Investigation of the effect of tourism on road crashes

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Abstract

The objective of this study is the investigation of the effect of tourism on road crashes. For this purpose, police data on road crashes in Greece for the five-year period of 2011-2015 were collected by the research team, and subsequently underwent processing in order to locate the contributing factors that characterize road crashes, i.e. the nationality of the driver, the season, the purpose of travelling and the region, and assign them as independent variables. Negative binomial regression models were developed for this analysis. Application and comparison of the models led to the conclusion that tourists are more often involved in road crashes. More specifically, it was observed that both the touristic season and tourism as the purpose of travelling led to an increase in road crashes, with the highest increase being observed in touristic regions. As far as nationality is concerned, the fact that foreign tourists are involved in fewer road crashes than Greek drivers is attributed to the relative risk exposure. However, the increase of the relative

rate ratio of road crash involvement for foreign tourists in touristic regions may indicate the increased risk of foreign tourists compared to Greek drivers.

Practical Applications: The present research actively contributes to current knowledge by quantifying the impacts of touristic activities on road safety. These insights can constitute the basis for road safety measures and policy changes in countries with increased tourist numbers, both on a steady basis and on touristic seasons separately, and with distinctively touristic regions.

Keywords: road crashes; road safety; tourism; negative binomial regression; marginal effects

1. Introduction

1.1. Overview

Road transport is an integral part of modern society and a milestone in the advancement of technology and the improvement of the quality of life. Unfortunately, road crashes are also an integral part of road transport. About 1.25 million people are estimated to lose their lives annually as a result of road and traffic crashes, with many associated direct and indirect costs, and this number has plateaued in recent years. (WHO, 2015 and 2017).

Road safety is undoubtedly a critical issue, and the pursuit for its improvement has repercussions throughout all aspects of transport. Even in highly developed areas, such as the EU, the above problem persists, especially in certain member states – Greece being one of them. Overall, EU roads are consistently being ranked amongst the safest globally, as confirmed by official statistics (CARE, 2016). Despite these positive achievements, road crashes in Greece have been significantly higher than the EU average, until about 2010. In the subsequent years, namely between 2010 and 2016, Greece registered the highest reduction of recorded serious road injuries amongst EU member states, (ETSC, 2017).

One important aspect of transport is tourism. Tourism is a frequent cause of trip generation, which results in road users finding themselves in unfamiliar environments. Tourists often have inadequate knowledge of the road network and the local layout and specific traffic conditions; sometimes they are lacking in overall skill and readiness to act.

The aim of this study is the exploration of the effect of tourism on road crashes. This aim is achieved with the examination and analysis of crash data from Greece as a country-wide case study. Several aspects of tourism, such as the purpose of travelling, the impacts of whether a region or season is touristic and nationality are examined.

Apart from its road safety fluctuations, Greece is a popular touristic destination due to its considerable natural beauty, culture and history, with increasing numbers of tourists every year. As an indication, there was a 58% increase of international visitors between the years 2009-2015 (SETE, 2016). It is thus evident that the specific attributes of Greece make it a country worth investigating for the impacts of tourism on road safety. In addition, the topic is of crucial interest for the country itself, in light of the aforementioned increasing tourist flows.

1.2. Existing literature findings

Although some relevant studies have been conducted in the literature, there appear to be significant margins for research of the impacts of tourism on road crashes. One of the most relevant studies has examined the risk of involvement in road traffic crashes involving foreign and Greek drivers in various road environments in Greece (Yannis et al., 2007). The analyses aimed to determine the combined effect of the driver's nationality, on the risk of being involved in road traffic crashes among others, such as the type of area (inside/outside urban area), the presence of junction and the lighting conditions (day/night). Results showed that foreign drivers in Greece were characterized by an increased risk of involvement in road traffic crashes. Additionally, it was found that the immigrant permanent residents from Albania to Greece, who are more familiar with the

road environment and traffic rules, appeared to be less vulnerable than EU country drivers and drivers of other nationalities, corresponding to tourists or other occasional users of the road network.

An older study investigated the risk factors for road traffic crashes in an area of Crete, Greece (Petridou et al., 1997). Hospital data of victims of road crashes from Heraklion, Crete were recorded. In addition, data on whether the vehicle belonged to the injured party or whether it was rented, the probable cause of the crash or proof of driving under the influence of alcohol, according to the traffic reports, the type and severity of the vehicle, and the effect of hospitalization were recorded as well. As a result, odds ratios were calculated for tourists; it was estimated that the corresponding ratio of road traffic crashes for tourists was close to 1:3, highlighting the importance of road traffic crashes as a significant health risk during leisure trips. The results also suggested that drivers from countries where driving is performed on the left side of the road are at increased risk of being involved in road traffic crashes, especially when driving a rented vehicle rather than their own. This phenomenon is more frequent while overtaking or performing other road maneuvers which require reflexes adapted to opposite directions. Finally, the results showed that while Greek drivers often commit serious offenses compared to foreign visitors, driving under the influence of alcohol is more frequent for the latter, which the authors hypothesized was probably due to the increased freedom that often characterizes them during their holidays.

A different Greek island, Corfu, was the study area of a similar study shortly afterwards (Petridou et al., 1999). Data from the island of Corfu were examined in an attempt to indirectly estimate the pattern of road traffic crashes associated with tourism. Several

cases of hospitalization for injuries of any type were documented at the island's only General Hospital. Tourists were from the permanent residents on the basis of their permanent residence and nationality. The study conducted statistical analysis based on proportions, and utilized simple x-square techniques, with stratification where required. Results showed that only about 15% of all crashes consisted of road traffic crashes of residents and Greek tourists, while they accounted for 40% of tourists of foreign nationalities. Moreover, the results reported an increased likelihood of road traffic crash injuries to foreign tourists of young age, particularly those who were under 24 years old.

A study in an island environment comparable to the Greek islands, namely the Balearic Islands, has been conducted in Spain (Rosselló & Saenz-de-Miera, 2011). This study obtained data from different databases for day-to-day vehicle collisions in the islands. Several statistical methods were considered for the analyses. The presence of over-dispersion led to the rejection of the Poisson regression model and the use of the Negative Binomial regression model. The results showed that tourism can be associated with a significant proportion of road traffic crashes in the Balearic Islands, as the study provided empirical evidence to show that, in fact, the presence of tourists leads to an increase in the number of road traffic crashes. Specifically, by quantifying the relationship between tourism and road traffic crashes, it was concluded that population growth due to the presence of tourists leads to an increase in road traffic crashes.

More recently, the familiarity of drivers with the road environment, and its relation with road traffic crashes was examined by a study using data from Norway (Intini et al., 2017). The familiarization of drivers with the place of the crash was characterized by taking into account the distance from their permanent residence. Familiar drivers were found to be

in most cases drivers involved in vehicle collisions at the rear. This is in line with the tendency for speeding and distraction, which often characterizes familiar drivers. Non-familiar drivers were found to be in many cases those who lost control or who invaded the opposite lane, resulting in collisions; the authors refer to potential differences between expectations and unexpected reality.

Concerning a more mainland touristic area, an analysis of road traffic crashes and their role in the mobility of tourists within distinct areas of activity was conducted for Scotland (Walker & Page, 2004). Police data were obtained from the respective databases for a four-year period. The results showed that drivers identified as visitors to the area participated in 28% of the crashes that occurred in central Scotland. However, they were more likely to be involved in serious or fatal crashes than locals. In addition, unlike local drivers, the road traffic crashes involving visitors have peaks in different areas (November, January and August). Furthermore, 40% of total crashes that occurred between the hours 1:00 and 11:00 involved visitors to the area.

Foreign drivers as members of foreign minorities have also been examined in a relevant study concerning Russian drivers in Finland (Leviäkangs, 1998). Based on road traffic crash statistics collected by the police and origin-destination studies conducted at the Finnish-Russian border, road traffic crash rates were calculated for both Finnish and foreign drivers. Results showed that the crash rates of foreign drivers are higher than those of local drivers. Finally, it was observed that the winter season was particularly dangerous for foreign drivers. The author argued that the driving etiquette of the different countries largely explains the differences, rather than other specific and technical risk parameters. Some possible risk parameters were identified to be the lack of knowledge

of traffic rules, insufficient driving skills during the winter and the lack of winter equipment, and the general attitude towards traffic safety, which is reflected in driving behavior.

2. Data and Methodology

2.1. Data Collection

The data collected for analysis consisted of all crashes reported in Greece during the five-year period of 2011-2015, as recorded nationally for Greece by Police officers at the scene and inserted into the national database by the Hellenic Statistical Authority. This national database includes all injury crashes, the related casualties, and the drivers involved for the period 1985–2015 as reported by the police.

It is underlined that the examined crashes do not include damage-only crashes, as crashes without victims (injuries or fatalities of involved persons) are not recorded. Furthermore, no sensitive information was recorded in the crashes to ensure that personal details of involved individuals remain untraceable. The analyses are conducted at a basis of aggregated crashes, as opposed to a basis involving injured persons. A sample of the obtained database can be seen on Table 1.

This approach was decided to better capture the impacts of tourism in crashes, as the possible number of several involved injured individuals in a single crash might introduce undesirable heterogeneity to the sample. A total of 39,720 crashes with information about the date and location of occurrence were considered. Other related variables, such as the numbers of involved injured individuals for every injury level (slight, severe and fatal

Crash ID	Crash year	Crash month	Crash prefecture	Nationality of involved persons	Number of fatalities	Number of serious injuries	Number of slight injuries	Crash count	Purpose of travelling	Season	Prefecture type
20394	2013	8	Arta	Greece	6	3	0	1	Travel to or from work	Summer	Non-touristic Region
20395	2013	8	Arta	Greece	6	3	0	1	Tourism-leisure	Summer	Non-touristic Region
34287	2015	9	Corinth	Albania	1	0	0	1	Business Travel	Summer	Non-touristic Region
34342	2015	9	Preveza	Albania	1	0	0	1	Business Travel	Summer	Touristic Region
34367	2015	9	Trikala	Albania	1	0	1	1	Tourism-leisure	Summer	Non-touristic Region
34798	2013	9	Chalkidiki	Germany	0	1	0	1	Other reasons	Summer	Touristic Region
34803	2013	9	Chalkidiki	Romania	1	0	0	1	Tourism-leisure	Summer	Touristic Region
34805	2015	9	Piraeus	Greece	0	0	1	11	Travel to or from work	Summer	Non-touristic Region
34806	2015	9	Piraeus	Greece	0	0	1	2	Tourism-leisure	Summer	Non-touristic Region
34807	2015	9	Piraeus	Greece	0	0	1	1	Other reasons	Summer	Non-touristic Region
34808	2015	9	Piraeus	Greece	0	0	1	6	Business Travel	Summer	Non-touristic Region
34810	2015	9	Piraeus	Greece	0	0	2	4	Travel to or from work	Summer	Non-touristic Region
34811	2015	9	Piraeus	Greece	0	0	2	1	Tourism-leisure	Summer	Non-touristic Region
34812	2015	9	Piraeus	Greece	0	0	2	2	Other reasons	Summer	Non-touristic Region
35047	2014	9	Chalkidiki	Germany	0	0	2	2	Tourism-leisure	Summer	Touristic Region
36301	2015	12	Piraeus	Greece	0	0	1	3	Travel to or from work	Winter	Non-touristic Region
36302	2015	12	Piraeus	Greece	0	0	1	2	Business Travel	Winter	Non-touristic Region
36304	2015	12	Piraeus	Greece	0	0	2	2	Travel to or from work	Winter	Non-touristic Region

Table 1: Crash database sample

injuries) or their nationalities were collected for further examination as well, as shown in Table 2.

Table 2: Variables considered and their respective value range

Variable	**Value Range**
Crash ID number	Natural number (1, 2, …)
Crash year & month	Number for year (2011-2015), nominal for month
Nationalities of involved persons	Nominal (i.e. France)
Number of slight injuries	Natural number (1, 2, …)
Number of severe injuries	Natural number (1, 2, …)
Number of fatalities	Natural number (1, 2, …)
Reason for trip	Nominal (i.e. Tourism-leisure)

2.2. Data Processing

After the crash data were obtained, they underwent considerable manipulation and processing. This was due to the fact that there were many possible combinations and groupings that were explored in order to achieve increased quality of the analysis and to isolate the effects of tourism in the highest possible degree.

An initial step was the creation of nationality groups. Having taken into account the particular geographical location and overall state of tourism in Greece, it was decided that the most beneficial categorization would be to split nationalities into the following groups: Greece, Albania, Europe, North America and Asia. The rest of the globe had essentially zero involvement in the examined crashes, and was thus excluded from the analysis. The Albanian nationality was examined separately because it represents a quite sizeable minority in Greece, which includes the largest percentage of permanent non-native residents. Albanians were also found to be involved in a considerable number of crashes, as data analysis which will be described later showed. For those reasons, Albanians were considered to be a non-tourist nationality.

It should be noted here that additional approaches were examined, such as grouping nationalities based on Gross National Income (GNI) and using the rate of fatalities per vehicle for each country. Alternatively, analyses per country were attempted with very limited categorization. Both approaches were ultimately discarded, as they resulted in the formulation of very large numbers of categories that were not statistically significant for the analyses. After consideration, similar binary approaches (tourism or non-tourism) as with the nationality variable were selected for the other variables, i.e. the purpose of travelling, season and region (touristic or non-touristic). Crashes that had parameters with unknown values (not completed by the authorities at the time) were excluded from the database as well.

In addition, crashes that occurred in the two major urban centers of Greece, namely Athens and Thessaloniki, were not taken into account for the analyses. This was due to the largely uniform crash distribution throughout the year in these large cities. Similarly, the months May and October were excluded from the analyses as transitional periods during which tourism effects are unclear.

2.3. Negative binomial regression

Following crash data collection and their respective processing, it was decided that negative binomial regression models would be appropriate for the statistical analyses, as explained in Washington et al. (2003). Negative binomial regression is a well-known method of analysis for crash data, and is used especially when over-dispersion is observed in crash count data (namely when sample variance is higher than the respective mean). It can be regarded as a generalization of Poisson regression.

In the analysis under consideration, the dependent variable is crash frequency. Essentially, each crash is treated as a trial with two potential outcomes termed "success" (say, crash occurrence) and "failure" (say, no crash occurrence). Thus, crashes are a random discreet variable X with a binary outcome. If there are n number of trials resulting in r number of successes, and the probability of success per trial is p, then the negative binomial probability per instance (or the probability mass function) is shown in equation (1):

$$P(X = r) = f(n, r, p) = \frac{(\mathrm{n}-1)!}{[(\mathrm{n}-\mathrm{r}) * (\mathrm{r}-1)]!}\,\mathrm{p}^{r}\,(1-\mathrm{p})^{\mathrm{n}-\mathrm{r}} \qquad (1)$$

Negative binomial regression links the dependent variable with various independent predictor variables, as shown in equation (2). If X is the dependent variable, predicted by the independent predictor variables x_i, then the variables are connected through the following relationship (Washington et al., 2003):

$$X = EXP(b_i x_i + \varepsilon_i) \qquad (2)$$

Where ε_i is the error term for each observation (independent variable). This relationship is important in order to interpret the output of the models after processing from the statistical software. Results are given by the coefficients b_i of the independent predictor variables x_i and the intercept c (fixed term of the model) as shown in equation (3).

$$log(X) = b_1 x_1 + b_2 x_2 + \cdots + b_n x_n + c \qquad (3)$$

Essentially, the log of the outcome is predicted as a linear function of the above predictors. Furthermore, in place of an elasticity analysis, it was decided to use marginal effects. Marginal effects reflect the effect of a “one unit” change in the independent variables x on the dependent variable. Following Washington et al. (2003), marginal effects are computed as:

$$ME_{x_i}^{X} = \frac{\partial X}{\partial x_{ik}} = b_k EXP(b_i x_i) \qquad (4)$$

Marginal effects can be more comprehensive when dealing with integer variables and particularly when dealing with binary "flag" variables (taking on values of zero or one) such as those present in the processed dataset.

3. Model formulation and Results

After applying negative binomial regression techniques, the following models were developed, as shown in Table 2. As previously stated, in all cases the dependent variable was crash frequency (examining the number of road crashes).

Table 3: Model classification

Model No.	Model Target Group	Number of Crashes analyzed
1	All crashes	39720
2	All crashes, excl. Athens & Thessaloniki	21393
3	Non-touristic season crashes	11358
4	Touristic season crashes	10035
5	Non-touristic region crashes	15263
6	Touristic region crashes	6130
7	Non-tourism as purpose of travelling crashes	14384
8	Tourism as purpose of travelling crashes	7009

The research team employed data manipulation and analysis in order to define each model category:

Descriptive statistics showed that the total number of crashes peaked during the four-month period of June to September, reaching the maximum number in August, while they were relatively lower in the six-month period of January to April and November to December. These periods were defined as the touristic season and non-touristic season respectively, which stands to reason since Greece is mostly a summer destination for tourists. For the remaining two months, May and October, the number of crashes ranged somewhere in-between the two seasons, and were thus considered as transitional periods and were excluded from the analysis. The abovementioned fully comply with the data derived by the Hellenic Statistical Authority regarding tourist flows.

Due to the fact that Greece has 51 different regions, a two-step methodology was employed to define touristic and non-touristic regions. The Region Category Index (RCI) was initially calculated by dividing the number of crashes that took place during the touristic season by the number of crashes that took place during the non-touristic season. The 15 regions with the highest RCIs were defined as touristic regions, with the rest falling into the non-touristic region category (although other sub-categories and categorizations were also examined but produced similar results). Not surprisingly, almost all of the touristic regions consisted of islands, barring a single coastal region (province of Magnesia). This classification complies with results of data derived by the Hellenic Statistical Authority regarding the most popular tourist destinations in Greece.

The purpose of travelling as recorded by the police at the scene is a novel approach on the effect of tourism on road crashes, and to the knowledge of the authors has not

been examined yet in the existing literature. The outcomes of defining the purpose of travelling as touristic (which included tourism and leisure purposes) or non-touristic was cross-referenced with respective graphs, indicating a peak of crashes during the touristic season for tourism as the purpose of travelling, while displaying a rather even distribution across the year for non-tourism as the purpose of travelling.

The resulting models capture the correlation between crashes and the aspects of tourism that affect them. Due to the fact that all the independent variables consist of nominal binary variables, relative marginal effects were used in place of elasticities calculations, as parameters that are capable of highlighting the individual influence of each of the independent variables on the dependent variable. The coefficients of the models, as well as the respective marginal effects of the variables of all models are presented in Table 3 (touristic variables are coded as 0, while their non-touristic counterparts are coded as 1 – for instance touristic season=0, non-touristic season=1).

It should be noted that the final selection of the results of the models was made after several configuration considerations of the many possible combinations of variables, which were documented but are not presented here for brevity. The primary method of selection of the optimal models was the maximization of the natural logarithm of the likelihood function, followed by the utilization of the Akaike Criterion of Information (AIC). The predictor variables are examined every time with regard to statistical significance as well; the software output provides separate statistical significance values per category.

Table 3: Overall results of models variations

Model			1 (All Crashes)					2 (Crashes excluding Athens & Thessaloniki)					
Dependent Variable			Crashes										
			b	Std. Error	Wald	Me_i	Me_i*	b	Std. Error	Wald	Me_i	Me_i*	ΔMe_i
Constant			0.727	0.0113	4131.930			0.204	0.0125	266.464			
Independent Variables	Nationality	0	-0.510	0.0197	672.156	-0.306	-10.427	-0.252	0.0206	149.653	-0.196	4.854	36.1%
		1	0					0					
	Purpose of Travelling	0	-0.195	0.0154	159.641	-0.160	-5.450	0.069	0.0148	21.626	0.074	-1.825	145.9%
		1	0					0					
	Season	0	0.029	0.0138	4.263	0.029	1.000	0.074	0.0145	26.559	0.080	-1.991	173.1%
		1	0					0					
	Region	0	-0.382	0.0178	462.778	-0.261	-8.875	-0.042	0.0155	7.392	-0.040	1.000	84.5%
		1	0					0					
Model			3 (Non-touristic Season)					4 (Touristic Season)					
Dependent Variable			Crashes										
			b	Std. Error	Wald	Me_i	Me_i*	b	Std. Error	Wald	Me_i	Me_i*	ΔMe_i
Constant			0.193	0.0147	172. 268			0.274	0.0141	380.437			
Independent Variables	Nationality	0	-0.297	0.0278	110.273	-0.221	-2.325	-0.215	0.0442	23.5620	-0.173	-1.679	21.4%
		1	0					0					
	Purpose of Travelling	0	0.087	0.0269	10.505	0.095	1.000	0.094	0.0223	17.7640	0.103	1.000	8.8%
		1	0					0					
Model			5 (Non-touristic Region)					6 (Touristic Region)					
Dependent Variable			Crashes										
			b	Std. Error	Wald	Me_i	Me_i*	b	Std. Error	Wald	Me_i	Me_i*	ΔMe_i
Constant			0.259	0.0119	471.131			0.173	0.0201	74.032			
Independent Variables	Nationality	0	-0.283	0.0314	81.240	-0.213	-3.469	-0.207	0.0303	46.691	-0.168	-1.557	21.1%
		1	0					0					
	Season	0	0.058	0.0181	10.143	0.061	1.000	0.098	0.0263	14.014	0.108	1.000	75.9%
		1	0					0					
Model			7 (Non-tourism as Purpose of Travelling)					8 (Tourism as Purpose of Travelling)					
Dependent Variable			Crashes										
			b	Std. Error	Wald	Me_i	Me_i*	b	Std. Error	Wald	Me_i	Me_i*	ΔMe_i
Constant			0.188	0.0154	149.663			0.291	0.0234	155.003			
Independent Variables	Season	0	0.062	0.0199	9.646	0.066	1.000	0.067	0.0294	5.225	0.072	-1.536	8.6%
		1	0					0					
	Region	0	-0.179	0.0299	35.742	-0.150	-2.269	-0.049	0.0212	5.310	-0.047	1.000	68.8%
		1	0					0					

4. Discussion

Following the statistical analyses, model development and results, a number of useful observations and results regarding the effect of tourism on road crashes have been obtained. The most important conclusions are summarized in the following cases, categorized in each case by the independent variables investigated:

4.1. Considering tourism as the purpose of travelling

Tourism as the purpose of travelling leads to an overall increase in road crashes compared to other purposes of travelling.

This is a notable observation, as it indicates the increased risk of tourists, both foreigners and Greeks, compared to non-tourists. This may be explained by the unfamiliar traffic conditions that tourists are required to adapt to during their holidays.

Furthermore, the relative marginal effect of tourism as the purpose of travelling on road crashes increases during the touristic season – as seen in Table 3, a transition from non-tourism to tourism as the purpose of traveling results in a marginal effect of 0.095 during the non-touristic season, compared to a marginal effect of 0.103 during the touristic season (for a relevant increase of 8.8%). This can be explained by the fact that during the summer tourism increases, and so does the corresponding traffic, resulting in both increased traffic of visitors and increased participation in crashes, possibly indicating their increased risk.

4.2. Considering tourist nationality

Foreign tourists are involved in fewer road crashes than Greeks in absolute numbers (several negative marginal effects). The most likely explanation is the exposure of drivers to risk, as Greeks (tourists and locals) account for the largest proportion of the population and travel more vehicle-kilometers.

The relative marginal effect of the involvement of foreign tourists in road crashes increases during both the touristic season (+21.4%) and in the touristic regions (+21.1%) compared to Greeks (tourists and locals). This possibly indicates the increased risk of foreign tourists, who are involved in relatively more road crashes when visiting the tourist areas of Greece in the summer.

4.3. Considering touristic season

During the touristic season crashes increase compared to the non-touristic season throughout Greece overall, which is probably due to increased traffic volumes in the summer, and possibly also partially due to secondary factors such as increased alcohol consumption or sensation seeking.

The relative marginal effect of the touristic season on road crashes greatly increases for touristic regions (+75.9%), and also increases for tourism as the purpose of travelling (+8.6%). This once again indicates the potential increased risk of tourists, who appear to be involved in more crashes in summer than non-tourists. As previously stated, this may be explained by the unfamiliar traffic conditions that tourists have to adapt to during their holidays.

4.4. Considering touristic regions

The relative marginal effect of touristic regions on road crashes increases considerably in the case of tourism as the purpose of travelling (+68.8%). This increase is expected, as touristic regions attract a large number of tourists, who are required to drive in unfamiliar environments, resulting in an increased number of road crashes.

4.5. Comparison with the two major cities

Several noteworthy results are also obtained from the comparison of road crashes with those of the two major cities, Athens and Thessaloniki. These urban areas were heavily influencing the analyses with non-representative results that might skew the accuracy of the analyses. The reason is that the majority of crashes happen there, primarily involve natives and non-tourism as the purpose of travelling, and are roughly evenly distributed throughout the year, for reasons described below. Additionally, a decision was made to exclude them from the previous analyses due to their unclear status regarding tourism:

The relative marginal effect of tourism as the purpose of travelling on road crashes is significantly increased when the two largest urban centers (Athens and Thessaloniki) are not included in the analysis. The fact that the marginal effect of tourism as the purpose of travelling is reversed and increases by 145.9% when excluding Athens and Thessaloniki is interpreted by the relatively larger numbers of tourists outside the two large cities compared to the indigenous population travelling there. It is noteworthy that while tourism as the purpose of travelling had a decreasing (and thus positive) effect on the number of crashes in the analysis that included the two large urban centers, it has an increasing (thus negative) effect on the number of crashes when those are removed from the

analysis. A possible explanation is that while there is significant foreign tourism in the urban centers, transportation there is mainly carried out via public transport, either individually or in organized groups, resulting in foreign tourists to be less likely to drive a vehicle and become involved in road crashes.

The relative marginal effect of foreign tourists on road crashes is increased (+36.1%) when excluding the two major urban centers from the analysis. This may be due to the concentration of road crashes of native residents in the urban centers, with foreigners being involved in comparatively more road crashes in other regions.

The relative marginal effect of the touristic season on road crashes is greatly increased when excluding the two major urban centers from the analysis. This increase is the greatest among all the increases in relative influences (+173.1%), and it is attributed to the fact that while road crashes in the two large urban centers are roughly evenly distributed throughout the year, the other regions usually display a peak during the touristic season.

The relative marginal effect of touristic regions on crashes is also greatly increased (+84.5%) when excluding the two major urban centers from the analysis. This could be explained by the fact that urban centers account for of a large number of road crashes, and as they are classified as non-touristic regions, they greatly reduce the influence of touristic regions. Increased relative marginal effect of tourist regions on road crashes indicates the increase in the number of crashes in said regions compared to non-tourist regions, and potentially indicates the increased risk of tourists.

5. Conclusions

From the reported results, it can be discerned that tourists are more often involved in road crashes than non-tourists. Moreover, the touristic season and tourism as the purpose of travelling are both contributory factors to crash involvement. Regarding nationality, foreign tourists appear to be involved in fewer road crashes than Greek drivers. This last finding, which might seem counterintuitive at first, is attributed to the relative risk exposure. When looking closer, the increase of the relative rate ratio of road crash involvement for foreign tourists in touristic regions may indicate the increased risk of foreign tourists compared to Greek drivers. Follow-up studies which would record and analyze exposure data are highly desirable in order to provide a clearer and more complete picture. However, it should be noted that this would constitute a significant endeavor of considerable magnitude, given the national scope of the data.

Practical Applications

Further to the previous, the impacts of tourism on road safety is a topic of crucial interest for Greece, and the authors hope that these results will provide new knowledge towards improving road safety specifically for the country and for many other similar touristic regions as well. There are certain measures that could be taken to target tourists specifically, such as stricter random breath tests and more Driving Under the Influence (DUI) checkpoints enforced, and overall more systematic signage and awareness raising for the Greek road network. These measures would be more effective when implemented in touristic areas of Greece (such as the islands) and during the more intense touristic

season (from June to September). Their design should take into account both the unfamiliarity that tourists inherently possess and the fact that they visit for limited amounts of time; therefore, there is a need to swiftly acclimate and educate foreign drivers without alienating them.

6. References

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