

## Smog alert in Paris on March 12: which public policies for which effects?

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N°2014-02

POLICY BRIEF

*On March 12, the fine particulate matters exposure indicator exceeded the safe level of 100 micrograms per cubic meter in the Paris region. On the third day, to cope with the pollution peak, the French government, the Region Ile-de-France and the municipality of Paris introduced special measures. They included free access to public transportation and alternate driving based on an odd/even license plate scheme .*

- Starting from the hypothesis that a given policy measure achieves in reality more than one policy target (thus potentially increasing its overall efficiency) the impact analysis of the observed modal transfers is extended from the local air pollutants balance to CO<sub>2</sub> emissions savings.
- Simultaneously implementing free access to public transportation and an odd-even license plate strategy proves to be more efficient for changing the modal structure and thus for reducing emissions levels than solely setting one of the two public policies at the time.
- Restricting the circulation is more efficient from an environmental point of view when based on the criterion of vehicles' age rather than the restriction established by the government (odd/even licence plate).

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## Smog alert in Paris on March 12: which public policies for which effects?

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On March 12, the fine particulate matters exposure indicator exceeded the safe level of 100 micrograms per cubic meter in the Paris region. On the third day, to cope with the pollution peak, the French government, the Region Ile-de-France and the municipality of Paris introduced policies. They include (between 14 of and 17 March):

- Free access to public transportation ;
- Speed limit reductions ;
- Bypass measures for heavy-goods vehicles ;
- Free access to Autolib' (for one hour duration) ;
- Free access to Vélib' (for one day) ;
- Odd/even licence plate strategy (solely for March 17<sup>th</sup>) ;
- Free parking for even-numbered vehicles (solely for March 17<sup>th</sup>) ;
- Free parking only for residents who own a parking card where residential parking is usually charged.

Those public policy measures aimed at reducing the emissions of particulate matters due to road traffic. However, even though the Ile-de-France Interdepartmental Road Directorate (DiRIF) has provided real-time information on traffic speed evolution and congestion mapping on the one hand, and if medias have massively released figures regarding Autolib' and Vélib' use increase on March 17<sup>th</sup>, final estimations of emissions balance have not yet been published.

Our analysis, based on simulations from a modal choice model – derived from the discrete choice theory – in the French Urban Community of Lille Metropole, shows that setting up at the same time a free access to public transportation and an odd/even license plate strategy is more efficient for inducing modal shift towards low-emitting modes than setting solely one or the other of the two public policies.

With regard to driving restriction, it appears that this measure is more efficient from an environmental point of view when based on the criterion of age rather than when based on a quite arbitrary criterion (odd/even licence plate).

## 1. Looking back to the pollution peak in Paris between 12 and 17 March

### 1.1. The design of anti-pollution measures

To cope with the pollution peak (the fine particulate indicator exceeded 100 micrograms per cubic meter in the Paris region on March 12<sup>th</sup>), the Region Ile-de-France has:

- Provided **free access to public transportation** (buses, subways, tramways, regional express network - RER in French - and trains) ;
- **Reduced regulatory speed limits** to 110km/h on motorways in the Paris region, to 70km/h where speed is usually limited to 90km/h, and to 60km/h on the Paris ring-road ;
- Established **bypass measures for heavy-good vehicles**.

Pursuing the same objective, the municipality of Paris has:

- Provided one hour **free access to Autolib'** service;
- Provided one day **free access to Vélib'** ;
- Made **parking free** for even-numbered vehicles (i.e. the use of such vehicles was not allowed on March 17<sup>th</sup>) and for residents who possess a parking card where residential parking is usually charged.

In addition, on March 17<sup>th</sup>, the French government has set up an odd/even licence plate strategy in Paris and within 22 neighbouring cities. Solely odd-numbered vehicles use was authorized (from 05:30 am to midnight). Exemptions were provided, notably for vehicles carrying at least three persons, and for electric, hybrid and natural gas motorizations.

### 1.2. First results

- Autolib', Vélib' and public transportation use

One of the most direct impacts of the anti-pollution measures is the increased use of Autolib' (+33% between March 13<sup>th</sup> and March 16<sup>th</sup>; and +60% on March 17<sup>th</sup> between 06:00 am and 02:00 pm). Moreover, a record was reached during the weekend. Over the same period, the number of daily tickets of Vélib' has increased of 61%. Commuters have benefited the most from free access to Vélib'. Actually, the number of occasional users has doubled on Thursday, Wednesday and Mondays mornings (i.e. 22,516 tickets vs. 10,071 the previous week).

With regard to public transportation use, an increase has also been observed. However, the latter increase is more difficult to estimate because of the lack of technical means to count visitors (access was authorized without the need to validate tickets).

- Acceptance and impacts of the odd/even licence plate strategy

90% of the vehicles on the roads were odd-numbered on the 17<sup>th</sup> of March and were thus allowed to circulate. The latter figure attests from a well-accepted effort. However, some perverse effects occurred. For instance, the use of an old diesel vehicle (because it is odd-numbered) instead of using a smaller (and less emitting) urban car that is even-numbered illustrates such a case. It is worth noting that if this measure was about to get permanent, such perverse effects could develop further. For instance, the one-car owners could be tempted to rent the vehicle that is allowed to circulate on a given day and so forth for the following days (particularly true in Paris where only 4% of Parisians are multi-motorized against around 20% in the Region Ile-de-France).

A reduction of traffic jams thanks to the odd/even licence plate strategy has been observed on Monday 17<sup>th</sup> of March (with a -62% congestion decrease compared to Monday 10<sup>th</sup> of March, at 02:00pm). Figure 1 below illustrates the decrease of traffic jams during the morning rush hour (top figures), and the evening rush hour (bottom figures) between Monday 10<sup>th</sup> of March (on the left-hand side) and Monday 17<sup>th</sup> of March (on the right-hand side).

FIGURE 1: TRAFFIC JAMS AT RUSH HOURS: COMPARISON BETWEEN MONDAY 10<sup>TH</sup> MARCH AND MONDAY 17<sup>TH</sup> MARCH



Source: Ile-de-France Interdepartmental Road Directorate (DiRIF), [www.sytadin.fr](http://www.sytadin.fr)

### 1.3. Discussion

Looking back to this event, a special attention must be also paid to the massive utilization of the transport network, i.e. to the additional internal costs (operational costs increase from maintenance, delays, etc.) and external costs (ex. induced congestion over certain road links and accidents due to higher presence of Autolib' et Vélib' on the roads) generated. Regarding the public transport system, a higher patronage leads to a risk of lower comfort for users, due to limited welcome capacity. To note that RATP and SNCF (the Parisian public transit and national railway operator) have added long trains on the network to absorb the expected inflow of commuters (in the range of one million supplementary seats).

Then, if the most visible effects of the measures have since been broadcasted in the medias, the real impacts in terms of fine particulate matters decrease (i.e. the initial target of the measures) are more difficult to appraise. Moreover, if a few days following the implementation of the measures, the French Air Quality Monitoring Association (AirParif) comes back on the origin of the phenomenon (and provides clearer distinctions between emissions and concentration (inspired air) ; background pollution *versus* neighboring pollution ; punctual or chronic threshold overrun (annually or daily) etc.), it alerts on the difficulty to disentangle local sources (agglomeration scale) from external explanations (regional imports) of air pollution.

Echoing to these different remarks, this note aims at shedding new lights on the effects of the measures implemented in the Paris region for tackling the smog peak (i.e. the fare-free public transport measure and alternate driving scheme). Evidences are based on a case study in the Urban Community of Lille Metropole. Indeed, the transport situation in Lille is relatively easy to transfer to Paris. The former was equally concerned by the smog alert; and mobility issues are quite similar: modal shift towards low-carbon modes and active modes (walk and bike) figures among the main objectives of the urban mobility plans; car use is dominant (particularly in Lille); and speed limits actions have been planned to be introduced along with fare-free public transport.

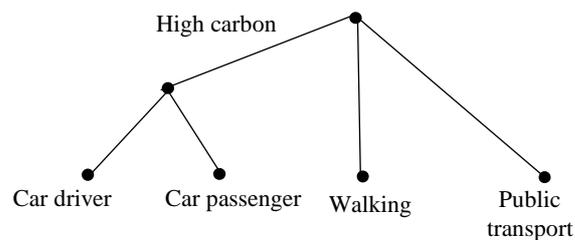
## **2. Free access to public transportation and/or restriction on circulation and air pollution : Case study in the French Urban Community of Lille Metropole**

### **2.1. The Model**

Based on the observed trips from the metropolitan area of Lille, in the Northern part of France, collected through the Household Travel Survey (HTS) of 2006, users' preferences are captured thanks to the estimation of a mode choice model. In the model, such « taste variations » of the residents in terms of traveling modes are reconstructed, both specifically to the alternatives (i.e. cost, time, etc.), to according to their socio-demographic situation (i.e. age, residential location, driving license holding, etc.) and reflecting the land use of the departing and arriving zones. To represent the variety of possibilities such variables are introduced in the utility functions of the following modal alternatives:

- Car driver and car passenger (considered as nested alternatives, that is to say as alternatives with dependent choice probabilities);
- Walking;
- Public transport (metros, tramways and buses).

The most relevant design of choice probabilities takes the form of the tree below:



The EEBT tool (Environment and Energy Budget of the internal Trips), performed by the French Environmental Agency ADEME and Transport research Institute INRETS in 2003, based on the European methodology COPERT 3, is used for computing the CO<sub>2</sub> outcomes of each simulation.

### **2.2. Simulation of free access to public transportation combined – or not – with restriction on circulation**

- Driving restriction test

Since data from the Household Travel Survey (HTS) carried out in 2006 in Lille do not enable to distinguish between odd and even numbered vehicles, one vehicle out of two is randomly selected and their owners are forced to use another traveling mode. Parking issue relative to those vehicles is not addressed here.

Driving restriction based on a vehicle's age criterion is also tested on its impact on modal shares and CO<sub>2</sub> emissions. This hypothesis comes from the following intuition: using a criterion (i.e. vehicle age) that is related to emissions would enable a greater decrease of emissions than using an arbitrary criterion (odd/even numbered). Indeed, according to the French car manufacturers (CCFA), the 10% oldest vehicles account for around 40% of emissions due to road transportation. Hence, vehicles that are older than the median age (i.e. of seven years old in the French Community of Lille Metropole) are excluded.

- Free access to public transportation simulation

Public transport prices are considered equal to zero into the utility function of this transportation mode.

- Policy scenarios

Five policy scenarios are run and compared to modal shares on the one hand and to the level of emissions on the other hand in the French Community of Lille Metropole in 2006 (i.e. the baseline situation).

- Scenario 1: Free access to public transportation (stand-alone);
- Scenario 2: Odd-even licence plate strategy (stand-alone);
- Scenario 3: restriction on circulation based on vehicle age (stand-alone);
- Scenario 4: Free access to public transportation combined with an odd-even licence plate strategy;
- Scenario 5: Free access to public transportation combined with a restriction on circulation based on vehicle age.

### **2.3. Results of simulations**

- Changes in modal shares (see Table 1 and Figure 2)

To increase the share of pedestrian trips, the only effective policy consists in controlling vehicle circulation (see the increases of the share “walk” in scenarios 2 to 5 vs. the decrease in scenario 1 “free access to public transportation), whereas providing free access to public transportation is the most efficient policy in order to increase the share of public transportation (from 6.63% in the baseline situation to 16.48% in scenario 1); although the latter share also increases when it is solely a measure of restriction of circulation that is implemented at the time (7.51% and 9.51% in scenarios 2 and 3). Furthermore, the highest share of public transportation (17.99%) is achieved when public transports are free and when restriction on circulation is based on vehicle age (scenario 5).

With regard to private car trips, providing free access to public transportation makes the share of trips by car as passenger (i.e. “share ride”) decrease (7.98% in scenario 1 vs. 10.73% in the baseline situation) while the latter share increases when vehicle circulation is limited (11.15% and 11.44% in scenarios 2 and 3). In addition, the impact of pricing policy prevails over the impact of the restriction on circulation so that the share of trips by car as passenger decreases when both of these two policies are simultaneously implemented. But, if the percentage of shared-ride trips decreases the most when public-decision makers only provide free access to public transports (7.98% in scenario 1 vs. 8.61% and 8.94% in scenarios 4 and 5), the share of car driver trips decreases more when vehicle circulation is controlled on the one hand and public transports are free on the other hand (47.01% in scenario 4 and 41.59% in scenario 5 vs. 48.94% in scenario 1).

- Changes in CO<sub>2</sub> emissions (see Table 2)

To reduce CO<sub>2</sub> emissions (assuming here that the decrease of emissions results from changes in modal shares), controlling vehicle circulation is less effective (-3.48% in scenario 2 and -9.92% in scenario 3) than providing free access to public transports (-20.74% in scenario 1). However, if public transportation is free, limiting vehicle circulation enables a greater reduction of CO<sub>2</sub> emissions (-22.76% and -27.13% in scenarios 4 and 5) than solely implementing faring policies (-20.74%). These figures highlight the policy complementarity; one policy consisting of a norm, the other one of an incentive.

## **Conclusion**

Few days following the air pollution peak in Paris agglomeration, its treatment, and first media coverage of its effects, this note provides new insights by simulating some of the adopted measures on the Metropole of Lille and extending the environmental balance to CO<sub>2</sub> appraisal.

Indeed, a high correlation is observed in our model between CO<sub>2</sub> (global pollution) on the one hand, and fine particles (local pollutants) on the other hand. If fine particulate matters constituted the major policy target of the adopted measures, the observed modal shifts have indirectly led to CO<sub>2</sub> emissions decrease too and this is quantified in our model. Our main hypothesis is that local instruments (« bottom-up » tools by contrast with « top-down » policy tools, directly intended at reducing the externality at focus – such as carbon fuel taxation in the case of CO<sub>2</sub>) actually contribute to a plurality of objectives, and that one cannot limit the appraisal to the unique particulate matters if that was the original intention of the measures (here, taking into account CO<sub>2</sub> emissions enhances the overall efficiency of the public intervention).

If the complementarity effect of combining instruments is clearly revealed in our results, the consistency and meaningfulness of the economic signal sent to car drivers is also important to consider. In this respect, implementing a regulatory instrument targeting vehicle age seems to encourage more efficiently trip-makers to leave their car (long-lasting length of the signal) for using low-carbon modes than restricting driving randomly, encouraging automobilists to change vehicles only according to the registration plate numbers. However, controlling the vehicle age is more difficult than controlling the license plate number.

One of the extensions of this case study in Lille would be to quantify local pollutants balance before/after the implementation of the measures. However, the effect of the instruments on local air pollutants (namely particles) is much more difficult to appraise than CO<sub>2</sub>, strongly depending on specific on-site conditions (type of road, motorization of vehicles and speed, outside temperature, year and month of the trip, etc.), and on several other technical determinants. Speed being at the core origin of such emissions, one interesting tool to test in priority would be the lowering of regulatory speed limits – as done subsequently on the Paris ring-road (in 1993 and 2014). Another extension of this work would be to consider in the model Autolib' and Vélib' as other modal alternatives, in order to take into account the modal transfers on such shared-modes due to the policy measures at focus.

At least, another learning from this note is the issue of societal acceptability of such a public policy. To the surprise of many politicians, the measures were relatively well perceived by the public opinion and driving restrictions on March 17 for even-numbered vehicles hasn't risen any hostility. The accompanying of this constraining measure by encouraging measures (fare-free public transport) has played a crucial role in such public acceptance. Besides, the longer the restriction on circulation, the more important the accompanying measures.

TABLE 1: MODAL SHARES (%) AND VARIATIONS (POINTS OF %; IN BRACKETS) COMPARED TO THE BASELINE SITUATION

	Walking	Public transport	Car driver	Car passenger
Baseline	26,86	6,63	55,79	10,73
1. Free access to public transportation	26,6 (-0.26)	16,48 (+9.85)	48,94 (-6.85)	7,98 (-2.75)
2. Odd-even license plate strategy <sup>a</sup>	28,97 (+2.11)	7,51 (+0.88)	52,38 (-3.41)	11,15 (+0.42)
3. Restriction on circulation (age) <sup>b</sup>	32,05 (+5.19)	9,51 (+2.88)	47,00 (-8.79)	11,44 (+0.71)
4. Free access to public transportation + Odd-even license plate strategy <sup>a</sup>	28,11 (+1.25)	16,27 (+9.64)	47,01 (-8.78)	8,61 (-2.12)
5. Free access to public transportation + Restriction on circulation (age) <sup>b</sup>	31,48 (+4.62)	17,99 (+11.36)	41,59 (-14.2)	8,94 (-1.79)

a. One vehicle out of two is taken into account  
b. Solely vehicles younger than seven years old are taken into account

FIGURE 2: MODAL SHARES IN THE DIFFERENT POLICY SCENARIOS

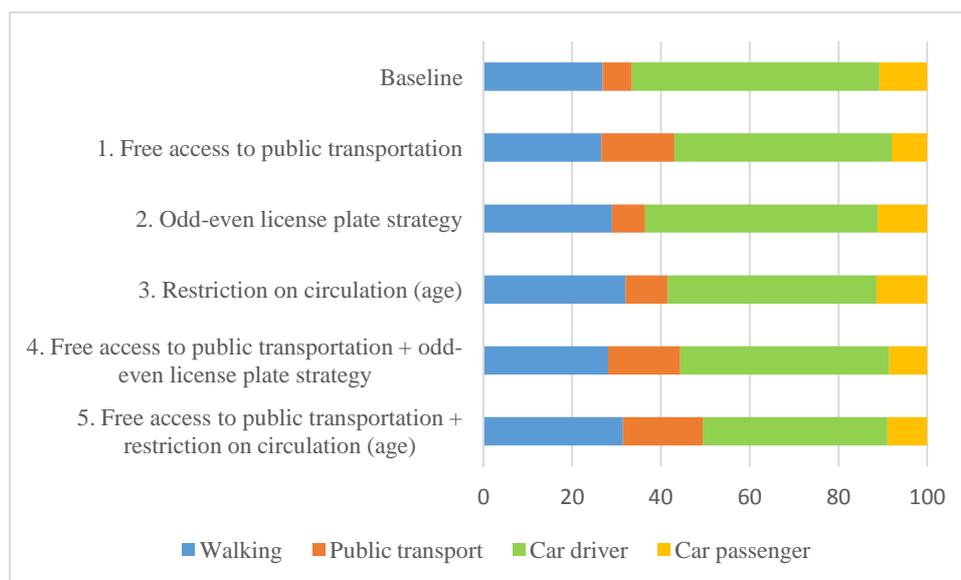


TABLE 2: VARIATIONS OF CO<sub>2</sub> EMISSIONS FOLLOWING PUBLIC POLICIES IMPLEMENTATION

	Tons of CO <sub>2</sub>	Variation
Baseline	12 229,2	
1. Free access to public transportation	9 693,2	-20,74%
2. Odd-even license plate strategy <sup>a</sup>	11 803,5	-3.48%
3. Restriction on circulation (age) <sup>b</sup>	11 098,1	-9.92%
4. Free access to public transportation + Odd-even license plate strategy <sup>a</sup>	9 507,7	-22,26%
5. Free access to public transportation + Restriction on circulation (age) <sup>b</sup>	8 911,4	-27,13%

a. One vehicle out of two is taken into account  
b. Solely vehicles younger than seven years old are taken into account