Analyzing Acceptance of Reduced Speed Limits on Greek Motorways: A Survey

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Abstract. This study explores the public acceptance of reduced speed limits on Greek motorways, investigating a decrease from 130 km/h to 120 km/h and 110 km/h. The inquiry is grounded on the urgent need to enhance road safety and achieve sustainable mobility, as high speeds significantly contribute to road accidents, air pollution, and fuel consumption, imposing economic burdens up to €8 billion annually on Greek society. Using a meticulously designed questionnaire, respondents were presented with scenarios involving different speed limits, evaluating their choices based on travel time, fuel consumption, and road accident risks. The resulting data was analyzed using binary and multinomial logistic regression models. Key findings indicate that involvement in property damage crashes, past traffic code violations, gender, and income are significant predictors in accepting speed limit reductions. Notably, individuals acknowledging the crucial role of speed in road accidents were more amenable to speed limit reductions. The study offers invaluable insights for policymakers and stakeholders, providing a nuanced understanding of public perception and acceptance of reduced speed limits, crucial for devising effective and widely accepted road safety interventions in Greece.

Keywords: Speed Limit, Motorways, Stated Preference, Logistic Models

1 Introduction

In recent decades, several studies have focused on the effects of speed and speed limit on road safety, showing that speed of travel is highly correlated with road accident frequency and severity (WHO, 2007; Aarts, 2011). In particular, driving on the high-speed motorway network can cause negative impacts such as air pollution, high fuel consumption and serious road accidents (Jin and Rafferty, 2021). In an effort to reduce the negative impacts of speed on road safety and promote safe and sustainable mobility for all, there is a global trend to implement lower speed limits (De Pauw et al., 2014). In addition to road safety, reducing driving speed can contribute to greener and more economical driving.

Reducing the speed limit on the Greek interurban road network, apart from its contribution to reducing road accidents and consequently injuries and mortality, is a measure that is estimated to bring significant economic benefits to the state. In particular, road accidents cost Greek society around €2.7 billion per year, while the actual cost

could potentially exceed €8 billion per year if the actual number of casualties and accidents with property damage alone are taken into account (ITF, 2020). In this context, the main objective of the present study is to investigate the acceptance of the reduction of the speed limit on Greek motorways from 130 km/h to 120 and 110 km/h.

2 Methodology

2.1 Data Collection

In order to achieve the study objective, a specially designed questionnaire was constructed. The questionnaire is divided into four sections covering a total of 43 questions. The questionnaires were collected in the form of an online survey via Google Forms. A total of 408 questionnaires were collected with the aim of gaining a representative sample in terms of gender, age and annual income. The first section of the questionnaire consists of questions regarding driving experience, main mode of transport, frequency of driving and possible involvement in road accidents. The second section examines the respondents' views on road accidents in Greece. In the third section, 10 different scenarios are introduced for a hypothetical three (3) hour out-of-town (long-distance) journey. Specifically, a choice between three alternatives is requested based on three parameters: travel time, fuel consumption, and the probability of being involved in a road accident with injury.

- Alternative 1: reduce the speed from 130 km/h to 110 km/h.
- Alternative 2: speed reduction from 130 km/h to 120 km/h.
- No change.

The following table shows a sample of one random scenario out of 10.

Table 1. Scenario example

Attributes	Alternative 1	Alternative 2	No change
Increase in Travel Time (minutes)	21	7	0
Reduction in Fuel Consumption (€)	9€	3€	0€
Reduction in the probability of road accidents with injury (%)	30%	10%	0%

2.2 Statistical Analysis

Logistic regression models are used when the dependent variable is distinct. Logistic regression is used to create models for predicting the influence of the presence or absence of certain characteristics in the selection of a particular alternative. In that context, utility function is used as a function of the attributes and other factors that affect the choice of the respondent.

More specifically, the utility function is defined as a mathematical model that describes the probability of the choice of each individual among alternatives based on the attributes. Based on the utility maximization context, as described by McFadden (1974) and Ben-Akiva and Lerman (1985), the utility of an alternative i (U_i) consists of a

systematic part V_i and an error term ϵ, where the systematic part consists of (a) a vector of attributes α with attribute values Xiα for a given alternative i, and (b) their marginal effect on utility βiα and an Alternative Specific Constant ASC that captures systematic but non-explained variability in the data:

$$U_i = V_i + \varepsilon \quad (1)$$

Where Vi is given by:

$$V_i = \beta' X_i + ASC_i \quad (2)$$

3 Results and Discussion

3.1 Binary Logistic Model

The binary logistic regression analysis presented in Table 2 illustrates how different variables influence the acceptance of speed limit reduction on Greek motorways.

Table 2. Binary logistic regression model

Parameters	**βi**	**p-value**	**Odds Ratio**
(Intercept)	1.815	<0.001	0,593
PROPERTY_CRASH	-0.883	<0.001	0.414
VIOLATATIONS	-0.506	<0.001	0.603
SPEED_ROLE	0.928	<0.001	2.529
IF_TRAFFIC	-0.852	<0.001	0.427
GENDER	-1.119	<0.001	0.327
INCOME2	-0.541	<0.001	0.582
INCOME3	-0.080	0.507	0.923
AIC	2960.5	-	-
X-squared	4.6897	0.196	-

The variables included in the model are defined below:

- PROPERTY_CRASH: Being involved in a crash with property damage
- VIOLATATIONS: Number of violations of the Road Traffic Code during the last 3 years.
- SPEED_ROLE: Importance of speeds for road crashes based on the respondents. 1 signifies low, 2 adequate and 3 high importance
- IF_TRAFFIC: Traffic existence as a factor of changing speed or the way of driving
- GENDER: the option "Woman" in the question "Choose your gender"
- INCOME2: 10.000 - 25.000€ as annual income
- INCOME3: Over 25,000 € as annual income

The odds ratios (OR) of the variables PROPERTY_CRASH, VIOLATIONS, IF_TRAFFIC, GENDER, and INCOME2 are less than 1 (0.414, 0.603, 0.427, 0.327, and 0.582 respectively), indicating a negative relationship with the dependent variable.

Notably, individuals who have been involved in property damage crashes (PROPERTY_CRASH), those who have violated the Road Traffic Code in the past three years (VIOLATIONS), individuals considering traffic as a factor influencing their speed or driving style (IF_TRAFFIC), women (GENDER), and those with an annual income between 10,000 and 25,000€ (INCOME2) are less likely to accept the reduction in speed limits.

On the other hand, the variable SPEED_ROLE, which represents the perceived importance of speeds in road crashes by respondents, exhibits an odds ratio of 2.529. This odds ratio greater than 1 signifies a positive correlation with the dependent variable. Consequently, respondents attributing high importance to speeds in road crashes are more likely to accept the speed limit reduction on Greek motorways. The variable INCOME3, representing individuals with an annual income over 25,000€, has an odds ratio close to 1 (0.923) and a non-significant p-value (0.507), indicating that it does not significantly influence acceptance of speed limit reduction.

3.2 Multinomial Logistic Model

This section presents the findings of the statistical analysis on participants' choice of speed reduction alternative, based on the data collected in the third section of questionnaire survey.

Table 3. Multinomial Logistic Model

Parameters	**βi**	**p-value**	**Odds Ratio**
(Intercept):1	0.233	0.388	-
(Intercept):2	-0.477	0.023	
Time	-0.026	0.005	0.450
Fuel	0.005	0.792	0.192
Accident	0.010	0.004	0.829
EXP:1	-0.413	0.001	1.997
EXP:2	-0.440	0.001	0.521
PROPERTY_CRASH:1	0.485	0.000	0.652
PROPERTY_CRASH:2	0.757	0.000	1.534
STAT_DEATHS:1	0.826	0.000	0.690
STAT_DEATHS:2	1.023	0.000	-
SPEED_ROLE:1	-0.821	0.000	0.520
SPEED_ROLE:2	-0.402	0.036	-
MOTO_RISK:1	-1.119	0.000	1.398
MOTO_RISK:2	-0.785	0.000	
GENDER:1	0.843	0.000	
GENDER:2	0.508	0.000	
INCOME:1	0.096	0.467	

INCOME:2	0.551	0.000
Log-Likelihood	-2338.5	
Likelihood ratio test : chisq	337.01	

The variables included in the model are defined below:

- Time: increase of travel time
- Fuel: decrease of fuel consumption
- Accident: decrease of the probability of getting involved in a road accident with injury
- EXP: The experience of drivers in years
- PROPERTY_CRASH: Being involved in a crash with property damage
- STAT_DEATHS: Number of deaths from road crashes based on statistics
- SPEED_ROLE: Importance of speeds for road crashes based on the respondents. 1 signifies low, 2 adequate and 3 high importance
- MOTO_RISK: motorcycles risk level when the speed is within the limits of 130 km/h.
- GENDER: Gender of the participant
- INCOME: income of the participant

The parameter 'Time' has a negative coefficient ($\beta i = -0.026$), indicating that as travel time increases, the log-odds of the dependent variable decreases. Despite its non-significant p-value, the 'Fuel' variable's low odds ratio (0.192) suggests that changes in this predictor have minimal influence on the outcome. On the other hand, 'Accident', 'EXP:1', and 'PROPERTY_CRASH:2', with positive coefficients and significant p-values, positively influence the dependent variable. For instance, an increase in the 'Accident' predictor is associated with increased log-odds of the outcome. Variables 'EXP:1' and 'EXP:2' denote the experience of drivers, where 'EXP:1' positively influences the response while 'EXP:2' negatively correlates with it, signified by their odds ratios of 1.997 and 0.521 respectively.

Additionally, 'PROPERTY_CRASH:1' and 'PROPERTY_CRASH:2', representing involvement in property damage crashes, exhibit odds ratios of 0.652 and 1.534 respectively, indicating varying degrees of influence on the dependent variable. 'STAT_DEATHS:1' and 'STAT_DEATHS:2', accounting for the number of road crash deaths based on statistics, present positive coefficients and significant p-values, suggesting their substantial impact on the model. Further, 'SPEED_ROLE:1' and 'MOTO_RISK:1' variables display negative coefficients, highlighting their inverse relationship with the outcome variable. The coefficients for 'GENDER' and 'INCOME:2' are positive and statistically significant, demonstrating their positive association with the dependent variable, while 'INCOME:1' shows a non-significant p-value, implying negligible influence. These insights provide a comprehensive understanding of factors affecting the modeled outcome, crucial for developing informed strategies and interventions.

4 Conclusions

The research paper primarily aimed to explore the acceptance of reduced speed limits on Greek motorways, from 130 km/h to 120 km/h and 110 km/h. This exploration was grounded on existing literature emphasizing the adverse impacts of high speeds on road safety, air pollution, fuel consumption, and subsequent economic implications for the state.

Through the analysis, the binary logistic regression model pinpointed key variables, such as involvement in property crashes, traffic code violations, gender, and income, as significant determinants in accepting reduced speed limits. For instance, those involved in property damage accidents or having traffic code violations in the past three years were less inclined towards reduced speed limits. Conversely, respondents acknowledging the pivotal role of speed in accidents showed a higher acceptance rate for speed reductions. The multinomial logistic model further detailed how travel time, accident likelihood, driving experience, and the number of road crash deaths, among others, shaped the preferences of respondents. Factors like longer travel time, increased experience, and higher statistics of road deaths influenced resistance to speed limit reductions. These findings are instrumental for policy-makers and stakeholders in crafting effective and well-accepted interventions to promote road safety and sustainability in Greece.

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References

1. Aarts, L., & Van Schagen, I. (2006). Driving speed and the risk of road crashes: A review. Accident Analysis & Prevention, 38(2), 215-224.
2. Ben-Akiva, M. E., Lerman, S. R., & Lerman, S. R. (1985). Discrete choice analysis: theory and application to travel demand (Vol. 9). MIT press.
3. De Pauw, E., Daniels, S., Thierie, M., & Brijs, T. (2014). Safety effects of reducing the speed limit from 90 km/h to 70 km/h. Accident Analysis & Prevention, 62, 426-431.
4. International Transportation Forum (ITF), (2018). Speed and Crash Risk.
5. ITF, 2020. Road Safety Report. Greece.
6. Jin, J., & Rafferty, P. (2021). How the speed limit policy affects travel speed?: Quasi-experimental approach. Transport policy, 103, 2-10.
7. McFadden, D. (1974). The measurement of urban travel demand. Journal of public economics, 3(4), 303-328.
8. World Health Organization. (2007). Global Status Report on Road Safety.