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The Demand of Car Rentals: a Microeconometric Approach with Count Models and Survey Data

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This study analyzes the demand side of the tourism market in the Autonomous Region of the Azores, Portugal, ranked by National Geographic as the second island destination for sustainable tourism among 111 islands in the world. Due to the high frequency of car rentals, this region is a "fly-and-drive" destination, experienced rapid growth in the tourism sector in recent years. It is well known that the excessive use of cars leads to negative externalities such as pollution and the degradation of roads. Considering ecological fragility, typical for small islands, it is crucial to investigate the extent of negative externalities for internalizing the congestion costs. This topic is very important in terms of policy-making for developing sustainable tourism destination as well as in a global environmental context, from the perspectives of "*eco-taxes*" used as instruments for enhancing environmental protection. A distinctive contribution of this study is the attention paid to the diversity of tourists used car rental services in the Azores. The demand function of car rentals is analyzed based on highly disaggregated, individual data containing a large number of tourists visited the Azores and the family of count models. Then, based on the price elasticity of demand for car rentals, the desired tax rates are suggested for internalizing the congestion costs.

Keywords*:* *Count Data Models, Survey Data, Tourism, Market Demand, Car Rentals, Tax Rates*

1 Introduction

Tourism is one of the important and fast growing economic activities around the globe. Its annual rate has been around 4-5% per year in recent years and it represented around 10% of

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the gross domestic product (GDP) and investment worldwide in 2010. According to the World Travel and Tourism Council (WTTC), the tourism sector will continue to rise, from about 9% in 2011 to 10% by 2020 of global GDP, at the annual rate of about 4.4%, supporting 303 million jobs around the globe. Consequently, the sector is one of the important fields of fiscal actions as well, particularly in tourist destination countries. The tax receipts generated by the tourism sector alone, for example, represented more than 10% of the tax revenue collected by some developed countries (McAleer, Shareef and Veiga 2005). This figure can be much larger in small island economies, where tourism plays a dominant role in economic growth and accounts for a large proportion in GDP (Shareef 2003). Shareef (2003), for example, provides the definition and unique characteristics of small island economies, where heavy reliance on tourism receipts plays a dominant role in economic growth, due to relatively small size in terms of population and territory, the specific nature of ecology and climate, and limited production capacity.

The prominent role of tourism in the economic growth of small islands is stressed by various authors in literature.[1] The dynamic contribution of tourism to the economic growth of 19 island economies, within the conventional augmented Solow growth model, is explored in Seetanah (2010). The study suggests that tourism significantly contributes to the economic growth of island economies. Similar view is confirmed in Sequeira and Nunes (2008), who argue that tourism is a positive determinant of economic growth in much broader sample, including poor and small countries, where earnings from tourism is one of the important sources of foreign exchange and employment. Since small islands are considered economically and environmentally vulnerable due to "*delicate ecosystems with regard to global warming and rises in sea levels*" (Shareef and McAleer 2005, p. 314), island-related research on tourism addressed various problems and opportunities faced by the sector. In particular, fiscal actions and tourism taxation are covered in Gago et al. (2009), where the mechanisms for indirect taxation are analyzed and compared. According to the authors, the indirect taxation mechanism may be more feasible, equitable, and neutral way to obtain tax revenues from the tourism sector. Congestion externalities caused by car rentals are considered in Palmer-Tous et al. (2007) where the count models are used for investigating the demand of car rentals by tourists.

The purpose of our study is to analyze the demand side of the tourism market in the island region of Portugal, the Autonomous Region of the Azores, experienced a large increase in the tourism sector during the last decade. According to Menezes, Moniz and Vieira (2008) and Menezes, Vieira and Carvalho (2009), tourist arrivals increased largely from 159 thousand in 1995 to 260 thousand in 2005, while the number of visitors in touristic accommodations more

[1] See, for example, Clarke and Ng (1993), Hellerstein (1991), Lanza, Markandya and Pigliaru (2005), Gago, Labandiera, Picos and Rodriguez (2009), Green, Hunter and Moore (1990), Palmer-Tous, Riera-Font and Rosello-Nadal (2007), Seetanah (2010), Sequeira and Nunes (2008).

than doubled, rising from 407 thousand in 1995 to 936 thousand in 2005. Such a rapid increase resulted from large public investments in the sector with the total number of hotels growing from 3 thousand in 1995 to 10 thousand in 2005 (Menezes et al. 2009). Azorean islands are, normally, a “fly-and-drive” destination given the high frequency of car rentals by the tourists (Menezes et al. 2008). It is well known that the excessive use of cars can lead to negative externalities such as pollution and degradation of roads.

Considering the growing number of tourist in the Azores and ecological fragility that is typical for small islands, it is crucially important to investigate the extent of these negative externalities, which by definition constitute deviation from socially optimal situation. The social optimum is reached when externalities are internalized by imposing fees or a single tax on the generator of negative externality directed, in this particular case, at reducing costs associated with cars rentals - congestion externalities (Palmer-Tous et al. 2007). This topic is very important not only in terms regional public policy-making focused on developing a sustainable tourism destination,[2] but also in the global environmental context. Specifically, from the perspectives of effective "*eco-taxes*" which are used as instruments for regional policy-making in internalizing negative externalities, enhancing environmental protection and promoting social optimum welfare. The contribution of our paper is the attention paid to the diversity of tourists used car rental services, using highly disaggregated micro-level data containing a large number of tourists visited the Azores.

The rest of this paper breaks down into four sections. The foundations and mechanism of taxation for internalizing externalities that caused by car users and a conceptual framework for modeling the demand function of car rentals are discussed in section 2. Section 3 deals with the empirical estimation of the demand for car rentals, using the micro-level surveys that cover a large number of tourists visited the region. These surveys present detailed information on the demographic characteristics of tourists (e.g. citizenship, age and gender), their social and economic status (e.g. marital status, education and occupation), experiences, habits and satisfaction in finding accommodation, visiting the islands, renting vehicles and other activities. The concluding remarks and practical suggestions on internalizing negative externalities are provided in section 4.

2 The Taxation and Demand of Car Rentals: Foundation and Conceptual Framework

The public regulation and taxation of tourism play a crucially important role in pursuing a balanced social benefit. This is because the tourism sector brings not only economic benefits

[2] According to a survey conducted by National Geographic in 2007, Azores is ranked as the second island destination for sustainable tourism among 111 islands in the world (http://traveler.nationalgeographic.com/2007/11/destinations-rated/list-text).

(additional value added and employment), but also incurs various costs such as congestion and environmental degradation. Public instruments for correcting these costs include tourism taxation, which became a very attractive tool in internalizing the congestion costs (Gago et al. 2009; Green et al. 1990; Palmer-Tous et al. 2007). There are a number of reasons for that. First of all, taxing is related to the magnitude of potential revenues obtained from the tourist activity. Secondly, taxes paid by tourists can act as a substitute for the prices of the public goods and services consumed by tourists. Finally, taxes can play a corrective role in internalizing the external costs resulted from tourist activities. This reason relates, basically, to environmental costs and congestion (Fujii, Khaled and Mak 1985; Green et al. 1990). Therefore, public intervention through the taxation of tourism is very important, since corrective taxes lead to the inclusion of environmental and congestion (external) costs in the final price of the tourism package (Clarke and Ng 1993). For these reasons, many countries introduced the wide range of taxes on the tourism sector (Gago et. al 2009).

A taxable base for internalizing the congestion costs can be defined in several ways. According to Palmer-Tous et. al (2007), it can be done by vehicle traffics in the congested area. The tax rate is equivalent to external congestion costs (Newbery 1990) or, alternatively, it can be linked to the traffic flows on the congested areas, directly or indirectly (Hau 1992; De Borger, Peirson and Vickerman 2001). The direct tax mechanism levied on vehicles implies that distance travelled or congested areas are taken into careful consideration. This requires, consequently, introducing special technologies such as licensing schemes, road tolls and electronic pricing system with vehicle identification capacity, enabling to distinguish the hired cars one from another. The tax rates should also differ, depending on the degree of congestion caused by an individual car at different times and places.[3] Due to the fact that this mechanism is costly in terms of technology investments required for identifying the cars and control systems for time and distance travelled, the indirect tax mechanism is considered more advantageous.

The indirect tax mechanism, in comparison to the direct one, does have little relation to the distance traveled and the use of congested areas. In addition, it does not differentiate tax bases spatially or temporally. Therefore, they have a low corrective capacity for externalities associated with the environment and traffic accidents. Nevertheless, these instruments are helpful for correcting the atmospheric or noise-related externalities (European Commission, 2002). Among various instruments, taxes on fuel consumption are considered a better *proxy* for internalizing environmental and congestion costs due the large number of vehicles, both on hire as well as privately owned ones, according to Palmer-Tous et. al (2007). The taxable

[3] For example, according to Mayeres and Van Dender (2001), taxes should be levied at times when there is “a surplus demand over and above a fixed capacity and in places where congestion occurred leading to incremental time losses”.

base in this case is the rate of daily car rental, which allows policy-makers to fix the daily amount of taxes to be collected from every single car.

A standard framework for analyzing the demand of car rentals is the family of count models. The choice of count models is justified by restrictions imposed on the car rentals, that is: the duration of car rentals cannot take a negative value. Therefore, the count models are used very often for analyzing a market demand, generally (Hellerstein 1991; Smith 1988; Palmer-Tous et. al 2007). The demand function of a car rental is defined in a generic and standard form as follows:

$$DC_i = f(x_i) \quad (1)$$

where DC_i stands for the number of days an individual i arranges to rent a car (i.e. $i=0,1,2\ldots$), x_i is the vector of variables including the rental price per day (*PD*), and the set of socioeconomic variables characterizing the tourists. The standard family of count models is demonstrated in Appendix 1, where the Poisson distribution (*P*) is used as an initial modeling approach, as demonstrated in e.g. Cameron and Trivedi (1986), Grogger and Carson (1991), and Heilbron (1994).

Among the count models, provided in Appendix 1, the zero-inflated Poisson and zero-inflated negative binomial regression specifications are preferable. The Poisson regression leads to the downward bias, since not all travelers use the car rental services. The standard negative binominal regression results in potential problems of zero truncation and bias, due to the non-observable prices of those tourists, choosing not to rent cars. Therefore, it is essential incorporating the decision of tourists in a logit-binary choice type with two inclusive steps: 1) whether to hire a car or not; and 2) for how long to hire. Following Cragg (1971), Mullahy (1986) and Palmer-Tous et. al (2007), we use a two-step process. Johnson, Kotz and Kemp (1992), Lambert (1992) suggest a Zero-Inflated Poisson model (ZIP) with larger extra weights in the probability of an observed zero and smaller likelihood of other observed results defined as a logit-type binary choice model. Consequently, the ZIP model represents a mixture that combines a count component and a point mass at zero, defined as:

$$\begin{cases} Pr(W_i = 0) = \pi_i + (1-\pi_i)\, exp(\lambda_i); \quad \text{and} \\ Pr(W_i = w > 0) = (1-\pi_i)\frac{exp\,(-\lambda_i)\lambda_i^{w}}{w!}, \quad w = 1,2,\ldots \end{cases} \quad (2)$$

In the expression *(2)*, π_i represents the probability of non-participation in the car rental market with Poisson function. The details of analogous Zero-Inflated Negative Binomial (ZINB) regression models are as follows:

$$\begin{cases} Pr\ (W_i = 0) = \pi_i + (1-\pi_i)\ \frac{(\alpha\lambda_i)}{[1+\lambda_i]^{\frac{1}{\alpha}}}; \qquad \text{and} \\ Pr(W_i = w > 0) = (1-\pi_i)\frac{\Gamma\left(w+\frac{1}{\alpha}\right)}{\Gamma(w+1)\Gamma\left(\frac{1}{\alpha}\right)}(\alpha\lambda_i)^w[1+\alpha\lambda_i]^{-\left(w+\frac{1}{\alpha}\right)},\ \ w = 1,2,\ldots \end{cases} \quad (3)$$

The advantage of this approach is in including the zero observations in both stages with higher number of observations, which is important when the demand for car rental is weak.

3 Application of the Count Models for the Market of Car Rental in the Azores

The data used in this study come from the survey conducted at the main regional airports on tourists visited the Azores in the summer of 2007. The data were gathered by the Studies and Consultancy Department of Norma - Acores. From 1000 questionnaires distributed, 987 were responded back, indicating that 514 visitors rented cars, while 473 did not. Consequently, the empirical estimations are based on the sample of 987 questionnaires. The average age of the interviewees is 43 with the youngest age 18 and the oldest 77. The sample median is 47 years old. Table 1 demonstrates detailed information on respondents, who hired and did not hire cars, by gender, marital status, residence, education, occupation and other characteristics.

From 987 respondents provided information on the marital status, 678 were married, representing 71% of the sample; 224 (or 23.4%) were single; and 54 (or 5.6%) had a different civil status. The country residence of the 329 interviewees is Portugal, representing about 43% in the sample data. The second largest country, in terms of the residence of tourists, is Germany with 11% of visitors, and the third place belongs to the UK with about 7% of tourists. According to Table 1, 49% of the interviewees did have university education, while 51% were with secondary school or technical education.

The work status of the tourists is characterized as the following: 81% of respondents were employed, 9% were retired, 6% represented students, 2.6% were housewives, and only 0.8% of tourists were unemployed at the moment of conducting the surveys. Most tourists (84.2%) did not have Azorean origin or local tires, while some (18% of the interviewed women and 14% of the men) did have such connections. Therefore, the main reason of the visit was holidays for 83% of the interviewees, while 12% came for visiting friends or relatives. Only 4% of the interviewees visited the islands for business or professional motives. The data presented in Table 1 suggests that 50% of the visitors were accompanied by spouses or partners, 21% visited with families and children, and 12% travelled alone. The majority of tourists used hotel accommodation, particularly on San Miguel (74%).

Table 1. Sample descriptive statistics

	% of total	Hired cars	Did not hire cars
The group of respondents by:			
1. Gender difference	**100%**	**52%**	**48%**
Male	50%	52%	48%
Female	50%	52%	48%
2.Marital status	**100%**	**53%**	**47%**
Single	23%	39%	61%
Married	71%	57%	43%
Other	6%	56%	44%
3.Country of residence	**100%**	**54%**	**46%**
Portugal	43%	45%	55%
Brasil	1%	60%	40%
The UK	7%	51%	49%
Germany	11%	74%	26%
Spain	5%	68%	33%
France	5%	57%	43%
Belgium	1%	64%	36%
Italy	2%	76%	24%
Holland	5%	76%	24%
Canada	4%	28%	72%
Finland	6%	58%	42%
Austria	1%	55%	45%
Mexico	1%	0%	100%
Sweden	2%	67%	33%
Luxemburg	1%	75%	25%
Other countries	7%	54%	46%
4.Education	**100%**	**52%**	**48%**
Primary	51%	46%	54%
University	49%	58%	42%
5.Occupation	**100%**	**52%**	**48%**
Employed	81%	56%	44%
Unemployed	1%	0%	100%
Student	6%	32%	68%
Retired	9%	31%	69%
Other	3%	59%	41%

	% of total	Hired cars	Did not hire cars
6.Accommodation			
Stayed on San Miguel	**100%**	**54%**	**46%**
Hotels	74%	53%	47%
Other types	26%	55%	46%
Stayed on other islands	**100%**	**34%**	**66%**
Hotels	53%	37%	63%
Other types	47%	31%	69%
7.Visited all Azorean islands	**100%**	**44%**	**56%**
Hotels	64%	46%	54%
Other types	36%	39%	61%
8.Reason for a visit	**100%**	**52%**	**48%**
Vacation	83%	56%	44%
Visiting friends or relatives	12%	29%	71%
Business/work	4%	40%	60%
Sporting events	1%	25%	75%
Other	0%	75%	25%
9.Accompanies	**100%**	**52%**	**48%**
Alone	12%	25%	75%
Family with kids	21%	66%	34%
Spouses	50%	54%	46%
Group of adults	16%	48%	52%
Co-workers	1%	40%	60%

Source: the authors' calculations.

The distribution of car rentals by days and the number of individuals is shown in Table 2. About 35% of tourists rented cars from 2 to 7 days, which made about 72.92% of total expenses spent by all tourists on renting cars.

The sample data employed for the estimations of count models cover the number of days in renting a car, a rental price per day, average daily expenses, and the set of dummy variables. The dummy variables are assigned the following variables: the countries of residence; accommodation type (hotel or other); the level of education (university or lower); marital status (single or married); family roots in the Azores (have ties or not); work status (employed or retired; employed or student); and the number of companions (alone or with adults; alone or with children). With these sample data, the different specifications of the demand function are estimated, using the models presented in section 3 (P, NB, TP, TNB, ZIP and ZINB). The TP and TNB models include only those individuals choosing to rent a car, while the rest of the models are estimated on the whole sample. The results of the estimations are presented in Table 3.

Table 2. The distribution of car hire by days

Days	Number of tourists	Percentage, % (or frequency)	Average price (by days and individuals), EUR	**Days**	Number of tourists	Percentage, % (or frequency)	Average price (by days and individuals), EUR
0	473	48%	0	16	2	0%	42
1	21	2%	85	17	2	0%	65
2	45	5%	62	18	4	0%	29
3	68	7%	60	19	2	0%	39
4	64	6%	45	20	4	0%	23
5	68	7%	56	21	3	0%	30
6	44	4%	48	22	0	0%	0
7	56	6%	42	23	0	0%	0
8	29	3%	39	24	1	0%	44
9	9	1%	53	25	0	0%	0
10	31	3%	60	26	0	0%	0
11	10	1%	38	27	0	0%	0
12	11	1%	39	28	0	0%	0
13	7	1%	42	29	1	0%	10
14	24	2%	36	30	0	0%	0
15	8	1%	31	Total	987	100%	26 564*

*) The total amount of expenses for renting cars by tourists.

Table 3. Estimation results - Dependent variable: Number of days in renting a car

	P	NB	**TP**	TNB	ZIP	Logit	ZINB	Logit
Rental price, day	0.0115 (0.0004)***	0.0266 (0.0020)***	-0.0058 **(0.0006)*****	-0.0060 (0.0009)***	-0.0056 (0.0006)***	#	-0.0053 (0.0009)***	#
Expences	0.0009 (0.0002)***	0.0005 (0.0006)	**0.0005 (0.0002)****	0.0005 (0.0003)*	0.0005 (0.0002)**	#	0.0005 (0.0003)*	#
The UK	0.5209 (0.0800)***	0.8045 (0.2204)***	**0.2654 (0.0813)*****	0.2607 (0.1113)**	0.2623 (0.0811)***	#	0.2605 (0.1091)**	#
Germany	0. 7873 (0.0501)***	0.9779 (0.1733)***	**0.4540 (0.0505)*****	0.4716 (0.0724)***	0.4493 (0.0503)***	#	0.4629 (0.0706)***	#
Spain	0. 4820 (0. 0769)***	0.4492 (0.2334)**	**0.2481 (0.0774)*****	0.2636 (0.1065)**	0.2442 (0.0769)***	#	0.2571 (0.1038)**	#
France	0.4948 (0.0766)***	0.9156 (0.2419)***	**0.4980 (0.0739)*****	0.4599 (0.1109)***	0.4952 (0.0737)***	#	0.4583 (0.1080)***	#
Italy	0.5664 (0.1092)***	0.6710 (0.3484)**	**0.1772 (0.1117)***	0.2068 (0.1511)	0.1753 (0.1111)*	#	0.2052 (0.1471)	#
Holland	0.8160 (0.0668)***	0.9279 (0.2291)***	**0.5941 (0.0664)*****	0.5929 (0.0982)***	0.5893 (0.0663)***	#	0.5853 (0.0958)***	#
Hotel, San Migel	-0.5183 (0.2023)***	-0.4052 (0.8079)	**-0.3702 (0.2012)****	-0.3899 (0.3248)	-0.3673 (0.2011)**	#	-0.3818 (0.3173)	#
Hotel, oth.islands	-0.5361 (0.0394)***	-0.4625 (0.1100)***	**-0.3678 (0.0382)*****	-0.3761 (0.0539)***	-0.3649 (0.0381)***	#	-0.3721 (0.0528)***	#
Single	-0.2952 (0.0514)***	-0.1834 (0.1323)	**-0.0815 (0.0525)***	-0.0770 (0.0712)	-0.0808 (0.0521)*	#	-0.0771 (0.0695)	#
Asorean Roots	0.0808 (0.0521)*	0.1319 (0.1373)	**-0.2880 (0.0514)*****	-0.2987 (0.0746)***	-0.2860 (0.0512)***	#	-0.2936 (0.0729)***	#
University education	0.1627 (0.0358)***	0.2981 (0.0982)***	**0.0267 (0.0365)**	0.0394 (0.0502)	0.0275 (0.0362)	#	0.0425 (0.0489)	#
Retired	-0.4702 (0.0775)***	-0.4081 (0.1810)	**-0.0766 (0.0793)**	-0.1108 (0.1100)	-0.0766 (0.0788)	0.9757 (0.2433)***	-0.1079 (0.1074)	0.9748 (0.2442)***
Student	-0.4602 (0.1106)***	-0.7772 (0.2380)***	**-0.0296 (0.1144)**	-0.0415 (0.1538)	-0.0280 (0.1131)	1.1439 (0.2952)***	-0.0374 (0.1492)	1.1478 (0.2957)***
Adult	-0.0251 (0.0126)**	-0.0102 (0.0278)	**-0.0022 (0.0166)**	-0.0007 (0.0235)	-0.0023 (0.0166)	0.0492 (0.0370)**	-0.0005 (0.0232)	0.0497 (0.0372
Child	0.0134 (0.0064)**	0.1276 (0.0601)**	**-0.0001 (0.0079)**	-0.0039 (0.0125)	0.0000 (0.0078	-0.2636 (0.0898)***	-0.0029 (0.0115)	-0.2627 (0.0904)***

Numbers in brackets are standard errors: ***,**,* , denoting 1%, 5% and 10% significance level, respectively; the model estimations include constant variables.

The estimated models, which are presented in Table 3, were compared based on test statistics (e.g. χ^2 , log-likelihood, AIC, BIC and Vuong statistics) presented in Table 4.

Table 4. Count model test statistics

Statistics:	**P**	**NB**	**TP**	**TNB**	**ZIP**	**ZINB**
Number of observations	987	987	**510**	510	987	987
R^2-pseudo	0.1956	0.0635	**0.1494**	0.0741	#	#
χ^2	1473	278	**465**	203	459	191
$\bar{\chi}^2(01)$		1956		**104**	#	
Log-likelihood	-3029	-2051	**-1325**	-1273	-1987	-1938
Degrees of freedom	18	19	**18**	19	23	24
Vuong tests					13.17	5.38
Akaike information criterion (AIC)	6095	2380	**2687**	2585	4020	3924
Bayesian information criterion (BIC)	6183	2461	**2763**	2665	4133	4041

According to Table 4, the zero-truncated Poisson (TP) and zero-inflated Poisson (ZIP) models yield, as expected, similar and better results compared to the Poisson (P) and negative binominal (NB) ones. The dispersion of the Poisson model clearly underestimates the observed dispersion, which can be seen in very large log-likelihoods, χ^2 and AIC (or BIC) criterion. Hence, the standard errors of coefficients in the P-model are downwardly biased and cannot be considered appropriate for describing the population of interest. This can be the result of latent heterogeneity in the data that cannot be captured by a single parameter λ in the Poisson model, causing this overdispersion due to the large frequency of zeros in the distribution.

One possibility to cope with the overdispersion issue is to assume that the latent heterogeneity can be adequately described by some density in terms of Poisson parameters. The traditional approach is based on using an additional shape parameter (α in our case) in a parametric model with the Gamma distribution, presented in section 3. In this case, the marginal density becomes the negative binomial. The results obtained by the negative binominal (NB) model in our study suggest that the model improves the fit significantly, performing better than the initial P-model. Still, it is not sufficient for modeling the excess zeros which can be seen from the large values of AIC and BIC criteria, for example. Therefore, the NB model can further be improved by using a non-parametric approach.

The non-parametric approach for dealing with overdispersion consists of weighting the latent heterogeneous subset in the data, without specifying any parametric density. This can be done by truncating the non-zero subset in the data or inflating the data by zeros, as it was presented Appendix. In our case, the zero-inflated models combine the (1-π) proportion of extra-zeros with the count Poisson and negative binominal distributions, as presented in expressions 6 and 7. Consequently, there are two sources of zeros, which may come from the point mass and count component. For modeling the latent state, a binary logit is used with an intercept and regressors that included four fictitious variables indicating whether the respondents are retired or students, have adult and child accompanies. The intuition behind this is that this subset of population may choose excess zeros due to underlying economic reason.

As shown in Table 3, the regression coefficients and the standard errors obtained by the truncated and zero-inflated models are rather similar, though very different from the Poisson and negative binominal estimations. Therefore, in terms of predicted means, the models give very similar results.[4] The models are further inspected by the associated test statistics, which leads to a conclusion that truncated and zero-inflated models lead to the best results in terms of likelihood on this data set. Overall, both models lead to the same qualitative results and very similar. Perhaps, the truncated Poisson model is slightly preferable in terms of its goodness of fit, which explains about 14.94% of variation in the data.

According to the estimates obtained by the truncated Poisson (TP) model, the price variable has a negative sign, as expected; the higher the prices, the weaker the demand for car rentals. Average daily expenditures for a family or travel party, which can serve also as a proxy for the incomes and spending capacity of tourists in our study, have a positive and significant impact on the demand of car hire. Being the residents of the UK, Germany, Spain, France and Holland seem to cause a stronger demand for the cars rentals. The dummy variables for other countries in the sample are dropped due to insignificant standard errors. Hotel accommodation is found to have a negative impact on the demand, compared to the other types of accommodation, such as renting a flat. Presumably, this reflects the fact that most hotels in the Azores provide organized transport services to their customers, in the form of shuttle or tourist buses.

The coefficients on variables describing the marital status (single tourists or family ties with the residents of the Azores) are negative. Most likely, public transport and organized tourist services, offered by local hotels and tourist agencies, are a reasonable alternative for single tourists. Better quality of those services with higher frequency and customer convenience may be a substitute for car rentals. The level of education seems to have a positive, but not significant impact on the demand of car rentals. The demand of car rentals by visitors, who have Azorean ties, is weak reflecting various possibilities for finding vehicles through local connections. The coefficients on the dummy variables for students, retired, having adult and infant companions are not significant, according to the results of the TP

[4] The associated partial Wald tests also lead to the same conclusions.

model. Taken as unobservable latent variables for inflating the ZIP model, however, these variables show high statistical significance. Based on those estimations, one can infer a positive relationship between the duration of car rentals and the certain attributes of tourists, such as whether they are retired or students. Being a tourist with adult accompanies seem to have a positive impact on the demand of car rentals, while for those having children the opposite is likely. This is clearly linked to the income factor. Namely, tourists with adults accompanies may share the expenses of car rentals.

The price elasticity of demand for car rentals is calculated based on the coefficient on the variable that stands for the price of car hire per day. An increase in the price of rental leads to the decrease in the duration of car rentals. Consequently, tax rates can be applied to daily rental fees, depending on the petrol consumed and for how long the policy-makers are willing to reduce the duration of car rentals. Table 5 provides the simulated values of a relationship between the price and duration of car rentals based on the TP estimates which resulted in the price elasticity of about 0.36.[5]

Table 5. The effect of price changes on the average number of days

Elasticity of demand is 0.36				
Daily tax rates in EUR	2	4	8	12
The effect on the number of days	-0.32	-0.76	-1.58	-2.33

Source: the authors' computations

Based on these results, one can see that the daily taxes imposed at the rates of 2, 4, 8, and 12 EURs would shorten the number of days by 0.32, 0.76, 1.58 and 2.33 days, correspondingly.

As discussed in section 2, the indirect tax mechanism is helpful for correcting the atmospheric or noise-related externalities. Due to an increase in the number of private as well as hired cars, levying taxes directly on cars may not be a very suitable tool for internalizing the congestion costs. Therefore, taxes on the consumption of fuel are suggested as a good *proxy* for the taxable base. In this case, the number of days in the rental of cars allows one to determine and monitor the rate and amount of taxes to be collected on a daily basis.

4 Conclusion

This paper focuses on the demand side of the tourism market in a small island economy, the Azores, which experienced a rapid growth in the tourism sector during the last decade. Since

[5] The price elasticity is based on a percentage decrease in the mean number of days across the sample, following a 1% increase in the prices of car rentals. Similarly, the impact of taxes is simulated by adding fixed rates to daily rental fees, which leads to a decrease in the average number of days when a car is hired.

the Azorean islands are characterized by high frequency in the car rentals of tourists, it is crucially important to take into account the extent of negative externalities caused by car rentals. A distinctive contribution of our study is the attention paid to the diversity of tourists in the car hire segment of the local market. The demand function of car hire is investigated based on highly disaggregated, individual data containing the large number of tourists visited the Azores. Based on the price elasticity of demand for car rentals, we then suggest desired tax rates for internalizing the congestion costs.

The results reveal that the TP and ZIP models lead to better outcomes in terms of likelihood on our data set. Overall, both models lead to similar qualitative results; however, the TP model is slightly preferable in terms of its goodness of fit, which explains about 14.94% of variation in the data. According to the estimates, the price variable has a negative sign, as expected: the higher the prices, the weaker the demand for car rentals. Based on the coefficient on the price variable, the price elasticity of demand is calculated. It suggests that an increase in the price of rental leads to a decrease in the duration of car rentals by approximately, as expected. The simulated values of a relationship between the price and duration of car rentals resulted in the price elasticity of about 0.36. Consequently, tax rates can be applied to daily rental fees, depending on the petrol consumed and for how long the policy-makers are willing to reduce the duration of car rentals. Based on these results, one can see that the daily taxes imposed at the rates of 2, 4, 8, and 12 EURs would shorten the number of days by 0.32, 0.76, 1.58 and 2.33 days, correspondingly. Taxing the consumption of fuel is suggested as a *proxy* for the taxable base. In this case, the rate and amount of the taxes will be determined based on the number of days in car rentals.

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Appendix

The Poisson distribution (*P*) is the first modeling step (see e.g. Palmer-Tous 2007):

$$Pr(W_i = w) = F_p(w) = \frac{exp(-\lambda_i)\lambda_i^W}{w!} \qquad i = 1,2, \ldots N. \tag{1.a}$$

The term *W* in the expression (*1*) is the *i*-th observation of the discrete variable of interest with *w* representing the set of non-negative variables such that (*w =0, 1, 2,…*). The term *N* represents the number of observations and the parameter *λ* denotes the mean and the variance of random variable W_i, defined as:

$$\lambda_i = exp(X_i\beta) \tag{2.a}$$

where *X* is a matrix *N*×*K* of explanatory variables and *β* is a vector of parameters to be estimated with the *K* dimension. According to Cameron and Trivedi (1986), the ratio of the conditional mean and the variance of the dependent variable can be greater than one under over-dispersion. This leads to a downward bias in the standard errors of the parameter *β*. In order to treat this issue, we use a standard negative binominal distribution (NB), defined as:

$$Pr(W_i = w) = F_{NB}(w) = \frac{\Gamma\left(w+\frac{1}{\alpha}\right)}{\Gamma(w+1)\Gamma\left(\frac{1}{\alpha}\right)}(\alpha\lambda_i)^w[1+\alpha\lambda_i]^{-\left(w+\frac{1}{\alpha}\right)}. \tag{3.a}$$

A non-observable price for those tourists, who choose not to hire a car, can lead to a zero truncation and possible bias in the estimation of the parameter β within the set-up provided in the expressions *(1)* and *(3)*. This problem can be dealt by estimating the Zero-Truncated Poisson (TP) and Zero-Truncated Negative Binomial (TNB) models suggested in Gerdtham (1997) and Lee, Wang, Yau and Somerford (2003), where the left-truncated density functions (*k*=0) can be expressed as the following expressions for t he TP and TNB processes, respectively (Grogger and Carson 1991):

$$Pr(W_i = w | W_i > 0) = F_{TP}(w) = \frac{exp\,(-\lambda_i)\lambda_i^W}{w!}[1 - F_p(0)]^{-1} = \frac{\lambda_i^W}{[exp(\lambda_i - 1)]w!};$$

$$Pr(W_i = w | W_i > 0) = F_{TNB}(w) = \frac{\Gamma\left(w + \frac{1}{\alpha}\right)(\alpha\lambda_i)^w}{\Gamma(w+1)\Gamma\left(\frac{1}{\alpha}\right)}[1 + \alpha\lambda_i]^{-\left(w + \frac{1}{\alpha}\right)}[1 - FNB(0)]^{-1}.$$