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Looking for traces of the Troika's intervention in European road safety

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A B S T R A C T

The recent economic crisis has required the bailout of some European States by the so-called *Troika*, with capital injections accompanied by financial austerity. This paper analyzes econometrically the impact of this support programme on road safety for an original panel data (1995–2015). The findings also corroborate the *Kuznets curve hypothesis* for traffic accidents in the long term. Regarding the impact of intervention in the short term, despite reductions in safety policy budgets due to austerity, financial support, and related austerity measures might have led to an improvement in road safety, reducing both the number of accidents and fatalities. Therefore, it seems that our result is more linked to the austerity measures than to the financial support given by the *Troika*.

1. Introduction

The origins of the recent financial and economic crisis can be traced back to around 2007, when the subprime mortgage bubble burst in the United States. It was triggered by the collapse of the Lehmann Brothers investment bank in 2008 (European Commission, 2018a; Mc Donald, 2016; Orviska and Hudson, 2017) and then rapidly expanded to other countries and had a major impact in the European Union-28 (EU-28).

Focusing on the European case, the EU-28 Gross Domestic Product (GDP) remained constant (at current prices) between 2008 and 2011, whereas there has been an enormous reduction in GDP at constant prices. Moreover, the crisis led to governments, European Central Bank, European Commission and other institutions (e.g., International Monetary Fund) baling out many actors in the European banking system, as well as other measures, such as quantitative easing (Frank et al., 2008; Frank and Hesse, 2009; Orviska and Hudson, 2017) and direct financial support (European Commission, 2018b). Not only financial institutions but also some States needed financial support from International Institutions to stabilize their accounts and balance sheets. Capital injections were accompanied by the intervention of the so-called *Troika* (the decision group formed by the European Commission, the European Central Bank, and the International Monetary Fund).

Geographically, the countries most impacted by the crisis because of their debt-to-GDP ratio, unemployment, and deficit (Sapir et al., 2014) and because of the *Troika*'s intervention, were those on the European periphery, especially those in the Mediterranean, as can be seen in Table 1. In fact, the mass media and academia have on occasion described the differential situation from this geographical perspective and distinguished between the creditor countries in central and northern Europe and debtor countries on the periphery (Cardao-Pito, 2017; Gutiérrez et al., 2013), with the most insulting version branding the latter as the PIGS (Portugal-Ireland-Greece-Spain).

One consequence of financial intervention was the implementation of austerity (*austericity* for some of its critics) in Public Finances (European Commission, 2018b; Sapir et al., 2014). The academic literature has addressed the effect of financial intervention on a country and the impact of the subsequent austerity measures in many socio-economic areas such as education (Chalari, 2016); care for vulnerable people (Janssen et al., 2016); and even direct reductions in the population's spending power and well-being (Botezat, 2017; Hespanha, 2015). This impact has also been seen in healthcare, where many studies empirically demonstrate that a relationship exists between austerity measures and a decline in mental and physical health (Borisch, 2014; Ifanti et al., 2013; Quaglio et al., 2013) and an increase in the suicide rate (Antonakakis and Collins, 2015). Therefore, the financial intervention and its accompanying austerity measures may well have impacted other specific areas of public spending whose links with road traffic accidents have previously been addressed in the academic literature, such as, for example:

a) Budget reductions as part of austerity programs for traffic safety policies (traffic enforcement or advertising) (Chen et al., 2012;

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Table 1
Financial Intervention to EU countries.
Source: Prepared by authors based on European Commission (2018b)

Country	Support period	Remarks
Cyprus	2013–2016	€10bn financial support starting in 2013. Program ended in March 2016 after improvements to public finances and return to sustainable economic growth.
Greece	2010-ongoing	Most significant *Troika* financial support program. Nearly €300bn in the two first phases (2010–2014) and subsequent continuous implementation of European Stability Mechanism.
Ireland	2010–2013	Second largest support program (after Greece). €85bn received. First country to recover after financial support and austerity program.
Portugal	2011–2014	Third largest *Troika* support program. €75bn received. *Troika* adjustment program ended, and post-program monitoring begun in June 2014.
Spain	2012–2015	Not included in *Troika* economic full support program. However, included in this study as the largest EU recipient country under the European Commission Financial Intervention program.

Dadashova et al., 2016; Jessie and Yuan, 1998; Krüger, 2013; Traynor, 2009) and for road network maintenance and expansion that have had negative effects, as proven in Nguyen-Hoang and Yeung (2014).

b) Worse post-traffic accident healthcare attention due to a reduction in health budgets (Borisch, 2014; Ifanti et al., 2013), also as part of austerity programs.
c) Worse vehicle stock due to the reduction in fiscal incentive policies for vehicle renewal and, in a more general sense, due to a reduction in household transport expenditure. This has resulted in vehicles that are, on average, older, and less well and more cheaply maintained (Cascajo et al., 2018).
d) Psychological effects of the austerity measures due to their communication to public opinion in the media (Antonakakis and Collins, 2015; Vandoros et al., 2014, 2018), which might lead to riskier driving behavior. However, the population of a country under financial intervention is more aware of the economic situation and reacts with more responsible behavior and a risk avoidance driving style that involves lower alcohol consumption and speed in order to avoid fines and save fuel (Lloyd et al., 2015; Noble et al., 2015; Petrou, 2019).
e) Medium- and long-term effects on factors that are more difficult to measure directly, such as the lower quality of the education system and even the judicial system, which may ultimately affect road user behavior and traffic law enforcement.

However, no studies have been found that use econometric tools to focus on the financial bailouts of countries by international institutions, and their associated austerity measures with cutbacks to the above-mentioned budget items, impact road safety, and that is the purpose of this paper.

Nevertheless, and contrary to the above-described effects, it might be thought *a priori* that Financial Intervention to the affected countries and cutbacks in public spending would worsen their economic situation. This would imply less mobility on roads and, as a result, less risk exposure, thus generating a positive externality in the shape of improvements to road safety indicators (see, for example, Rodríguez-López et al., 2016 and Wiklund et al., 2012 on the correlation between the economic cycle and road traffic accidents and fatalities according to the behavior of economic activity-related factors such as risk exposure and mobility; or Toffolutti and Suhrcke, 2014 on road safety in the EU-28 during the latest economic and financial crisis). Again, this influence of driving behavior and exposure on traffic safety during the economic crisis has been thoroughly analyzed by other research papers. Specifically, Chi et al. (2013) find evidence that points to rises in fuel prices during this crisis triggering traffic safety improvements and Kweon (2015) empirically demonstrates that both price and unemployment increases are related to traffic safety improvements. Attending to the mechanisms behind the changes, He (2016) finds that a decrease in mortality is caused by a change in driving behavior rather than any changes in exposure. This is in line with Brüde and Elvik (2015), who associate the long-term reduction in traffic fatalities for the USA and Denmark with the speed limits imposed in response to the 1973/74 energy crisis. However, Lloyd et al. (2015) find that both factors (reduction in exposure and changes in driving behavior such as alcohol drinking avoidance) are significant for the UK during the recent financial crisis. Special attention is given to Yannis et al. (2014), who provide a very comprehensive and rigorous analysis of the topic, and Noland and Zhou (2017), who analyze the evolution of traffic fatalities during recession in the USA. Results point in the same direction in both cases: economic recessions create positive externalities (lower mobility, risky avoidance behavior, efficient driving) that lead to an improvement in traffic safety and smooth the negative factors (mainly, lower budgets for Traffic Departments and Infrastructure investment and maintenance).

As different types of effects have coincided, this paper seeks to test, on the one hand, whether, in the context of the recent economic crisis experienced by European countries, the financial support provided to peripheral States has resulted in any effects on road safety that might have to any extent countered the general improvement that has come from the economic crisis (Bergel-Hayat and Christoforou, 2013; Noland and Zhou, 2017), which was exacerbated by intervention; and, on the other hand, whether, considering the overall effects of the intervention, this has had any influence on the long-term relationship between the economic cycle and road safety, as addressed in the literature and summarized in the theory known as *Kuznets curve hypothesis*. According to this curve, the relationship between traffic safety and economic activity (commonly measured by GDP) is an inverted-U shape: due to the rapid expansion of the motorization rate in the first phases of economic development, risk exposure rapidly rises, leading to higher accident and fatality rates (Elvik, 2010; García-Ferrer et al., 2007; Kopits and Cropper, 2005). However, once a certain level of development is reached, fatality rates decrease, as a result of improved infrastructure and vehicles, better health assistance, and the Administration's application of more effective road safety policies that lead to higher skills and safety awareness among drivers and other stakeholders (Castillo-Manzano et al., 2014; Török, 2015).

Our hypothesis states that, a priori, the intervention and austerity measures subsequently imposed by the Troika could have had a clear negative effect on the countries under intervention, specifically by increasing the numbers of traffic accidents on their roads on account of the following factors: budget reduction for safety policies; worse post-traffic accident healthcare attention due to a reduction in health budgets; worse and older vehicle stock; and even negative psychological effects as a result of the harsh impact of the crisis on people's personal and professional expectations. This effect would be separate from and should compensate—at least in part—for the lower traffic accident rate sparked simply by less risk exposure in these countries due to the greater decline in the GDP

This could theoretically affect the way that the countries under intervention have evolved during the economic crisis and the shape of the above-described *Kuznets curve*. This research, therefore, aims to answer the following research questions:

- Did financial intervention have a negative impact on road safety?
- Did financial intervention attenuate or intensify the effects of that the crisis *per se* would have had on safety?
- Does financial intervention affect the long-term behavior predicted by the *Kuznets curve hypothesis*?

In light of the above, this paper is organized as follows: after the introduction, Section 2 describes the chosen methodology and the variables and data used in the analysis. Section 3 gives the results of the econometric analysis, which are assessed and linked to the scientific bibliography. Section 4 sets out the main conclusions of the research and is followed by the references.

2. Empirical framework: data, variables, and methodology

Using available official data, panel data were constructed *ad-hoc* for a sample made up of the EU-28 countries, with particularly close attention paid to States on the geographic periphery that had received financial support from the *Troika*. The period of analysis spans from 1995 to 2015. Time coverage includes the pre-crisis, crisis and recovery periods and is sufficiently broad for reliable available data to be obtained for most of the analyzed countries. Two models are estimated to exploit these data. Total traffic fatalities and total road traffic accidents are used as endogenous variables with the same exogenous variables.

Panel data have been econometrically treated with the STATA package using an econometric model that takes country i during period t in Eq. (1)[1] (variables defined below).

$$\text{Ln}\,(\text{E}\,[\text{Y}_{it}]) = \alpha + (\beta_k + \beta'_k \text{int}_{it})\text{X}_{it} + \gamma_k \text{Z}_{it} + \nu_t \text{Year}_t + \delta_i \text{Country}_{it} + \zeta \text{int}_{it}\,\nu + \varepsilon_{it,} \quad (1)$$

As a consequence of the advantages introduced in the following lines, we chose a micro-panel approach instead a macro-panel one, even though for our case, amount of countries is not much lower than years. However, following Antoniou et al. (2016), our panel cannot be clearly classified in any of the groups (as a period of 20 years falls between "Small" and "Large" time categories). As the objective of the paper is in a treatment evaluation framework, we have opted to include the country fixed effects in our model using N-2 dummy variables. This follows the approach introduced by Allison and Waterman (2002) and successfully used previously in the Traffic Safety scientific literature by Castillo-Manzano et al. (2015) and Gilpin (2019). In addition, Hausman tests were performed and led to the use of random effects models being discarded and reinforced the choice of Country Fixed Effects that have also allowed us to control for time-constant unobservable factors (Verbeek, 2000).

In this regard, we applied the logic of differences in differences (DiD), which is a common methodology employed in the treatment evaluation framework (see Angrist and Pischke, 2009; Gertler et al., 2016 for details). The identification strategy in a DiD analysis relies on collecting data for two groups of observations over several years; one group affected by the treatment/policy at some point in the considered period, with the other group, the control group, not affected by the policy.

In this context, one essential element of the DiD analysis is the inclusion of country fixed effects.

As mentioned previously, the main purpose of this paper is to assess the impact of the *Troika*'s financial interventions on road safety. So, Eq. (1) becomes (2) when a country has not received any Financial Intervention and (3) when it has.

$$\text{E}\,[\text{Y}_{it\_noint}] = \exp\,[\alpha + \beta_k \text{X}_{it} + \gamma_k \text{Z}_{it} + \nu_t \text{Year}_t + \delta_i \text{Country}_{it} + \varepsilon_{it}] \quad (2)$$

$$\text{E}\,[\text{Y}_{it\_int}] = \exp\,[\alpha + (\beta_k + \beta'_k)\text{X}_{it} + \gamma_k \text{Z}_{it} + \nu_t \text{Year}_t + \delta_i \text{Country}_{it} + \zeta + \varepsilon_{it}] \quad (3)$$

Thus, the total change in the behavior of a country that has received financial support is expressed in Eq. (4).

$$\text{E}\,[\text{Y}_{it\_int}] = \text{E}\,[\text{Y}_{it\_noint}] \cdot \exp[\beta'_k \text{X}_{it} + \zeta] \quad (4)$$

All the considered control variables are based on factors typically analyzed in previous road safety studies of EU-28 countries (Albalate and Bel, 2012; Castillo-Manzano et al., 2013, 2014, 2015, 2016; Dee, 1999; and Tolón-Becerra et al., 2013). Table 2 describes the considered variables and the sources from which they have been taken, and Table 3 gives the variables' descriptive statistics.

a) Y_{it} are explained road safety variables for either the total number of traffic accidents or the total number of traffic fatalities (within the following 30 days, according to the Vienna Convention). As explained in Section 3, totals have been chosen instead of per capita variables due to population being used as an exposure variable in the model. As shown in Table 3, accident data are taken from a single source (UNECE). However, different definitions of accidents may be considered in different countries (the UNECE database is fed by CARE EU and directly by national databases in some cases). So, as recognized directly by the European Commission (2018c), this heterogeneity may be considered in outcome interpretation. This is the reason why we have also analyzed fatalities, for which a more homogeneous definition exists.
b) X_{it} contains each country's vector of economic attributes (measured by GDP per capita and GDP squared per capita). GDP per capita is used to test a potential relationship between economic development and road traffic safety. As mentioned in the Introduction section, the relationship between economic development and traffic safety is usually positive and linear (Kopits and Cropper, 2005). Nevertheless, once a certain income level has been reached, this relationship can be reduced or even reversed (Bishai et al., 2006). In this article, both GDP per capita and GDP squared per capita are considered as exogenous variables to model any possible change in dynamics after a specific level of development.
c) Z_{it} are control variables that measure:
d) c.1 road safety policies (alcohol consumption limits, implementation of a points-based driving license system, speed limit, and a dummy variable to model the change in measures in Romania with the inauguration of a new Traffic Safety ofice in 2005)[2] .
e) c.2 demographic parameters (median age of the population, population density). With respect to the population, a variable is included for the median age of the population in each of the countries to model differences in driving behaviors for different ages. According to the existing scientific literature (such as Kanaan et al., 2009; Keall et al., 2004; Prat et al., 2015; Wegman et al., 2017), the youngest drivers present riskier behavior and greater drugs and alcohol consumption and therefore contribute by raising the likelihood and severity of accidents. The elderly population has been demonstrated to have a positive influence on traffic safety (according to Albalate et al., 2013); however, fatality is expected to be higher with elderly drivers as this collective is more vulnerable since they are frailer in the event of an accident (Koppel et al., 2011; Li et al., 2003).
f) c.3 mobility (passenger cars-km and highway density). Passenger cars-km (or miles) is a variable that has been used to model exposure in previous research papers (Kweon, 2015; Kweon and Kockelman, 2003), while highway density has also been used in

[1] As it is justified in Section 3, the endogenous variable is modeled using a Negative Binomial distribution with population used as an exposure variable.

[2] A 200% increase in recorded accidents was observed in Romania in 2005 (and continued in the following years). This increase coincides with the launch of a new Traffic Safety office and so is probably due to a change in the recording methodology (Tomescu and Casapu, 2009).

Table 2
Variables used in empirical analysis.

Variables	Description	Source
Accidents	Total number of road traffic accidents recorded	UNECE Transport Division Database
Fatalities	Total number of road traffic fatalities within 30 days of the accident (according to Vienna Convention)	Eurostat
GDP per capita	Gross Domestic Product per capita (in thousands of Euros) at market prices	Eurostat
BAC	Maximum blood alcohol concentration rate (g/l) allowed (for standard driver)	European Commission Road Safety Website and World Health Organization
PPS	Points-based driver's license (Demerit Point System or Penalty Point System). Dummy variable that takes a value of 1 if driver's license is points-based (Demerit Point System or Penalty Point System); 0, otherwise	SWOV (2008) Fact sheet demerit points systems: http://www.swov.nl/rapport/Factsheets/FS_Demerit_points.pdf
Speed limit	Maximum speed limit (km/hr) for cars on highways	European Commission Road Safety Website
Romanian office	Dummy for creation of new Traffic Safety office in Romania in 2005 that led to a change in record keeping. Dummy variable that takes a value of 1 for Romania from 2005 onwards (new Traffic Safety Office is operative); 0 otherwise.	Tomescu and Casapu (2009)
Median age	Median age of population in years	Eurostat
Population density	Number of inhabitants per km^2	Eurostat
Highway density	Km of highways per km^2	UNECE Transport Division Database
Passenger cars-km	Number of passenger cars per km	European Commission, European Commission, Mobility and Transport, Statistical Pocketbook
Financial Intervention	Dummy variable that takes a value of 1 if a country has been receiving Financial Intervention for at least one year (according to Table 1); 0 otherwise	European Commission (2018b); Sapir et al. (2014)
Population	Inhabitants: Population on January 1	Eurostat

Table 3
Variables: descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Accidents	583	46,927.17	79,055.22	577	395,689
Fatalities	585	1,600.23	1,995.79	9	9,454
GDP per capita	574	29,061.07	12,858.55	9,020	88,590
BAC	588	0.40	0.23	0	0.80
PPS	588	0.57	0.50	0	1
Speed limit	588	121.50	13.51	80	130
Romanian office	588	0.02	0.14	0	1
Median age	582	38.76	2.66	30.80	45.90
Population density	573	168.74	237.46	16.80	1,369.50
Highway density	534	0.018	0.019	0	0.221
Passenger cars-km	588	158.23	240.37	1.70	926.90
Financial Intervention	588	0.046	0.21	0	1
Population	588	17,679,662	22,317,659	376,433	82,536,680

various articles (Anwaar et al., 2012; Bester, 2001; Jacobs and Cutting, 1986). Following prior studies (Albalate and Bel, 2012; Castillo-Manzano et al., 2013, 2015; Kopits and Cropper, 2005), a motorization rate variable was initially included; however, it has been omitted from the final model as it presented a very high correlation with GDP per capita. The relationship that should be expected for mobility is not very clear. Obviously, higher mobility levels imply greater exposure to traffic accidents but, in addition (mainly, in developed countries), other parameters such as better infrastructure and better vehicles, more progressive policies and more beneficial social attitudes toward road safety (Castillo-Manzano et al., 2013) cancel out the effect.

g) $Year_t$ is the year when each data is measured. This is equivalent to introducing a linear time trend.

h) $Country_{it}$ are fixed effects per country. Country effects are included in the model to quantify all the specific geographic and socio-economic characteristics of the countries but are not measured with the other variables. The purpose of these variables is to consider inherent topics such as weather conditions, cultural features (see Haustein and Nielsen, 2016), and geographic variables. Country effects are normally included when working with panel data in road traffic research projects (Toffolutti and Suhrcke, 2014).

i) int_{it} is the Financial Intervention variable (as defined in Table 2). As commented in the Introduction, the current article's most novel contribution lies in the inclusion of variables to analyze the specific effects that financial intervention provided to a country has on road safety. The Financial Intervention variable is included in the model in two different ways: first, a Financial Intervention variable is included as a stand-alone in the model (direct effect), linked to the notification and implementation of the financial support program in the country. This should theoretically capture all the direct, immediate effects, such as cutbacks in the National Safety Agency and Traffic Police budgets. Second, the Financial Intervention variable multiplies the economic variable/s (indirect effect) as it represents the influence that financial support has on the long-term relationship between traffic safety and economic development shown by the *Kuznets curve*.

The effect of financial support can, therefore, be split into two parts (direct and indirect):

i) direct effect of financial support, with elasticity ζ and modeled through the Financial Intervention variable (int_i).
ii) indirect effect of financial support, with elasticity β'_1(GDP per capita)$_{it}$ + β'_2 (GDP squared per capita)$_{it}$.

The total effect of financial support is shown in Eq. (5).

$$\text{Total\_financial\_assistance\_effect} = \exp\,[\beta'_k X_{it} + \zeta] \quad (5)$$

a) εit is the mean zero random error.

3. Results and discussion

As commented previously, with sample panel data it is customary for a negative binomial distribution to be used to model the exogenous variable in the estimating Eq. (1). Count data models (and particularly, negative binomial) are regularly used to analyze road safety dynamics (for example in Albalate et al., 2013; Castillo-Manzano et al., 2015; Johansson, 1996).

Estimations can present heteroskedasticity and temporal autocorrelation problems in the error term if they are not correctly treated. Initial values for the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity and the Wooldridge test for first-order autocorrelation are given in Table 5 and show that model estimations without corrections may suffer from these problems. Therefore, the used model is robust to heteroskedasticity (Huber-White standard error) and uses AR(1) to include autocorrelation effects. The Levin-Lin-Chu test is also applied to

Table 4
Correlation matrix.

	GDP per capita	BAC	PPS	Speed limit	Romanian office	Median age	Population density	Highway density	Passenger cars-km	Financial Intervention
GDP per capita	1									
BAC	0.4116	1								
PPS	0.2073	0.2359	1							
Speed limit	0.0639	−0.3423	0.0789	1						
Romanian office	−0.1191	−0.2537	0.0222	0.0988	1					
Median age	0.1557	0.09	0.401	0.095	0.0319	1				
Population density	0.1423	0.3958	0.0758	−0.3956	−0.0452	0.0412	1			
Highway density	0.5526	0.2614	0.05	0.248	−0.1183	0.1494	0.1635	1		
Passenger cars-km	0.2203	0.3164	0.2748	0.2078	−0.0541	0.2659	0.044	0.1844	1	
Financial Intervention	0.0068	0.072	0.0222	−0.0708	−0.0224	−0.0035	−0.0436	0.0728	−0.0546	1

the endogenous variables (converted to logarithms). Finally, a normality test (Shapiro-Wilk) is performed on the endogenous variables, as included in Table 5. The endogenous variables cannot be inferred to follow a normal distribution. Thus, for this reason, the choice of a negative binomial distribution would also seem to be a good approach.

Table 4 gives the correlation matrix of the variables used in the analysis. As can be observed, there are no high correlations among the endogenous variables used, apart from the logical and traditional correlation between the GDP and the Highway Density variables, which, nevertheless, is below 0.6. This implies that there may not be any significant multicollinearity problems.

Estimation results for the models introduced in the previous section are given in Table 5.

For all of the models that include GDP squared per capita, a nonlinear relationship has been demonstrated to exist between road safety and GDP that approximates to a concave parabola (inverted-U shaped traffic safety behavior in relation to the economic situation; see GDP per capita and GDP squared per capita variables). These results complement the previous scientific literature, in the sense that the present analysis corroborates the *Kuznets curve hypothesis* (i.e., economic growth creates resources that can lead to a decrease in traffic fatalities in the long term) (see e.g., Antoniou et al., 2016; Law et al., 2011, among others) and, in addition, extends this finding for traffic accidents.

The total effect of the financial intervention on road safety is shown as a mix of both direct and indirect effects.

On one hand, the indirect effect of financial support is not statistically significant in any of the models tested. Thus, there is no empirical evidence of a change in the long-term dynamics of road safety and economic development modeled with the *Kuznets curve*.

On the other hand, the direct effect of financial support is negative in most cases, although not very significant. So, despite its effect on reducing traffic safety policy budgets (traffic police and enforcement, road infrastructure, safety advertising campaigns, among others), Financial Intervention and related austerity measures might have a positive effect on traffic safety, i.e., they may have reduced the number of accidents and fatalities, although this latter hypothesis is unlikely. This paradox is discussed below. It seems that austerity measures lead to an (even) higher mobility reduction by impacting economic activity and contribute to a change in driving behaviors, and so is therefore connected with a reduction in accidents and fatalities.

Having analyzed the economic cycle and Financial Intervention, the outcomes for the rest of the variables used in the model are reported below.

First, the blood alcohol limit seems to have no influence on accidents in line with the findings in the scientific literature. However, surprisingly, it does correlate negatively with fatalities. We have also tested models with BAC omitted but all the remaining variables included, with no changes in the significance levels or the signs of the results. Although, we decided not to include these alternative models here for the sake of simplicity, the outcomes are available upon request.

Furthermore, we highlight that, as shown by Castillo-Manzano et al. (2017), the effect of the blood alcohol limit could be distorted by Eastern European countries, which have higher fatality rates despite having very low BACs. This is due, among other things, to the high alcohol consumption rates in these countries, which would affect the negative relationship found here.

Concerning the implementation of a points penalty system, the models used do not provide any empirical evidence of an influence on traffic safety. This is in line with Castillo Manzano et al. (2010), who demonstrated for the Spanish case that the implementation of a points penalty system has a positive impact on traffic safety, but that the effect disappears after a transition period.

The speed limit presents a positive and significant relationship with both accidents and fatalities. Elasticity is greater for road traffic fatalities; i.e., higher speed limits and, therefore, higher speed, increase the likelihood of accidents, but they have a major influence on the severity and consequences of these accidents (Chen et al., 2012; Dadashova et al., 2016).

In the present case, no significant relationship has been found between traffic safety and median age. However, as can be seen from the results, population density has a negative impact on road safety (as it increases the number of accidents, see Nghiem and Connelly, 2015).

Focusing on the mobility-related variables, highway density positively influences road safety by reducing the number of accidents. This finding is in line with the results of previous studies (Anwaar et al., 2012; Bester, 2001). In other respects, distance traveled (modeled by passenger cars per km) has a negative impact on traffic accidents, as it is a clear proxy of risk exposure. Nevertheless, there is no impact on fatalities, as these are more influenced by other variables (linked to crash severity and post-crash healthcare) that cancel out the negative effect of the accident exposure factor for fatalities, as shown in Castillo-Manzano et al. (2013).

It also needs to be highlighted that the time trend (modeled through the variable period) is negative. This means that both accidents and fatalities are being reduced by time that a State is a member of the European Union, in line with previous studies by Castillo-Manzano et al. (2014).

Finally, the inauguration of a new road safety office in Romania (modeled by the Romanian office variable) also has a significant impact. This simply shows the increase in the number of recorded accidents and fatalities due to a change in the recording method in the country.

4. Concluding remarks

The recent economic and financial crisis required the bailout of some European States by the *Troika*. These financial interventions have led to austerity measures and reductions in public budgets in general, with a geographic difference between countries on the periphery that

Table 5
Estimation results (panel data model, population averaged with negative binomial distribution and logarithmic link).

Endogenous Variable	Accidents	Accidents	Accidents	Fatalities	Fatalities	Fatalities
GDP squared per capita included?	Yes	No	Yes	Yes	No	Yes
Indirect Effects included?	Yes	No	No	Yes	No	No
GDP per capita	0.3804*** (0.1300)	0.1422* (0.0803)	0.3726*** (0.1323)	0.4551*** (0.0979)	0.1982*** (0.0673)	0.4521*** (0.0957)
GDP squared per capita	−0.0268** (0.0125)		−0.0260** (0.0121)	−0.0301*** (0.0076)		−0.0298*** (0.0074)
BAC	0.1049 (0.8536)	0.4194 (1.0061)	0.1610 (0.8457)	−2.0791** (0.9130)	−1.5670* (0.8958)	−2.0583** (0.9016)
PPS	−0.0028 (0.0193)	−0.0036 (0.0193)	−0.0036 (0.0196)	−0.0111 (0.0284)	−0.0155 (0.0278)	−0.0121 (0.0282)
Speed limit	0.0505*** (0.0059)	0.0488*** (0.0063)	0.0498*** (0.0058)	0.0567*** (0.0126)	0.0541*** (0.111)	0.0565*** (0.0124)
Romanian office	1.1009*** (0.0167)	1.1087*** (0.0156)	1.1003*** (0.0168)	0.3466*** (0.0327)	0.3430*** (0.0285)	0.3439*** (0.0317)
Median age	0.0233 (0.0369)	0.0456 (0.0388)	0.0299 (0.0369)	−0.0163 (0.0248)	0.0078 (0.0210)	−0.0148 (0.0240)
Population density	0.000535 (0.0023)	−0.000107 (0.0027)	0.00052 (0.0022)	0.0023** (0.0009)	0.0012 (0.0016)	0.00225** (0.0009)
Highways density	−2.3658*** (0.3733)	−2.6565*** (0.4317)	−2.4571*** (0.3992)	−0.5706 (0.5060)	−0.8685 (0.5823)	−0.5750 (0.4974)
Passengers cars km	0.00071*** (0.0003)	0.00072*** (0.00026)	0.00067** (0.00028)	0.00103 (0.0007)	0.00103 (0.0006)	0.00103 (0.0007)
Financial Intervention	−1.7658 (2.5047)	−0.1633** (0.0802)	−0.1446* (0.0831)	0.3712 (1.2254)	−0.0759** (0.0315)	−0.0528 (0.0383)
(GDP per capita) x (Financial Intervention)	1.3022 (1.7211)			−0.2379 (.8313)		
(GDP squared per capita) x (Financial Intervention)	−0.2459 (0.2849)			0.0313 (0.1363)		
Year$_t$ (linear time trend)	−0.0392*** (0.0135)	−0.0400*** (0.0143)	−0.0405*** (0.0134)	−0.0630*** (0.0069)	−0.0640*** (0.0068)	−0.0632*** (0.0068)
Country fixed effects	YES	YES	YES	YES	YES	YES
Wald chi2	47129***	45056***	45941***	52700***	51757***	52511***
Modified Wald test for groupwise heteroskedasticity (Ho: Constant variance)	10251***	5798***	10311***	1341***	809***	1201***
Wooldridge test –autocorrelation (Ho: No first order autocorrelation)	86.98***	82.63***	87.15***	1.16	1.46	1.14
Levin-Lin-Chu test Adjusted t* (Ho: nonstationarity)	−3.4971***	−3.4971***	−3.4971***	−4.3515***	−4.3515***	−4.3515***
Shapiro-Wilk test for normality (W)	0.9814***	0.9814***	0.9814***	0.9655***	0.9655***	0.9655***
Doornik-Hansen multivariate Normality test (chi^2)	38162***	38162***	38162***	37600***	37600***	37600***
No. Observations	468	468	468	469	469	469
No. Countries	28	28	28	28	28	28

Note 1: standard errors in brackets, robust to heteroskedasticity and grouped by country. Regressions specify a within-group AR(1) correlation structure for panels. Population is used as exposure variable.
Note 2: Statistical significance at 1 % (***), 5 % (**), 10 % (*), respectively.
Note 3: Wald chi2 calculated for the model without corrections.

received Financial Intervention and those in Central and Northern Europe that did not.

In this context, the current paper applies econometric tools to test whether providing States with financial support has an impact on road safety and whether the impact is positive or negative. For this, an ad-hoc set of panel data was constructed for the EU-28 countries for the 1995–2015 period.

The results show that financial support of countries on the periphery has been found to have absolutely no negative impact on road safety, either direct or indirect.

In fact, should any such effect have existed, it would have been positive, especially in the case of accidents, as the countries on the geographic periphery that have received Financial Intervention have presented behavior that has been, on average, better during the years of the intervention. It would seem that the harsher effects of the economic crisis experienced in these countries and economic austerity are associated with a higher mobility reduction and that the greater awareness caused by the intervention programs favors a degree of change in driver behavior, with drivers being more careful to try to avoid any possible road sanctions. Therefore, it seems that our result is more linked to the austerity measures than to the financial support given by the *Troika*.

Despite the above, any *austericity* process has to be rejected in relation to road safety, however many assumptions there are that would support it. These results should make us ponder just how much the ample negative literature—especially in the media—that in the last decade has been written about *austericity* in particular, and, more generally, about the way in which the EU has handled the economic crisis, stands up to any serious scrutiny. However, in this post-truth era, this literature has infused the ideology of insurgent and/or populist political alternatives with claims that are clearly anti-European.

The inverse quadratic relationship between economic development (measured by GDP per capita) and road safety variables has existed not only for fatalities, but also for accidents, in a heterogeneous group of countries such as the EU-28 throughout a period of 21 years.

Notwithstanding, with the economic recovery now underway (European Commission, 2018b; Salmon, 2017; Pezzuto, 2017), a greater number of road accidents should be expected due to the increase in mobility derived from greater economic activity, which could explain the historic upswing in accidents that some of these countries have been experiencing; e.g., while fatalities in EU-28 fell by 3.0 % (European Commission, 2018a) during the 2015–2017 period, the number increased by 8.3 % in Spain. In this scenario, we should also take into account the current influence on road safety of the cutbacks in health and road maintenance during the financial intervention. For example, as reported by the Spanish Ministry of Transport (Ministerio de Fomento, 2016), average investment in Spanish roads was reduced from €41k per km during the 2004–2008 period to €23k per km during the 2012–2016 period.

This research also shows evidence of the positive impact of low speed limits on traffic safety, which is in line with the previous scientific literature, and finds a negative relationship between blood alcohol limits and road traffic fatalities, possibly due the heterogeneous characteristics of the countries assessed. This is especially true in the case of Eastern European countries, where high accident rates are common despite their low BACs. However, it finds no effects of the penalty point systems on traffic safety, as was also demonstrated by previous research projects (after a transition period, the effect disappears). Population density was also found to have a negative impact, while that of highway density was positive.

New lines for future research can be developed based on our main outcomes. First, given the freedom that the intervened countries had to make whatever budget cuts they thought best once the Troika had set the deficit goals, it would make sense to carry out individual analyses of each of the countries. This would allow us to determine the types of cutbacks (from lesser expenditure on marketing campaigns to poorer road maintenance) that are less harmful to road safety.

In addition, in connection with the methodology, an alternative research study is advised that uses macro-panel analysis to address the heterogeneous time slopes shown by country variables among the panels to complement the results found here. Nevertheless, this focus would make more sense when the time period is longer than the period that we have been able to use in this analysis (see Antoniou et al., 2016, on the appropriateness of these models for t is equal to or greater than 30).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.aap.2020.105461.

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