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Smeed's law and expected road fatality reduction: An assessment of the Italian case

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ABSTRACT

Introduction: Smeed's law defines the functional relationship existing between the fatality rate and the motorization rate. While focusing on the Italian case and based on the Smeed's law, the study assesses the possibility for Italy of reaching the target of halving the number of road fatalities by 2020, in light of the evolving socio-economic situation. *Method:* A Smeed's model has been calibrated based on the recorded Italian data. The evolution of the two indicators, fatality and motorization rates, has been estimated using the predictions of the main parameters (population, fleet size and fatalities). Those trends have been compared with the natural decreasing trend derived from the Smeed's law. *Results:* Nine scenarios have been developed showing the relationship between the fatality rate and the motorization rate. In case of a limited increase (logistic regression) of the vehicle fleet and according to the estimated evolution of the population, the path defined by motorization and fatality rate is very steep, diverging from the estimated confidence interval of the Smeed's model. In these scenarios the motorization rate is almost constant during the decade. *Conclusions:* In the actual economic context, a limited development of the vehicle fleet is more plausible. In these conditions the target achievement of halving the number of fatalities in Italy may occur only in case of a structural break (i.e., the introduction of highly effective road safety policies). *Practical application:* The proposed tools can be used both to evaluate retrospectively the effectiveness of road safety improvements and to assess if a relevant effort is needed to reach the established road safety targets.

1. Introduction

The fatality rate is the benchmark according to which road safety conditions of a country can be measured. Its evolution measures the gradual improvements (or deteriorations) of road safety. In a cross sectional analysis, Smeed observed that the increase of motorization in a country leads to a decrease in the fatality rate defined as the ratio between the deaths and the vehicle fleet size, according to a mathematical formula named Smeed's law (Smeed, 1949). Points are located on a curve, described in most cases by a hyperbola equation:

$$\frac{D}{N} = \alpha\left(\frac{N}{P}\right)^{\beta}. \quad (1)$$

With:

D	Number of annual road deaths;
N	Fleet size;
P	Population.

D/N and N/P ratios identify respectively the fatality and motorization rates, whereas α and β are the calibration coefficients of the model.

Smeed found a close connection between the observed data and his theoretical model, finding the following values for the coefficients α and β:

α	0.0003
β	−2/3.

Smeed's law can be used for analyzing the phenomenon evolution. The higher the motorization rate in a country, the less is the fatality risk.

In 1980, John Adams revised the Smeed's law (Adams, 1987) and concluded that the total vehicle distance traveled, expressed in vehicle-kilometers, identifies better the conditions to risk exposure.

Several studies analyzed the relationship between road fatalities and their determinants using a range of socio-demographic, economic, environmental, and policy-related variables in order to better predict road safety outcomes in a country (Adams, 1987; Fridstrom et al. 1995; Kopits & Cropper, 2005; Dupont, October 2014). A recent study (Koren & Borsos, 2010) found that Smeed's formula describes reasonably well the change in fatalities up to the 0.2–0.3 vehicles/person motorization rate, whereas above this level the formula seems to

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overestimate the fatality rate. The fatality rate trend can be influenced by external events (e.g., introduction of new laws and/or technological revolutions) that can potentially introduce strong deterrent effects and/or drastic improvements to the safety conditions. Kopits and Cropper (2005) showed that, in developing countries, the rate of growth in vehicle ownership increases more rapidly than the reduction of the fatality rate. However, in industrialized countries, motorization rate tends to increase at a slower rate than the rate of reduction in the fatalities per vehicle.

During the last decade Italy has succeeded to significantly reduce road fatalities from 7096 in 2001 to 4090 in 2010 with an average annual rate of almost 6%. In this period the vehicle fleet and the traffic

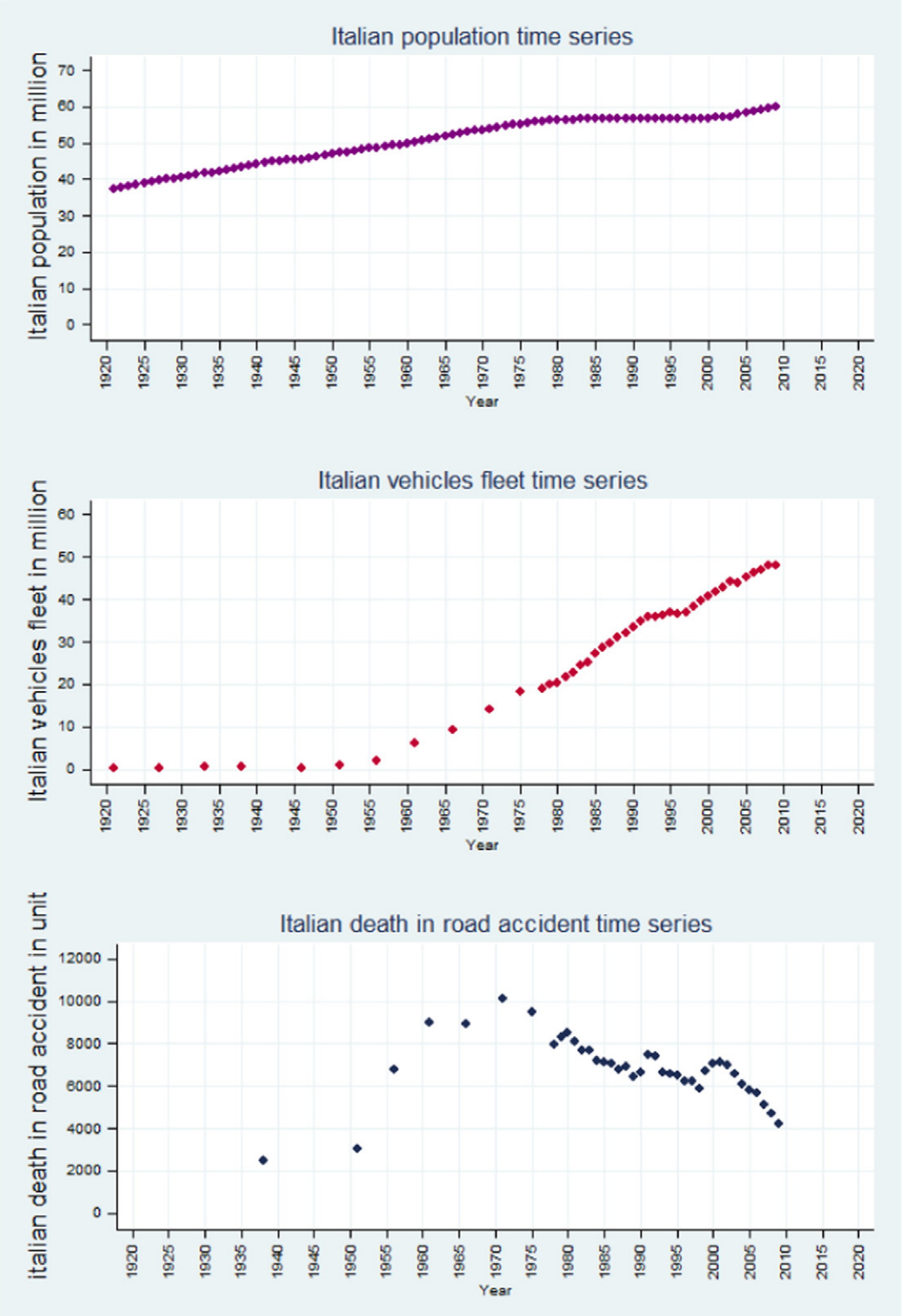

Fig. 1. Graphical view of the historical trend of the three basic macro-aggregates.
Source: ACI and ISTAT.