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“Are traffic violators criminals? Searching for answers in experiences of European countries”

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Abstract

The connection between road traffic safety and criminal behavior has recently become a topic of interest in the literature, although little emphasis placed on the relationship with road accidents. Evidence worldwide shows that people who commit other offences characteristic of antisocial attitudes, are more prone to suffer road traffic accidents and infringe traffic laws. Here we examine the records of the 28 current member states of the European Union over the period 1999-2010. Our aim is to test the hypothesis that crime rates (and specifically, motor vehicle-related crimes) may be considered as predictors of fatal road traffic accidents. If they may, this could justify, at least prima facie, the tendency in several countries to consider traffic offences as crimes in their penal codes and to toughen the punishment imposed on those who commit them. We also analyze the effect of the severity of the legal system applied to traffic offences. Our results reveal that road traffic fatality rates are higher in countries whose inhabitants have more aggressive behavior, while the rates are lower in countries with more severe penal systems.

JEL Classification: C33, I18, K42, R41.

Keywords: Road fatalities, Motor Vehicle Crime, Law enforcement, Panel Data, European Union.

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1. INTRODUCTION.

Road traffic accidents (RTAs) are a major cause of mortality and serious morbidity with high economic costs in the European Union (EU) (Castillo-Manzano et al., 2014; Orsi et al., 2012). Among the issues that contribute to the occurrence of RTAs, most of studies highlight behavioral factors as a principal explanation; particularly those that reduce capabilities (drowsiness, fatigue, alcohol or drug consumption) or increase risk while driving (traffic offences, driver stress, violence and aggressiveness in traffic, motor vehicle crimes) (Petridou & Moustaki, 2000 analyze this classification in depth).

After initial studies such as Portefield (1960), in the last two decades special attention has been paid in the literature to the connection between road traffic safety and criminal behavior. The roles of both traffic law enforcement (TLE) and legal systems have been highlighted as deterrence and punitive measures to improve compliance with traffic rules (see the comprehensive international overviews provided by Brace et al., 2009 and Zaal, 1994, respectively). Much research has provided evidence worldwide that people with antisocial attitudes who commit aggressive and other offences due to a lack of assimilation of social norms, are more frequently involved in risky driving situations and are more prone to RTAs and traffic violations (Broughton, 2007; Săucan et al., 2012; Sümer, 2003; West et al., 1993).

In fact, the relationship between road safety and criminality has been addressed by applying different psychological, sociological and criminological research approaches (Brace et al., 2009; Junger et al., 1995a, for a broad analysis). For instance: the tendency to commit crime according to personality traits (with the theory labeled as “Mild Social Deviance” based on involvement in accidents associated with expression of hostile attitudes, aggression and antisocial forms of behavior, Meadows et al., 1998; West et al., 1993); diverse situational hypotheses that suggest that the way one drives is closely linked to other behavioral traits in one’s personal and social life, because driving behavior is actually a part of a complex system determined by attitudinal and motivational factors that affect individuals in their relations with society (the so-called “Self-control Theory” and “Social Control Theory” and the “Hierarchical Approach” applied to traffic research by Hatakka et al., 2002; Junger et al., 1995b; Junger & Tremblay, 1999, among others).

However, the connection between criminal or unsafe behavior and road safety seems to be a relatively under-researched topic both nationally and above all internationally. Different causal links are explored in the literature, predominantly: between general crimes and traffic offences with an special emphasis in recidivism (Broughton, 2007; Palk et al., 2005; Rose, 2000); between antisocial or negative behavior (homicide, robbery, consumption of alcohol and illicit drugs) and dangerous driving (Everett et al., 1999; Marshall et al., 1996); and to a minor degree, the relationship between general criminal behavior and RTAs (in terms of the number or accidents, fatalities or injury rates) (Giacopassi & Forde, 2000; Porterfield, 1960). Although there is a general consensus on the main theoretical hypotheses that a strong correlation holds, certain authors state that this might be spurious and that the statistical association between crime and RTAs is actually the result of a common causal process related to socioeconomic context (age and

sex, risk exposure to accident, income level, unemployment, etc.), (Junger et al., 1995a, 1995b; Junger & Tremblay, 1999; Sivak, 1983).

Our contribution to the literature falls into this field. The main aim of the current study is to examine econometrically the association between criminal behavior and traffic fatalities per capita through a panel for the 28 current member states of the European Union (EU28) for the 1999-2010 period. We aim to test the hypothesis that crime rates (and specifically, motor vehicle-related crimes) may be considered as predictors of fatal RTAs. Following Brace et al. (2009) and Giacopassi & Forde (2000), there has been very little research undertaken to explore the effects of the relationship between general criminal behavior and crash involvement specifically.

We consider that our research has several advantages over previous studies that guarantee its originality. Firstly, this issue has received some attention from researchers in certain countries that have analyzed the issue at the national level; although, to our knowledge, no previous study considers a broad panel of countries, or focuses specifically on the influence of criminal behavior (not only general crime but also specific motor vehicle crime) on death from traffic accidents.

Secondly, our study also aims to explore the role of the legal system on the relationship between criminality rates and RTAs for the EU28 countries. Logically, the EU28 countries show a heterogeneous spectrum of cultural attitudes and social norms (Vereeck & Vrolix, 2007), and also a wide range of traffic law frameworks (e.g., several countries with better road safety records, such as the Netherlands, processes traffic offenses under administrative laws, while other leaders such as the United Kingdom apply a criminal traffic law system; ETSC, 1999). In fact, some studies state that compliance with the traffic rules (and with general law), is dependent not only on the social attitudes of road users or certain behavior (see e.g., Benedettini & Nicita, 2012 for the selective compliance and the so-called “Peltzman effect”), but also on the optimization of the law and its enforcement (TLE for traffic) that should form part of a global strategy to improve road safety: legislation, education, enforcement and judicial procedures (see e.g. Wegman, 1992).

The effects of changes in the level of sanctions (tickets and fines, jail sentences, demerit/penalty points systems) or enforcement (number of police officers, number of breath tests for alcohol/drugs, speed cameras) on the level of road safety (accident rates) has been analyzed by much economic research interested in an optimal allocation of scarce resources, but with no conclusive findings. Nevertheless, there seems to be general agreement that enforcement of road rules should be aimed primarily at deterrence, being accompanied by publicity that is unpredictable and difficult to avoid, with a mixture of highly visible and less visible activities and continued over a long period of time because the effects are short term (Stanojević et al., 2012; Zaal, 1994). Special attention has been paid by authors such as Deshapriya & Iwase (1996) and Tay (2005) to the severity of sanctions as a deterrence mechanism to increase the individual’s perceived risk of apprehension and punishment. In the road safety arena, stricter sanctions seem to achieve better and faster results if they are mainly determined by the legislature and administrative/judiciary system (i.e., the introduction of tougher jail sentences and punishments may reduce traffic violation rates, although for a limited period; see for example cases as varied as Castillo-Manzano et al., 2011 for Spain; Li et al., 2014 for Hong Kong; Liberatti et al., 2001 for

Brazil; Montag, 2014 for the Czech Republic or Sen, 2001 for Canada). Therefore, in this paper we examine the nature of the most severe legal systems as determining factors of the level of EU28 road safety.

In short, we attempt to determine if there may be a clear correlation between road fatality rates and the mainstream types of crime at an international level, which would serve to justify, at least *prima facie*, the increasingly widespread tendency to consider traffic offences as crimes and toughen the penalties imposed in the penal codes. Following this argument, we simultaneously analyze whether the degree of severity of the legal system applied to traffic offences could be a good tool in the constant struggle of Western societies to diminish the drama of RTAs.

After this brief theoretical introduction, the following sections present the methodological framework of our research, a discussion of our findings and finally a summary of our main conclusions.

2. VARIABLES AND METHODOLOGY.

In our empirical analysis, we develop a fixed-effects model that takes the following form for country i during period t :

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

where Y_{it} is the log of the total per capita fatality rate (within 30 days of the accident, according to the Vienna Convention definition)¹, X_{it} refers to variables that identify the criminal attitudes of the country's inhabitants, Z_{it} contains the vector of the country's economic and demographic attributes, and W_{it} are both the severity of legal system-related variables as proxies of law enforcement, and specific variables related to road safety policies. μ_i are country fixed effects that control for omitted time-invariant country-specific variables, v_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.

We use data for the EU28 countries for the time period from 1999 to 2010. This means that this is the broadest database in terms of both time and geography used in an analysis with these objectives. Table 1 provides the descriptions, information sources and descriptive statistics (mean and standard deviation) of all the variables used in the analysis.

[INSERT TABLE 1]

As we state above, the main aim of our empirical analysis is to examine whether the criminal attitudes of the inhabitants of a country have an effect on traffic fatality rates. According to earlier studies (Brace et al., 2009; Junger et al., 1995a; Junger et al., 2001b; Porterfield, 1960; Sivak, 1983; Sümer, 2003), we may expect a positive correlation between criminal activities and the

¹ Albalate (2008), Albalate & Bel (2011), Dee (2001) and Eisenberg (2003) consider that this is the most appropriate dependent variable for assessing road traffic fatalities as the interpretation of policy variables is clearer.

attitudes of drivers on the road, in the sense of a higher likelihood that they are involved in a fatal RTA. The hypothesis we test here is that levels of social aggression are a predictor of traffic accidents: higher crime rates are associated with more deaths on the roads, bearing in mind the possible influence of the spuriousness thesis supported by scholars such as Junger et al. (1995a) and Sivak (1983), as we mentioned in the Introduction above. In equation (1) we include four explanatory variables that identify the criminality rates of a country's population, and we also consider some control variables that are described in the following paragraphs.

We collected complete data for two variables related with general criminality rates, also used by previous empirical research, although it only considered specific countries (Giacopassi & Forde, 2000; Junger et al., 1995b; Junger et al., 2001a; Sivak, 1983): the number of homicides and the number of robberies. Moreover, as we mention above in the Introduction, almost all the earlier research focused on general crime variables or on typical driving violations-related variables, such as alcohol consumption (Deshapriya & Iwase, 1996; Petrie et al., 2010; West et al., 1993) or others, such as so-called "joy-riding" crime (Marshall et al., 1996).

Furthermore, we include two variables of crimes specifically linked to road vehicle traffic: the number of drug trafficking crimes and the number of motor vehicle thefts. All these variables are measured in relative terms according to the country's population. While we may expect that the coefficient associated with the crime variables is positive, such an effect should be particularly relevant for those variables, such as drugs, that are more linked to road vehicle traffic, in agreement with Gjerde et al. (2011) and Smink et al. (2005) for certain countries.

Along with variables related with different types of crime in the country's population, we also analyze whether the severity of the criminal justice system influences road mortality ratios. As a proxy for the severity of the penal/legal system in a country, we include an index variable that takes the value zero if no life imprisonment sentence may be applied, the value one if such a sentence is revisable and the value 2 if the indefinite sentence is not revisable. Our expectation is that the coefficient associated with this variable will be negative, following prior results of e.g., Castillo-Manzano et al. (2011), Liberatti et al. (2001) Montag, 2014 or Sen (2001) regarding the beneficial effects of stricter punishment applied to traffic violators, specifically on road safety outcomes. Indeed, the traffic fatality rates may be lower in countries with more severe penal/legal/administrative systems as the penal systems may have a strong influence on the social behavior of citizens and drivers.

We also consider additional variables for road safety policies. Following previous studies on road safety (Albalade, 2008; Castillo-Manzano & Castro-Nuño, 2012; Castillo-Manzano et al., 2013, 2014; Deshapriya & Iwase, 1996; Eisenberg, 2003), we consider the influence of preventive policies such as legal blood alcohol limits, and include a dummy variable that takes a value of one for countries and periods where the maximum blood alcohol concentration allowed is lower than 0.5 g/L. Most EU28 countries have set the limit at 0.5 or lower, so we are able to test whether blood alcohol concentration rates lower than 0.5 are effective in reducing road traffic fatalities.

Additionally, we include a variable that captures the application of points-based driving licenses. Indeed, one of the explanatory variables in equation (1) is an index variable that takes the value one if a penalty driving license system is applied, the value two if a demerit driving license system is applied and the value zero if any points system is applied. We expect to find a negative sign in the coefficient associated with this variable. The application of any points system to driving licenses may lead to lower traffic fatality rates although the long-term effect of this policy has been questioned (see Castillo-Manzano & Castro-Nuño, 2012, for an international meta-analysis of the effects of such policies).

Another road traffic policy variable that we take into account is for the maximum speed limit allowed on motorways. According to previous studies (Afukaar, 2003; Elvik, 2012), we may expect a positive sign in the coefficient associated with this variable, as a higher speed limit (and its subsequent enforcement) may have as a consequence higher road traffic fatalities.

With respect to control factors, we include variables that are typically used in studies of road traffic safety and that are related to the country's economic conditions. In this vein, we include the per capita gross domestic product (GDP) as an indicator of the country's economic development (Castillo-Manzano et al., 2013, 2014; García-Ferrer et al., 2007; Grimm & Treibich, 2012; Orsi et al., 2012).

The relationship between a country's economic development and road traffic fatalities is complex and we may expect that it takes a non-linear form (Anbarci et al., 2006; Bishai et al., 2006; Kopits & Cropper, 2005). Indeed, fatality rates may increase with economic development in very poor countries due to increased exposure to RTAs. However, the relationship between economic development and traffic fatality rates may become flat or even invert after reaching a certain wealth threshold. We test the hypothesis concerning non-linearity between GDP and traffic fatalities by including the GDP and the square of the GDP as explanatory variables. If the non-linear relationship is confirmed, then the coefficient associated with the GDP variable will be positive and the coefficient associated to the square of the GDP variable will be negative.

Meanwhile, studies show that overall crime rates and property crimes are higher when economic conditions are poor due to unemployment or recession (Krüger, 2011) with a positive relation evidenced for the EU by Altindag (2012), following the rational crime theory, because the opportunity cost of committing a crime seems to decrease and the net individual's benefit might be higher (Krüger, 2013). GDP is therefore quite a useful control variable when the intention is to study any possible correlation with crime rates.

The country's level of motorization is also taken into account. This variable is related to the development of private transportation. 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 RTAs. On the other hand, more developed countries may enjoy better infrastructure and vehicles,

more advanced policies and more beneficial social attitudes towards road safety (Kopits & Cropper, 2005). In this vein, Albalade (2008) and Albalade & Bel (2011) found a negative relationship between traffic fatalities and the level of motorization.

The number of passenger-kilometers weighted by country population is an additional explanatory variable in our model. This variable seeks to capture the intensity of traffic on the roads. We could expect a positive relationship between the amount of traffic and rate of road fatalities since the total amount of driving is an indication of the population's exposure to road accident risk (Albalade & Bel, 2011; McCarthy, 2005; Orsi et al., 2012). However, such a relationship could be dependent upon congestion levels (Li et al., 2012).

We also take into account the influence of the quality of the transport infrastructure by including a variable for motorway density. The expected sign of the coefficient associated to this variable is negative. Indeed, we may expect a negative relationship between the quality of transport infrastructure and road traffic fatality rates as found in Albalade & Bel (2012), Jamroz (2012) and Noland (2003).

Moreover, we also consider two control variables related with the percentage of vulnerable population in the country. First, we include a variable for the percentage of population over 60 years old. Second, we also consider a variable for the percentage of population aged 20-39 years old. While we may expect that risk exposure is higher for a younger population because younger road users usually take more risks (Langford et al., 2006), the impact of accidents may be higher for older road users so that morbidity and mortality are higher for older populations (Braver & Trempel, 2004; Yee et al., 2006). Thus, we expect a positive sign in the coefficient associated with both explanatory variables; but its statistical significance is not clear.

3. RESULTS AND DISCUSSION.

Table 2 shows the variance decomposition of the continuous variables used in the empirical analysis in two orthogonal components: the within-component (variability within each country) and the between-component (variability across countries). This table shows that the variability across countries is higher than the variability within each country for all variables except the vehicle-km driven.

[INSERT TABLE 2]

The estimates may present heteroscedasticity and temporal autocorrelation problems in the error term. The Wooldridge test for autocorrelation in panel data shows that we may have a problem of serial autocorrelation that must be addressed. However, the Breusch-Pagan/Cook-Weisberg test indicates that we do not have a problem with heteroscedasticity. We also apply the panel unit root test 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 there is no non-stationarity problem with our dependent variable.

Taking the results of these tests into account, we performed the estimation using the ordinary least squares (OLS) method including dummies for countries and years. To deal with the problem of serial autocorrelation, we assume an AR(1) process in the error term. Table 3 contains the results of the estimates of the determinants of road traffic fatalities equation.

[INSERT TABLE 3]

We find evidence of a non-linear relationship between road traffic fatality rates and countries' economic development. Indeed, the coefficient associated with the GDP variable is positive and statistically significant, while the square of the same variable is negative and also statistically significant.

The coefficient associated with the motorization variable is negative and statistically significant. Thus, we find lower road fatality rates in countries with higher levels of motorization. It seems that the effect of better infrastructure and vehicles prevails over higher exposure to RTAs. In a similar vein, we also find that the coefficient associated with the motorway density variable is negative and statistically significant, which confirms that the quality of transport infrastructure has a significant effect on road safety.

In addition, the coefficient associated with the variable of vehicle-kilometers driven is not statistically significant. More traffic on the roads implies higher exposure to accidents but this effect may be partially compensated by lower speeds (and therefore less severe accidents) due to congestion.

The coefficient associated with the variable for older populations has a positive sign and it is statistically significant, while the coefficient associated with the variable for younger populations is positive but not statistically significant. These findings are consistent with the idea that risk exposure is higher for a younger population, although the impact of accidents means that morbidity and mortality are higher for an older population. Indeed, elderly collision victims may have an increased risk of morbidity and mortality because of increased fragility.

Concerning road safety policies, those related to the maximum blood alcohol concentration and speed limits seem to be effective in reducing traffic fatality. The coefficients associated with both variables have the expected signs and they are statistically significant.

Importantly, we find evidence that the criminal attitudes of a country's inhabitants have a relevant influence on road traffic fatality rates. In particular, the coefficients of the variables that measure the number of crimes more specifically linked *prima facie* with traffic violations are positive and statistically significant. Indeed, higher numbers of drug trafficking crimes and motor vehicle thefts lead to higher road traffic fatality rates in the country. The coefficients of the other variables that measure the general level of criminality in the country, the number of homicides and robberies, are

also positive but not clearly statistically significant. Note here that the statistical significance of the variable for robberies is at the 11% level. In addition to this, the coefficient associated with the variable for life imprisonment is negative and statistically significant, as expected.

Note that these findings are obtained from a rich dataset that includes 28 countries for 12 years and by considering many control variables. The overall explanatory power of our model is very high with an R^2 close to 1. Hence, we should be confident that our results are not affected by spurious correlations due to the existence of omitted variables that are correlated with traffic fatalities per capita and the main explanatory variables we are interested in, as was suggested could be the case in the studies of Junger et al. (1995a, 1995b), Junger & Tremblay (1999) and Sivak (1983).

Overall, we find evidence that the road traffic fatality rates are higher in countries where the inhabitants have more socially aggressive behavior, while the traffic fatality rates are lower in countries with more severe penal systems. Tougher national legislation seems to send a signal to the population in general and drivers in particular, about the visibility of stricter TLE and heavier sanctions and penalties schemes, creating a deterrence effect on driving attitudes.

Both these results may be in line with the Giacomassi & Forde's theory (Giacomassi & Forde, 2000) known as "Crumpled Fenders" (the traffic equivalent to Wilson & Kelling's "Broken Windows" theory; Wilson & Kelling, 1982) about criminality rates (particularly motor vehicle crimes, in our case) that might be used as an indicator of lawlessness, leading not only to a disregard of traffic rules but to a higher fatal crash rate².

4. SUMMARY AND CONCLUSIONS.

As we detail in the Introduction above, the issue of the correlation between criminality and road safety has been addressed by many studies, but relatively few of them explore the relationship between criminal behavior and fatal accidents from an econometric perspective. There is a need for more detailed research in this area, especially into any link between crime and RTA outcomes (fatalities, injuries); and even more so when the research is carried out using a sample taken from a broad number of countries rather than only from the analysis of some specific case studies. This study therefore fills a gap in the research on this topic.

Our findings suggest that the relationships between traffic-related crime and becoming a victim of an RTA hold for a very broad range of economic conditions and traffic risk exposure, types of vulnerable population and diverse road safety policies. In particular, our research provides confirmation of a non-linear relationship between road traffic fatality rates and countries' economic conditions (according to previous scholars such as Anbarci et al., 2006; Bishai et al., 2006 or Kopits & Cropper, 2005); that the effect of better infrastructure and vehicles prevails over

² "The belief is that an orderly environment is necessary to establish pro-social community norms which, in turn, can be nurtured to support law enforcement and to suppress criminal behavior" (Giacomassi & Forde, 2000, p. 402).

higher levels of motorization (in line with Albalade & Bel, 2011; Jamroz, 2012 or Noland, 2003); that higher exposure to accidents (due to more traffic) may be partially compensated by lower speeds (due to traffic congestion), following Li et al. (2012); that risk exposure is higher for younger population although, from the point of view of the impact of accidents, morbidity and mortality are higher for an older population (consistent with Langford et al., 2006 and Yee et al., 2006); that road fatality rates are inversely related to strategies such as the maximum blood alcohol concentration rate allowed and speed limits (in accordance with Afukaar, 2003 or Deshapriya & Iwase, 1996), although we do not find clear effectiveness of the points-based driving license policy (following earlier studies, this policy may lead to reduced road deaths, but with a questioned long-term effect; see Castillo-Manzano & Castro-Nuño, 2012).

In addition, our results seem to support previous studies that have shown that fatal accident involvement might be predicted by an individual's criminal history and behavioral factors, even when we consider other control variables that could affect this correlation. However, unlike earlier studies based on experiences in specific countries (such as Brace et al., 2009; Junger et al., 1995a; Junger et al., 2001b; Porterfield, 1960; Sivak, 1983; Sümer, 2003), our study is of a broad sample: EU28 and a full twelve years of research, and shows that this is not a generic relationship but is limited to specific criminal behavior being linked to reckless driving. These are specifically the offense categories of motor vehicle theft and drug trafficking, which closely correlate with traffic accidents.

Another relevant result of our research is that there is also a clear correlation between a reduction in the road fatality rate and the life imprisonment variable, which can be considered to be a clear proxy of the general stringency of each country's criminal code. Thus, the severity of the sanction may be used as a deterrence mechanism to increase the individual's perceived risk of apprehension and punishment (a signal about the visibility of stricter TLE and heavier sanctions); and social control might be achieved through deterrence by stricter laws.

All these comments support the idea of a clear correlation between criminal behavior and RTAs, inasmuch as specific strategies used to contend with the former also help to reduce RTAs. The road fatality rates seem to be higher in European countries where the inhabitants show more socially aggressive behavior, while they are lower in countries with more severe penal systems.

Finally, together all these findings could be considered to be indirect empirical support for countries such as Brazil, Canada, the Czech Republic or Spain that have toughened sanctions to combat road accidents, either through heavier economic and administrative sanctions or even jail sentences, which are envisaged in their penal codes for reckless behavior behind the wheel. In short, it shows support for the countries that treat this reckless behavior and the people responsible for it as criminals.

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TABLE 1. Variables used in the empirical analysis.

| Variables | Description | Source | Mean | Standard Deviation |
|-----------------------|--|---|-------------|---------------------------|
| Per capita fatalities | Fatality rates per million inhabitants | CARE (EU road accidents database) | 108.44 | 45.04 |
| Life imprisonment | Index variable that takes the value 0 if no life imprisonment sentence may applied; 1 if imprisonment sentence is revisable (pardon, amnesty or other release may be applied); 2 if indefinite sentence is not revisable | INTERNATIONAL JUSTICE RESOURCE CENTER | 1.57 | 0.67 |
| Homicides | Number of homicides per 100,000 inhabitants (Intentional killing of a person, including murder, manslaughter, euthanasia and infanticide) | EUROSTAT | 2.24 | 2.31 |
| Robbery | Robbery crimes per 100,000 inhabitants (Stealing from a person with force or threat of force, including muggings- bag-snatching and theft with violence) | EUROSTAT | 88.83 | 70.35 |
| Drugs | drug trafficking crimes per 100,000 inhabitants (Illegal possession, cultivation, production, supplying, transportation, importing, exporting, financing etc. of drug operations which are not solely in connection with personal use) | EUROSTAT | 66.34 | 65.82 |
| Motor vehicle theft | Motor vehicle theft per 100 000 inhabitants (Theft of all land vehicles with an engine that run on the road which are used to carry people, including cars, motorcycles, buses, lorries) | EUROSTAT | 219.55 | 184.68 |
| Per capita GDP | Per capita gross domestic product in International Comparable Prices (US\$ at 2005 prices and PPP) | UNECE Statistical Division Database, compiled from official national and international (CIS, EUROSTAT, IMF, OECD) sources | 24960 | 11653 |
| Motorization | Number of registered vehicles per 1000 inhabitants | UNECE transport division, Eurostat, World Bank and national databases | 424.74 | 111.99 |
| Vehicles-km driven | Number of passenger-cars-km expressed in 1000 million km and weighted by national population | European Commission (Directorate General for mobility and transport) | 39.97 | 317.52 |
| Motorway density | Number kms of motorways divided by square km of the | EUROSTAT and UNECE | 1.69 | 1.73 |

| | country | | | |
|--------------|--|--|-------|-------|
| Old | % population over 60 years old | EUROSTAT | 20.67 | 2.52 |
| Young | % population aged 20-39 years | EUROSTAT | 28.75 | 1.92 |
| BAC_05 | Dummy variable that takes a value of 1 for countries and periods where the maximum blood alcohol concentration rate allowed is less than 0.5 | European Commission Road Safety Website | 0.28 | 0.45 |
| Point system | Index variable that takes the value 1 if the penalty system driving license is applied; 2 if the demerit system driving license is applied; 0 if any point system is applied | European Transport Safety Council (ETSC) | 0.92 | 0.88 |
| Speed limits | Maximum speed limits (km/hour) | European Commission Road Safety Website | 121.5 | 13.51 |

TABLE 2. Variance decomposition of continuous variables

| Variables | Variability across countries | Variability within each country |
|-----------------------|------------------------------|---------------------------------|
| Per capita fatalities | 37.68 | 25.60 |
| Homicides | 2.23 | 0.73 |
| Robbery | 65.18 | 29.99 |
| Drugs | 61.60 | 25.75 |
| Motor vehicle theft | 168.78 | 80.95 |
| Per capita GDP | 11610.77 | 2248.88 |
| Motorization | 105.03 | 42.40 |
| Vehicles-km driven | 147.84 | 282.27 |
| Motorway density | 1.73 | 0.26 |
| Old | 2.38 | 0.92 |
| Young | 1.68 | 0.96 |
| Point system | 0.68 | 0.57 |
| Speed limits | 13.74 | 0 |

TABLE 3. Results of estimates (Country fixed effects with an AR-1 disturbance)

| Independent variables | Dependent variable: Fatalities rates per capita |
|----------------------------------|--|
| Life imprisonment | -0.048 (0.01)*** |
| Homicides | 0.018 (0.014) |
| Robbery | 0.0006 (0.0003) |
| Drugs | 0.0004 (0.0001)*** |
| Motor vehicle theft | 0.0003 (0.00008)*** |
| Per capita GDP | 0.00006 (0.000018)*** |
| Per capita GDP ² | -4.39e-10 (1.33e-10)*** |
| Motorway density | -0.14 (0.02)*** |
| Motorization | -0.0007 (0.0002)*** |
| Vehicles-Km driven | -2.10e-07 (0.000011) |
| BAC_05 | -0.74 (0.24)*** |
| Point_system | -0.02 (0.013) |
| Speed limits | 0.02 (0.004)*** |
| Old | 0.06 (0.02)** |
| Young | 0.012 (0.011) |
| R-Sq. | 0.97 |
| Test joint sign (Wald χ^2) | 519258.91*** |
| Number observations | 326 |

Note 1: Standard errors are given in brackets

Note 2: Statistical significance at 1% (***), 5% (**), 10% (*)



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