The influence of road, vehicle and driver characteristics on the circumstances that cause traffic accidents

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Problem statement

Traffic accidents directly impact on the social and physical environment; for this reason, scientific research is particularly oriented to such a topic. During the last year, road accidents produced in Italy about 20 billion EUR, corresponding to 1.1% of the national Gross Domestic Product (GDP) (ACI, 2017).

Most of the studies presented in the literature focused on the accident severity in terms of human fatalities and injuries. In particular, the factors influencing accident severity are investigated in order to reduce it. Various authors adopted different kinds of mathematical models for identifying the weights of the different factors on the severity of an accident. As an example, Al-Ghamdi (2002) used the logistic regression and found that accident location and cause of accident are significantly associated with a fatal accident. de Oña et al. (2013) used Latent Class clustering to identify key factors affecting accident severity; they found that the combined use of both techniques reveals further information that would not have been obtained without a prior segmentation of the data. Dissanayake (2014) adopted a logistic regression for comparing the severity affecting factors between young and older drivers involved in single vehicle crashes. Other studies were instead oriented towards drivers' accident risk perception evaluation, with the aim to identify the key factors that affect risk perceptions and driver's behaviour (Eboli and Mazzulla, 2008; Machado-Leon et al., 2016; de Oña et al., 2014; Cardamone et al., 2014; Eboli et al., 2017).

Differently from the major part of the studies analysing factors influencing traffic accidents, this study focuses on the circumstances causing traffic accidents. More specifically, in order to give an original contribution to the literature, this study suggests a methodology for analysing which characteristics of road, driver and vehicle produce certain circumstances that lead to the traffic accidents.

Research objectives

The present work focuses on the accidents involving two vehicles, and has the objective to determine how road, vehicle and driver characteristics affect the presumed circumstances of an accident due to traffic problems. When a traffic accident between two vehicles happens, the operations of the vehicles involved are detected by the police and refer each to a vehicle. These operations correspond to the presumed circumstances and can be related to the traffic accident.

The study is implemented on the data of traffic accidents occurred in Italy during 2016 (Istat, 2018).

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Methodological approach

The influence of road, vehicle and driver characteristics on the presumed circumstances of the accident due to traffic problems will be investigated using a Logistic Regression model, a regression method applied when the dependent variable Y is dichotomous. Therefore, the method of regression function estimation joins the probability that the response takes the value of 1 with a set of explanatory variables (Fabbris, 1997). The explanatory variables X_k can be dichotomous, nominal, ordinal or quantitative.

While in the linear regression the estimation of the Y variable has value between $-\infty$ and $+\infty$, in the logistic regression the estimation of Y varies between 0 and 1, and assumes the meaning of probability that Y takes the value of 1 as a function of the explanatory variables X_k. When the variables are of a qualitative nature, the β_k coefficients are estimated by the *Maximum Likelihood* method, which provides the parameter values maximizing the probability of observing the experimental data set.

The data referred to accidents between two vehicles were selected from the whole database. By analysing the data, a certain number of most frequent combinations of circumstances were obtained. More specifically, we selected the accidents where vehicle A proceeded regularly whereas vehicle B proceeded with an incorrect driving behaviour. Particularly, five circumstances were considered, namely vehicle B proceeded: (1) with distracted driving and undecided pace; (2) without maintaining the safety distance; (3) with speeding; (4) by manoeuvring to get into the circulation flow; (5) against the flow.

All the explanatory variables were defined as dichotomous where the values 1 and 0 were established as reported in the following. Road surface: dry (1), other conditions (0); vehicle: car (1), other vehicles (0); year of vehicle registration: after 1996 (1), before 1996 (0); driver age: <45 years (1), >45 years (0); gender: male (1), female (0); driver license: car license (1), other license (0); license issue year: after 2006 (1), before 2006 (0).

Expected results

The methodology was implemented on the data of traffic accidents occurred on the Italian roads during 2016; the final dataset consists of 12,186 records.

The survey, similarly to what happens in other European countries, was carried out with the collaboration of public bodies with local expertise (traffic police, local or municipal police, and other bodies) that have the possibility to collect elements characterising traffic accidents. The survey was performed by recording the data and sending a file containing the information filling out a paper questionnaire. All traffic accidents involving stationary or moving vehicles and from which injuries have been caused to persons were recorded. Claims from which injured persons that did not occur in areas open to public traffic, and claims in which no vehicles are involved are excluded from the survey. The survey refers to the time when the incident occurred. Definitively, each record of the database is the single road accident with injured persons, where information on violations of the rules of the roads is included as a support of the traditional indicators on road accidents.

As reported in table 1, accidents mainly occurred on straight road (80.4%), whereas the most common type of accident results the rear-end collision (42.7%). The majority are non-fatal accidents (98.6% of no dead within 24 hours; 99.8% of no dead within 30 days). In accidents with injured persons, the most frequent number of injured is 1 (64.9%).

Table 1: Accidents characteristics

Tract	Straight road (80.4%); Curve (16.3%); Bump, bottleneck (0.8%); Slope (1.9%); Lit tunnel (0.5%); Unlit tunnel (0.1%)
Road surface	Dry (82.3%); wet (16.7%); slippery (0.6%); icy (0.3%); snowy (0.2%)
Type of accident	Frontal collision (11.3%); Front-side collision (30.0%); Side collision (16.0%); Rear-end collision (42.7%)
Dead within 24 hours	0 (98.6%); 1 (1.2%); 2 (0.1%); 3 (0.1%)
Dead within 30 days	0 (99.8%); 1 (0.2%)
Injured persons	0 (0.5%), 1 (64.9%); 2 (23.5%); 3 (7.1%); 4(2.5%); 5(0.8%); >5 (0.7%)

Table 2 and table 3 show the characteristics of vehicles and drivers that collide.

Table 2: Vehicle and driver characteristics

Vehicle	Car (76.0%); Bus (0.8%); Truck (8.6%); Motorcycle (13.3%); Other vehicles (1.2%)
Year of vehicle registration	Before 1996 (4.6%); After 1996 (95.4%)
Driver's age	<18 (0.8%); 18-29 (26.8%); 30-44 (35.3%); 45-54 (23.2%); 55-64 (13.8%); >64 (0.1%)
Driver's gender	Male (72.8%); Females (27.2%)
Driver's license	Motorcycle license (4.6%); Car license (86.1%); Heavy vehicle license (9.1%); Driving license not required (0.2%)
License issue year	Before 1987 (5.6%); 1987-1996 (10.0%); 1997-2006 (14.9%); 2007-2016 (69.5%)
Driver's injury	Unharmed (57.7%); Injured (41.6%); Dead within 24 hours (0.6%), dead within 30 days (0.1%)

Five different models were calibrated, where the dependent variable in each model was represented by a dichotomous variable explaining each of the five different circumstances. In all the models, the independent variables are the same. Preliminary results showed a significant difference between young and older drivers, expert and non-expert drivers and professional and non-professional drivers. Also road surface and vehicles conditions have been found as characteristics influencing driving behaviour.

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