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Benchmarking Analysis of Road Safety Levels for an Extensive and Representative Dataset of European Cities

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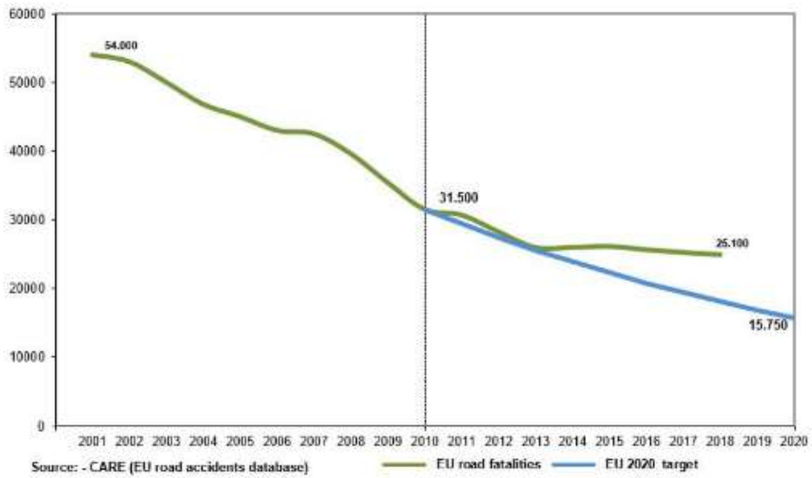
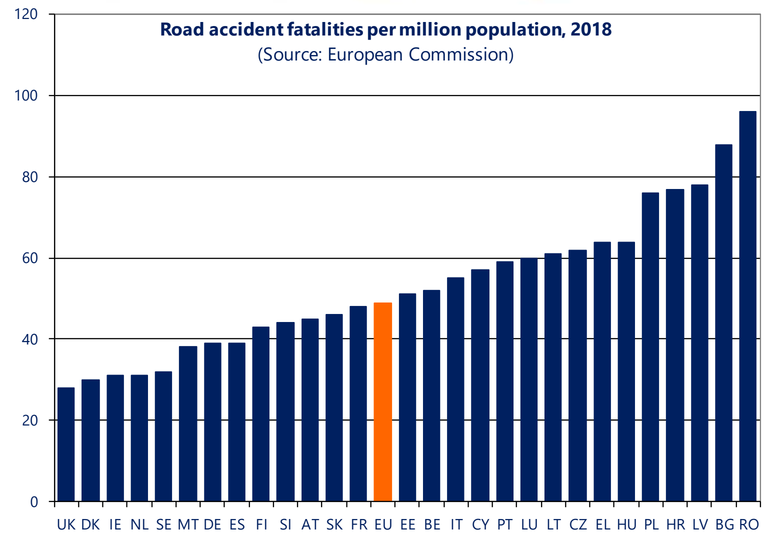
Introduction

- **1,35 million people** are killed in road accidents worldwide each year
- In the EU, in 2018, around **25.100 road fatalities** were recorded
- **Great discrepancies in road safety performance** exist among the 28 EU countries
- **At regional level**, the disparities are even larger in the EU





Objectives and Methodology

Objective:

- To **evaluate the road safety performance of EU urban regions**, taking into account the evolution of road safety, transport and economic characteristics over the time period 2008-2016

Methodology:

- **Two procedure concepts** of benchmarking analysis (DEA) together with Tobit regression
  - to identify the best and under-performing regions
  - to identify the factors affecting the efficiency of the region's road safety performance

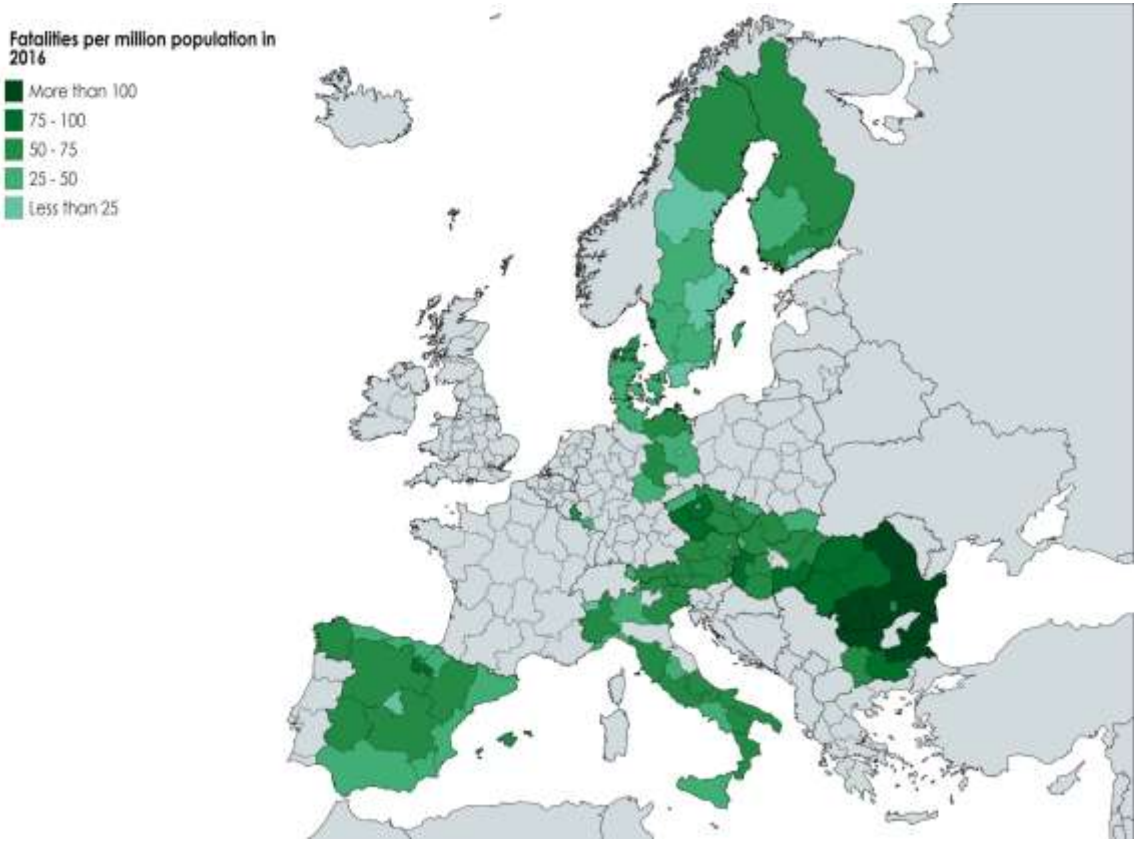
Data Description (1/2)

- Data for **101 NUTS 2 regions** covering 13 European countries
- Data refer to the period **2008-2016**
- **Time-series** data on:
    - Road accident fatalities
    - Population
    - Gross Domestic Product (GDP)
    - Vehicle Fleet
    - Length of road network
    - Length of motorways
- **Sources of data**: EU CARE database, Eurostat

Data Description (2/2)

- A **geographical variation** of fatality rates is obvious
  - higher fatality rates in **Southern** and **Eastern** European countries
  - lowest fatality rates in **Northern** countries

- Accident fatality rates, however, **vary at a large scale among the regions within the borders of a country**



Fatalities per million population by NUTS 2 region in the EU, 2017

Data Envelopment Analysis

- To identify **under and best-performing regions** in terms of road safety
- **DEA method**:

$$min \sum_{i=1}^{p} w_i y_{i,s}$$

Subject to $\sum_{i=1}^{p} w_i y_{i,s} \geq 1, s = 1, \dots, n$

$$w_i \geq 0, i = 1, \dots, p$$

where, $y_{i,s}$: i^{th} indicator of the s^{th} DMU (region)
w_i: the weight attributed to indicator $y_{i,s}$
n: total number of DMUs (i.e., 101)
p: total number of indicators

Tobit Analysis

- What **determinants affect the efficiency** of the region's road safety performance
- Mathematical formation of **Tobit model**

$$
\begin{aligned}
y_t &= X_t\beta + u_t \quad && if \;\; X_t\beta + u_t \; > 0 \\
y_t &= 0 && if \;\; X_t\beta + u_t \; \leq 0 \\
& && t = 1,2, \ldots, N
\end{aligned}
$$

where, N: number of observations (i.e., 101)

y_t: dependent variable (efficiency scores),

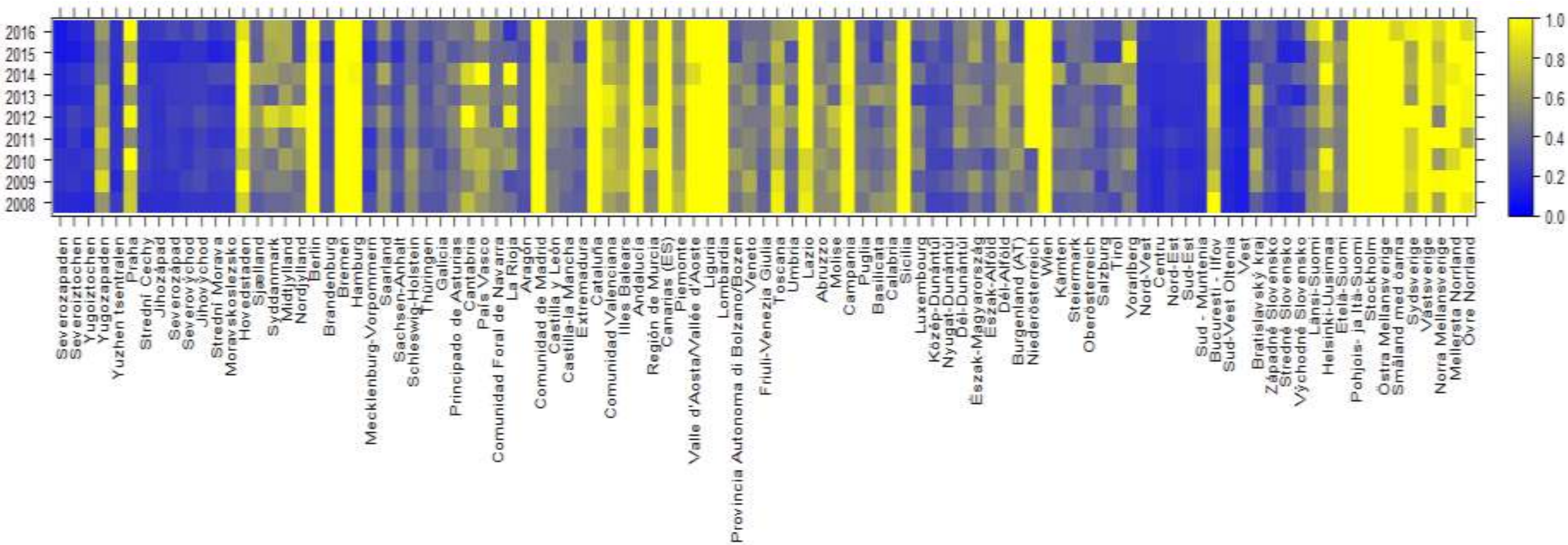
X_t: a vector of independent variables

β: a vector of unknown coefficients

u_t: an independently distributed error term

Results – DEA (1/2)

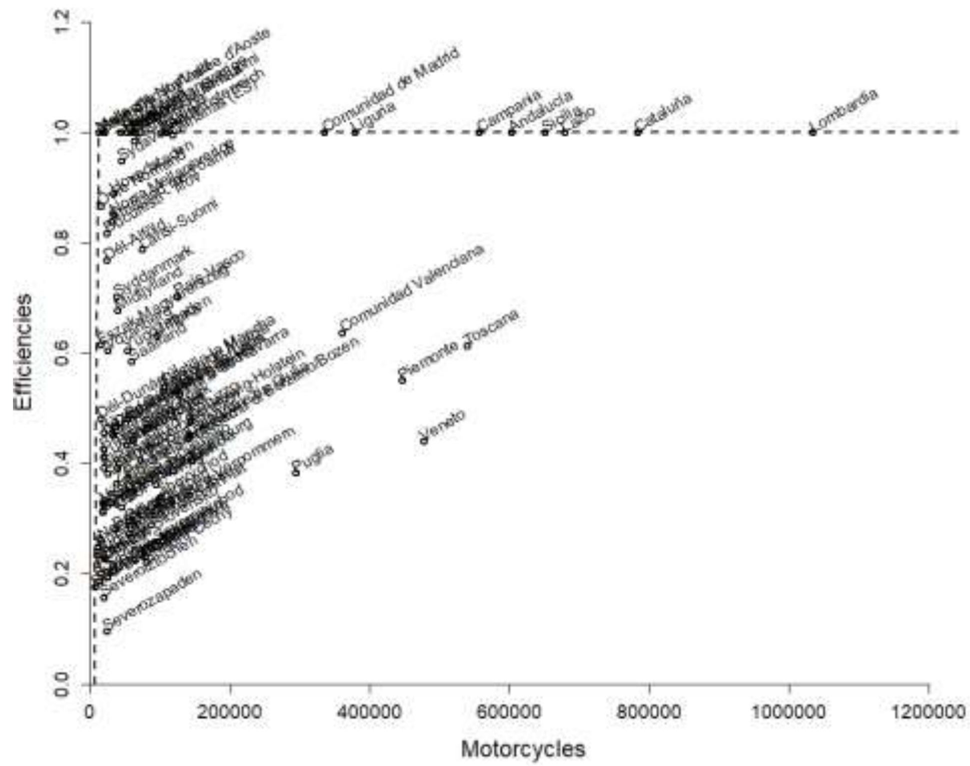
- **Output**: road fatalities
- **Inputs**: socio-economic, demographic and transport infrastructure characteristics
- 11 out of the 101 regions appeared to **best-perform** out of the years



Results – DEA (2/2)

- For the different socio-economic, demographic and road infrastructure characteristics we have **different benchmark regions**

- Explanatory variable **"Motorcycles"**: An under-performing region should focus on the benchmarking regions (e.g. Cataluna, Lazio, etc.), which are best-performing



Results – Tobit Regression

- Regions with a high **population** record more fatal accidents
- Regions with high **GDP** have also a good efficiency
- **Motorway density** in each region is positively correlated with the efficiency
- Number of **vehicles** and **passenger cars** are negatively correlated with efficiency

Variables/Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Intercept	2.537e-01*** (5.05e-02)	2.75e-01*** (4.94e-02)	3.52e-01*** (4.93e-02)	2.38e-01*** (4.83e-02)	3.49e-01*** (5.13e-02)	2.39e-01*** (5.03e-02)	3.25e-01*** (4.97e-02)	1.36e-01** (5.23e-02)	2.11e 01*** (4.66e-(
Population	-1.490e-07*** (3.65e-08)	-1.53e-07*** (3.62e-08)	-1.53e-07*** (3.67e-08)	-1.36e-07*** (3.67e-08)	-1.88e-07*** (4.49e-08)	-2.06e-07*** (3.95e-08)	-1.92e-07*** (4.59e-08)	-1.65e-07*** (4.86e-08)	-1.56e 07*** (4.57e-(
Vehicles	-1.866e-06* (9.44e-07)	-2.078e-06* (9.23e-07)	-2.32e-06* (9.23e-07)	5.84e-07* (2.42e-07)	-	-	-	-	-1.72e-((8.51e-(
Lorries	2.451e-06* (9.94e-07)	2.70e-06** (9.75e-07)	3.17e-06** (9.73e-07)	-	1.19e-06*** (2.89e-07)	1.10e-06*** (2.89e-07)	1.14e-06*** (2.87e-07)	1.01e-06*** (2.97e-07)	2.59e-06 (8.93e-(
Motorcycles	9.095e-07* (3.87e-07)	8.340e-07* (3.69e-07)	8.41e-07* (3.59e-07)	1.19e-06*** (3.43e-07)	8.12e-07* (3.62e-07)	3.98e-07. (2.30e-07)	8.33e-07* (3.44e-07)	9.08e-07** (3.51e-07)	6.42e-0 (3.25e-(
Passenger Cars	1.790e-06. (10.00e-07)	1.991e-06* (9.79e-07)	2.21e-06* (9.82e-07)	-8.43e-07** (2.88e-07)	-1.99e-07. (1.17e-07)	-	-1.86e-07. (1.13e-07)	-2.50e-07* (1.15e-07)	1.57e-((9.00e-(
Buses	4.52e-05** (1.41e-05)	4.54e-05** (1.38e-05)	3.29e-05* (1.43e-05)	5.369e-05*** (1.418e-05)	3.96e-05** (1.50e-05)	3.977e-05** (1.403e-05)	3.90e-05** (1.44e-05)	5.89e-05*** (1.47e-05)	5.05e 05*** (1.39e-(
Motorway Density	4.75e-03*** (8.26e-04)	4.53e-03*** (8.09e-04)	4.22e-03*** (7.94e-04)	4.888e-03*** (7.987e-04)	4.49e-03*** (8.56e-04)	4.718e-03*** (8.365e-04)	4.375e-03*** (8.14e-04)	4.79e-03*** (8.47e-04)	4.48e 03*** (7.28e-(
Other Roads	1.02e-05*** (2.18e-06)	1.22e-05*** (2.13e-06)	7.36e-06*** (2.10e-06)	1.234e-05*** (2.029e-06)	9.34e-06*** (2.11e-06)	1.085e-05*** (2.031e-06)	9.40e-06*** (2.01e-06)	1.42e-05*** (2.10e-06)	1.23e 05*** (1.90e-(
GDP	3.11e-06** (1.03e-06)	3.59e-06*** (1.05e-06)	3.76e-06*** (9.54e-07)	3.445e-06*** (8.982e-07)	4.14e-06*** (9.48e-07)	3.118e-06*** (8.086e-07)	4.31e-06*** (8.76e-07)	4.31e-06*** (8.77e-07)	4.31e 06*** (7.66e-(
Log-Lik.	28.21	30.61	31.11	32.08	24.26	26.92	28.15	24.88	32.49
AIC	-34.42	-39.23	-40.22	-44.16	-28.52	-35.83	-36.29	-29.76	-42.98

Note: Parenthesis denotes the standard error of the variables

-: denotes the non-statistically variables that were omitted from the model

Conclusions

- A straight forward methodological framework for assessing **road safety performance at regional level**
- **Under- and best performing regions** were identified, while for each variable examined different benchmark regions exist
- Depending on the priority areas of each region, the respective **best-performing regions should be identified** and their road safety policies should be followed as examples
- The **high economic performance** of the regions, the existence of **upgraded road infrastructure** network and the **availability of public transport** are associated with high road safety performance

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