

# **ECONOMICS, ECOLOGY AND THE ENVIRONMENT**

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Between Three Approaches For Pollution Control**

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# **EMPIRICAL EVIDENCE SHOWING THE RELATIONSHIPS BETWEEN THREE APPROACHES FOR POLLUTION CONTROL**

Clevo Wilson

## **Abstract**

Willingness to pay models have shown the theoretical relationships between the contingent valuation, cost of illness and the avertive behaviour approaches. In this paper, field survey data are used to compare the relationships between these three approaches and to demonstrate that contingent valuation bids exceed the sum of cost of illness and the avertive behaviour approach estimates. The estimates provide a validity check for CV bids and further support the claim that contingent valuation studies are theoretically consistent.

**Key Words:** Avertive Behaviour, Contingent Valuation, Cost of Illness, Willingness to Pay.

# EMPIRICAL EVIDENCE SHOWING THE RELATIONSHIPS BETWEEN THREE APPROACHES FOR POLLUTION CONTROL

## 1. Introduction

Models that compare and describe the theoretical relationships between willingness to pay (WTP) valuation approaches for pollution control are well known in the literature. Several empirical studies have been conducted to compare the relationships between approaches, but have been limited to two approaches only (for e.g. see Alberni and Krupnick, 2000). In this paper, field survey data are used to compare the relationships between contingent valuation (CV), cost of illness (COI) and avertive behaviour approaches and to demonstrate that CV bids exceed the sum of cost of illness and the defensive behaviour estimates. As pointed out by Alberni and Krupnick (2000) comparison of estimates acts as a validity check for the WTP figures reported by the respondents in the CV survey and provides further support to the claim by Carson et al. (2001) that empirical CV studies are theoretically consistent. The pollution in question is farmers' exposure to pesticides.

## 2. Brief Discussion of the Theoretical WTP Model

The relationships between the CV, COI and avertive behaviour approaches have been examined by Cropper and Freeman (1991) using a model of health production and consumption. They have shown that CV WTP bids exceed the sum of COI and avertive behaviour bids combined together. Despite all three approaches being used as WTP measures for pollution control, the COI and the avertive behaviour approaches, unlike the CV approach, do not consider the intangible costs of exposure to pollution. Hence, these two approaches provide only lower bounds for the correct measures of WTP. As shown by Cropper and Freeman (1991), the true WTP measure (which is the direct CV approach) to avoid an increase in pollution, therefore, consists of the following equation:

$$WTP = w \frac{dS}{dP} + \frac{dM}{dP} Q_M + \frac{dD}{dP} Q_D - \frac{U_S}{\lambda} \frac{dS}{dP} \quad (1)$$

Note: Proof can be submitted on request

where  $\lambda$ , the marginal utility of income converts the disutility of illness,  $\partial U/\partial S$ , into monetary values. As equation (1) shows CV WTP consists of the amount resulting from the COI expenditures (the first two terms on the RHS) plus the amount resulting from defensive behaviour expenditures (the third term) and the monetary value of the disutility arising from pollution induced illnesses (the fourth term). An individual directly asked, using the CV approach, for his or her WTP to avoid direct exposure to pollution, say pesticides, may consider all expenditures shown in Equation (1) in revealing his or her WTP bid. Equation (1) also implies that only when the defensive measures undertaken are inadequate that the first two terms and the fourth term can exist. On the other hand, if defensive measures undertaken to prevent total exposure are sufficient, then there will mainly be defensive expenditures. Hence, depending on the adequacy of the defensive expenditures, the first two terms and the last term can be large or small. If defensive expenditures undertaken are small (inadequate) then the first two terms and the last term are large, and vice versa.

### **3. Field Survey Data Showing the Relationships Between the Three Approaches**

A field survey was conducted in Sri Lanka using the three valuation techniques to compare and determine whether the CV results exceed the COI and defensive behaviour expenditures as theoretically demonstrated. Data were collected from five regions in the Central and North-Central Provinces of the island. An eleven page questionnaire was used to collect data from 203 farmers on the private costs<sup>1</sup> of ill health (including all private medical expenditures and lost time) and defensive expenditures resulting from direct exposure to pesticides. CV bids were also obtained using the same questionnaire. Farmers spraying pesticides were interviewed rather than farm workers because the latter group are only employed on farms as 'part time seasonal' workers.

The respondents were told that the CV question was aimed at measuring how much people are willing to pay to avoid direct exposure to pesticides and the resulting illnesses if a programme was devised to prevent such illnesses from exposure to pesticides. Respondents were also informed of the economic sacrifice they would have to make to support such a prevention programme. The farmers were told that the money will have to come out of their income. They were specifically told about the range of options available to avoid direct

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<sup>1</sup> Only private costs of ill health are considered because medical treatment in government hospitals in Sri Lanka is provided free of charge.

exposure to pesticides [for example, using safer but more expensive pesticides, adopting integrated pest management (IPM) strategies which, however, could cost more to adopt and growing crops that involve no or less pesticides]. The choice of the payment vehicle to undertake prevention programmes was also made as realistic as possible. All the respondents in the study areas were provided with the same information, including the payment vehicles suggested. An open-ended question format asking what the maximum amount is that they would be willing to pay in order to avoid direct exposure to pesticides and the resulting morbidity effects was used. The data were obtained by direct interviews. Despite dichotomous choice (referendum) CV questions gaining popularity during the past decade and being the choice recommended by the NOAA panel, it was not used in this study for several reasons. One major reason was that the farmers, before they were asked about the CV question, had already stated the costs arising from illnesses and precautions taken due to direct exposure to pesticides. Hence, the respondents were already aware of the costs incurred. In such a case it was better for the farmer to give a value rather than for the interviewer to suggest a payment. As mentioned previously, Whittington (1998) points out that if the amount the enumerator asks lacks credibility, the respondent is unlikely to answer the question on the basis of the prices asked. Hence, there is difficulty in setting the right referendum prices.

The survey data show that although farmers take precautionary measures whilst handling and spraying pesticides, they suffer from many adverse health effects, thus incurring large medical and time costs. This implies that, although farmers have taken precautions to minimize or avoid ill health arising from direct exposure to pesticides, such measures are inadequate and hence they incur medical and time costs due to pesticide exposure related illnesses. In such cases, farmers also suffer from pain, stress and discomfort. These costs are not captured by the COI approach. Examination of the data reveal that the CV WTP bids are sensitive to scope. It can be seen that farmers who suffered severe and/or frequent health problems from exposure to pesticides were willing to pay more to avoid exposure than those who suffered mild symptoms or suffered symptoms less frequently. The results of the field study (Table 1), show differences in costs among the three approaches. As can be seen in Table 1, CV bids are larger than the COI or defensive behaviour expenditures or even both estimates combined.

**Table 1: Comparing the Three Approaches Using Field Survey Data**

Symptom	Sample Size	Mean yearly CVM bid (RS)	Mean yearly Private COI expenditures (RS)	Mean Yearly Private AB expenditures (RS)
Ill-health resulting from direct exposure to pesticides	203	11,471.18	5,465.54	405.14
		95% Confidence Intervals		
		9,726.14 < $\mu_x$ < 13,216.21	4,484 < $\mu_x$ < 6,447.08	293.01 < $\mu_x$ < 517.26

Note: The 95% confidence intervals in Table 1 indicate that 95 out of 100 times such intervals will include the true  $\mu_x$ . AB = Avertive Behaviour; COI = Cost of Illness; CVM = Contingent Valuation Method.

The defensive expenditures are low. There are many reasons for this. One major reason is that because of farmers' low incomes (average income of surveyed respondents was Rs 4,748) they were unable to purchase expensive protective gear. Farmers also re-use the protective gear, although this practice is harmful because pesticides contaminate the protective gear unless properly cleaned. Farmers in developing countries also borrow equipment and protective gear without a payment. Similarly, time spent on purchasing protective gear, reading instructions and repairing protective gear have been omitted due to the difficulties in calculating such costs.

These findings confirm the results of Equation (1) which show that CV WTP bids exceed the sum of changes in avertive behaviour expenditures and the costs of illnesses combined. This is because a person affected by direct exposure to pesticides, when asked how much he or she would be willing to pay to avoid ill-health resulting from such exposure, is likely to consider all the costs of illnesses (including money and time costs), intangible costs (such as pain, stress, suffering and discomfort) and the defensive costs incurred in revealing his or her true WTP to avoid direct exposure to pesticides. This was evident during the field survey.

#### 4. Conclusions

The field survey data show that WTP estimates obtained from the three approaches not only vary, but that COI and avertive behaviour estimates provide only lower bound WTP values. This is mainly because, unlike the CV approach, these two approaches do not consider intangible costs. Therefore, CV bids not only exceed the sum of COI and avertive behaviour bids, but it is also the true WTP measure. Furthermore, comparison of estimates not only act



as a validity check for CV WTP figures, but they also provide further support to the claim by Carson et al. (2001) that empirical CV studies are theoretically consistent.

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