0.05	0.07	0.05	0.08	0.05	0.09	0.06	0.07	0.05	0.09	0.06	0.11	0.07
2010	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.02	0.06
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Panel C: Hidrocarburos														
1985	1.36	1.62	1.18	1.41	0.86	1.03	1.30	1.55	1.13	1.35	3.39	4.05	N/A	N/A
1990	0.85	1.01	0.81	0.97	0.80	0.95	0.88	1.05	0.72	0.86	0.81	0.97	N/A	N/A
1995	0.37	0.38	0.35	0.36	0.33	0.34	0.41	0.43	0.36	0.37	0.38	0.39	0.56	0.58
2000	0.23	0.19	0.23	0.19	0.21	0.17	0.24	0.20	0.23	0.19	0.24	0.20	0.33	0.27
2005	0.07	0.05	0.07	0.05	0.07	0.05	0.08	0.05	0.06	0.04	0.07	0.05	0.11	0.07
2010	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.02	0.06	0.04	0.13
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03

A simple public-private transport model

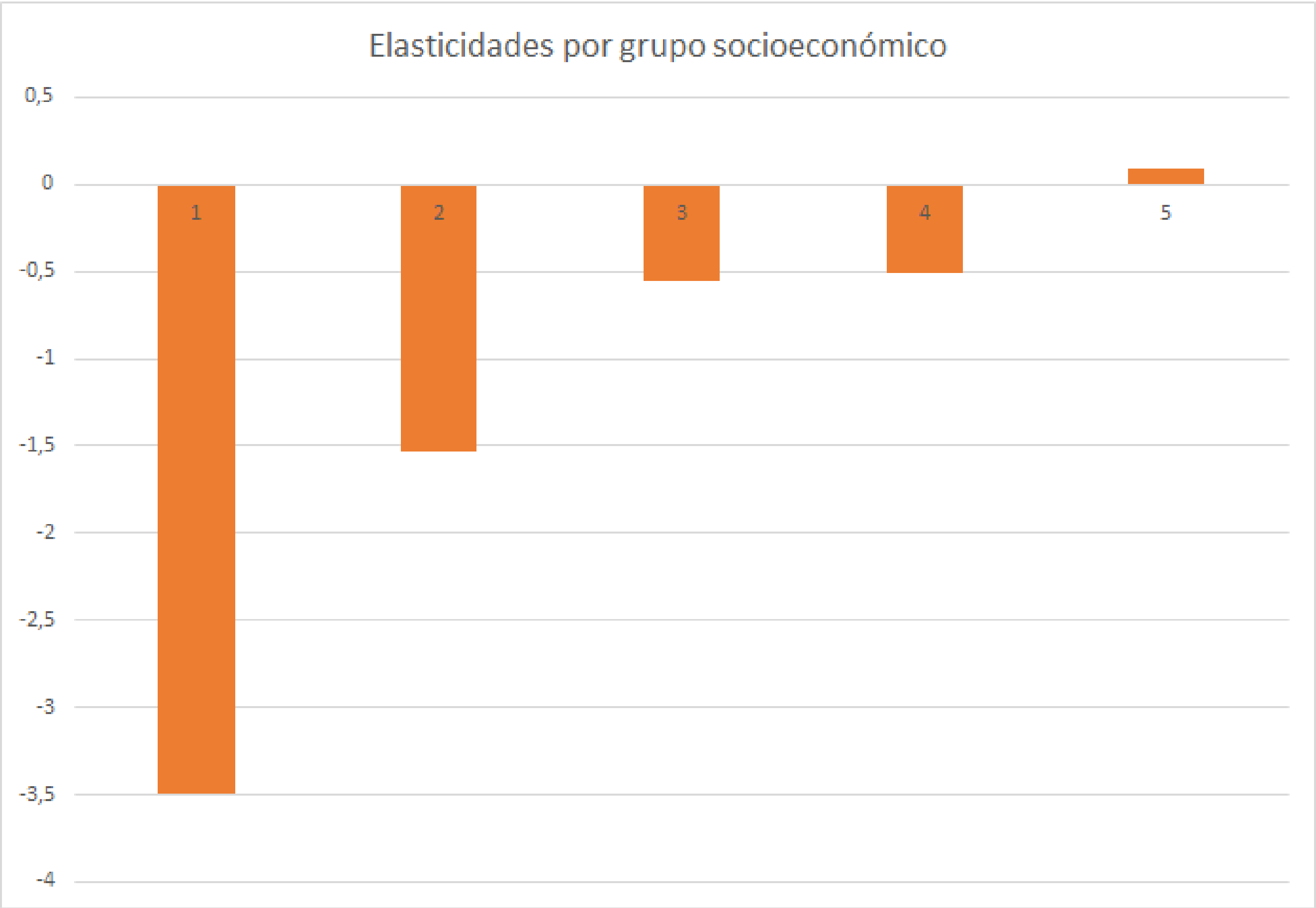
- a large number of individuals commute everyday of the week at peak hours to the city center
- two transport modes available: cars and public transport (buses)
- only a fraction of individuals own a car
- Individual k's surplus from weekly commute as a function of mode preferences, and monetary and time costs (Basso & Silva 2014 AEJ-EP)

$$S_k = \Omega_k \left(d_k\right) - C_k \left(d_k, r, p_c, p_b\right) - T_k \left(d_k\right)$$

$d_k = 1, \ldots, 5$ is the number of days k commutes by car (if she has one)
$r = 0, \ldots, 5$ is the days of restriction
p_c is the toll and p_b is the bus-subway fare

- authority decides r and p_c, but can also lower p_b

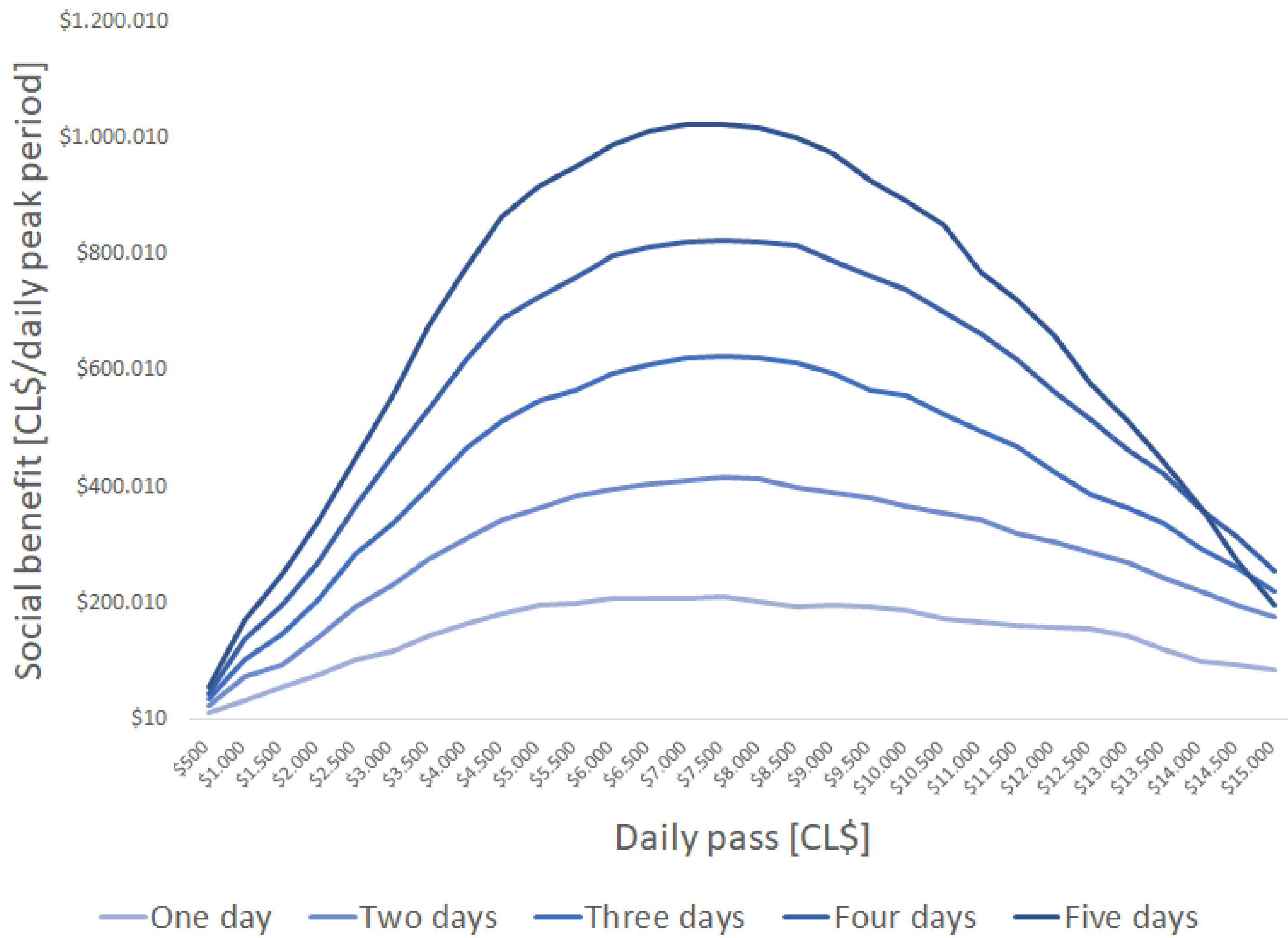
Model Calibration: Elasticity of private driving by income group



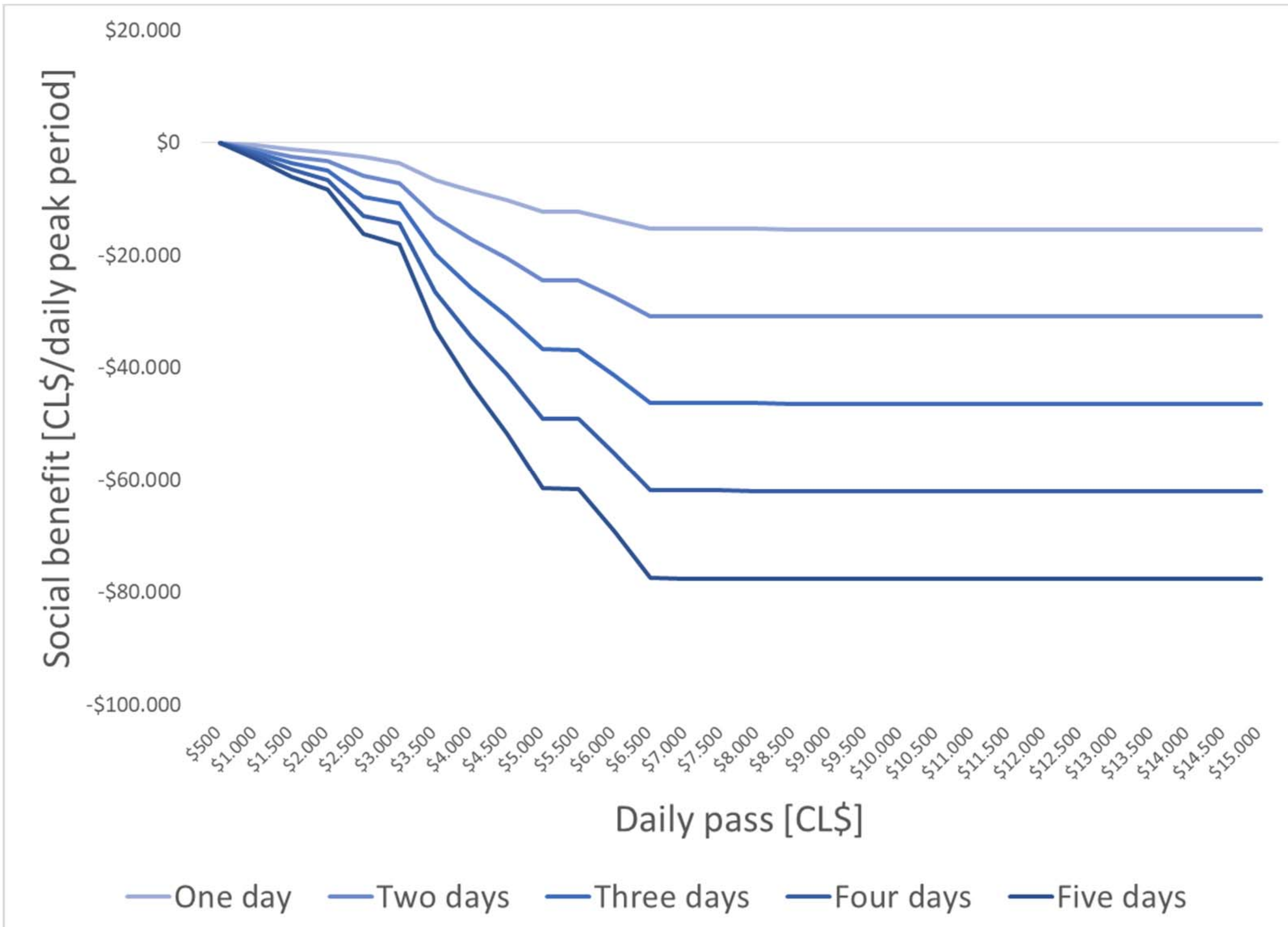
Average elasticity is -0.27

Consistent with literature (Litman, 2013) that shows variations between -0.15 and -0.5

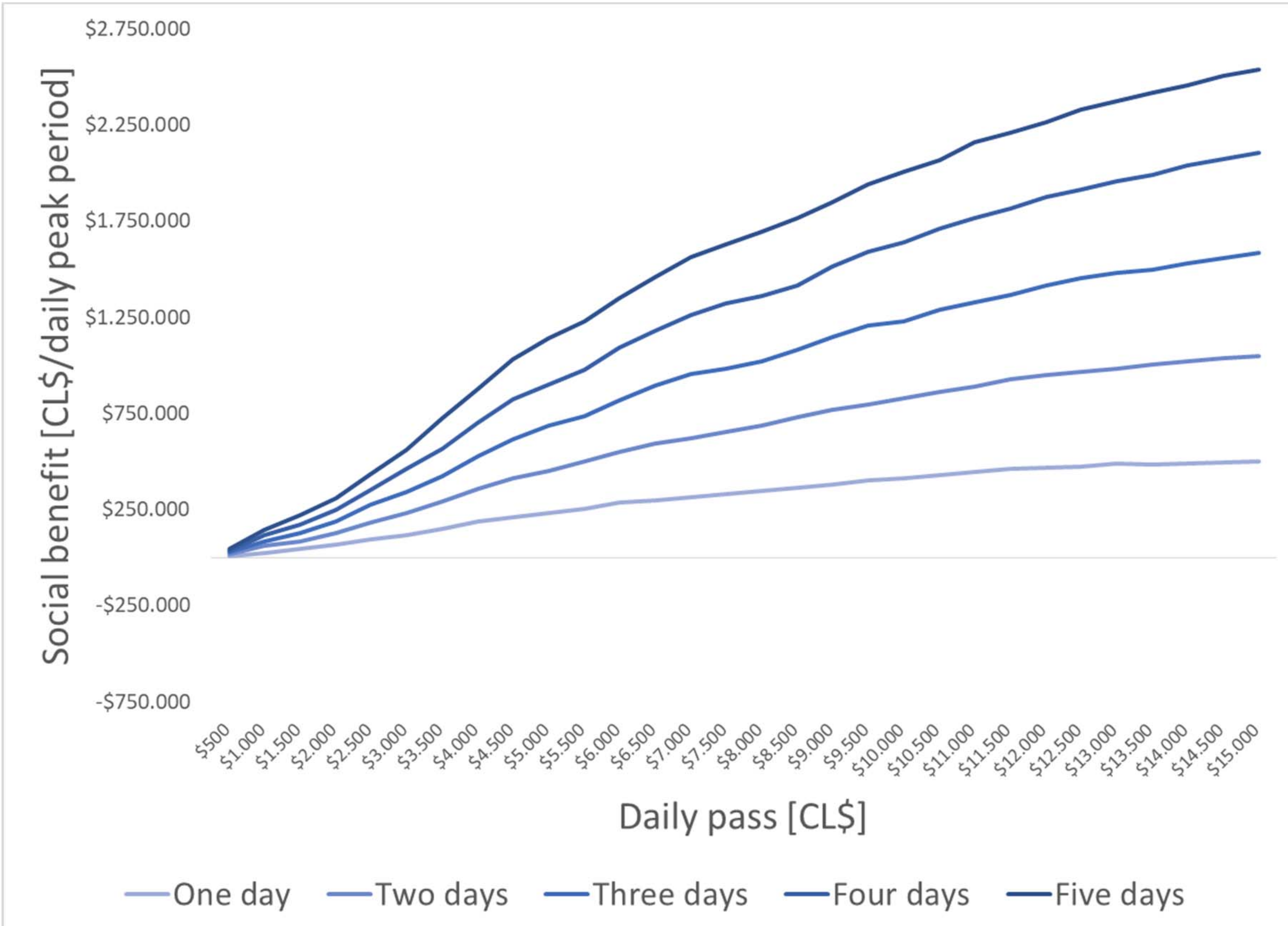
Overall welfare gain from different restriction-tolls for summer/spring (Basso et al 2019)



Welfare gain/loss for lowest-income quintile



Welfare gain/loss for highest-income quintile

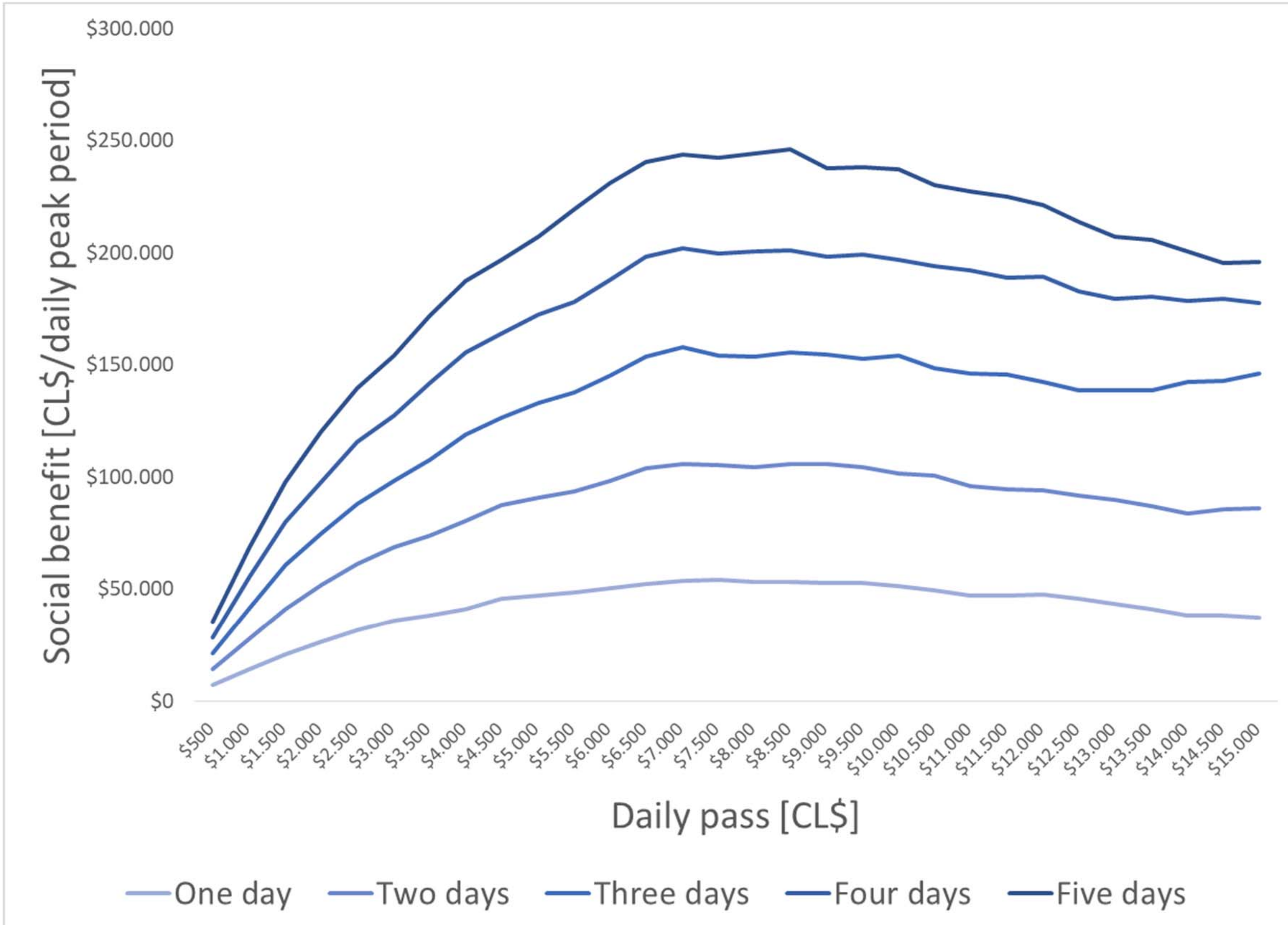


Distributional implications when the toll collection is recycled 100% to reduce the public-transport fare

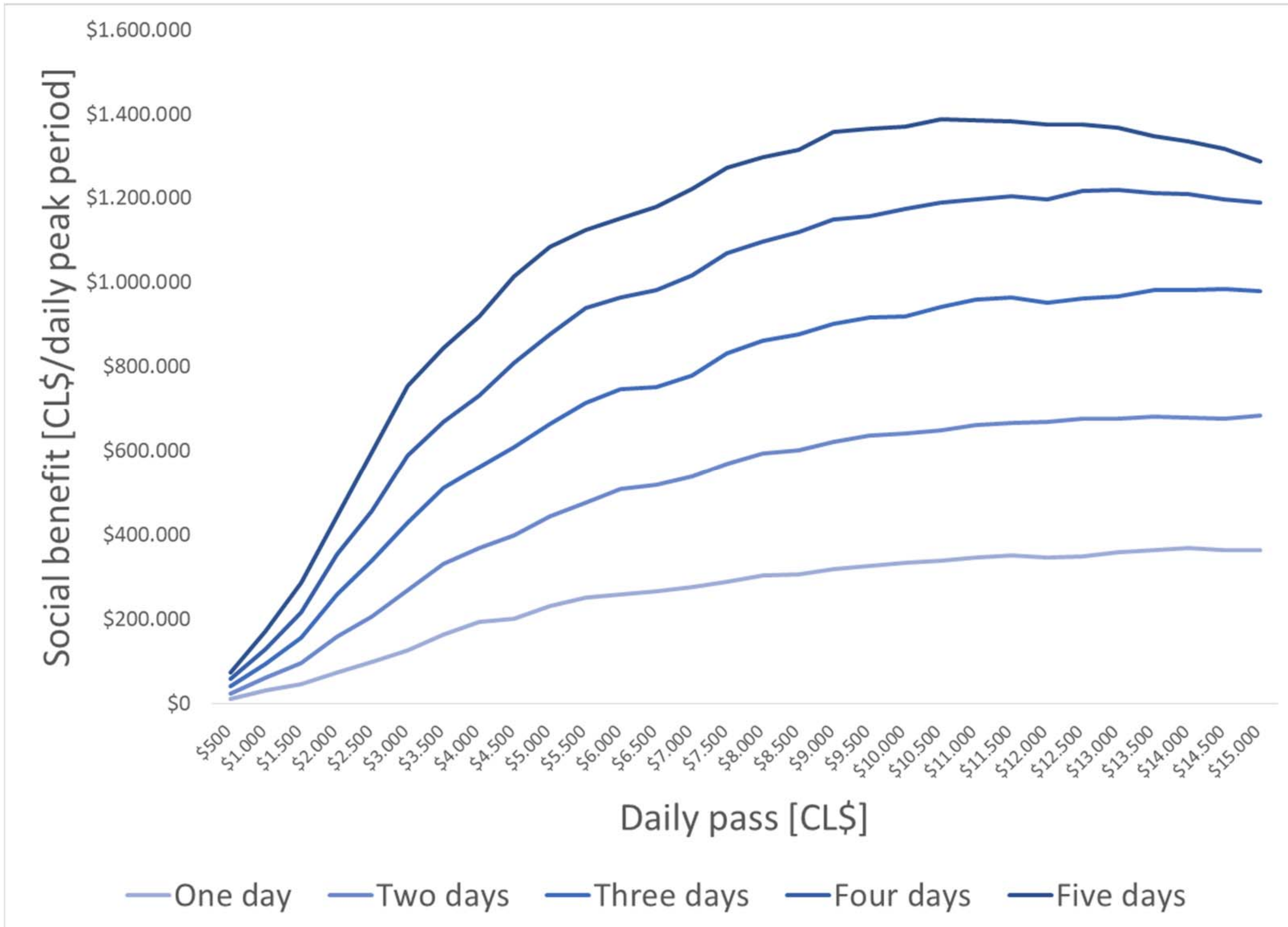
by 60% under a 5-day restriction

by 35% under 2-day of restriction

Low income households after fare reduction



High income households after fare reduction

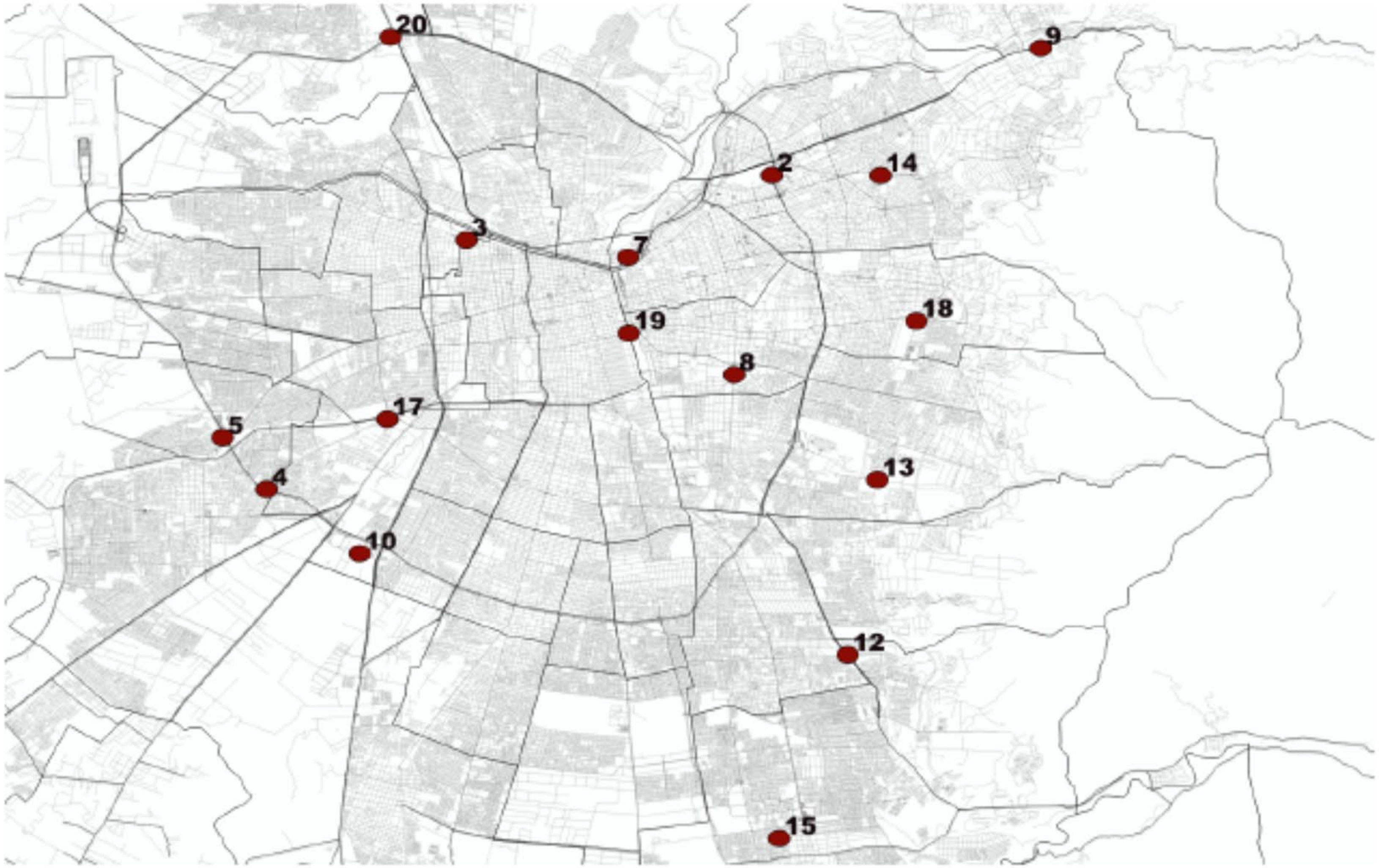


SMOG CHECKS: DO THEY HELP?

The problem with smog checks

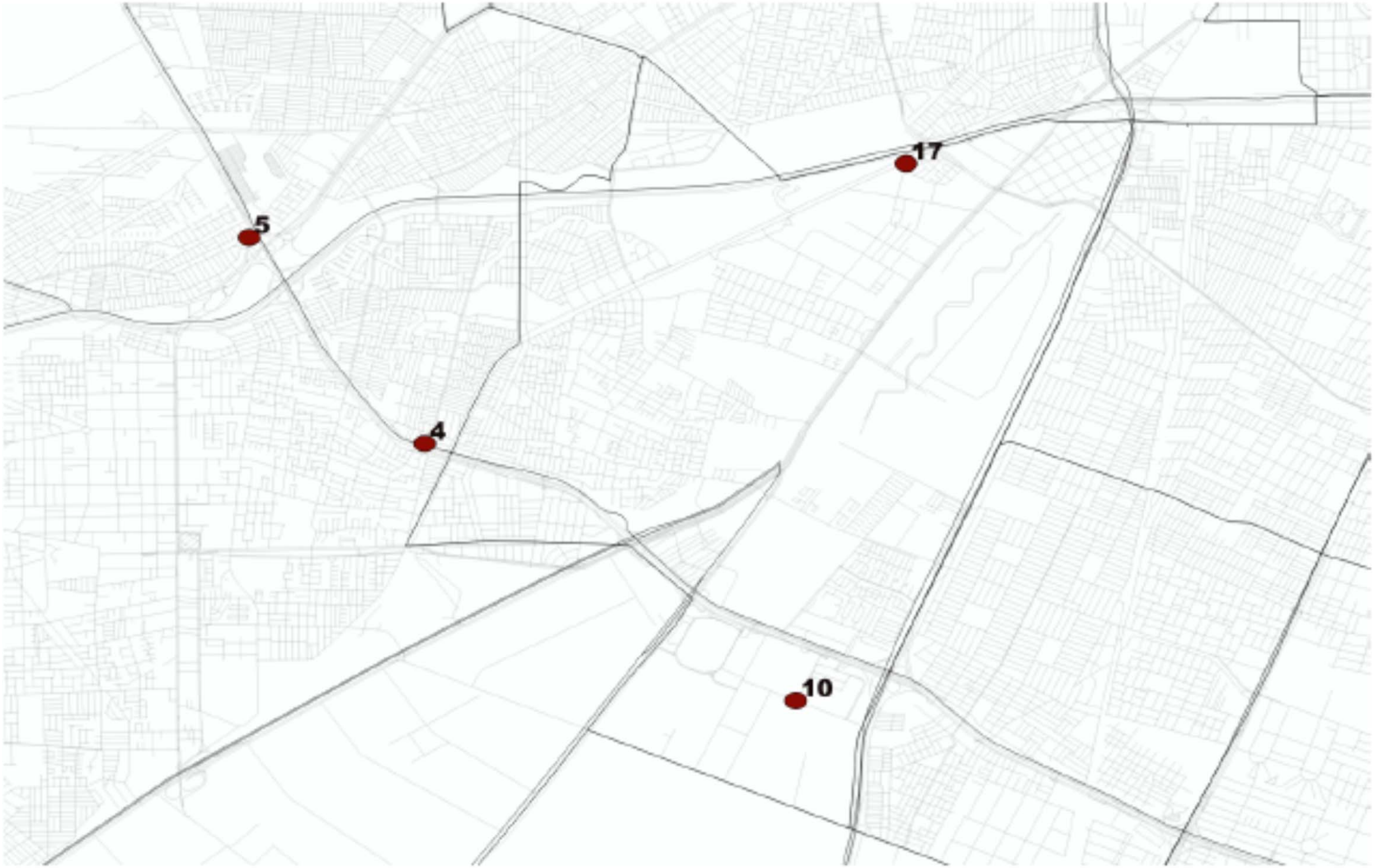
- Corruption and fraud (Oliva JPE 2015)
- Variation in inspection stations quality (Sanders and Sandler 2017; Hubbard RJE 1998)
- High variance in emissions for the same car, fast deterioration of the repairs (Wenzel et al., 2004).
- Too much competition among inspection stations? (Barahona et al 2020):
  - To study this, we exploit entry of new inspection stations in Santiago, which enter with much lower prices (50% less on average)
  - Data: 17 million observations with all inspections during 2008-2017

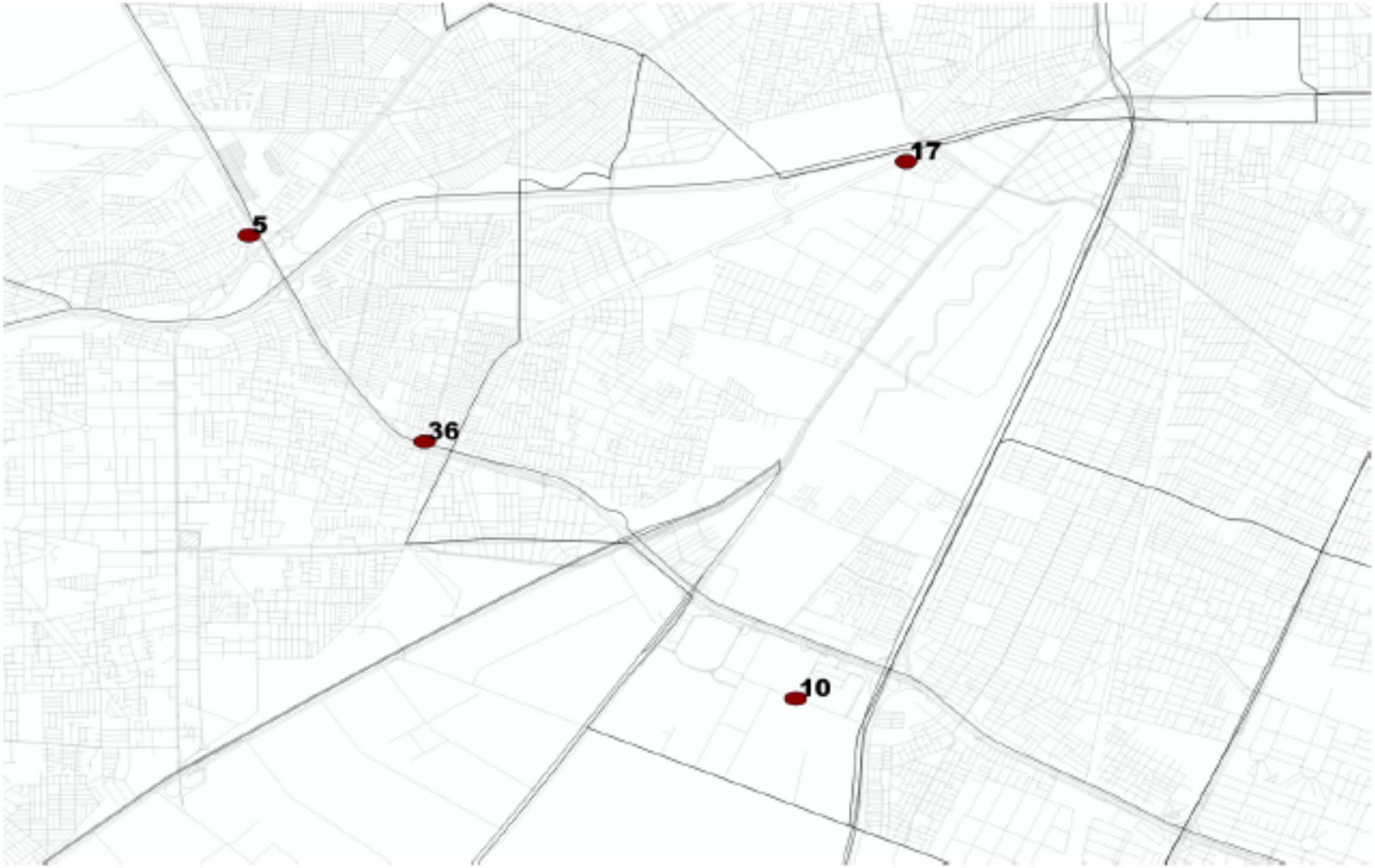
Smog-check stations in Santiago in 2014




20


20
31


5
17
4
10


17
5
36
10

Conclusions

- Paying attention to the political economy of what can and can't be done is essential
  - rationing schemes -- driving restrictions are increasingly popular
  - congestion pricing (and pollution pricing) highly unpopular
  - (EV and scrappage) subsidies are expensive!
- Key is to target the existing fleet; targeting only the new fleet (e.g., subsidising EVs and/or tighting CAFE/Euro standards may take too long)
- When it comes to (local) pollution, key to understand how the existing fleet evolves over the long run (dynamic car market equilibrium)
  - gasoline taxes in the short v. long run
  - Uniform driving restrictions
- Distributional (and market structure) considerations are crucial, e.g., inject the toll revenues back to the public transport system to leave everyone better off
- More research needed (and more involvement in public policy discusion too)