MODELLING DRIVER CHOICES TOWARDS ACCIDENT RISK REDUCTION

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Abstract

This research deals with the identification of the driver behavioural parameters that influence his choices in order to reduce the accident risk. In this context, a questionnaire-based survey was conducted and the stated preference method was used to develop an explanatory model. The application of the logistic regression model developed showed that parameters related to trip duration and increase of trip cost and time have an important impact on the choice of risk reduction alternatives. Other parameters with significant impact concerned gender, family status, driving experience and annual family income. Furthermore, the application of the model revealed that absolute value of additional trip time - not its percentage change - seems to play the most important role in driver choice towards accident risk reduction independently of the trip duration. Results from this sensitivity analysis of critical parameters affecting driver choices could prove useful for the identification of appropriate road safety strategies, programmes and measures for the improvement of driver behaviour.

Key-words: risk reduction, road accident, logistic regression, stated preference

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1. Introduction

Road transport is today one of the most significant causes of life loss, especially among young people. Road safety is therefore an important factor in transportation planning and related decision-making (European Commission, 2001). Users of the road transport system appreciate safety (i.e. risk reduction) and are disposed to pay the necessary cost up to a certain degree. Road safety is important, but how much people are disposed to change their behaviour? For drivers trip time is often more important than their safety, as the safety cannot be easily quantified (ETSC, 1997). Driver behaviour towards accident risk reduction is a complex phenomenon and involves individual's differences (Golias et al., 1997, Kanellaidis et al., 1999), which are complicated to predict, even if relevant models are developed.

For the facilitation of the task of planners and decision makers in the field of road transport, various methodologies for the estimation of road accident costs have been developed, in an attempt to quantify the economic and human benefit from the prevention of road accidents and their casualties (Trawen et al., 2000, Elvik, 1994, COST 313, 1994). In some of these methodologies, driver choice is taken into consideration by the use of specialized techniques (e.g. willingness-to-pay) for the recording of drivers stated preferences (Jones-Lee et al., 1992).

The recording of opinions, attitudes and preferences in view of identifying choices of public, constitute an essential stage for related research in various sciences. The most commonly used methodologies for such surveys can be separated in two categories: the stated preference and revealed preference methodologies. In the first category belong methodologies that record the public's opinions usually toward certain hypothetical situations, which have never been encountered in the past. This is the only way to study the public attitude towards a situation, since neither measurements nor observations could be possible for this non-existing situation. The second category consists of methodologies that record actual behaviour and choices of public on alternative scenarios. A classic example of this methodology is the recording of choice between transport means (Ben-Akiva and Lerman, 1985), by the use of measurements and observations in existing situations.

For the development of mathematic models that value transport demand, revealed preference methodologies appear more suitable (Kroes et al. 1986). However, they present certain restrictions that decrease their wide and general use. The revealed preference methodologies lack flexibility; therefore many difficulties are presented in the examination of every parameter that could be interesting for the research. For example, correlations between interesting parameters (e.g. trip time and cost) cannot be used directly in the evaluation of situations that do not exist. These methodologies presuppose that the parameters can be expressed in absolute units and as a result, their use is limited in the collection of elements for initial interest parameters. Frequently they can be used in the evaluation of effect of changes in regard to secondary parameters, as for example the location and comfort of stations of public transport means.

On the other hand, stated preference methodologies constitute a more attractive tool for research for non-existing situations (Bates, 1988). The analysis of stated preference data originated in mathematical psychology with the seminal paper by

Luce and Tukey (1964). Stated preference methods were further developed in marketing research in the early seventies (Green et al., 1978) and over several decades have had several transportation-related applications, including transportation planning (Green and Srinivasan, 1978, Steer and Willumsen, 1981, Sheldom and Steer, 1982). More recently, stated preference techniques have been used, for example, to examine the effect of travel information on mode choice (Abdel-Aty et al., 1996, 1997, Khattak et al., 1995, 1996, Polydoropoulou et al., 1996).

The basic idea of stated preference experiments is to obtain a rich form of data on behaviour by studying the choice process under hypothetical scenarios designed by the researcher. There are many advantages to these data including the ability to: capture responses to non-existing or unavailable alternatives, design explanatory variables such that they are not collinear and have wide variability, control the choice set, easily obtain numerous responses per respondent, and employ various response formats that are more informative than a single choice (for example, ranking, rating, or matching).

However, a basic disadvantage of stated preference methodologies is the fact that many times the interviewee could act against his declarations. This phenomenon can be critical under certain circumstances, when for example the results are not verified with results from similar research. Additionally, particular attention should be given to the results explanation, because (Lin et al., 1986, van der Hoorn et al., 1984) people have the tendency to exaggerate when they conceive that they take part in some experiment. Overcoming drawbacks of stated preference methodologies is possible by the use of a series of special techniques (Roberts et al., 1986).

Areas of stated-preference-related research include experimental design, design of choice experiments, developing the choice model, validity and biases. A discussion of the methods can be found in Carroll and Green (1995) and a general review of related issues is available in Louviere et al. (2000).

The primary drawback to stated preference data is that they may not be congruent with actual behaviour (for example due to biases). For this reason, techniques to combine stated and revealed preferences (developed by Ben-Akiva and Morikawa, 1990), which draw on the relative advantages of each type of data, are becoming increasingly popular. For example, joint stated-preference/revealed-preference models have been used to model recreational site choice (Adamowicz et al., 1994), intercity mode choice (Ben-Akiva and Morikawa, 1990), choices among gasoline and alternative-fuel vehicles (Brownstone et al., 2000), and pre-trip decisions as influenced by traveler information systems (Khattak et al., 1996).

This research proposes the use of stated preference methodologies, so that on the basis of models predicting driver's behaviour, a reliable estimate of driver choices towards accident risk reduction can be obtained. While most studies using the stated preference methodology have been focusing on the monetary value of particular alternatives, the aim of this research is to qualify the contribution of specific parameters towards risk-reduction. Relevant references include Ortuzar and Rizzi (2001) and Rizzi and Ortuzar (2003) who were also interested in the value of attributes (travel time, toll and annual accident rate) instead of sheer monetary value of accidents. Given the limited research in this specific area, sensitivity of accident risk reduction choice constitutes an interesting research field for the investigation of the interrelation between the various parameters involved. Furthermore, the outcome of this research could assist the development of strategies aiming to change driver behaviour towards significant accident risk reduction.

For that purpose, a specially designed questionnaire-based survey was carried out in a representative sample of Greek drivers. Logistic regression was used for the development of a mathematical model, and thus the identification of the parameters affecting driver choice towards accident risk reduction. The application of this model led to the extraction of a series of interesting conclusions for driver behaviour sensitivity towards accident risk reduction.

2. Theoretical background

In order to predict the driver behaviour towards accident risk reduction, a mathematical model was developed. The model parameters were estimated with the application of logistic regression analysis, which is commonly employed in transport mode choice situations, to identify those parameters that are significant in affecting these choices. Before deciding for the choice of logistic regression, other methods were also considered, like linear regression, discriminant, probit and logit analysis. Logistic regression analysis was chosen in this work not only because it allows for the development of models on alternative choice probabilities for discreet dependent parameters (Ben-Akiva and Lerman, 1985), but also because it makes easier the identification of the sensitivity of the impact of the parameters examined. The logistic regression constitutes a suitable method for the elaboration of data resulted from independent observations or statements of the public and is considered appropriate for analysis of answers to stated preference surveys.

The estimators of the logistic regression model parameters are calculated with the maximum likelihood method. The mathematic model that results initially from the analysis provides the utility function, which is based on the random utility theory. This logistic regression model associates in a linear way the parameters influencing the decision. The probability of this choice is directly calculated through appropriate transformation of the utility function. The relation between probability and utility function is not linear. The logistic regression can be used for the development not only of binary models, but also of models with more alternative choices. In general, the utility function can be stated as (Ben-Akiva and Lerman, 1985):

$$U_{in} = V_{in} + \varepsilon_{in} \qquad (1)$$

where:

n = individual

i = considered alternative

V_{in} = quantitative characteristics observed (systematic component)

ε_{in} = not observable parameter expressing the deviation from reality of observations on the basis of individual taste (random disturbance)

The most appropriate method to be used depends on the distribution of e_{in}. If e_{in} is assumed to be logistically distributed (i.e. the disturbances are independent and identically Gumbel, or type I extreme value, distributed), a logit method is used. If e_{in} is normally distributed, a probit method is used. If e_{in} is uniformly distributed, linear forecast probability models are used. With the assumption that e_{in} is logistically distributed the probability of choosing alternative i is:

$$P_{in} = \frac{e^{\mu Vi}}{\sum e^{\mu Vj}} \qquad (2)$$

where:

j = 1,…,i,…,n alternatives

μ = a positive scale parameter

With the assumption that the utility function is linear-in-the parameters, it can be argued that μ cannot be separated from the parameter coefficients, therefore for the case of two alternatives, the relation becomes:

$$P_i = P(U_{in} \geq U_{jn}) = \frac{e^{Ui}}{e^{Uj} + e^{Ui}} = \frac{1}{1 + e^{Uj-Ui}} \qquad (3)$$

where:

P_i = the probability of choosing i, while the probability of not choosing i (in a binary model, such as the one considered in the present research) is obviously 1 - P_i.

and:

$$U_i = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + ... + a_nx_n \qquad (4)$$

where:

U_i = utility function,

$x_1 \ldots x_n$ = the parameters (explanatory variables),

a_0 = the constant term which shows the effect of factors that influence the choice and have not been included as parameters in the mathematic model,

$a_1 \ldots a_n$ = the coefficients of the parameters (estimators).

3. Field survey

The field survey was carried out through questionnaire-based interviews on selected points of the Greek national road network (gas stations, parking areas) and concerned a randomly chosen sample, as one out of eight drivers arriving in each selected point was questioned. Furthermore, since the drivers were already out of their cars and taking a break from the trip, the response rate was higher than 90%. The interviews took place on national roads close to Athens (the 3,5 million inhabitants Greek capital) and to Kalamata (a Greek city of 80.000 inhabitants, 250 km south-west of Athens).

The points, days and hours for the administration of the field survey were chosen so that the sample covers all different driver and trip characteristics (e.g. young and old drivers). The sample established was composed by 260 persons. The comparison of basic sample characteristics with driver characteristics in Greece from other studies (SARTRE, 1998) showed that percentages of each value of parameters concerning gender, age groups and annual mileage present similar values on a 10% level of significance (overlapping confidence intervals for all cases) (Dixon and Massey, 1969).

Experience from similar research (Jones-Lee et al., 1985, 1992, Harvatis, 2000) was exploited for the preparation of the questionnaire, specially designed for this research. Pilot interviews took place allowing for the definition of the most suitable value ranges for the various parameters, as well as for the identification of necessary improvements to the questionnaire. The finally adopted questionnaire allowed for the application of the logistic regression model to the survey results. The questionnaire was composed of four Parts.

The First Part of the questionnaire concerns information about the driving characteristics of the interviewee (driving experience, type of vehicle usually driven, yearly kilometres driven, etc). The Second Part contains basic questions on road accidents with ultimate objective to make the interviewee understand the current road accident risk and to familiarise him with the probability of being involved in a road accident. The Third Part of the questionnaire contains a series of choices in relation to accident risk reduction and contains two cards with four sets of choices each, as shown in Figure 1. The Fourth Part refers to the driver characteristics (gender, age, income, family status, occupation and level of education).

In the Third Part of the questionnaire, the two cards correspond to two different trip durations: typical interurban trip of three hours, typical short urban trip of thirty minutes. Each driver offers his choices to both cards, choosing for each set of choices a scenario related to low and high accident risk reduction proposed. Eight choices for each driver are thus recorded. Realistic values for parameters describing each scenario are proposed to the drivers. These parameters are the percentage of risk reduction (equal to 0 for the case of non-reduction), the trip duration increase in minutes and the extra cost in euros the driver is required to pay for the specific risk reduction percentage. These parameters were chosen carefully to reflect the key elements of driver behaviour. The low and high reduction scenarios are defined as a 20% and 50% respectively decrease in the current probability - as perceived by the driver after answering the related questions - to be involved in a road accident in the specific trip. A third scenario is also proposed corresponding to the refusal of both the above alternatives. On each card, each driver has to select one out of the three alternatives.

The respondents were not just confronted with the questionnaire and asked to complete it on their own. Instead, the interviewers were available to answer their questions and assist them. Indeed, this was important in the collection of reliable and representative data. The main issues that the interviewers confronted were the inability of the respondents to accurately understand the hypothetical scenarios (presented through the questionnaire) and their reluctance to provide some socioeconomic data (e.g. income). All issues were overcome through the support of the interviewers.

First, they helped the respondents visualize the hypothetical scenarios, so that they could decide on which of the alternatives they would choose. Part of this effort included presenting data in different forms, more accessible to the layman. For example, the probability of having an accident (e.g. 1 in 10000) was put in perspective, as well as several potential slight to serious injuries. The reluctance of the respondents to provide socioeconomic data (e.g. income levels) was overcome by explaining to them that this was a purely academic research, not affiliated, for example, with insurance companies or other agencies.

Figure 1: Part three of the questionnaire

CARD 1
Trip duration 3 hours
Cost* 30 euro

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	20 minutes	3 euro	A
High reduction (50%)	1,5 hour	3 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	1,5 hour	3 euro	A
High reduction (50%)	3 hours	15 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	20 minutes	30 euro	A
High reduction (50%)	1,5 hour	3 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	20 minutes	15 euro	A
High reduction (50%)	3 hours	30 euro	B
No reduction	-----	-----	C

CARD 2
Trip duration 30 minutes
Cost* 1 euro

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	3 minutes	0,5 euro	A
High reduction (50%)	15 minutes	0,1 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	15 minutes	1 euro	A
High reduction (50%)	30 minutes	1 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	15 minutes	1 euro	A
High reduction (50%)	30 minutes	0,1 euro	B
No reduction	-----	-----	C

Risk reduction	Additional time	Additional cost	Choice
Low reduction (20%)	3 minutes	0,5 euro	A
High reduction (50%)	30 minutes	0,5 euro	B
No reduction	-----	-----	C

***Cost**: Comprises fuel expenses, taxes, toll expenses, vehicle acquisition capital amortization, vehicle safety equipment and maintenance, etc.

During the interview, it is explained to the interviewee that additional trip time proposed refers to driving at lower speed (e.g. higher degree of complying with speed limits) and subsequent accident risk reduction. It is also explained that additional trip cost refers to extra cost paid for vehicle safety equipment and maintenance, higher tolls and taxes for improved road network maintenance and safety policies. The value of time is not included in the additional trip cost.

4. Model Development

The logistic regression model developed in this research used the sample data obtained by the above-mentioned interviews. The data comprise (a) values of parameters assumed to have an impact on the choice of accident risk reduction and (b) an indicator of the choice made by the interviewee. Every driver had to choose among three different scenarios (high risk reduction, low risk reduction, no reduction) in each of the eight set of choices proposed (Figure 1). If the "no reduction" option is chosen, i.e. if both other options are rejected, the data element corresponding to this interview is not taken into account in the analysis. This means that the driver attitude modelled refers only to the two driver choices for accident risk reduction (high and low) and consequently a binary model was developed. In this way, focus of this research was put on choice sensitivity analysis of drivers accepting risk reduction, allowing for the identification of the maximum potential for accident risk reduction. The data file produced in this way contains 1.641 observations, which are used for the statistical analysis.

Among the various parameters considered, only those with a statistically significant impact were finally retained. On this purpose, the results from the Wald-test corresponding to the coefficient of each parameter were used. The Wald-test follows a chi-square distribution and when a parameter has a single degree of freedom, it is calculated as the square of the ratio of the coefficient to its standard error (Washington et al., 2003). The higher the value of Wald-test is, the more statistically significant is the corresponding parameter. The minimum absolute value of Wald-test for retaining a parameter was set to 1,645 for level of significance 95%.

The parameters finally retained in the model development procedure as well as the related value ranges - as established during the pilot interviews - are shown at the following Table 1. Part A shows the basic driver characteristics retained while part B refers to the basic parameters related to trip cost and time. The combination of some of the basic parameters led to a number of composite parameters that could have a satisfactory explanatory power for driver behaviour, usable for future analyses. These parameters are shown in part C.

Table 1. Parameters examined and parameters retained in the model

A. Basic parameters of driver characteristics
*G: gender (0: female, 1: male),
*I: annual family income (KEuros)
*M: family status (0: single, 1: married)
*D: driving experience (1: 1-4 years, 2: 5-9 years, 3: 10-14 years, 4: ≥15 years)
A: age groups (1: 18-24, 2: 25-34, 3: 35-44, 4: 45-64, 5: ≥65 years)
E: education level (1:primary, 2:secondary, 3:university)
W: profession (1: white collar, 2: grey collar, 3: unemployed)
V: vehicle usually driven (1: passenger car, 2: two-wheel, 3: lorry/bus)
AC: accident involvement (number of accidents)

B. Basic parameters related to trip cost and time
P: initial trip cost (1 euro and 30 euro)
C: additional trip cost (0,1-1 euro for 30 minutes trip, 3-30 euro for 180 minutes trip)
T: additional trip time (3-30 minutes for 30 minutes trip and 20-180 minutes for 180 minutes trip)

C. Composite parameters
*C/P: percentage of additional trip cost over the initial trip cost
*1/T: inverted additional trip time

1/C	T/D
P/C	D/T
(C+P)/P	(D+T)/D
(C+P)/C	(D+T)/T
P/(C+P)	D/(D+T)
C/(C+P)	T/(D+T)

* retained in the model

The final model developed is summarised in (5), showing the utility function of the choice for low reduction of the probability to be involved in a road accident:

$$U_{\text{low reduction}} = 2{,}3706 - 0{,}5422 * \mathbf{G} - 0{,}3411 * \mathbf{M} + 0{,}1609 * \mathbf{D} - 0{,}0117 * \mathbf{I} - 1{,}1069 * (\mathbf{C} / \mathbf{P}) - 31{,}8843 * (1/\mathbf{T}) \quad (5)$$

The other alternative (high risk reduction) is therefore stated as the base case for this model. This specification has been tested using both informal specification tests, as well as rigorous statistical tests. Specification tests rely on the interpretation of the sign and magnitude of the estimated coefficients and provide a valuable tool to detect specification errors. Furthermore, the analysis of the estimated coefficients provides useful insight into the model specification and the collected data.

The alternative specific constant for the low risk reduction has a positive value, which implies that drivers are more willing to accept a low risk reduction (than a higher risk reduction). This is intuitive, as higher risk reductions are often accompanied by more radical, complicated, and costly measures (while moderate risk reductions can often be obtained more easily). The gender variable G has a negative coefficient, which (given the coding that is used, i.e. 1 for male) implies that male subjects are more willing to seek high risk reduction. Similarly, the family status variable M has also a negative coefficient (albeit with a smaller absolute magnitude), implying that married subjects are more willing to seek higher risk reduction. This is an intuitive finding, as married people tend to have more responsibilities (e.g. they may have their spouse and/or kids on board).

Driving experience D has a positive coefficient. Given the way that the values are coded, this supports the intuitive expectation that more experienced drivers would opt for low risk reduction (potentially placing more trust on their capabilities and experience). The coefficient on income I has a negative coefficient, implying that – consistent with expectations- more affluent drivers would opt for high risk reduction.

The composite variable (**C / P**) that reflects the percentage of additional trip cost over the initial trip cost has a negative coefficient. This implies that the same risk-reduction measure (cost-wise) would urge drivers to opt for a higher risk reduction in trips with lower initial cost. Looking at the same process from a different angle, this implies that for the same trip, more costly measures would urge the drivers to opt for high risk reduction. Finally, the coefficient for the inverted additional trip time (1/T) has a negative coefficient, indicating that drivers tend to select high risk reduction if the additional trip time is small, but as the increase in additional travel time increases the tendency to opt for high risk reduction –intuitively- decreases.

The goodness of fit ratios of the above model are 68,9% for the choice "low reduction" and 78,1% for the choice "high reduction". This means that the probability that the model achieves the correct prediction is 68,9% of the cases that a driver will opt for the low risk reduction and 78,1% of the cases that a driver will opt for high risk reduction. The goodness of fit ratios for the maximum likelihood method are calculated using the Wald test (Greene, 2000). The Wald-test results are presented in Table 2. The threshold for the Wald-test for 95% level of significance is 1.645.

Table 2. Model coefficients and Wald-test results

Parameter	Coefficient	Wald
Constant	2,3706	109,54
G	-0,5422	-17,36
M	-0,3411	-4,10
D	0,1609	5,08
I	-0,0117	-5,46
C/P	-1,1069	-47,26
1/T	-31,8843	-130,72

5. Model application

Initially and in view of identifying broad limits of driver choice sensitivity, an example of results of the model application for two different indicative scenarios of choice between high and low accident risk reduction for initial trip duration of 3 hours was prepared as presented in Table 3. One of the two scenarios uses parameter values favourable for high accident risk reduction, while another one uses values favourable for low accident risk reduction. It is noted that the no-risk reduction choice was not considered and consequently the driver behaviour modelled refers only to drivers disposed to make sacrifices for accident risk reduction.

The value of each utility function parameter, the calculated value of accident risk reduction utility and the respective probability estimated by the binary logit formula (3) are shown for every scenario in Table 3 so that an indication of the results range to be expected is presented. It can be seen that depending on how favourable the parameter values are for high accident risk reduction the corresponding percentage may vary from 0% to about 82%, i.e. it may cover the largest part of the possible range.

Table 3. Indicative scenarios for initial trip duration of 3 hours

Parameters	**Coefficients**	**Scenarios**	
		Low risk reduction	**High risk reduction**
Constant	2,3706	2,3706	2,3706
Gender	-0,5422	0	1
Family Status	-0,3411	0	1
Driving Experience	0,1609	4	2
Family Income	-0,0117	10	35
Additional Time	-31,8843	180	30
Additional Cost	-1,1069	3	30
Initial Cost		30	30
Utility Function $U_{(low\ reduction)}$		2,6094	-0,7701
Choice: Low risk reduction		**99,46%**	**17,65%**
Choice: High risk reduction		**0,54%**	**82,35%**

In order to measure the magnitude of the impact of the model parameters on the outcome probability of choosing high or low accident risk reduction, the dimensionless measure of elasticity was used. Elasticity can be interpreted as the percent effect that a 1% change in the independent parameter Xi has on the outcome of the dependent parameter Yi and is computed from the partial derivative for each observation *n* (Washington et al. 2003):

$$Ei = \frac{\partial\, Yi}{\partial\, Xi} \times \frac{Xi}{Yi} \qquad (6)$$

In logistic regression the elasticity estimate is given by:

$$Ei = bi \times Xi \qquad (7)$$

Elasticity calculations for the high accident risk reduction for the three continuous parameters of the model developed produced an average value of 2,39 for the 1/T parameter, 0,46 for the C/P parameter and 0,10 for the Income parameter. This means that a 1% increase in the 1/T ratio results in a 2,39% increase in the probability of choosing high risk reduction. Consequently, it can be argued that the inverted additional trip time (1/T) has a more important impact on driver choice towards high risk reduction than the percentage of additional trip cost over the initial trip cost (C/P).

An interesting example of the model application is presented at the indifference curves (Manheim, 1984) of Diagram 1 for all combinations of choices among which the driver is indifferent. In this diagram, the cross-correlation of probability of driver choice for high risk reduction in road accident with the increase of trip time (expressed in percentage of the initial trip duration) for the two initial trip duration scenarios (30 minutes and 3 hours) is indicated. In Diagram 1, the other parameters are attributed the following values Gender = male, Family status = single, Driving experience = 10-14 years, Annual family income = 15.000 euros and Additional trip cost = 0,5 euro (30 minutes) or = 15 euro (3 hours).

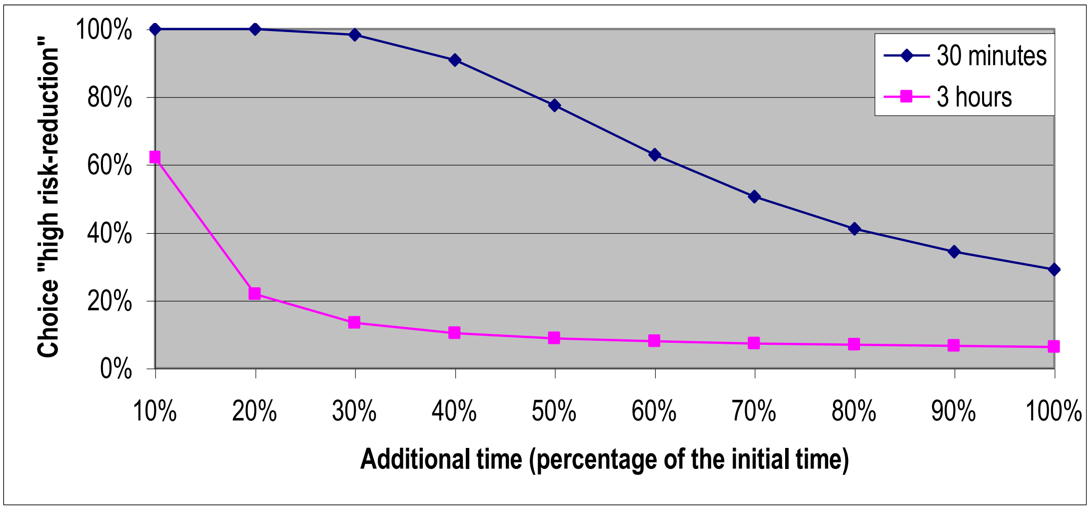

Diagram 1. Choice of high risk reduction in relation to additional trip time

In the above diagram, the two curves present different shapes and it can be seen that, when the initial trip duration is low, drivers are more easily accepting an increase of trip time. In the 30 minutes trip duration, the probability of high reduction choice ranges from 100% to 30%, whereas in the 3 hours trip duration, this probability ranges from 63% to 8%. Further exploration of this diagram revealed that in fact it is the absolute value of additional trip time and not its percentage change, which plays the most important role in driver choice. For example, from diagram 1 it can be deduced that about 60% of the drivers accept high accident risk reduction for an increase of additional trip time of about 18 minutes (~60% of 30-minute trip or 10% of 3-hour trip), independently of the trip duration.

6. Discussion and conclusion

The quantified explanation of the driver behaviour concerning choice of accident risk reduction alternatives is not straightforward due to the complexity and variety of interactions involved. This research establishes links between a number of parameters and the choice between high and low accident risk reduction with the use of stated preference techniques. The logistic regression model developed reveals that the parameters, which are usually taken into consideration in the more general framework of choices (cost, time, etc.) in transportation (Ben-Akiva and Lerman, 1985), are also those having an important impact in driver behaviour towards accident risk.

The proposed methodology provides a methodological framework for the determination of how accident risk reduction choice decisions are taken and can offer better answers to the prediction of driver behaviour in the specific field of choice among accident risk reduction alternatives. The methodology has been applied to a random sample of Greek drivers. It is worth re-iterating that this application has been based on stated-preference data only. Therefore, it may be subject to the usual criticism of stated-preference studies (e.g. regarding response biases). Future research could include a study combining stated-preference with revealed-preference data (assuming the existence of revealed-preference data on this field).

A basic finding of this research is the fact that trip time related parameters, like the inverted additional trip time, have a more important impact on driver choice towards high risk reduction than trip cost related parameters, like the percentage of additional trip cost over the initial trip cost. Furthermore, the model application revealed that the absolute value of additional trip time - not its percentage change - seems to play the most important role in driver choice towards accident risk reduction independently of the trip duration. Thresholds of this absolute value of additional trip time can be found for the different driver characteristics by the use of the model developed.

It was also concluded that, accident risk reduction choice decisions depend on some of the driver characteristics such as gender, family status, driving experience and annual family income. In general, male (vs. female), married (vs. single), with long driving experience (vs. short driving experience) and with high annual family income (vs. limited annual family income) are more reluctant to high accident risk reduction (through trip time and cost increase). It is also worth mentioning that a small percentage of Greek drivers were found to insist in denying to sacrifice trip time and to increase trip cost in order to decrease their road accident risk.

Findings from this research concern the sensitivity of Greek driver choices towards accident risk reduction. The model proposed is based on data referring to typical Greek drivers. It is of course obvious that before this model is applied in other similar research areas, the existence of any particularities referring to driver behaviour should be carefully considered. In such cases, the methodology followed can be used for the identification of risk reduction choice sensitivity.

The quantification of the parameters that influence the driver choice of accident risk reduction, which is attempted in this research, could be useful for the identification of suitable ways for the improvement of driver behaviour. Consequently, the combined use of quantified results from the proposed methodology and from other related researches could assist in improving the design and implementation of the appropriate strategy and particular measures for the improvement of driver behaviour (DTPE, 2001). The identification of the appropriate driver target groups is necessary for the elaboration of the most appropriate measures and related implementation aiming at the reduction of road accident risk.

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