Modeling Willingness-to-Pay Values for Rural Bus Attributes Under Different Trip Purposes

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The paper focuses on estimating willingness-to-pay (WTP) values associated with attributes of bus travel in rural regions of a developing country. Using stated choice data, Multinomial Logit (MNL) and Random Parameter Logit (RPL) models with constrained triangular distribution for random parameters are developed for various trip purposes. WTP values are estimated for travel time, travel discomfort and headway of service. It is found that WTP values of job trips are highest among all trips, followed by recreation and business trips; and the values for discomfort are found to be highly sensitive to trip purpose. Also, it is found that the MNL model underestimated WTP values more than the RPL model.

INTRODUCTION

In India and other developing countries, a majority of the population is located in rural and suburban areas. Personal vehicle ownership is generally low in rural areas and, therefore, rural passengers are essentially captive to the bus transportation system. Rural bus services generally have low travel speed, longer headways, high discomfort level (i.e., crowding inside buses) and low reliability. Improvement in rural bus service may be achieved by suitably changing one or more of its attributes, such as travel speed, frequency, comfort, etc. But, improvements in bus services are often associated with an increase in fare. For judicious improvement planning of existing bus services and evaluation of user benefits, it is necessary to understand the values trip makers place on different attributes of travel.

The literature shows several willingness-to-pay (WTP) values in the context of transport and non-transport improvements in developed countries (Hensher 1994; Jose Holguin-Veras 2002; Hensher and Greene 2001; Adamowicz et al. 1994; Carlsson et al. 2003; Onyango 2004). A large number of works have reported WTP values for travel time savings in developed countries (Algers et. al. 1998; Greene et. al. 2005; Hensher 2001a,b; Hensher and Sullivan 2003; Hess et al. 2005; Carlsson 1999; Cherchil and Polak 2005). WTP values for travel time savings in developing countries have been reported by Farhad and Kirit (2004) for rural areas of Bangladesh, I. T. Transport (2004) for rural regions of Tanzania & Ghana, Kumarage (2005) for Colombo, Sri Lanka, and Mumbai Metro Planning Group (1997); and Praveen and Rao (2002) for Mumbai, India. In general, there is very limited information available in the literature about WTP values for rural bus attributes in developing countries such as India.

The objective of this paper is to model WTP values considering both quantitative and qualitative attributes of rural bus service in a developing country context, and the variation of WTP values with trip purpose. The empirical study is a rural bus route connecting a district headquarter (Midnapur) and a tourist place (Digha) in West Bengal, India. Travel demand along this route is largely served by bus service, which takes about five hours to cover a distance of 142 kilometers and serves about 35 intermediate stops.

The paper is organized as follows: The methodology section introduces preferences and model specifications and it is followed by questionnaire design, data collection, and model estimation respectively. Next, the results of the analysis and conclusion are presented.

METHODOLOGY

Approach

Revealed Preference (RP) or Stated Preference (SP) data have been used in diverse fields for estimating the WTP values (Adamowicz et al. 1994; Bates 1982; Kroes & Sheldon 1988; Louviere 1988; Hensher 1994; Jose Holguin-Veras 2002). At times, RP data may be inappropriate as they cannot accommodate non-existing attributes or variability of attributes which, in turn, does not permit establishing their influences. On the other hand, SP data facilitate inclusion of hypothetical attributes and variability of attributes. Stated choice (SC) experiments provide a framework for studying the relative marginal disutility of variations in attributes, and their potential correlations (Louviere et al. 2000). Stated Choice (SC) methods have a strong theoretical foundation based on economic theory, and are an established approach for understanding and predicting consumer tradeoffs and choices in marketing research. SC methods are used extensively to model the behavior of individuals (Hensher and Greene 2001; Hensher 2001; Hensher and Sullivan 2003; Carlsson et al. 2003; Onyango 2004). In the present paper, the SC method is adopted to elicit preferences by generating hypothetical profiles using various attributes and their levels. These profiles are presented along with a base profile (revealed data) to respondents in the form of a choice set, and 'choice' responses are utilized to estimate the WTP values.

Generally, SP and/or RP data are analyzed using traditional Multinomial Logit (MNL) models due to simplicity in estimation. However, the MNL model imposes some restrictions such as independence of irrelevant alternatives (IIA). Modifications to the MNL models to reduce the influence of these restrictions lead to Random Parameter Logit (RPL) or Mixed Logit (ML). For the development of RPL models, it is necessary to assume suitable distributions for random parameters. Different distributions for random parameters such as normal, lognormal, uniform, and triangular have been attempted by researchers while developing RPL models (Algers et al. 1998; Hensher 2001a; Hensher and Greene 2001). The lognormal distribution is suitable if the mean of the random parameter needs to be of specific (non-negative) sign. However, a long upper tail of the lognormal distribution results in extremely high WTP values. A uniform distribution with a (0, 1) bound is suitable for dummy variables. The triangular distribution where the density function looks like a tent with a peak in the center and dropping off linearly on both sides of the center is advantageous over normal or lognormal distributions due to its bounded nature. However, like normal or uniform distribution, triangular distribution also has the disadvantage of producing wrong signs for some shares due to spread or standard deviation. It is possible to overcome the disadvantage of triangular distribution by imposing a constraint on the spread (Hensher and Green 2001). When the mean and the spread are equal, the constrained distribution has a peak in the density function with two endpoints of the distribution fixed at zero and two times the standard deviation, so that there is no free variance (scaling) parameter.

In this paper, constrained triangular distribution of random parameters is assumed because of the following advantages: First, constrained triangular distribution assures that the sign of the mean is the same throughout the sample unlike a normal, lognormal, or triangular distribution, which shows sign reversal for some samples. Second, its estimation of WTP value is simple as the impact of spread is negligible due to equality between the mean and the spread. The ratio of the mean coefficient of any attribute to the mean coefficient of cost directly gives WTP. This is unlike normal or lognormal distributions where the standard deviation or spread has a significant effect on WTP. Lastly, unlike normal or lognormal distributions, the triangular distribution is bounded in nature and results in early convergence.

WTP values may be influenced by one or more socioeconomic attributes, such as age, income, household size, etc. The effect of socioeconomic characteristics on the mean of a random parameter (called 'mean heterogeneity') is investigated with RPL models.

Econometric Model

In econometric models based on Random Utility Theory (Thurstone 1927; McFadden 1974), the utility of each element consists of an observed (deterministic) component denoted by *V* and a random (disturbance) component denoted by ε,

(1) $U = V + \varepsilon$

The deterministic part *V* is again a function of the observed attributes (*z*) of the choice as faced by the individual, the observed socioeconomic attributes of the individual (*S)* and a vector of parameters (β). Therefore,

(2) $V = V(z, S, \beta)$

A probabilistic statement can be made (due to the presence of the random component) as, when an individual 'n' is facing a choice set, C_n, consisting of J_n choices, the choice probability of alternative i is equal to the probability that the utility of alternative 'i', U_{in}, is greater than or equal to the utilities of all other alternatives in the choice set, i.e.,

(3) $P_n(i) = \Pr(U_{in} \geq U_{jn}, \text{ for all } j \in C_n)$

(4) $P_n(i) = \Pr(V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn}, \text{ for all } j \in C_n, j \neq i)$

Assuming IID (Gumbel distribution) for ε, the probability that an individual chooses i can be given by the MNL Model (McFadden 1974; Ben-Akiva and Lerman 1985),

(5) $$P_n = \frac{e^{V_{in}}}{\sum_{j \in j_n} e^{V_{in}}}$$

This model can be estimated by maximum likelihood techniques and is useful for modeling choice behavior. However, it has several limitations, the most severe of which is the IIA property, which states that a change in the attributes of one alternative changes the probabilities of the other alternatives in proportion. This substitution pattern may not be realistic in all settings. Secondly, the coefficients of all attributes are assumed to be the same for all respondents in a choice experiment, whereas in reality there may be substantial variability in how people respond to attributes. To overcome these limitations, a generalized form of MNL (i.e., a random parameters logit model) is used to account for unobserved heterogeneity.

Let the utility function of alternative i for individual n be,

(6) $U_{in} = \beta x_{in} + \varepsilon_{in} = \beta^{I} x_{in} + \hat{\beta}_n x_{in} + \varepsilon_{in}$

Thus, each individual's coefficient vector β is the sum of the population mean β^{I} and individual deviation $\hat{\beta}_n$. $\hat{\beta}_n x_{in}$ are error components that induce heteroskedasticity and correlation over alternatives in the unobserved portion of the utility. An important implication of the mixed logit specification is that we do not have to assume that the IIA property holds.

Let tastes, β, vary in the population with a distribution density $f(\beta \mid \theta)$, where θ is a vector of the true parameters of the taste distribution. If the error terms (ε_{in}) are IID type I extreme value, it is a random parameter logit model (Train 1998). The conditional probability of observing a sequence of choices is the product of the conditional probabilities:

(7) $S_n(\beta_n) = \prod P(k(n,t)t \mid \beta_n)$

Where k (n,t) denotes the sequence of choices from choice sets that an individual n chooses in situation t. In the choice experiment, the sequence of choices is the number of hypothetical choices each respondent makes in the survey. The unconditional probability for a sequence of choices for individual n is then expressed as the integral of the conditional probability in equation (7) over all values of β:

(8) $$P_n(\theta) = \int S_n(\beta) f(\beta \mid \theta) d\beta$$

In general, the integral cannot be evaluated analytically, and one has to rely on a simulation method for the probabilities. Here a simulated maximum likelihood estimator, using Halton draws is used (Train 1999). This type of random parameter model is less restrictive than standard conditional logit models. However, these less restrictive models should be applied cautiously. Apart from being more difficult to estimate, the literature shows that the results can be rather sensitive to the distributional assumptions and the number of draws applied in the simulation (Hensher and Greene 2001).

SURVEY INSTRUMENT AND STUDY

Survey instruments were designed for collecting respondent's trip characteristics, socioeconomic characteristics, and stated preference 'choice' from the choice set. A questionnaire consisting of three parts was designed. The first part was to collect information related to respondent's trip characteristics, such as origin, destination, trip purpose, etc. The second part was to record the respondent's sociodemographic information, such as age, gender, income, etc. The third part was to observe a respondent's 'choice' from the choice sets. Choice sets are prepared using four attributes, each described by four levels.

During preliminary investigation it was observed that journey speeds for buses were low (about 30 kmph), comfort was less and average headway was about 30 minutes. Therefore, quantitative attributes, such as travel speed (a proxy for in-vehicle travel time), travel cost and headway, and a qualitative attribute, discomfort, were considered for the preparation of choice sets. Each attribute was further described by four levels. The levels of these attributes were decided following discussions with experts and trip makers. The attributes and their corresponding levels used in the study are shown in Table 1.

Table 1: Attributes and Levels

Attributes	Level 1	Level 2	Level 3	Level 4
Discomfort Level	Seating	Partly Standing Partly Seating	Stand Comfortably	Stand in Crowd
Headway (minutes)	15	30	45	60
Travel Speed (kph)	30	35	40	45
Travel Cost (p/km)	35	40	45	50

kph – kilometers per hour
p/km – paise per kilometer, where paise is India monetary unit

Four attributes with four levels each would produce 4^4 (256) alternatives from full factorial technique. However, it was neither necessary nor practically possible to include all these combinations in the SP experiment. Therefore, some of the choice sets were eliminated using the fractional factorial technique. Fractional factorial orthogonal main effects using SPSS 7.5 (Hensher et al. 2005) produced 16 alternatives. Pairing these 16 alternatives would result in eight choice sets, and evaluating eight choice sets may lead to fatigue and biased responses. To reduce fatigue in respondents, these 16 alternatives were randomly grouped into four choice sets, each containing four hypothetical alternatives. A base alternative was also added to each of these four choice sets. As a result, each choice set contained five alternatives of which four alternatives were hypothetical (generated) ones and one was the base (bus) alternative revealed by the respondent. A fixed experiment approach where each respondent faces exactly the same choice sets at exactly the same stage of the choice task was adopted for presenting the choice sets. All the alternatives in a choice set were presented in generic form (i.e., alternative A, alternative B, etc.).

Interviewers were trained in multiple sessions to improve the quality of the work. Interviewers were equipped with information to be incorporated into the SP part of the questionnaire based on the information from the RP part. Along with speed, corresponding travel time between the origin and destination given by each respondent was also presented by the enumerator to improve clarity while obtaining the choices. A sample of an SP choice set is presented in Figure 1.

Figure 1: Sample Choice Set

Attribute	Base	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Comfort	Revealed	Seating	Standing Comfortably	Standing Comfortably	Partly Standing Partly Seating
Frequency	Revealed	30min.	15min	45min	60min
Travel Time	Revealed	*@ 30kph* ___	*@40kph* ____	*@45kph* ____	*@35kph* ___
Fare	Revealed	*@ 40p/km*___	*@45p/km*____	*@40p/km*____	*@45p/km* __
Choice					

kph – kilometers per hour
p/km – paise per kilometer, where paise is India monetary unit

Face-to-face interviews were carried out at 16 major stops along the route, including market places, banks, schools, recreational spots, bus stops, etc. Respondents were approached randomly (i.e., random sampling). During the study, 750 respondents were approached to participate in the survey and 475 (63%) gave their consent. Each respondent was requested to provide information related to the most recent trip undertaken, socioeconomic characteristics, and then to choose an alternative from each of the four choice sets. When respondents pick one alternative from a choice set, they are evaluating four alternatives of a choice set and picking one. This means that while choosing one from each of the four choice sets, the respondent evaluates all 16 alternatives. Thus, this not only gave each respondent an opportunity to evaluate all the 16 alternatives, but also enriched the database with more SC observations (than the number of respondents).

DATABASE

The database includes respondent's socioeconomic characteristics such as age, occupation, personal income, family size, and household income. It also includes trip characteristics such as origin, destination, purpose, duration of the trip, fare paid, and route characteristics such as length of the route, number of bus stops, fare structure, schedule, and the SP 'choice.' Route characteristics and mode characteristics data were collected from secondary sources such as the Regional Transport Authority (RTA) and Transport agencies. From the trip characteristics, trips were classified as business, educational, job, recreation, agriculture and other trips. Though 475 people were interviewed at various locations along the study route, which would have given 1,900 choices, some were removed due to incomplete information. This resulted in only 1,489 refined observations for the purpose of model development. Summary statistics of the information about trip purposes and socioeconomic details including gender, age and household income forming the database for the present work are given in Table 2.

Table 2: Descriptive Statistics of Some Sociodemographic Data

Variable		Number
Observations		1489
Male		1209 (80%)
Age	< 15yrs	0
	15-35	694
	36-60	778
	> 60	17
Household Income per month		
≤ 5000 INR (≈ US$ 113)		489
5000-10000 INR (≈ US$ 113-227)		515
10001-15000 INR (≈ US$ 227-341)		238
≥ 15000 INR (≈ US$ 341)		247
Work Trips		435 (29.2%)
Business Trips		332 (22.2%)
Recreation Trips		360 (24.3%)
Education Trips		130 (8.7%)
Agriculture Trips		151 (10.1%)
Other Trips		81 (5.4%)

MODEL ESTIMATION

The refined observations were used to estimate utility models using LIMDEP 8.0 (Green 2002). Models were estimated for total trips as well as trip purposes (i.e., business, educational, job, recreation, agriculture, and others). In each case, both MNL and RPL models were developed. In the development of RPL models, in-vehicle travel time, headway, and levels of comfort were taken as random parameters, while travel cost was considered a fixed (i.e., non-random) parameter. The reasons for keeping the travel cost parameter fixed are: (1) it simplifies the estimation of marginal WTP for other parameters - simple division of the coefficient of attribute by the coefficient of cost, (2) the distribution of the marginal willingness-to-pay for an attribute is simply the distribution of that attribute's coefficient, and (3) to restrict the price variable to be non-positive for all individuals. RPL models were estimated with simulated maximum likelihood using intelligent Halton draws with 500 replications. The MNL and RPL models developed for various trip purposes are presented in Tables 3 through Table 9. For all the RPL models developed and reported in Table 3 through Table 9, attempts were made to study the influence of socioeconomic characteristics on the mean estimates of random parameters. However, their coefficients were found to be statistically insignificant. Following Hensher et al. (2005) we removed the variables with insignificant coefficients and re-estimated the models.

RESULTS AND DISCUSSION

Table 3 through Table 9 show the results of MNL and RPL models for all trips as well as for different trip purposes. It is observed that the signs of the parameters are as expected and in agreement with the actual condition of the study route. The negative signs of the parameters indicate that utility decreases with an increase in the magnitude of the respective attributes. It is evident from the t-ratios that the parameter estimates are statistically significant. The overall goodness of fit is considered on the basis of ρ^2. A value of the ρ^2 between 0.2 and 0.4 indicates acceptable model fit (Louviere et al. 2000). The ρ^2 values indicate that these models are good in fit. The ρ^2 value also improved from MNL to RPL models.

The interpretation of the coefficients is not straightforward except for significance. Therefore, the marginal rate of substitution between each attribute and cost is calculated by taking the ratio of the coefficient of the attribute to that of cost. The resulting ratios can be interpreted as marginal WTP for a unit change in each attribute under consideration. In the cases of qualitative attributes, estimation of WTP values is based on rescaled coefficients of the levels, where the last level is considered the reference level (set to zero), and the estimated values are with reference to the last level (i.e., for a shift from last level to the level under consideration). The marginal WTP estimates from the MNL and RPL models are shown in Table 10 for various attributes and for different trip purposes. The value of headway is estimated for average trip lengths of respective trip purposes.

It is observed from Table 10 that for the total sample, trip makers' marginal WTP for in-vehicle travel time is about 2.7 times that of headway in both the MNL and RPL estimates. However, the RPL model is found to produce WTP values that are 43% higher for in-vehicle travel time and 31% higher for headway than the corresponding values from the MNL model. The marginal WTP values increased consistently for changing from comfortable standing, partly standing, and partly seating, and comfortable seating in both the MNL and RPL models. The difference between the RPL and MNL estimates of WTP for comfort in Table 10 is from 41% to 97%, with the RPL model producing higher WTP values.

For business trip makers, the WTP values for in-vehicle travel time are 2.7 to 3.3 times those of headway. For discomfort, changing from comfortable standing, partly standing, partly seating, and comfortable seating increases WTP values as expected.

Job trip makers value travel time about 2.5 times higher than waiting time. For them, the WTP values produced by the RPL model for discomfort are about 48% to 94% higher than those from the MNL model estimates in Table 10.

For recreation trip makers, the subjective value of travel time from the RPL model is 41% more than that from the MNL model, while the WTP value associated with headway is 32% higher. In-vehicle travel time for recreational trip makers is valued nearly twice as much as headway. For discomfort, the WTP values from the RPL model for these trip makers are about 40% to 80% higher than those from MNL model.

Agricultural, educational, and other trip makers value in-vehicle travel time about 3 to 4 times the value of headway. The WTP values produced for discomfort by the RPL model range between 1.4 to 2 times the values from the MNL model for agricultural trip makers. On the other hand, the WTP values are 1.3 to 2.2 times the values for other trip makers, and 1.2 to 1.5 times the values for educational trip makers.

For all trip makers, travel time is valued at 2 to 3 times as much as headways are valued. This is in contrast to observations in developed countries where waiting time usually is valued higher (almost double) than travel time. This high value of travel time may be attributed to the poor comfort conditions inside the vehicles and the longer journey times. A comparison of willingness-to-pay values shows that it is sensitive to trip purpose. Discomfort, for example, is highly sensitive to trip purpose with the highest value of each level being approximately 3.5 to 5.5 times its lowest value. Willingness-to-pay value for travel time and headways are also sensitive to trip purpose, varying from 2.7 to 3.3 and 3.5 to 4.7 times their lowest values respectively. Job trips have the highest willingness-to-pay values for all attributes, and this may be attributed to the prevailing poor operating conditions in terms of long travel times and crowding experienced daily by travelers. Recreational trips, which generally are pleasure trips, also have high values for discomfort as people making such trips prefer to have highest comfort. For agriculture and other trips, predominantly made by low income groups, all the attributes have relatively low values.

A comparison of WTP estimates in Table 10 from MNL models and RPL models indicates that the MNL models gives lower WTP values in all the cases. The average gain in trip purpose WTP estimates, from RPL models, for in-vehicle travel time is about 35%; and for headway it is about 22%. Similar observations are reported by Bhatt (1998) and Hensher (2001) in developed country context.

Table 3: MNL and RPL Model Estimates for Total Trips

	MNL		**RPL**	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-5.540	19.35	-6.563	14.88
Service Headway	-0.047	10.24	-0.052	8.72
Comfortable seating	1.195	17.44	1.466	13.75
Part seating	0.548	7.23	0.476	5.59
Comfortable standing	-0.423	2.79	-0.238	1.50
Fixed Parameters				
Travel Cost	-0.103	4.36	-0.086	3.51
Random parameter spread				
Travel Time	-	-	6.563	14.88
Service Headway	-	-	0.052	8.72
Comfortable seating	-	-	1.466	13.75
Part seating	-	-	0.476	5.59
Comfortable standing	-	-	0.238	1.50
Observations	1489		1489	
Log Likelihood	-988.17		-987.13	
$\rho 2$	0.484		0.484	

Table 4: MNL and RPL Model Estimates for Business Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-8.212	8.68	-10.705	5.12
Service Headway	-0.074	4.75	-0.080	3.28
Comfortable seating	1.405	7.66	1.956	4.52
Part seating	0.888	3.87	0.716	2.62
Comfortable standing	-1.154	2.52	-0.789	1.40
Fixed Parameters				
Travel Cost	-0.155	2.55	-0.139	1.65
Random parameter spread				
Travel Time	-	-	10.705	5.12
Service Headway	-	-	0.080	3.28
Comfortable seating	-	-	1.956	4.52
Part seating	-	-	0.716	2.62
Comfortable standing	-	-	0.789	1.40
Observations	332		332	
Log Likelihood	-161.77		-163.72	
ρ2	0.606		0.601	

Table 5: MNL and RPL Model Estimates for Job Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-5.699	-10.63	-6.620	8.12
Service Headway	-0.049	-5.59	-0.054	4.79
Comfortable seating	0.999	7.56	1.213	6.55
Part seating	0.573	4.07	0.486	3.14
Comfortable standing	-0.285	-0.94	-0.124	0.40
Fixed Parameters				
Travel Cost	-0.073	1.68	-0.055	1.91
Random parameter spread				
Travel Time	-	-	6.620	8.12
Service Headway	-	-	0.054	4.79
Comfortable seating	-	-	1.213	6.55
Part seating	-	-	0.486	3.14
Comfortable standing	-	-	0.124	0.40
Observations	435		435	
Log Likelihood	-276.9		-278.4	
ρ2	0.502		0.500	

Table 6: MNL and RPL Model Estimates for Recreation Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-5.283	9.19	-6.243	7.22
Service Headway	-0.046	5.11	-0.051	4.38
Comfortable seating	1.308	9.27	1.598	7.24
Part seating	0.649	3.99	0.613	3.30
Comfortable standing	-0.290	0.96	-0.080	0.25
Fixed Parameters				
Travel Cost	-0.095	2.01	-0.080	1.64
Random parameter spread				
Travel Time	-	-	6.243	7.22
Service Headway	-	-	0.051	4.38
Comfortable seating	-	-	1.598	7.24
Part seating	-	-	0.613	3.30
Comfortable standing	-	-	0.080	0.25
Observations	360		360	
Log Likelihood	-238.8		-238.8	
ρ2	0.498		0.498	

Table 7: MNL and RPL Model Estimates for Education Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-4.570	5.73	-5.022	4.87
Service Headway	-0.033	2.58	-0.033	2.35
Comfortable seating	1.215	5.75	1.396	4.80
Part seating	0.463	2.08	0.451	1.84
Comfortable standing	-0.276	0.68	-0.102	0.25
Fixed Parameters				
Travel Cost	-0.115	2.19	-0.112	1.98
Random parameter spread				
Travel Time	-	-	5.022	4.87
Service Headway	-	-	0.033	2.35
Comfortable seating	-	-	1.396	4.80
Part seating	-	-	0.451	1.84
Comfortable standing	-	-	0.102	0.25
Observations	130		130	
Log Likelihood	-107.33		-107.46	
ρ2	0.367		0.366	

Table 8: MNL and RPL Model Estimates for Agricultural Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-5.091	6.33	-5.476	5.31
Service Headway	-0.042	3.23	-0.041	2.86
Comfortable seating	1.039	5.41	1.171	4.60
Part seating	0.558	2.71	0.525	2.29
Comfortable standing	-0.442	1.11	-0.214	0.55
Fixed Parameters				
Travel Cost	-0.173	2.58	-0.148	2.27
Random parameter spread				
Travel Time	-	-	5.476	5.31
Service Headway	-	-	0.041	2.86
Comfortable seating	-	-	1.171	4.60
Part seating	-	-	0.525	2.29
Comfortable standing	-	-	0.214	0.55
Observations	151		151	
Log Likelihood	-126.12		-127.09	
ρ2	0.363		0.359	

Table 9: MNL and RPL Model Estimates for Others' Trips

	MNL		RPL	
Attribute	**Coefficient**	**Abs. t-ratio**	**Coefficient**	**Abs. t-ratio**
Random Parameters				
Travel Time	-5.385	4.87	-6.190	3.96
Service Headway	-0.043	2.34	-0.042	2.09
Comfortable seating	0.839	3.12	0.933	2.72
Part seating	0.204	0.73	0.112	0.37
Comfortable standing	-0.290	0.53	-0.059	0.11
Fixed Parameters				
Travel Cost	-0.18	1.95	-0.163	1.76
Random parameter spread				
Travel Time	-	-	6.190	3.96
Service Headway	-	-	0.042	2.09
Comfortable seating	-	-	0.933	2.72
Part seating	-	-	0.112	0.37
Comfortable standing	-	-	0.059	0.11
Observations	81		81	
Log Likelihood	-70.78		-70.69	
ρ2	0.281		0.282	

Table 10: WTP Values of Attributes for Different Trip Purposes

Attributes / Trip Purpose	Travel Time Paise**/min		Headway * Paise/min		Comfortable seating Paise/km		Part seating Paise/km		Comfortable standing Paise/km	
	MNL	*RPL*	MNL	*RPL*	MNL	*RPL*	MNL	*RPL*	MNL	*RPL*
1. Total Sample	53.66	*76.60*	20.50	*26.94*	24.37	*37.02*	18.10	*25.46*	8.70	*17.13*
2. Business	52.90	*77.05*	19.34	*23.50*	16.39	*27.63*	13.06	*18.71*	0.09	*7.88*
3. Job	77.86	*121.23*	32.23	*47.93*	31.22	*51.05*	25.40	*37.73*	13.68	*26.57*
4. Recreation	55.58	*78.29*	27.86	*36.77*	31.30	*46.77*	24.37	*34.42*	14.49	*25.73*
5. Education	39.63	*44.66*	9.83	*10.27*	22.69	*27.92*	16.17	*19.52*	9.77	*14.60*
6. Agriculture	29.38	*37.11*	9.26	*10.55*	12.67	*17.97*	9.89	*13.59*	4.12	*8.58*
7. Others	29.90	*38.08*	11.46	*12.37*	8.84	*11.81*	5.31	*6.76*	2.57	*5.71*

* values are for average trip length of respective trips ** 100 paise = 1 INR and 44 INR = US $1

CONCLUSIONS

For judicious improvement planning of rural bus service and evaluation of user benefits, it is necessary to estimate users' WTP values. In the present paper, WTP values associated with different attributes of rural bus service are estimated in a developing country context. Using stated choice data, both MNL and RPL models are developed and WTP values associated with travel time, comfort, and headway are estimated for all trip purposes as well as for different trip purposes. The estimated WTP values are found to be significant and in agreement with the actual conditions of the study route.

It is observed that trip makers' marginal WTP is not the same for all attributes of travel, and the WTP values also vary with trip purpose. The WTP values associated with comfort and travel time are higher for job trips. Recreational trip makers value travel time, comfort and headway slightly less than job trip makers, but more than business trip makers. The WTP values associated with job, business, and recreational trips are more than those for education, agriculture, and other trips.

A comparison of WTP values produced by the MNL and RPL models developed in the present study reveals that estimates from the MNL model are generally lower than those of the RPL model. In general, use of RPL models should be encouraged for estimating WTP values as they relax the restrictions imposed by MNL. Though contextual, the results presented here can be valuable inputs to policy makers for improvement planning of bus services in rural areas of developing countries.

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Acknowledgments

The work presented in the paper is based on the research project sponsored by the Department of Science and Technology (DST), Ministry of Science and Technology, Government of India.

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