

## **EFFECTS OF THE 80 KM·H<sup>-1</sup> AND VARIABLE SPEED LIMITS ON AIR POLLUTION IN THE METROPOLITAN AREA OF BARCELONA**

The European Union (EU) establishes air pollution limits in order to prevent, avoid or reduce harmful effects on public health and the environment as a whole. Following EU guidelines and mandates, various policies have been implemented by EU member states to reduce pollution in large urban agglomerations. Various options are available to these policymakers for improving air quality in a metropolitan area, and optimizing speed limits on the roads is one such strategy for reducing the negative environmental effects of traffic. These include congestion charges, which have recently been introduced in a number of leading European cities, improving transport system or speed limit policies, among others.

Here we report an empirical evaluation of two policies implemented on motorways in the Barcelona metropolitan area. We seek to determine the environmental impact of 1) lowering the speed limit to 80 km·h<sup>-1</sup> from either 120 or 100 km·h<sup>-1</sup> and 2) introducing a variable speed system by examining improvements in air quality in terms of pollutant concentrations of NO<sub>x</sub> and PM<sub>10</sub> generated by road traffic. This paper makes various contributions to the literature. First, whereas most previous studies of the environmental impact of reducing speed limits on metropolitan motorways involve computations based on theoretically established parameters, we conduct an empirical analysis for both policy measures using air quality data. Second, we are able to undertake an empirical evaluation that is able to compare the impact in urban and interurban areas subject to speed reductions and those in which speed limits were not modified. Third, the study draws on data (speed limits as well as air quality pollutants and related information) for a much longer period (five years) than is customary in the literature. Thus, we seek to

contribute to the literature by providing a more robust and more accurate evaluation of air quality policies. Fourth, we combine an analysis of two distinct policies (fixed 80 km·h<sup>-1</sup> speed limit and a variable speed system), both pursuing similar targets, in the same geographical area using a differences-in-differences method. To the best of our knowledge, this is the first study to compare two speed policies that pursue pollution abatement.

This study is based on a database created by different entities within the regional government of Catalonia. Measurement of pollutants is reported by 15 air quality surface stations in the Barcelona metropolitan area. The time period studied extends from 2006 to 2010, and includes 1,826 temporal observations. Earlier periods are not included due to the small number of air pollutant and traffic monitoring stations in operation. 2010 is the last year for which the 80 km·h<sup>-1</sup> maximum limit was in force.

In the absence of a randomized trial, the method adopted is a slight extension of the difference-in-differences estimation procedure specified as a two-way fixed effects model. The difference-in-differences method was deemed appropriate for the following reasons: we do not need to know all the variables affecting the pollutant concentrations, it allows us to discern how much of the change is attributable to policy impact and how much would have occurred regardless of the implementation of a speed limit policy and it allows us to avoid selection bias due to unobservable factors affecting the model.

Our empirical analysis reveals that an 80 km·h<sup>-1</sup> maximum speed limit results in a deterioration in air quality, while the variable speed system improves it. The former policy increases PM<sub>10</sub> concentration by between 5.4 and 5.8%, while the latter reduces particulate matter concentration by between 11.3 and 13.5%. In the case of NO<sub>x</sub>, the 80 km·h<sup>-1</sup> speed limit increases concentrations by between 1.6 and 2.5%, while the variable

speed system reduces NO<sub>x</sub> by between 5.2 and 11.7%, the range depending on the model, method or data employed.

The implementation of variable speed systems would appear to yield far better environmental outcomes than the introduction of indiscriminate fixed maximum speed limits, at least within the ranges of speeds evaluated here. Our empirical evidence suggests the need to extend the variable speed limit system, as opposed to fixing maximum limits, in congested areas in order to decrease air pollution.