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Impact of provincial characteristics on the number of traffic accident victims on interurban roads in Spain☆

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ABSTRACT

This study has two aims. The first is to determine how various factors impact on the number of fatalities, serious injuries and slight injuries adjusted for the level of traffic on interurban roads in Spain. The second is to establish the number of victims per million vehicle-kilometres (veh-km) travelled on interurban roads in each province resulting from the effect of its specific characteristics. To this end, we developed six fixed effect panel data models with panel corrected standard errors for the 1999–2015 period. Our results show that while the proportion of high capacity roads, the unemployment rate and the motorization rate contribute to a reduction in the number of fatalities, serious injuries and slight injuries adjusted for level of traffic, the penalty-points licence system is effective in reducing the number of fatalities and serious injuries but not the number of slight injuries. Furthermore, the specific conditions in Ávila, Toledo, Madrid, Santa Cruz de Tenerife, Las Palmas de Gran Canaria, the Balearic Islands, Lleida and all the provinces on the Mediterranean coast cause a higher number of victims per million veh-km travelled than in the remaining provinces. Thus, greater public investment and more socially responsible behaviour are essential tools for reducing the number of traffic accident victims on Spanish interurban roads. Moreover, the provincial institutions emerge as key agents in improving road safety, due to their greater knowledge of the specific conditions and factors affecting each province.

1. Introduction

Traffic crashes are one on the major causes of death across the world. According to the World Health Organisation (WHO) in their 2009 and 2013 Reports on Road Safety, more than one million people per year die as a result of traffic crashes (WHO, 2009, 2013). Furthermore, these reports reveal that each year between 20 and 50 million people suffer injuries or trauma due to traffic crashes (WHO, 2009, 2013). Crashes are currently the eighth leading cause of death globally and the leading cause for young people aged 15–29. If no major effort is made to reduce these figures, current trends suggest that by 2030 road traffic deaths will become the fifth leading cause of death globally (WHO, 2013).

In the light of these figures it is not surprising that many authorities claim that road traffic crashes are a public health problem requiring special attention (Plasència and Cirera, 2003; WHO, 2004). Organizations such as the World Bank, the United Nations and the WHO have published reports highlighting the seriousness of the problem and proposing measures to reduce the number of accidents (WHO, 2004). The situation not only causes public health problems but also impacts on countries' economic and social systems. Many studies have aimed to identify the effect of traffic crashes on healthcare, economic and social costs (Alfaro et al., 1994; Gómez-Restrepo et al., 2014; López Bastida et al., 2004; Shen and Neyens, 2015). The relationship between traffic accidents and the economic cost to social and health services is one of our future research lines.

The deaths and injuries caused by traffic crashes need to be eradicated, and, as in all problems, the first step to finding a solution is to identify the underlying factors, conditions and variables. This information provides countries with guidelines to help them establish measures to reduce the effect of traffic crashes. However, when studying the factors associated with traffic accidents, it must be taken into account that the determinants of individual cases of a health problem may not be the same as those of the incidence rate for that same problem (Rose, 1985).

A large number of factors have been utilized over the last 20 years to attempt to explain accident rates in different countries. One of the most widely used variables is the level of exposure, expressed in the total number of kilometres travelled by vehicles (Aparicio Izquierdo et al., 2013; Blum and Gaudry, 2000; Fournier and Simard, 2000;

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Fridstrøm and Ingebrigtsen, 1991; Jaeger and Lassarre, 2000; McCarthy, 2000; Tegnér et al., 2000; Van den Bossche and Wets, 2003). These studies suggest a positive relationship, which means the greater the level of exposure, the greater the risk of accidents. A number of studies incorporate various demographic factors in order to analyse the level of exposure, using different indicators (Campos, 2003; Fridstrøm, 2000; Grimm and Treibich, 2013; Tolón-Becerra et al., 2013). The impact differs according to the variable selected.

The economic conditions of a country are related to accident rates. Consequently, many works use different variables to analyse this relationship and its impact (Aparicio Izquierdo et al., 2013; Fournier and Simard, 2000; Fridstrøm, 2000; Grimm and Treibich, 2013; Jaeger and Lassarre, 2000; McCarthy, 2000; Rivas-Ruiz et al., 2007; Tolón-Becerra et al., 2013; Van den Bossche and Wets, 2003). On one hand, gross domestic product or income-related indicators are also included in many models, intuitively accepting a positive relationship between economic conditions and accident rates. On the other, the unemployment rate is negatively related to traffic accidents.

Public investment both in highways and the healthcare system (Aparicio Izquierdo et al., 2013; Campos, 2003; Castillo-Manzano et al., 2014; Fridstrøm, 2000; Fridstrøm and Ingebrigtsen, 1991; Grimm and Treibich, 2013) are included in models to analyse their impact on the number of accidents, with an expected negative relationship.

The impact of weather conditions on accident rates cannot be ignored. It is one of the most commonly used factors in the studies in our review of the literature, with variables including different meteorological aspects such as mean precipitation, hours of sunlight in a specific location, snowfall or temperature (Fournier and Simard, 2000; Fridstrøm, 2000; Fridstrøm and Ingebrigtsen, 1991; Fridstrøm et al., 1995; Jaeger and Lassarre, 2000; McCarthy, 2000; Rivas-Ruiz et al., 2007; Van den Bossche and Wets, 2003). The impact differs according to the variable selected.

A clear relationship exists between infrastructure quality and accident rates. Consequently, the length of the road network or the proportion of a certain type of interurban road are included as explanatory variables, with the relationships revealed differing according to the variable selected (Aparicio Izquierdo et al., 2013; Campos, 2003; Fridstrøm, 2000; Grimm and Treibich, 2013; Jaeger and Lassarre, 2000; Tegnér et al., 2000; Tolón-Becerra et al., 2013).

Finally, a large number of studies analyse the effect of changes in legislation on traffic and road safety (Blum and Gaudry, 2000; Fournier and Simard, 2000; Fridstrøm, 2000; McCarthy, 2000; Tegnér et al., 2000; Van den Bossche and Wets, 2003). The legislation included in these variables ranges from measures related to the use of helmets or seat belts to those concerning changes in speed or alcohol limits. In recent years, a commonly used variable is the introduction of the penalty-points driving licence. Many studies have found a negative association between this measure and the number of traffic accidents in countries where the system has been implemented (Aparicio Izquierdo et al., 2011; Castillo-Manzano and Castro-Nuño, 2012; Castillo-Manzano et al., 2010).

Drawing on our review of the literature, we propose two aims. The first is to determine how various factors impact on the number of fatalities, serious injuries and slight injuries adjusted for the level of traffic on interurban roads in Spain. The second is to calculate the number of victims per million vehicle-kilometre travelled (MKVT) on interurban roads in each province resulting from the effect of provincial characteristics. To achieve these two aims, we develop six fixed effect panel data models. This econometric technique allows us to examine the effect of different variables on the type of victims and obtain the number of victims resulting from each province's specific conditions or characteristics.

This study makes two new contributions to the literature. The first is our research on the impact of the same group of variables on different types of traffic accident victims. The second is the geographical distribution of the number of victims resulting from the specific conditions of each province, broken down by the severity of injury. Our results are not only of benefit to the literature but also to the institutions responsible for directing road safety policy. On one hand, the models demonstrate that not all the variables have the same impact on the three types of victims and, hence, the introduction of measures to reduce the number of road accidents might have contrasting effects depending on the type of victim analysed. On the other, the differences in the number of victims resulting from the specific characteristics of each province provide a starting point for a review of road safety policy in Spain, which should give greater planning autonomy to the provincial institutions, since they possess greater knowledge of the specific conditions of their own province. The improvements which might thus be obtained would positively impact on public health and the economy in the provinces and in Spain as a whole.

This work is organized as follows: Section 2 includes the empirical approach, explaining the configuration of the database and the choice of the econometric model. Section 3 sets forth the results and discussion. Section 4 proposes the main conclusions.

2. Empirical approach

The econometric models were created using annual data from 1999–2015 for all the Spanish provinces, excepting Ceuta and Melilla, which due to their reduced size, distort the study. The choice of frequency and period was determined by the availability of data on the variables. Table 1 shows the main characteristics of all the variables

Table 1
Variables used in empirical analysis.

Name	Description	Mean	SD
Dependent variables			
Fatalities per MVKT (1), (2)	Number of fatalities per MVKT	0.015	0.009
Serious injuries per MVKT (1), (2)	Number of serious injuries per MVKT	0.060	0.037
Slight injuries per MVKT (1), (2)	Number of slight injuries per MVKT	0.236	0.087
Independent variables			
Penalty-points driving licence (4)	Dummy variable taking the value 1 in all provinces in the period in which the penalty- points licence is implemented	0.588	0.492
Traffic volume (2)	Number of vehicles per year that travel on interurban roads in each province, expressed in thousands	1549.815	1250.231
Motorization rate (1), (3)	Number of vehicles per 1000 inhabitants	632.410	81.871
Annual variation in population density (3), (5)	Annual variation in the number of inhabitants per square kilometre	1.047	2.845
Unemployment rate (3)	Percentage of jobless in relation to the working population	15.570	8.175
Precipitation (5)	Total volume of precipitation in millimetres	559.827	341.130
Proportion of high capacity roads (2)	Percentage of high capacity roads in relation to total number of road kilometres	8.948	5.048
Investment in replacement per km of road (2)	Investment in replacement interurban roads expressed in thousands of €/kilometre	13.358	8.970
Investment in construction per km of road (2)	Investment in construction of interurban roads expressed in thousands of €/kilometre	27.558	24.521

(1) Directorate General for Traffic (DGT); (2) Ministry of Public Works and Transport; (3) National Statistics Institute; (4) National Legislation (5) MAGRAMA.