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European Countries' Road Safety Evaluation by Taking Into Account Multiple Classes of Fatalities

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Context

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Introduction

• The road safety conditions in Europe are such that allow the characterization of the European roads as the safest in the world.



The United Nations General Assembly Proclaimed the decade 2011-2020 as the "Decade of Action for Road Safety".

HOWEVER

 This target was not met entirely, since a lot of road deaths still recorded in Europe (European Commission). Additionally, fatalities of vulnerable road users (pedestrians, cyclists and motorcyclists) had also a fall in their numbers but in a slower trend.

THEREFORE

• It is essential supporting the road safety strategies of the EU countries that have an under-performing system (in terms of road safety levels), by incorporating socio-economic and demographic factors and providing a comparative analysis of the performances of EU countries.

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Scope

Support of road safety policymakers by:

- Investigating the road safety performance of 18 EU countries over the time period 2007-2016 for 5 different types of road users.
- Incorporating the exposure level and the socio-economic and demographic context of the EU countries.
- Measuring the effects that the socio-economic and demographic factors have on the EU countries' road safety performance.



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Data



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Car Occupant (fatalities per million population) Nethenlands Malta Sweden Cyprus Belgium Poland Norway Ireland Estonia Latvia Germany Denmari Lithuania Italy France Slovenia Croatia Czechia Hungary Finland Buigaria Romania Luxembourg Greece

Bulgaria is in the top place recording the highest number of fatalities and Malta is in the last place (Year 2016).

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Greece and Cyprus recorded highest numbers of Powered Two Wheelers (PTW) fatalities (Year 2016)

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HGVs(fatalities per million population)



Portugal, Latvia, Poland, and Croatia record the highest numbers of Heavy Goods Vehicles (HGVs) fatalities (Year 2016)

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Pedestrian(fatalities per million population)



Romania, Latvia, Poland, and Lithuania have the highest numbers of pedestrian fatalities (Year 2016)

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Cyclist(fatalities per million population)



Netherlands, Romania, Poland, and Hungary recorded the highest numbers of cyclists' fatalities (Year 2016)

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Methodological Framework-2 Stage Approach

- <u>1st Stage Approach</u>: For the investigation of the road safety performance of 18 EU countries over the time period 2007-2016 for the 5 different types of road users a Benchmarking analysis was implemented, namely, Data Envelopment Analysis (DEA).
- <u>2nd Stage Approach</u>: For measuring the effects that the socio-economic and demographic factors have on the EU countries' road safety performance (which was identified from DEA), Tobit regression was developed.



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Methodological Framework-DEA

DEA is a linear programming methodology that compares the service units (e.g., countries) considering the socio-economic and demographic factors and provides the rankings of the countries (best-performing or under-performing), in terms of performance. The measure of efficiency in DEA is the maximum of a ratio of weighted outputs to weighted inputs subject to some conditions-constrains. However, for the purposes of using DEA for studying the road safety performance of the Decision Making Units (DMUs) which are the EU countries, it is important that the measure of efficiency change, i.e. minimum output level (fatalities) given that of the inputs.

min θ_o^t

Subject to:

$$\sum_{j=1}^{s} x_{ij}^{t} \lambda_{j}^{t} \geq x_{io}^{t}$$
; $i = 1, ..., m$

$$\sum_{j=1}^{m} y_{ij}^t \lambda_j^t \leq \theta_o^t y_{ro}^t$$
; $r = 1, ..., s$

 $\lambda_{i}^{t} > 0; j = 1, ..., n$

Where $\min \theta_o^t$ is the uniform proportion reduction in the DMUo's, λ_j^t with j=1,...,n is the dual weight given to the jth DMU's inputs and outputs and x_{ij}^t and y_{ij}^t are the vectors containing the ith input and output respectively of the jth DMU concerning the tth year of the variables.

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Methodological Framework-Tobit

The concept of Tobit was employed for analyzing what determinants affect the efficiency of the region's road safety performance. The reason for developing Tobit and not a classic regression model was due to the capability of Tobit of analyzing censored data and thus Tobit is also known as the censored regression model.

Where, N is the number of observations (i.e., 18 countries), y_t is the dependent variable (efficiency scores), X_t is a vector of independent variables, β is a vector of unknown coefficients, and u_t is an independently distributed error term assumed to be normal with zero mean and constant variance σ_2 .



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



Spain, Italy, France etc. are benchmarking countries for the under-performing countries concerning the factor "GDP per capita".



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, Germany, etc. are benchmarking countries for the underperforming countries concerning the factor "Passengers Cars".



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, Germany, etc. are benchmarking countries for the underperforming countries concerning the factor "New passenger car registration".



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, Germany, etc. are benchmarking countries for the underperforming countries concerning the factor "Buses & Coaches".

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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, etc. are benchmarking countries for the under-performing countries concerning the factor "Pump price for diesel fuel".



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, etc. are benchmarking countries for the under-performing countries concerning the factor "Total length of road network".



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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, Germany, benchmarking are etc. for the undercountries performing countries concerning the factor "Registered Powered Two Wheelers".

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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, Spain, Germany, etc. are benchmarking countries for the under-performing countries concerning the factor "Registered Passenger Cars".

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Best-performing and under-performing countries were identified, and benchmarking countries were denoted for every under-performing countries based on the different explanatory variables.



UK, France, Spain, Germany, etc. are benchmarking countries for the underperforming countries concerning the factor "Total registered vehicles".

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Application and Results-Tobit

Tobit was able to measure the extend of affection that socio-economic and demographic factors have on the road safety performance of the 18 EU countries over the period 2007-2016.

For example: In 2014 pump price for diesel fuel had an affection to the countries' road safety performance by increasing their performance and thus decreasing road fatalities. This measure can be considered to the policymakers as a measure for decreasing fatalities.

	Variables/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Intercept	0.219 (0.370)	-7.260e-03 (0.325)	0.819*** (0.049)	0.470*** (0.092)	0.751*** (0.057)	0.615*** (0.095)	0.058 (0.338)	-0.110 (0.288)	0.059 (0.311)	0.198 (0.229)
	GDP per capita	-	-	-	8.714e-06** (3.192e-06)	-	6.102e-06. (3.152e-06)	-	-	-	-
	Total length of road network	-	-	-	-	-	-	-	-	-	-
	Pump price for diesel fuel	0.468. (0.258)	0.553* (0.234)	5.163e-06. (2.732e-06)	-	-	-	0.356* (0.178)	0.482** (0.160)	0.439* (0.196)	0.399* (0.166)
	Registered Passenger Cars (thousand)	-	5.268e-06. (2.846e-06)	-	8.238e-06** (2.586e-06)	6.494e-06* (3.073e-06)	5.024e-06. (2.728e-06)	7.794e-06** (2.602e-06)	6.989e-06** (2.457e-06)	6.316e-06* (2.602e-06)	5.512e-06* (2.392e-06)
	Log-Lik.	5.926	8.873	8.310	9.128	5.719	7.845	8.524	9.417	8.358	10.047
	AIC	-5.852	-9.745	-10.620	-10.256	-5.437	-7.691	-9.048	-10.833	-8.716	-12.094
	Note:	Parenthesis denotes the standard error of the variables									
		-: denotes the non-statistically variables that were omitted from the model									
		Significance codes, o'***' o oot'**' o ot'*' o ot'' o o'' o o'' o o''' o o''' o o'''' o o''''''									



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Conclusions

- This paper investigated the road safety performance of 18 EU countries based on their ten years' fatality record (2007-2016) on five different modes of transportation (car, PTW, HGVs, pedestrian, and cyclists) using their socio-economic and demographic context.
- The methodological framework was developed for identifying under and best-performing countries (in terms of road safety) by estimating their efficiency rates using DEA (1st Stage Approach). From this approach we also identified the benchmarking countries that should be followed by the under-performing countries.
- Then the efficiency rates were used for measuring the extend of affection of the socio-economic and demographic context of the countries on their performance developing a Tobit regression model (2nd Stage Approach).
- Tobit models showed that pump price of diesel can be used as a valid and significant factor for improving the countries' road safety performance. Additionally, it appeared that over the economic period 2010 and 2012 GDP per capita was also a significant factor which showed that affected the 18 EU countries road safety performance, in a positive way.
- Overall, the straightforward analysis reveal several aspects for improving the road safety performance in a national and regional level.

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THANKYOU! QUESTIONS?

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