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An Economic Evaluation of Freeway Service Patrols.

David Levinson, Pavithra Kandadai Parthasarathi

Abstract--Highway assistance services, also called the freeway service patrols (FSPs), are one of the main approaches used by incident management programs. The objective of this study was to investigate the factors that contribute to people choosing to rely on the highway assistance services (FSP) in comparison to private assistance services such as the Automobile Association of America (AAA). Further the effectiveness of the Freeway Service Patrol was studied by carrying out a Benefit-Cost Analysis using Los Angeles as a test case. The results indicate that the probability that an individual would choose to depend on the highway assistance services depends on the key attributes like the annual fee of the program, the fee at the time of assistance, the time of waiting for assistance and cost of breakdown. The B/ C ratio for the Los Angeles FSP was calculated to be 5.91.

I. INTRODUCTION

Freeway Service Patrols aim to identify incident locations, reduce incident duration, restore full freeway capacity, and reduce the risks of secondary accidents to the motorists (1). They use vehicles to patrol the heavily traveled segments and congested sections of the freeways that are prone to incidents (2).

In addition to the public highway assistance services like the freeway service patrols, there are also private emergency services, often operated by auto clubs, which provide similar services. These offer services to stranded motorists who are members. The largest auto club is the Automobile Association of America (AAA), a non-profit, fully taxpaying federation of 90 motor clubs with offices in the United States and Canada, formed in Chicago in 1902.

This goal of this study was to determine the value that people place on the benefits offered by freeway service patrols in comparison to private assistance services. This was done by estimating how much they would be willing to pay to avoid being stranded when their vehicle breaks down on the freeway.

This first part of this paper looks at the studies that have been carried out on the FSP. The

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remaining part of the paper looks at the methodology used namely the Stated preference and the Benefit Cost analyses.

II. RESEARCH BACKGROUND

California PATH (Partners for Advanced Transit and Highways) evaluated the effectiveness of the freeway service patrol at a San Francisco Bay Area freeway section (3). The study found that, based on the savings in incident delay and fuel consumption, the introduction of the freeway service patrol was cost-effective at the test site.

A second PATH study (4) evaluated the effectiveness of the freeway service patrols operating on a 7.8-mile test section of the I-10 (Beat 8) freeway in Los Angeles. The benefit/cost ratio was calculated using the delays and fuel savings due to reductions in incident duration. The study showed that the introduction of the freeway service patrol resulted in significant benefits at the test site. The B/C ratio obtained due to the FSP was greater than 5:1 for reduction in duration of about 15 minutes. The introduction of the freeway service patrol in the test section increased the number of incidents assisted and reduced the detection and response time of the incidents.

Another study carried out by the Texas Transportation Institute (1) showed that these patrols have a high benefit-to-cost ratio that varied from 2:1 to 36.2:1.

The studies to date have focused on the effectiveness of the freeway service patrol whereas this study (5) analyzes the factors that influence people in choosing to rely on the freeway service patrol vs. an auto club.

III. MODELING METHODOLOGY

A. Stated Preference Analysis

A survey was done to find out the value people place on the benefits of the highway assistance services. The aim of the survey was to find out how much people are willing to pay to avoid being stranded on the freeway when their vehicle breaks down on the freeway.

The pilot survey was done on a sample of sixteen individuals, mostly college students at the University of Minnesota, Minneapolis in spring 2000. Nineteen questions were asked in total. The questions were framed to identify the way people react to avoid being stranded based on the time of breakdown (midnight/morning), cost of assistance, time of waiting for assistance and how much they would be willing to pay for specific services offered by the highway assistance services.

The logit model was used for the survey analysis. The model was used to estimate the probability of a person choosing a particular alternative given breakdown related characteristics presented to the respondents in the survey and certain individual characteristics obtained from the respondents.

The various hypotheses that were considered as part of the analysis were:

1) Public vs. Private highway emergency services

The respondents were offered series of questions in which they had to choose between:
(a) Public highway emergency services (FSPs).
(b) Private emergency services (AAA).

It was hypothesized that the probability of an individual choosing (a) compared to (b) was a function of the difference in the time of waiting between alternative (a) and (b), difference in the cost of assistance between alternative (a) and (b), time of breakdown on the freeway (midnight/morning) and the socio-demographic characteristics namely age, sex, work status and vehicle ownership.

The difference in the time of waiting between the alternatives (time of waiting for alternative a minus time of waiting for alternative b) and the difference in the cost of assistance between the alternatives (cost for alternative a minus cost for alternative b) alone were significant and seemed to have influenced the choice probabilities (Table 1).

A 1% increase in the difference in the time of waiting between the alternatives reduced the probability of people choosing to rely on the government provided highway assistance service by 0.0006%. A 1% increase in the difference in the cost between the alternatives reduced the probability of people choosing to rely on the government provided highway assistance service by 0.010% (Table 1).

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2) Annual Fee Hypothesis

The respondents were provided with two alternatives:
(a) To pay an annual fee and not pay a fee at the time of breakdown
(b) Not to pay an annual fee but pay a fee at the time of breakdown
The two fees were varied for the various questions.

It was hypothesized that the probability of an individual choosing (a) compared to (b) was a function of the difference in the annual fees between alternative (a) and (b) (Annual fee for alternative a minus annual fee for alternative b), difference in the fees at the time of assistance between alternative (a) and (b) (assistance fee for alternative a minus assistance fee for alternative b), and the related socio-demographic variables.

The difference in the annual fees and the fees at the time of assistance between the alternatives, age and work status of the individual seemed to have influenced the probability of an individual choosing between alternative (a) or (b) (Table 2).

A 1% increase in the difference in the annual fee between the alternatives reduced the probability of people choosing the public highway assistance service by 0.073%. A 1% increase in the difference in the assistance fee between the alternatives reduced the probability of people choosing the public highway assistance service by 0.047% (Table 2).

From the analysis it was seen that the factors like time of waiting, cost of assistance, age and work status contribute to the probability of an individual selecting a particular option. The reason that some variables did not contribute to the probability might be due to the small sample size of the survey. Further, the homogeneity of the sampled group might have also been a reason for the socio-economic and demographic variables not being significant and influencing the probabilities. We anticipate that a larger sample size and a more heterogeneous sample would give better results.

B. Benefit-Cost Analysis

The Benefit-cost analysis calculated the effectiveness of the Freeway Service Patrol. The analysis consisted of two parts. The first part of the analysis aimed at developing a cost model to attain an estimate of the total cost of the program. The second part of the analysis calculated the total benefits of the program as seen by users willingness to pay.

The cost model was developed using the data for the highway assistance services operating in the various states (1). The population data for the various metropolitan areas was obtained from the Census data (7,8,9).

The independent variables considered to affect the cost of the program were the number of vehicles used by the patrol, number of routes the patrol operates and the population of the area in which the program operates. The annual budget of the patrol was taken to be the dependent variable.

A simple OLS regression was done to identify the significant variables. The results showed that the variables considered were significant and influenced the annual cost of the program. The annual cost of the program was seen to increase with the number of vehicles and number of routes that the program operates, that is, the size of the program (Table 3).

The Los Angeles FSP was used as a test case for the cost analysis. The Los Angeles FSP operates on 41 routes and uses 150 vehicles (1). The total annual cost for a program of this size was found to be $18,687,338 (Table 3).

The benefit analysis used the model estimated from the Stated preference (SP) survey. The individual utilities obtained from the SP survey were scaled using the population parameter to obtain the total benefits due to the FSP. The data used for the Public vs. Private highway emergency services hypothesis of the SP survey was used for the benefit analysis.

Two scenarios were considered for the benefit analysis. The first, *before*, scenario had just the AAA operating and no FSP operating in the area. The second, *after*, scenario had both the FSP and the AAA operating in the area.

The following assumptions were made for the analysis.

- The average waiting time for the FSP and the AAA was taken to be 15 minutes and 30 minutes respectively.

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- The average cost of assistance for the FSP and AAA services was taken to be $0 and $25 respectively.
- Individuals were assumed to be full time workers.
- Age was taken to be 30 years.
- Individuals were assumed to own vehicles and maintain those vehicles in good condition.
- The waiting time and the cost of assistance in the no FSP scenario was assumed to be double that of the AAA services, that is, 60 minutes and $50 respectively.

The logit model used for the SP analysis had been framed in such a way that the utility of the private emergency services (AAA) was taken to be one. The utility of the FSP was a linear function of the difference in the time of waiting, the difference in the cost of assistance, time-of-day and the related socio-demographic variables.

The individual utility of the FSP was calculated for both the before and after case scenarios using the coefficients obtained from the logit model of the SP analysis. The log-sum formula was then used to get the difference in the individual utility between the two scenarios.

The difference in the utilities between the two scenarios is given as follows (6):

$$\text{Logsum} = \frac{1}{m}\ln \sum_{i \in C_n^2} e^{mV_{in}^2} - \frac{1}{m}\ln \sum_{i \in C_n^1} e^{mV_{in}^1}$$

where C_n refers to the choice set

m is a scale parameter

V_{in} is the utility of alternative i to individual n

The logit model used in our case was a binary logit model and the scale parameter could hence be taken to be one (6). The superscripts 1 and 2 refer to the before and after scenario. The difference in utility was divided by the coefficient of travel cost obtained for the after case scenario to convert it into monetary terms.

The difference in the individual utilities of the two scenarios was calculated and divided by the coefficient of the cost of assistance to convert the units of utility (utils) into monetary terms. This monetized difference was then scaled using the population of Los Angeles to get the total benefits due to the FSP. Clearly this was an approximation, as we were not examining the socioeconomic makeup of the Los Angeles population, and the SP analysis was conducted on a small sample. These results should be considered a "proof of concept" that describe how more accurate results could be obtained rather than as final results themselves.

Recognizing those caveats, the calculations showed that the individual utility in the after case scenario was higher than the before case scenario. The B/C ratio was then calculated by dividing the total benefits by the total costs. The calculated B/ C ratio for the Los Angeles FSP is 5.91 (Table 1).

IV. CONCLUSIONS

This paper aimed to find the factors that influence the probability of an individual choosing to rely on publicly provided freeway service patrols as opposed to the private assistance services and to determine how much people are willing to pay to avoid being stranded on the freeway.

The findings showed that the probability that an individual would choose the highway assistance services depends on the key attributes like the annual fee of the program, the fee at the time of assistance, the time of waiting for assistance and cost of breakdown.

The data set for this study has been small. We anticipate that larger data sets would give us better results and clearly indicate the factors influencing people's choice. We expect that expanding this pilot study to a larger scale would give us a better idea about the factors influencing people's choices. A larger more heterogeneous sample would give us better indications about the way that socio-demographic variables impact the choice probabilities.

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Results of Analyses

Dependent Variable = Select Private Emergency Services
Logit estimates

Variable	Coefficient	z	utility(FSP)	utility(no FSP)	Elasticity	Details
Difference in time of waiting *	-0.0674	-5.003	1.011	-2.022	-0.006	Number of obs=112
Difference in cost *	-0.0331	-2.3	0.828	-0.828	-0.010	LR chi2(12)= 43.65
Age	-0.115	-1.003	-3.450	-3.450		Prob. > chi2=0.000
Time of day	0.145	0.299	0.145	0.145		Pseudo R2 =0.283
Sex	-1.312	-1.633	-1.312	-1.312		Log likelihood = -55.361
Full time Student / Non Worker	-0.44	-0.272	0.000	0.000		
Full time Worker / Non Student	0.198	0.133	0.198	0.198		
Full time Student/ Full time Worker	0.853	0.515	0.000	0.000		
Full time Student /Part time worker	-0.657	-0.421	0.000	0.000		
Vehicle ownership	1.238	1.045	1.238	1.238		
Vehicle repair	-1.166	-0.854	-1.166	-1.166		
constant	3.102	0.789	3.102	3.102		
		Sum of utilities	**0.594**	**-4.095**		
		Log sum difference		1.017		
		Monetized value		30.718		
		Total Benefits		$110,510,102		
		B/C ratio		**5.914**		

* Indicates significance at 95% confidence level

Table 1: Highway Assistance Choice and Benefit-Cost Analysis

Dependent variable = Select Annual Payment
Logit estimates

Variable	Coefficient	z	Elasticity	Details
Difference in annual fee *	-0.0561	-3.025	-0.073	Number of obs = 55
Difference in fee of assistance *	-0.0283	-2.729	-0.047	LR chi2(8) = 30.81
Age*	0.549	2.64		Prob > chi2=0.000
Sex	-0.137	-0.138		Pseudo R2 =0.435
Full time Worker *	-3.201	-1.999		Log likelihood = -20.049
Part time worker *	-16.6	-2.766		
Full time Student /Part time worker *	-3.515	-2.692		
Vehicle ownership	-0.878	-0.803		
constant	-10.242	-2.209		

* Indicates significance at 95% confidence level

Table 2: Highway Assistance Choice: Annual vs. Per Use Payment

Dependent Variable = Budget

Variable	Coefficient	t	Los Angeles Data	Total	Details
Vehicles*	102603	5.177	150	15,390,450	Number of obs = 30
Routes*	143769	2.120	41	5,894,561	Adj. R-squared = 0.9631
Population*	-0.588	-2.485	3597556	-2,115,170	
constant	-483	-2.175	1	-482,503	
			Total Cost for LA	**$18,687,338**	

* Indicates significance at 95% confidence level

Table 3: Cost model-OLS regression and Application to Los Angeles