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Can cars and trucks coexist peacefully on highways? Analyzing the effectiveness of road safety policies in Europe

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ABSTRACT

We examine the impact on the traffic accident rate of the interaction between trucks and cars on Europe's roads using a panel data set that covers the period 1999–2010. We find that rising motorization rates for trucks lead to higher traffic fatalities, while rising motorization rates for cars do not. Empirically, the model we build predicts the positive impact of stricter speed limit legislation for trucks in the reduction of road fatalities. These findings lend support to European strategies and aimed at promoting alternative modes of freight transport, including rail and maritime transport.

1. Introduction

According to Baindur and Viegas (2011), from 2004 to 2013 the European Union (EU) experienced significant growth in road freight transport of about 60%, adding 20.5 billion tonne-kilometres per year across the EU25 States. According to the European Commission (2013a), in 2011 total goods transport activities in the EU27 amounted to 3824 billion tonne-kilometres. Most freight is transported by road, accounting for 45.3% of this total, compared to 11% rail, 3.7% inland waterways and 3.1% oil pipelines, albeit with differences from one state to another (see for example, Castillo-Manzano et al., 2013, for a broad consideration of rail–truck freight transport modal distribution).

Consequently, truck operations have recently become an important focus of academic research, not only because road freight transport is the backbone of logistics, but because trucks are associated with negative externalities, including pollution, congestion and accidents (Rowangould, 2013). While the negative environmental impacts of truck operations have been extensively analyzed, comparatively little attention has been paid to the role of trucks in road accidents (Kim and Van Wee, 2014) despite the fact that, according to the EU-OSHA (European Agency for Safety and Health at Work, 2010), transportation vehicle-related accidents are the second largest cause of fatal crashes, and around a third of the deaths in EU workplace accidents are linked to transport.

To date, the relevant literature that has analyzed accidents related to truck–traffic safety issues has mainly focused on the frequency of accidents and identifying determinants (Cantor et al., 2010; Häkkänen and Summala, 2001). Special attention has been paid to the variables that explain accident severity (Chang and Chien, 2013; Lemp, 2011; Zhu and Sirnivasan, 2011) and the strategies that might be effective for prevention (see the review by Mooren et al., 2014); risk factors associated with truck driver behavior, including cell phone use, fatigue and drowsiness, alcohol and drug consumption (Loeb and Clarke, 2007); truck characteristics (dimensions and weights) and technical facilities (roadway types, electronic stability programs) to improve performance of vehicle maneuvering (Mooren et al., 2014); interaction between trucks and other vehicles on roads; rural and urban settings (Chen and Chen, 2011; Gabler and Hollowell, 2000; Harwood et al., 2003; Peeta et al., 2004; Summala and Mikkola, 1994); and the characteristics of heavy and large trucks (Ortega et al., 2014).

Another area of study addresses safety issues regarding differential treatment applied to trucks as a consequence of the peculiar characteristics of these vehicles and their traffic operations (a greater truck mass, weight and dimensions; nighttime and commercial driving schedules) which further increase risk to traffic safety in general (see Choi et al., 2014, for a specification, and Cherry and Adelakun, 2012, for an examination of truck drivers' perceptions). Certain strategies have been developed to mitigate these aspects; separating trucks and facilitating their maneuvers

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(such as lane operations, and differential road safety policies, such as speed limits by vehicle type; specific enforcement) although there seem to have been comparatively few studies evaluating their effectiveness (Cate and Urbanik, 2004; El-Tantawy et al., 2009; Neeley and Richardson, 2009; Qi et al., 2012). In this line, most previous research has explored the characteristics of accidents and associated risks when larger trucks are involved (Chang and Chien, 2013; Dong et al., 2014; Lemp et al., 2011; Zhu and Srinivasan, 2011, among many others).

This paper focuses on the complex nature of the coexistence of trucks and passenger cars by drawing on a panel data set for European countries. Applying econometric techniques to a panel data from EU countries for the period 1999–2010, we examine whether greater numbers of trucks and cars per capita on the roads have positive or negative impacts on road safety. We also assess the efficacy of two regulations for trucks, not harmonized as yet in the EU, namely, speed limits and maximum blood alcohol concentration (BAC) rates. For this, the article is divided into the following sections: apart from Section 1, Section 2 describes the data and variables, and defines the methodology, Section 3 presents the resulting estimates, Section 4 lays out the appropriate discussion; and finally, Section 5 offers a set of concluding remarks with policy implications within the current EU transport policy framework.

2. Empirical approach

We estimate a model that takes the following form for country i during period t:

$$Y_{it} = \alpha + \beta_k X_{it} + \gamma_k Z_{it} + \lambda_k W_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is a variable that indicates the number of total fatalities (within 30 days of the accident, according to the Vienna Convention definition), X_{it} contains the vector of the country's economic and demographic attributes, Z_{it} refers to variables that identify the motorization rates for trucks (i.e., number of trucks per capita; in their entirety, with no distinction in terms of weight and size) and motorization rates for passenger cars (i.e., number of passenger cars per capita), and W_{it} are specific variables related to road safety policies. μ_i are country fixed effects that control for omitted time-invariant country-specific variables, ν_t are year dummies that control for the common trend in all the countries in the dataset and ε_{it} is a mean-zero random error.

The data used are for the EU-28 countries from 1999 to 2010. Table 1 provides a description of the variables and the data sources, the unit of observation being the country-year pair. The explanatory variables include factors typically examined in road safety studies (see for example, Dee and Sela, 2003; Albalate and Bel, 2012).

Per capita GDP is included as an explanatory variable to test for a possible relationship between economic development and road traffic fatalities (Kopits and Cropper, 2005). It is not clear what the sign of the coefficient associated with this variable should be, a priori. On the one hand, traffic fatality rates may increase with economic development in poorer countries, due to increased exposure to road traffic fatalities. On the other hand, the relationship between economic development and traffic fatality rates may become flat or even reverse after a certain wealth threshold has been reached (Bishai et al., 2006).

The influence of the quality of the transport infrastructure is also considered with the inclusion of a motorway density variable. In this regard, a negative relationship is expected between the quality of transport infrastructure and road traffic fatality rates (Noland, 2003).

Furthermore, two control variables are included relating to the percentage of vulnerable population in the country (Langford et al., 2006; Braver and Trempel, 2004). The first variable is for the population over 60 years old. Indeed, the impact of accidents may be higher for older road users as morbidity and mortality are higher for older populations (see Yee et al., 2006).

The second variable considered is for the percentage of population aged from 20 to 39 years. This wide 20–39 age range enables the capture of the relevant sociological changes that have taken place in the young driver's profile in many developed countries in recent years that have led to a sharp decline in the numbers of young people gaining driving licenses and owning cars (see the systematic literature review on this topic by Delbosc and Currie, 2013). Borrell et al. (2005) conclude in this respect that the youth group between 20 and 39 years is an important risk group contributing to fatal traffic accidents.

One of the innovative contributions of the analysis lies in the distinction drawn between two motorization rates: the number of trucks per capita and the number of passenger cars per capita. In this regard, a country's aggregate level of motorization is usually taken into account in studies on the determinants of road traffic fatalities (Albalate, 2008; Albalate and Bel, 2012; Kopits and Cropper, 2005). It is not clear what relationship with road traffic fatalities should be expected. On the one hand, higher levels of motorization may imply higher exposure to road traffic accidents. On the other hand, more developed countries may enjoy better infrastructure and vehicles, more advanced policies and more beneficial social attitudes towards road safety (such as major post-accident medical care, see Castillo-Manzano et al., 2014a). In our

Table 1
Variables used in the empirical analysis.

Variables	Description	Source
Fatalities	Number of traffic fatalities	CARE (EU road accidents database)
Motorization_trucks (per capita)	Number of trucks (irrespective of weights and dimensions)/1000 inhabitants	UNECE, EUROSTAT (for population)
Motorization_cars (per capita)	Number of registered passenger cars/1000 inhabitants	UNECE, EUROSTAT (for population)
Per capita GDP	Per capita Gross Domestic Product in International Comparable Prices (US$ at 2005 prices and PPP)	EUROSTAT
Motorway density	Number kms of motorways divided by km^2 of the country	UNECE, EUROSTAT
Old	% population over 60 years old	EUROSTAT
Young	% population aged 20–39 years	EUROSTAT
BAC_05, BAC_05_professional	Dummy variables that takes a value of 1 where the maximum BAC rate allowed for conventional car drivers or professional drivers is less than 0.5 g/l	European Commission Road Safety Website
Penalty_system, Demerit_System	Dummy variables that takes the value 1 if the penalty system driving license is applied or if the demerit system driving license is applied	European Transport Safety Council (ETSC)
Speed limits	Maximum speed limits for cars and heavy good vehicles – over 3.5 t (km/h)	European Commission Road Safety Website

context, we examine a possible differential impact between the motorization rates for trucks and passenger cars, both in terms per capita.

We have used the motorization rate per capita as exogenous variable, both for number of passenger cars and number of trucks because this is a common indicator in international statistics and road safety literature, as shown in several previous studies such as e.g., Albalate et al. (2013); Elvik (1995); Kopits and Cropper (2005); Nishitateno and Burke (2014); Page (2001); Yannis et al. (2011). In this regard, it might be interesting to test our model with an alternative indicator of motorization as it could be the number of passenger cars and number of trucks in relation to the number of kilometers of roads. Unfortunately, Eurostat data for the number of roads is very poor. It is not available for several countries and reported data shows huge differences between countries (taking into account its size) and big changes within some countries in just one year.

Finally, as in previous studies (e.g., Eisenberg, 2003; Elvik, 2012; Loeb, 2007), the effects of specific policies that may have an influence on road safety traffic fatalities are analyzed.

Two dummy variables are included to capture the application of points-based driving licenses. On the basis of earlier research, such as Castillo-Manzano et al. (2014a,b), a dummy variable is introduced as an explanatory variable that takes the value of one if a penalty system driving license is applied. Furthermore, a dummy variable that takes the value of one if a demerit system driving license is applied is included. These variables are used to examine the effects of the introduction and application of any points system to driving licenses on traffic fatality rates.

We also consider road safety measures for cars and trucks. First, two dummy variables are included that identify maximum BAC rates below 0.5 g/l for conventional car drivers and professional drivers, respectively. Additionally, the maximum speed limits for both cars and trucks are also considered. Please note that we consider the impact of the maximum speed limits allowed for trucks that present a particular hazard in the road safety context (heavy goods vehicles).

To contribute to the scarce previous literature on road safety strategies for different vehicle types, here attention is placed on these policies when specifically applied to trucks. In this regard, the aim is to test the effectiveness in reducing road traffic fatalities of maximum blood alcohol concentration rates and speed limits for trucks. In keeping with recent studies, it is expected that stricter regulations for truck drivers may have a positive impact on road safety (see Saifizul et al., 2011 for speed limits and Živkovic' et al., 2013 for BAC rates).

3. Results

Estimates of this type are liable to present problems of heteroscedasticity and temporal autocorrelation in the error term. Indeed, the Wooldridge test for autocorrelation in panel data shows that there may be a problem of serial autocorrelation that needs to be addressed, while the Breusch–Pagan/Cook–Weisberg test indicates that we may also have a heteroscedasticity problem.

We also apply the panel unit root test, as developed by Levin et al. (2002), which can be regarded as an augmented Dickey–Fuller (ADF) test when lags are included. This test indicates that our dependent variable does not present a non-stationarity problem.

The variables used in the empirical analysis in the context of this study also need to be tested to determine whether they are distributed normally. The Doornik–Hansen test for multivariate normality is therefore applied and this shows that our variables are not distributed normally.

Taking these test results into account, the estimation was performed using the negative binomial method using standard errors robust to heteroscedasticity and clustered by year. The use of count models is common in the analysis of the determinants of road traffic fatalities (e.g., Albalate et al., 2013; Johansson, 1996; Karlaftis and Tarko, 1998; Quddus, 2008). Note that we use population as an offset variable so that we are effectively estimating the ratio fatalities/population.

Note that country year dummies are included to control for omitted time-invariant country-specific variables and year dummies are also included to control for the common trend across all the countries in the dataset. Hence, our approach is essentially identical to that of estimating a fixed effects regression model, which has the advantage of allowing us to control for any omitted variables that correlate with the variables of interest and which do not change over time.

The country fixed effects can be included in the model in two different ways. We can include dummy variables for all countries (less one) to directly estimate the fixed effects. Alternatively, we could factor out the fixed effects via the overdispersion parameter as suggested by Hausman et al. (1984). In our context, we consider more convenient to use a simple negative binomial model rather than the model specified by Hausman et al. (1984) due to its computational convenience. The implementation of the technique developed by Hausman et al. (1984) does not allow us to apply clusters to the standard errors. In this regard, recall that the Wooldridge test for autocorrelation in panel data shows that there may be a problem of serial autocorrelation that needs to be addressed. Furthermore, the regression with the model developed by Hausman et al. (1984) does not converge to any value if we do not drop the year dummies which control for the common trend across all the countries in the dataset. In this regard, Allison and Waterman (2002) show that the simple negative binomial model have good estimation properties in comparison to that developed by Hausman et al. (1984), while Guimaraes (2008) shows that the model of Hausman et al. (1984) will only control for individual specific effects under a very specific set of assumptions.

Table 2 shows the descriptive statistics of the variables used in the empirical analysis, while Table 3 gives the correlation matrix of these variables. As could be expected, the levels of motorization per capita are much higher for cars than for trucks. Furthermore, it is not surprising that speed limits are generally stricter for trucks. It should also be noted that maximum BAC rates below 0.5 l/g are more likely to be applied to professional than conventional drivers.

The correlation matrix shows that there is high correlation between the GDP per capita and motorization rates for cars (number of passenger cars per capita) variables. This close relationship has been examined in previous studies (see for example, studies by Bishai et al., 2006; Kopits and Cropper, 2005). Such high correlation may pose a multicollinearity problem that could distort the individual identification of either of these two variables. Hence, two different regressions have been run. In the first regression, all the explanatory variables considered in Eq. (1) have been used. In the second regression, the GDP per capita variable has been omitted. It should be remembered that our main interest lies in the differences between motorization rates for trucks and cars, both in terms per capita, and so in our context it is more logical to exclude the GDP variable to deal with the multicollinearity problem than the motorization rates per capita for cars variable.

Table 4 contains the results of the estimates. In general terms, it should be noted that our findings do not seem to be substantially affected by the inclusion or omission of the GDP per capita variable as an explanatory variable.

Specifically, as can be seen in the table, different patterns seem to show both the motorization of passenger cars per capita and trucks per capita coefficients. In the first case (the number of passenger cars per capita), the resulting coefficient is negative and

Table 2
Descriptive statistics of the variables used in the empirical analysis.

Variables	Mean	Standard Deviation	Minimum value	Maximum value
Fatalities	108.44	45.04	27	253
Motorization_cars (per capita)	424.74	111.99	134	686
Motorization_trucks (per capita)	58.03	34.18	6.32	175.97
Per capita GDP	24960.43	11653.04	6737	74128
Motorway density	1.69	1.73	0	6.35
BAC_cars	0.67	0.45	0	1
BAC_trucks	0.28	0.46	0	1
Penalty_system	0.19	0.40	0	1
Demerit_system	0.28	0.45	0	1
Speed_limits_cars	121.5	13.51	80	130
Speed limits_trucks	87.39	8.91	80	112
Old	20.67	2.52	15.1	26.3
Young	28.75	1.92	24.3	33.2

statistically significant, while the coefficient associated with the number of trucks per capita is positive although not statistically significant.

Moreover, different effects can be observed depending on the exogenous variable considered. The coefficient associated with GDP per capita is not statistically significant but other factors that may influence road traffic accidents are statistically significant. Indeed, the coefficient associated with motorway density is negative and statistically significant, and the coefficients associated with a high percentage of vulnerable population (both young and old population) are positive and statistically significant.

Regarding the variables representing road safety policies, as can be seen in Table 4, different results have been obtained: the coefficients for the driver's license points are not statistically significant either for penalty or demerit systems, while the coefficients of the variables related to the application of maximum speed limits (for both cars and heavy goods vehicles) and BAC levels (for both conventional and professional drivers) are found to be statistically significant. As expected, the sign of the coefficients associated with the maximum speed limit variables is positive, and the sign of the coefficients associated with BAC levels is negative.

4. Discussion

Basically, the results for the control variables are in line with results published elsewhere (e.g., Loeb and Clarke, 2007). As a novelty, we have found a differential impact of the motorization rates in terms of numbers of passenger cars and trucks per capita, respectively, on road traffic fatalities. The presence of a higher number of passenger cars per capita on European roads seems to have a negative effect on fatal accidents, while higher numbers of trucks per capita do not seem to be relevant.

The motorization rate can be considered to be related to developments within private transportation. It should be remembered that higher motorization rates may have two different effects on road traffic fatalities: (1) greater exposure to accidents, meaning that the relationship between motorization rates and road traffic fatalities would be positive, and (2) better infrastructure and vehicles, and more advanced policies and social attitudes towards road safety, as a result of which the relationship between motorization rates and road traffic fatalities would be negative. The results for the passenger car variable suggest that the second effect is clearly dominant (in line with Smeed's Law; Smeed, 1949; Smith, 1999), while the results for the number of trucks per capita suggest that the two effects are partially offset. Hence, the results of our analysis provide some evidence that the positive effect on road traffic fatalities related with a greater exposure to fatal accidents is stronger for trucks than for passenger cars.

As suggested by Chang and Chien (2013), accidents involving trucks usually have a greater risk of producing severe injuries or fatalities, due mainly to the car/truck size disparity. In fact, although small trucks seem to contribute more to congestion than private cars (Nitzsche and Tscharaktschiew, 2013) and longer and heavier trucks may appear to be associated with lower accident rates (see e.g., Lemp et al., 2011) given the fact that they may reduce traffic flow speeds (Anastasopoulos et al., 2012), authors such as Cantor et al. (2010) conclude that trucks in general have to contend with more hazardous situations – vehicles have a greater mass, drivers are exposed to worse driving conditions (longer distances and nighttime schedules), vehicles have to undertake

Table 3
Correlation matrix of the variables used in the empirical analysis.

Variables	Fat	Mot_cars	Mot_trucks	GDP	Motorw_dens	BAC_cars	BAC_trucks	Point_s	Demerit_s	Speed_cars	Speed_trucks	Old	Young
Fatalities	1												
Motorization_cars (per capita)	−0.39	1											
Motorization_trucks (per capita)	−0.05	0.31	1										
Per capita GDP	−0.43	0.76	0.13	1									
Motorway density	−0.24	0.49	0.07	0.65	1								
BAC_cars	0.08	−0.56	−0.30	−0.42	−0.42	1							
BAC_trucks	0.18	0.02	−0.08	−0.02	0.02	0.42	1						
Penalty_system	0.22	0.18	−0.02	0.05	-0.01	0.04	0.01	1					
Demerit_System	−0.21	0.11	0.14	0.05	0.09	−0.18	−0.17	−0.30	1				
Speed_limits_cars	0.06	−0.07	−0.45	0.12	0.49	0.11	0.28	0.14	0.02	1			
Speed limits_trucks	−0.05	−0.17	−0.19	−0.07	0.07	0.01	−0.14	−0.4	−0.23	0.11	1		
Old	−0.12	0.23	−0.15	0.02	0.10	−0.16	−0.11	0.04	0.05	0.09	0.10	1	
Young	0.32	−0.24	0.14	−0.19	−0.16	0.17	0.09	−0.12	0.01	0.13	0.08	−0.49	1

Table 4
Results of estimates (negative binomial regression).

Independent variables	Dependent variable: number of traffic fatalities	
	All variables	Excluding GDP
Motorization_cars (per capita)	−0.0006	−0.0005
	(0.0002)***	(0.0002)**
Motorization_trucks (per capita)	0.008	0.0001
	(0.0012)	(0.001)
Per capita GDP	5.41e-06	–
	(7.46e-06)	
Motorway density	−0.10	−0.10
	(0.02)***	(0.02)***
BAC_cars	−0.27	−0.29
	(0.11)***	(0.10)***
BAC_trucks	−0.26	−0.20
	(0.14)**	(0.07)***
Point_system	−0.011	−0.009
	(0.04)	(0.04)
Demerit_system	−0.03	−0.03
	(0.02)	(0.02)
Speed_limits_cars	0.05	0.04
	(0.008)***	(0.007)**
Speed limits_trucks	0.08	0.012
	(0.007)***	(0.005)**
Old	0.06	0.07
	(0.01)***	(0.017)***
Young	0.05	0.05
	(0.02)***	(0.01)***
Intercept	−11.39	−11.29
	(1.42)***	(1.31***)
Country dummies	Yes	Yes
Year dummies	Yes	Yes
Pseudo R^2	0.19	0.19
Test joint sign (Wald χ^2)	857.60***	861.97***
Log likelihood	−1820.79	−1823.94
Breusch–Pagan/Cook–Weisberg test for heteroskedasticity (Ho: constant variance)	42.05***	39.93***
ADF test non-stationarity (Ho: non-stationarity)	−0.34**	−0.34**
Wooldridge test–autocorrelation (Ho: First-order autocorrelation)	76.98***	78.39***
Doornik–Hansen test for multivariate normality	1794.18***	1711.28***
Number observations	311	311

Note 1: Standard errors are given in brackets. Robust to heterocedasticity and clustered by year.
Note 2: Statistical significance at 1% (***), 5% (**), 10% (*) respectively.

more dangerous maneuvers, and, as a consequence, face more severe accident outcomes.

Secondly, no strong relationship is found between road traffic fatalities per capita and a country's level of economic development. Bearing in mind that our sample is based on middle-income or high-income countries, this result is entirely consistent with previous studies that have suggested inconclusive evidence on how economic activity may explain changes in road casualties (Bishai et al., 2006; García-Ferrer et al., 2007; Kopits and Cropper, 2005). Nevertheless, the quality of transport infrastructure is confirmed to have a significant effect on road safety; i.e., as per previous findings by Albalate and Bel (2012) and Jamroz (2012), among others, a higher motorway density is related to a decrease in road traffic fatalities.

Special mention should be made of the vulnerable population-related variables. According to our estimates, a rising percentage of vulnerable population is shown to increase traffic fatalities for both the "young" and "old" variables. These findings are in line with the conclusions drawn by other scholars, such as McGwin and Brown (1999). However, most studies show that accident rates are higher with larger young populations and decline with older populations (see e.g., Constantinou et al., 2011; Langford et al., 2006), as a consequence of the higher risk exposure of younger people that comes from voluntary risk-taking (reckless behavior, more driving errors and the consumption of alcohol/drugs while driving). Certainly, older populations are likely to be more experienced, and may drive less and more carefully (see specifically the case of heavy vehicles drivers analyzed by Guest et al., 2014); nevertheless, they also may have certain physical deficits that lead them to be more fragile (Li et al., 2003), so even if they are involved in fewer accidents, the impact of these is greater in terms of morbidity and mortality (Koppel et al., 2011; Yee et al., 2006).

A far as road safety policy-related variables are concerned, although the penalty point system applied to driving licenses does not seem to be completely effective (according to Castillo-Manzano and Castro-Nuño, 2012), other national road safety policies, such as the speed limits that apply to cars and the more dangerous categories of trucks (heavy goods vehicles) are found to be useful for reducing road traffic fatalities (in line with Castillo-Manzano et al., 2014c; Saifizul et al., 2011). The specific case of stricter speed limits applied to trucks by States might complement other EU technical strategies, such as mandatory speed limiters (SLs, or speed governors, that automatically limit a vehicle's speed). The initial EU legislation requiring SLs to apply a 90 km/h limit to improve safety and reduce environmental effects was adopted in 1992 (Directive 1992/6/EEC) for large commercial vehicles over 12 t, and extended in 2002 (Directive 2002/85/EC) to smaller commercial vehicles over 3.5 t and to all buses with more than nine seats. Despite their drawbacks (see Van der Pas et al., 2014), the extension of this compulsory measure to light commercial vehicles is currently being considered for use in European countries as a first step to introducing Intelligent Speed Adaptation Systems (ISA).

There is little empirical literature that assesses the effectiveness of SLs for the traffic safety of trucks in Europe compared to studies in the U.S. (Bishop et al., 2008; Hickman et al., 2012). E.g., for the case of the United Kingdom, Transport Canada (2008) concluded that there had been a 26% drop in the accident involvement rate for speed-limited heavy trucks during the 1993–2005 period; a meta-analysis by Elvik et al. (1997) estimated that installing SLs in heavy goods vehicles could contribute to a 2% reduction in all crashes with injuries; and a recent ex-post evaluation published by the European Commission (2013b) on the installation and use of speed limitation devices reveals that the application of SLs (plus a voluntary ISA system) would lead to an approximately 25% reduction in the number of fatal accidents on European roads involving large and light commercial vehicles (600 fewer fatalities annually), whilst decreasing speed limits for large trucks to 80 km/h would lead to an approximately 5% reduction in fatal accidents.

Finally, BAC rates are clearly effective in reducing road traffic fatalities both for conventional and professional drivers. It should be noted that BAC rates for professional drivers are low in most of the countries considered during the period analyzed, and the relevant effect that we find for this variable should therefore be highlighted. In this regard, as previously mentioned in Section 1, these drivers spend many more hours driving with clear evidence that they are more prone to certain behavior risk factors (fatigue, drowsiness, alcohol and drug consumption, etc).

Our results point to the desirability of lowering the national BAC levels allowed in line with the so-called 'zero tolerance' laws (0.0 BAC limit) recommended by the European Commission (see Živkovic' et al., 2013) and implemented in the Czech Republic, Germany, Italy, Slovakia, Slovenia and Romania. Other interventions might enhance the effectiveness of this specific strategy, including: enforcement by means of random and selective breath testing (see Kallberg et al., 2008); and/or the installation of alcohol ignition interlock devices (alcolocks) (tested by Bjerre and Kostela, 2008; Silverans et al., 2006) currently considered as part of the 4th European Road Safety Action Programme (2011–2020) (Podda, 2012).

5. Conclusions

This paper examines the coexistence of trucks and cars on roads and how this influences the number of fatalities that come from traffic accidents. Econometric models were developed using a European Union (EU) panel data set for the 1999–2010 period. The impact of two road safety regulations for trucks (as yet not harmonized by EU members) is also evaluated: permitted speed limits and maximum blood alcohol concentration rates.

We find a differential impact of motorization rates in terms of trucks and passenger cars on road traffic fatalities. Indeed, results of our analysis provide some evidence that the effect related with a greater exposure to fatal accidents is stronger for trucks than for passenger cars. These effects remain constant across Europe, even in the most highly developed countries boasting the best highway networks. As such, this study's findings might offer indirect support to public policies implemented at the macro European level to promote multimodal transport corridors. Road freight transportation forces negative externalities upon society, revealing the need to shift traffic to alternative transportation modes. In this respect, there is an increasing focus at the European level on how freight transport can be moved from trucks on roads to more environmentally-sustainable modes, such as rail and ship (see Rich et al., 2011).

Despite the complex nature of this modal shift, previous studies such as Rowangould (2013) conclude that in terms of accident prevention the reduction in truck journeys that would result from shifting goods traffic from road to rail would result in fewer accidents, less congestion, lower maintenance costs, and fewer air pollutant emissions.

On the other hand, and as a counterpoint to the negative impact of trucks on fatal accident rates, the results presented here support the appropriateness of efforts made in road safety policy (based on specific traffic regulations by vehicle type introduced by member States) for counteracting the negative externalities of freight transportation in the EU. In this respect, the application by governments of stricter speed limit legislation and stricter BAC rates seems to be effective in reducing road traffic fatalities.

The findings of this research suggest that specific and stricter road safety policies should be implemented for trucks at the national level. These could act as a complement to other technical measures for accident avoidance taken at the EU level, such as the mandatory speed limiters that have been required for trucks for several decades, or the application of alcohol interlock devices for truck drivers (alcolocks) that is currently being discussed.

To summarize, our findings show that the differential treatment of trucks is not only appropriate for mitigating an important source of congestion and pollution, but that the implementation of stricter road safety measures in the case of trucks also contributes to reducing fatalities.

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