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***THE VALUE OF IMPROVED AIR QUALITY:  
A CONTINGENT VALUATION STUDY ON  
WONJI TOWN(ETHIOPIA)***

124

***BY  
ESSEY TAKELE***



***A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN  
PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE IN ECONOMICS (ECONOMIC POLICY ANALYSIS)***

***MARCH, 2000***

**ADDIS ABABA UNIVERSITY**  
**School of Graduate Studies**

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on Wonji Town (Ethiopia)*

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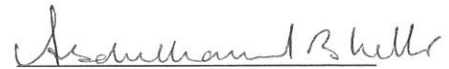
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12/4

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## DEDICATION

This work is dedicated to my late brother, Solomon Takele. And also to my mother,  
Ejigayew Bedaso

## Abstract

The purpose of this study is twofold: (i) To estimate the benefits of reduction in air pollution in wonji town. (ii) To identify the variables which determine willingness to pay for air pollution reduction.

The contingent valuation method was used for investigation. The survey is based on a sample of three hundred thirty two households. The study reveals that most people are aware of emission problems and willing to pay to reduce it. Censored data (300) was used to analyse the determinants of WTP, and to estimate benefits.

Both Tobit and ordered probit models were applied to capture the effects of some variables such as distance from the polluter factory, wealth, income, education, pollution related diseases, etc. The signs of coefficients, except pollution related diseases, are as expected. Wealth, education, distance from polluter, interest in environmental problems and concern for future generations have significant impact on WTP. The estimated benefit, using frequency distribution, is nearly 29,000 birr per month. On the other hand, the benefit, using the mean WTP, is nearly 31,000 birr.

These benefits may help to finance measures which could reduce the pollution level such as improved quality fuels, operational and maintenance improvement, and pollution control equipment improvement/installation.

## ACKNOWLEDGMENT

No word of thanks and gratitude is sufficient to appreciate what the God has done for me.

My special thanks are extended to my advisor, Dr. Alemu Mekonen, for his professional and helpful comment which has made this a better work. I would like to thank all individuals and institutions who have helped me to this end.

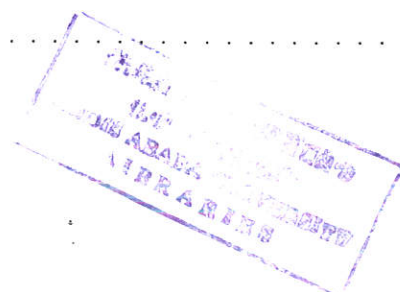
My loving thanks goes to my family for their prayer and moral support which contributed so much for all my achievements. Thanks to my colleagues, Taddese Ababu, Solomon Kidane, Zerheun Maru, Luelseged Asefaw, Habtamu Denboba and others for their helpful comment and encouragement. My appreciation also goes to W/t Bizunesh Wondium who has helped me in typing this paper.

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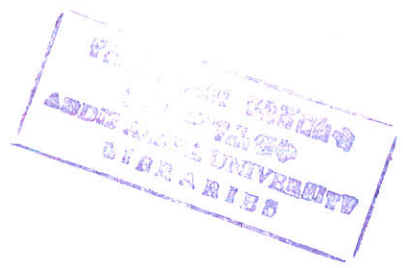
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## Acronyms

CVM =	Contingent Valuation Method
CSA =	Central Statistical Authority
HPM =	Hedonic Pricing Method
KM =	Kilometre
NGO =	Non-Government Organization
TCM =	Travel Cost Method
WTA =	Willingness to Accept
WTP =	Willingness to Pay

## CHAPTER 1

### 1. INTRODUCTION

#### 1.1 Background

Early economists concentrated on development issues and search for optimal growth without considering the externalities of the policies they proposed. They failed to recognize the role of environmental resources as economic goods.

Nowadays, a project to be implemented must take into consideration environmental and social impacts. Tension may exist between the private gains and social costs, short run and the long run resource use sustainability and between national objectives and international responsibilities (Turner, 1993).

Moreover, the 1992 "Earth Summit" in Rio de Janeiro concludes that without better environmental stewardship, development will be undermined, and without accelerated development in poor countries, environmental policies will fail. Practical evidence, in Sub-Saharan Africa, shows that "Slash and Burn" approaches to agriculture are creating vicious cycles of soil degradation and impaired productivity. In some cities like Bangkok, Sao Paulo and Mexico City, the polluted water and air are a serious cause for health damage (Serageldin, 1993).

Policies aimed at controlling pollution in developing countries are far from being adequate to control or improve it with minimum cost. For some of these countries, policies to control pollution level do not even exist at all. For example, imports of

heavily polluting used cars and machinery are not subject to any emission constraints. There are several reasons for the ineffectiveness of these policies in these countries. One reason, according to World Bank's Annual Report on the Environment, 1990, is the weakness of monitoring, enforcement and regulatory capacity. For instance, in Mexico, the influence of regulation has been limited by the resources of the enforcement agency and the low level of fines. The other one is that these policies are often poorly designed meaning that they would have been both weak and unnecessarily costly even if they had been implemented vigorously. For example, emission regulations in developing countries frequently provide no incentives for polluters to choose least-cost abatement options. Also general economic policies often aggravate the problems of environmental policies because environmental effects are not considered when such economic policies are designed (Eskleand et al, 1991).

In Ethiopia, policy makers do not seem to consider environmental problems as an important issue. Many environmental policies, such as air pollution control policy, have not been developed yet. Although environmental effects are not considered, in Ethiopia, as a basic factor in economic activities, degradation of the environment has its own effects on human health and can be a cause for poor economic performance. So actions for stopping this environmental degradation are urgently needed.

In case of Wonji town, residents have problems to deal with, and urban air quality may not be put as a priority but it is expected to be one of the sensitive problems. The town of Wonji is located 107 Km east of the capital of the country. Several factories such as sugar, pulp and paper, and candy are found in the town. Total number of inhabitants is

19,653 based on the 1994 population census of CSA. Most of the people are either employed in factories or engaged in small scale commercial activities.

Since government intervention towards reduction or alleviation of pollution is very weak or non existent, pollution usually affects the well-being of many individuals. So the demand side of the issue needs to incorporate in reduction of air pollution. Socio-economic factors, demographic and attitude factors are believed to determine demand for air quality. The aim of this case study is to estimate the benefits of a 50% air pollution reduction. Moreover, this benefit may be important to provide information for guiding government policy regarding new investment such as provision of air quality service.

## **1.2 Statement of the Problem**

Different types of pollution, such as air, water and land, have a problem to current and future generations. Air pollutants are known to be a cause for health and environmental damages. They also affect different productive sectors, damage materials (by corrosion), and have a negative ecological impact. In US, 90% of total health damages are caused by air pollution (Freeman, 1982). In Mexico City, 20 million inhabitants are affected by air pollution that comes from 2.6 million motorvehicles and 30 thousand industrial firms (Eskleand et.al, 1991). There are women and children who suffer from indoor air pollution that results from burning unclean bio-fuels. For example, smoke in household kitchens in poor rural areas of the Gambia, India and Kenya routinely have suspended particulate matter of concentrations exceeding World Health Organization peak guidelines by four to five times (Mink, 1993).

In the particular case of Wonji town (industrial area), high concentration of particulate matter (Visible smokes consisting small dust particles) has been one of the environmental problems. The high concentration of particulate matter can damage human health and reduce people's well-being through:

1. Lost earnings (wage)
2. Reduced life expectancy
3. Increased medical expenses associated with treating pollution born diseases.
4. Expenditure associated with attempts to prevent pollution born diseases.
5. Disutility related with pain and lost opportunity for leisure activities.

Since reducing pollution will be beneficial to individuals or society because it reduces some or all these adverse effects, there is a need to investigate the demand for improved air quality. Therefore, this study focuses on using the contingent valuation method (CVM) in order to understand the fundamental importance of the value that people living in Wonji place on reduced air pollution.

### **1.3 Objectives of the Study**

The main objective of this study is to estimate the willingness to pay for a 50% air pollution reduction in Wonji town.

Specific objectives of the study are to:

- Elicit willingness to pay of people living in Wonji for 50% reduction in the level of particulate matters caused by the industrial sector (sugar factory) based on household survey.

- Describe the relationship between willingness to pay (WTP) and factors such as socio economic, demographic and attitude.

#### **1.4 Significance of the Study**

It will be an additional contribution to few studies that have been undertaken in the past to evaluate environmental goods in Ethiopia. It should be noted that very few studies on the subject have been attempted in Ethiopia and none for Wonji town. Therefore, this study will provide a basis for further empirical study on the subject. Moreover, the result of this study is expected to be of interest to the Regional Government, NGOs and the Central Government in providing information for guiding policy in relation to environment.

#### **1.5 Hypotheses to be tested**

- The respondents in the area near to the polluter are more willing to pay for improved air quality than those farther away from it.
- There is a positive relationship between WTP on the one hand and education and income on the other.
- Respondents who are affected by pollution born diseases are more willing to pay for pollution reduction than those not affected.

## **1.6 Outline of the Study**

The remaining chapters are organized as follows: Chapter II deals with literature review. Chapter III describes data collection and estimation methodology while chapter IV deals with results and discussions. The last chapter presents conclusion and policy recommendation.

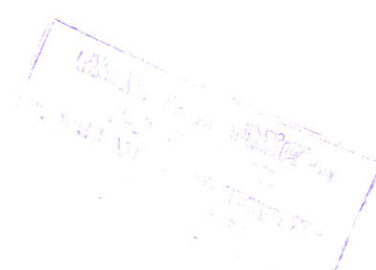
## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Theory of Non-Market Valuation

Environmental goods and services often do not have a market value and are considered as public goods with uncertainty that usually encircles their real value and significance.

Theory of environmental resources valuation has encouraged economists, both in intensity and scope, in valuing an increasing number of environmental goods and services around the world. Increasing complexities, in designing procedures and analytical structures, have enhanced the optimism of economists about using non-market valuation as a basic instrument to assist decision making. Practically, non-market valuation faces a critical problem in understanding how people perceive these services and how they value changes on the genetic, species, regional and global scale. At present, economists suggest a solution for this problem by forwarding the concept of total value which consists of both use value (direct, and indirect and option) and non-use value (option and existence). Use value is the economic value of current use. Non-use value is the sum of existence and option value. Option value is the value to preserve the resources for potential future use. Existence value is, extreme concentric view as conservation, the value that attached to only existence resource (especially for endangered species) (Hanley et.al, 1997).



### **2.1.1 Valuation Methods for Non-Market Goods**

There are various methods available to estimate the economic value of non market goods or environmental resources. To indicate some of these methods: (i) Revealed Preference (indirect) Method which consists of Travel Cost Method (TCM), Hedonic Pricing Method (HPM) and Production Function Method (PFM). (ii) Stated Preference (direct) Method ie, survey method using Contingent Valuation Method (CVM). (iii) Non Preference Method which includes Shadow Cost Method (Opportunity Cost) and Implicit Valuation (Hovenenagel, 1994).

The first two approaches are widely applied in estimating the economic value of environmental resources or non-market goods. Especially, HPM, TCM and CVM are, in most researches, used in assessing the value of the environment.

#### **2.1.1.1 Hedonic Pricing Method (HPM)**

This method attempts to estimate the price of environmental goods based on the market price of heterogenous goods such as house, automobile and production factors (labour, land etc.). This means, when the quality or quantity of heterogenous goods changes, the value of environmental goods will change for both consumers and producers. This follows the works of Lancaster (1966), Ridker and Henning (1967) and Freeman (1982). From the above works we understand that consumers consider the level of environmental quality (such as air quality) in addition to other characteristics of a house when deciding about their location for living and that house prices are expected to differ depending on the environmental quality.

The advantage of HPM is that the resulting benefits are based on market behaviour such that it can be used to estimate the value an individual places on reduced air pollution. However, this method may not be suited to this research because there is no well developed housing market in the area under study. It needs also some assumptions otherwise the results may be unrealistic.

#### **2.1.1.2 Travel Cost Method (TCM)**

TCM is mostly used to estimate the value of recreational sites using the information on the time and money spent to get to a recreational site. In other words, it includes the costs of transportation, fuel and toll together with a monetary value for travel time and time spent on the site of recreation to determine what people have to pay to get into recreational sites. Different studies have used TCM to estimate WTP for different environmental resources. For example, study on water base recreational activity by Desvougues et.al (1983); a study on Coastal Wetlands by Sellar et.al (1985); Loomis (1987) reviewed several travel cost works that estimated the benefit of different land waterway flows. Eventhough TCM is advantageous in measuring benefits based on actual behaviour, it is restricted to use values of resources. And for this study, TCM is not applicable because there is no recreation site that is affected by air pollution in the study area.

The above two indirect approaches (TCM and HPM) are not always used to estimate the value of environmental goods or intangible goods. For example, they are unlikely to estimate non-use values because they depend on the actual market situations such as buying a house etc.

### **2.1.1.3 Contingent Valuation Method (CVM)**

CVM is a direct approach to estimate the WTP/WTA of an environmental good (both use value and non use value). It attempts to elicit information on how much individuals would be willing to pay or accept for a specified environmental quality improvement or deterioration. CVM was first applied in the early 1960's by R.K. Davis (1963) to estimate the benefits of outdoor recreation in Main Backwoods area. Since then, it has been widely used to estimate the values of environmental goods without market data.

The CVM can be conducted using various ways such as mail, telephone and personal interview. A CV study in developing countries should be conducted through face to face interview to be more accurate. If resources are available to properly train and supervise enumerators, it can provide good quality data. A CV questionnaire typically consists of three parts:

i Hypothetical description of the proposed good or service:

It is the first part of the questionnaire that presents enough information for the respondent to consider the value of the proposed goods. For example, diagrams or pictures may be used to describe the proposed good.

ii Willingness to pay or accept question:

It is the second section of the questionnaire that helps to determine how much an individual is willing to pay for the service or to accept in compensation for welfare loss. There are several techniques that can be used to estimate WTP.

- a. Open-ended question:- the respondents are asked a direct question about the maximum he/she is willing to pay for the good or service. It is highly exposed to strategic bias (free-rider problem). It also needs more effort to estimate maximum WTP.
- b. Iterative bidding:- a set of yes/no questions as to whether or not she/he wants to pay for a specified amount of a good or service. If a starting price is accepted, the interviewer suggests higher and higher amount till the maximum WTP is reached. If the initial bid is rejected, the interviewer should revise the starting bid downward until the maximum WTP is reached. This shows that the bidding process can be affected by starting bid (Cameron and Huppert, 1988).
- c. Payment cards:- the respondents are asked simply to choose and circle the maximum amount they would be willing to pay from a given range of values, beginning at zero. Like dichotomous choice, it minimizes respondents' effort. It was introduced as an alternative to iterative bidding to minimize starting point bias (Mitchell and Carson, 1989).
- d. Close ended referendum or Dichotomous Choice (DC):- one can ask the respondent a single yes/no question to take it or leave it for the good/service being valued. The above techniques (a,b, and c) analyse quantitative responses but DC analyses qualitative answers so that it provides much less information about the respondents' actual preference. It avoids a strategic reason to answer untruthfully (Haneman, 1994). It is more difficult for the respondents to influence the mean willingness to pay i.e DC reduces incentives for the respondents to either overstate or understate their WTP.

### **iii.Characteristics of respondents:**

The last part of CV survey consists of socio-economic, attitude and demographic characteristics of the respondents or his/her family. For instance, income, education, family size, etc. of the respondents.

The information obtained from questionnaires will be used to analyse the responses in different ways. These ways include examining the frequency distribution, looking at cross tabulation between WTP and socio economic characteristics as well as using regression analysis.

#### **2.1.1.3.1 The Advantages of CVM**

CVM is the only method that can measure non-use benefits and willingness to accept values. The results of most CV studies have been shown to be broadly consistent with the results of market based valuation studies. In general, it is advantageous in many respects compared to other methods:

- (i) The applicability of this method is larger compared to the other valuation methods in terms of completeness.
- (ii) It is able to measure a wide range of goods, including those not yet supplied in a manner consistent with economic theory
- (iii) This method can measure non-use values (comprehensiveness) and option values in case of risk and uncertainty.
- (iv) It has been judged as being superior due to its potential validity and ease with which the method can be implemented (Hovenenagel, 1994).

**Table 1 Comparison of four valuation methods**

Methods	Potential validity	Comprehensiveness	Completeness	Ease with which the method can be implemented
Production	+	-	+	+
Hedonic price	+	+	-	+
Travel Cost	+	+	-	+
Contingent Valuation	++	++	++	++

**Source: Hovenenagel (1994: 128)**

- ++ Represent high position
- + Moderate position
- Represent less than minimal position

#### **2.1.1.3.2 The Disadvantages of CVM**

According to Seip and Strand (1992), the hypothetical situations that are described in CV survey do not analyse the actual behaviour, people have little experience in making explicit decisions about the value of non-marketable goods. So it becomes more difficult to understand than other survey methods. The CV method of measurement depends on the institution of property right. This concerns the way in which property rights are defined and enforced. If property right is on the side of polluters, WTP is a correct measure of consumer surplus because the respondents should contribute to obtain social benefits from the project. If property right belongs to the society at large, willingness to accept (WTA) will be appropriate because the respondents would need to be compensated for their loss in welfare. A CV survey technique is subject to a number of biases which may affect the reliability of the result.

**Free-riding and Strategic bias:-** If respondents think of giving specific answer so that the service will be provided, they may tend to overstate their preferences especially if the service is related to a public good. On the other hand, a respondent may understate his preference to get the service free of charge (free-ride). This difference, between the true value and over/under stated value, is termed strategic bias. This kind of bias can arise due to other reasons. Respondents may not give appropriate answers to some kinds of questions in specific ways due to cultural reason or the respondent answers only to please the interviewer (compliance bias). However, if the survey is well designed and interviews are properly conducted, one can minimize these biases.

**Hypothetical bias:-** This bias relates to the possibility that respondents may fail to take the survey seriously. Since he or she will not have to pay the estimated value, the respondent may treat the survey casually, providing ill-considered answers. If the proposed scenario is not clear to the respondents, it will be exposed to information bias. To minimize these biases, the scenario should be realistic, believable and accurate as much as possible.

**Starting Point bias:-** This is normally associated with bidding games. There is a view that the choice of low/high starting point leads to a low/high mean WTP (Bateman and Turner, 1993).

Theoretically, WTA and WTP are supposed to provide almost the same results, but practically they give different estimates i.e, the estimated value of the WTA tends to be

greater than WTP (Turner, 1993). Russel (1982) held the view that the difference between WTP and WTA in empirical studies is by chance and should not be taken seriously. Knethsh (1993) understood the difference to be significant and argued that people tend to underestimate what they must pay for and overestimate what they receive so as to be advantageous. If CV surveys are properly planned and executed, most of the problems can be minimized to an acceptable level. Besides, since the level of accuracy can be affected by sample size and the description of the market scenario, the sample should be representative and the respondents are provided with detail information about the good to be valued by way of a hypothetical market.

## **2.2 Economic Theory and CVM**

CV (direct approach) method is not related to traditionally used definition of consumer surplus as the area under Marshallian demand curve and above price level. This fundamental theoretical problem arises from the presence of "income effects" which makes Marshallian Consumer Surplus inaccurate measure of welfare change. With environmental public goods, the goods are often unpriced, the individual usually faces a quantity rather than a price constraint. Usually, these goods have also a much higher income elasticity than market goods due to change of quantity and low elasticity of substitution (Turner, 1993).

So, to solve the problem, there is a need to compensate for the income effects by holding real income constant. In other words, we have to move from an ordinary Marshallian demand to Hicksian demand. If the proposed change is welfare increasing then the

appropriate measure is the compensating surplus. This measure can be explained as the "Consumer's maximum willingness to pay in order to gain the quantity increase and still maintain his initial level utility" (Mitchell and Carson, 1989).

But, in real world, estimation of demand function for environmental goods is very difficult due to lack of sufficient market information. CVM is the best technique to solve the problem by creating market scenario that resembles true market situations for goods and services. By using CV survey, maximum willingness to pay data is obtained which is important to construct demand curves and to estimate the consumer surplus for the change in quantity of environmental goods.

The utility function,  $U(X,Z)$ , will depend on market goods  $(X_1, \dots, X_n)$  and non market good  $(Z)$ . We assume that  $U_x, U_z > 0, U_{zz} < 0$ , where subscripts denote relevant partial derivatives. Using Marshallian approach, individuals are assumed to maximize their utility (1) subject to budget constraint (2)

$$\text{Max } U = U(X,Z) \dots\dots\dots(1)$$

$$\text{St. } PX - Y = 0 \dots\dots\dots(2)$$

Where,

$P(P_1, P_2, \dots, P_k)$  is price of market goods and  $Y$  is income of the consumer. Since consumers level of utility has a non-decreasing relation with all its determinants ( $X$  and  $Z$ ), the improvement or increase of non-market good cause to move (increase) utility level from  $U_0$  to  $U_1$ .

$$U_1 (X, Z_1, Y) > U_0 (X, Z_0, Y) \text{ Where, } Z_1 > Z_0$$

On the other hand, Hicksian approach assumes that an individual would minimise expenditure (3) subject to the given target level of utility (4)

$$\text{Min } PX = Y \dots\dots\dots(3)$$

St.

$$U(X,Z) \geq U \dots\dots\dots(4)$$

By applying the Lagrangean method with some manipulations, we can obtain the expenditure function (E),  $E = E (P,Z,U)$ . The derivative of E with respect to Z gives Hicksian inverse demand function which tells us the amount of income that must be sacrificed to hold utility constant when the specific level of Z changes (Hovenagel, 1994).

$E(P,Z,U) = Y$  where Y is the minimum income needed to maintain utility level (U)

Here, we assume that the consumer will prefer  $Z_1$  to  $Z_0$ . The compensating surplus (WTP) for increase in Z from  $Z_0$  to  $Z_1$  can be represented by the difference between two expenditure functions with different environmental goods change (such as air quality).

$$CS (WTP) = E (P,Z_1, U_0) - E (P,Z_0, U_0)$$

Hence, for a proposed welfare gain (i.e change in the provision of environmental goods which increase utility, for example less pollution), the compensating surplus tells us how much money income individuals are willing to give up (WTP) to ensure that the change occurs (Bateman and Tuner, 1993).

## **2.3 Empirical Literature Review**

CV Survey has been a widely applicable method in valuing reduced air pollution, water quality improvement, ecologically important species, etc. There are over 2000 studies in the world where the CVM has been used to value different types of environmental amenities (see Carson et al, 1995). Until 1987, the application of CVM was limited in developed countries but few available works suggest that it can be successfully applied in developing countries as well [Whittington et.al (1990 and 199), Boadu (1992), Fissaha (1997), Alemu (1997), Rogat (1998) and Belhaj (1998)].

### **2.3.1 CVM Application on Reduced Air Pollution**

In Morocco, Belhaj (1998) adopted CVM using iterative and dichotomous approaches in valuing WTP to reduce air pollution in Rabat Sale cities, based on a survey of 400 households. The majority of the households in the survey (93%) were aware of environmental problems and 36% of them gave priority to environmental pollution problems in the area. Furthermore, 56% of the respondents agreed that the authorities are indifferent to reducing emissions. The study, using iterative approach, established WTP to reduce air pollution with a mean of 67.25 Dirahms and a median of 50 Dirahms per month while for dichotomous choice mean and median were 63 and 60 Dirahms per month respectively <sup>1</sup>. The results, especially the means, differences between iterative and dichotomous approaches are insignificant.

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<sup>1</sup> The exchange rate used was 1 US\$ = 8.4 Dirhams

The result of the probit and generalized Tobit for CV study indicates that there is a decrease interest to control emissions as age increases, and high WTP as income increases. To check the impact of family size on WTP the researcher replaced both income and family size by ratio of family size to household income in the probit model and the result is found to be highly significant implying that large families care about the future and are willing to pay for quality air. The result of the marginal effect for a women is -0.11, this may be interpreted as women are responsible for household economy and constrained by its budget.<sup>2</sup>

Rogat (1998), used a CV survey (iterative approach) to estimate willingness to pay among citizens living in Santiago de Chile for a 50% decrease in the level of pollutant emissions from transport sector, based on the responses obtained from 1000 households. 59% of the respondents were aware of environmental problems. Only 17% of the respondents gave first priority to environmental problems although the problems have been very serious. The study tried to explain why the respondents gave low attention as follows:-

- a. Maybe developing countries give poor attention for it, simply due to lack of basic needs they do not want to think about other issues.
- b. Maybe due to the existence of air pollution problems for a long time, it has been accepted as part of their life.

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<sup>2</sup> Dummy Variable which takes the value one for women

- c. May not consider it as a serious problem compared to other problems such as poverty.

In the study, the average WTP for monthly payment was US \$ 17, and US\$ 53 for lump-sum-payment. Income, education, car ownership, degree of attention for future generations and concentration level of particulate matters are factors that influence WTP the most. Other factors such as gender, age, pollution related diseases were seen to be less influential.

Shechter et.al (1986) adopted a CV survey to estimate the WTP for 50% reduction of pollution level, based on data obtained through a large-scale household survey in Israel. On the average, an individual living in moderately polluted neighbourhood would be willing to pay a yearly sum of WIS 37.9 (\$1USA = WIS 25.2). The regression (OLS procedure) from CV study indicated that most of demographic and socio-economic factors significantly influenced WTP.

Brookshire et al.(1982) tried to estimate households' WTP for reduction of air pollution in U.S.A, using a CV survey, based on information gathered from 290 respondents. The results of the study indicate that people were willing to pay for improved air quality, implying that the survey method (CVM) is valid in measuring the value of environmental goods.

### **2.3.2 CV Application on Some Other Resources in Ethiopia**

Fisseha (1997) used a CV survey to estimate the WTP for better water quality, using 266 respondents, in Maki town. The questionnaire was designed to test for strategic and starting point biases, and they were not statistically significant. Half of the respondents have not been satisfied by current water quality and need better water quality provision with higher charge than the current price. Income and time spent to fetch water have a significant impact on WTP. Other factors such as education, occupation and number of domestic animals owned are insignificant.

Alemu (1997) assessed, using CVM, the value of community forests in Ethiopia, based on a rural household survey. Income, household size, number of trees owned, sex of household head and distance of homestead to plantation have a core role to determine WTP. The conclusions of the paper indicate that household specific and local factors should be embraced to assure local sustainability of community afforestation projects.

Dunffa (1998) adopted a contingent valuation method to estimate the willingness to pay for improvements in water quality, in Adia-Liben district. WTP for improved water has a positive and significant relation with income, distance to fetch water, quality of current water source and credit. Education, family size, wealth and female household head have a positive impact on WTP but insignificant. Dunffa recommends that improved rural water has to be given for households that use low water quality such as river and lake. And also local authority should make price revision (charging higher tariff) and use the increased revenues to invest in and maintain better water quality supply services.

Girmma (1998) used CVM to determine the benefit of Abiyata-Shalla Lakes National Parks. Visitors income, length of visit in a day, year of acquaintance with park, park stock and the ratio of visit costs to ease access were used as explanatory variables and found to have significant impact on WTP.

Moges (1999) applied a CV survey to estimate the WTP for the Tana Recreation site, based on 200 households. Income, level of education and family size were found to have a significant impact on WTP. The study puts these points as recommendation:-

- a. The lake should be protected as a park to get better benefits.
- b. Entrance fee for domestic visitors has been one birr per person but the survey results indicate that, on average, the respondents are willing to pay more than four times the current charge so that authorized body should consider it and can increase the revenues.

Based on various studies that have been carried out in both developed and developing countries, among other techniques, CVM has shown promise as a powerful technique to estimate the economic benefit of the provision of non market goods.

## CHAPTER III

### DATA COLLECTION AND ESTIMATION METHODOLOGY

#### 3.1 Data Source

The data source of the study is primary data that was generated from a CV survey conducted on selected sample of households, using face to face interview with a member of the household,<sup>3</sup> in Wonji town from October 21 to November 9,1999. Besides, it is supported by the secondary data that was obtained from different sources such as the Town's Hospital, CSA and Sugar Factory's information and public relation department.

#### 3.2 Sample Selection

Random sampling technique was applied to draw samples from the entire households. It is desirable to have a large sample as much as possible but limitation in time and cost hindered the sample size to a total of three hundred thirty three, i.e 8.5% of the total households<sup>4</sup>.

#### 3.3 Design and Administration of the CV Survey

Except for some adjustments, the design of our CV survey questionnaire follows the recommendation by Mitchell and Carson (1989).

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<sup>3</sup> The youngest respondent in the survey was 18 years .

<sup>4</sup> Based on C.S.A (1994), total number of households in the town was 3918

The questionnaire has three parts. The first part of the questionnaire presents an introductory statement and questions that are directly related to air pollution problem which include describing the hypothetical market, why the study is being conducted, what instrument will be used to reduce the pollution and which institution will be responsible for delivery of the service.

The second part of the questionnaire tries to determine how much the respondent values the service. Based on the pretest, we felt that the bidding game question format worked better than open ended questions. Respondents generally felt more comfortable with the bidding game format (easily understood) because it was similar to the ordinary kind of the bargaining that goes on in local markets of the town. Therefore, we used the bidding game questions in the elicitation section.

Answers were elicited in terms of "yes" or "no" to questions expressed in the form "would you pay amount X...?". A "Yes" answer would lead the enumerator to raise the amount and repeat the question, may be several times, until a "no" answer was obtained. A "no" answer would lead the enumerator to reduce the amount until a "yes" answer was obtained.

It was emphasized that the respondent was to assume that the vehicle for payment used in a particular game was the only possible way in which air quality improvement could be obtained. If a respondent indicated that he/she was willing to pay nothing at all, he/she was asked a question to find out why. A respondent indicating that he/she did not

consider his/her household to be harmed by the emissions or income constraint was recorded as bidding zero. If a respondent indicated that his/her zero bid was in protest against the game (a respondent said the polluter factory should be responsible for the problems), his answer was considered as a non response to the bidding game <sup>5</sup>

It is a challenging task to determine the percentage of air pollutants reduction and to explain the problem for respondents before the WTP questions. Some studies used photographs of visibly polluted and relatively clean days to show pollution effects. Summer (Bega) and winter (Kiremt) days were used to display air pollution problem in the survey town. This means, in the summer, the sugar factory working time, the air is highly polluted compared to winter days. Getting enough information for accurate description of the degree of reduction has been difficult. However, the study used fifty percent in order to ask the respondents' willingness to pay for improved air quality [since the concept of "half" is more simple to understand compared to other percentages as in Shechter et.al (1991)].

The last part of the questionnaire includes questions about the socio-economic and demographic characteristics of the respondent and her/his family such as income, education, family size, etc.

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<sup>5</sup> "For the purpose of estimating the benefits of abatement, the treatment of "protest bids" as non responses is legitimate. By definition, a "protest bid" recognizes that positive benefits from abatement exist, but registers a protest against a particular methods of financing abatement. We recognize that the elimination of "protest bids" from analyses aimed at estimating the benefits of abatement fails to remove all downward bias from the responses to particular games: some respondents may bid low (i.e., underestimate the benefits to themselves of abatement) in conscious or subconscious protest against the method of financing assumed in a game" (Ives etal, 1974).

### 3.4 The Field Procedure

Eight individuals served as interviewers and questionnaire administrators. Some of them had an exposure to college education and a good experience as interviewers.

The questionnaire was pre-tested before conducting the final interview. Thirty nine households were selected for pilot survey which helped us from two directions:

- i) To reconstruct the questionnaire formats through discussion.
- ii) To determine the starting values of the bidding game in the elicitation part of the questionnaire.

During the pilot survey, the respondents were asked to state their maximum willingness to pay for a 50% reduction of pollution. Several responses were observed ranging from 0 to 40 birr. The starting bids used in the final survey were median, first quartile ( $Q_1$ ) and third quartile ( $Q_3$ ).

5 Birr ( $Q_1$ )	10 Birr (median)	15 Birr ( $Q_3$ )
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We divided randomly the total sample into three equally sized groups and different starting values were given to each of them.

### 3.5 Model Specification

The information obtained from a CV survey can be analysed in two ways:

- i) By using descriptive statistics.
- ii) By applying multivariate techniques.

#### 3.5.1 The Models

Iterative bidding requires the use of accurate models for estimation. In this case, estimation with ordinary least squares (OLS) would not be efficient because the dependent variable includes a large number of zeros. To see which method better fitted the data, Tobit and Ordered probit models are used.

##### The Tobit Model

One referred to as the censored regression model or Tobit model proposed by Tobin (1985).

The following form can explain the type-one tobit:

$$MWTP_i = \alpha + \beta X_i + \epsilon_i \text{ if } MWTP_i > 0$$

$$MWTP_i = 0 \text{ otherwise}$$

where,

MWTP<sub>i</sub> = The mid point of WTP interval in the bidding game.

$\alpha$  = Intercept

B<sub>i</sub> = Parameter

X<sub>i</sub> = Independent variables

$\epsilon_i$  = Disturbance term.

### The Ordered Probit Model

The observed dependent variable obtained from the bidding game procedure is not the maximum amount of WTP but, rather, an interval within which the "true" WTP falls. Therefore, we used in this study also the ordered probit model:

$$A_h = \alpha + \beta X_h + \epsilon \dots \dots \dots (1)$$

where,

A<sub>h</sub> represents household willingness to pay for reduction of air pollution, X<sub>h</sub> is a vector of household characteristics,  $\alpha$  and  $\beta$  are parameters of the model, and  $\epsilon$  is a random term. A<sub>h</sub> is not observable from the bidding game so it is difficult to estimate Eq (1). However, from respondents' responses we know the ranges within which A<sub>h</sub> will fall. Let  $\pi_1, \dots, \pi_n$  be the n prices which divide the range of WTP space into n + 1 categories, and T<sub>h</sub> be a categorical variable:



$$\begin{aligned}
T_h &= 1 \text{ if } A_h \leq \pi_1 \\
&= 2 \text{ if } \pi_1 < A_h \leq \pi_2 \\
&= n + 1 \text{ if } \pi_n < A_h
\end{aligned}$$

Let  $i = 1, \dots, n + 1$  from Eq (1), we have  $T_h = i$  if

$$\pi_{i-1} < A_h < \pi_i$$

or

$$(\pi_{i-1} - \alpha - \beta X_h) < \epsilon < (\pi_i - \alpha - \beta X_h)$$

we assume  $\epsilon$  follows a standard normal distribution

$$\begin{aligned}
P(T_h=i) &= P(\pi_{i-1} < A_h < \pi_i) \\
&= F(Y_i - \beta X_h) - F(Y_{i-1} - \beta X_h)
\end{aligned}$$

where,

$Y_i = \pi_i - \alpha$  and  $F(\cdot)$  is cumulative standard normal density function (Green, 1993).

Results from the model are obtained by using maximum likelihood estimation. And entering the probabilities into log-likelihood function yields,

$$\begin{aligned}
\text{LnL} &= \sum_h \text{lnL}_h = \sum_h \text{Ln Prob} (T_h = i) \\
&= \sum_h \text{Ln} [ F (Y_i - \beta X_h) - F(Y_{i-1} - \beta X_h) ]
\end{aligned}$$

With the help of the computer package LIMDEP, version 7.0, we can obtain the estimates.

### **3.5.2 Description of Explanatory Variables**

#### **Households income (HHI)**

Households are expected to get an average monthly income from different sources in the town such as employment in a factory, pension security and small business activity. Households with higher income may have stronger preference for an improved air quality and are willing to pay for the proposed service. Ordinary demand theory supports this hypothesis except for inferior goods.

#### **Household head education (HHE)**

Educated persons have more potential to understand the problems which are caused by air pollution emissions such as pre-mature death, disutility related to health damage, material damage and ecological impact than the illiterate ones. Educated household heads (HHE), therefore, may give special attention to better air quality and have a higher WTP.

#### **Family size (FS)**

The willingness to pay for improved air is expected to increase as family size increases ie, households with large family more care about their family.

### **Children size <sup>6</sup> (CS)**

Individuals having children would be thought to care about the environment in which their children will grow up. So families with more children are likely to pay more for air quality improvement.

### **Wealth (WEL)<sup>7</sup>**

Wealth estimation is difficult, however, ownership of assets such as electronics and electrical items can be used as indicators of wealth of households. Households with more assets are likely to pay more to protect their materials from pollution damage.

### **Sex of household head (SHH) <sup>8</sup>**

In most poor countries, it is assumed that men are more responsible for outdoor activities i.e women in developing countries are responsible for home activities. Therefore, men are expected to be more interested in air quality. On the other hand, these emissions may have an impact on home activities such as preparing food, cleaning house and looking after children so that female heads may have a higher WTP.

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<sup>6</sup> Younger than 16 years are included in children size.

<sup>7</sup> Dummy variable taking the value one if a household owns at least three electrical or electronics equipment.

<sup>8</sup> Dummy variable which takes the value one for men.

### **Interest in environmental problem (IEP)<sup>9</sup>**

Respondents who are interested in environmental problems may have stronger tendency for high WTP responses.

### **Concern about future generations (CFG)<sup>10</sup>**

The interviewed people who are concerned about future generations are expected to pay more for the proposed service since they have a desire to transfer better quality environment for the coming generations.

### **Household head age (AGHH)**

Old household heads may not think of living for a long time. As a result, their willingness to pay for improved air quality becomes low.

### **Main occupation of household head (HHMO)<sup>11</sup>**

Household heads who are working in sugar enterprise may have a higher WTP since they understand the problem easily. On the contrary, they may have a lower WTP due to afraid of loosing job.

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<sup>9</sup> Dummy variable taking the value one if a respondent is interested in environmental problem.

<sup>10</sup> Dummy variable taking the value one if a respondent is concern for future generations.

<sup>11</sup> Dummy variable taking the value one if a household head is working in sugar enterprise.

### **Pollution related diseases (PRD)<sup>12</sup>**

Respondents or members of the households who suffer from pollution related diseases are expected to be more willing to pay in order to reduce the pollution problems.

### **Distance from polluter factory (DIS)**

Living close to a polluter factory in Wonji town is often associated with fly ashes, which may reasonably mean that people who live near to the factory give more value for better air quality and higher WTP responses are expected.

### **Interview day (IND)<sup>13</sup>**

We have used this variable to check information flow among the inhabitants and its impact on WTP.

### **Starting values in the bidding game (STBI)**

They are included in the model as explanatory variables to test for starting point bias.

### **Interviewers**

To test interviewer bias, we included interviewers as explanatory variable, using dummy, in the model.

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<sup>12</sup> Dummy variable which takes one if any member of the household suffered from pollution related diseases.

<sup>13</sup> Respondents who were asked on the first day received 1, 2<sup>nd</sup> day received 2, etc.

## CHAPTER IV

### RESULTS AND DISCUSSION

#### 4.1 Effects of Air Pollutants on Human Health

Inhabitants of Wonji town are affected by different kinds of air pollutants which are released from the sugar factory such as high concentrations of particulate matters (fly ashes),  $SO_x$ ,  $NO_x$ ,  $CO_x$ , etc. These pollutants can be a cause for health damage, especially for children and productive people (see table 2).

For a better understanding of the relation between some pollutants and human health, we present a brief overview:

- i. Particulate matter:- This pollutant is a visible smoke which consists of small solid particles (fly ashes). During production time, the boiler in the industrial plant consumes a lot of sugar-cane residuals as fuel and they produce smoke consisting of small dust particles (fly ashes). These particles affect the respiratory system and if they are of a small size they are able to bypass the respiratory system's own mucous filtering process and penetrate to the lungs. They may slow down ciliary function and this inhibits the removal of harmful substances in the mucous flow causing such illness as bronchitis.
- ii Nitrogen oxides ( $NO_x$ ) :- These oxides mainly affect the respiratory tract where  $NO_2$  is one of the most toxic. High concentrations of nitrogen dioxide ( $NO_2$ ) decrease gaseous exchanges in the blood and increase respiratory symptoms providing lower lung-function values.

- iii Sulphur oxides ( $\text{SO}_x$ ) :- These pollutants are produced when sulphurous are burnt in the boiler plant during the production process. Sulphur dioxide ( $\text{SO}_2$ ) emissions are highly toxic and a cause for respiratory and skin irritation diseases. For example the episodes of "London Smog" of the post war period. It has been shown that the 4,000 premature deaths in Dec. 1952 were related to high levels of  $\text{SO}_x$  and particulate matter emissions.
- iv. Carbon monoxide (CO): This gas combines with haemoglobin over 200 times faster than oxygen and blocks its function restricting the supply of oxygen to the blood. Typical symptoms of carbon monoxide poisoning are serious headache and dizziness which can cause death. For further information about the health effects of pollution emissions (See OECD,1986).

**Table 2: Out patients (with some air pollution related diseases) from 1996/97 to 1998/99**

Diseases	Age																				
	< 1			1-4			5-14			15-44			45-64			> 64			Total		
	96/97	97/98	98/99	96/97	97/98	98/99	96/97	97/98	98/99	96/97	97/98	98/99	96/97	97/98	98/99	96/97	97/98	98/99	96/97	97/98	98/99
TB. Respiratory disease	1	1	5	3	3	26	5	23	49	14	126	410	7	23	115	-	2	16	30	178	622
Asthma	3	1	1	16	7	14	85	74	49	386	625	563	56	177	216	2	-	4	547	884	847
Pollen allergy	2	9	11	15	19	20	35	75	81	218	331	386	38	83	84	-	-	1	308	517	583
Bronchitis	27	83	245	11	70	500	18	75	300	38	185	983	9	48	245	-	3	3	103	464	2276
Upper respiratory problems	298	383	831	495	915	1613	548	994	1680	1150	1828	3456	260	360	682	12	3	6	2763	4483	8268
Eye infection	95	67	140	362	338	282	574	571	502	1302	1321	1508	516	355	308	7	10	10	2656	2662	2750
Skin irritation	22	29	101	20	39	223	35	78	419	105	237	676	8	39	98	-	-	-	190	422	1517
Total	448	573	1334	922	1391	2678	1300	1890	3080	3213	4653	7982	693	1085	1749	21	18	40	6597	9610	16,863

Sources: Wonji Hospital

From table (2) we understand that from total out patients, those who have access for medical service, productive people <sup>14</sup> and children (less than 15 years) shared nearly 58% and 41% respectively in each year i.e from 1996/97 to 1998/99. This reveals that air pollutants can be a cause for health damage and reduce the well-being of the society through lost earnings, premature death, medical expenses and disutility associated with pain. Since it affects both children and productive body, it may be a cause for poor economic performance in the town at present as well as in the future. As we observe from the table, the total number of patients has been increasing from year to year and reached nearly 17,000 in 1998/99, which is about 77% of total inhabitants in Wonji town<sup>15</sup>. Reasons for this may be:

- i. As production increases, the amount of burning fuels, sulphurs and limes increase which expose more people to air pollutants related diseases.
- ii. Due to the existence of these emissions for a long time, inhabitants potential to resist pollution related diseases becomes weak.

For instance, to show lost earnings due to emissions related diseases, we assume a patient spent a day in treatment and take an average (mean) household head income per month from the survey (661.97 Birr). Let's take last year (1998/99) for illustration:

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<sup>14</sup> Productive people means in this study a person whose age is between 15 and 64 years.

<sup>15</sup> Projected population figure in 1998/99 was 22,033.

Total amount of lost income= Number of productive people who were patients in 1998/99 multiplied by average income per day <sup>16</sup>

$$= 9731 \times 22.08 \text{ birr}$$

$$= 214,763.17 \text{ birr (This lost income can be either from the individuals$$

or the sugar factory's side).

In addition to this, 471 and 567 patients were admitted to hospital due to air pollution related diseases (on average a patient spent 8.1 days in hospital) in 1997/98 and 1998/99 respectively.

#### **4.2 Household Characteristics and Respondents' Answers**

From the total sample of households, 332 individuals answered the questions properly and only one person refused to provide any information. Respondents' gender distribution in the sample was 70% men and 30% women. Among them, 244 (73.5%) are government workers, 19(5.7%) are pensioned, 45 (13.6%) are housewives, 9 (2.7%) are students, 13 (3.9%) are small businessmen and 2 (0.6%) are unemployed. Ninety percent of household heads have been employed in government organization since the town is an industrial town. Of the interviewed individuals 35.8% are below 30 years, 69.2% are between 30 and 50 years old and only 9.7% are above 50 years old. Regarding household heads age, 18.4% are below 30 years old, 69.2% are between 30 and 50 years old and 12.4% are older than 50. The mean value of family size is 4.67 ranging from 1 to 15 which seems reasonable since the average (mean)

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<sup>16</sup> Average income per day = An average household income per month divided by 30.

family size of the town is 5<sup>17</sup>. On the other hand, the mean size of children is 1.7 which indicates that most of household members in the sample are older than 15 years old.

Concerning education level from total household heads 0.7% are illiterate, 5.1% participated in adult literacy program, 13.8% are at elementary level, 9.2% are at junior level, 44.2% are at high school level and 27% are above 12 grade. Of the household members whose age reached for school 97.7% are literate.

#### **4.2.1 The Problem that is Given Priority in the Town**

In the first part of the questionnaire the interviewed individuals were asked to rank the problem in the order of priority as they felt. Of the first priority problems given were: 46% for environmental problems, 25% for poverty, 20% for unemployment, 7% for drug and alcoholism and 2% for absence of school.

The above information indicates that most of the respondents put the environmental problem as a sensitive issue in the town. This reveals that there exist different kinds of environmental pollution in the study area such as water contamination, air pollution, household wastes and sound pollution.

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<sup>17</sup> Based on C.S.A (1994), the average (mean) family size was 5.

**i) Water Contamination**

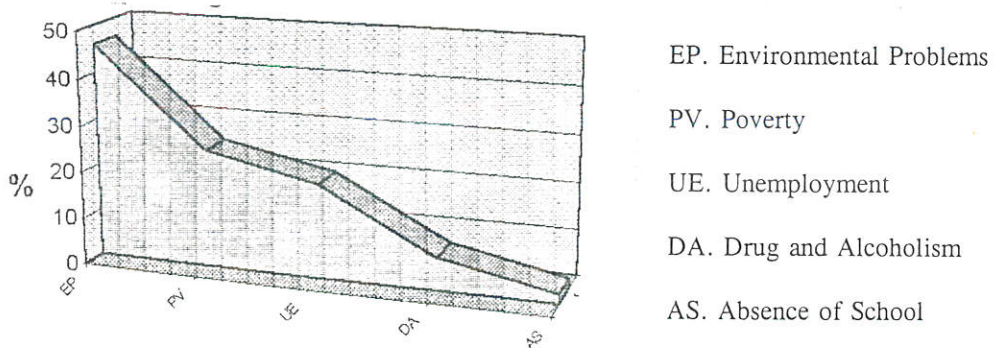
In the study area, the water is highly contaminated (Its fluoride content is high). So it is a cause for bone and tooth damages. Some waste products released from the factory also contaminate the Awash River.

**ii) Air pollution**

Different kinds of air pollutants that come out from the sugar factory frequently cause health and material damages.

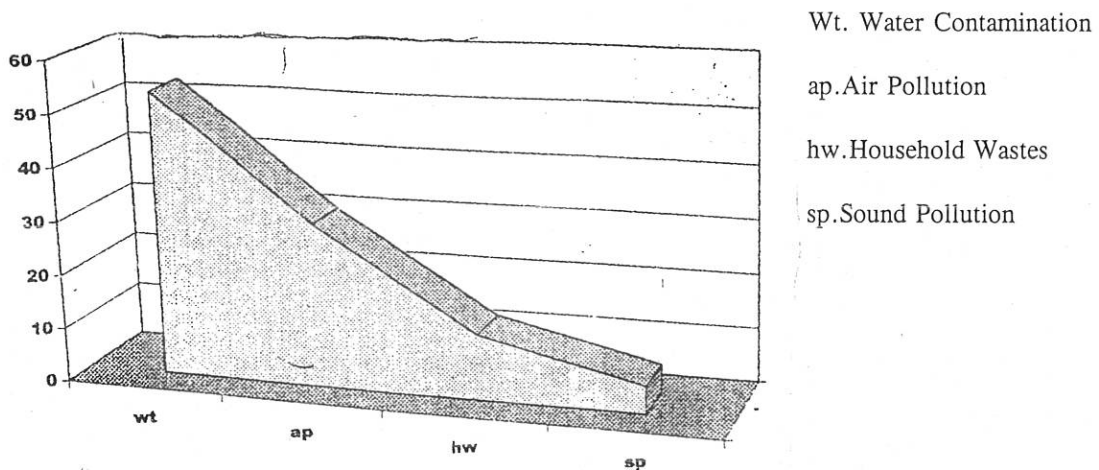
iii) Sound pollution and household wastes are also common problems in the town.

**Figure 1: Percentage of first priority problem**



Among the environmental problems which were indicated in questionnaire, 53% of the respondents gave first priority to water contamination, 30% to air pollution, 12% to household wastes and 5% to sound pollution. As expected, water contamination received the highest percentage since it is serious and common problem in the Rift Valley area and the remaining environmental pollutions follow one after the other.

**Figure 2: Environmental problem given first priority (percentage)**



### *Air quality*

Regarding the quality of air, the results of the survey indicate that 72% of the respondents found it as critical or serious problem i.e they ranked it as a poor quality. On the average, 63% of the respondents or household members suffer from pollution related diseases in general.

Based on the respondents' responses in the interview, the number of people affected by pollution related diseases is presented in the table below.

**Table 3: The number of people affected by pollution related diseases.**

Pollution related diseases	Number of patients
Asthma	62
Pollen allergy	62
Bronchitis	74
Eye irritation	28
Upper respiratory organ problems (Common cold, influenza, etc)	337
Total	563

**Source: Computed from the survey data**

Of total household members in the sample, only 36% have suffered from air pollution related diseases. This figure is low compared to the hospital data and can be interpreted as follows:

- i. Perhaps some types of air pollution related diseases were not specified in the survey questions.
- ii. Since we used random sampling technique and have a small sample, those who have suffered from air pollution related diseases might not be included in the sample.

#### **4.2.2 Household Income and Asset Ownership**

According to the survey results, the average (mean) household monthly income is 718.00 birr. This leads to a per capita income of 161 birr per month for the town since the mean household size in the sample is 4.46. About 16% of the households

have an income below 300 birr per month. On the other hand, 39% have monthly income above mean.

**Table 4: Average (mean) values of income and assets in the sample of households**

Title	Mean	Minimum	Maximum
Monthly household income (in birr)	718.40	70	4681
Monthly household head income (in birr)	661.97	50	3950
Number of electrical/ electronic property owned by the household	2.3	0	5

**Source: Computed from the survey data**

From the table we see that, there is a discrepancy between household mean income and household head mean income. This shows that the source of household income may not only be the household head but other members also contribute.

To estimate household wealth level, information on ownership of electronics and other assets was collected during the survey (see the questionnaire). The results show that 97% of households own at least one of these items. And 34% of the households possess at least three of these items. To cross check household income figures' accuracy, the questionnaire was constructed to capture various expenditure.

**Table 5: Households monthly expenditure for various aims**

Types of expenditure	Mean (in birr)	Minimum	Maximum
Food	332.49	50	800
Education	38.50	0	300
Transportation	28.73	0	180
Telephone	3.35	0	169
Electricity	0.8	0	17
Water	.32	0	17
Medical	2.12	0	50

**Source: Computed from the survey data**

Around 86% of households have free access to electricity, water, medical and housing services. But in case of medical, only parents and children below 18 years old have the right.

#### **4.2.3 Housing Characteristics**

Concerning housing characteristics, the sample data shows that 86.4% are owned by the organization, 12% are private owned and 1.6% are rented from Kebele.

#### **4.2.4 Respondents' Attitudes**

Almost 98% of the respondents believe that leaving a better environment for future generations is very important i.e they are highly concerned for future generations. 54.5% of the respondents found air pollution to be a problem that should be of concern to everybody in the town while 45% transferred the responsibility to the government or the sugar organization. When they were asked about authority

attention, 73% answered no attention had been given by any authorized body at all. 73.5% of the interviewed people have had an environmental problem awareness and considered themselves to be very interested in environmental issues. Respondents gave their opinion on different methods that should be implemented in order to reduce or alleviate the air pollution problem. 62% agreed on the idea of introducing better pollution control equipment. 16% suggested that the factory should use improved fuels while 11% recommended that the whole production process should be changed. The remaining respondents supported the idea of operational and maintenance improvement.

#### **4.4.3 Frequency Distribution of WTP**

Respondents in the survey gave different responses to the questions of an improved air provision. The following table reveals the frequency distribution of households' WTP per month for improved air quality from sampling survey.

**Table 6: Frequency distribution of WTP for improved air quality**

WTP Per month (in Birr)	Frequency distribution	Percentage
0	79	23.8
0.01 - 5.00	71	21.4
5.01 - 10.00	97	29.2
10.01 - 15.00	58	17.5
15.01 - 20.00	18	5.4
20.01 - 25.00	1	0.3
25.01 - 30.00	7	2.1
30.01 - 35.00	1	0.3
Total	332	100

**Source: Computed from the survey data**

From survey results we observe that 76.2% of the households are willing to pay for improved air quality. Around 29% of the households are willing to pay between 5.01 and 10 Birr per month for the proposed service. 23.8% of the respondents are not willing to pay at all. The reasons they gave were:

- i. The sugar organization itself should be responsible for the air pollution problem. Among the respondents who were not willing to pay for the proposed service, 41% (32) said the organization should cover the whole cost to reduce or alleviate the problem.
- ii. Most of the households who are living farther away from pollution source responded a zero willingness to pay. Their share is 50% of the total households who were not willing to pay for the service. These people are living relatively in better air quality compared to dwellers near to the polluter.

iii The reason for 9% of the respondents who were unwilling to pay for reduction of air pollution is a low level of income. This indicates that the contribution of income constraint for unwillingness to pay is low compared to the above two reasons, this may be due to the fact that the average (mean) income of the town's dwellers is in a better position.

Respondents who gave the first reason were in protest against the game. So we eliminated them from analyses aimed at estimating the aggregate benefits as indicated in section 3.3.

#### Starting Bids:

In this study we used the bidding game questions in the elicitation section i.e the interviewers start asking the respondents with initial prices. The relation between WTP and starting bids is presented in the table below based on consored data.

**Table 7: Relation between willingness to pay and starting bids**

Number of observations		Starting bids (in birr)	Mean of WTP interval mid points (in birr)	
300	105	5	5.8	7.9
	99	10	8.2	
	96	15	10	

**Source: Computed from the survey data**

As we observe from the table, there seems to be a starting point bias in the survey because the higher the bid is, the higher mean WTP. But the mean WTPs for 10 and

15 initial bids are below the starting bids due to a large number of zero WTPs in these groups. There are some reasons for this starting point bias:

- i. Since the problem is challenging in many respects in the town, most of the respondents never hesitate to pay what ever they are asked. This study reveals that 72% of the respondents found it as critical or serious problem.
- ii. Estimating the value of air quality for majority of the respondents was strange and difficult and might think given starting bid as accurate price. We can see the share of "yes" for starting bids as follows:

**Table 8: Percentage of "yes" for starting bids**

Starting bids	Share of "Yes"
5	(92/105) 87.6%
10	(74/99) 74.7%
15	(67/96) 69.8%
Total	77.7%

#### 4.4 The Determinants of WTP

Factors which determine the WTP responses, based on information obtained from a CV survey, can be analysed in two ways:

- i. By looking at cross-tabulations between WTP responses and socio-economic, demographic and attitude information obtained from the respondents.
- ii. Using multivariate statistical techniques to estimate a function that relates the respondents' WTP to explanatory variables.

The purpose of the two types of analysis is to determine whether respondents answers are consistent with theory and commonsense, and to establish models that can be used to aggregate responses to the overall households under the study .

#### **4.4.1 Cross-Tabulation Analyses**

Cross-tabulation analyses can be used to determine, using simple statistics, whether different group of people in the sample gave different responses to the valuation question. This may answer questions like who is willing to pay the most/least for the service, why is that so, etc. The following cross-tabulation gives the mean of some regressors falling in each of these intervals (see table 9).

**Table 9: Cross tabulation of the WTP with independent variables.**

Intervals for WTP bids (Birr per month)	Observation	HHI	WEL	HHE	IEP	CFG	DIS (in K.M)	IND	PRD	STBI	FS
0-5	118	545.40	0.20	8.50	0.62	.89	1.42	4.52	0.61	9.12	4.52
5.01-10	97	846.46	0.39	11.52	.86	0.92	0.75	4.74	0.66	8.92	4.11
10.01-15	58	804.16	.43	12.02	.86	.95	.83	4.14	.57	13.28	4.26
15.01-20	18	924.17	.50	11.61	0.61	1.00	0.60	3.33	0.89	11.39	5.17
20.01-25	1	2000.00	1	15	0.00	1.00	0.50	9	0.00	5	3
25.01-30	7	821	0.71	12.29	0.57	1.00	0.68	2.57	0.29	12.14	4.43
30.01-35	1	150.00	0.00	12	1	1	0.10	1	1	10.00	3
Total	300										

Source: Computed from the survey data

\* See the description of the variables in section 3.5.2.

The lowest WTP bids interval, from the above tabulation, is characterized by a lower mean income. This is due to the fact that most household heads or members in this group are engaged in small business activities or in a factory as labourers, and others expect pension security. Households in this group are also found to be relatively farther away from the polluter factory. On the other hand, the highest bid group in the tabulation is found nearer to the polluter factory. This shows that people near to the factory are highly exposed to emissions and are willing to pay more.

In general, household head education(HHE), wealth(WEL) and concern for future generations (CFG) are also have a positive relation with WTP. Distance (DIS) has an inverse relation with WTP. The remaining variables have no uniform direction with WTP responses.

This, cross tabulation, confirms the accuracy and reliability of the data collected through a CV survey since it is consistent with the consumer demand theory and commonsense hypothesis as indicated in section 3.5.2.

**Table 10: Statistical description of the variables included in the final regression equation**

Variables	Mean	Sta.deviation	Min	Max
Family size (FS)	4.45	2.18	1	15.00
Household wealth(WEL)	0.35	.47	0	1.00
Pollution related diseases(PRD)	.63	.48	0	1.00
Interest in environmental problem (IEP)	.74	.45	0	1.00
Concern for future generations (CFG)	.92	.28	0	1.00
Distance from Pollutants source (DIS.in km)	.98	0.83	0.10	3.00
Interview (IND)	4.37	2.54	1.00	9.00
Starting bids (STBI)	10.57	4.09	5.00	15.00
Household head education (HHE)	10.52	4.22	0	18.00
Household income per month (HHI)	743.75	494.21	70.00	4681.00

Source: Computed from the survey data

#### 4.4.2 Multivariate Analyses of the Determinants of WTP

The general approach of this technique is to estimate a valuation function that relates the hypothesized determinants with the WTP responses. It also provides greater insights into factors that may determine an individual's willingness to pay than simple cross tabulation.

The variables to be included in the models were mainly based on the degree of theoretical importance, and their significant impact on WTP. For theoretical reasons, several variables were included in the models, even though they were insignificant. Regression with and without correcting for heteroscedasticity were done in both models (Ordered probit and Tobit). The presence of heteroscedasticity is detected by carrying out a likelihood ratio test<sup>18</sup>. The results from ordered probit and tobit models are presented in the table below.

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<sup>18</sup> The log-likelihood function for the unrestricted model is -411.63 while for restricted model is -484.66. Then  $-2[-484.66 - (-411.63)] = 146 > 7.89$ , where 7.89 is the critical value for the chi-square distribution with one degree of freedom. The hypothesis in favour of homoscedasticity could be rejected at the 0.005 level with one degree of freedom.

Table 11: Estimates (Coefficients) of Ordered Probit and Tobit Models

	Ordered Probit	Tobit
Constant	-1.351 (-2.123**)	0.204E.01 (0.013)
Family size (FS)	0.527E-01 (1.09)	0.7546.01 (0.685)
Household wealth(WEL)	0.539 (1.75)	1.720 (2.540**)
Pollution related diseases(PRD)	-0.183 (-0.715)	-1.218 (-2.025**)
Interest in environmental problem (IEP)	0.55 (2.251**)	0.620 (1.069)
Concerne for future generations (CFG)***	0.782 (2.148**)	2.164 (2.848*)
Distance from Pollutants source (DIS)	-0.724 (-3.391*)	-0.723 (-1.334)
Interview day (IND)	-0.211 (-3.008*)	0.565 (-3.784*)
Starting bids (STBI)	0.158 (4.068*)	0.494 (6.554*)
Household head education (HHE)	0.159 (3.893*)	0.240 (2.438**)
Household income (HHI)	0.312E-03 (1.022)	0.017 (1.522)

\*\* significant at 5%, \* significant at 1%  
 N = 300, \*\*\*variable corrected for heteroscedasticity, Numbers in brackets are t-ratio  
 Source:- Computed from the survey data

### *Results from the models*

#### *Household wealth (WEL)*

The coefficient of this variable is positive as expected but insignificant in ordered probit model which means the WTP increases as the household assets increase. This indicates that households with more assets are willing to pay more to protect their equipment from damage caused by emissions. This variable is significant in tobit model.

#### *Interest in Environmental Problem (IEP)*

The respondents who considered themselves very interested in environmental problems have a positive impact on WTP and significant in ordered probit model. We conclude from the result that if the respondents' interest towards environmental problem increase, the households WTP response becomes high.

#### *Family size (FS)*

It has a positive impact on willingness to pay for air quality as expected i.e households with large family more care about their family but insignificant in both models.

#### *Pollution related diseases (PRD)*

What is very unexpected is that the respondents or household members who suffered from pollution related diseases have a negative and insignificant impact on WTP in ordered probit model. This is surprising since they were expected to understand the problem more than the non-victimed. It may be interpreted as:

- i. They may expect some compensations from the organization rather than to pay.
- ii. Due to free access to a medical service, they may not consider it as a serious problem.
- iii. They may think that the diseases were not caused by the pollution or they simply say since once we are victimized why we worry about others. The result is significant in tobit model.

#### ***Starting bids (STBI)***

The result of starting values for the elicitation method is positive and very significant in both models implying that there is a starting point bias. It seems that high starting values are likely to bring high mean WTP values, and the reverse can occur for low starting values. The occurrence of this bias may be related with some facts (see section 4.3). The same starting point biases were shown by different studies in Morocco (Behaj, 1998); Chile (Rogat, 1998) and Ethiopia (Genanaw, 1999). Further clarification about starting bids for respondents and using a number of starting bids may help to reduce the problem.

#### ***Distance from pollutants source (DIS)***

The coefficient of the variable is negative and significant in ordered probit model. This shows that the more households are farther away from pollution source, the lower WTP since these people are relatively not exposed to air pollution problem.

### ***Interview day (IND)***

This variable was used to test information flow among the people which may be a cause for respondents' WTP responses to be high or low. In this study, the result is negative and highly significant in both models which shows that the respondents who were asked on the latter interview day had low WTP responses. One reason for this problem may be the respondents who were asked on the latter interview day also displayed a high probability of being at the same time in the farther away dwellers category compared to those who dwell nearer to the polluter factory (sign. = 0.0000).

### ***Household head education (HHE)***

The level of household head education has a positive and significant effect on WTP in both models i.e the higher education level, the higher WTP responses, which seems reasonable since a higher level of education could be related to a better understanding of the problem.

### ***Concern for future generations (CFG)***

There is a positive relationship between the respondents who are very concerned for future generations and the households willingness to pay for improved air quality. Since these people have interest to deliver better environment for future generations, the result is as expected and statistically significant in both models.

### ***Household income (HHI)***

Household income has a positive relation with WTP responses. This implies that the higher the income of households, the higher WTP but not significant in both models.

Comparing the results of the Tobit to those of the Ordered probit reported in the table the coefficient of all variables have the same corresponding sign in both models. On the other hand, interest in environmental problem (IEP) and distance from polluter (DIS) are significant in Ordered probit but not in Tobit.

To see interviewer bias, interviewers were included as explanatory variable, however, no interviewer bias was observed. Interviewers had an exposure to higher education and many years experience as interviewer can be the possible reasons for insignificant impact on WTP responses.

#### **4.4.3 Estimating Aggregate Willingness to Pay for Air Quality**

From the survey we can estimate the aggregate willingness to pay for air quality. The total WTP of the town for better air quality can be calculated by multiplying the percentage distribution of the sample (table 12 column 2) by the total households (3918), to get the estimated households in each WTP interval (column 3). Then, by assuming that the mid point of each interval is the mean WTP (column 4), the households can be multiplied by this mean to estimate total willingness to pay (column 5). Total WTP for improved air quality is birr 28,915 per month.

**Table 12 Total WTP for improved air quality**

Intervals for WTP bids (Birr Per month)	Percentage	Total households in the town	WTP mid points	Total willingness to pay (Birr per month)
0	15.3	600	0	0
0.01 - 5.00	23.7	928	2.5	2320
5.01 - 10.00	32.4	1269	7.5	9517.50
10.01 - 15.00	19.4	760	12.5	9500.00
15.01 - 20.00	6	235	17.5	4112.50
20.01 - 25.00	0.4	16	22.5	360.00
25.01 - 30.00	2.4	94	27.5	2585.00
30.01 - 35.00	0.4	16	32.5	520.00
Total	100%	3918		28,915.00

Source: Computed from the survey data.

If we assume a uniform payment in each month, the estimated aggregate WTP (benefit) for the proposed service is found to be Birr 346,980 per year. On the other hand, the estimated mean value of WTP for the representative households (MWTP)<sup>19</sup> can be used to calculate the aggregate WTP or benefit for improved air quality:

Total estimated benefit = MWTP multiplied by total households in the town

$$= 7.9 \text{ birr} \times 3918$$

$$= 30,952.20 \text{ birr per month}$$

or

$$= 371,426.40 \text{ birr per year}$$

The value of the aggregate benefit using mean WTP is higher. This result may be used as benefit for cost recovery of 50% improved air quality since CVM is a tool

<sup>19</sup> This can be obtained by calculating the weighted mean of WTP mid points (column 4 in table 12)



of cost-benefit analysis. At last, this study could not relate these benefits (CV results) with the corresponding costs in order to see if the measure or policy is worth implementing since there is no available data costs for reducing emissions.

## CHAPTER V

### CONCLUSION AND POLICY RECOMMENDATIONS

#### 5:1 Conclusion

In developing countries, especially in Ethiopia, environmental problems in general and air pollution in particular have not been given attention by the governments. However, the study conducted in Wonji town reveals that most people are aware of pollution problem and willing to pay to reduce it.

A contingent valuation approach was used to investigate whether households in Wonji town are aware of air pollution caused by the sugar factory, and whether they are willing to pay for the proposed service. We selected 332 households, using simple random sampling technique, to elicit the willingness to pay for a 50% reduction in the emissions. The concept of "half" is simple to understand compared to other percentages that is why the study used 50%. Seventy percent of the respondents had environmental awareness and found it to be critical or serious problem and 63% of the interviewed people or member of households suffered from air pollution related disease. Besides, the hospital data reveals that 77% of total people suffered in 1998/99 with these diseases. A bidding game approach was used in the valuation questions in order to ask their willingness to pay since it was similar to the bargaining that goes in local markets and the censored data used in both Tobit and Ordered probit models to analyse the determinants of WTP. There are ten explanatory variables included in the final regression models based on the degree of theoretical importance, and their significant impact on WTP.

In general, except for pollution related diseases, the sign of the coefficients of the explanatory variables are in the expected direction. Concerned for future generations, pollution related diseases, household head education and household wealth have a significant impact on WTP. Family size, distance from pollutants source, household income, and interest in environmental problem are insignificant or seem to have less influence on WTP in Tobit model. Interest in environmental problem and distance from pollutants source are significant in the ordered probit model.

Starting bid is positive and significant in both models implying the presence of a starting point bias. This indicates that high starting values are likely to bring high mean WTP values. Interview day has a negative and significant impact on WTP in both models which shows that the respondents who were asked on the latter interview day had a lower WTP. A reason for this problem may be that the respondents who were asked on the latter interview day also displayed a high probability of being at the same time in the farther away dwellers category. Besides, no interview bias was observed.

The frequency distribution of the survey data on WTP bids, using estimates of table 12, is important to calculate the aggregate benefits (WTP) of a 50% reduction in air pollution (particulate matters). The estimated benefit is nearly 29,000 birr per month. On the other hand, the aggregate benefit, using the mean WTP, is nearly 31,000 in the monthly payment.

The overall survey results suggest to us about the accuracy and reliability of the data collected through a CV survey since it is consistent with economic theory and common sense hypothesis. Therefore, these estimations may be considered to provide a useful estimate of the order of magnitude of the benefits resulting from an air quality improvement programme.

## **5.2 Policy Recommendations**

Based on the CV findings and supplemented secondary sources, the study addressed few points which may be important in guiding policy to reduce the existing air pollution problem in the town:

- Evidences from the study display that there is no responsible body for air pollution problem in the town. One possible reason for this problem there is no registered law related to air pollution policy in the country. This may have its own impact in aggravating the problems which urgently need written law in air pollution aspects in the country to control the problem.
- Eventhough there may not be an official policy to control the air pollution problem, the Environmental Protection Agency together with the Sugar Factory are expected to do their best to protect the environmental damage.

- Establishing environmental organization at town level: such organization may contribute for improved air quality through encouraging cost sharing and management.
- The aggregate WTP (CV results) may be used as benefit for air quality improvement programme in the town since CVM is a tool for cost-benefit analysis. This benefit may help to finance measures which could reduce the pollution level such as improved quality fuels, operational and maintenance improvement, and pollution control equipment improvement/ installation.

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Appendix 1: Questionnaire for the Study on Improved Air Quality Service

code \_\_\_\_\_

House N° \_\_\_\_\_

Interviewer: \_\_\_\_\_

Kebele/Camp \_\_\_\_\_

\_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_ to \_\_\_\_\_

\_\_\_\_\_

I, Essey Takele, am currently studying in Addis Ababa University. This research is partial fulfilment for the award of MSC in Economics and focuses on environmental problems.

You have been chosen, through random sampling, as one of the persons to participate in a survey regarding the environmental contamination in Wonji. Your answers are voluntary and will be completely confidential.

Before beginning the questionnaire we will give you a brief introduction about the health-contamination relation, and about the purpose of this study.

Thank you for your cooperation

## **Introduction**

Wonji is one of the industrial towns in Ethiopia. There are several problems exist in the town such as poverty, drug and alcoholism, unemployment, environmental pollution, etc. The town is highly affected by the concentration of particulate matter. These particulate make a significant contribution to poor local air quality and most importantly, damage human health, causing effects such as asthma, bronchitis, pollen allergy, eye irritation, etc.

## **Purpose of the Survey**

The demand for consumer goods is generally regulated through the price of the good. Public goods such as recreational parks and the air we breath, are however, goods whose benefits can not exclude any one. For this reason setting a price on these goods is more complex.

The deterioration of environmental good (air we breath) demands the application of measures to repair this deterioration. The application of these measures, inevitably, gives rise to a cost, which directly or indirectly has to be paid by all of us because no effort has been observed to reduce or alleviate the emissions by any institute till now. The atmospheric contamination existing today in the town which indirectly excludes many persons from the essential right to breath clean air. In order to compare the social costs of air contamination plus the required costs to improve air quality with the benefits that clean air gives us, it is necessary to know the willingness to pay for this good. This survey intends to evaluate the willingness to pay. You, by answering this questionnaire can make it possible.

## Questionnaire

The questionnaire is divided into two sections, A and B. Questions belonging to section A are directly related to the problem of atmospheric contamination. Section B contains questions related to personal data and others such as income, age, household assets, pollution related diseases, etc.

### Section A

1. In the town we are dealing with different types of problems that need a rapid solution. Rank each one in order of priority

1                      2                      3                      4                      5

--	--	--	--	--

1. Poverty
2. Absence of School
3. Environmental Pollution
4. Unemployment
5. Drug and Alcoholism

2. What degree of importance do you place on the problem of air pollution?

1. Critical
2. Serious
3. Less serious
4. Not important

3. Rank each environmental problem in order of priority

1. Water Contamination



3. Every citizen?

8. Concerning the atmospheric pollution in the town, do you find that the authorities have given.

1. Much attention?

2. Some attention? \_\_\_\_\_

3. Not attention at all?

9. In other countries around the world with similarly atmospheric contamination problems, several measure have been applied to solve the problem. Which of the following measures do you think should be applied in Wonji.

1. Raw materials and/or fuel quality improvement?

2. Process control and/or modification?

3. Operational and maintenance improvements? \_\_\_\_\_

4. Pollution control equipment improvement and/or installation?

5. Other, which ?

10. As mentioned before (in que. No 9) the application of these measures cause a cost which direct or indirectly will be paid by all of us. Suppose the authorities presented a program which will decrease the level of pollution by 50%. Would you be willing to contribute x birr per month inorder to cover in part the cost of the program?

1. Yes =====> go to 11a

2. No =====> go to 11b \_\_\_\_\_

11. Would you be willing to contribute

a.  $1\frac{1}{2}$  X

1. Yes == => go to 12a
2. No =====> go to 13 \_\_\_\_\_

b. 3/4 X

1. Yes =====> go to 13
2. No =====> go to 12b \_\_\_\_\_

12. Would you be willing to contribute

a. 2X

1. Yes =====> go to 13 continue until the respondent says I can't pay more. \_\_\_\_\_

2. No =====> go to 13

b. X/2

1. Yes == => go to 13

2. No =====> to 13 continue until the respondent says

I am willing to pay. \_\_\_\_\_

13. If zero bid is given to the WTP question ask: Are you totally not willing to pay because you believe that:

- a) No air pollution problem in my area
- b) The government or factory should cover the whole cost.

\_\_\_\_\_

c) Income constraint

D) others \_\_\_\_\_

14.

## Section B

N°	Name	Family relationship	Sex		Age	Main occupation	Average monthly income (in birr)	Education	House type	House hold Assets	Expenditure Monthly (in birr)	Remark
			M	F								
1	Respondent											
2									Gov.	Car	School	
3									Private	Television	Electricity	
4									Rented from	Radio	food	
5									i) Private	Refrigerator	Medical	
6									ii Kebele	Video	Water	
7										Stove	House rent	
8										Telephone	Transport	
9											Telephone	

15. Do you or your family members suffer from any of the following diseases.

N°

1. Asthma \_\_\_\_\_
2. Pollen allergy \_\_\_\_\_
3. Bronchitis \_\_\_\_\_
4. Eye irritation \_\_\_\_\_
5. Some other diseases related to atmospheric pollution? \_\_\_\_\_

—

16. Distance from polluter factory \_\_\_\_\_ K.M

17. Do you have any additional comments or suggestions about the problems?

\_\_\_\_\_

Appendix 2: Correlation matrix for explanatory variables

	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>	X <sub>11</sub>
X <sub>1</sub>	1.00	-.13 (0.018)	0.40 (0.000)	0.07 (.195)	0.05 (.375)	-0.02 (0.778)	.38 (0.000)	-.55 (0.00)	0.02 (.720)	-0.02 (.688)	0.2 (0.000)
X <sub>2</sub>		1.00	-0.02 (.785)	.08 (0.142)	0.08 (0.151)	0.10 (0.068)	-0.12 (0.028)	0.13 (0.017)	0.03 (0.614)	0.01 (0.968)	-0.09 (0.67)
X <sub>3</sub>			1.00	0.21 (0.000)	-0.21 (0.000)	-0.10 (0.065)	0.01 (0.960)	-0.492 (0.000)	-0.35 (0.000)	0.03 (0.593)	-0.1618 (0.003)
X <sub>4</sub>				1.00	0.37 (0.000)	-0.09 (0.093)	0.04 (0.500)	0.23 (0.000)	0.43 (0.000)	0.03 (0.593)	-0.16 (0.008)
X <sub>5</sub>					1.00	0.02 (0.724)	0.05 (0.374)	0.43 (0.000)	.56 (0.000)	-0.04 (.508)	-0.01 (0.963)
X <sub>6</sub>						1.00	0.05 (0.353)	0.01 (0.804)	0.04 (0.442)	-0.06 (0.268)	0.07 (0.185)
X <sub>7</sub>							1.00	-0.31 (0.000)	0.17 (0.003)	-0.06 (0.244)	0.24 (0.000)
X <sub>8</sub>								1.00	0.49 (0.000)	-0.01 (0.978)	-0.10 (0.065)
X <sub>9</sub>									1.00	-0.05 (0.378)	0.02 (0.759)
X <sub>10</sub>										1.00	-0.03 (0.653)
X <sub>11</sub>											1.00

X<sub>1</sub> - AGHH      X<sub>4</sub>IND      X<sub>7</sub> FS      X<sub>10</sub> STBI  
X<sub>2</sub> - CFG      X<sub>5</sub>WEL      X<sub>8</sub> HHE      X<sub>11</sub> PRD  
X<sub>3</sub> - DIS      X<sub>6</sub>IEP      X<sub>9</sub> HHI

Note: two-tail significance level in parentheses


The description of the explanatory variables is given in section 3.5.2

Note: Multicollinearity problems had been expected among HHI, HHE, WEL, IEP and CFG however the results did not Show.

## DECLARATION

I, the undersigned, declare that this thesis is my own original work and has not been presented in any university. All sources of materials for this thesis have been fully acknowledged.

Name: Essey Takele

Signature: 

Date: March, 2000

Place: Addis Ababa