Valuation of the Water Pollution in Karun River (Case Study of Ahvaz City)

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Abstract: Discharge of different agriculture, industrial, and wastewater pollutants cause Karun to be one of the critical centers in terms of environmental pollution. According to this river’s importance in providing Ahwaz’s drinking water, to estimate its citizens like to pay for reducing the city’s pollution, contingent valuation method in the form of both Logit and two –step Heckman methods was used. Data was collected through questionnaire completion and interview with 248 citizens using random sampling. Results indicate that 80 percent of the people are ready to pay some money for reducing Karun water’s pollution. In addition, variables of age and proposed price have a negative and significant effect and ones of income, education, and respondents attitude have a positive and significant effect on the individuals’ willingness to pay. Variables of household members and gender were not statistically significant but having the respected points. In addition, the average of the individuals payment fro reducing the water’s pollution were estimated to be 2340000 and 2448000 Rials. because the variable of education has become significant, with the probability of accepting the proposed price, in order to reduce the water pollution, it is suggested that the level of awareness concerning the issue of pollution should be increased, especially among the low-educated individuals; this can lead to successful results in order to motivate people to pay for reducing Karun water’s pollution. Classification:

Key words: pollution, contingent valuation, Logit model, Heckman two-step method, Karun River.

INTRODUCTION

Nowadays, development of cities and construction of industrial and agricultural units caused the rivers to be a natural channel of wastewater and sewages transportation (Razmkhah, h., 2007). Rivers, in a natural process, based on the Hydraulic and Hydrologic properties, are able to remove or filter the entering pollutants, but, in the case of the pollutants’ continuousness, the ability would face serious limitations resulting economical, social, political, and environmental damages; Karun river, however, as one of the most important hydraulic arteries of the country, is not an exception (Afkhami, m., 2000). According to the evaluations, currently, 2 billion m$^3$ of agriculture drainage water is annually enter this river directly; it is predicated that this amount increase to more than ¾ billion m$^3$ in 1400. In addition to the agriculture wastewaters, the discharged - in - Karun industrial and city sewages are annually 186 and 151 million m$^3$, respectively (Marashi, sh., 2007). Because the main part of the pollutants are discharged from the industrial and city units and these pollutants can have a negative effect on the individuals’ health imposing costs to the households, in the recent years, the willingness of the individuals’ payment in order to reduce the pollutants has been considered by the scientists of different fields of study. Different studies have been carried out concerning the individuals’ willingness to pay for reducing the pollutants; some are indicated below.

Zhen et al., (2011) estimated that households’ willingness to pay for water pollutions resulted from the overuse of fertilizers and pesticides by the local farmers of Poyang Lake, China, is averagely $802-956. Basarir et al., (2009) Calculated that farmers’ willingness to pay to prevent the low yield of agriculture products and environmental pollutions is 363 and 1437 dollars, which is 15 percent of their monthly income. Evaluation of the risk takers and risk avoiders’ willingness to pay for increasing the water quality in the United States carried out by Tanellavi et al., (2009). Risk avoiders have more willingness to reduce the risk and like to pay for it; promotional courses and family conditions are considerable factors in the individuals’ willingness to pay for increasing the water quality. In addition, the average of the individuals’ willingness to pay was $97.058 per month. Akram and Olnstead (2005) evaluated the low-income households’ willingness to pay, $7.5-9 per month, for increasing the water supply using parametric and non-parametric methods. Lipton (2004) evaluated the quality of Chesbek Gulf’s water indicating that each household is ready to pay $63 to reduce the water pollution. As well, concerns of the water quality’s health effect increased the willingness to pay in this region.

Naemifar, (2008) evaluated the farmers’ willingness to pay for reducing the drink water pollution in Gilan and Mazandaran provinces. Results showed that each Gilan and Mazandran household’s willingness to pay in 1388 changed from 372530 to 422721 and 388999 to 438275 Rials per hectares, respectively.

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Currently, pollution’s condition of Ahwaz water is higher than the world standard and unacceptable causing outbreak of diseases such as sinusitis, Diabetes and cancer of the esophagus and stomach (Shearbafiyan, A., 2008). Because Karun’s pollution caused problems such as the cost of water infiltration, purchase of water bottles, and digestive diseases for middle and southern people of Khuzestan drinking its water, a careful and organized planning by the national and province authorities in order to evaluate these issues and problems is necessary. In addition, evaluating the individuals’ rate of awareness regarding the problems resulted from the water resources pollution and their rate of willingness to pay for resolving them, whether they are interested in paying for the pollutions or losing some of their interests in order to maintain the quality of water resources can be effective in giving strategies to resolve the mentioned problems and stopping the increase of the river’s pollution. Consequently, this study was aimed at evaluating Ahwaz citizens’ view regarding the aspects of pollution and their financial participation in the form of willingness of monthly payment for reducing the water pollution.

MATERIAL AND METHODS

Most of the environment services can’t be dealt in market and are not depended or related to the market goods, so people can not show what they like to pay for their purchase from the market. In such conditions, evaluation and estimation (survey) of the mentioned willingness to pay is used, wanting people to express what they like to pay for a service directly based on hypothetical scenario (Hayati, b., 2010). One of these survey approaches is the contingent valuation used in this study to evaluate the individuals’ willingness to pay for reducing water pollution. This method was firstly (1947) introduced by Creasy Wantrap and used by Davis in 1960 (Mafi, h., 2008). This method tries to determine the individuals’ willingness to pay in hypothetical markets (Ghorbani, m, 2007). For this reason, this method is often called the Preferred method and is used in benefit-cost analysis and evaluation of environmental impacts (Hayati, b., 2010).

In this method, it is supposed that individuals have a utility function as follow (Ghorban, m., 2009):

\[ u = (Y, S) \]

(1)

Where \( U \) is the indirect desirability function, \( Y \) is the individual’s income, and \( S \) is a vector of all individual’s economical-social factors. People are ready to pay a cost as a proposed cost (A) for reducing the water pollution making a desirability for them. In other words, without-pollution-water makes the desirability for them indicating the relation below

\[ u = (1 - Y - A S) + \varepsilon_1 \geq u(0, Y S) + \varepsilon_0 \]

(2)

Where \( \varepsilon_0 \) and \( \varepsilon_1 \) are the random variables equally and independently distributed with an average of zero. The difference of desirability can be calculated as below (Mafi, h., 2008).

\[ \Delta u = u(1, Y - A S) - u(0, Y S) + (\varepsilon_1 - \varepsilon_0) \]

(3)

If the desirability difference is > 0, the individuals maximize their desirability by saying yes and approval of paying a cost for goods. So, there will be a 0 or 1 answer for each respondent. Income, proposed cost, and socio-economic variables are factors affecting these yes or no answers. Thus we have an econometric model model with a dichotomous dependent variable. Dichotomous models such as Logit and Probit are used to estimate this kind of regression functions (Yazdani, s., 2008). Although Logit and Probit models can be used as valuation criterion, they can’t separate the factors affecting the willingness to pay and ones affecting its rate so, in the next step, Heckman two-step method was used to differentiate the factors affecting the willingness to pay and ones affecting its rate.

Logit model of probability (\( P_i \)) in which the individual accepts one of the proposals is as below:

\[ P_i = F_1(\Delta u) = \frac{1}{1 + \exp(-\Delta u)} = \frac{1}{1 + \exp\left\{ - (x - BA + y Y + \theta) \right\}} \]

(4)

Where \( F(\Delta U) \) is the cumulative distributive function with a standard Logistic difference including some of the socio-economic variables such as income, proposed cost, age, gender, household size, and education.
β, γ, and θ are these variables’ estimable coefficients (Raheli, h., 2009). In addition, Logit model estimates the forecasted probability amounts between 0 and 1 using the normal distribution of probability. Logit model has a standard normal distribution as below: 

$$F(t) = \int_{-\infty}^{t} \frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}} dx$$

(5)

random variable variance in the standard normal distribution is equal to 1 and because its distribution is polar, so: \( f(-t) = 1 - f(t) \), so: 

$$P_j = Pr(Y_i = 1) = 1 - F(-B'X) = F(B'X)$$

(6)

Based on the standard normal cumulative distribution function, the Logit model is as below. In other words, based on the Logit model, the probability \( p_i \) in which an individual accepts one of the proposals (A) is indicated as follow:

$$P(Y_i = 1) = \int_{-\infty}^{0} \varphi(t) dt = \varphi(B'X)$$

(7)

Interpretation of the estimated coefficients in the Logit model is not completely reliable; however, its final effect should be calculated. In the Logit model, change in the success probability affected by one-unit change in the independent variable, which is called the final effect, is calculated as below:

$$ME = \frac{\delta P_i}{\delta X} = \frac{\delta \varphi(B'X)}{\delta X} = \varphi(B'X)B$$

(8)

As it is seen, probability’s rate of change depends on primary probability and, then, on the primary values of all independent variables and their coefficients. Tension related to each variable indicates the amount of changes occurred for the probability of \( Y=1 \) by a 1 percent change in the descriptive variable. In the Logit model, elasticity of the \( i^{th} \) descriptive variable can be attained through the relation below:

$$E^p = \frac{\delta \varphi(B'X)}{\delta X} \frac{X}{\phi(B')} = \frac{\varphi(B'X)B_X}{\phi(B')}$$

(9)

In the logit model, likelihood ratio (LR) is used to evaluate the model’s overall significance and good fitting (Hayati, b., 2010). But, because of the Logit model’s inefficacy in evaluating the factors affecting the willingness to pay’s rate, Tobit model is used. In this model, if the individuals are ready to pay, the real amount is given to the dependent variable, and if they are not, zero amounts are given. Mistake of assuming the variables which determine the individuals’ decision to participate in the desired activity similar with ones determining the rate of that activity execution is one of this model’s limitations. Knowing this model’s inefficiency in separating both groups of the effective factors, Heckman introduced the Tobit model’s two-step estimation method (Hoseinzadeh,j and s. Shorafa, 2007).

General form of the Tobit model is indicated as relation 10:

$$Y_i = B'X_i + \epsilon_i \quad i = 1,2,....N$$

(10a)

$$Y_i = B'X_i + \epsilon_i \quad Y_i > 0 \quad \text{of}$$

$$Y_i = 0 \quad \text{of} \quad Y_i \leq 0$$

In the model above, β is the estimated model’s coefficients and Xi indicates the independent variables of the model. For respondents like to pay, Yi indicates the willingness to pay in Toman. In addition, Yi of respondents do not like to pay is considered zero (Amirnejad,h., s. Ajdari, 2011).
For the observations of zero, probability of each observation's occurrence from the relations above is defined as below:

\[ P(Y_i = 0) = p(u(B'X_i)) = 1 - F(B'X_i) \]  \hspace{1cm} (11)

Where P is the probability distribution and \( f(0) \) is the density function of the error sentence evaluated in the BXi amounts. So, the probability of each Yi > 0 observation is attained from the relation below:

\[ P(Y_i > 0) = 1 - P(Y_i = 0) = F(B'X_i) \]  \hspace{1cm} (12)

The Yi amounts in this model are attained from the relation below:

\[ E(Y_i) = X_i\beta + \delta \phi(I) \quad i = 1,2, \ldots, n \]  \hspace{1cm} (13)

For Yi>0 observations, this relation is below:

\[ E(Y_i | Y_i > 0) = X_iB + \frac{I}{\Phi(I)} \]  \hspace{1cm} (14)

Tobit model in Heckman method is divided in two models of Probit and linear regression (Ghorban, m., 2009). Factors which can affect the respondents’ decision about the acceptance of payment are entered the probit model as independent variables, and ones which can affect the willingness to pay’s rate are entered in the independent variables group in the linear regression model; however, these two groups are not necessarily inconsistent.

Probit model and the linear regression resulted from the separated two-step Heckman method is indicated as below:

Probit model:

\[ Z_i = B'X_i + V_i \quad i = 1,2, \ldots, N \]  \hspace{1cm} (15)

\[ Y_i > 0 \quad \text{of} \quad Z_i = 1 \]

\[ Y_i < 0 \quad \text{of} \quad Z_i = 0 \]

Linear regression model:

\[ Y_i = B'X_i + \sigma \lambda_i + e_i \quad i = 1,2, \ldots, N \]  \hspace{1cm} (16)

In the model above, \( Z_i \) is the dependent variable including an artificial variable with zero and 1 amounts, which indicate the ith individual’s lack of willingness and willingness to pay, respectively. \( Y_i \) is the hidden variable of the model, \( Y_i \) is the ith individual’s rate of the willingness to pay, \( \beta \) and \( \sigma \) are the model’s parameters which should be estimated, and \( Z_i \) is the descriptive variables such as income, gender, household members and respondents’ attitude toward Karun river’s pollution. \( V_i \) are the error sentences in the model above, independent from the descriptive variables, and are based on the assumption of normal distribution with the average of zero and constant variance of \( \sigma \). \( \lambda_i \) is the inverse of the willingness ratio attained from the relation below:

\[ \lambda_i = \frac{Q(B'X_i)}{1 - Q(B'X_i)} \]  \hspace{1cm} (17)

Where \( \phi(BX_i) \) and \( 1 - \phi(BX_i) \) are the density and standard normal distribution functions, respectively. At the first step of Heckman two-step method, probit model is estimated using the maximum likelihood method. The second model (linear regression) is estimated by adding a new independent variable, known as the invert of willingness ratio, which is created using the estimated parameters of the first model (probit) for all \( Y_i > 0 \) observations, and by using ordinary least squares (OLS) method. Existence of the inverse of willingness ratio in
the linear regression removed the model’s variance dissimilarity and, if this variable’s coefficient is more than zero, removal of the zero observations from total ones zigzags the model’s estimated parameters. In addition, significance of the willingness ratio indicates that there is a difference between variables affecting the willingness to pay and ones affecting the willingness to pay’s rate (Behjatì, t., 2010).

After estimating the Logit and Heckman regression models, willingness to pay’s rate is calculated through WTP average method and is used to calculate the expected value of WTP or the numeral integral from zero to the maximum proposal (A).

\[
E(WTP) = \int_{0}^{\text{MAXA}} F\eta(\Delta U)dA = \int_{0}^{\text{MAXA}} \left( \frac{1}{1 + \exp(-\alpha + \gamma Y + \theta)} \right) dA
\]

Where E(WTP) is the prospected amount of the willingness to pay and \( \alpha \) is justified intercept, which is added to the intercept main sentence by the socio-economic sentence (Khodaverdizadeh, M., 2007).

In this study, in order to estimate the individuals’ willingness to pay for reducing the water of Karun river’s pollution, 248 questionnaires were extracted through Morgan formula with random sampling method.

**Results:**

After extracting the statistics and information, the descriptive findings of the important parameters and variables are evaluated in tables 1 to 6.

**Table 1: Economic and social characteristics of respondent.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Average</th>
<th>Max</th>
<th>Min</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.75</td>
<td>72</td>
<td>17</td>
<td>12.28</td>
</tr>
<tr>
<td>Monthly income (thousand Rial)</td>
<td>832</td>
<td>4000</td>
<td>200</td>
<td>13582000</td>
</tr>
</tbody>
</table>

Resource: findings of the study

In the case of study, most respondents are between 17 and 31 years old. So it can be concluded that most of the respondents are of a young society. In addition, the average income of the respondents is 832000 Tomans, close to the per capita income of the individuals (723881.8 Rial) in Khuzestan province.

**Table 2: Frequency distribution of education level of respondents.**

<table>
<thead>
<tr>
<th>Level of education</th>
<th>PhD</th>
<th>MS1</th>
<th>BA</th>
<th>Associate degree</th>
<th>High school</th>
<th>Guidance school</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>5</td>
<td>13</td>
<td>71</td>
<td>38</td>
<td>104</td>
<td>17</td>
<td>248</td>
</tr>
<tr>
<td>Percent</td>
<td>2.04</td>
<td>6.8</td>
<td>28.6</td>
<td>15.4</td>
<td>41.9</td>
<td>6.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Resource: findings of the study

Based on the individuals’ structure of education in Khuzestan, information of the table above indicates that the collected sample has a relatively appropriate transmittal among different levels of education in this province. Results of the willingness to pay are illustrated in table 3.

**Table 3: Answers to proposed prices to estimate the WTP of Ahwaz citizens.**

<table>
<thead>
<tr>
<th>Acceptance status</th>
<th>Primary proposal 250000 Rial</th>
<th>Low proposal 100000 Rial</th>
<th>High proposal 400000 Rial</th>
<th>Payment surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance of the proposed price</td>
<td>number</td>
<td>63</td>
<td>64</td>
<td>55</td>
</tr>
<tr>
<td>percent</td>
<td>25.4</td>
<td>25.8</td>
<td>22.17</td>
<td>20</td>
</tr>
<tr>
<td>Non-acceptance</td>
<td>number</td>
<td>185</td>
<td>121</td>
<td>8</td>
</tr>
<tr>
<td>percent</td>
<td>74.5</td>
<td>48</td>
<td>3.22</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>number</td>
<td>248</td>
<td>185</td>
<td>63</td>
</tr>
<tr>
<td>percent</td>
<td>100</td>
<td>73.8</td>
<td>25.39</td>
<td></td>
</tr>
</tbody>
</table>

Resource: findings of the study

Numbers of table above indicate that 185 ones (74.5 percent) did not accept the first proposal (250000 Rial) and were not interested in paying 250000 Rial of their monthly income, while 63 ones (254 percent) accepted it. Respondents accepted the first proposal (250000 Rial) were placed at the higher proposal group, whether they are interested in paying 400000 Rial for reducing the pollution of Karun river’s water ? 8 ones (3.22 percent) did not accept the third proposal but 55 ones (22.17 percent) accepted it. 50 persons (20 percent) did not accept the minimum proposed cost for reducing the pollution of Karun river’s water because they believed that the government should necessarily pay for reducing the pollution. They stated that the government must pay the cost of reducing the water pollution. In addition, 16 ones (6.45 percent) has a surplus willingness to pay,
meaning that their interest is more than the cost they paid. Thus, they will have more welfare in the society (Tanellavi, e., 2009). Results of Logit model devaluation indicated in table 4 are discussed below.

Table 4: Results of Logit model to estimate the WTP of Ahwaz citizens for the pollution of Karun river.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Value of T statistic</th>
<th>Tension in average</th>
<th>Overall weight tension</th>
<th>Final effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>1.46</td>
<td>0.49</td>
<td>43161</td>
<td>-</td>
</tr>
<tr>
<td>Proposed price</td>
<td>-0.17</td>
<td>** -2.04</td>
<td>-20.22</td>
<td>-0.17</td>
<td>-0.43</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.19</td>
<td>-1.42</td>
<td>-0.12</td>
<td>-010</td>
<td>-0.47</td>
</tr>
<tr>
<td>Age</td>
<td>-0.29</td>
<td>** -3.75</td>
<td>-0.49</td>
<td>-0.42</td>
<td>-0.72</td>
</tr>
<tr>
<td>Education</td>
<td>0.46</td>
<td>*5.05</td>
<td>0.55</td>
<td>0.47</td>
<td>0.1</td>
</tr>
<tr>
<td>Income</td>
<td>0.49</td>
<td>*3.27</td>
<td>0.19</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Household members</td>
<td>-0.84</td>
<td>-0.12</td>
<td>-0.14</td>
<td>-0.12</td>
<td>-0.2</td>
</tr>
<tr>
<td>respondents’ attitude toward pollution of the river</td>
<td>0.62854</td>
<td>** 2.74</td>
<td>0.51</td>
<td>0.44</td>
<td>0.15</td>
</tr>
</tbody>
</table>

LOG-LIKELIHOOD = - 343.24; LIKELIHOOD RATIO TEST = 75.9985
MADDALA R-SQUARE = 0.4153 PERCENTAGE OF RIGHT PREDICTIONS = 0.64458

Resource: findings of the study
*, **: in the order of significance at 1 and 5 percent levels

Variance analysis was used to evaluate the existence or nonexistence of collinearity in this study. Results indicated that there is not any collinearity between the descriptive variables used in the model. Typical methods such as Brooch-Pagan, White, and Goldfield –Cowan tests can’t be used to evaluate the existence or nonexistence of variance dissimilarity in Logit and Probit models. Davidson and McKinnon (1984), introduce a statistic (LM2) to test the variance dissimilarity in the Logit and Probit models. This statistic depends on LM method having an artificial regression which is created using the results of Logit and Probit models estimation; this regression is used to test the variance dissimilarity. Results of using this statistic reject the assumption of dissimilarity existence (Khodaverdizadeh, M., 2007). Likelihood ratio (LR) was used to evaluate the regression’s overall significance. Amount of LR at a7 degree of freedom in Logit models is 75.99 and, because this amount is more than the provided likelihood amount, the whole estimated model is statistically significant at a 1 percent level. Amount of Mandala coefficient of determination is 41 percent, which is acceptable according to dependent variable observations. In Logit model, the primary estimated coefficients only show the signs of the descriptive variables’ effect on the probability of accepting the dependent variables, but it does not have quantitative explanation. In this case, final effect and weight tension are used. In this model, variables of income and education have weight tensions of 0.15106 and 0.47073, respectively. In other words, assuming that all factors are constant, averagely, 1 percent increases in the variables above increase the WTP to 15.106 and 0.47073, respectively. In addition, the overall weight tensions in the variables of proposed price and age were -0.17457 and –0.42876,respectively,indicating these variables’ negative and significant effect on WTP, meaning that with 1 percent increase in these variables, the probability of WTP would have -.17457 and -0.42876 percent increase. variable of the individuals’ attitude toward water pollution was entered the model to evaluate its effect having a final effect of 0.1553, meaning that the probability of WTP of the aware-of –water pollution individuals increases to 0.1553 percent. In addition, in this model, variables of age and proposed price have a negative and significant effect on the respondents’ WTP, but the variables of the household members and gender are not statistically significant, they, however, have the prospected signs. Results of estimating the model using two-step Heckman method are indicated in table 5. Based on the statistic of , 50 percent of the WTP variance is explained by the independent variables.

Table 5: Results of two-step Heckman method to estimate the WTP of Alwaz citizens.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Value of T statistic</th>
<th>Tension in average</th>
<th>Weight tension</th>
<th>Final effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>29514</td>
<td>8.837</td>
<td>0.21776</td>
<td>-</td>
<td>8.837</td>
</tr>
<tr>
<td>Gender</td>
<td>0.78732</td>
<td>0.24103</td>
<td>0.21776</td>
<td>-</td>
<td>29514</td>
</tr>
<tr>
<td>age</td>
<td>-0.10305</td>
<td>-0.86330</td>
<td>-0.7765</td>
<td>-0.3268</td>
<td>-</td>
</tr>
<tr>
<td>education</td>
<td>-0.8812</td>
<td>-3.821</td>
<td>-0.4936</td>
<td>-0.4389</td>
<td>-</td>
</tr>
<tr>
<td>income</td>
<td>0.9646</td>
<td>0.51496</td>
<td>0.45511</td>
<td>0.95573</td>
<td>1431.3</td>
</tr>
<tr>
<td>Household members</td>
<td>3.3305</td>
<td>0.17965</td>
<td>0.14803</td>
<td>0.11457</td>
<td>0.954*</td>
</tr>
<tr>
<td>Respondents’ attitude</td>
<td>-5.114</td>
<td>-1523.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Inverse of the willingness ratio</td>
<td>0.37177</td>
<td>2.7581</td>
<td>0.48579</td>
<td>0.4393</td>
<td>0.147</td>
</tr>
<tr>
<td>intercept</td>
<td>-5.07</td>
<td>316.67</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

LOG-LIKELIHOOD = -343.24; MADDALA R= 0.13214
LIKELIHOOD RATIO TEST = 70.5810 P-VALUE= 0.00000
ESTRELLA R= 50% MCFADDEN R= 0.10282
D.W=1.9503

* It is measured Using Likert Scale (Bad, very bad, good, very good).
Dissimilarity variance of the model above was evaluated using White test indicating no problem. The coefficient of determination ($R^2$) related to the linear regression is 60 percent. In addition, significant of the inverse of willingness ratio at 1 percent level indicates that factor affecting the WTP is not similar with factors determining the rate of WTP confirming the use of two-step Heckman method.

The overall weight tensions of the descriptive variables of income and education are 0.11457 and 0.45511, respectively, meaning that with the assumption that all variables are constant and according to their positive and significant relationship, a percent increase in these variables increases the individuals’ WTP to 0.11457 and 0.45511 percent, respectively. Other artificial variable having a positive and significant effect on the willingness to pay is the respondents’ attitude, which has a final effect of 0.147, meaning that a 0.147 percent increase of willingness to pay for individuals who are aware of the water pollution harms for health. The negative and significant relationship of the individuals’ age shows that 1 percent increase in the age of individuals reduces their willingness to pay to -0.71247 percent.

Variables of income and education in the linear regression indicate that with a unit increase in the rate of income and educational level of individuals, the respondents’ WTP would be respectively increases to 3.600 and 0.9546 units. In addition, the variable of household members in the linear regression indicates that with the increase of the household members, because of the per capita reduction, WTP would be increased to -5.114 units.

Results of these models show that each household of Ahwaz is ready to pay 234000 and 2448000 Rials per year to reduce the pollution of Karun river’s water.

Discussion and Conclusions:

In the present study, the averages of WTP in the estimated models are 2340000 and 2448000 Rials per year, close to the amount calculated by Marsh and Mkware (2009), for increasing the water quality in Newzland ($123.55 which is equal to 2223900 Rials), Atkins et al., (2007) for reducing the water pollution in the Denmark Abdare ($127 which is equal to 2286000 Rials), and Randall et al., (2002), for estimating the economical value of protecting the water quality of Kataba river’s Hoze ($139 which is equal to 2502000 Rials). Results indicated that in both Logit and Heckman models, the variables of age and proposed price have a negative and significant effect on the respondents’ WTP, but the variables of household members and gender were not statistically significant; however, they had the prospected signs. In addition, based on Heckman model, factors such as gender, age, respondents’ attitude toward the pollution of river affect the willingness and unwillingness to pay and the household members affect the rate of willingness to pay; only the variables of income, education, and respondents’ attitude have a significant effect at both steps. It is also concluded that although the two-step Heckman method can differentiate between the factors affecting the acceptance of WTP and factors affecting it, generally, it estimated the WTP less than the other method. In addition, results indicated that in both Logit and Heckman methods, variables of education, income, age, and household members are the most important factors affecting the rate of WTP for reducing the pollution of the river’s water.

It was identified that the household income is the most important variable; positive and significant effect of this variable in both models indicates that individuals with more income are more able to pay and, evidently, would have more WTP. These results are confirmed by Zhen et al., (2011), Wang et al., (2011) and Hao (2007), The second effective variable in the estimated models is the level of education. In both models, this variable has a positive and significant effect, meaning that the level of education increases the probability of WTP. The positive effect of educational level is indicated by Birole et al., (2006), mirajul et al., (2009), Imandoust and Ghandam (2007), Houtven et al., (2007) too. The third one is the respondents’ attitude toward the pollution of river. In other words, individuals, who are more aware of the water pollution, are more interested in paying and, at the dominant conditions; their decision is a logic one for reducing the pollution of water. The variable of age, in both models, has a negative and significant effect on the probability of WTP. In other words, individuals get more interested in gaining more income as they get older, so their family’s welfare is reduced, which is a factor reducing the willingness to pay. These results are confirmed by Birol et al., (2006). In addition, the negative and significant effect of the proposed price in Logit model showed that in the scenario of hypothetical market, if the proposed price is increased, the willingness to pay would be reduced, too. This result is confirmed by Wendimu and Bekele (2011), Marsh and Mkware (2008) Tanellavi et al. (2009).

The positive and significant effect of the variables of income and education in the linear regression indicates that the liquidity for daily activity is increased with the increase of per capita income, so the individuals’ rate of WTP is increased, too. These results are confirmed by Hess and Borgç (14), Davi et al (2010), Atkins et al (2007), Khodaverdizadeh et al (2007) and Hashemzadeh et al (2010), in addition, the negative effect of the variable of household members in the linear regression shows that the rate of WTP is reduced with the increase of the household members’ number and this is because of the per capita reduction. This negative relationship is also concluded by Aboali and Carlsson (2004), Hayati et al (2010), Amirnejad and Ajdari (2011), and Sadeghi (2011).
Results of the study indicate that there is a possibility that at least a part of the cost of increasing the water resources quality should be paid by the citizens and the second part should be provided by the government. In determining the rate of this tariff, considering the factors affecting the rate of payment such as education, household size, and etc. is suggested. In addition, because the variable of education with the possibility of accepting the proposed prices are significant, in order to reduce the water pollution, increasing the level of awareness regarding the pollution issue, specially for individuals with low literacy, is suggested; this can lead to successes in order to motivate the individuals to pay for reducing the pollution of Karun river’s water. Since the willingness to pay for reducing the water pollution is increased by improving the individuals’ income, supports and income improvement, especially for the low-income individuals can be effective in accepting the proposed price. In addition, policies of optimum distribution of income and increasing the level of households’ welfare at macro level affect the households’ willingness to pay, too.

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