WPS5422

Policy Research Working Paper 5422

# Economic Valuation of Development Projects

## A Case Study of a Non-Motorized Transport Project in India

*Hua Wang*
*Ke Fang*
*Yuyan Shi*

The World Bank
Development Research Group
Environment and Energy Team
September 2010

Policy Research Working Paper 5422


## Abstract

One of the major difficulties in doing cost-benefit analysis of a development project is to estimate the total economic value of project benefits, which are usually multi-dimensional and include goods and services that are not traded in the market. Challenges also arise in aggregating the values of different benefits, which may not be mutually exclusive. This paper uses a contingent valuation approach to estimate the economic value of a non-motorized transport project in Pune, India, across beneficiaries. The heads of households which are potentially affected by the project are presented with a detailed description of the project, and then are asked to vote on whether such a project should be undertaken given different specifications of costs to the households. The total value of the project is then derived from the survey answers. Econometric analysis indicates that the survey responses provide generally reasonable valuation estimates.


---

This paper—a product of the Environment and Energy Team, Development Research Group—is part of a larger effort in the department to understand and improve environmental governance in developing countries.. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hwang1@worldbank.org.

# Economic Valuation of Development Projects: A Case Study of a Non-Motorized Transport Project in India

**Hua Wang**[1]

**Ke Fang**

**Yuyan Shi**

[1] Authors are Sr. Economist, Sr. Transport Specialist and Consultant of the World Bank respectively. Views expressed in this paper are solely of those authors and do not necessarily represent those of the World Bank, its Board of Executive Directors or the countries they represent. Special thanks go to Ms. Shabari Shetty and her team for helping conduct the household survey in Pune, India. Corresponding email address: hwang1@worldbank.org.

## 1. Introduction

One of the major difficulties in doing cost-benefit analyses of development projects is to estimate total values of the project benefits, which are usually multi-dimensional and include goods and services that are not traded in the market. Take a non-motorized transport (NMT) project for example. The major benefits may include improving travel convenience and safety, reducing congestion and saving time, improving environmental quality, and reducing driving costs. Most of the benefits, however, are nonmarket goods and cannot be easily valued[2]. Even if an economic value can be estimated for each of the project benefits, the final aggregation may still face a number of issues such as double counting. One potentially feasible solution to estimating the total value of a development project can be the contingent valuation (CV) method, with which a survey can be designed and implemented to collect preference information of the potential project beneficiaries and a total value of the project in monetary terms can be inferred. As the utility level of a respondent should be affected by the various aspects of the multi-dimensional benefits associated with a development project, a CV survey can be so designed that a respondent is required to consider a total value of the benefits of the project for his/her family.

After 50 years of research in the area of non-market valuation, the CV method has been developed from its initial controversial stage to a legitimate and most popular valuation approach, given that a number of survey design and execution requirements are satisfied. The CV method has been successfully developed and applied in the area of environmental economics, but has not been well tested in estimating the total value of a transport project. As a big part of the benefits of a transport project, such as time savings, improvements in environmental quality and public health, increased land value, etc., are not generally traded in the market, no such information on market demand or competitive market prices is readily available, especially in developing

[2] Transport economists have developed sophisticated valuation models for time savings, but for other benefits there has been no much research.

countries. Therefore, development and use of the CV method can be very important for cost-benefit analyses of transport projects in developing countries.

This paper reports a contingent valuation study of an NMT project in Pune, India. Recently, it has been proposed to have the World Bank finance an NMT project under India's Sustainable Urban Transport Program (SUTP) which aims to improve road conditions for pedestrians and cyclists. A CV survey is developed and applied to potential beneficiaries of the Pune NMT project[3], and an internal validity test on the WTP estimation is conducted. This study has also tested the heteroskedasticity assumption in WTP modeling which has been mostly neglected in the literature.

The paper is organized as follows: in the following section, we briefly review existing literature on CV from various threads, especially the application of CV method in transportation sector and the evolution of heteroskedasticity treatment in recent years. In section 3, we introduce the policy context, goal and proposed activities of Pune NMT project and the potential benefits this project may generate. Section 4 summarizes the survey design and implementation, the WTP elicitation strategy, and the descriptive statistics of major questions in the questionnaire. In section 5, we present our analytical framework that accommodates heteroskedasticity assumption in payment card (PC) elicitation strategy. The estimation results are also shown in this section. Section 6 discusses and concludes the paper.

## 2. Literature Review

The CV method is principally developed and established in the area of environmental economics; however, application of the CV approach in the transport sector has become more widespread over the past decade. Feitelson (1996) examined the effects of aircraft noise following an airport expansion by using the open-ended (OE) CV approach. Verhoef (1997) asked

[3] The survey was applied to the original version of the project proposal, dated as of December, 2008. The final version of the project design has been changed significantly after the survey was conducted.

respondents the minimum time gains they required for a certain road process, the answers to which implied a maximum WTP for time gains. Painter (2002) employed the OE CV elicitation strategy to measure the economic value of regional rural transit that had both user and nonuser values. Also with an OE value elicitation strategy, Walton (2004) found motorists were willing to pay for improved fuel efficiency and reduced interior vehicle noise from road surface pavement, but reduction in vehicle stopping distance resulting from the same project was not valued by motorists. There has been little consideration given to valuing the total benefit of a transport project as the one presented in this paper. In the meantime, despite the increasing volume of transportation literature in contingent valuation, WTP has been obtained from fairly simple elicitation strategies such as open ended (OE) or dichotomous choice (DC) questions, and homogeneous variance is the common assumption for such estimates. A few papers have attempted to either accommodate heteroskedasticity in error terms, or employed more advanced elicitation techniques that acknowledged individual uncertainty. Carlsson (2000) found that the estimated marginal effects of WTP for improved air quality are quite robust to homoskedasticity assumption based on OE elicitation questions. Using split-sample design, Afroz (2005) investigated the convergent validity of different CV strategies including OE, DC and payment card (PC). The results suggested that WTP values for air quality improvement did not differ significantly across strategies.

In the CV literature, some studies relying on conventional elicitation strategies, such as OE questions and one bid DC questions, have acknowledged and tested the heteroskedasticity assumption in error terms. For example, Lanford (1994) detected the presence of over dispersion of un-observables which may lead to biased parameter estimates or overestimated significance levels in DC models. Cameron (2002) found that dispersion of error terms vary systematically with elicitation models across elicitation techniques including OE, DC, PC, and multiple bounded discrete choice strategies (MBDC), based on results from split-sample design. Violation of homoskedasticity assumption does not result in biased or inconsistent coefficient estimates in OE

ordinary linear square models, but it may cause the variance of the coefficients underestimated. Thus weighted least square regression is often used to correct heteroskedasticity in such models in order to judge the true relationship of significance. One bid DC models that fail to represent empirical heterogeneity in variance, however, may yield substantial bias or inconsistency in coefficient estimates as well as WTP estimates (Halvorsen, 1998). Horowitz (1993) argued that if the specified distribution function is qualitatively different from true data generation process, i.e., error dispersion is not drawn from the same distribution, the bias in coefficient estimates based on maximum likelihood estimation could be substantial. Their finding is consistent with another study by Gourieroux (1984) that estimation of discrete choice models are suggested quite sensitive to distribution error term assumptions.

The concept that an individual's valuation for goods or services is best viewed as a random variable associated with a distribution or a range of possible values rather than a single point value has been gradually accepted in the community of CV research (Welsh and Bishop 1993, 1998; Wang, 1997; Wang and Whittington, 2005). The concern of respondents' WTP uncertainty has led to the more advanced elicitation techniques that allow respondents explicitly state their choice uncertainty or increase number of bids offered to respondents so as to enhance the information about WTP qualitatively or quantitatively (Wang and Whittington, 2005). The representative examples of such development are doubled bounded DC, PC and MBDC strategies. Unlike one bid, yes/no type of DC questions, doubled bounded and PC strategies cover a wider range of biding prices presented to respondents in order to narrow down the underlying WTP interval for the given good or services. In recently developed MBDC questions, respondents are shown a number of different possible prices, and instead of asking them to simply accept or reject each of these prices, the respondents are asked to select one of several pre-established possibilities, such as Definitely Not, Probably Not, Not Sure, Probably Yes, Definitely Yes, that the respondent would accept the price. This approach has been suggested to yield more meaningful results and better match the hypothetical nature of the survey.

Although recent improvement of CV questionnaires has to some extent accommodated the uncertain nature of respondents' WTP distribution, most of such studies assume the variance of WTP distribution is homoskedastistic with only a few exceptions (Alberini et al, 1997; Wang and Whtington, 2005). For example, Welsh and Poe (1998) adapted the "return potential" format and employed MBDC strategy that asked respondents to express both the choice and voting certainty for the referendum at each bid value. They found MBDC questions significantly reduced confidence intervals around the estimated WTP mean. However, as pointed out by Wang and Whittington (2005), the underlying assumption in Welsh and Poe model is that all respondents share same distribution, and heterogeneity in WTP variance was not considered. Alberini et al (2003) built upon the random valuation threshold model of Wang (1997) to model WTP thresholds be functions of respondent characteristics. While the uncertainty in thresholds was acknowledged, the variance estimated in their model was still based on homoskedasticity assumptions. Alberini et al (1997) also noticed the heteroskedasticity possibility in doubled bounded DC strategies and modeled the WTP distance to price bids to capture the heterogeneity in variance. Although the results were mixed depending on model specifications, the assumption of heteroskedasticity was not rejected.

This study considers the role of heteroskedastic variance in WTP estimation based on the payment card approach, in which respondents are asked to present their WTPs as intervals.

**3. NMT Project in Pune**

Pune, located near the west coast of India, is the eighth largest metropolitan city in the country. According to 2001 Census, Pune has about 244 square kilometers in municipal area and population density - 10,403 per square kilometers (World Bank, 2008). The area in the center of the city is densely populated. The main driver of the economy of Pune is auto industry and its educational, research and development institutions.

Pune is historically known for its use of bicycles. While the usage of bicycle has been gradually coming down over recent years with increasing urban sprawl and rising income levels, it still consists of a major component of Pune transportation due to the significant slum population and student population. Walking and cycling currently constitute approximately 33-35% of the total trips in Pune (World Bank, 2008).

The current transport infrastructure in Pune, however, does not adequately meet the needs of NMT mode. It is characterized by traffic congestion with rapid increase in private cars and two-wheelers ownership; narrow, poorly maintained, unpaved and limited road network; scarcity of parking space; motorized and non-motorized transport modes sharing roadways; inadequate roadway accommodation for buses and NMT; lack of traffic signals, poor traffic control and management; increasing traffic accident risks especially among pedestrians and cyclists; overcrowded, non-accessible and inefficient public transport; alarming levels of pollution and noise associated with transportation; lack of transport infrastructure specifically designed for pedestrian and cyclists.

The Pune NMT project is a component of India Sustainable Urban Transport Program (SUTP), which is proposed to be financed by the World Bank. It is a comprehensive transportation infrastructure construction program including various physical investments in public transport, intelligent transport system technology applications, and investments in technical assistance and capacity building. The component NMT was specifically designed to improve the pedestrian and cycling infrastructure of the feeder roads along the two pilot Bus Rapid Transit (BRT) corridors - first running south on the Mumbai-Bangalore National Highway for a length of 5.6 km and the other running east along the Pune-Sholapur highway for a length of 8.2 km. The key objectives of the NMT project include: facilitating the integration between BRTS and non-motorized transport; Improving safety and comfortable environment for non-motorized transport; using the “raised crosswalk” concept and underpasses for both pedestrians and cyclists to connect important BRT stations and non-motorized transport clientele; and

formulating an integrated solution in the form of a network for non-motorized transport. The total length of the feeder roads which is to be renovated is 41.5 kms, with 23.8 kms in the vicinity of BRTS1 (Satara Road) and 17.7 kms on BRTS2 (Sholapur Road). The average width of the feeder roads is 20 meters. The construction includes footpaths, cycle tracks, cycle stands, underpasses, and trees, etc. The width of the footpaths and cycle tracks are 2 meters each. The construction should be completed in about one year after the project is approved, and the quality will last for at least 10 years. This project aims to provide better access to urban activity centers for pedestrians and cyclists and make the roads a safer place for them to travel. Separate lanes for cyclists and pedestrians, wide roads, and leveled pavements free of debris and other material will make walking & cycling attractive alternatives to using motorized vehicles. Visual signs in the form of road markings, signage, would be put up and distinctive paving material used .The facilities which are created especially for pedestrians & cyclists would also make motor vehicle users conscious of the rights and privileges of the pedestrians & cyclists on the road. A more equitable distribution of road space would be sought to be achieved for motorized and non-motorized traffic. The whole project will be enthusiastically promoted to encourage citizens to use the facilities created for them.[4]

## 4. Survey Design, Implementation and Summary Statistics

### 4.1 Survey design and administration

A CV survey was conducted in Pune in March-April, 2009, to provide data estimating the potential multi-dimensional benefits that NMT could bring to the residents of Pune. Prior to the main survey, two focus groups and 116 pretests were carefully conducted to enhance the

[4] World Bank (2008) provides more details about the project, but the final project design has been changed significantly after this study.

understanding of Pune transportation situations and to improve the wording of the questionnaire and the visual aids. The survey was carried out by ten professional enumerators in a specialized survey company in Pune, and the survey enumerators were trained by one of the authors of this paper. Face-to-face interview was chosen as apposed to telephone interview to reduce selection bias, besides being a more effective technique for explaining the CV scenario to the respondents and gauging if respondents have understood the scenario they are being asked to evaluate. The target respondents were heads of those households who can make decisions on behalf of the entire families and are situated within the project area, which are defined as potential beneficiaries. The sample area covered the seven wards of Pune (Tilak Road; Sahakar Nagar; Bibvewadi; Hadapsar; Vishrambaughwada/ Kasba Peth; Bhavani Peth, and Dhole Patil Road) that are neighboring the project sites. The total number of households located in the seven wards was estimated to be 234,689, or roughly 1.17 million individuals. A number of starting addresses in each ward were randomly selected first, and following the right hand rule, households neighboring the starting addresses were all selected to participate in the interview. A total of 1,512 household heads were finally interviewed. Table 1 gives the details of sample selection and interview. Except Dhole Patil, which had an extremely high refusal rate of 55.5%, response rates of all other six wards were quite high (>=70%).

The final survey questionnaire consisted of four sections: (A) Urban development & transport. Questions were asked about current socio-economic conditions in Pune, issues & problems of the city, level of satisfaction with the current transport system. (B) Bus Rapid Transit (BRT) System. This section covered current household usage of public transport and BRTs, difficulties in access, awareness of and experience in BRTs. (C) The NMT project and WTP elicitation. This key component provided respondents with the background, feature and benefits of the project, and elicited individual information on their WTP preferences. (D) Follow-up questions about WTP and about individual and household demographic characteristics.

During the survey, visual aids were presented to facilitate the communication between enumerators and respondents (**Appendix 2**). A map shows the scale and location of the project and highlights the project streets and feeder roads proposed to be renovated. A set of pictures of the streets after improvements explains the aim and benefits of the project, and a set of pictures of current streets helps respondents ponder over road & traffic conditions in the city. Respondents can have a better understanding in changes that the project will bring to them by comparing the two sets of pictures.

## 4.2 WTP elicitation

Before answering the question on WTP for NMT road renovation, respondents were provided with the key goals and objectives of the project, the background and rationale for the CV scenario, potential payment vehicle, which is part of the electricity bill, and the possible impacts of the project on their households in near future (**Appendix 1**). The project activities were reiterated to stress the fact that the project would bring about a significant improvement over the current situation. We want to make sure the respondents are reasonably familiar with the major concerns associated with the project and therefore able to consider these thoughtfully in a personal context.

In the questionnaire, the respondents were told that in order to complete this project, it is necessary to invest large sums for which the government will require new sources of financing. We told the respondents that “Given that the PMC cannot cover all the cost for improving the transport situation in Pune, it is only reasonable that some additional fees be collected from households like yours. Every effort will be made to ensure the fees collected be solely used for this project. The purpose of the survey is to determine how strongly citizens like you will support this transportation project which may introduce some cost to the household.” The respondents were told that “if the total fee collected from the households like yours is enough for the project, the project will be implemented and will be implemented properly. If the fee collected is not

enough, this project will have to be cancelled." The respondents were told that once this project passes a referendum, a special urban construction fee, which will be solely used for the project, will be charged to the household through the electricity bill or other utility bills.

Respondents were then asked to think of their income and other necessary expenditures of the household in the future on food, clothes, transport, and entertainment, etc. before they select their WTP answers in the payment card. Respondents were told that all potential costs to a household are listed, from 0 to a very large number that nobody would like to pay. For each cost, respondents were asked to give an answer. The cost is the total payment that the household would have to make for this project, but can be made monthly in the next two years, or 24 times. Respondents were reminded that there is no right or wrong answer and we only want an honest answer from the respondent. To minimize the starting point bias, the enumerator did not necessarily begin at zero and proceed sequentially. In an attempt to help the enumerator select the starting point in the PC, respondents, in an earlier question, were asked to state their average monthly electricity bill. As the electricity bill is a fairly good indicator of the standard of living of the household, it was decided to take 30 % of the household electricity bill as the starting cost point at which enumerators could begin the PC question. Enumerators then moved forwards or backwards as the case needed. Such design to a large extent minimized protest bids, excess zeros or implausibly large responses.

Three versions of payment cards were designed in the survey. **Version A**: The respondents had two options either 'Yes' or 'No ' to respond to their WTP at each cost point. **Version B**: the respondents had 3 options. 'Yes', Not Sure' & 'No'. **Version C**: the respondents had five options to respond to their willingness to pay question 'Definitely Yes', 'Probably Yes', 'Not Sure', 'Probably No' and 'Definitely No'. All three versions consisted identical series of 24 price bids ranging from 0 to 1000 Indian Rupees per month. Respondents were randomly assigned with one of these three PCs across entire samples. In the main survey, however, we found only 4% respondents assigned to payment card Version B ever chose "Not Sure", and 8%

respondents assigned to payment card Version C made circles at “Probably Yes”, “Not Sure” or “Probably No”. All the rest of respondents in latter two elicitation strategies simply ignored intermediate answers which revealing their answer uncertainties. As a result answers in all three WTP elicitation strategies are converged to conventional payment card and information of the lower bound and upper bound an individual was willing to pay was able to be utilized in the final WTP estimation. **Table 2** gives the standard payment card design.

4.3 Descriptive statistics

1,512 responses were collected, and **Table 3** summarizes the statistics of the major variables that may influence WTP for these 1512 respondents. These variables were grouped into 6 broad categories: (1) Individual and household demographic characteristics; (2) Household economic status; (3) Household current use of transportation system; (4) Perceptions about the proposed project; (5) Project impacts; and (6) Personal uncertainties.

Statistics showed that 82.74% respondents were male. Average age of the respondents was 43 years old. 92% of respondents reported Hindu as their religion, and 89% were married. Approximately one third of respondents had undergraduate diploma or higher, very few of them currently inactive in labor force (6%). Average household size was 4 persons. On average it takes 14.6 minutes of walking from home to the nearest roads to be renovated.

The average monthly income of the households that participated in our survey was approximately 9.58 thousand Rupees[5] (equivalent to 192 USD). Electricity bill accounted for about 5% of total household income, and 11% of income was spent on transportation associated activities.

On matters pertaining to transportation, 47% people viewed transportation as one of the top three most important problems that Pune needs to urgently address, while the top transport related issues were road congestion, maintenance and safety. According to the respondents, the

[5] One India Rupee equals to roughly 0.02 US Dollar.

most favorable option for reducing traffic congestion and transport related air pollution was improving public transportation and stricter enforcement of vehicle emission limits. 99% of the respondents said that improving current transport of the city was important or very important. 73% of the respondents had family members who used public transport last month and most of them said it was not easy to access to the public transport system. Over a half of the households reported two-wheeler as the most frequent transportation mode, and 70% families used two-wheeler in last two months. Almost all of the respondents were aware of BRTS in PUNE and 77% of them had family members who used the BRTS last month in various ways, but most of them (73%) were not satisfied with their experience in using BRTS. 62% of the respondents thought the BRTS were very useful or somewhat useful, and 76% agreed that it's good idea for Pune to construct more BRTS type of roads.

33% respondents said the roads around their home were worse than the average road in Pune shown in the picture (**Appendix 2**). For 41% of the respondents, they witnessed some accidents in the NMT project affected streets in the past 3 months. 77% of the respondents thought the project is useful to their families and 90% said the project would be very important or somewhat important to their families. Only 30% of the respondents asserted that PMC could do a good job in managing the implementation of the project. Population confidence in money collection feasibility was not very high as well: only 11% stated that PMC would not have any problem at all to collect money and another 39% believed there will be some problem but it was still possible.

Various impacts of the NMT project were explored during survey. 17% respondents said the project would have significant positive impacts on city environment, 15% said the streets would be a lot safer after renovation, and a third of them thought people's health would be significantly improved as people walk or cycle on the renovated roads more. The direct income effect of the NMT project is deemed marginal: only 10% stated their household income would be

increased as a result of road construction. Majority of households stated that they would use renovated streets in various ways including walking, cycling, driving or taking bus.

All the above 5 broad categories of major explanatory variables would be included in the maximum likelihood function for WTP mean $\mu$ estimation. To estimate WTP standard deviation $\sigma$, we would also include a unique set of variables revealing personal perception on future uncertainty. We hypothesized that individual WTP dispersion increases when a person has relatively higher uncertainty in the specified commodity or in the future expectation associated with purchase capabilities. Two indicators were therefore generated to represent personal degree of future uncertainty: whether or not respondent knew how to use roads after construction, and whether or not respondent had faith in their household future income increase. Concerning the degree of certainty that respondents had with respect to future use of roads after construction, statistics shows that 28% respondents were not sure about which activity the household would use most. A smaller proportion (18%) of respondents was uncertain regarding the expectation of future household income growth.

**5. Analytical Framework and Estimation Results**

As stated above, each of the respondents has a lower value on the payment card where a "yes" answer is recorded and an upper value where a "no" answer is recorded. Modeling this double bounded payment response can be built upon the double bounded dichotomous choice model introduced by Hanemann (1991) and conventional payment card approach developed by Mitchell and Carson (1981). Combining the advantages of both strategies, the double bounded payment card can be more efficient because it not only asks individual preference at a lengthy list of price bids, as the payment card approach does, but also progressively narrows WTP down to a narrower and more accurate bid interval, as the double bounded discrete choice model does.

Assume that the indirect utility of an individual i depends on the usage of constructed NMT road and other explanatory variables. Let $q^1$ and $q^2$ represent the utility levels associated with and without the NMT project, y is income, $W*$ is the amount of money an individual is willing to pay, X represents the vector of socioeconomic characteristics or other factors that may affect WTP. The WTP that equates the two indirect functions under initial condition without project and under improved situation with project can be written as:

$$v[(q^1, y - W*, X, \varepsilon)] = v[(q^0, y, X, \varepsilon)] \quad (1)$$

Where $\varepsilon$ represents uncertain factors which are not reflected in y, q, W.

Solving for the equation, W* = $WTP(q^1, q^0, y, X, \varepsilon)$. Suppose that each individual has his or her own willingness to pay $W_i*$ and $W_i*$ follows some form of cumulative distribution function F(t). Although we do not directly observe $W_i*$ from payment card responses, we know $W_i*$ for individual $i$ lies somewhere between $W_{iL}$ and $W_{iU}$, where $W_{iL}$ is the lower bound that individual $i$ would vote for, and $W_{iU}$ the upper bound that individual $i$ would not vote for. Thus the probability for individual $i$'s WTP falling between the interval [$W_{iL}$, $W_{iU}$] is

$$\Pr(W_{iL} \le W*_i \le W_{iU}) = F(W_{iU}) - F(W_{iL}) \quad (2)$$

We may assume F(t) a specific distribution function, for example, normality, with unique mean $\mu_i$ and standard deviation $\sigma_i$ for each individual. The likelihood function for estimation therefore is

$$LogL = \sum_{i=1}^{n} \log[\Phi(\frac{W_{iU} - \mu_i}{\sigma_i}) - \Phi(\frac{W_{iL} - \mu_i}{\sigma_i})] \quad (3)$$

Suppose mean $\mu_i$ and $\sigma_i$ are linear functions

$$\mu_i = \beta_0 + x_i'\beta_1 + \gamma_i$$

$$\sigma_i = \delta_0 + z_i'\delta_1 + \nu_i \quad (4)$$

Where $x_i$ and $z_i$ include individual and household characteristics, and error terms $\gamma_i$ and $\nu_i$ in the two equations are assumed to be mean zero and normally distributed.

The alternative is a homoskedasticity model which assumes all respondents share same $\sigma$. The hypothesis of equality between estimated maximum likelihood functions under heteroskedastistic assumption and homoskedastistic assumption can be formally assessed using likelihood ratio (LR) test:

$$LR = -2\ln(\frac{ll_{homo}}{ll_{hetero}}) \sim \chi^2(df_{homo} - df_{hetero}) \quad (5)$$

Where $ll_{homo}$ and $ll_{hetero}$ are the log likelihood associated with homoskedastistic model and heteroskedastistic model, respectively. The twice difference in these log likelihoods follows a chi-square distribution with ($df_{homo}$ - $df_{hetero}$) degrees of freedom.

5.1 Estimation Results – WTP Categories

**Table 4** shows the categories of WTP responses among 1512 respondents in the sample, which include protect bids, zero and negative bids, zero/very small positive bids (between 0 and

10 rupees, the lowest price in the payment card), and significant positive bids. In order to distinguish protest bids from valid positive WTP responses and investigate their motivations, we asked a follow-up question for those respondents why they said "no" to the price of zero (**Appendix 3**). Among the 10 statements provided, 5 were classified as valid answers for zero/negative WTPs, and the other 5 were classified as protesting to the WTP scenario. Based on the answers to the follow-up questions, 41 responses were identified as protest bids, 59 as negative bids and 124 as true zeros. To better understand the protest bids, we did binary Probit analyses on those who said "no" to the price of zero, and the results are reported in **Table 5**. In general, the results are consistent with expectation. If a respondent was with high income or bad current condition of roads close to the household or thought that the project was useful or that the project might generate positive impact on their income but still gave a negative response to the price of zero, the answer is more likely a protest bid.

A total of 1,286 respondents were willing to contribute some positive values to the proposed project. Despite the high participation rate in the proposed NMT project (85%), it did not translate into high WTP. Among the 1,286 respondents, 841 were only willing to pay very limited amount ranging between 0 and 10 Rupees per month; another 445 reported at least 10 Rupees per month as their WTP lower bound. Two observations do not have complete information on WTP, and they need to be removed from further analysis.

**INSERT TABLE 4**

**INSERT TABLE 5**

5.2 Estimation Results – WTP distribution estimation

The distribution of aggregate WTP curve based on the response of lower bound price bid in PC is illustrated in **Figure 1**. For each price listed as the minimum value that a respondent would vote for, the fraction of such respondents out of total 1286 was provided. Roughly two thirds (65%) of positive WTP respondents were willing to pay a very limited positive amount of

something between 0 and its adjacent price 10. The percentage of respondents who reported positive lower bound answers dropped dramatically as price went up, indicating the underlying WTP for majority respondents were relatively small amounts.

**INSERT FIGURE 1**

**Table 6** shows the maximum likelihood estimation results of six different model specifications. Coefficients, t-values (in parentheses), log likelihood values were listed. Mean and 95% confidence intervals of average WTP and standard deviation were simulated using Krinsky and Robb (1986) approach. Statistical significance level is indicated using asterisks.

**INSERT TABLE 6**

Under heteroskedasticity distribution assumption, we hypothesized that WTP distributions are likely to be more dispersed as WTP going up because WTP for some respondents may be high enough to make them indifferent to a range of values around the mean. Therefore the estimated $\mu$ becomes a natural regressor in $\sigma$ equation. In addition, the WTP elicitation design in our study was such that the intervals between two adjacent listed prices on PC were not a constant, but rather exponentially increased. Then, there should be a design effect on the correlation between the WTP mean and the variance. Alberini et al (1997) treated variance as a function of the distance between WTP and bid price provided to respondents. We also incorporated the difference between WTP lower bound and upper bound in the $\sigma$ estimation as a replacement of $\mu$.

We started with benchmark model 1, which included full set of regressors and assumed variance heterogeneity is captured by determinants of $\mu$ and individual uncertainties. An effective sample of 1,272 respondents who were willing to pay some positive WTP was analyzed. Based on the estimation results of this benchmark model, simulated average positive WTP for NMT project is 20.91 Rupees per month or $10 in two years, and the 95% confidence interval is 19.09-22.75 Rupees per month among population that were willing to finance the project.

In model 1, it is assumed that those who are willing to pay zero or a very small amount behave in the same way as those who are willing to pay a significant positive amount. In order to better understand the difference, we conducted sub-sample experiments using 437 respondents who were willing to pay more than 10 Rupees per month, with three alternative models under same heteroskedasticity assumption. Results were listed in subsequent column 4- column9 in **Table 6**. Model 2 was simply the sub-sample analysis of the benchmark model 1. Model 3 only kept individual demographic characteristics and uncertainty in $\sigma$ estimation and neglected the association between $\sigma$ and WTP; while Model 4 defined standard deviation $\sigma$ as a function of WTP interval, personal uncertainty plus basic individual demographic characteristics. Among the three alternative heteroskedasticity models, Model 3 yielded highest mean WTP of 59.64 Rupee per month or $28.6 in two years (%95 CI: 52.34-66.37 Rupees per month), followed by Model 2 for 58.43 Rupees per month (%95 CI: 52.61-63.69) and Model 4 for 55.10 Rupees per month (%95 CI: 50.43-61.60); while mean of standard deviation was 45.03, 44.70 and 45.03 Rupees per month for Model 2, 3 and 4 respectively.

Because Benchmark Model 1 utilized full sample information, in some cases we observed quite different results in variable significance levels or even coefficient signs relative to three alternative models, but in general the determinants of mean value $\mu$ and standard deviation $\sigma$ were quite consistent in four alternative heteroskedasticity models, and WTP varied generally in logical ways with most explanatory variables and had substantial face validity. Among individual demographic explanatory characteristics, religion, education levels and labor force status were found significantly associated with WTP levels. The coefficient of home distance to nearest renovated road, however, switched its sign from significantly positive in full sample analysis to significantly negative in sub-sample analysis. This indicated that the unexpected positive relationship between distance and WTP was primarily driven by WTP responses from people who were willing to pay merely a very small amount. In general households living nearby

should be willing to spend larger amount on the project because they were supposed to benefit more. As for household economic status, we may expect richer households would spend more if road construction is a normal good. This was confirmed by positive and significant estimates of household income, travel expense, and electricity bill[6]. Households whose current transportation mode was two-wheeler were willing to pay 30%-40% more than other transportation mode users. The current condition of the roads around home in general did not affect the level of WTP. The sign of people's perception on project usefulness indicated an insignificant and negative relationship with WTP in benchmark Model 1, but the sign changed to its opposite in three sub-sample models and the significance level substantially increased in Model 4. As for the capability of project operation, the positive sign suggested that people did seriously consider this issue and such confidence led them to pay 6-10 Rupees more per month relative to incredulous respondents. Among the variables of project future impact, the effects of direct income increase, environmental benefit and street safety were mixed depending on the sample analyzed, while personal health improvement and future street use were consistently associated with respondents' valuation of the project across four heteroskedasticity models[7].

Regarding distribution standard deviation $\sigma$ estimation equation, most significant variables that appeared in $\mu$ estimates were shown significantly correlated with $\sigma$ in benchmark Model 1. This supported our prior hypothesis that estimated WTP captured a large portion of the distribution heterogeneity. The difference between WTP lower bound and upper bound was also illustrated a significant and positive relationship with WTP standard deviation, confirming our second hypothesis that WTP variation was partly picked up by the pre-set payment card intervals. The increased log likelihood suggested that incorporation of WTP in $\sigma$ estimate in Model 2 and Model 4 had led to a substantial improvement of model fit relative to Model 3 that included only

[6] The effects of electricity bill may also capture some start point effects, as respondents started working on the payment cards at values close to one third of their electricity bills.

[7] We also tested on the effects of questionnaire version dummies in all four models and found that the dummy variables were not significant. The results are not shown in the tables but are available upon request.

individual and household demographic characteristics and individual uncertainties to capture WTP variance heterogeneities. The uncertainty of future street use mode further enlarged the WTP dispersion around the mean, as we expected, and the uncertainty of future household income also significantly and positively contributed to WTP variance in sub-sample models.

Comparing the benchmark model, model 1, with the three alternative heteroskedasticity models, we find that the alternative models, which are run for those who are willing to pay a significant amount for the project, perform much better. Two important variables – distance from home to project site and usefulness of the project, show correct sign in the alternative models. This may indicate that those who are willing to pay zero or very little have different behaviors from those who are willing to pay a significant amount. Among the three alternative models, model 4 gives the best results, which show that for those who have higher income or higher education, are not in job force (staying at home), using two-wheelers, viewing the project as useful, having positive health impact, believing that PMC can do a good job, or having family members walking or cycling in the renovated streets, WTP is higher, while for those who are Hindu, far away from the renovated streets, or taking bus in the renovated, or thought that transportation improvement in Pune was very important, the WTP is less. It seems counterintuitive for those who think transportation improvement in Pune to be very important to be willing to pay less. One reason could be that those people are not satisfied with the current project design or scale and would like to have a bigger improvement. Significant variables in the variance equation include gender (men have lower variance), Hindu (higher variance with those Hindu), education (positive correlation), uncertainty with future use of the renovated streets, and WTP interval (the design effect and natural correlation between WTP mean and variance).

The last four columns of **Table 6** present the WTP mean $\mu$ estimate under homoskedasticity assumptions. In model 5, it includes the full sample of those who are at least positive at the price of zero, and in model 6 those who are negative at the lowest price (10 rupees) are removed. Despite the significant level and even the coefficient signs varied in a few cases,

two homoskedasticity models yielded generally similar estimation results relative to their heteroskedasticity model counterparts. Hausman test suggested that the difference in coefficients between homoskedasticity model and heteroskedasticity model was systematic, and likelihood ratio test also supported our hypothesis that the models controlling for variance heteroskedasticity substantially improved data fit. Simulation generated slightly but significantly higher average WTPs than the heteroskedasticity models. Homoskedasticity Model 5 based on full sample yielded an average WTP of 23.64 Rupees/month (%95 CI: 21.38-25.78), and an average WTP of 60.41 (%95 CI: 55.31-65.43) is obtained for those who reported WTPs significantly different from zero in homoskedasticity Model 6.

**6. Conclusion and Discussion**

This paper presents a contingent valuation study of non-motorized transport (NMT) project in Pune, India, which has multi-dimensional benefits, including public health, safety, environment, congestion and convenience, etc. The respondents are presented with a detailed description of the project: the current status and use of the roads, the project activities and objectives, the potential project impacts, etc., and then are asked to vote on whether or not to have such a project under a list of costs to the households. The respondents are reminded that if the project passes the referendum with a total payment higher than the project cost, the project will be implemented and the payments will be enforced by the government via the electricity bill, but if the total payment is less than the project cost, the project would not be implemented. As this study is based upon a real development project under consideration, the respondents are found to take the survey seriously. The econometric analyses show that the survey responses are generally reasonable and are consistent with economic theories.

In the design and implementation of the study, the respondents are assumed to have valuation ranges or distributions, rather than single true values, in their minds. The results show that household income, distance from the renovated roads, current use of the transport service,

future use of the project streets, perceived project impacts, views on the usefulness of the project, the importance of transportation improvements and the effectiveness of PMC in implementing the project, as well as respondents' education, job status, religion background, can all significantly affect the WTP, as expected. Respondents' uncertainties in the future use of the project roads are found positively significantly correlated with WTP variance, also as expected. It is also found that considering heteroskedasticity in the modeling process will produce different estimates of the model coefficients and the final WTP, which suggest that heteroskedasticity should be considered in such studies.

The final results of this study show that the total willingness to pay for the project in Pune is not high. Most respondents living in or close to the project area are willing to finance the proposed NMT project, but only 35% of total respondents are willing to pay some positive amounts significantly higher than zero, or more than 10 Rupees per month. On average, a household is willing to pay a biennial amount $8.73 after considering those who do not want to contribute anything to the project. This will generate an aggregate WTP of roughly 10 million US dollars, which is about two thirds of the estimated project cost[8]. Including those who are only willing to pay a very small amount for the project into the modeling process is found to make the conventional linear WTP modeling technique not fit well, and excluding those responses with very small WTPs can provide a better fit.

The conventional way of estimating the total value of a development project with multi-dimensional benefits is to first estimate the value of each benefit component and then add the values of all benefit components together. Challenges exist with the conventional approach not only in estimating the values of different benefit components, each of which can be a very serious valuation study, but also in aggregating the values of different benefits, which are sometimes not mutually exclusive. The contingent valuation approach, as presented in this study, may provide an

[8] World Bank estimated the project cost to be about $16.8 million. As mentioned earlier, after the survey, the final project design has been significantly changed.

alternative solution. It is generally believed that individuals understand their own preferences better than researchers, especially after a series of communications conducted on all relevant issues involved in the valuation process. However, it is always a challenge to help respondents to form and reveal their values accurately. It is also hard to conduct an external validity test on a CV study, which may well pass an internal validity test, such as the one presented in this paper.

**References**

(1) Alberini. A, Kanninen B., Carson. T. R. (1997). Modeling response incentive effects in dichotomous choice contingent valuation data. Land economics 73(1997), 309-324

(2) Alberini, A., K. Boyle and M. P.Welsh (2003), "Analysis of contingent valuation data with multiple bids and responses options allowing respondents to express uncertainty". Journal of Environmental Economics and Management 45(2003), 40-62.

(3) Afroz Rafia, Hassan Nasir Mohd, Awang Muhamad, Ibrahim Akma Noor (2005). "Willingness to pay for air quality improvements in Klang Valley Malaysia". American Journal of Environmental Sciences 1 (2005) 194-201

(4) Cameron T.A., Poe L. G, Ethier G. R, Schulze D. W (2002). Alternative non-market value-elicitation methods: are the underlying preferences the same? Journal of Environmental Economics and Management 44(2002), 391-425

(5) Carlsson Fredrik, Johansson-Stenman Olof (2000). "Willingness to pay for improved air quality in Sweden". Applied Economics 32 (2000), 661-669

(6) Duan, N., Manning,W.G., Morris, C.N., Newhouse, J.P., (1983). A comparison of alternative models for the demand for medical care. Journal of Business and Economic Statistics 1 (2) (1983), 115–126.

(7) Duan, N., Manning, W.G., Morris, C.N., et al., (1984). Choosing between the sample-selection model and the multipart model. Journal of Business and Economic Statistics 2 (1984), 283–289.

(8) Gourieroux, C., Monfort, A., Trognon, A. (1984), "Pseudo maximum likelihood methods: theory," Econometrica 52 (1984), 681-700

(9) Halvorsen B, Soelensminde K. Differences between willingness-to-pay estimates from open-ended and discrete-choice contingent valuation methods: the effects of heteroskedasticity. Land Economics 74(1998), 262-282.

(10) Hanemann Michael, Loomis John, Kanninen (1991). “Statistical efficiency of doubled-bounded dichotomous choice contingent valuation”. American Journal of Agricultural Economics 73 (1991), 1255-1263.

(11) Heckman, J. (1979). Sample selection bias as a specification error. Econometrica, 47 (1979), 153–61.

(12) Horowitz, J.L. (1993). “Semiparametric and onparametric estimation of quantal response model” in Hadbook of Statistics, vol 11, G.S. Maddala, C.R. Rao and H.D. Vinod. Elsevier Science Publisher, B.V.

(13) Krinsky Itzhak, Robb A. Leslie (1986). “On approximating the statistical properties of elasticities”. The Review of Economics and Statistics 68 (1986), 715-719

(14) Langford H. Ian (1994). “Using a generalized linear mixed model to analyze dichotomous choice contingent valuation data”. Land Economics 70 (1994), 507-514

(15) Li, C. and L. Mattsson, (1995). “Discrete choice under preference uncertainty: An improved model for contingent valuation”. Journal of Environmental Economics and Management 28(1995), 256-269.

(16) Manning, W.G., Morris, C.N., Newhouse, J.P., et al., (1981). “A two-part model of the demand for medical care: preliminary results from the Health Insurance Study”. In: van der Gaag, J., Perlman, M. (Eds.), Health, Economics, and Health Economics. North Holland, Amsterdam, (1981), 103–123.

(17) Mitchell, R.C., Carson, R.T., (1981) “An Experiment in Determining Willingness to Pay for National Water Quality Improvements”. Draft Report to the US Environmental Protection Agency, Washington, DC.

(18) Painter M. Kathleen, Scott II Robert Douglas, Wandschneider R. Philip, Casavant L. Kenneth (2002) “Using contingent valuation to measure user and nonuser benefits: An application to public transit” Review of Agricultural Economics 24 (2002), 394-409

(19) Verhoef T. Erik, Nijkamp Peter, Rietveld Piet (1997). “The social feasibility of road pricing: A case study for the Randstad area”. Journal of Transport Economics and Policy 31 (2002), 255-276

(20) Wang, H. (1997). “Treatment of “don’t-know” responses in contingent valuation surveys: a random valuation model”. Journal of Environmental Economics and Management 32(1997), 219-232.

(21) Wang, H. and D. Whittington, (2005). “Measuring individuals’ valuation distributions using a stochastic payment card approach”. Ecological Economics 55 (2005), 143-154.

(22) Walton D., Thomas J.A., Cenek P.D (2004). “Self and others’ willingness to pay for improvements to the paved road surface” Transportation Research Part A 38 (2004) 483-494

(23) Welsh, M. P. and R. M. Bishop, (1993). “Multiple bounded discrete choice model”, in J. Bergstrom (ed.), Benefits & costs transfer in natural resource planning, Western Regional Research Publication, W-133, Sixth Interim Report, Department of Agricultural and Applied Economics, University of Georgia, 331-352.

(24) Welsh, M. P. and G. L. Poe (1998). “Elicitation effects in contingent valuation: comparisons to a multiple bounded discrete choice approach”. Journal of Environmental Economics and Management 36(1998), 170-185.

(25) World Bank (2008), “Sustainable Urban Transport Program of India: Pune-Integration of NMT with BRT,” Internal draft project preparation document, Washington, DC. June, 2008.

**TABLE 1: Sampling Details**

| Wards | Ward population* | Number of starting address used | Households contacted | Heads of Households not available | Households refused interview | Successful interview (% of household heads contacted) |
|---|---|---|---|---|---|---|
| Vishrambaughwada/ Kasba Peth | 209044 | 59 | 526 | 171 | 77 | 278 (78.3%) |
| Bhavani Peth | 197547 | 52 | 502 | 193 | 69 | 240 (73.3%) |
| Hadapsar | 188244 | 53 | 431 | 123 | 69 | 239 (77.6%) |
| Tilak Road | 162041 | 39 | 319 | 121 | 24 | 174 (87.8%) |
| Bibvewadi | 154516 | 52 | 385 | 86 | 33 | 266 (88.9%) |
| Dhole Patil | 143483 | 40 | 704 | 322 | 212 | 170 (44.5%) |
| Sahakar Nagar | 118568 | 35 | 301 | 111 | 45 | 145 (76.3%) |
| | | | | | | |
| Total | 1173443 (100%) | 330 | 3168 | 1127 | 529 | 1512(74.1%) |

*Ward population source: www.janwani.org

**TABLE 2: Payment Card**

| **Total in Rs ( for 2 years )** | 0 (free) | 240 | 480 | 720 | 1200 | 1680 | 1920 | 2400 |
|---|---|---|---|---|---|---|---|---|
| Monthly | 0 (free) | 10 | 20 | 30 | 50 | 70 | 80 | 100 |
| Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Total in Rs( for 2 years )** | 3600 | 4800 | 7200 | 9600 | 12000 | 14400 | 16800 | 19200 |
| Monthly | 150 | 200 | 300 | 400 | 500 | 600 | 700 | 800 |
| Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Total in Rs( for 2 years )** | 24000 | 36000 | 48000 | 72000 | 120000 | 168000 | 192000 | 240000 |
| Monthly | 1000 | 1500 | 2000 | 3000 | 5000 | 7000 | 8000 | 10000 |
| Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**FIGURE 1: Aggregate Lower Bound Distribution**

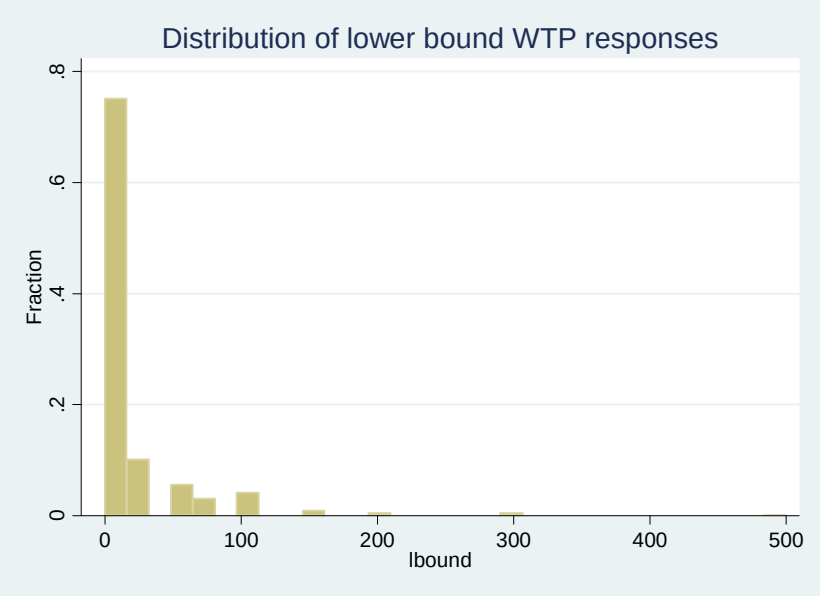


**TABLE 3: Descriptive Statistics of Major Variables**

| Variable | Description | Mean | Std |
|---|---|---|---|
| *(1) Individual and household demographic characteristics* | | | |
| male | Gender (male=1, female=0) | .82 | .37 |
| age | Age | 43.29 | 12.47 |
| Hindu | Religion (Hindu=1, other=0) | .92 | .26 |
| married | Marital status (married=1, other status=0) | .89 | .30 |
| highedu | Education category (undergraduate or higher including vocational=1, higher secondary or below=0) | .36 | .48 |
| notinlf | Labor force status (not in labor force=1, in labor force=0) | .060 | .23 |
| hhsize | Household size | 4.62 | 1.98 |
| distancetime | Home walking distance (minutes) to nearest road to be renovated | 14.58 | 10.83 |
| *(2) Household economic status* | | | |
| hhincome | Household monthly income in thousands | 9.58 | 6.83 |
| electricbill | Household monthly electricity bill divided by household monthly income | .053 | .050 |
| travelexpense | Household monthly transportation cost divided by household monthly income | .11 | .084 |
| *(3) Household current use of transportation system* | | | |
| transportimport | Think transportation is one of the three most important problems in Pune (yes=1, no=0) | .47 | .49 |
| modewheeler | Current most frequent transportation mode in household (two-wheeler=1, other=0) | .55 | .49 |
| BRTuse | Household member used BRT in last month (yes=1, no=0) | .77 | .42 |
| *(4) Perception about proposed project* | | | |
| roadworse | Current road condition around home compared to the picture shown to respondent (worse=1, better or same=0) | .33 | .47 |
| projectuseful | Think project is generally useful to household (yes=1, no or not sure=0) | .77 | .41 |
| PMCgoodjob | Think Pune Municipal Corporation (PMC) can do a good job in project operation (definitely yes or to some extent yes=1, definitely no or to some extent no or neutral=0) | .29 | .45 |
| *(5) Project impact and use* | | | |
| environmentimpact | Think project will have positive impact on environment (yes, significant impact=1, no impact or maybe some impact=0) | .17 | .38 |
| incomeimpact | Think household income will increase as a result of road renovation in two years (yes=1, no or not sure=0) | .10 | .31 |
| streetsafe | Think roads will be safer after renovation (yes, a lot safer=1, no or only a little bit safer or not sure =0) | .15 | .35 |
| healthimprove | Think people's health will be improved as people use renovated roads (yes, significantly=1, no or very marginal improvement or not sure=0) | .31 | .46 |
| futurewalkcycle | Household member will walk or cycle on renovated | .54 | .49 |

| | | | |
|---|---|---|---|
| | road in future (yes=1, no=0) | | |
| futurevehicle | Household member will drive on renovated roads in future (yes=1, no=0) | .87 | .32 |
| futurebus | Household member will take bus on renovated roads in future (yes=1, no=0) | .71 | .45 |
| morepeople | Think more people will walk on roads after renovation (definitely yes or probably yes=1, no or not sure=0) | .73 | .43 |
| *(6) Personal uncertainty* | | | |
| notsureuse | Respondent was not sure which activity house member would use the renovated roads the most (not sure=1, sure=0) | .28 | .45 |
| notsureincome | Respondent was not sure whether household income will increase in future (not sure=1, sure=0) | .18 | .38 |

**TALBE 4: Categories of Response Pattern to the PC Valuation Questions**

| Category | Category of response pattern | Percentage |
|---|---|---|
| 1 | Protest bids: respondents who gave a negative answer to the price of zero and chose one of the following as the reason: "I should not pay; it is government's or other persons' responsibility", "I disagree with the project design", "I would need more information or time to think about the issue", "I think only 'user fees' should be charged to finance the project", and "I don't trust the government" | 41 (2.71%) |
| 2 | Negative bids: respondents who gave a negative answer to the price of zero and responded "yes" to the reason "the project has negative impact on my household" | 59 (3.90%) |
| 3 | Zero bids: respondents who gave a negative answer to the price of zero and chose one of the following as the reason: "the project is not useful or important to me", "I do not have money", , "I am not interested in this project", and "I am satisfied with the current situation" | 124 (8.20%) |
| 4 | Zero or very small WTP (between 0 and 10 (monthly)): respondents who said "yes" to the price of zero but "no" to 10 rupees, the lowest price listed in the payment card | 841 (55.62%) |
| 5 | Significant positive bids: respondents who said "yes" to the price of 10 rupees, the lowest bid in the payment card. | 445 (29.43%) |
| 6 | Missing WTP information | 2 (0.13%) |
| Total | | 1512 |

**TABLE 5: Analyses on the Protest Bids**

| Variable | 1=negative/zero bid; 0=protest bids, |
|---|---|
| *(1) Individual and household demographic characteristics* | |
| Male | -.35(-0.55) |
| Age | -.00086(-0.06) |
| Hindu | -.48(-0.51) |
| Married | .32(0.59) |
| Highedu | .33(0.86) |
| Notinlf | -.66(-0.98) |
| Hhsize | -.058(-0.73) |
| Distancetime | -.037(-1.50) |
| *(2) Household economic status* | |
| Hhincome | -.099(-3.04)*** |
| Electricbill | -.90(-0.31) |
| Travelexpense | -.47(-0.18) |
| *(3) Household current use of transportation system* | |
| Transportimport | .14(0.41) |
| Modewheeler | .35(0.95) |
| BRTuse | -.016(-0.04) |
| *(4) Perception about proposed project* | |
| Roadworse | -.82(-1.99)** |
| Projectuseful | -1.74(-3.13)*** |
| PMCgoodjob | -.38(-0.78) |
| *(5) Future project impact* | |
| environmentimpact | .85(1.49) |
| Incomeimpact | -.71(-1.64)* |
| Streetsafe | -.068(-0.12) |
| Healthimprove | -.61(-1.47) |
| Futurewalkcycle | -.60(-1.59) |
| Futurevehicle | .14(0.26) |
| Futurebus | -.44(-1.13) |
| Morepeople | -.41(-0.98) |
| | |
| Ward dummies | Yes |
| | |
| OBS | 222 |
| Log Likelihood | -49.495 |

* p<.1; ** p<.05; *** p<.01

## TABLE 6: WTP Estimation results

| Variables | Heteroskedasticity Models | | | | | | | | Homoskedasticity Models | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Model1 | | Model2 | | Model3 | | Model4 | | Model5 | Model6 |
| | **mu** | **lgsigma** | **Mu** | **lgsigma** | **mu** | **lgsigma** | **mu** | **lgsigma** | **mu** | **mu** |
| Constant | 4.48 | 1.26 | -6.62 | 1.33 | 11.82 | 1.83 | 36.73 | 2.09 | -3.18 | 11.57 |
| | (0.95) | (5.64)*** | (-0.55) | (3.17)*** | (0.78) | (5.71)*** | (3.85)*** | (7.60)*** | (-0.32) | (0.49) |
| *(1) Individual and household demographic characteristics* | | | | | | | | | | |
| Male | -.39 | .012 | 6.84 | .098 | 6.72 | .31 | .25 | -.16 | 1.87 | 9.50 |
| | (-0.31) | (0.19) | (2.01)** | (0.84) | (1.49) | (3.03)*** | (0.08) | (-1.66)* | (0.59) | (1.32) |
| Age | -.017 | .00053 | .18 | .0048 | .21 | .0064 | .049 | .00062 | -.0072 | .18 |
| | (-0.40) | (0.22) | (1.35) | (1.13) | (1.19) | (1.59) | (0.47) | (0.17) | (-0.07) | (0.69) |
| Hindu | -4.96 | -.20 | -1.66 | .34 | -6.13 | .53 | -8.11 | .27 | -3.71 | -8.14 |
| | (-2.01)** | (-2.23)** | (-0.37) | (2.01)** | (-1.18) | (3.14)*** | (-2.25)** | (1.84)* | (-0.85) | (-0.83) |
| Married | -2.83 | -.17 | .96 | .029 | 6.61 | .23 | .87 | .030 | .82 | 8.42 |
| | (-1.69)* | (-2.00)** | (0.22) | (0.20) | (1.37) | (1.68)* | (0.27) | (0.24) | (0.20) | (0.93) |
| Highedu | 1.61 | .45 | 19.14 | .51 | 29.60 | .62 | 7.15 | .15 | 11.33 | 31.66 |
| | (1.13) | (8.12)*** | (4.38)*** | (5.07)*** | (5.07)*** | (6.58)*** | (2.49)** | (1.72)* | (4.16)*** | (5.13)*** |
| Notinlf | -2.49 | -.19 | 30.15 | .20 | 29.25 | -.23 | 13.25 | -.14 | -4.93 | 5.35 |
| | (-1.53) | (-1.65)* | (2.70)*** | (0.75) | (2.73)*** | (-0.85) | (2.11)** | (-0.56) | (-0.95) | (0.31) |
| Hhsize | 1.46 | .10 | .34 | .059 | .50 | .02 | -.61 | .028 | 1.66 | 1.50 |
| | (4.29)*** | (8.00)*** | (0.41) | (2.69)*** | (0.47) | (1.36) | (-1.01) | (1.62) | (2.68)*** | (1.16) |
| distancetime | .10 | .000060 | -.37 | -.0062 | -.23 | .0084 | -.19 | .000056 | .13 | -.27 |
| | (2.24)** | (0.02) | (-2.69)*** | (-1.34) | (-1.28) | (2.29)** | (-1.95)* | (0.02) | (1.12) | (-1.05) |
| *(2) Household economic status* | | | | | | | | | | |
| Hhincome | .80 | .063 | 2.02 | .032 | .81 | .011 | .39 | -.0054 | .65 | 1.08 |
| | (4.01)*** | (10.64)*** | (3.66)*** | (3.88)*** | (1.46) | (1.53) | (2.40)** | (-0.87) | (3.11)*** | (2.60)*** |
| Electricbill | 37.96 | 8.28 | 280.49 | 7.29 | 84.54 | | 18.44 | | 92.11 | 219.80 |
| | (1.72)* | (14.06)*** | (4.78)*** | (6.72)*** | (2.11)** | | (0.88) | | (3.46)*** | (4.09)*** |
| travelexpense | 20.73 | 1.12 | 12.59 | .37 | -.38 | | 9.36 | | 15.69 | 22.13 |
| | (2.38)** | (2.88)*** | (0.53) | (0.55) | (-0.02) | | (0.65) | | (1.02) | (0.62) |
| *(3) Household current use of transportation system* | | | | | | | | | | |
| transportimport | -4.16 | -.27 | -9.89 | -.29 | -9.74 | | -4.54 | | -5.31 | -3.68 |
| | (-3.91)*** | (-4.55)*** | (-3.04)*** | (-2.76)*** | (-2.30)** | | (-1.92)* | | (-2.09)** | (-0.62) |
| modewheeler | 2.77 | .21 | 3.96 | -.019 | 8.42 | | 7.57 | | 2.51 | 3.75 |
| | (2.31)** | (3.93)*** | (1.16) | (-0.19) | (1.94)** | | (2.84)*** | | (0.94) | (0.60) |
| BRTuse | -1.59 | -.069 | 5.74 | .25 | 7.24 | | 2.18 | | -3.35 | 5.41 |
| | (-0.90) | (-1.01) | (1.55) | (2.15)** | (1.46) | | (0.71) | | (-0.95) | (0.75) |
| *(4) Perceptions about proposed project* | | | | | | | | | | |
| Roadworse | 1.11 | .021 | -1.48 | -.037 | -6.47 | | -1.13 | | -.57 | -10.89 |
| | (1.03) | (0.40) | (-0.47) | (-0.35) | (-1.56) | | (-0.48) | | (-0.22) | (-1.79)* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| projectuseful | -2.39 | -.32 | 2.33 | -.29 | 5.49 | 5.77 | -.94 | -3.77 |
| | (-1.26) | (-4.16)*** | (0.53) | (-2.11)** | (1.01) | (1.72)* | (-0.26) | (-0.47) |
| PMCgoodjob | 6.88 | .21 | 6.56 | -.16 | 9.37 | 6.42 | 8.67 | 3.13 |
| | (4.67)*** | (3.81)*** | (2.14)** | (-1.79)* | (2.39)** | (2.61)** | (3.21)*** | (0.55) |
| *(5) Future impact and use* | | | | | | | | |
| environment impact | 2.99 | .39 | -1.97 | .31 | .14 | -4.09 | 4.21 | -4.75 |
| | (1.64)* | (5.33)*** | (-0.43) | (2.70)*** | (0.03) | (-1.51) | (1.29) | (-0.69) |
| incomeimpact | 7.69 | .56 | -3.60 | -.040 | .0033 | -3.49 | 7.02 | -5.93 |
| | (3.09)*** | (6.43)*** | (-0.73) | (-0.26) | (0.00) | (-1.00) | (1.79)* | (-0.73) |
| Streetsafe | 6.06 | .38 | 13.36 | .38 | 9.06 | -.60 | 4.93 | 10.57 |
| | (2.57)*** | (5.63)*** | (2.80)*** | (3.02)*** | (1.68)* | (-0.19) | (1.37) | (1.39) |
| healthimprove | 7.16 | .35 | 9.87 | .013 | 10.94 | 7.15 | 8.88 | 9.80 |
| | (4.92)*** | (6.69)*** | (3.11)*** | (0.13) | (2.56)** | (2.76)*** | (3.21)*** | (1.62)* |
| futurewalkcycle | .057 | -.12 | 3.65 | -.32 | 5.28 | 9.40 | -.19 | 6.56 |
| | (0.05) | (-1.99)** | (1.01) | (-2.81)*** | (1.16) | (3.30)*** | (-0.07) | (0.97) |
| futurevehicle | .21 | .38 | 15.71 | .62 | 12.69 | .50 | 1.83 | 16.50 |
| | (0.16) | (4.67)*** | (4.38)*** | (4.20)*** | (2.39)** | (0.17) | (0.47) | (2.08)** |
| Futurebus | -1.04 | .0068 | -2.40 | -.020 | -6.92 | -5.45 | -2.48 | -5.72 |
| | (-0.71) | (0.10) | (-0.61) | (-0.18) | (-1.36) | (-1.87)* | (-0.78) | (-0.82) |
| morepeople | .55 | .027 | -6.49 | .085 | -6.52 | -4.93 | .46 | -5.88 |
| | (0.43) | (0.45) | (-1.83)* | (0.76) | (-1.29) | (-1.60) | (0.16) | (-0.82) |
| *(6) Personal uncertainty* | | | | | | | | |
| Notsureuse | | .39 | | .056 | -.031 | .18 | | |
| | | (5.33)*** | | (0.41) | (-0.26) | (1.89)* | | |
| notsureincome | | -.12 | | .25 | .14 | .13 | | |
| | | (-1.80)* | | (1.93)** | (1.27) | (1.40) | | |
| WTPinterval | | | | | | .030 | | |
| | | | | | | (15.64)*** | | |
| OBS | WTP 0+ respondents (#=1272) | | WTP 10+ respondents (#=437) | | WTP 10+ respondents (#=437) | WTP 10+ respondents (#=437) | WTP 0+ respondents (#=1272) | WTP 10+ respondents (#=437) |
| Log Likelihood | -2822.801 | | -930.582 | | -1020.59 | -812.496 | -3373.680 | -1107.163 |
| Mean Mu (Standard Deviation) | 20.91 (0.97) | | 58.43 (2.96) | | 59.64 (3.72) | 55.10 (2.38) | 23.64 (1.15) | 60.41 (2.60) |
| Mu %95 CI | 19.09-22.75 | | 52.61-63.69 | | 52.34-66.37 | 50.43-61.60 | 21.38-25.78 | 55.31-65.43 |
| Mean Sigma (Standard Deviation) | 26.46 (1.82) | | 45.03 (5.17) | | 44.70 (10.19) | 45.03 (4.97) | 41.18 | 54.87 |
| Sigma %95 CI | 23.07-30.03 | | 34.88-59.73 | | 24.72-73.51 | 35.27-63.98 | | |

* p<.1; ** p<.05; *** p<.01. Note: Mu and Sigma estimate both included ward dummies (results not shown here).

## Appendix 1

## Excerpts from the Questionnaire

**PUNE SUTP NMT Project**

The Pune Municipal Corporation (PMC) is committed to tackle the transportation problems faced by the citizens. PMC recognizes the problem with the current BRTS and is trying their best to fix the issues. In the mean time, PMC is considering a non-motorized transportation project (NMT) and asking for financial assistance from the World Bank. The primary work of this project is to improve the quality of some of the feeder roads to the BRT system, so that pedestrians and cyclists can have better access to the BRTS.

The key objectives include:

1) Facilitating the integration between BRTS and non-motorized transport;
2) Improving safety and comfortable environment for non-motorized transport;
3) Using the "raised crosswalk" concept and underpasses for both pedestrians and cyclists to connect important BRT stations and non-motorized transport clientele;
4) Formulating an integrated solution in the form of a network for non-motorized transport

**Project Finance**

In order to complete this project, it is necessary to invest large sums for which the Government will require new sources of financing. Given that the PMC cannot cover all the cost for improving the transport situation, it is only reasonable that some additional fees be collected from households like yours. Every effort will be made to ensure the fees collected will be solely used for this project. The purpose of this survey is to determine how strongly citizens like you will support this transportation project which may introduce some cost to the household. In other words, we want to know how much is the maximum increase in household expenditure you are willing to have in order to ensure that you have the proposed improvement in transport service . If the total fee collected from the households like yours is enough for the project, the project will be implemented and will be implemented properly. If the fee collected is not enough, this project will have to be cancelled.

**Willingness to Pay Question (Payment Card)**

As said, once this project passes a referendum, a special urban construction fee, which will be solely used for the project, will be charged to your household through the electricity bill or other

utility bills from your household.  Think of the project we just described and think of your income and other necessary expenditures of your household in the future on food, clothes, transport, and entertainment, etc..

Now suppose you have an opportunity to vote for such a project which would involve a certain cost to your home. Remember, if the majority of people voted for the project, the project would go into effect and every household would have to pay. If the majority of people voted against the project, no one would have to pay and the project would be called off or postponed.

We will list all potential costs to your households from 0 to a very large number that nobody would like to pay. For each cost, we would like to see how likely you would vote for the project. The cost is the total payment that your household would have to make for this project, but can be made monthly in the next two years, or 24 times. As said before, this would be collected as an additional urban construction fee through the electricity bill or other utility bills that you would have to pay.

Can you please tell me what the electricity bill of your household was last month?

[Show and explain the payment card]

Please take a look of the card. For each cost, we will need an answer from you. There is no right or wrong answer; we only want an honest answer from you.

[Enumerator: Please start from the monthly cost number which is close to around 30 % of the electricity bill.]

Are you going to vote for this project? Please circle an answer for each of the possible costs.

**Appendix 2**

**Questionnaire Visual Aids**

[Show the map and the pictures of BRTS, and explain]

Pune Municipal Corporation has been trying to improve the public transport system. Two pilot BRTS corridors are under execution at present. One corridor is on the Pune Satara Road running for a length of 5.6 kms and the other is on the Pune Sholapur Highway for a length of 8.2 kms. Buses run in the middle lanes with segregated cycle tracks adjacent to the footpaths on both sides of the right of way.

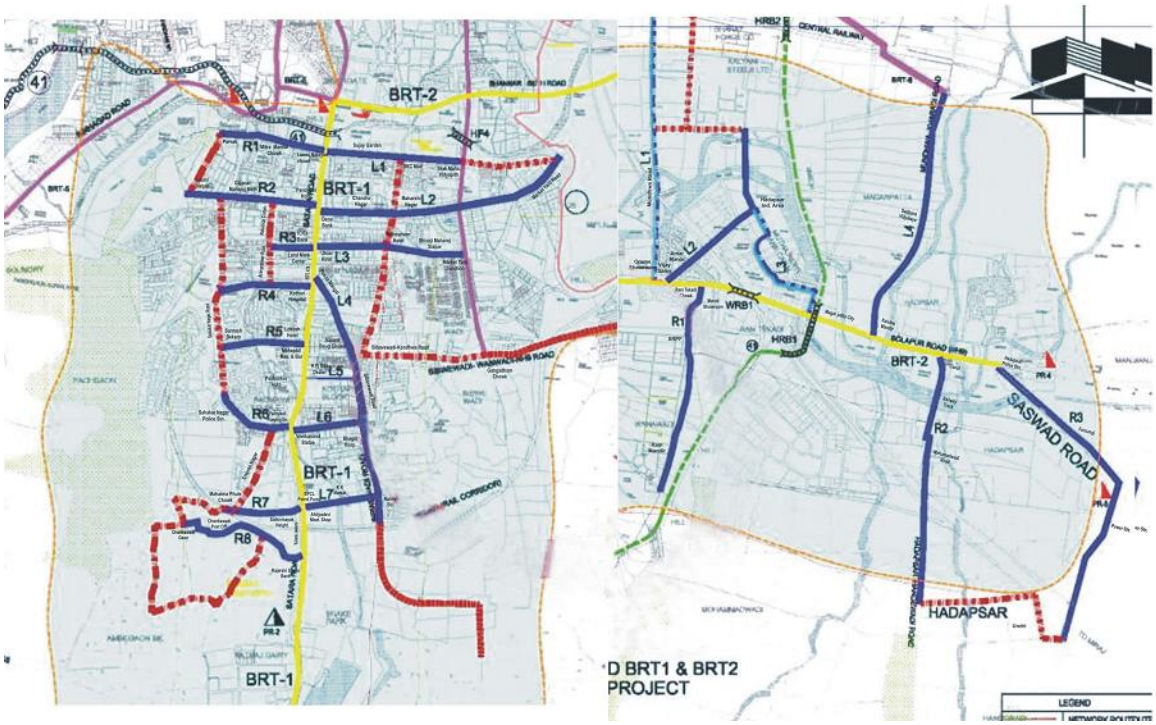

[Show and explain the set of pictures of current streets that are to be renovated.]

You can see from the pictures that the current roads in Pune are not well designed and constructed and are not friendly for pedestrians and cyclists. The current traffic situation is not well disciplined and during peak hours, all vehicles, big and small, motorized and non-motorized, are in the race with each other to get ahead. Illegal parking, signals not working insufficient cops to man the traffic, only worsens the situation. The Pedestrians and Cyclists are the worst hit. The

pictures here only show the Average roads. Situations in some places can be better and in some places be worse.


[Show the project map]

Here is a map showing the scale and location of the project**.** The project streets are marked in blue color on the map. The total length of the feeder roads which is to be renovated is 41.5 kms, with 23.8 kms in the vicinity of BRTS1 (Satara Road) and 17.7 kms on BRTS2 (Sholapur Road). The average width of the feeder roads is 20 meters. The construction includes footpaths, cycle tracks, cycle stands, underpasses, and trees, etc. The width of the footpaths and cycle tracks are 2 meters each. The construction should be completed in about one year after the project is approved, and the quality will last for at least 10 years.




[Show and explain the set of pictures of improved situation after project implementation.]

This project aims to provide better access to urban activity centers for pedestrians and cyclists and make the Roads a safer place for them to travel. Separate lane for cyclists and pedestrians, wide roads, leveled pavements free of debris and other material will make walking & cycling attractive alternatives to using motorized vehicles. Visual signs in the form of road markings, signage, would be put up and distinctive paving material used .The facilities which are created specially for pedestrians & cyclists would also make motor vehicle users conscious of the rights and privileges of the pedestrians & cyclists on the road. A more equitable distribution of road space would be sought to be achieved for motorized and Non-Motorized traffic. The whole project will be enthusiastically promoted to encourage citizens to use the facilities created for them.


The improved situation after project implementation
Raised Bike Lane
travel lane
bike lane
sidewalk

## Appendix 3

## Follow-up Questions on Potential Protest Bids

Some people have told us they would support the project because improving the current transport situation is high priority for them. Others say they would not support the plan because the project will not directly benefit them as they do not stay close to the project area. Some people have told us that they would not support the project because they are not convinced that the money would be used for improvements in transportation system and yet others have told us they cannot afford to pay. [ASK ONLY IF the answer is not "yes" or "definitely yes" or "probably yes" when the payment is Rs 240, the lowest cost., i.e the maximum amount of willing to pay is zero]
SHOWCARD: You seem unwilling to pay anything for this project. In the following card, I have listed a number of possible reasons that people like you may have for not willing to pay anything. Please tell me which of these reasons apply to you

| | |
|---|---|
| The project is not useful or important to me. | 01 |
| I don't have money. | 02 |
| The project has negative impact on my household. | 03 |
| I am not interested in this project. | 04 |
| I am satisfied with the current situation. | 05 |
| I should not pay; it's government's or other persons' responsibility. | 06 |
| I disagree with the project design. | 07 |
| I would need more information or time to think about the issue. | 08 |
| I think only 'User fees' should be charged to finance the project. | 09 |
| I don't trust the government. | 10 |
| Any other. (Please specify)._____ | 11 |