Traffic Fatalities and Serious Injuries in Europe – A study of association with cultural, demographic and income variables

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ABSTRACT

This contribution reviews key data on road traffic fatalities across Europe and seeks associative links between the afore-mentioned data and per capita income, new car sales and national cultural dimensions of European countries. The rate of population shift from poverty to affluence has been exponentially growing in many countries, with access to products and systems having increased. Understanding the association between cultural dimensions and road fatalities can point, at the European level, to the countries, where national dimensions of culture represent a predisposition for greater or less risk adversity and safe or unsafe road behaviors. This study may hence assist decision makers, nationally and at European level to tailor prevention campaigns and safety programs and measures to each national reality and culture. The regression model showed a single independent variable within the model of traffic fatalities per capita, which was power distance.

Keywords: Power Distance, Uncertainty Avoidance, Traffic Safety, Risk Taking in Traffic

INTRODUCTION

Previous studies on car seat comfort (Coelho & Dahlman, 1999, 2012) and car design and infrastructure paradigms (Camboa & Coelho, 2010; Coelho & Camboa, 2010) touched upon safety concerns. In the current paper, an association approach (Coelho et al., 2013; Coelho, 2011) is used to identify cultural predispositions for behaviors conducive to traffic fatalities. In the EU, for every person killed on the road, an estimated ten are seriously injured. Some 250 000 people are estimated to be seriously injured in road accidents every year - compared to the 28 000 road fatalities in 2012 (europa.eu/rapid/press-release_MEMO-13-232_en.htm). An appropriate mix of legislation, awareness-raising, enforcement, engineering, cooperation and knowledge transfer among relevant stakeholders, for example through the European Road Safety Observatory, plus research support will be needed.

Per capita income, new car sales and national cultural dimensions (Hoefstede, 1980; Smith-Jackson & Essuman-Johnson, 2014) are used as independent variables against which association is tested with regard to fatalities and serious injuries, taking each EU country as a case. Demographic pyramid information, focusing on the percentage of citizens over 64 year of age (http://ec.europa.eu/transport/road_safety/specialist/knowledge/old/index.htm) is also used as independent variable. Additionally, the variance in national income is also characterized and used in the

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association study.

TRAFFIC RELATED DATA

Road Deaths

Road fatalities across the EU have decreased by 9% in 2012. In the following EU-27 countries are considered, in data for 2012 (or as close to this year as possible and available) (Table 1).

Table 1 - Country by country statistics on road deaths for 2012 (source: europa.eu/rapid/press-release_IP-13-236_en.htm)

	Fatalities per million inhabitants				**Evolution of fatalities**		
E. U. Member State	**1965**	**2010**	**2011**	**2012**	**Average annual decrease 2000-2010**	**2010-2011**	**2011-2012**
Belgium	147	77	78	73	-6%	2%	-12%
Bulgaria	91	103	89	82	-3%	-15%	-8%
Check Republic	150	76	74	71	-5%	-4%	-4%
Denmark	212	46	40	32	-6%	-14%	-18%
Germany	234	45	49	44	-7%	10%	-10%
Estonia	178	58	75	65	-10%	29%	-14%
Ireland	124	47	41	36	-7%	-12%	-12%
Greece	89	111	101	92	-4%	-9%	-10%
Spain	114	54	45	41	-9%	-17%	-9%
France	249	62	61	56	-8%	-1%	-8%
Italy	186	68	64	62	-6%	-6%	-2%
Cyprus	162	73	85	59	-5%	18%	-28%
Latvia	290	97	86	86	-10%	-18%	-2%
Lithuania	250	90	97	100	-9%	-1%	2%
Luxembourg	250	64	64	65	-8%	3%	3%
Hungary	86	74	64	60	-6%	-14%	-5%
Malta	36	36	51	26	-1%	40%	-48%
Netherlands	202	32	33	32	-7%	2%	-1%
Austria	252	66	62	64	-6%	-5%	4%
Poland	79	102	109	93	-4%	7%	-15%
Portugal	117	79	84	71	-6%	-7%	-16%
Romania	98	111	94	96	0%	-15%	1%
Slovenia	327	67	69	59	-7%	2%	-13%
Slovakia	128	68	60	55	-5%	-13%	-9%
Finland	230	51	54	48	-5%	7%	-11%
Sweden	170	28	34	31	-8%	20%	-7%
United Kingdom	146	31	31	28	-7%	3%	-12%
EU	171	62	60	55	-6%	-2%	-9%

In 2011, some 1.5 million people were reported injured on EU roads. Of these, around 250,000 were serious injuries (European Commission, 2014-a). But different EU countries use different reporting criteria, so the real figure – based on consistent medical criteria – could actually be significantly different. Comparable statistics across the European Union should be available, starting from the end of the year 2014. Hence, the following analysis considers comparable data across the European Union countries.

Older drivers have a relatively high fatality rate. Older drivers have the second highest fatality rate. Only the youngest group of drivers (18- and 19-year olds) has a higher fatality rate. Driver's age and fatality rate shows a well-known U-shape: fatality rates of the young drivers are high, after which the rate declines to a minimum for drivers of the age of 40-60 years. Then it increases again, to a maximum for those aged 75 and older. The injury rates, plotted against driver age also show a U-shape, but this one levels off on the right-hand side. Whereas young drivers (18-24 years old) have a relatively high injury rate as well as a high fatality rate, the injury rate for older drivers is much lower than their fatality rate (http://ec.europa.eu/transport/road_safety/specialist/knowledge/old/older_drivers_risky_or_at_risk/high_fatality_rate_more_crashes_or_more_severe_injuries.htm).
Individuals who have a low social status are more frequently involved in road accidents than individuals who have a high social status (ETSC, 2007). Research has been called for to study the association between social status and road accident risk, at the individual level. Based on a review made by Sælensminde (2001) and the review of de Blaeij et al. (2004), Table 2 shows the official monetary valuation of a road accident death in a number of countries according to ETSC (2007).

Table 2 – Official monetary valuation of a road accident death in selected European countries (ETSC, 2007)

country	Monetary valuation (Euro in 2002 prices)
Portugal	55,812
Spain	150,253
Greece	206,087
Poland	221,392
Belgium	462,717
France	589,177
Denmark	679,737
Italy	791,748
Austria	899,014
Ireland	1,170,695
Germany	1,266,000
Finland	1,273,372
Netherlands	1,741,000
Sweden	1,954,000
Switzerland	2,010,000
Great Britain	2,107,000
Norway	2,707,000

Passenger Vehicle Age, Density and Renewal

In 2010 cars in the EU were on average 8.3 years old (source ANFAC, ACEA, 2012), average car age for 12 European Union countries is shown in Table 3. Moreover, passenger car density per 1000 inhabitants in the European Union is also shown in Table 3. New passenger car registrations per 100 inhabitants in units for 2012 and 2012 GDP per capita are shown in Table 4.

Table 3 — Average passenger car age by country in 2010 (source: ANFAC, ACEA, 2012) for vehicles in use and passenger car density per 1000 inhabitants in the European Union (2011) (source, ACEA 2012)

country	**average car age (2010)**	**passenger car density per 1000 inhabitants (2011)**
Luxembourg	-	658
Italy	-	610
Malta	-	589
Lithuania	-	570
Finland	11.9	551
Cyprus	-	545
Austria	7.5	535
Germany	8.3	525
Slovenia	-	519
France	8.2	502
Belgium	8.0	490
Spain	-	482
Poland	-	470
Netherlands	-	470
United Kingdom	7.3	466
Sweden	9.8	464
Greece	10.7	461
Portugal	10.1	447
Czech Republic	-	436
Estonia	12.0	428
Ireland	6.3	417
Denmark	-	394
Bulgaria	-	368
Slovakia	11.5	324
Latvia	-	300
Hungary	-	298
Romania	-	203

Table 4 – New passenger car registrations per 100 inhabitants in units for 2012 (source ACEA, 2014) and 2012 GDP

per capita in PPS (Index EU28=100; Eurostat, 2014)

country	New passenger car registrations per 100 inhabitants (2012)	GDP per capita in PPS (Index EU28=100; 2012)
Luxembourg	9.8	263
Switzerland	4.9	158
Belgium	4.4	120
Austria	4.0	130
Germany	3.8	123
Norway	3.7	195
Iceland	3.5	115
United Kingdom	3.3	106
France	3.1	109
Denmark	3.1	126
Netherlands	3.0	128
Sweden	3.0	126
Slovenia	2.4	84
Italy	2.3	101
Finland	2.1	115
Ireland	1.7	129
Czech Republic	1.7	81
Spain	1.5	96
Cyprus	1.3	92
Estonia	1.3	71
Slovakia	1.3	76
Portugal	0.9	76
Poland	0.7	67
Hungary	0.5	67
Greece	0.5	75
Latvia	0.5	64
Lithuania	0.4	72
Romania	0.3	50
Bulgaria	0.3	47

Traffic Fatalities reported by Age Group

Fatalities reported by country (different years from 2009 to 2012) have been broken down according to age groups and shown in percentage according to age structure in Table 5.

Table 5 – Age group percentage of reported fatalities in EU countries (European Commission, 2014) and age structure for selected age groups for 2011 (Eurostat, 2014)

country	year	<15	15-17	18-24	25-49	50-64	65+
Belgium	2011	4% (17%)	2%	17%	41%	15%	22% (17%)
Bulgaria	2009	3% (13%)	3%	18%	41%	17%	18% (18%)
Czech Republic	2012	2% (14%)	2%	13%	42%	19%	21% (16%)
Denmark	2011	4% (18%)	4%	16%	29%	19%	29% (17%)
Germany	2011	2% (13%)	3%	18%	32%	18%	26% (21%)
Estonia	2009	4% (15%)	2%	22%	40%	13%	19% (17%)
Ireland	2010	3% (21%)	3%	27%	40%	13%	14% (12%)
Greece	2011	2% (14%)	3%	15%	41%	17%	23% (19%)
Spain	2011	2% (15%)	1%	11%	43%	18%	24% (17%)
France	2012	3% (18%)	4%	21%	37%	15%	20% (17%)
Italy	2010	2% (14%)	3%	14%	39%	16%	26% (20%)
Cyprus	2012	0% (17%)	4%	20%	45%	14%	18% (13%)
Latvia	2012	4% (14%)	3%	10%	40%	24%	20% (18%)
Luxembourg	2012	3% (18%)	6%	18%	41%	6%	26% (14%)
Hungary	2012	3% (15%)	2%	7%	39%	28%	20% (17%)
Malta	2010	8% (15%)	0%	31%	54%	8%	0% (16%)
Netherlands	2012	4% (18%)	2%	13%	30%	16%	33% (16%)
Austria	2011	2% (15%)	5%	15%	31%	18%	29% (18%)
Poland	2012	3% (15%)	2%	16%	37%	23%	18% 14%)
Portugal	2011	2% (15%)	1%	12%	34%	21%	30% (19%)
Romania	2012	4% (15%)	3%	11%	36%	23%	22% (15%)
Slovenia	2011	4% (14%)	3%	12%	44%	21%	16% (16%)
Slovakia	2010	3% (15%)	2%	19%	40%	21%	15% (13%)
Finland	2011	3% (16%)	5%	17%	32%	15%	28% (18%)
Sweden	2010	3% (17%)	2%	18%	31%	20%	26% (18%)
United Kingdom	2012	3% (18%)	4%	19%	35%	16%	23% (17%)

Official road accident statistics are incomplete and inaccurate in all countries. The level of reporting for injuries treated in hospitals is, on the average, less than 50%. Injuries are not always correctly classified by severity in police accident reports (ETSC, 2007). The long-term consequences of transport-related injuries within the EU are to a large extent unknown. Mortality rates are fairly well known in the different member states. Statistics on survivors are much less reliable, especially for slight injuries. These patients are usually only to a small extent included in the trauma registries or police records, even though the long-term consequences of injury might be severe (ETSC, 2007).

NATIONAL MEASURES OF CULTURE

The argument according to which culture exerts a profound influence on the innovative capacity of a society has been largely supported by empirical research. Barnett (1953) postulated a positive correlation between the individualism of a society and its innovative potential: the greater the freedom of the individual to explore and express opinions, the greater the likelihood of new ideas coming into being. Hofstede (1980) indicated that societies that score high on individualism and low on power distance tend to display higher growth and innovation rates. Shane (1993) found that individualistic societies that accept uncertainty and exhibit a low level of power distance are those who attain better innovation performance. Hussler (2004) introduced a culture-based taxonomy of innovation performance. Societies that succeed by innovating on their own are those that possess a "culture of endogenous innovation". Vice versa, those countries with high uncertainty avoidance and high power distance can be defined as "cultures of imitation". The four measures of national cultures, initially identified by Hofstede (1980, 2001), are summarized in the following paragraphs.

Power distance is the extent to which less powerful members of organizations expect power to be equally distributed (Hofstede, 1980). In low power distance countries there is limited dependence of subordinates on their bosses. Power is very decentralized as well as decision-making. In contrast, in high power distance countries, hierarchy is the fundamental principle on which all relationships are based. Power is centralized as well as decision-making, leading to more emphasis on formal methods for gathering and analyzing external information (Flynn and Saladin, 2006).

Individualism is the degree to which people are oriented towards acting as individuals as opposed to acting as a group (Hofstede, 1980). In individualist countries people tend to value individual success and achievement. Members of individualist countries are autonomous and confident, tending to rely primarily on their own ideas (Snell and Hui, 2000). In collectivist countries, people are bound in groups such as the extended family or the village and are more likely to rely on information provided by others in formulating their opinions (Snell and Hui, 2000).

Masculinity is the extent to which success and aggressiveness are valued (Hofstede, 1980). In high masculinity countries, high earnings, advancement through opportunities and challenging work are mostly emphasized. The use of information to support decision-making is dependent on its expected effectiveness in gaining advantage over competitors (Flynn and Saladin, 2006). In contrast, in high femininity countries, relationships, concern for the others, inclusiveness and society's best interest are valued. Cooperation is often a visible feature. The use of information to support decision-making is very typical of a feminine national culture (Wacker and Sprague, 1998).

Uncertainty avoidance is the degree to which people feel confident about the future (Hofstede, 2001). National cultures that score high in uncertainty avoidance have an emotional need for rules. Vice versa, national cultures that score low in uncertainty avoidance dislike formal rules, setting them only when it is necessary (Flynn and Saladin, 2006).

Long term orientation stands for the fostering of virtues oriented towards future rewards, in particular perseverance and thrift. It's opposite pole, short term orientation, stands for the fostering of virtues related to the past and present, in particular, respect for tradition, preservation of 'face' and fulfilling social obligations.

In what concerns the current validity of Hofstede's cultural measures, criticisms addressed to the construct of national culture as a suitable variable for differentiation, apply directly to all four measures (Coelho, 2011). Different corporate, organizational, industrial and/or sector specific cultures may co-exist within the same firm and might as well conflict and counterbalance the national one (Vecchi and Brennan, 2009). Furthermore, in many

countries, different ethnic or national cultures co-exist (Au, 2000), as result of people mobility around the globe. Within the same country, different sub-cultures might persist, standing apart on religious, language or ethnicity grounds. As a consequence, the four measures of national cultures could be far from being reliable proxies for cultural homogeneity for a given national culture (Vecchi & Brennan, 2009).

The data extracted from Hofstede's measures of national culture, that was used in the correlation analyses is presented in Table 6. The data has been cross-validated in an empirical study by Van Oudenhoven (2001) for Belgium, Denmark, Germany, United Kingdom, Greece, Spain and the Netherlands.

Table 6 - National culture dimensions for European countries (Hoefstede, 2001)

Country	**Power Distance**	**Uncertainty Avoidance**	**Individualism (vs. Collectivism)**	**Masculinity (vs. Femininity)**	**Long/Short-term Orientation**
Belgium	65	94	75	54	38
Bulgaria	70	85	30	40	-
Czech Republic	57	74	58	57	13
Denmark	18	23	74	16	46
Germany	35	65	67	66	31
Estonia	40	60	60	30	-
Ireland	28	35	70	68	43
Greece	60	112	35	57	-
Spain	57	86	51	42	19
France	68	86	71	43	39
Italy	50	75	76	70	34
Luxembourg	40	70	60	50	-
Hungary	46	82	80	88	50
Malta	56	96	59	47	-
Netherlands	38	53	80	14	44
Austria	11	70	55	79	31
Poland	68	93	60	64	32
Portugal	63	104	27	31	30
Romania	90	90	30	42	-
Finland	33	59	63	26	41
Sweden	31	29	71	5	33
United Kingdom	35	35	89	66	25

RESULTS OF ANALYSIS OF ASSOCIATION

The percentage of fatalities for under 15 years of age is strongly correlated with individualism (rho=0.619; p=0.011) and long-term orientation (rho=0.693; p=0.003). The percentage of fatalities in the age group from 15 to 17 years old is negatively correlated with uncertainty avoidance (rho=-0.546; p=0.029) and power distance (rho=-0.541; p=0.031). Interestingly, opposite results are obtained for the 25 to 49 year old group, showing strong and positive correlations with power distance (rho=0.557; p= 0.025) and uncertainty avoidance (rho= 0.560; p= 0.024).

A composite variable obtained by calculating the ratio between the two variables obtained in the two last columns of Table 6, which is a variable that provides a measure of the degree to which more people in the 65 plus age group die in traffic accidents than the demographic structure would support, showed a correlation with masculinity. It is a negative correlation (rho=-0.590; p=0.016). Additionally, the GDP per capita shown in Table 4 is negatively correlated with power distance (rho=-0.598; p=0.014).

Total fatalities per country in the period from 2010 to 2012 are very much associated with two dimensions of national culture: power distance and uncertainty avoidance. The Spearman rank order correlation coefficients and significance are shown in Table 7.

Table 7 – Association between fatalities per capita per country in the period from 2010 to 2012 are very much associated with two dimensions of national culture obtained from Spearman rank order correlation coefficient analysis (significance shown as p-values in parentheses).

Reference year	Power Distance	Uncertainty Avoidance
2010	0.654 (0.006)	0.853 (0.000)
2011	0.627 (0.009)	0.831 (0.000)
2012	0.600 (0.014)	0.817 (0.000)
2010 to 2012 (average)	0.651 (0.006)	0.857 (0.000)

Moreover regression analysis using the backward entry method (Hastie, 2009) was used as a means to test the possibility of modeling the phenomenon. The regression model showed a single independent variable for fatalities as dependent value, this was power distance.

DISCUSSION

Deaths of people under 15 years of age are associated with high individualism and high long term orientation. Individualism is the degree to which people are oriented towards acting as individuals as opposed to acting as a group. As people under the age of 15 may not be driving automobiles, but can be driving bicycles and in some countries mopeds, it would be necessary to expand the data to understand if these underage deaths result from being a passenger or a two-wheeled vehicle driver. Hence individualism can harm passengers of this age or the driver her or himself in the latter case. Long term orientation stands for the fostering of virtues oriented towards future rewards, in particular perseverance and thrift. Hence the association between this cultural dimension and fatalities in this age group is somewhat unexpected.

Fatalities in the age group from 15 to 17 years old are negatively correlated with uncertainty avoidance and power distance. This may be explained by the association of low uncertainty avoidance and low power distance with more affluent countries, where people in this age group have access to motorized vehicles (e.g. scooters). The biggest age group (25 to 49), shows positive correlation for fatalities and uncertainty avoidance as well as for fatalities and

power distance. This may be explained by the fact that societies with high uncertainty avoidance and high power distance have a tendency to 'bend' rules and have decision-making centralized.

More feminine countries have a higher rate of fatalities than more masculine growth for the age range over 65, because in the former, more women have been driving for longer and they outlive men, and keep driving well past 65. Hence, more older drivers on the road and greater longevity of women explains this association.

Interestingly, economic indicators such as GDP per capita, included in the analysis, did not show any association with fatality data across the European union countries, but in this case GDP per capita is negatively associated with power distance. This is a reminder that any many of the less affluent European countries, the difference between rich and poor has been growing.-

The results are extremely clear in what concerns power distance and uncertainty avoidance, as these are strongly and significantly associated with fatalities per capita. In high power distance countries, hierarchy is the fundamental principle on which all relationships are based. Power is centralized as well as decision-making, which strongly associates with increased traffic fatalities. Uncertainty avoidance is the degree to which people feel confident about the future. National cultures that score high in uncertainty avoidance have an emotional need for rules. Apparently traffic rules are not totally fulfilling that need, at least not in every occasion, given the high number of per capita traffic fatalities registered.

These countries with high traffic fatalities per capita also have inherent high uncertainty avoidance besides high power distance can be defined as cultures of imitation, as opposed to countries of innovation.

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