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# MEASURING BENEFITS FROM REDUCED AIR POLLUTION IN MANALI INDUSTRIAL AREA OF CHENNAI USING CONTINGENT VALUATION

**J. Sacratees***

*This paper estimates welfare gains due to hazardous air quality of Manali Industrial Area of Chennai City; which is one of the fast developing metropolitan cities of South India using contingent valuation model. This area is surrounded with high industrial corridors and operating with heavy vehicles. The economic benefits was estimated using econometric methods like Logit and Tobit models in order to introduce Willingness To Pay (WTP) to improve the area of North Chennai due torrential industrial activities. The primary data collected through household surveys were used in the estimation model. We analysed how the monetary value of health benefits could be increased by way of reducing air pollution, which will be useful to policy makers to reduce the incidence of air borne diseases in the polluted industrial zone of North Chennai, TamilNadu. The economic costs associated with these health risks were then evaluated using available economic information. It enabled us to measure the cost of illness and man-days loss, wage loss, cost of medicine and cost of hospitalization due to air pollution. Thus, this study addresses the current status and consequences of air pollution, which causes concern in rapid industrialized cities like North Chennai.*

## INTRODUCTION

Environmental pollution is a serious and growing issue in both industrialized and developing countries. The primary cause of air pollution in the study area of Manali is industrial operations. The health effects of certain air pollutants have been documented in numerous studies (Cropper, 1997) and high concentrations of these substances in many developing countries are known to lead to increased incidence of illness (morbidity), especially among individuals suffering from respiratory problems which cause premature death (mortality). Air pollution causes various types of damages that are normally inflicted on society at large rather than on those directly responsible. In the past these external impacts were mostly ignored but recently emphasis has been placed on fact that such effects do involve an *economic cost*. Commodities could be distinguished by the characteristics they possess and their prices are functions of theses characteristics. From the point of view of the owner, land property could be distinguished in terms of its location, size, and local environmental quality, while from the worker's perspective, a job is a differentiated product in terms of the risk of an on job accident, working conditions, prestige, training and enhancement of skills, and the local environmental quality at the work place. Environmental characteristics like air or water quality affect the price of land either as a producer good or as a consumer good. Ridker (1967) and Rider and Henning (1976) provided the first empirical evidence that air pollution affects the property values. In recent year's quantitative health risk assessment and comparative health risk assessment (CRA) procedures have been used to quantify human health risks associated with particular environmental exposures and rank them according to the magnitude and severity of health damages. The World Bank (Carter Brandon, 1995) has initiated such efforts, whereby the economic costs of environmental degradation have been estimated for several cities in India.

**Head, Department of Economics, Manonmaniam Sundaranar University, Tirunelveli – 600 012. Tamil Nadu, India. Email: jsocrates@rediffmail.com*

Atmospheric pollution has been increasing at an alarming rate all over the globe. Most of the traditional pollutants directly affect the respiratory and cardiovascular systems and are more serious for certain sections of the population that may be at greater risk, for example, the young and the elderly, who are already suffering from respiratory and cardiopulmonary disease with hyper tension (WHO/UNEP, 1992). Increased mortality, morbidity and impaired pulmonary functions are associated with elevated levels of particulate matter. Exposure to $SO_2$ causes impairment of respiratory function, aggravation of existing respiratory disease and decreased ability of lungs to clear foreign particles (Godish, 1991; US EPA 1994). The studies from many countries confirm that long-term exposure to common air pollutants and living in urban as compared with rural areas, may be associated with increased prevalence of respiratory symptoms, lung function disturbances, cardiovascular irregularities and increased adult and infant mortality (Gilliland et at, 1999; Jedrychowski and Flak, 1995; Seaton and MacNee, 1995; Tango. 1994; Toulomi and Pocock, 1994; WHO, 1994).

The existing legal measures with regard to air pollution controls are unhelpful because laws are particularly ineffective but the law enforcement mechanism is ***spineless.*** The basic motivation behind this research is threefold: One is to discuss what exactly is the real impact of air pollution on human health; Second, is to assess the welfare gains by way of reducing air pollution in Manali industrial area of Chennai; Third, is to introduce willingness to pay (WTP) to control air pollution.

## METHOD

The purpose of the study is to provide a new framework to strengthen the air quality control mechanism and mitigate the air pollution factor on disease burden. The principal core aim of the study is to assess human health risks associated with air pollution exposures using previously established dose-response information and cross sectional epidemiological information collected during the course of the study. The economic costs associated with these health risks are then evaluated using available economic information to enable us to rank particular environmental concerns on the basis of health and economic risks. The study is mainly focused on the area of Manali industrial corridors of Chennai based on national air quality monitoring programme since 1999 to 2001. The present study is descriptive based on both primary and secondary sources of data. Primary Data are collected through questionnaire administration. Time-series data on the number of deaths that might be due to air pollution was collected from the Primary Health Centres of Manali industrial area of Chennai. The secondary data of air pollution induced mortality and morbidity data were collected from vital statistics department. This study focused on selected areas over a period of five years from 1999-2002 (air quality data taken only for four years). The other factors that are often thought to influence the health of the population, such as percentage of smokers, income level, occupational exposure to pollutants, access to medical care and age distribution, socio-economic status and location of the house where they are living were incorporated into the analysis. Stratified random samplings of different income categories respondents of 100 samples were used for analyzing the data with minimum 500 meters of distance from the air quality monitoring point. Secondary sources of Ambient Air Quality Monitoring (AAQM) data were collected from Tamilnadu Pollution Control Board (TNPCB) and National Environmental Engineering Research Institute (NEERI) Chennai. In addition to that other information relating to economic costs like cost of hospitalization, average wages, wage days lost, costs of medication and defensive expenditure to prevent illness etc were also collected through sophisticated survey questionnaire. The health costs of morbidity and mortality were estimated by taking into account all the above information for the research. A household survey was conducted continuously for a period of three months to ascertain the type and incidence of illness and average health costs. A few regression models were run to arrive at willingness to pay to reduce air pollution and to improve the health status of community.

## Impact And Cost of Air Pollution

An important reason for controlling air pollution is the damaging effects they have on human health, particularly the increasing particulate matter or sulfur dioxide. In recent years, the morbidity and mortality rates are increasing tremendously due to increase in pollution levels. One cornerstone of the Clean Air Act and its subsequent amendments is that improved air quality leads to better human health. These health benefits of improved environmental quality are usually obtained by combining epidemiological evidence, linking pollution levels to health outcomes with the value of avoiding such outcomes (Alberini and Krupnick, Cropper and Freeman). Unfortunately, very few original epidemiological or willingness to pay studies have been conducted in developing countries, leading the analysts to offer recommendations based on extrapolating both concentration-response functions and the value of avoiding illness from U.S. studies (Krupnick et al., Ostro).

## Cost of Manali Industrial Area of Chennai

The Manali industrial area of Chennai has witnessed high levels of air pollution in the past few decades. No effort has been taken to curb the increasing level air pollution in the industrial corridor's of Manali since this area is not only covered by industries but also by the residential. This study presents an economic valuation of benefits from reducing pollution in the industrial area as the main economic rationale for controlling emissions is the welfare gain from improvements in air quality. The current study focuses on the three most important economic impacts of air pollution namely health impacts and restrictions imposed on economic activities through environmental contingencies and people's willingness to pay to improve the health status of the people in the study area. The health hazards associated with SO2, NOx. RDP and PM10 are studied because these substances are the most important in terms of violating pollution standards. The concentration levels depend on the amount and location of emitted pollutants, geographical characteristics and industrial activities. The pollution loads are still far above current air quality standards (See Table-1). We estimated the willingness to pay to avoid health damages due to air pollution of Manali industrial residents based on the classification done by Tamilnadu Pollution Control Board (TNPCB). The respondents filled out daily questionnaire about minor respiratory symptoms and the actions taken to relieve these symptoms. Air pollution induced health effects were recorded from the respondents of industrial area of Manali.

The table-1 shows that annual mean concentration of various air pollutants during the year of 1999 to 2001. The mean level of pollution with respect to SO2 has gone up from 15.33 in 1999 to 19.03 micro gram/cubic metre in 2001 based on 98 days air quality monitoring per year. Similarly, the SPM has gone up from 119.04 micro gram/cubic metre to 156.60 µg/m3 (>10u) in 2001 based on 97 days in a year. It is common knowledge that chronic exposure to higher levels of RSPM and SPM will lead to respiratory diseases at an alarming rate in Manali industrial area of Chennai. The average level of pollution with respect to RSPM has gone up from 42 micro gram / cubic

**Table 1**

**Annual Mean Concentration of various Air Pollutants during the years 1999 to 2001**

| In 1999 | Descriptive Statistics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Various Pollutants | N | Range | Mini | Maxi | Sum | Mean | Std. Error | S.D | Variance |
| $SO_2$ µg/m3 | 98 | 74.46 | .70 | 75.16 | 1501.91 | 15.33 | 1.38 | 13.64 | 185.92 |
| NOx µg/m3 | 98 | 47.13 | 2.45 | 49.58 | 1285.49 | 13.12 | .75 | 7.43 | 55.24 |
| SPM µg/m3 (>10u) | 98 | 213 | 29 | 242 | 11666 | 119.04 | 4.50 | 44.55 | 1984.49 |
| In 2000 | Descriptive Statistics | | | | | | | | |
| Various Pollutants | N | Range | Mini | Maxi | Sum | Mean | Std. Error | S.D | Variance |
| $SO_2$ µg/m3 | 97 | 75.7 | 2.2 | 77.9 | 1613.5 | 16.63 | 1.17 | 11.49 | 132.11 |
| NOx µg/m3 | 97 | 34.8 | 2.8 | 37.6 | 1473.0 | 15.19 | .77 | 7.58 | 57.53 |
| SPM µg/m3 (>10u) | 97 | 368 | 0 | 368 | 15175 | 156.44 | 6.97 | 68.69 | 4717.81 |
| RSPM µg/m3 (<10u) | 39 | 133 | 17 | 150 | 3241 | 83.10 | 5.10 | 31.82 | 1012.25 |
| In 2001 | Descriptive Statistics | | | | | | | | |
| Various Pollutants | N | Range | Mini | Maxi | Sum | Mean | Std. Error | S.D | Variance |
| $SO_2$ µg/m3 | 97 | 63.0 | 2.7 | 65.7 | 1846.3 | 19.03 | 1.21 | 11.95 | 142.92 |
| NOx µg/m3 | 97 | 45.10 | 3.40 | 48.50 | 2029.91 | 20.93 | .99 | 9.83 | 96.70 |
| SPM µg/m3 (>10u) | 97 | 248 | 0 | 248 | 15190 | 156.60 | 4.19 | 41.26 | 1702.41 |
| RSPM µg/m3 (<10u) | 97 | 149 | 0 | 149 | 9418 | 97.09 | 2.68 | 26.36 | 694.56 |

Source: Computed data of AAQM, TNPCB

metre in 2005 to 71 mg/m3 at MMC in 2006. Similarly, the SPM has gone up from 121 micro gram / cubic metre to 171 mg/m3 in a year. It is common knowledge that chronic exposure to higher levels of RSPM and SPM will lead to respiratory diseases. It is basically because of industrial and heavy vehicles which have been carry goods and services from industries. However, the TamilNadu Pollution Control Board has showed air pollution like Sulphur dioxide and Nitrogen dioxide within permissible limits in Manali industrial area but whereas these pollutants has been measured only in the day time since the industrialist's will release the gases in the midnight when the city is sleeping. This statement has been made by the residents of the Manali area if the TNPCB revitalize the monitoring into 24 hours, we could see the real picture of the air quality status of the Manali. The

the morbidity data for the year 1999 shows, the total number of heart diseases has occurred both male (0.79) percent and (0.76) percent. The highest ratio of respiratory diseases has been occurred about 58.62 percent among the adults and 63.08 percent among the children since children are the highly mitigate to the increasing air pollution in the study area. Whereas morbidity data for the year 2000, the total number of heart diseases has existed among both male (0.70) percent and (0.86) percent. The highest ratio of respiratory diseases has been occurred about 58.16 percent among the adults and 69.69 percent among the children since children are the highly mitigate to the increasing air pollution in the study area. This statistics reveals that children and women are highly influenced by the air pollution. However, this figure is excluding of June and October due to non-availability of data. The table-2 shows that morbidity data for the year 2001, the total number of heart diseases has been occurred among both male (6.87) percent and (4.00) percent. The highest ratio of respiratory diseases has been occurred about 52.70 percent among the adults and 52.86 percent among the children since children are the highly mitigate to the increasing air pollution in the study area. This statistics reveals that children and women are highly influenced by the air pollution. Due to non-availability of data.

The table shows that morbidity data for the year 2002, the total number of heart diseases has been occurred among both male (11.99) percent and (7.79) percent. The highest ratio of respiratory diseases has been occurred about 46.94 percent among the adults and 44.36 percent among the children since children are the highly mitigate to the increasing air pollution in the study area. This statistics reveals that children and women are highly influenced by the air pollution. However, this figure is excluding of August, September, October, November and December due to non-availability of data. Hence, the ratio of morbidity in Manali has been increasing manifolds during current years due vast expansion of industrialization in urban Chennai.

The table-3 shows that total household sample annual rupee WTP is Rs.1, 36,800 in order to improve the air quality and thereby avoid foregone expenditure of health. The total annual health cost of the 100 sample household has been estimated of Rs.3, 91,920 with total population of 28,174 (2001 census). The mean wage loss of each sample household has been estimated of Rs.674.45 per month due to increasing level of air pollution in the study area. This paper, focused only unlike studies such as Hernandez-Avila and others (1995), who focused only on hospital costs, assesses a wide range of health benefits of reducing air pollution.

The survey questionnaire also facilitated us to determine actual exposure to outdoor pollution concentration, such as the actual time the respondent exercised or maximum hours spent outdoor each day. The data diaries were then matched with pollution level and other related information taken from monitoring point within 500 meters of respondent's residence. The total cost incurred by the sample respondents who have spent has been stated in the table-7 only for respiratory problems not for other major diseases like cardiac and cancer. Many studies have demonstrated that PM10 (particular matter less than 10 microns in diameter) is associated with a wide range of adverse health outcomes. Given the high correlation between pollutants PM10 may also serve as a surrogate measure for other pollutants including very fine particles (less than 2.5 microns) and a host of traffic related toxins.

A recent study conducted in Austria, France and Switzerland has estimated a large impact on population health, with for example, some 40,000 deaths per year attributable to PM10 in the three countries (Kuenzli, 1999). The pollutants like $SO_2$ and PM load has been decreasing as per Chennai

**Table 2**

**Manali industrial area morbidity data for the year 2001 and 2002 (Excluding of August)**

| | In 2001 | | | | | | In 2002 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ADULT | | | CHILDREN | | | ADULT | | | CHILDREN | | |
| 1. HEART DISEASES | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| a. Congenital | - | - | - | 3 | 3 | 6 | - | - | - | - | - | - |
| b. Rheumatic Heart Disease | - | - | - | - | - | - | - | - | - | - | - | - |
| c. Heart Failure | - | - | - | - | - | - | - | - | - | - | - | - |
| d. Ischaemic Heart Disease | - | - | - | - | - | - | - | - | - | - | - | - |
| e. Hypertension | 184 | 200 | 384 | 10 | 10 | 20 | 270 | 275 | 545 | - | - | - |
| Total | 184 (6.87) | 200 (4.00) | 384 (5.01) | 13 (0.44) | 13 (0.44) | 26 (0.44) | 270 (11.99) | 275 (7.79) | 545 (9.43) | - | - | - |
| 2. RESPIRATORY DIS-EASES | | | | | | | | | | | | |
| a. Asthma | 304 | 347 | 651 | 135 | 151 | 286 | 290 | 342 | 632 | 206 | 243 | 449 |
| b. Pneumonia | - | - | - | - | - | - | - | - | - | - | - | - |
| c. Respiratory Tract Infection | 1115 | 2212 | 3327 | 1456 | 1340 | 2796 | 606 | 1475 | 2081 | 572 | 732 | 1304 |
| d. Puculota | - | 64 | 64 | 14 | 41 | 55 | - | - | - | - | - | - |
| Total | 1419 (52.97) | 2623 (52.56) | 4042 (52.70) | 1605 (53.79) | 1532 (51.93) | 3137 (52.86) | 896 (39.79) | 1817 (51.50) | 2713 (46.94) | 778 (38.50) | 975 (50.49) | 1753 (44.36) |
| 3. SKIN INFECTION | 319 (11.91) | 525 (10.52) | 844 (11.00) | 539 (18.06) | 398 (13.93) | 937 (15.79) | 331 (14.70) | 372 (10.55) | 703 (12.16) | 309 (15.29) | 272 (14.09) | 581 (14.70) |
| 4. CANCER | - | - | - | - | - | - | - | - | - | - | - | - |
| 5. OTHERS | 757 (28.26) | 1643 (32.92) | 2400 (31.29) | 827 (27.71) | 1007 (34.14) | 1834 (30.91) | 755 (33.52) | 1064 (30.16) | 1819 (31.47) | 934 (46.21) | 684 (35.42) | 1618 (40.94) |
| Grand Total | 2679 (100.0) | 4991 (100.0) | 7670 (100.0) | 2984 (100.0) | 2950 (100.0) | 5934 (100.0) | 2252 (100.0) | 3528 (100.0) | 5780 (100.0) | 2021 (100.0) | 1931 (100.0) | 3952 (100.0) |

Source: Primary Health Centre, Manali

Ambient Air Quality Monitoring data of TamilNadu Pollution Control Board (TNPCB), in reality these figures are quite high due to alarming rate of increasing vehicular population in the recent days. The researcher has covered entire diseases like respiratory illness, cardiac and cancer diseases while administering the questionnaire but he has not included here the cost incurred for cardiac and cancer diseases. If we add the cost incurred for cardiac and cancer would be more than the respiratory diseases. Hence, the annual per capita health expenditure for treatment of respiratory problems alone has been taken into consideration. Hence, the derived information about the cost of illness exclusively for air pollution alone has been placed in the table. The income level of the respondents of Manali is very low when compared to urban areas. This shows that majority of the respondents depended on primary health centre rather than private clinics. Hence, this study is not statistically significant based on health cost due to air quality but morbidity data is highly significant due to increasing level of air pollution.

**Table 3**

**Annual Mean Value of Rupee WTP, Health Cost, and Day's Lost, Income, Per Capita Wage and Wage Loss Derived from the Statistical Analysis**

| Area | Variables | Annual (Rs.) | Sample Mean (Rs.) |
|---|---|---|---|
| Manali | Rupee WTP | 136800 | 1368 |
| | Health cost | 391920 | 3919.2 |
| | Days lost | 1685 | 16.85 |
| | Annual income | 2273132 | 22731.32 |
| | Wage | 8762.73 | 87.63 |
| | Wage loss | 67445.23 | 674.45 |

Source: Computed from primary data

## Empirical Analysis of WTP for Air Quality Improvement

Here, we have used regression models in which the dependent or response variable itself can be dichotomous in nature. Basically, it is a 'Yes' or 'No' type answer received from the respondents with regard to improvement of the air quality. We used 1 or 0 value to measure this. In this question, some of the respondents are willing to pay and some are not. To estimate and infer problems, we have used Logit model. We have classified all categories according to their actual contribution in terms of rupees to avoid air pollution. We have found nearly 15 percent respondents are not willing to pay to reduce air pollution. To measure the actual contribution for the respondent's air quality improvement we have used Tobit model.

The specification of the Logit equation is,

$$WTP=\alpha+\beta_{1Age}+\beta_{2Sex}+\beta_{3Income}+\beta_{4Distance}+\beta_{5Hcost}+\beta_{6Wage\ loss}+\beta_{7Primary}$$
$$+\beta_{8High}+\beta_{9Degree}+\beta_{10Private}+\beta_{11Govt}+\beta_{12Business}+\beta_{13Fairly}+\beta_{14Greatly}+u_i$$

Where,

Dependent variable WTP=1; if willing to pay for air quality improvement=yes = 0 otherwise

Dummy Independent variables (Description)

$\beta_1$ =Age of the respondent (years)

$\beta_2$= 1 if Sex = Male, 0= otherwise

$\beta_7$= 1 if primary educated, 0=otherwise

$\beta_8$= 1 if high school educated, 0=otherwise

$\beta_9$= 1 if graduated, 0=otherwise *Base Category – Illiterates (for education)

$\beta_{10}$=1 if private employee, 0=otherwise

$\beta_{11}$= 1 if govt. employee, 0=otherwise

$\beta_{12}$=1 if business, 0 =otherwise **Base category- Unemployed

$\beta_{13}$=1 if the person is fairly affected by air pollution, 0=otherwise

$\beta_{14}$=1 if the person is highly affected by air pollution, 0=otherwise

***Base category – not at all affected by air pollution

This study reports a survey of willingness to pay for the improvement of air quality in Manali industrial area of Chennai. Data from various income categories were pooled together to get a willingness to pay group. Out of 100 samples 85 samples i.e., 85 percent of the respondents has given positive answers towards willingness to pay and the rest of the respondents has given negative answer for willingness to pay for improving air quality. These results have several noteworthy features. First of all, the model is having a good fit. The chi-square value is 23.10, which is highly significant at 1 percent level. Pseudo $R^2$ value is 24.48, which means that about 24 percent of the variables in the WTP are explained by the included independent variables. Almost all the independent variables have positive influence on WTP. Hence all the variables are highly statistically significant. Age variable is positively related to WTP. As the age goes up the probability of WTP also increases. Variables Sex, Income, Education and Distance have higher probability of influencing willingness to pay for improving the environment. In the case of variable Sex, Male respondents have higher probability towards improving air quality compared to female and they have more awareness compared to female respondents. Their income level also is high compared to female respondents. When the respondent's income level has risen by 1 percent, the probability of WTP for better air quality would also raised by 0.1149 percent. Age, Sex, Income have the positive sign and significance at 5 and 10 percent level. The variable distance has the negative sign and it has the expected sign and significance showing that if the distance is closer to the monitoring stations (traffic point) the probability of WTP for air quality improvement goes up and if farther the probability of WTP drops down. The variable health cost also plays a vital role in determining WTP. If the health cost is more the probability of WTP for air quality improvement goes up at 1 percent level of significance. The Wage loss is the major deciding criteria for WTP among the respondents. It directly influences the WTP. It indicates a positive sign and significance at 1 percent level. It's a good sign of awareness among respondents that their health deterioration is due to air pollution and something has to be done to improve the air quality in order to protect them from the air pollution induced illness and enjoy a healthy life. The variable Education at Primary and High school level has the negative sign and significance. Thus, education may also be interpreted as a proxy for the environmental awareness of the respondents and it clearly highlights the importance of education for environmental awareness. As the education level goes up the probability of WTP for air quality improvement rises up. This is very evident at Degree level education. It has got positive sign and significance at 1 percent level confirming the earlier results obtained through various studies (Alberini and Krupnick, 1998).

**Table 4**

**Logit Estimates of WTP for Environmental Improvement**

**Dependent Variable: WTP (Willingness to Pay for Air Quality Improvement)**

| Independent variable | Co-efficient | Marginal effects |
|---|---|---|
| Constant | 6.23617(2.47) | 0.0134 |
| Age | -0.0505(-1.53) ** | .1269 |
| Sex | -2.0587(-2.45)*** | .0142 |
| Income | .00025(1.58)** | .1149 |
| Distance | -0.0046(-2.14)*** | .03198 |
| Health cost | 1.7624(0.104)* | .91638 |
| Wage loss | -8.1117(-0.48)* | .6305 |
| Primary | -1. 9483(-1.37)*** | .1707 |
| High | 2.1435(2.07)** | .03805 |
| Degree | 2.3783(1.43)* | .151951 |
| Private | -1.2044(-0.85)* | .39675 |
| Government | -1.4314(-0.87)** | .384699 |
| Business | 1.4187(0.73)*** | .468276 |
| Fairly | -0.9635(-0.59)** | .548631 |
| Greatly | -0.6408(-0.39)* | .690165 |
| Log likelihood | -31.72202 | |
| Restricted loglikelihood | -43.96699 | |
| Chi-square | 24.48994 | |
| Pseudo $R^2$ | 0.279 | |
| N | 100 | |

Source: Computed from primary data

Note: figures in parenthesis show the t-values

*Statistically significant at the 1% level;

** Statistically significant at the 5% level;

*** Statistically significant at the 10 % level

The variable occupation at private and business group is having negative impact on WTP. Private employees are working for less wage and they may not afford to pay for air quality improvement. The business group is affluent enough to use air cooler, A/C car, and good ventilated houses with exhaust fan, gas fuels, etc., to avoid the ill effects of air pollution. This is highly influencing WTP. As expected only private employees especially those who are working currently in various industries in Manali are more concerned and thus it has positive response for WTP. The personal health loss due to ambient air quality created lot of awareness among public. Irrespective of the degree of health loss due to environmental degradation, the results have positive significance at 5 percent level. Thus, all the observations and results greatly influence each other and give positive result.

**Table 5**

**Tobit Estimates of WTP for air quality improvement**

**Dependent variable: Willingness to Pay (WTP)**

| Independent variables | Co-efficient | Marginal effects |
|---|---|---|
| Constant | 1.3729 (5.01)*** | 5.40 |
| Age | -0.0069 (-1.93)** | 0.50 |
| Sex | -0.2494 (-2.65)*** | 0.01 |
| Income | 1.1419 (1.28)* | 0.20 |
| Distance | -0.0005 (-1.89)** | 0.05 |
| Health cost | -5.2404 (-0.27)** | 0.78 |
| Wage loss | 3.2491 (0.19)* | 0.84 |
| Primary | -0.2203 (-1.18)** | 0.23 |
| High school | 0.2808 (1.99)* | 0.04 |
| Degree | 0.2788 (1.45)* | 0.14 |
| Private | -0.2086 (-1.46)** | 0.14 |
| Government | -0.2239 (-1.38)** | 0.16 |
| Business | 0.0175 (0.10)* | 0.91 |
| Fairly affected | -0.0279 (-0.32)** | 0.74 |
| Highly affected | 0.0272 (0.31)* | 0.75 |
| Sigma | 0.381665 | |
| Likelihood function | -58.5408 | |
| N | 100 | |

Source: Computed primary data

Note: figures in parenthesis show the z-value

*Statistically significant at the 1% level

**Statistically significant at the 5% level

***Statistically significant at the 10 % level

Under this Tobit model, each variable has its own significance. In this model, the actual value of WTP is directly linked with the respondent's willingness to improve air quality. If the coefficient sign is positive, one unit increases in age when other things remaining constant, would increase the WTP amount by about 0.50 percent. Sigma value (0.3816) is highly significant. Because of this OLS is an unbiased estimate, which is highly significant, and it shows that leaving the sample lead to selection bias. Same is the case with that of the variable sex. It would increase the probability of WTP by about 0.01 percentages for 1 percent increase in sex ratio. Income has a probability of increasing WTP by about 0.20 percent. If the distance is decreases, the probability of WTP increases by 0.09 percent. Health cost and wage loss have got direct influence on WTP. It would increase the probability by 0.108 percent and 0.011 percent respectively. Education has much influence. As expected it had improved the WTP amount at each level of education namely primary, high school and degree level by about 0.23 percent, 0.04 percent and 0.14 percent respectively. Occupation as private employee has negative influence on WTP amount. Private employees are less worried about the deterioration of air quality and less concern to improve the air quality due to low wages. So, as predicted in theory so many reasons influence them to deviate. It has negative sign and insignificant too. But the variables government employees and business group has positive effect on WTP. In contrast business group variable one unit increase would influence the WTP by 0.91 percent as against the government employee variable, which is just 0.16 percent. The respondents have responded to the personal health loss due to air pollution as a subjective variable which influences an increase in WTP amount by 0.74 and 0.75 percent respectively for fairly affected and highly affected variables. Thus, the Tobit model is a good model fit enough to explain the results.

## CONCLUSION

The increasing threat posed to human health as a consequence of deteriorating air quality in Manali industrial area of Chennai has become burning issue in recent years. This research paper has attempted to introduce environmental tax in order to improve air quality by the way of WTP. The results of the WTP indicate that health cost and preventive cost per household has increased drastically due to air pollution. The survey result shows that the respondents are well aware of present air quality and the necessity of their participation to restore the same. The study results also give a positive scope for introducing environmental tax. Most of the WTP studies carried out in developing countries in the past have been mainly limited to the estimation of user's mean WTP and sometimes been controversial. This research has attempted to extend the use of WTP survey results indicating that charging for improving the air quality for Manali may not have negative impact amongst the public. In this case of observed behaviour method, the assumptions made about the use of WTP for air quality improvement services may be far from true in the developing Countries. Also, there could be difficulties in charging excessive amounts as WTP because of low levels of education and incomplete perception about environmental values due to lack of awareness. The paucity of adequate data on the degree of air pollution and its effects on people's health cannot screen the fact. Generally, the community and nature in general can only be speculated but the fast deteriorating trend of the air quality of the Manali industrial area can never be denied. It has been shown that nearly 85 percent of the pollution comes from industrial activities as a result of which the cost of medication was estimated to be Rs.3, 91,920 only for sample population. If the present quantum of air pollution continues to exist in future without taking preventive steps to control it, the society's cost of health expenditure may give huge burden among the people. The most important requirement is to do the design of environmental management plans. A tremendous air quality database needs to be revitalized for public domain for further research. Hence, the prevalence of diseases is more compared to developed countries. On top of that, air quality must be monitored round the clock and real data will be displayed for public domain for further research.

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