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Evaluation of road safety policies performance across Europe: Results from benchmark analysis for a decade

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ABSTRACT

The economic developments experienced within the countries of European Union (EU) in the recent years have reported impacts on road safety levels, especially in serious injuries and traffic fatalities. In order to support the road safety strategies of the EU countries, it is essential to investigate the association of road safety levels with economic, social and demographic factors and finally comparatively evaluate the performance of each country. This paper aims at analyzing the road safety performance of EU-23 countries over a decade (2005–2014) considering their socio-economic and demographic background. For doing so, two distinctive models were applied, in particular, Data Envelopment Analysis (DEA) and DEA-Cross Efficiency Model (DEA-CEM), both suitably adapted to the road safety particularities. Moreover, the concept of road safety evaluation is performed by using comparable road safety indicators, namely, mortality rate and fatality risk. The results of this study contribute to the decision/policy making agenda from the perspective of evaluating road safety performance levels by using short-term and long-term road safety targets. Additionally, an unbiased 'picture' of the countries' road safety performance over a period of 10 years is provided, accompanied with information on the intra-period countries' efficiency of their road safety targets. The proposed intra-period analysis has useful practical and methodological implications since it is able to expose the evolution of road safety levels among the countries, besides a static overall picture. Finally, this study offers valuable insights on the cross-evaluation of road safety levels among the EU countries by considering a target-setting approach for each of them before and during a turbulent financial period for Europe.

1. Introduction

Road traffic fatalities are an important issue not only because of the cost to society (est. 130 billion euro per year) but mainly because of the loss of human lives and the deterioration of the quality of life due to crash injuries. In this matter, European Commission has adopted the Road Safety Programme, which has an objective to reduce road deaths in Europe in half, inside the decade 2011–2020 (European Commission, 2017). In this regard, a rich body of research focuses on various approaches of macro-level analyses, resulting with many factors that appeared to have an effect (positive or negative) on road traffic fatalities. Moreover, since the road safety performance varies among countries it is important to unbiasedly identify 'success-cases', facilitating policy-making by knowledge, examples and experience transfer from suitable cases/countries, resulting to a helpful tool (especially for the

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under-performing countries) for strategic road safety planning (e.g. by introducing best-practices from the most suitable/relevant benchmark cases to underperforming countries). In particular, in order to understand and thus to identify the road safety performance of each country, a thorough and representative benchmarking analysis is needed. However, for benchmarking a group of countries a set of factors has to be selected with a strong rationale with the phenomenon under study (here road safety performance), covering a reasonable time period. For this purpose, evidence from the literature has been utilized for selecting an extensive (but relevant) number of factors reflecting the socio-economic and demographic context of each country, but also correlated with road traffic fatalities (e.g. Dimitriou et al., 2016; Antoniou et al., 2016), covering a period of one decade.

Furthermore, the understanding of the road safety performance of the European Union (EU) countries can support the development of suitable policy changes toward the desired goal. Consequently, the identification of the best-performing countries (in terms of road safety) can be a helpful tool to the strategic road safety planning for the under-performing countries (in the same terms) by considering them as benchmark cases. The studies that have been developed so far, showed that benchmarking analysis is a useful policy-making supporting tool. Many researchers have developed benchmarking analysis in order to evaluate the road safety performance for a set of countries (e.g. Hermans et al., 2009). Some of them turned their attention to particular instances years (e.g. Shen et al., 2012) and some others to entire time periods (Alper et al., 2015), while some of them used targets for the countries in order to improve their road safety performance. To the best of our knowledge, the present study contributes in the literature, by studying the road safety performance of 23 EU countries (EU-23) considering a time period (a decade) but also the intra-period (each year of the decade) instances, in a comprehensive and unbiased multiple-input-multiple-output framework. Moreover and importantly enough, this study also takes advantage of the benchmark analysis results for identifying/proposing short-term and long-term 'targets' for the selected safety indicators and analyze the countries performance with respect to them, which is a novel and very useful element for policy making.

The objective of the current study is to evaluate the road safety performance of EU-23 countries, not for an isolated year/instance, but over a reasonable time period (here the decade of 2005–2014) taking into account their socio-economic and demographic context. Therefore, three main data 'domains' were considered for data collection, reflecting social, economic and demographic conditions for each country and these were considered for the same decade. The analysis follows three steps. A preliminary data visualization analysis was implemented for identifying possible trends or correlations in the dataset. In order, to observe possible homogeneities among countries, in terms of socio-economic and demographic conditions, hierarchical cluster analysis was conducted. The aim of clustering was to provide a realistic strategic planning for the under-performing countries and then suggesting the most effective practices for each case/country based on the cluster that each country belongs. Then, for evaluating road safety performance, the use risk exposure indicators were preferred, aiming to provide meaningful comparisons. For this aim, two appropriate risk exposure indicators were considered, namely, mortality rate (road traffic fatalities per million inhabitants) and fatality risk (road traffic fatalities per billion passenger-kilometers traveled). As noted by Shen et al. (2012), although the risk indicator mortality rate permits comparisons with other causes of death, however, concerning comparisons of traffic-related risks it has the disadvantage of excluding the level of motorization. As for the risk indicator fatality risk, this is used by road transport authorities more frequently as it implicitly discounts fatality rates if travel is increased. In the proposed analytical framework, both indicators have been complementarily used (in a multiple-input-multiple-output modeling structure) since they were considered that contribute different perspectives of risk, useful in the current thorough benchmarking analysis of national road safety performance.

A technically sound method and a powerful benchmarking technique that handles multi-inputs and multi-outputs are Data Envelopment Analysis (DEA), and this is the reason it was preferred for meeting the current study's scope. Therefore, suitably adapted to road safety framework, DEA and DEA-Cross Efficiency Model (DEA-CEM) were introduced and applied for the EU countries' road safety evaluation over 2005–2014. However, the possible reflection of EU's economy (e.g. the financial crisis of 2008–2009) on countries' road safety performance cannot be captured when the evaluation is considering for the whole decade. Thus an intra-period evaluation was undertaken which eventually showed that EU's financial situation in 2008 and 2009 had effects on each country's road safety performance. The proposed intra-period analysis has useful practical and methodological implications since it is able to expose the evolution of road safety levels among the countries, besides a static overall picture.

Finally, after the preceding benchmark analysis, road safety targets have estimated all countries by taking into consideration their efficiency scores. Due to the fact that each country needs different time horizon for updating/implementing road safety strategies towards the improvement of road safety levels, a two-stage target-setting approach was assumed, namely short- and long-term. In doing so, long-term targets were set based on average 2005–2014 socio-economic and demographic data. Short-term targets were based on previous years' data. It is noted that both short- as well as long-term target values referred to each risk exposure indicator (mortality rate and fatality risk). Thus, the countries who are considered to have an effective road safety strategy towards the reduction of road traffic fatalities are those who achieved both mortality rate and fatality risk targets. The findings of the current implementation identify the ineffective countries and policy strategies.

The paper is organized as follows. Section 2, provides previous related works to the current paper. Section 3, describes the dataset with the visual presentation of the data. Section 4, describes the methodology that was followed for the implementation of the extended in road safety framework DEA and DEA-CEM models and the targets setting approach. Section 5, presents some interesting insights on how efficiently was performing each country in the decade and annually and also shows the results from the long-term and short-term target setting. Section 6, offers conclusions and remarks on the paper's approach and highlights some points of further research.