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Investigation of Citizens' WTP for Mashhad Air Pollution Reduction: Applying Heckit model

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Abstract

Granted that causing welfare increases in urban areas, industrial Revolution has started to exhaust and destroy the environment terribly. Consequently, importance of the environmental protection was started to be recognized as one of the principle concerns of the latter half of the 20th century, and has dominated political agenda at the beginning of third millennium. However there is an increasing recognition of the need to protect environment, losses and degradations have continued in all over the world. One reason is that economic values of environment do not take part in the economic decision processes; as a result, a number of methods were improved to value environmental goods to integrate inside the economic decision process in the developing world. Contingent Valuation approach (CVA) is one of those approaches that are used to integrate the benefits of public goods and services such as forests, water, air etc. into economical decision process By using cross-section data of Mashhad which were gathered through a survey research in 2005-2006, and applying contingent valuation approach and Heckit model this study has tried to determine economical value of air pollution 30 Percent improvement and effective factors on people WTP. Results showed that 30 percent improvement of air pollution quality total value in high-polluted region equals 7134146560 Rials per month and in middle-polluted region equals 5242428950 Rials per month. Therefore according to citizens' mentality, value of 30 percent improvement of Mashhad air pollution state equals 12376575510 Rials per month. Based on results of this study, in decision-making stage, education level, age, kind of settlement region, sex and having child are significant variables on citizens' WTP for air pollution reduction. In addition education level, sex, age, household income, having child and having car are effective factors on people willingness to pay in administrating stage.

Key words : Air Pollution, Heckit Model, Mashhad, Contingent Valuation.
JEL: Q53,Q52,Q58.C42.

1. Introduction

In the current era of technology and the expansion of communications, man is continuing the destruction of environment, unfortunately. The environment pollution is perhaps one of the most dreadful legacies of the industrial revolution. The outbreak of population and the increasing trend of consumption of natural and artificial materials have changed the face of the earth. It seems the environment has not been paid due attention in the current generation's life. Moreover, many people pass it easily. We should bear in mind that Iran's natural environment is badly threatened.

Greenhouses gases which are produced mainly by some countries have implications on climate. Moreover, hospital and chemical wastes worsen the case. Many of diseases are as a result of irregular use of natural resources. In fact, man has changed the environment in his favor and so has led to an unsustainable development world-wide. The ever increasing use of natural resources has not only unbalanced the ecosystems, but also has increased pollutions. Ecosystems have been replaced by buildings, roads, and factories.

This paper have investigated public preferences for improving Mashhad air pollution by estimating willingness to pay (WTP) to the end that it is organized in six sections. This is followed by a short description of the CV and presented information of the empirical study; subsequently, theoretical formulation of the model is declared. The results of the study are then presented and discussed. At last practical conclusions are presented.

Stated preferences methods are used for changes in non marketed goods such as landscape, natural or cultural heritage that have no complementary or substitute market good. In that case, one can only resort to directly asking individuals (in a survey) how much they are willing to pay to obtain that change (or to avoid it). The precise way to ask that question is the subject of much debate and has given rise in practice to several methods. The contingent valuation (CV) is the most developed stated preferences method and is very well documented, see e.g. (Bateman and Willis, 1999).

2. Study Site

As it is mentioned earlier, present study has investigated Mashhad air pollution effects. Mashhad is a big populated city and located in north-east of Iran on a plain between Binalood and Hezar-Masjed heights; Furthermore, Mashhad has temperate climate, and it has about 270-300 days of thermal inversion in year (Mousavi, 2003). Figure 1 represents Mashhad air pollution monitoring station sites.

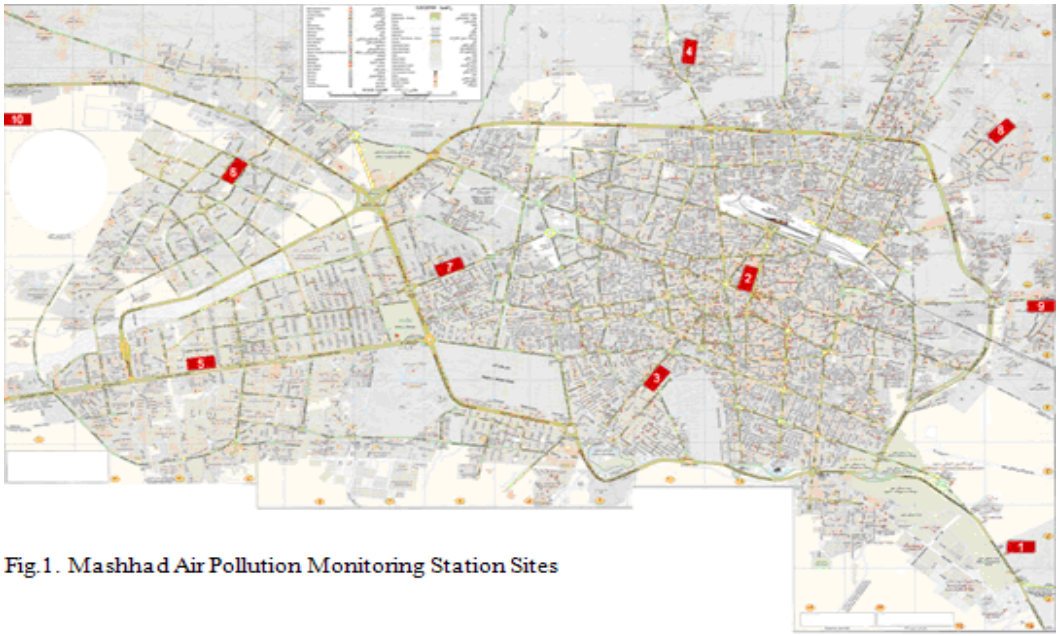

Fig.1. Mashhad Air Pollution Monitoring Station Sites

This city is home to more than 2.5 million people. In addition to this, on religious ground, this city receives over 14 million pilgrims annually. Table 1 reports the priorities of air pollutant sources of Mashhad (Mousavi, 2003).

In addition to thermal inversion, air stability and lack of rain, we should acknowledge that the most important factor of Mashhad air pollution is man-made pollutions like automobiles, factories and other pollutants. Based on statistics of environment office of Khorasan Razavi province about 72 percent of Mashhad air pollution is because of motor-vehicles traffic. In this metropolis about 800 thousands motor-vehicles are in traffic. Moreover, there are many polluting units like factories, compost plants, etc in Mashhad suburbs which are not compatible with dominant winds.

According to many physicians the reason of many diseases including gastrointestinal, heart, respiratory and vascular diseases in Mashhad is breathing polluted air. On this base environment office of Khorasan Razavi province in some periods of time recommends citizens having heart and respiratory diseases not to leave their homes.

It is worth noting that distribution of air pollution in Mashhad differs in various times and zones of the city. Air pollution measurement through 12 measurement stations which are observing and registering Mashhad air pollution status shows that air pollution is more critical in Qale-sakhteman, Panjrah, Shohada and Sajad regions (fig 2). Furthermore, early morning hours of a day due to lack of ascending currents in big and industrial cities like Mashhad are more polluted. Thermal inversion and air stability bring about more air pollution in fall and spring rather than other seasons.

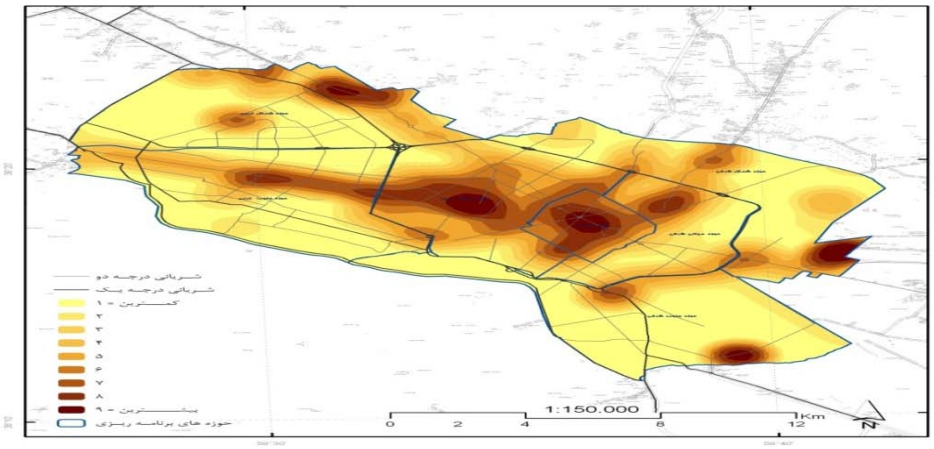

Fig2. Distributions of air pollution in Mashhad zones

Air pollution in Mashhad is responsible for a number of negative effects. It has been proved that air pollution can affect human health. These health effects include increased hospital admissions due to the exacerbation of cardiac and respiratory diseases, as well as increased mortality. In addition to adverse health effects, air pollution in Mashhad is in charge of poor visibility, black fallout and bad odor. In evaluating any policy that would reduce air pollution, it is useful to compare the policy's costs to its benefits expressed in monetary units.

Table 1- The priorities of air pollutant sources of Mashhad

source	priority	source	priority	source	priority
vehicles	1	Industries (inside the city)	1	planes	3

Indoor	1	Filling stations (inside the city)	1	Filling stations (outside the city)	4
commercial	1	trains	2	Industries (outside the city)	4

Based on consultation with staff of environment office of Khorasan Razavi province[1], this study stratified Mashhad into two regions; high-polluted region and middle-polluted region. As mentioned before, since there is no market available that places values on the benefits of improved air quality, one of the non-market valuation methods called CV has been applied. Using a pilot study in both regions, samples sizes were determined 160 and 126 households for high polluted and middle polluted regions, respectively. By applying stratified random sampling method the data were obtained through a survey in these two regions in year 2006. In this study Shazam 8.0 software package was used to estimate the Heckit model.

The valuation question has an open ended format: respondents are asked to state the value of thirty percent improvement in air quality.

3. Methodology

In analytical terms, this means that the dependent variable is left-censored at zero, since the value of the biodiversity index by definition cannot be negative. Ordinary least squares regression yields biased and inconsistent estimates when applied to this kind of data. The Heckit model is one of the common methods for analyzing censored data sets of this type. Thus, for our regression, we used a two-step Heckit model of the following form:

The two-step Heckman model separates the decision process into two distinct steps similar to real-life decision- making behaviour scenarios. In the first step, a decision is made by households to have willingness to pay for increase in air quality (a binary choice amenable to the probit model), while they decide on the measurements of the payments in the second step. The implicit assumption is that the two decisions are generated by separate probability processes (Pohlmeier and Ulrich, 1995). We applied probit estimation to obtain the probability of a household to have willingness to pay for increase in air quality, in the following selection model:

$$z_i^* = w_i'\gamma + u_i,\ z_i = 1 \quad \text{if } z_i^* > 0 \text{ or } 0 \text{ otherwise.} \qquad (1)$$

Where z_i^* is a latent variable related to the underlying propensity to report the outcome of interest (e.g. to have willingness to pay). The underlying variable z_i^* is unobserved; therefore the estimation of the probit model is based on the maximization of the likelihood function of z_i, which depends on the conditional probability: $p_i(z_i = 1) = \Phi(w_i'\gamma)$, where $\Phi(\bullet)$ is the standard normal cumulative distribution function and p denotes the probability. We proceeded by obtaining a probit estimate of γ to obtain the Inverse Mill's ratios $\hat{\lambda}_i$ for each observation in

[1] Mashhad is center of Khorasan Razavi province.

the selected equation which we used to obtain consistent estimators for $\hat{\beta}_i$ $(\beta_\lambda = \rho\sigma_\varepsilon)$ from the second-stage OLS regression of y on x and $\hat{\lambda}$.

The second step is represented in the following equation:

$$E(y_i|z_i = 1,\ x_i,\ w_i) = x_i'\beta + \rho\sigma_e\lambda\left(w_i'\gamma\right) \qquad (2)$$

w_i' and x_i', were observed while y_i is observed only when $z_i^* = 1$. The error terms $(u_i,\ \varepsilon_i)$ are independent of x and distributed iid normal with zero mean (Cho, et al, 2005; Abegunde and Stanciole, 2008).

4. Results

In this section, measures of people's WTP and WTA have been presented; furthermore, effective factors on measures of WTP have been investigated. As it is illustrated by table 2, measures of willingness to pay for thirty percent improvement in air quality in high-polluted, middle-polluted and whole regions are 26440, 24530 and 25600 Rials per month, respectively. Also, from the table it is clear that measures of Mashhad dwellers' willingness to accept for current trend of air pollution are 4241520, 2646750 and 3626870 Rials per month.

Table 2 – Measures of WTP and WTA resulted from Contingent Valuation Approach

region	WTP (Rial per month)	WTA (Rial per month)
High polluted	26440	4241520
Middle polluted	24530	2646750
Total (Both regions)	25600	3626870

As a whole, based on contingent valuation approach and considering each region population, it is concluded that air pollution total value of high-polluted and middle-polluted regions equal 7134146560 and 5242428950 Rials per month, respectively; therefore, value of thirty percent improvement in air pollution condition equals 12376575510 Rials per month.

Effective factors on willingness to pay - Peoples' willingness to pay is determined by individual, structural and economic factors. Individual factors include age, education level, sex, having child, hours of hiking in week; furthermore, household income and having car are considered as economic factors influencing on WTP. In addition, region type of settlement and distance between home and source of pollution are structural effective factors. In other words, it is expected that a number of variables such as age, education level, sex, having child, hours of hiking in week, household income, having car, region type of settlement and distance between home and source of pollution affect on willingness to pay measures. Table 3 illustrates characteristics of effective variables on WTP.

Table 3 – Means, STD error and Expected sign of effective variables of WTP

Variable	High polluted region		Middle polluted region		Both regions		Expected sign
	Mean	STD error	Mean	STD error	Mean	STD error	
Education	5.64	1.12	5.68	1.35	5.65	1.23	+
Sex (Male)	0.85	0.36	0.79	0.40	0.82	0.38	+
Household income[2]	240.53	132.86	281.49	146.45	258.82	140.32	+
Settlement region[3]	-	-	-	-	0.56	0.49	+
Having child[4]	0.48	0.50	0.58	0.49	0.53	0.50	+
Having car	0.43	0.49	0.47	0.50	0.45	0.50	+
Age	27.78	8.37	30.56	8.49	29	8.52	+
Distance between home and source of pollution	0.11	0.31	0.07	0.26	0.09	0.29	-
Hours of hiking in week	3.15	2.18	3.28	2.23	3.21	2.19	+

As seen in the table average of education level is technician, and it is expected that increasing in education level increases willingness to pay for air quality improvement. From the table, also, it is clear that men constitute about 82 percent of sample size. Men are likely to have more WTP. Individuals' average income equals 2.6 million Rials per month, and its expected sign is positive; therefore, it is predicted that income increase increases household WTP. As shown by the table about 57 percent of individuals are settlers of high polluted region and it is expected that dwellers of high polluted region have more WTP in order to enhance air quality. About 52 percent of sample household have child; what is more, it is likely that having child increases household WTP. As illustrated by the table, about 45 percent of households of under survey sample have car. It is probable that having car increases WTP for air quality improvement. It is clear from the table that average of age in the sample is about 29 years; furthermore it is likely that age increasing increases measures of WTP. Also, it is expected that far distance between home and source of pollution decreases WTP measures. As shown by the table hours of hiking in week are about three hours and it is likely that increasing in it increases measures of WTP.

In order to estimate effects of mentioned variables on WTP, this study has applied tobit model. The regression results are shown in Table 7.

[2] 1000 Rial per month
[3] High polluted = 1
[4] Younger than 18

In order to determine effective factors on WTP for air quality improvement this study has applied Heckit model. It is necessary to mention that in this study threshold of WTP is determined based on statistical tests and statistics having been represented in environment office and tax office of Khorasan Razavi province.[5]

Estimation of Probit model (first stage of Heckit model) - As mentioned earlier in the first stage of Heckit model; probit model and Maximum likelihood estimation method are brought into play. Results of Probit model are represented in table 4.

Table 4- Results of probit model (First stage of Heckit model)

variable	coefficient	S.E	t	Elasticity
Education	1.0804	0.2438	4.4313***	0.2787
Sex (Male)	0.0067	0.0047	1.1223°	0.0261
Household income[6]	-0.0006	0.0007	-0.8236	-0.0407
Settlement region[7]	0.4659	0.1919	2.4274***	0.0774
Having child[8]	0.1180	0.0963	1.2254°	0.0243
Having car	0.0087	0.0180	0.4844	0.0063
Age	0.0329	0.0094	3.4843***	0.2579
Distance between home and source of pollution	0.2164	0.3417	0.6333	0.0061
Hours of hiking in week	-0.1518	0.2855	-0.5316	-0.0068
constant	-1.0457	0.2805	-3.7280	-

***: $p<0.01$ °: $p<0.2$

As Table 4 indicates, education level, age, region type of settlement, sex and having child are significant variables on having willingness to pay for improvement of air quality or not. On the basis of these results increase in percentage of educated individuals, age, percentage of High-polluted regions settlers and households having child will lead to have more decisions for willingness to pay.

educated individuals are tend to pay more for improvement in air quality inasmuch as accompany with increasing in education level individuals' knowledge of air pollution damages increases; consequently, measures of WTP for air quality improvement increases.

On the basis of these results educated individuals are tend to pay more for improvement in air quality inasmuch as accompany with increasing in education level individuals' knowledge of air pollution damages increases; consequently, measures of WTP for air quality improvement increases.

[5] Mashhad is center of Khorasan Razavi province.
[6] 1000 Rial per month
[7] High polluted = 1
[8] Younger than 18

As it is shown in the table, 10 percent increase in the number of households having child brings about 0.2 percent increase in WTP decision. From the table it is clear that having child increases air pollution WTP. Households who have child, due to taking their children's health into consideration, try to reduce air pollution; accordingly, they pay more for air pollution improvement.

As shown by the table, age has a positive and significant effect on WTP; hence, increasing in average age of society increases WTP for improvement in air quality on the ground that accompany with age increase in addition to increasing in individuals' physical sensitiveness, usually individuals become more risk averse; therefore, they endeavor to insure themselves by paying more for air quality improvement. Ten percent increase in persons age leads to 2.6 percent increase in WTP. Results for other variables are shown in table 4 and descriptions of them are similar to these ones.

Estimation of probit model in the first stage in addition to determining effective factors of decision for WTP generated a variable which is necessary for second stage. In this stage we omit observations of dependent variable which are under censored threshold- WTP lower than 2000 Rial. Results of this stage have shown in table 5.

Table 5- Results of stage two of Heckit model

variable	coefficient	S.E	t	Elasticity
Education	0.6558	0/4150	*1/5803	0/2263
Sex (Male)	0.7289	0/3939	*1/8502	0/2365
Household income[9]	0.0084	0/0012	***6/9471	0/7656
Settlement region[10]	0.0404	0/2819	0/1432	0/0094
Having child[11]	-0.9633	0/2667	***-3/6126	-0/1941
Having car	0.7872	0/2872	***2/7408	0/1277
Age	0.0482	0/0194	***2/4839	0/5197
Distance between home and source of pollution	0.2262	0/4955	0/4566	0/0066
Hours of hiking in week	-0.0521	0/4901	-0/1064	-0/0017
Mills Ratio	-0.1464	0/2354	-0/6220	-
constant	-1.8805	0/8770	**-2/1440	-
Goodness of Fit Criteria				
R^2= 0.34	D-W= 1.80	F= 10.037 (0.0000)		
χ^2 = 70.961(>0.05) No Heterscedasticity		F= 1.112(0.331) No Specification Error		

***: p<0.01 **: p<0.05 *: p<0.1

As it is shown in table 5, education level, sex, age, income level, having child and having car are significant variables on measures of payment for improvement of air quality.

[9] 1000 Rial per month
[10] High polluted = 1
[11] Younger than 18

Based on these results 10 percent increase in number of educated persons will increase measures of payment for air pollution improvement by 2.2 percent. 10 percent increase in number of males, households' income, having car and age will increase measures of payment 2.4, 7.7, 1.3 and 5.2 percent, respectively.

As illustrated by the table, 10 percent increase in number of households having child will decrease 1.9 percent measures of payment for air pollution improvement; however, having child increase WTP decision. One reason for this is income limitation in stage two of estimation.

From the table it is clear that Settlement region, Distance between home and source of pollution and Hours of hiking in week in addition to not having significant influence on payment for air pollution improvement, the measure of this non-significant influence is negligible.

5. Conclusion

Based on results of this study increase in education level brings about more WTP; therefore, we can conclude that persons who have more education level learn more about externalities of air pollution and so they have more payment for air pollution improvement; therefore, we should make some ones not having high level of education aware of negative effects of air pollution to increase their payment. As we saw females have lower payment for air quality improvement, so it is necessary to convince them their payment for air quality improvement has positive effects in their life. In addition we should inform young people about harmful effects of air pollution in long-run. It brings about more payment for improvement in air quality.

6. References

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