Willingness to Pay for Potable Water in the Southeastern Turkey: An Application of both Stated and Revealed Preferences Valuation Method

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Abstract

We estimate both averting behavior and stated preferences about water quality improvements in the southeastern Anatolian region using reduced form equations. The model reveals that income, education, perception about water features, household living conditions, regional variables are only statistically significant in both the RP and SP data models. The WTP estimate was around 6.43 New Turkish Liras. And also simulation analysis show that increasing income and education foster the willingness-to-pay for treating water, while an increase in bid prices and perception reduce the WTP.

1. Introduction

Quality for potable water is a serious health problem in the developing countries in which half of their populations are exposed to many chronic diseases associated with water supply and sanitation (Gadgil, 1998; Rosado et al., 2006). Gadgil reported that about 400 children under age 5 die per hour in the developing nations from waterborne diseases such as diarrhea. The possible sources of drinking water contaminations are chemicals from agriculture, outflow from improperly functioning sewage system and cesspools with improper storage and disposal of household products from residential area, spillage, leakage and improper handling of materials used in manufacturing and naturally occurring substances (Gadgil, 1998).

The contamination of public water supplies is a serious problem in Turkey throughout its history. In year 2005 about 8,000 people in Malatya province in Turkey were treated in hospital during a week because water from disposable pipe was flowed into potable water pipe. The lack of foundation of sanitation infrastructures and environmental protection institution in the country makes it difficult to properly evaluate the quality of ground/surface water in time when it needs. Of course, for the optimal management of water resources, both water quality and quantity should be properly handled together. New quality remedies adapted and implemented for ground and surface water protection in the country lack to provide good quality drinking water to the public on the one hand. The economic value on which people place the ground/surface water protection is unfortunately not known and not measured on the other hand.

In this paper we estimate peoples' willingness to pay (WTP) for improvements in drinking water quality and ground/surface water contamination in Southern Anatolian Region abbreviated as GAP. By determining optimum economic value of drinking water protection will give opportunities to public officials and policy makers to choose best economically sensible specific drinking ground/surface water protection plans. In addition, the study aims to determine what social characteristics affecting the willingness to pay for protecting drinking water. As such, we combine households' defensive expenditure choice model (i.e., averting behavior approach or stated preference, SP) with revealed preference (RP) choice to better understand household WTP for drinking safe water. Cameron (1992) and Adamowicz et al. (1994) have shown that pooling SP and RP data improve efficiency in estimation, reduce multicollinearity and extent the range of data. Contingent valuation (CV) for potable water was based on household data that were collected from six dominates cities in the region: Gaziantep, Diyarbakir, Sanliurfa, Adiyaman, Mardin and Batman.

The theoretical reduced form model initiates household WTP for improving drinking safe water using SP and RP data under Random Utility Model (RUM) framework In dual context, averting behavior data (RP) states whether household uses spring water instead of water from municipality direct network pipe line connected to household. The spring water bears additional cost to the household. On the other hand, SP data reveals whether household would to pay an extra Turkish Liras (e.g., a bid price presented to each household) to their water billing statement to be able to drink network tap water without purchase the spring water.

We estimated the RUM model using a reduced form model. The deterministic part of the random utility model includes both household characteristics in general and respondent characteristics in particular.

2. The Model

Following Rosado et al. (2006) notation, the household WTP for treating water using averting behavior data (RP) and contingent valuation data (SP) is estimated from a random utility model (RUM) framework . The utility derived by household *i* from alternative *j* is given

$$U_{ji}^{k}\left(Inc_{i} - Cost_{ji}^{k}, X_{i}\right) \qquad (1)$$

where j = 1 is treating water, j = 0 otherwise, $k = r$ is for RP and $k = s$ for SP data. The costs of alternatives and household characteristics affect the utility function. X is a set of variables reflecting household head and household characteristics. The $Cost^k$ variable indicates the cost of treating drinking water. For example, in the case of RP data, the

$Cost^k$ represents the revealed costs associated with demijohn spring water. On the other hand, in the case of SP data, $Cost^k$ is a fee equal to the valuation bid C from the contingent valuation presented to households and Inc_i represents household monthly income.

We assume that each household *i* chooses between treating drinking water and therefore purchase spring water with a spending a New Turkish Liras amount, $Pricedam_i$, or not treating the drinking water when the averting behavior concepts are present. This household decision is modeled using the RP data with Tobit model framework. In contrast to RP behavior, household *i* chooses between owing treated water and paying a fee equal to $Bidprice_i$ or not having treated potable water (Abrahams et al, 2000; Rosado et al., 2006).

The RUM assumes that the utility household *i* holds has two components: a deterministic part embodying the costs of treating drinking water or not and all household-related characteristics and a stochastic term not known to the researcher. As such, the indirect utility function for the household *i* and alternative *j* is

$$\begin{aligned} &U_{ji}^k = V_{ji}^k + \varepsilon_{ji}^k \\ &where\ \ V_{ji}^k = V^k\left(Inc_i - Cost_{ji}^k, X_i\right) \end{aligned} \qquad (2)$$

By assuming a linear indirect utility function, we can define dual situations (e.g., treating the drinking water or not treating), respectively, as

$$\begin{aligned} &U_{1i}^k = \delta^k\left(Inc_i - Cost_i^k\right) + \boldsymbol{\gamma}_1^k \mathbf{X}_i + \varepsilon_{1i}^k \\ &and \\ &U_{0i}^k = \delta^k\left(Inc_i - Cost_i^k\right) + \boldsymbol{\gamma}_0^k \mathbf{X}_i + \varepsilon_{0i}^k \end{aligned} \qquad (3)$$

Let y_i^s equal to 1 if household *i* accept bid prices presented, and 0 otherwise. Assuming that the error term are iid normally distributed, the probability that $y_i^s = 1$ is given

$$\begin{aligned} P\left(y_i^s = 1\right) &= P\left\{U_{1i}^s > U_{0i}^s\right\} \\ &= P\left\{-\delta^s Cost_i^s + \left(\boldsymbol{\gamma}_1^s - \boldsymbol{\gamma}_0^s\right)\mathbf{X}_i + \left(\varepsilon_{1i}^s - \varepsilon_{0i}^s\right) > 0\right\} \\ &= P\left\{-\frac{\varepsilon_i^s}{\sigma^s} < -\frac{\delta^s}{\sigma^s} Cost_i^s + \frac{s}{\sigma^s}\mathbf{X}_i\right\} \\ &= P\left\{-\frac{\varepsilon_i^s}{\sigma^s} < m_i^s\right\} = \Phi\left\{m_i^s\right\} \end{aligned} \qquad (4)$$

where $\boldsymbol{\gamma}^s = \left(\boldsymbol{\gamma}_1^s - \boldsymbol{\gamma}_0^s\right)$, $m_i^s = -\frac{\delta^s}{\sigma^s} Cost_i^s + \frac{s}{\sigma^s}\mathbf{X}_i$, $\varepsilon_i^s = \left(\varepsilon_{1i}^s - \varepsilon_{0i}^s\right)$ distributed iid $N\left(0, \left(\sigma^s\right)^2\right)$. Φ stands for the standard cumulative normal distribution, cdf. We, therefore, have a standard probit model for the SP data set, while Tobit model for the RP data sets because the dependent variable for the RP is the quantity consumed of spring water measured as the number of demijohn bottles. Rosado et al. (2006) incorrectly estimated the RP and SP data sets using a bivariate probit model because the SP is also as a function of the RP, averting behavior. Therefore, their estimates are inconsistent and biased. We instead follow a two stage reduced forms as

$$y_r^* = x'\beta_r + \varepsilon_r \qquad y_r = Max\left(0,\ y_s^*\right)$$

$$y_s^* = \alpha_s y_r^* + x'\beta_s + \varepsilon_s \qquad y_s = \begin{cases} 1 & if\ \ y_s^* > 0 \\ 0 & if\ \ y_s^* \le 0 \end{cases}$$

Where y_r , and y_s are the RP, and SP dependent variables, respectively. β_r and β_s are parameter sets to be estimated for the RP and SP models. We do not observed the value of y_r^*, but instead observing the y_r as stated above.

We first run the RP model and obtained the expected value of y_r^* using Tobit model and then use it as an additional regressor in the primary equation, probit model. We also obtain residuals from Tobit model and use an additional regressor in the probit model to see whether the heterogeneity in the probit model is statistically significant (Vella, 1993). The variance-covariances of parameter estimates of the probit model were then corrected due to the two-step procedure.

3. Data

The current study used the data collected from a survey in 2007 in six biggest cities in the Southeastern Anatolian Region (SAR). A sample of 2,000 household in the region was identified. The data collection was carried out in two phases: The first phase included chemical levels such as nitrite and nitrate from sample water taken from households. When the water sample was taken, the second phase included follow up distributing a survey related to water quality. A one week later, enumerators then went to the house by informing the level of chemicals in their water and whether these chemical are below or exceed the required levels. Enumerators also collected the survey at second visit. If the household has not yet completed survey, the specified time was then determined and then the surveys were collected in the follow-up visits. Household headed member was requested to provide information related to water quality and all household socio-demographic characteristics. Overall 1,140 surveys were collected. In the current study, the water quality sample includes 702 household observations after the deletion of records with the missing observations, outliers, or other information relevant to the study.

Table 1 shows descriptive statistics of the sample variables included in the specified reduced form equations. The dependent variable in the Tobit model indicates the number of demijohn spring water in which each demijohn weighs 19 liter, while the dependent variable in the primary binary choice model is the probability of accepting a bid price presented. Price for demijohn spring water, monthly household municipality bill including sewage and water costs, income, a perception index calculated from likert scales varying from 1 to 4 about odor, taste, appearances of network water supplied from the municipality, household size, the number of members of households employed, household head age and education level, tenant households, whether a household head ic currently employed, whether a household resides in an apartment, whether household is directly connected to the municipality network water system, a household using a filter for water, households residing in greater municipalities (e.g., either in Gaziantep or Diyarbakir provinces) are among explanatory variables used in the Tobit model. In addition to this primary information, the bid prices are also included in the intensity model. We used the predicted number of demijohn spring water in the binary choice model because of the possible endogeneity problem associated with the probability of WTP (Wooldridge, 2003).

If household does not consume spring water, unit prices are missing on that particular good. To obtain missing prices, we regress the natural logarithm of implicit prices of the spring water consumed on household head and household characteristics, and regional dummies. Results are used to obtain the missing prices for those households which do not consume the spring water. Several studies provide the description of properties of this computation (Gourieroux and Monfort, 1981; Heien and Wessells, 1990) used extensively in the microeconometric studies (Diansheng et al., 2004; Diansheng and Kaiser, 2005; Yen and Lin, 2006; and among others).

4. Results and Discussions

Results are given in Table 2. The averting behavior model (RP model) was presented in the first column of the Table 2. Focused on statistically significant variables, interestingly a spring water price does not affect the quantity demanded of the spring water. The quantity demanded of spring water increases significantly as household payment on municipality bill and income increase, indicating that wealthier families consume more spring water than poorer households. Interestingly, less educated household head demands more spring water than the higher educated household head. Households residing in an apartment demand less quantity of the spring water in comparison to households residing in elsewhere. This could be related to the fact that a tenant household resides likely in an apartment with one third of their income usually spent on rent. Households that keep water filters in their shelters less likely consume spring water as expected. Households residing in greater municipalities either in Gaziantep or Diyarbakir cities demand significantly more spring water than households residing in other cities. The significant variance coefficient for the water intensity shows that after accounting for covariate differences, some households would likely demand more while others less on spring water.

Results for primary equation (e.g., probit model) were presented in the second column of the Table 2. The regressor obtained from RP model (e.g., residuals from Tobit model) is statistically significant, indicating that ignoring the heterogeneity of simultaneity in the probit model would result in biased estimates and therefore wrong policy implication.

Marginal effects of the binary probit model were also presented in the Table 3 and we focus on the discussion on the marginal effects because initial estimates in the binary choice model do not reflect unitary impact on the probability of the willingness to pay (Greene, 2003). As expected, an increase in the presented bid prices reduces significantly the WTP for households. A one New Turkish Liras increase reduces the probability of WTP by 0.05 per cent. Households would likely pay significantly more for an improvement in network water quality as income increases.

Perception indices variable is negatively related to the probability of the WTP, indicating that improving qualities such as odor, taste, appearances and etc. in network water are likely and significantly to reduce the willingness-to-pay for an additional quality improvement in network water distributed by city municipality. This echoes with the findings of Abdalla et al. (1992) that quality risk perception and knowledge of contamination are important determinants of households' decisions to pay more for improvements in water. Higher human endowment had a positive impact on the WTP, indicating that an additional education contributes more on the WTP. In this case, school programs should more embody health related emphasis in general, water borne diseases in particular. Tenant households are less likely to pay on good quality water than households owing a house. This is an expected result because income constraints make this group of people less favorable for an improvement in water quality than households with relatively higher income. People residing in an apartment are more favorable to pay for improvement than households living in elsewhere.

A simulation scenario in statistically significant variables in the probit model was analyzed. We increase income, bid prices, education and perception in relevant ranges and observed the changes in the number of household. The results of the simulation are depicted in graphics 1 and 2. An increase in bid prices reduces the willingness-to-pay, while increasing income increases the WTP. An increase in education and perception levels increases and reduces the number of households for the treating water, respectively.

The WTP estimates can be obtained as

$$WTP = -\frac{\hat{\vartheta}}{\hat{\beta}_{Bidprice}}$$
$$where \quad (6)$$
$$WTP = An\ average\ willingness - to - pay\ \ and$$
$$\hat{\vartheta} = \bar{X}'\hat{}$$

where $\hat{\vartheta}$ excludes the bid price variable and its associated parameter estimate. The average monthly WTP was estimated to be around 6.43 YTL. Households spend monthly 13.84 YTL (= 4*3.46) on spring water. The predicted WTP estimate is one-half the spring water spending, indicating that the household would benefit if the municipalities in the region set to improve water quality. The calculated monthly WTP estimate for treating drinking water is approximately around 2,923,567 YTL for these cities.

5. Conclusions and Implications

In RP intensity model, we found that water spending, income, education, residing in an apartment, and living in greater municipalities are all statistically associated with the probability of using demijohn water. The variance estimate shows the better off-households have interestingly more heterogeneous tastes.

In SP choice model, presented bid price is statistically negative, indicating that household becomes less willing to pay an extra Liras for a tap water from municipality as bid price rises. Perception indices about a tap water from municipality have a significantly negative impact on the probability to pay for drinking safe water. Income, education, and households living in an apartment have positive effects on WTP, while tenant households are less likely to pay an extra Lira for improving drinking water. The estimated WTP per month is about 6 Turkish Liras which is definitely less than the monthly averting cost of demijohn. This could be an expected result because households may believe some other party should pay for improving water quality in the region or disbelieve the effectiveness of the program. This is a common phenomenon in developing countries where local institutions are likely not perceived as credible (Rosado et al., 2006).

Under each simulation scenarios, the movement how households behave was also observed. An important implication is that the WTP estimates vary with households' qualitative perception of the knowledge of water features. Municipality functionalities which affect perception of drinking water may change the estimates of benefits and costs of their strategies. The low level of the WTP estimate indicates that households underestimated WTP for tap water directly from municipality pipes than averting expenditures. This indicates that people regard local institutions as sole responsible for improving drinking water. Public should be notified when any water contamination and quality improvement in water are taken into consideration. The analysis showed that households' perceptions about treating water vary as the agencies set to improve water qualities. Notification efforts could be directed to those households which appear to be more sensitive with water quality. In general, programs targeted to inform people about the diseases related to water contamination could be delivered at schools, child care centers and pediatricians' offices.

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Table 1: Descriptive statistics of variables

Variables	Unit	Mean	Std
Y_s	1 if the household accept the bid price, 0 otherwise	.5883	.4925
Y_r	Number of demijohn spring water taps for a weekly consumption	.7821	2.9469
Pricedam	Prices for spring water for demijohn in YTL	3.4592	.5007
Bidpric1	Bid prices presented in YTL	5.1830	2.6550
Munispnd	Household's water and other swages bill to their municipality	23.5259	13.0709
Income	Monthly income divided by 1000 in YTL	1.0320	.5192
Hindex	Health index indices created from Likert type scale	2.5370	.8700
Perceptn	Perception index indices about network water features	5.9473	1.5347
Hsize	Household size	5.1637	2.9176
Nworkers	Number of persons working in household	1.6048	.9552
Age	Age of the household head in years	37.6679	11.1432
Educn	The household head education levels in years	10.4046	4.3609
Genderm	1 if the household head is male, 0 otherwise	.5385	.4989
Mstatusm	1 if the household head is married, 0 otherwise	.7208	.4489
Tenant	1 if the household resides in rented home, 0 otherwise	.4330	.4959
Workingp	1 if the household head is currently employed, 0 otherwise	.4815	.5000
Apartmnt	1 if the household lives in an apartment, 0 otherwise	.8889	.3145
System	1 if the household has an network water pipe directly from the municipality, 0 otherwise	.9459	.2264
Wfilters	1 if the household uses water filters, 0 otherwise	.1026	.3036
Gmunicp	1 if the household resides either in Gaziantep or Diyarbakir provinces, 0 otherwise	.4715	.4995
N	Number of observations	702	

Table 2: Maximum likelihood estimates of both models

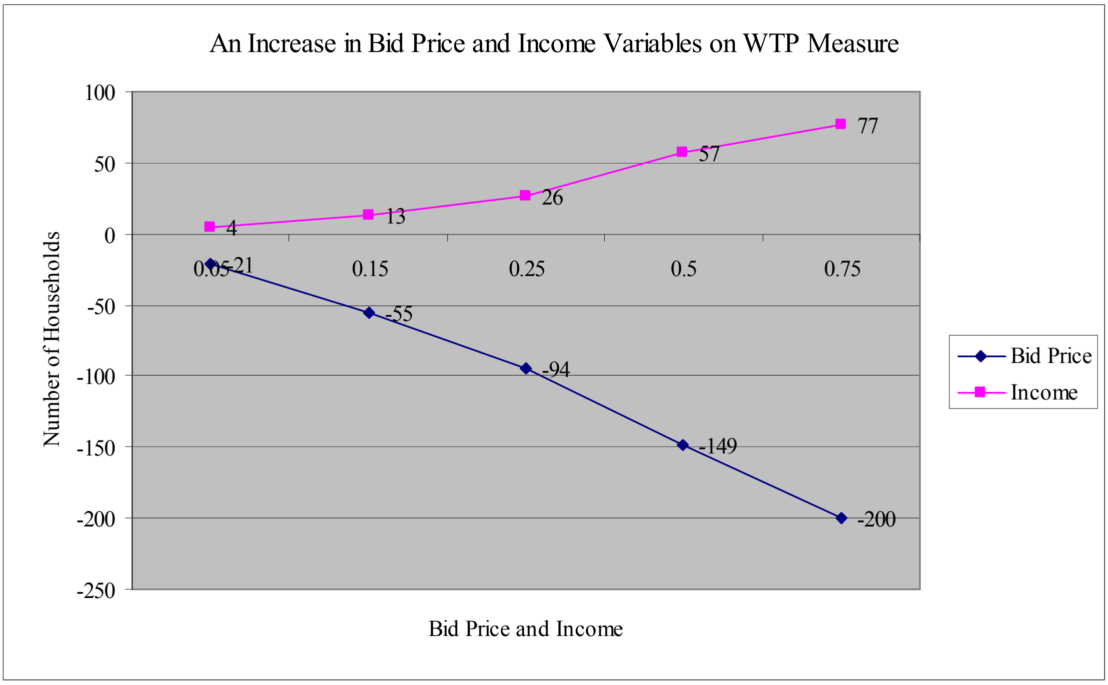
Variables	Tobit model		Probit model	
	Estimate	t-value	Estimate	t-value
Constant	-.1924	-.043	.6846	1.458
Bidprice	---------	---------	-.1387 [a]	-6.994
Pricedam	-.4037	-.520	---------	---------
Munispnd	.0956 [a]	3.209	-.0026	-.618
Income	4.0774 [a]	4.260	.3520 [a]	2.669
Hindex	-.4896	-1.031	.0470	.786
Perceptn	---------	---------	-.0893 [a]	-2.567
Hsize	-.2866	-1.394	-.0034	-.196
Nworkers	.4517	1.057	.0454	.786
Age	-.0605	-1.310	-.0021	-.381
Educn	-.2652 [a]	-2.185	.0422 [a]	2.742
Genderm	-1.2858	-1.335	-.0921	-.750
Mstatus	-1.0969	-1.057	-.0066	-.049
Tenant	-.5199	-.597	-.1813 [b]	-1.658
Workingp	.7723	.742	-.0013	-.010
Apartmnt	-4.0394 [a]	-3.237	.5059 [a]	2.874
System	-.4434	-.265	.0559	.240
Wfilters	-2.8702 [b]	-1.796	-.1224	-.723
Gmunicp	2.2727 [a]	2.731	-.1834 [b]	-1.661
Damacan	---------	---------	-.0333	-1.160
Grt	---------	---------	.0042 [b]	1.755
Sigma	7.5759 [a]	15.629		
Log-Likelihood	-724.8494		-413.3456	

Note: [a, b] represent statistically significant levels at 0.05 and 0.10 percent respectively.

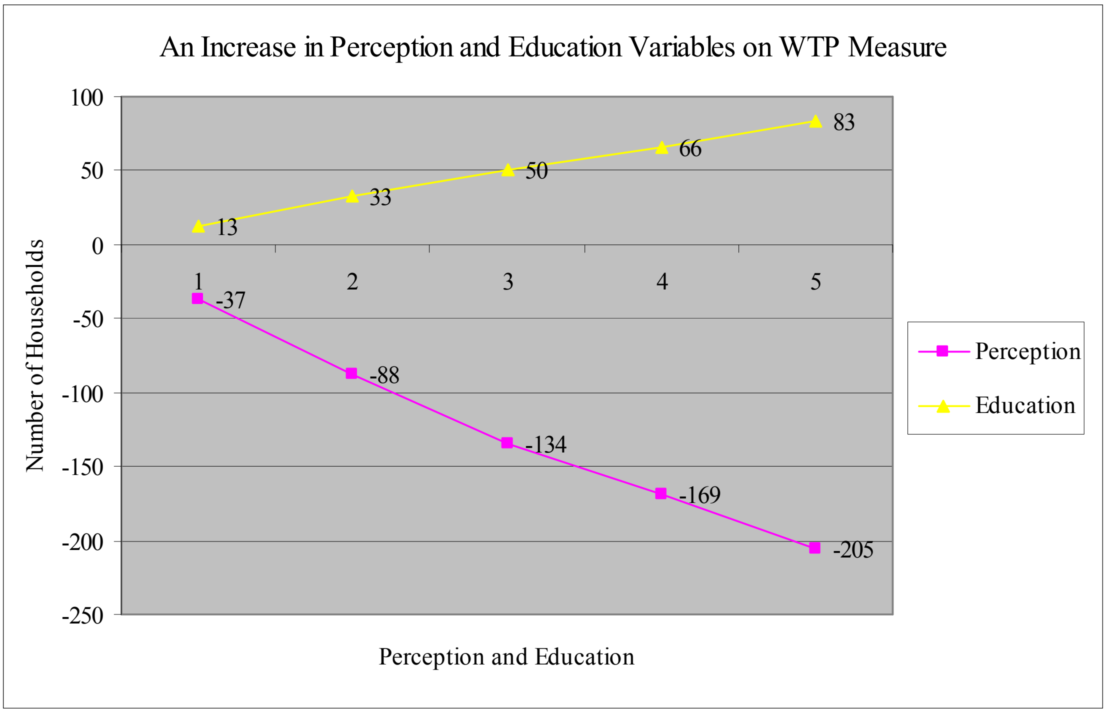
Table 3: Marginal effects of models

Veriables	Tobit model		Probit model	
	Estimate	t-value	Estimate	t-value
Constant	-.0360	-.043	.2641	1.461
Bidprice	----------	----------	-.0535[a]	-7.005
Pricedam	-.0755	-.518	----------	----------
Munispnd	.0179[a]	3.196	-.0010	-.618
Income	.7623[a]	4.297	.1358[a]	2.672
Hindex	-.0915	-1.031	.0181	.786
Perceptn	---------	----------	-.0345[a]	-2.567
Hsize	-.0536	-1.402	-.0013	-.196
Nworkers	.0845	1.059	.0175	.787
Age	-.0113	-1.309	-.0008	-.381
Educn	-.0496[a]	-2.194	.0163[a]	2.742
Genderm	-.2404	-1.336	-.0355	-.751
Mstatus	-.2051	-1.059	-.0025	-.049
Tenant	-.0972	-.597	-.0701[b]	-1.657
Workingp	.1444	.742	-.0005	-.010
Apartmnt	-.7552[a]	-3.253	.1993[a]	2.900
System	-.0829	-.265	.0217	.239
Wfilters	-.5366[b]	-1.810	-.0477	-.717
Gmunicp	.4249[a]	2.731	-.0708b	-1.664
Damacan	----------	----------	-.0128	-1.159
Grt	----------	----------	.001b[a]	1.756

Note: [a, b] represent statistically significant levels at 0.05 and 0.10 percent respectively.



An Increase in Bid Price and Income Variables on WTP Measure
100
50
0
-50
-100
-150
-200
-250
Number of Households
0.05
0.15
0.25
0.5
0.75
4
13
26
57
77
-21
-55
-94
-149
-200
Bid Price
Income
Bid Price and Income



An Increase in Perception and Education Variables on WTP Measure
Number of Households
100
50
0
-50
-100
-150
-200
-250
1
2
3
4
5
13
33
50
66
83
-37
-88
-134
-169
-205
Perception
Education
Perception and Education