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FACTORS THAT DETERMINE THE STATED WILLINGNESS TO PAY FOR AIR POLLUTION: A CASE OF BOPHELONG TOWNSHIP

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─Abstract ─

The aim of this paper is to quantify the willingness to pay for improved air-quality in a typical low-income settlement in South Africa by making use of the contingent valuation method (CVM). Direct valuation methods or stated preferences methods such as CVM are used to value goods that do not have a market value i.e. price-quantity data does not exist for such goods. The mean WTP to reduce air pollution in Bophelong is approximately R132 per annum. The econometric analysis found that most parameters had their expected sign. WTP was found to be positively correlated with employment status and income. Males were however, found to be less likely to have a positive WTP than their female counterparts. Household size was also found to be negatively correlated with WTP.

Key Words: *Pollution, Willingness to pay, Bophelong*

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JEL Classification: Q51, Q53

1. INTRODUCTION

Pollution is defined as the introduction into the environment of substances or energy liable to cause hazards to human health, harm to living resources, and ecological systems, damage to structure or amenity, or interference with legitimate use of the environment (Kidd, 1997). In addition, the National Environmental Management Act 39 of 2004 defines air-pollution as any change in the composition of air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances. Human beings exist in an environmental space. The environment offers a great deal of services to mankind; firstly, the environment acts as a form of a consumption good by offering services to humankind in the form of air to breath and space; secondly, the environment supply resources such as water, sun and oil; thirdly, the environment is a recipient for waste through the atmosphere, land and water and lastly, the environment acts as a geographical location for economic activities (Bella, 2003).

Air pollution is regarded as a negative externality to production. Producers treat environmental goods such as air and water as free goods and consequently do not internalise them in their production processes. It is in this light that economists saw the need to develop theories that will force producers to be more responsible in the process of producing goods and services. Two main theories that deal with the issue of externalities and social cost are the Pigouvian theory and the Coasean theory. Pigou preferred government intervention to address the issue of market failure. Pigou's theory advocates for the levying of taxes to close the divergence that exist between marginal private net benefits and marginal social costs. Coase on the other hand was in favour of the market mechanism to deal with the issue of externality. The main thrust of his argument is that in cases where property rights are well defined and transaction costs are minimal, the market system will produce an optimal level of production regardless of who owns the property rights (Simpson, 1996).

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The aim of this paper is to quantify the willingness to pay for improved air-quality in a typical low-income settlement in South Africa by making use of the contingent valuation method (CVM). Direct valuation methods or stated preferences methods such as CVM are used to value goods that do not have a market value i.e. price-quantity data does not exist for such goods (Brookshire & Crocker, 1981). The paper is structured as follows: Firstly, literature review, followed by the methodology used in the study. Thirdly the analysis of the data is done followed by concluding remarks.

2. LITERATURE REVIEW

An increase in human production and consumption does lead to unintended negative consequences such as increased health risk and damage to the environment (Nas, 1993). There is therefore, a need for an adequate policy response to combat the health damage resulting from air pollution caused by human activities. Environmental economics provide economists with a variety of tools that can be used to value the environment. Before the introduction of the economic valuation tools environmental decisions were taken without quantifying the costs and benefits of the decisions. All the economic valuation techniques have strengths and weaknesses and each of them should therefore be used for a purpose for which it is most appropriate. One major criticism against environmental valuation is that some people find it wrong to attach a monetary value to environmental goods such as good air quality. Some kind of evaluation of the environment is, however, necessary because there is a need to timorously and systematically assess the consequences of an environmental decision (Rabi et al., 2007).

Contingent valuation is a stated preference approach to valuation. This approach enquires about future behaviour by asking willingness to pay (WTP) and willingness to accept (WTA) type of questions (Todaro & Smith, 2006). This method is very useful in measuring the value of public goods. Under market conditions people are well informed and rational; the same behaviour is however not displayed when it comes to public goods (Hanemann, 1994).

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The divergence between WTP and WTA can be described in terms of the compensating variation and the equivalent variation concepts. For a welfare gain the compensating variation is the amount that an individual is willing to pay to experience the welfare gain, whilst the equivalent variation refers to the amount of monetary income an individual is willing to accept in lieu of the improvement in welfare (Nas, 1996). For a welfare loss, the compensating variation refers to the amount of monetary income that an individual is willing to accept as compensation for the loss of welfare, whilst equivalent variation refers to the amount of monetary income that an individual is prepared to sacrifice to be exempted from the welfare loss or to prevent the welfare loss from occurring in the future (Nas, 1996). Thus in theory, there is not supposed to be any divergence between results measured using either WTP or WTA. Both methods are used to measure individuals' willingness to pay and willingness to accept for a welfare change. Empirical studies have, however, shown that in most cases there is no convergence between WTP and WTA results (Vankatachalam, 2004). The divergence between WTP and WTA can be attributed to factors such as the existence of income and substitution effects, transaction costs and property rights. In empirical studies WTA values in most cases were found to be larger than WTP. Economists in general prefer the use of WTP over WTA, because WTA is considered not to be consistent with convergent validity as it does not adequately measure economic surplus (Vankatachalam, 2004). Hence this paper analyse the factors that determine the stated WTP for air pollution in Bophelong.

3. METHODOLOGY

3.1. SURVEY DESIGN

Approximately 300 households were visited and personally interviewed by trained fieldworkers. Of the 300 households interviewed in the survey only 285 were analysed. Fifteen questionnaires were destroyed due to incompleteness, largely due to the reluctance of respondents to answer questions pertaining to income. This survey has to a large extent attempted to adhere to the steps and guidelines of conducting a Contingent valuations survey as outlined by Pope III and Miner (1988). Information was obtained mainly from the head of the household, spouse and children above the age of 18. The questionnaire made use of an open-ended

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question to elicit respondents' willingness to pay. Open-ended questions are deemed desirable as they generally manage to overcome the problem of starting point bias and secondly, they tend to provide a more conservative result as they tend to produce lower WTP than referendum type questions (Carlsson & Johansson-Stenman, 2000). The survey made use of probability sampling which is more statistically acceptable than convenience sampling. Face-to-face interviews were conducted at the homes of the respondents as home is the place where respondents are more likely to feel comfortable and are expected to provide well thought-out responses.

3.2. REGRESSION MODEL

Binary choice models such as logistic and probit models are commonly used in environmental valuation studies to predict dichotomous outcomes. In this paper WTP is estimated using a regression analysis. The aim of a regression analysis is to determine the factors which cause the variation of the dependent variable namely, WTP. In this paper a basic OLS regression could not be used to estimate WTP since WTP is a censored dependent variable. Using a basic OLS regression would yield negative WTP values which would not make sense from a theoretical point of view. In assessing an individual's willingness to pay for the reduction of air-pollution the authors made use of an open-ended elicitation format wherein respondents could indicate if he/she is willing to pay for reduced air-pollution (i.e. "yes" or "no" answer) and how much he/she is willing to pay. WTP is regarded as a qualitative regress and i.e. a person is either willing to pay or not. The response variable can take only two values namely 1 if the person is willing to pay and 0 if not. As indicated above, the WTP variable is binary in nature. In order to analyse the dichotomous choices made by the respondents a logistic model was used as it was considered the most appropriate for this type of study. (Loureiro & Umberger). The logistic regression can be specified as follows:

$$WTP = Log\left(\frac{Pi}{1-P_i}\right) = \beta_1 + \beta 2EDU + \beta 3EMP + \beta 4Gender + \beta 5HHSize + \beta 6INC + \beta 7AGE + \varepsilon_i \quad (1)$$

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Where:

$WTP = Log\left(\frac{Pi}{1-P_i}\right) =$ The logistic formula stated in terms of the probality that $WTP =$ 1 if the household is willing to pay (p_i), and = 0 otherwise ($1-p_i$)

$EMP =$ Employment status of the head of household

$GEN =$ Gender of the head of household (Male = 1, Female = 0)

$MAR =$ Marital status of the head of household (Married = 1, Not Married = 0)

$EDU =$ Educational level of the head of household

$HH\ Size =$ Household size – number of people in the household

$INC =$ Household income (monthly)

$AGE =$ Age of the head of household

$\varepsilon_i =$ The error term that follows a logistic regression

4. ANALYSIS

The mean WTP to reduce air pollution in Bophelong is approximately R132 per annum (the annual figure was obtained by multiplying the mean WTP of approximately R11 by the number of months in a year). The annual social cost of pollution in Bophelong can be calculated by multiplying the mean annual WTP with the estimated total population of Bophelong. Bophelong's population was estimated at 49 408 in 2009 (Slabbert & Sekhampu, 2009). The annual social cost of pollution in Bophelong is thus estimated at R6 521 856. The logistic regression model was evaluated using the Likelihood Ratio test which is operationalised using the Chi-Square.

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Table 1: Log-Likelihood Ratio Test for the Logistic Regression

Logistic regression	**Number of obs**	**274**
	LR chi2(7)	25.8
	Prob > chi2	0.0005
Log likelihood = -161.27051	Pseudo R2	0.0741

Source: Calculated from Survey Data, 2012

Table 1 summaries the results of the log likelihood test. The Log likelihood was 161.27. The Log likelihood Ratio test as measured by the Chi-Square was 25.8 with a p-value of 0.0005. That means even at 1 percent, the null hypothesis that the model was not a good fit is rejected in favour of the alternative hypothesis that the model was a good fit.

As Table 2 shows, the choice to have a willingness to pay or not, was found to be inelastic to changes in education levels. The elasticity between education and WTP for pollution in Bophelong was inelastic at -0.256. An increase in education by one unit however had the possibility of lowering the WTP as evidenced by the negative sign.

Employment status was also inelastic in influencing the WTP for reduced air pollution in Bophelong. The employment status elasticity of WTP was 0.15; therefore, employment status could not be regarded as a very important factor that influences the level of WTP in the area. However, there was a positive elasticity meaning that those who were employed were more likely to have a positive WTP for reduced air pollution in Bophelong.

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Table 2: Marginal Effects reporting elasticities

	ey/ex	Std. Err.	Z	P>|z|	[95% Conf.	Interval]
Education	-0.25567	0.230419	-1.11	0.267	-0.70728	0.195946
Employment status	0.146747	0.07565	1.94	0.052	-0.00152	0.295017
Sex	-0.04969	0.124649	-0.4	0.69	-0.294	0.194617
Size of household	-0.42625	0.247223	-1.72	0.085	-0.9108	0.058294
Income	0.0979	0.048435	2.02	0.043	0.002969	0.192831
Marital status	-0.07518	0.141086	-0.53	0.594	-0.35171	0.201344
Age of head of household	-0.7785	0.456018	-1.71	0.088	-1.67228	0.115278

Source: Calculated from Survey Data, 2012

The elasticity of WTP due to gender was estimated at -0.049. This implies that gender as represented by Sex in table 2 did not have any significant influence on the WTP. However, males were less likely to have a positive WTP than females since the sex elasticity of WTP for reduced air pollution was negative In the study by Carlsson and Johansson-Stenman (2000) the marginal effects for gender were found to be significant but with opposite signs. The reported marginal effects in the Carlsson and Johansson-Stenman (2000) study were -0.054, which implied that men have about 5 percentage units lower probability of a positive Willingness to Pay than women. Again the size of the household was also found to be inelastic although it was negative. Households with higher numbers of inhabitants were less likely to have a positive WTP compared to those with small members. The size of household elasticity of WTP for pollution was -0.426.

The income elasticity of WTP was about 0.1 which was inelastic. Those with higher income levels however were more likely to have a positive WTP for pollution compared to those with lower levels of income. An elasticity coefficient of less than one is common in CVM studies for environmental goods. In the

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Carlsson and Johansson-Stenman (2000) study the elasticity for income was calculated as 0.32.

Marital Status also was inelastic and negative. Households whose head was married were less likely to have a positive WTP for reduced air pollution compared to those with single heads. Lastly, age of the head of household also was inelastic in influencing the WTP for pollution in Bophelong. This means that although the relationship was inelastic, older people were less likely to have a positive WTP compared to younger people. Wang and Mullahy (2006) also found that age has a negative relationship with the probability of a positive WTP, which implies that as age increases people's probability of having any positive Willingness to Pay for the reduction of air-pollution decreases. A similar study by Alberini et al. (1997) whose objective was to determine WTP for reducing fatal risk by improving air quality also found that age and WTP were inversely related. Another study by Tanrivermi (1998) on WTP and WTA measures in Turkey also found a negative correlation between age and WTP.

5. CONCLUSION

This paper estimated WTP for the reduction of air pollution in Bophelong Township. The mean willingness-to-pay for the reduction of air pollution in Bophelong was estimated at R132 per annum. The regression analysis was performed making use of the more appropriate logistic model instead of the basic OLS regression model. The econometric analysis found that most parameters had their expected sign. WTP was found to be positively correlated with employment and income. Males were however, found to be less likely to have a positive WTP than their female counterparts. Household size was also found to be negatively correlated with WTP.

The paper made use of the open-ended format because it did not want to overestimate the social cost of air-pollution in Bophelong Township. The open-ended elicitation format made use of a willingness to pay question rather than willingness to accept question. Firstly, a willingness to pay question generally yield lower estimates than willingness to accept because the willingness to pay is tied to the respondent's ability to pay which is not the case with willingness to

accept (Beder, 2005). Secondly willingness to pay may also be affected by various factors such as lack of information about the good being valued and opinion. For instance, many of those who indicated that they are not affected by air-pollution stated low willingness to pay bids as opposed to those who indicated otherwise. Lastly, with Bophelong Township being a low-income settlement it would be expected that the estimated willingness to pay would be lower as willingness to pay is a function of ability to pay.

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