

# Motorway performance in Europe and Greece

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## Abstract

In terms of road safety, motorways offer much better records as compared to other road types. In EU motorways represent an approximately 10% of all paved road network. Greece has until recently a significantly lower percentage but during the last 15 years this percentage has been sharply increased to approach the EU average. The paper provides a comparative analysis of motorway safety between Greek and the EU motorways using certain safety indicators, mainly fatality rates. The analysis is particularly concentrated in similar to Greece EU countries. Overall, Greek road safety records are traditionally poor compared to other EU countries, aggressive driving being the main reason. However, safety records in Greek motorways are comparable to those of EU motorways, hence the many km of newly constructed motorways in Greece have been contributed to improve country's safety indices.

*Keywords:* motorways; road safety; safety indicators; road fatality index.

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## 1. Introduction

Road safety in motorways is systematically better than in other road types. Any accident rate on motorways is significantly lower than on main trunk or other primary highways connecting urban areas or other major trip generators. This occurs in spite of the significantly higher speeds in motorways and is mostly attributed to both access control and the separation of traffic streams. Motorway is an expensive road infrastructure but offers value for money, all speed, comfort and travel safety together. It is in favour of traffic safety to upgrade trunk roads to motorways.

In most EU member states, motorways represent a small percentage of all primary and secondary roads of the national and regional network which varies between 1% and 27% (EU15). In Greece this figure has been at the lower limit until 2004; since then it has been sharply increased, exceeding 5%. Road safety levels have been also improved as a consequence of that.

Traffic safety levels vary widely within countries and road types, the least variation met in motorways. However, even in motorways traffic safety levels depends on geometric characteristics, traffic volume and composition, vehicle speeds and speed variation, posted speed limits and the country's driving culture.

The aim of this paper is to compare motorway safety performance among EU states emphasising on Greek motorways and how they contributed to alter safety indices in the latest years. It also attempts to interpret

relevant findings and to identify some of the possible causes for that.

Data have been obtained by OECD, international and European transport and safety websites, Hellenic Police, Hellenic Motorways (Egnatia Odos, Attica Odos etc.), Eurostat and Greece national statistical service. Statistical data have been homogenised and analysed to serve the objective to compare motorway safety in the EU and Greece.

Many safety indicators could be used, both simple and combined, concerning accident types and severity. Fatality index has been selected as the most suitable. Indicators should be deduced to road type length and/or to millions of vehicle-kilometres travelled.

## 2. Road safety in Europe versus Greece

Road safety in the EU as a whole has definitely been improving during the last years. Ambitious objectives set by the EU respective policy have not exactly met but quite well approached in most member States. Figure 1 shows the actual versus the target road fatalities in the EU of 15 member States during the period 1990-2010, Papaioannou et al [1]. These older data are presented to show a quite effective implementation of road traffic policy. An overall reduction of 45% has been achieved. For the current decade, 2010-2020, the target of halving road fatalities by 2020 seems difficult. In following Tables a stagnation may be detected. However, new fields helping traffic safety emerge and will flourish

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during the next decade 2020-2030, concerning automations, artificial intelligence and vehicle interconnection. Levels of auto pilot, for instance, would enhance safety. Vehicle industry has announced huge alliances and investments towards auto pilot level 5, a driver independent status of driving. There are estimations that auto pilot and vehicle interconnection might cut accident figures by as much as 90%. Since all these are still conjectures no relevant reference is provided. On the other hand the noiseless motion of electric vehicles may boost accident figures in urban areas.

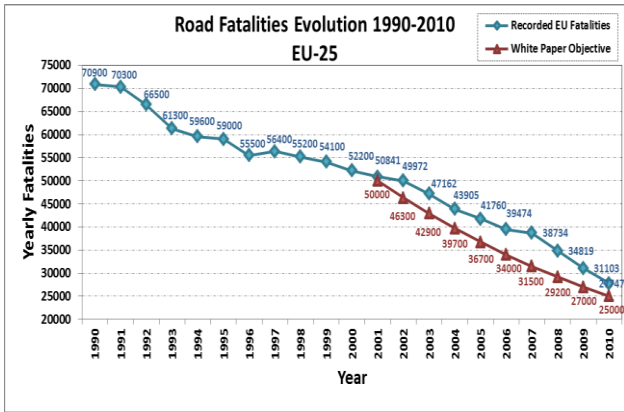


Fig. 1: A historic plot of 20-year reference EU-25 fatalities: recorded versus white paper objectives

For comparison Figure 2 presents the safety performance in Greece in the same reference period of 1990-2010. A gentler slope of accident reduction curve is obvious. A worth noting peak is also detected during years 1998-2000. The peak is actually erroneous, because during that period the definition for a heavy injury road accident has been changed in Greece and adapted to the EU standard, concerning both types of injuries and days of hospitalization. During 1998, a change in accident reporting and registering procedure, also reduced underreporting. For a road fatality the definition is that of a death within a 30-day period due to injuries received in the road crash. Overall, historically, accident safety performance in Greece was both worse and slower improving than in other EU countries. In an attempt to explain that slow improvement, the reference period 1990-2010 was a prosperous carefree period for the Greek society bucking against austere targets and transformations.

As been mentioned, the length of motorways in the various EU member States varies between 1% and 27%. Table 1 presents the length of motorways and of all other primary and secondary rural roads in the various member States and its share in % terms. States are presented in alphabetical order, apart from Greece which is given at the top of the Tables. Greece lags in motorway length figures. However, during the recent 20 years (2000 – 2020), motorway construction plans in Greece flourish and the relevant figures have been

impressively improved. Figures and percentages of rural roads are fuzzy, because there are differences in the border between secondary rural roads (included) to lower-type rural roads (not included) among countries.

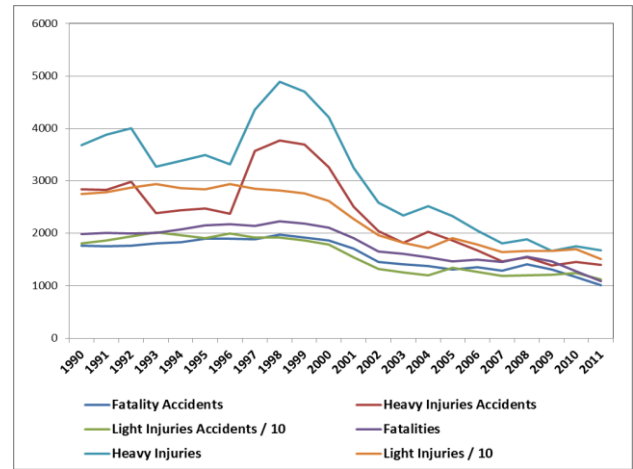


Fig. 2: Evolution of accidents, fatalities and injuries in Greece during the same reference period 1990-2010

Table 1: Length (km) of motorways and rural road types in EU member states (2000, 2010). Percentage for 2010 figures

Country	Motorways 2000	Motorways 2010	Rural Road 2010	% of M/ways to rural r.
GR	600	1.300	40.000	3,2
AT	1.600	1.700	35.000	5
BE	1.700	1.800	15.000	12
CZ	700	700	55.000	1,3
DE	12.000	13.000	220.000	6
DK	900	1.200	75.000	1,6
ES	9.000	14.000	150.000	9
FI	600	800	27.000	3
FR	10.000	11.500	390.000	2,8
HU	1.100	1.300	31.000	4,2
IE	100	450	17.000	2,6
IT	6.500	6.800	180.000	3,7
LT	350	350	20.000	1,7
LU	120	150	3.000	5
NL	2.300	2.600	10.000	26
PL	700	900	50.000	1,8
PT	1.500	2.700	10.000	27
SE	1.500	1.900	100.000	1,9
SI	600	700	6.000	11,5
UK	3.500	3.700	175.000	2,1
Totals	55.000	65.000	1,6 million	4

Table 1 shows that, apart from Greece, Ireland, and Portugal are also the member States with the highest increase in motorway length during the reported time period. Netherland and Portugal are the states with the highest % of motorways followed by Belgium. It should be relevantly commented, that, apart from the poorer economic indices for Greece, the country has a particularly ragged terrain making the construction of motorways more expensive per kilometre length.

Rounded figures have been generally preferred to accurate ones. It is the simplest way to reduce the ‘noise’ at the various indices and showcase the main trends. Also, among the many traffic safety indices, only the one concerning the fatalities has been selected for emphasis. Generally all safety indices provide consistent results, but that referring to fatalities is the most depressive and readily perceived one.

In Table 2 the average yearly motorway fatalities in European countries are displayed against relevant figures in Greece. Fatalities are presented in rounded 4-year periods. This is to reduce both the extent of the Table and the noise of a year-to-year variations, which may obscure the real trend. Comparably to countries of similar extent bigger figures are acknowledged for Greece. Also the decline of the fatalities is not as sharp as in other States.

Table 2: Average yearly fatalities along European countries’ motorways

Country	2000-2003	2004-2007	2008-2011	2012-2015	2016-2019
GR	80	110	90	70	50
AT	180	110	80	50	35
BE	200	150	110	100	100
CZ	45	40	30	30	25
DE	800	690	440	400	400
DK	40	40	35	15	15
ES	360	160	90	70	80
FI	20	15	10	10	5
FR	560	330	270	240	280
HU	50	60	45	30	
IE	5	10	10	10	5
IT	770	700	380	220	280
LT			30	15	10
LU	100	85	60	75	70
NL	50	35	40	50	70
PL	130	110	110	65	50
PT	30	25	20	30	25
SE	25	25	25	20	20
SI	200	200	110	100	100
UK	950	800	600	350	210

Data for Tables 2 and 3 have been obtained compoundedly by many sources [2-5].

The temporal motorway fatalities increase in Greece during the period 2004-2007 is attributed to the coincidental sharp increase in the length of trafficked motorways.

During the last four year period, an increase at motorway accident fatalities can be spotted in few countries as well as a stagnancy in many more. Actually, advanced in traffic safety countries, have achieved the peaks at traffic safety indices beyond which any improvement would be very difficult and marginal by existing means. Hopes for impressive further safety improvement are put on the eminent electronic and artificial intelligence evolutions.

Fatalities across the rest rural road network are presented in Table 3. It is necessary to show these figures as a reference, because the length of motorways may vary considerably, whilst the length of the primary and secondary rural roads are almost constant and representative to the extent of each country. Empty slots means that relevant data could not be found.

Table 3: Average yearly fatalities along European countries’ rural roads

Country	2000-2003	2004-2007	2008-2011	2012-2015	2016-2019
GR	950	800	600	350	210
AT	550	460	340	170	170
BE	840	640	460	350	310
CZ	800	600	490	460	360
DE	300	200	140	120	110
DK	4500	3000	2400	2400	2200
ES	4500	3000	1900	1250	1350
FI	300	270	210	200	170
FR	5300	3300	2600	2200	2400
HU	750	750	460	360	
IE	300	290	150	130	120
IT	3000	3100	2100	1600	1900
LT			530	250	130
LU	70	50	40	30	10
NL	560	400	260		
PL	3000	3000	2400	1800	1600
PT	950	690	400	240	170
SE	400	300	220	190	240
SI	170	100	100	50	30
UK	2400	2200	1300	1200	1200

It should be mentioned that Table 3 does not present all the other fatalities in the European countries road network. There are few fatalities in lower hierarchy

rural roads, as well as quite strong figures in urban areas. Comparably to countries of similar population bigger figures are again acknowledged for Greece. However, the improvement of road safety in terms of fatalities decline is as sharp as in other States. Greece having the most unfavourable starting point achieves rival safety improvements. It worth mentioning that Greece lags analogue EU countries by almost twenty years.

However, the proper denominator should neither be country's extent nor population. The proper denominator over which all traffic accident figures should be reduced is the relevant number of the travelled vehicle-kilometres. This best measures the exposure to traffic incidents. Vehicle-kilometres per road type is a difficult figure to be obtained. Consequently, the second best ratio would be used, that of fatalities to the length of the relevant category road network. This is considered a better indicator than that of the number of registered vehicles, because the study is concentrated in motorways. A combination of figures of Table 1 and 2 would yield the average yearly fatalities in 4-years subperiods per motorway kilometre along European countries. These figures are presented in the following Table 4.

Table 4: Average yearly fatalities per motorway km along European countries

Country	2000-	2004-	2008-	2012-	2016-
	2003	2007	2011	2015	2019
GR	0,12	0,11	0,07	0,05	0,04
AT	0,11	0,07	0,05	0,03	0,02
BE	0,05	0,05	0,04	0,03	0,02
CZ	0,05	0,05	0,04	0,03	0,02
DE			0,09	0,05	0,03
DK	0,09	0,06	0,05	0,03	0,02
ES	0,05	0,05	0,05	0,04	0,03
FI	0,12	0,07	0,05	0,03	0,02
FR	0,02	0,01	0,01	0,01	0,01
HU	0,05	0,04	0,03	0,03	0,02
IE	0,03	0,02	0,02	0,01	0,01
IT	0,04	0,04	0,03	0,03	0,02
LT	0,02	0,02	0,01	0,01	0,01
LU	0,07	0,06	0,04	0,03	0,03
NL	0,04	0,02	0,01	0,01	0,01
PL	0,06	0,04	0,03	0,02	0,02
PT	0,1	0,1	0,07	0,04	0,03
SE	0,08	0,05	0,05	0,05	0,05
SI	0,06	0,06	0,04	0,03	0,03
UK	0,12	0,08	0,04	0,03	0,03

Figures for travelled vehicle-kilometres along motorways are available for Greece. The ratio of motorway fatalities to travelled vehicle-kilometres are presented in Table 5.

Table 5: Average yearly fatalities per 10<sup>9</sup> vehicle-kilometre along Greek motorways

Country	2000-	2004-	2008-	2012-	2016-
	2003	2007	2011	2015	2019
GR	20	13	11	8,5	6,5

The trend, as well as the rate of reduction is similar to that of Table 4. This secures the conclusion drawn by studying Table 4 only.

Generally, to compare traffic safety indices along motorways is the safest way to evaluate certain traffic safety issues. Motorways have the most consistent and of high quality characteristics in all countries, thus traffic safety indices along them reflect differences mainly in traffic monitoring and policing, speed limits and driver's behaviour. Delving into Table 4 figures, Greece has systematically the worst traffic fatalities ratios. However, these ratios are not as bad as the absolute figures presented in Tables 2 and 3, relatively to the rest EU countries. The sharp increase in Greek motorway network during the 20 year period of the study improved the traffic accident fatality ratio.

However, in 2019 Greek motorway fatality ratio remains one of the highest. First parameter to explain that is the poor policing applied along Greek motorways. The operation and utilization of Greek motorways belongs mostly to the private sector. Traffic monitoring is in a European average level, but traffic policing lags. Also, vehicle age is higher comparing to other European countries, but very few accidents (2%) are mainly attributed to vehicle failures, Mungnimit [6]. Greek driver's behaviour is rather aggressive. They ignore Highway Codes suggestions mainly due to the poor policing. Driver's behaviour is generally the main cause of traffic accidents and the leading variable explaining the worse than average Greek motorway safety performance.

It is a principle that comparisons are more realistic under similar conditions. In Table 4 European countries independently their size, terrain type or traffic safety culture are presented. The ragged terrain of Greece has no match to many other EU countries. Thus, it would be interested to constrain the comparison among same size countries to Greece. In Figure 3 the average yearly fatalities in 4-years subperiods per motorway kilometre for similar to Greece EU countries is presented. As such, Czech, Hungary, Eire, Lithuania and Portugal have been selected. Greece has, historically, the poorest traffic safety records among EU countries, thus it is not fair and realistic to be compared with other similar to population

countries like Netherlands, Belgium or Danish, having excellent traffic safety performance for decades. The case of Austria is specific. Austria is the only EU country having a similar (actually more) ragged terrain to Greece. The comparison of Austria versus Greece is independently presented in Figure 4.

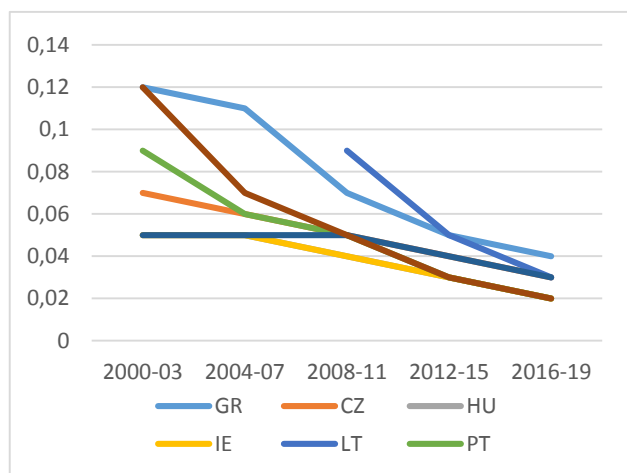


Fig. 3: Motorway fatality numbers for similar to Greece countries

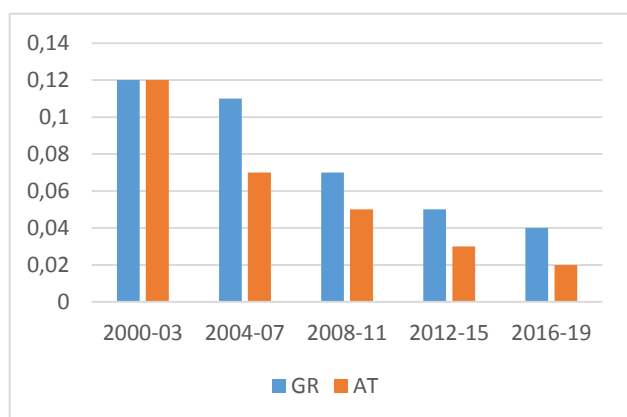


Fig 4: Motorway fatality numbers for Greece and Austria

Again among somehow similar European countries, Greece has the poorest motorway safety records. Lithuania, a country recently entered the European Union, with poorer entry relevant records has outperformed Greece in 2016-19 period. However, the differences are not prominent, motorway safety records for Greece (as already mentioned) are quite near to other similar European countries.

The same is valid for Austria as well, a country with better established traffic safety culture (figures by Table 2) and a comparable to Greece ragged terrain. Actually, Austria and Greece have a similar motorway safety starting point (year 2000), but Austria achieved a better improvement during that 20-year period, being a more discipline and better policed society.

A final aspect of European motorway safety is presented in Table 6. This table gives a comparison of an average percentage distribution of motorway fatalities per mode of transport for the 21 EU member states and for Greece. The only figure that clearly differentiates between Greece and EU-21 countries are those of the contribution of lorries and 2-wheelers. Greece, lying at the edge of Europe, has the lowest percentage of lorries in her motorways. Also, the mild climate of Greece encourages more kilometres to be travelled by 2-wheelers, therefore the higher participation in traffic accidents of this mode of transport is absolutely unsurprising. It should be mentioned, however, that a typical motorway accident involving a 2-wheeler has higher death rates than one without a 2-wheeler. This observation may partly explain the higher fatality rates met along Greek motorways.

Table 6: Comparison of % distribution of motorway fatalities per mode of transport (EU-21 versus Greece)

	Cars	Lorries	2wheelers	Ped.	Others
EU-21	65,2%	13,5%	11,3%	8,2%	1,8%
GR	64,2%	6,7%	20,0%	8,2%	1,0%

### 3. Discussion and conclusions

The higher design standards of motorways enhance safety. Along motorways traffic accidents are seldom comparing to other road types. In this respect, the higher the percentage of motorways in the total road network the better the road safety in the country. During the recent 20 years (2000 – 2020), motorway construction plans in Greece flourish and the relevant figures have been impressively improved and approach EU averages. The most representative and most impressive road safety indicator is that of fatalities reduced to fatalities per kilometre of motorway network.

Greek motorway safety, as expressed by fatalities per motorway length is worse than the EU averages. Even for similar to Greek countries by size or by type of terrain, Greek motorway safety performance lags. That hysteresis can be quantified to 20-50%. The poorer safety performance may be attributed to deficient policing, more aggressive driving behaviour and greater percentage of 2-wheelers.

An in-depth examination of accidents along Greek motorways, as well as along the whole road network, is necessary in order to determine the most important causal factors. The full application of a recently introduced safety audit methodology is expected to contribute towards this goal, PIARC [7, 8]. Relevant projects have started to be materialized during recent years both along motorways and the rest primary road network.

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