Willingness-to-Pay for Usage-Based Motor Insurance

Athanasios Theofilatos, Dimitrios I. Tselentis, George Yannis, Manos Konstantinopoulos

Department of Transportation Planning and Engineering,
School of Civil Engineering, National Technical University of Athens

Transportation Research Board
96th Annual Meeting
January 8–12, 2017 ▪ Washington, D.C.

Introduction

- Usage-based motor insurance (UBI) schemes, are a new innovative concept that has recently started to be commercialized around the world.
- Pay-as-you-drive (PAYD) and Pay-how-you-drive (PHYD) are two very popular schemes.
- Recent schemes but with very promising practice.
- Significant potential impact on traffic safety, traffic congestion mitigation and pollution emissions reduction.

Objectives

- The main objective is to **investigate which parameters affect users' willingness to pay for alternative usage-based motor insurance pricing schemes.**
- Pay-as-you-drive (PAYD) and Pay-as-how-you-drive (PHYD) schemes are chosen.
- A dedicated questionnaire was designed and administered to participants.
- A mixed logit model is implemented to investigate effect of driving characteristics, drivers' demographics, and the price of vehicle insurance premiums on vehicle insurance choice.
- The findings of the study are expected to extend previous research and add to current knowledge.

Data

✓A dedicated questionnaire designed including both revealed preference questions about current vehicle and insurance type as well as stated preference scenarios related to current and alternative insurance schemes.

✓To increase the number of alternative tested scenarios, two different sheets were designed with four PAYD and eight scenarios PHYD each and each of the 100 respondents answered a single sheet. The questionnaire is structured in 4 sections and questions included:

- general respondent's driving data (years since license was obtained, vehicle make, current insurance cost etc.)
- driving behavior data
- alternative stated preference scenarios about the new insurance premium policies (PAYD and PHYD) and their benefits
- personal - demographic data.

✓The required time for completion was 10-12 minutes and it was administered to drivers being stopped at a motorist's service station in Attica region in Greece.

✓As for the number of scenarios chosen, it was decided that for the proper implementation of the research the number of scenarios should be reduced.

✓Based on the number of possible values that the variables of the stated preference questionnaire were designed to take, the number of different scenarios results to 16 for PAYD and 80 for PHYD.

✓The number of different combinations in this study was reduced based on an orthogonal design that was implemented, under the assumption that no correlations between typical alternatives exist.

✓In stated preference surveys fractional factorial design can be used instead of full factorial design.

✓Both these designs ensure orthogonality however, the full factorial design would include 16 out of 80 scenarios respectively, in contrast to the fractional comprising fewer combinations and are guaranteed to meet some desirable statistical properties such as the identification and accuracy.

Method of Analysis

- The core analysis of this study is the **mixed logit model (random parameters logit model).**
- Superior to the fixed effects model
- The mixed logit model is used to **account for potential unobserved heterogeneity**.
- Assumes that the estimated parameters vary across observations.
- Each variable set as random follows a distribution (e.g. normal, uniform)
- Widely used in discrete choice experiments.
- Estimation of the mixed logit model takes place by using simulation methods due to the difficulty in computing probabilities.
- A mixed logit model is any model whose choice probabilities can be expressed in the form:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta$$

- where Lni(β) is the logit probability evaluated at parameters β:

$$L_{ni}(\beta) = \frac{e^{V_{ni(\beta)}}}{\sum_{j=1}^{J} e^{V_{nj(\beta)}}}$$

- Then the mixed logit probability takes the usual form:

$$P_{ni} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}}\right) f(\beta) d\beta$$

Results (1/2)

Descriptive statistics

INDIVIDUAL SPECIFIC VARIABLES	Abbreviation	Mean	St.deviation	Min.	Max.
Gender = Female	GENDER_F	0.45	0.50	0.00	1.00
Age: 18-25 (reference category)	AGE1	0.04	0.20	0.00	1.00
Age: 25-30	AGE2	0.07	0.26	0.00	1.00
Age: 30–40	AGE3	0.43	0.50	0.00	1.00
Age: 40-50	AGE4	0.28	0.45	0.00	1.00
Age: >50	AGE5	0.11	0.31	0.00	1.00
PC usage is made	USAGE_PC	0.98	0.14	0.00	1.00
Smartphone Owner	SMARTPHONE	0.78	0.41	0.00	1.00
Married	MARRIED	0.53	0.50	0.00	1.00
Income <10000 (reference category)	INCOME1	0.06	0.24	0.00	1.00
10000 < Income < 25000	INCOME2	0.54	0.50	0.00	1.00
Income > 25000	INCOME3	0.40	0.49	0.00	1.00
Occupation: Public Sector	OCCU1	0.45	0.50	0.00	1.00
Occupation: Private Sector	OCCU2	0.24	0.43	0.00	1.00
Occupation: University Student	OCCU3	0.03	0.17	0.00	1.00
Occupation: Freelancer	OCCU4	0.09	0.29	0.00	1.00
Occupation: Enterpreneur	OCCU5	0.03	0.17	0.00	1.00
Occupation: Household	OCCU6	0.02	0.14	0.00	1.00
Occupation: Technician	OCCU7	0.00	0.00	0.00	0.00
Occupation: Pensioner (reference category)	OCCU8	0.07	0.26	0.00	1.00
Occupation: Unemployed	OCCU9	0.02	0.14	0.00	1.00
Occupation: Other	OCCU10	0.05	0.22	0.00	1.00
Education: Primary Education	EDU1	0.03	0.17	0.00	1.00
Education: Secondary Education (reference category)	EDU2	0.24	0.43	0.00	1.00
Education:Technological Educational Institute	EDU3	0.34	0.17	0.00	1.00
Education: University Degree	EDU4	0.11	0.31	0.00	1.00
Education: Postgraduate Degree	EDU5	0.24	0.43	0.00	1.00
Education: Ph.D.	EDU6	0.03	0.17	0.00	1.00
Education: Other	EDU7	0.03	0.17	0.00	1.00

ALTERNATIVE SPECIFIC VARIABLES	Abbreviation	Mean	St.deviation	Min.	Max.
PRESENT INSURANCE					
% change in mileage (current Insurance)	KM	0.00	0.00	0.00	0.00
% change in Insurance Cost (current Insurance)	COST	0.00	0.00	0.00	0.00
% change in Speed (current Insurance)	SPEED	0.00	0.00	0.00	0.00
PAYD INSURANCE					
% change in mileage (PAYD Insurance)	KM	-11.76	6.58	-20.00	-5.00
% change in Insurance Cost (PAYD Insurance)	COST	-11.69	6.63	-20.00	-5.00
PHYD INSURANCE					
% change in mileage (PHYD Insurance)	KM	-6.25	9.61	-20	5
% change in Insurance Cost (PHYD Insurance)	COST	-11.43	6.78	-20.00	-5.00
% change in Speed (PHYD Insurance)	SPEED	-11.47	6.80	-20.00	-5.00

PAYD model

Variables	Estimate	Standard error	p-value	Conclusion	Odds ratio
Random parameters (normal distribution)					
Constant term	2.104	1.780	0.237	non-significant	8.202
Standard deviation of constant term	0.939	0.602	0.119	non-significant	-
Km	0.228	0.055	0.000	95% significant	1.256
Standard deviation of Km	0.126	0.044	0.004	95% significant	-
Cost	-0.154	0.032	0.000	95% significant	0.857
Standard deviation of Cost	0.008	0.284	0.977	non-significant	-
Fixed parameters					
EDU1	3.182	1.640	0.052	90% significant	24.104
USAGE_PC	-3.930	1.766	0.026	95% significant	0.020
SMARTPHONE	1.138	0.448	0.011	95% significant	3.122
GENDER_F	0.585	0.330	0.076	90% significant	1.795
Log-likelihood of the empty model	-259.279				
Log-likelihood of the full model	-198.100				
McFadden's pseudo R^2	0.2332				

- The variable "Km", the variable "Cost" and the constant term, were set as random following the normal distribution.
- However, only the standard deviation of the Km was found to be statistically different from zero. Therefore, the other two variables (constant term and cost) are considered as fixed.
- According to the Z score table and the normal distribution function, some 3.52% of observations are lower than zero. This means that in about 96.48% of observations, Km is associated with increased likelihood of selecting PAYD while only 3.52% of observations show a negative correlation. Therefore, as offered percentage reduction in driven mileage decreases, it is more likely that the driver chooses the PAYD policy.
- The cost parameters was considered as fixed, therefore, the negative sign of the beta coefficient (-0.154) denotes that as the cost reduction is lower, drivers are more likely to choose the present insurance.
- People with primary education are more likely to choose PAYD.
- The negative value of the coefficient of USAGE_PC variable (-3.93), denotes that drivers who are more familiar with personal computer usage are more likely to choose the present insurance rather than the PAYD policy.
- Familiarity with smartphone use is more likely to make drivers choose the PAYD policy.
- The gender variable shows that female drivers tend to prefer the PAYD compared to males. More specifically, probability to select PAYD is almost twice higher than males.

Results (2/2)

PHYD model

Variables	Estimate	Standard error	p-value	Conclusion	Odds ratio
Random parameters (normal distribution)					
Constant term	-1.789	0.429	0.000	95% significant	0.167
Standard deviation of constant term	1.197	0.270	0.000	95% significant	-
Km	0.114	0.017	0.000	95% significant	1.121
Standard deviation of Km	0.061	0.027	0.022	95% significant	-
Cost	-0.179	0.025	0.000	95% significant	0.836
Standard deviation of Cost	0.065	0.025	0.009	95% significant	-
Speed	0.091	0.020	0.000	95% significant	1.095
Standard deviation of Speed	0.077	0.022	0.001	95% significant	-
Fixed parameters					
AGE4	-0.846	0.274	0.002	95% significant	0.429
AGE5	-1.176	0.433	0.007	95% significant	0.309
SMARTPHONE	0.627	0.309	0.042	95% significant	1.872
GENDER_F	1.005	0.244	0.000	95% significant	2.731
Log-likelihood of the empty model	513.250				
Log-likelihood of the full model	-416.500				
McFadden's pseudo R^2	0.216				

- The variables "Km", "Speed",, "Cost" and the constant term, were set as random following the normal distribution. Km has a mean value of 0.114 and a standard deviation of 0.061, Cost has a mean of -0.179 and standard deviation 0.065, while Speed has a mean value of 0.091 and 0.077. On the other hand, the constant term was found to have a mean value of -1.789 and standard deviation 1.197.
- Concerning Km, the calculated Z-values indicate that 97% of observations have a positive correlation with PHYD.
- Regarding speed, indicate that about 11% of observations have a negative association with PHYD while 89% have a positive association with PHYD. This means that as the percentage reduction in speed tends to zero, the driver is more likely to choose the PHYD policy scheme.
- The variable Cost has a negative mean value as in the previous model, indicating that the percentage reduction in cost tends to be zero, the present policy is more probable to be selected by drivers than the PHYD.
- Drivers 40-50 years old and older than 50 years old are more likely to prefer the present insurance policy compared with younger drivers. More specifically, young drivers are almost 2.5 times and almost 3 times more probable to choose the PHYD policy, compared to drivers 40-50 years old and older than 50 years old respectively
- Familiarity with smartphone and applications suggests high probability for drivers choose the PHYD scheme (similarly to the PAYD) compared to the present policy.
- The gender variable shows that female drivers would prefer the PHYD compared to male drivers.

Conclusions - Discussion

- A methodological approach is proposed to identify the parameters that affect users' willingness to pay for alternative usage-based motor insurance pricing schemes such as PAYD and PHYD.
- Kilometers and cost reduction were also found to affect similarly the choice for both UBIs i.e. the higher the kilometers reduction the lower the probability of the UBI scheme to be chosen and the higher the cost reduction the higher the probability of the UBI scheme to be chosen by a user. Moreover, the higher the speed reduction imposed to the user the lower the probability of the UBI scheme to choose it.
- Future research could carry out surveys:
  - ➢ on a national sample
  - ➢ in different countries
  - ➢ different scenarios
  - ➢ including more parameters.
  - ➢ alternative models to account for heterogeneity could be utilized, for example the latent class model.
  - ➢ ranking of alternatives schemes
  - ➢ best-worst scaling modeling

Acknowledgement

The authors would like to thank Vasilis Stivaktakis and Petros Fortsakis from OSeven Telematics, for the fruitful exchange of ideas during the development of the questionnaire.