Investigating the acceptance and willingness-to-pay of an urban pricing scheme: The case of Athens

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SHORT SUMMARY

Urban pricing strategies have been widely implemented in order to reduce externalities generated by traffic. These strategies have been considered effective schemes that not only it is possible to relieve congestion from metropolitan areas that have heavy traffic, but can also reduce emissions from cars and promote public transport usage. The scope of this paper is to investigate the users' perceptions towards the measure of urban tolls in the center of Athens. Applying discrete choice models to data from a stated preference survey, it was resulted that the majority of respondents would not accept such measure. Furthermore, it was found that drivers are willing to pay an extra 8-euro cents in order to save 1 minute on the travel time of their trip.

Keywords: MNL Models, Road Pricing, Stated Preference Survey, Urban tolls.

1. INTRODUCTION

Several studies all around the world have examined the impacts and the schemes of different pricing policies in urban areas, which aim at minimizing transportation externalities generated by traffic. Given that cars dominate the road network in most metropolitan areas, the importance of implementing such measures is evident since it has positive effects on human and social welfare, such as relieving traffic congestion and reducing emissions.

There are numerous strategies to implement congestion pricing. The most well-known schemes are found in London and Stockholm, in which it has been observed that the implementation of urban tolls reduced the traffic volume by 25% and significantly improved air quality (Croci, 2016). A study in Singapore (Adnan et al., 2020) examined the time-based pricing strategies in public transportation. Peak and off-peak pricing strategies are crucial policy tools used to spread peak demand and decongest the network.

The main challenge when applying a congestion pricing scheme is to avoid the users' hesitance of accepting this scheme. In an empirical research carried out in five European cities (Dieplinger & Fürst, 2014) it was found that a great majority of users are not willing to pay a fee for their entrance into the center of a city. However, higher acceptability rates can be achieved when the importance of such measures has well been communicated, in order for users to realize that their own trips would contribute to traffic congestion. Furthermore, perceived consequences of traffic congestion influence public acceptance of congestion pricing (Rentziou et al., 2011).

2. METHODOLOGY

In order to investigate the acceptance of the application of urban pricing strategies – a new transport concept, it is necessary to collect stated preferences data, which reveal the users' perceptions towards these measures. To this end, a structured questionnaire was designed and a field survey was conducted. Following the collection of the data, MNL models were applied aiming to identify the characteristics and the conditions under which users would accept such a measure.

Stated preferences survey

To investigate the intention of users to accept a cost for their entrance into the center of Athens (the Athens ring), which aims at decongesting the center of Athens and improving the environmental conditions, a questionnaire survey was designed. The stated preferences survey was carried out during the period 15/11/2021-26/11/2021 on the field, and more precisely in the center of Athens during the morning hours (10:00 a.m. – 4:00 p.m.). The total number of the collected questionnaires is 1,260.

The questionnaire consists of 4 parts and includes 21 questions in total. In the first parts, the questionnaire focused on capturing the mobility profile of each driver (i.e., residential area inside or outside the Athens ring, peak hours trips, travel mode, frequency of entering the Athens ring, trip purpose, whether the car enters the Athens ring every day and if not how respondents travel, departure time flexibility, and parking cost). In the second part, the respondents were asked to answer questions regarding their perception of the urban tolls. Indicatively, each individual was required to opt between a set of conditions under which an urban toll would be acceptable (e.g., if the traffic congestion was reduced or the revenues be given for the improvement of public transport). Afterward, the respondents were asked to agree or disagree with the measure of urban tolls, mention the travel mode that would be chosen in case the urban tolls were applied, and indicate the groups of people that based on the respondent perception should be offered a discount (e.g., residents of the center of Athens, vulnerable groups). The third part consists of 11 scenarios referring to pairs of cost of urban tolls and time-gain for trips with different travel times and aims at identifying the patterns of drivers in case urban tolls were applied. The respondents were asked to choose a number of cost-gain in time pairs trips with 20-,40- and 60-minutes travel time. It is worth mentioning that the cost sometimes increased analogously with the profit in time and sometimes did not. The last part of the questionnaire includes the demographic characteristics of the respondents.

Model development

In transportation research, discrete choice models are usually developed to predict travel behaviors, more specifically choices on modes of transportation, time of day, destinations, and even routes (Chen et al., 2016). Discrete choice models are developed relying on the Utility Theory, based on which the traveler is rational and consistent. This means that the decision-maker will always choose the best alternative (maximum utility) given all the available information. The Multinomial Logit (MNL) family of models are utilized in order to understand the behavioral characteristics of users' travel choices, such as the value of time (VoT). The VoT can be computed by the ratio of the emerging coefficient for time and the price or cost coefficient (Brownstone et al., 2003). The VoT represents the amount of money one is willing to pay for a desirable change of one unit in time or how many monetary units correspond to the time spent travelling.

In the present paper, 5 logit regression models were developed. Models 1 and 2 are binary logit models and estimate the factors that affect the acceptance of the measure of urban tolls and the mode choice after the application of such measure, respectively. Moreover, Model 3 was built in order to estimate the acceptance of different urban-tolls schemes. Finally, Models 4 and 5 estimate the preference of users among cheap and expensive pricing schemes. Models 3, 4 and 5 used the responses from the questions referring to the scenarios.

3. IMPLEMENTATION AND FINDINGS

Analysis of responses

The first step after collecting the questionnaires is to perform a preliminary statistical analysis in order to understand the characteristics, travel patterns and intentions of drivers. The socio-demographic characteristics of the sample of 1,260 respondents are shown in the Table 2.

Table 2: Socio-demographics of the Sample

Variable	Example	Percentage of sample
Gender	Male	49.13%
	Female	50.87%
Age	Young (18-34)	37.54%
	Middle-aged (35-54)	45.48%
	Elderly (>55)	16.98%
Income	Low (< € 10,000)	39.92%
	Medium (€ 10,000 - € 20,000)	44.92%
	High (> € 25,000)	15.16%
Occupation	State employee	8.49%
	Private employee	45.71%
	Freelance	33.49%
	Unemployed	1.11%
	Retired	3.65%
	Student	7.54%

Findings demonstrated evidence that most of the respondents (80.3%) are not willing to pay a fee for their entrance with a car into the Athens ring. However, it has been shown from studies in numerous cities that the acceptance of such new concepts tends to increase after the implementation (Eliasson, 2002).

An interesting finding concerning the mobility profile of drivers is presented in Figure 1. More specifically, it shows the distribution of the mode of transportation for the respondents who live inside and outside of the center of Athens. It is worth mentioning that the majority of the respondents (78%) live outside of the center of Athens. It seems that 60% of people living outside the center use their cars and 20% of them use the public transport. These percentages are reduced for the residents of the center and a share of them is replaced by the usage of motorcycle, taxi and walking/bicycling.

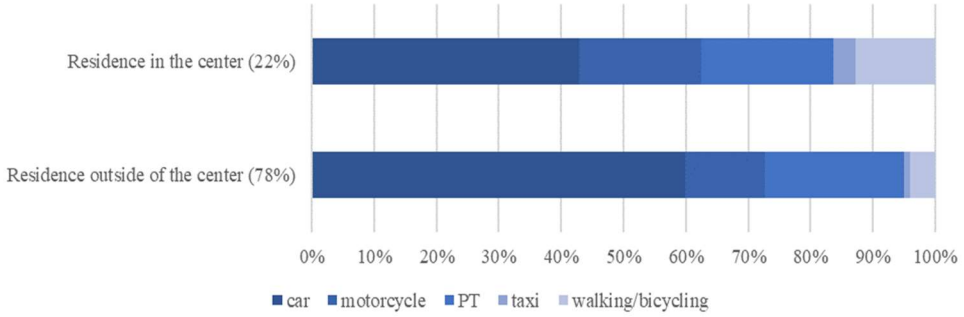

Figure 1: Travel Mode Choice for Residents of/outside of the Center of Athens

Analysing the responses – regarding the scenarios – of drivers who would choose to enter the center of Athens with car after the implementation of urban tolls, it was resulted that most of them would opt for the cheaper fee charge, as shown in Figure 2. In fact, 55% of them chose the cheapest option for all scenarios. It was found that for trips with smaller travel times, users are not willing to pay a high fee in order to have some profit in their travel time. However, when the cost of the fee is increased in both options the users' preference for the more expensive option increases. Finally, it is clear that for trips with longer travel time, in this case one-hour journeys, while the majority of respondents chose the cheaper option, the choice of the most expensive fare exceeded 35%.

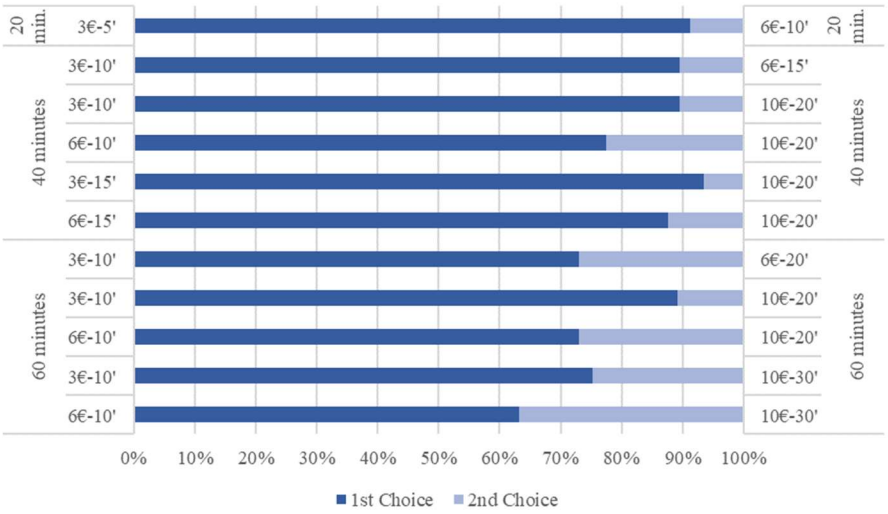

Figure 2: Responses for Various Scenarios for Car Drivers after the Application of Urban Tolls

Modelling respondents' options

First, two binary logit models were built aiming to identify the factors affecting the acceptance of the measure of urban tolls and also the factors affecting the option of using a car or not after the implementation of this measure. Regarding the toll-acceptance model, the acceptance of the measure was encoded with the value of "1", whereas the non-acceptance of the measure was encoded with the value of "0". Respectively, for the mode choice after the implementation of the measure, the usage of car was encoded with the value of "1", whereas the option of using another mode was encoded with the value of "0". The accuracy of the toll-acceptance model and the mode-choice model was calculated 68.6% and 72.5%, respectively. Moreover, the ROC curve had 0.684 Area Under the Curve for the toll-acceptance model and 0.727 for the mode-choice model.

Table 3 summarises the significance of the main variables for these models. The main factors that affect the users' acceptance of urban tolls are the age, gender, income and the premise that there will be credible transport alternatives. More specifically, young people and men tend to be more positive towards such a measure compared to older people and women. Finally, as expected, people with higher income are more likely to accept the measure of urban tolls. Regarding the travel mode choice after the implementation of urban tolls, the most significant factors that affect it are the residential area (inside/outside of the center of Athens), the travel during peak hours and the premise that there will be credible transport alternatives.

Table 3: Significance of Variables in the Urban Toll Acceptance and Mode-choice Model

Variables	**Coefficients/p-value**			
	Urban tolls acceptance		Mode choice after the implementation of urban tolls	
	Coefficients	p-value	Coefficients	p-value
Residence in the center of Athens	n/a	n/a	-0.346	**
Peak hour trips	-0.464	***	0.537	***
Age	-0.340	***	n/a	n/a
Gender	0.286	***	n/a	n/a
Income	0.782	***	n/a	n/a
Occupation (private employee)	0.359	*	-0.359	*
Occupation (freelance)	0.565	***	0.352	*
Occupation (unemployed)	1.314	***	-1.608	**
Occupation (retired)	0.630	**	-0.264	
Occupation (student)	1.072	***	-0.065	
Mode (motorcycle)	-0.116		-3.017	***
Mode (PT)	-0.083		-2.690	***
Mode (taxi)	0.560	.	-15.726	
Mode (walking/bicycling)	0.066		-1.988	***
Under the condition of the existence of credible transport alternatives	0.772	***	-0.709	***
Under the condition of improving PT	0.305	**	n/a	n/a
Under the condition of road Network improvement	0.767	***	n/a	n/a
Under the condition of tax reduction	-0.530	***	n/a	n/a
Under the condition of charging depending on the travelled distance	0.347	***	n/a	n/a
Under the condition of reducing the road congestion	n/a	n/a	0.535	***
Under the condition of charging depending on the vehicle type	0.903	***	0.372	***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' 1

Following, an MNL regression model was built to model the choices of users – regarding whether they would choose the cheap or the expensive option or even if they would choose not to enter the Athens ring. These choices were encoded with the values "1", "2" and "3", respectively. Table 4 shows the coefficients and the significance of the independent variables used in this model. These variables were defined as the time-gain (in minutes) and the additional cost of the trip corresponding to the toll fee (€). This model was built without an intercept in order for the differences between the three options to be fully reflected in the values of the coefficients of each independent variable.

Table 4: Significance of Variables in the Urban Toll Acceptance Model from Declared Preference Scenarios

	Coefficients	Std. Error	p value
Time-gain	0.021	0.006	**
Toll fee	-0.248	0.014	***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' 1

Moreover, two MNL regression models were built, in order to investigate the preferences between cheap and expensive options in the scenarios for drivers who would switch to another travel mode after the implementation of urban tolls and for drivers who would stick to their preference and continue to use their car. Tables 5 and 6 present the correlation of the travel time and the fare variables with the preferred option in the various scenarios.

Table 5: Significance of Variables in the Opting-for-scenario Model for Drivers who would Switch to Another Travel Mode after the Implementation of Urban Tolls

	Coefficients	Std. Error	p value
Intercept (2nd choice)	-1.741	0.151	***
Time-gain	-0.109	0.009	***
Toll fee	-0.243	0.032	***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' 1

Table 6: Significance of Variables in the Opting-for-scenario Model for Drivers who would Use their Car after the Implementation of Urban Tolls

	Coefficients	Std. Error	p value
Intercept (2nd choice)	-1.719	0.176	***
Time-gain	-0.11	0.01	***
Toll fee	-0.216	0.036	***

Significance: 0 '***' 0,001 '**' 0,01 '*' 0,05 '.' 0,1 ' ' 1

Subsequently, the Value of Time (VoT) was estimated for each of the above 3 models. Based on the results, a driver is willing to pay an extra 8-euro cents for every 1 minute that is saved on travel time. Consequently, a user would pay up to € 6 to save 1 hour in their travel time. As far as the users' preference in the scenarios, drivers who would use another travel mode after the implementation of urban tolls cost their time 0.45 €/min, whereas the respective value for drivers who would continue to use their car after the implementation of such measure is 0.51 €/min. From the aforementioned, it can be observed that the value of time for drivers who would stick to their preference of using their cars after the application of urban tolls is 13% greater than drivers who would shift to another travel mode.

4. CONCLUSIONS

The present study examines the users' attitudes towards the measure of urban tolls in the Athens ring. To this end, binary logit and MNL models were developed using data from stated preference survey. Findings demonstrated evidence that a great majority of people would not agree to pay for their entrance in the center of Athens and the main factors affecting this option are the age, the gender, the income and the premise that there will be credible transport alternatives. Furthermore, the most significant factors that affect the mode choice after the implementation of urban tolls are the residential area, the travel during peak hours and the premise that there will be credible transport alternatives. A more in depth look at the results shows that drivers are willing to pay an extra 8-euro cents for every 1 minute that is saved on travel time. Additionally, drivers who would use another travel mode after the implementation of urban tolls cost their time 0.45 €/min, whereas the respective value for drivers who would continue to use their car is 0.51 €/min.

Results from this study can assist in better understanding the users' perception towards the measure of urban tolls in order to communicate efficiently the decision of applying such measure and following the effective strategy for improving social and environmental conditions.

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