Research Paper

Deriving Willingness to Pay: A Framework for Environmental Protection

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ABSTRACT

With the intensification of globalization and progressive strides towards fostering economic growth, environmental degradation in India has increased manifold with the development process amplifying it as a consequence of increased human consumption. This paper established quantitatively estimated conditional possibilities of willingness to pay by an individual as a measure to contain environmental degradation. Using logit regression, the study empirically validated the willingness to pay conditions by focusing on a primary data sample of 164 respondents from Ranchi district as the study area in Jharkhand. This study indicated that corrective actions by individuals to contain environmental degradation can be effectively induced by increased governmental interventions. This study is significant in the present context when the developmental process in India is manifested by increasing environmental degradation.

HIGHLIGHTS

⊙ Establishing conditions for individuals' WTP that effectively lower environmental degradation.
⊙ Impact of governmental interventions on environmental protection.
⊙ Assessment of individual accountability towards abating environmental degradation.

Keywords: Environmental degradation, Willingness to pay, Government interventions, Environmental intrusions

The intensification of globalization since the early 1990s in India has led to a matched growth in consumerism (Dey, 2015) which has been stealthily accompanied by the escalating pressure on environmental resources due to unsustainable current consumption patterns and urbanization (Mittal and Gupta, 2015; Kattumuri, 2017). Over time, the use of the environment has grown exponentially which subsequently has led to the degradation of the holistic environment thereby saturating the carrying capacity of the environment. In the process, the environment gradually converted into a universal garbage bin by forced absorption of the wastes accumulated by the human consumption process. Instead of addressing the issue's root cause of increasing industrialization and human consumption, the

world chose to reimagine sustainable development (Smith and Bastidas, 2017). Our environment offers a plethora of mediums to sustain human life balancing the supply and demand nexus of human needs. The ever-growing contemporary human wants have led to a reversal in this supply-demand nexus by being more lopsided toward the demand side. This reversal has contributed to aggravating environmental degradation over time. The worldwide environmental changes raise concerns about whether global civilization is on a sustainable path or is consuming excessively by

depleting essential natural capital since they could have significant negative effects on future human well-being (Polasky *et al.* 2019). The retrospective aspects of consumption demand indicate that before industrialization, the lopsided demand-supply nexus, as it exists today was an even equation where the demand for natural resources seldom exceeded its supply. According to trends in global industrialization, both urbanization and industrialization are sources of harmful emissions that worsen environmental degradation (Ahmed *et al.* 2022). However, with industrialization speeding up along with the economic growth in India, an exponential surge in the demand was experienced which added humongous pressure on the environment leading to the overuse of the environment. This resulted in a reversal of the abundant supply of natural resources to a scanty supply concerning its demand, which has grown towards unmanageable limits. This constant weakening of the environment has suppressed the agenda of sustainable development whereby intensifying the need to review this situation and assist towards the cause of the Global Goals as adopted by the United Nations in the year 2015. Corrective actions imbibe coercive steps to club the present environmental situation in India. With an alarming growth in population leading to an increase in rapid industrialization, multiplicity of vehicles, etc., urgent attention is assigned to the issue. Article 51A(g) of the constitution of India assigns fundamental duty to the citizens for environmental protection (Prasanna and Dhivya, 2018). One of the mediums to ease this situation is by assigning accountability to an individual for their share of environmental degradation. Self-realization for this accountability among individuals may not drive them to address the cause. Here, coercing initiatives shall ensure better self-discipline and practices toward lowering the environmental degradation process. The obligation to enforce an individual's accountability concerning the environment rests with the government to formulate legislative laws and policies both at the center and the state levels to address the problem. Though such governmental regulations are in place, however, they are seldom exercised effectively.

Understanding the economic value people place on environmental concerns is crucial to develop a framework for environmental protection. Knowing people's WTP can help in evolving an understanding of the trade-offs and preferences they have when it comes to environmental conservation. Making educated decisions based on society's values and interests requires considering the costs and benefits of various environmental policies and projects. Finding the willingness to pay (WTP) for an improvement in the prevalent environmental conditions is central to attaining sustainability and policy formulation towards environmental conservation which demands a thorough insight into the present environmental problems as an outcome of an individual's consumption behavior for the environmental goods. Conceding this aspect, the present research is an earnest step towards addressing the environmental cause by making individuals accountable for their share of environmental degradation through governmental regulations. In this quest, the study orbits around the investigative inquiry to develop a framework that can effectively determine people's WTP for environmental protection. This research question aims to explore approaches to derive an individual's WTP taking into account various environmental criteria.

The objective of this study is to establish quantitative conditions that ascertain an individual's willingness to pay for abating environmental degradation which entails deriving conditional possibilities to build a willingness to pay model as a cost to an individual consumer thereby indicating the effectiveness of government interventions to offer curative measures to address the cause of environmental degradation. Furthermore, this research seeks to delve into validating the conditions established in the model by an empirical investigation of the abating behavior of the respondents from the Ranchi district in Jharkhand towards environmental degradation. A paradigm for assessing WTP could help allocate resources for environmental preservation more effectively by taking into account the financial viability of various environmental projects based on individual preferences. Consequently, resources can be steered towards places where they have the greatest impact by giving projects with a higher willingness to pay priority, warranting the most effective use of scarce resources. It offers a mechanism to put an economic value on

environmental resources like clean air, biodiversity, and ecosystem services that aren't usually priced. Policymakers can more effectively include these values in cost-benefit studies by quantifying people's willingness to pay, leading to more thorough evaluations of the underlying economic value of natural assets.

LITERATURE REVIEW

Environmental degradation has been growing at an accelerating pace which is leading to a worsening climate change. In India, the most precarious environmental issue is air pollution, and as per the World Air Quality Report, 2021 where 63 of the top 100 most polluted cities are in India (Igini, 2022). Subramanian (2018) argued that the speeding industrialization along with the increasing consumption is creating anthropogenic pressure on natural resources which is leading to their exploitation, whereas, at the same time less attention is acknowledged towards efforts leading to the replenishment of spent resources. Resonating the concern over environmental degradation, Hazarika and Bhattacharjee (2022) indicated that a combination of factors including population growth, poverty, weak property rights, etc., leads to severe degradation of the environment in India and points that the growing demand for the products obtained from natural resources is adding pressure on the forests.

To protect the depleting environment, Dhulia and Ganguli (2018) expressed that environmental protection acts in India did take a definitive approach but these regulations are not marked by strict enforcement to curb the menace of environmental degradation. Turaga and Sugathan (2020) in their study mentioned that the increase in the intensity of environmental depletion is attributed to the failure of the environmental governance and regulatory infrastructure in matching the pace of economic growth in India. They also stated that the gap between expectations of environmental compliance and the state of affairs in the country has been a cause of concern. The World Bank publication (2021) stated that India has been taking a plethora of steps in responding to environmental issues. With the revision of ambient air quality standards including the vehicular and industrial emission standards with an emphasis on

renewable energy and emphasis on electric vehicles, India is taking steps to control the speeding levels of air pollution. Peng *et al.* (2020) expressed their concerns while researching the importance of policy implementation in India's electricity sector, that a key barrier to the environmental protectionist governmental policies remains enforcement, and found that limited enforcement of pollution controlling policies leads to worsening of the future air quality. In recent years India has been adopting measures and has been enacting policies to curb the menace of environmental degradation (Singh *et al.* 2022). However, the key lies in the efficient enforcement of laws and prudent enactment of environmental conservation programs to contain environmental degradation in India. The present study acknowledges this and discusses a framework for increased governmental interventions to serve the pertinent cause of the protecting life-supporting environment.

METHODOLOGY

The study was based on estimating the average willingness to pay (WTP) with the help of a random utility model (Banerjee, 2017). This study further derived quantitative conditions for consumers' willingness to pay and outlined the need for governmental intervention concerning the containment of environmental degradation. At first, an incidence function is derived which is then used to obtain the willingness to pay (WTP) expression for a consumer, indicating the cost of generating environmental pollution as a means to tax the individual towards corrective actions. To validate the WTP expression obtained, the study uses primary data collected through a survey in the Ranchi district, Jharkhand for which the sample size of 164 respondents was drawn using the purposive sampling method. As the capital of Jharkhand, Ranchi frequently serves as a hub for concentrated human activity, including business and industrial operations, and transportation systems, and abounds in dense populations. These elements have a big potential to harm the ecosystem and hence exploring the respondents here can assist in investigating the direct and indirect effects of human activity on the environment. This study incorporated the econometric model of logit regression to validate the WTP expression developed.

RESULTS

The social cost of environmental pollution

Considering δ_{ij} as the negative externality caused due to pollutants coming from i'th source and polluting j'th part of the environment, which takes the functional form as:

$$\delta_{ij} = \sum_{1}^{n} I \qquad \ldots(1)$$

where I, is the index for the factors that aggravate environmental degradation. For obtaining the social cost of pollution, expression (1) is used to estimate the willingness to pay (WTP) condition for an individual. The following consumer utility function is taken:

$$U_{ij} = f\left(Y_i, \delta_{ij}\right)$$

where, U_{ij} is the i'th consumer's environmental utility function for j'th location, Y_i is the income of the concerned consumer. At a single point in time, this utility function cannot be comprehensively measured. What can be observed is U_{ij}^* which remains only a part of U_{ij}, which is given by:

$$U_{ij}^* = \alpha Y_i + \delta_{ij} + e_i$$

where α is the part of income that the consumer spends on essentials and e_i is the stochastic term reflecting consumers' level of inclined interest toward environmental protection. Considering the utility theory, a rational consumer desires to optimize his satisfaction given the budget constraint. In this context, the budget constraint of the consumer is indicated by:

$$Y_i = p_1 q_1 + p_2 q_2 + \ldots + p_n q_n$$

However, a rational consumer will also strive to save a proportion of his income for futuristic and contingent requirements. Considering this behavior, the influence of futuristic savings by a consumer has the effect of rationalizing the budget constraint to the expression:

$$Y_i' = p_n q_n + s^r$$

If the i'th consumer is asked if he is willing to pay an amount *m* to improve the state of pollution from $\delta_{ij(t)}$ representing the state of pollution at location *j* in time *t* to $\delta_{ij(t+1)}$ indicating an improved state of pollution at location *j* in time *t+1* concerning the index of environmental pollutants, subject to,

$$\delta_{ij(t+1)} > \delta_{ij(t)}$$

then the condition for willingness to pay concerning the cost to the individual consumer is:

$$\left[\left\{\delta_{ij(t+1)} + \alpha\left(Y_i' - m_i\right) + e_{i(t+1)}\right\} \geq \left(\delta_{ij(t)} + \alpha Y_i' + e_{i(t)}\right)\right]$$

$$= \left\{\delta_{ij(t+1)} - \delta_{ij(t)}\right\} - \alpha m_i \geq e_{i(t)} - e_{i(t+1)}$$

$$= \mu \geq \eta + \alpha m_i \qquad \ldots(2)$$

where m_i is the required cost to the ith consumer for environmental maintenance through government interventions, $\mu = \{\delta_{ij(t+1)} - \delta_{ij}\}$ and $\eta = \{e_i - e_{i(t+1)}\}$. The expression (2) represents the social costs (S_C) of pollution. Private costs are given by P_C which constitutes the cost for a consumer who in the consumption process negatively influences the carrying capacity of the environment.

Determinants of consumer's willingness to pay for environmental protection

The private cost and social cost are related according to the relation:

$$P_C + E_C = S_C$$

where E_C is the external cost and S_C is the social cost. External costs remain costs to society, regardless of who pays for them, and are not reflected in a firm's income statements or consumers' decisions. If the following conditions hold:

$$E_C > 0, \text{ then}$$

$$S_C > P_C \qquad \ldots(3)$$

This results in negative externalities since the consumption process imposes external costs on third parties for which no appropriate compensation is paid and causes social costs to exceed the given

private costs. The conditions given by expressions (2) and (3) constitute the determinant of the consumer's willingness to pay by i'th consumer for corrective approaches intended to control the environmental degradation of j'th location concerning the emergence of negative externalities.

Assessment of the willingness to pay framework

The condition for willingness to pay apprehends two plausible situations:

Possibility 1:

Considering there are no governmental interventions, accordingly, the i'th consumer will not be willing to pay the amount m_i to improve the state of pollution from $\delta_{ij(t)}$ to $\delta_{ij(t+1)}$, then the expression (2) gets reduced to:

$\mu \geq \eta + 0$, or

$$[\delta_{ij(t+1)} - \delta_{ij(t)}] \geq [e_{i(t)} - e_{i(t+1)}] \qquad \ldots(4)$$

The expression (4) indicates that the divergence between the improved state of pollution in time (*t*+1) and the state of pollution in time *t* becomes greater as compared to the divergence between stochastic variables in time t and (*t*+1) indicating an increase in the level of environmental degradation as the consumer's willingness to assist in environmental protection is debilitated in the absence of coercion by the government.

Possibility 2:

If the government imposes its interventions coercing the consumer to pay m_i through legislation towards improving the state of environmental pollution equivalent to the cost i'th consumer incurs in polluting the environment, the expression (2) holds. This proposition suggests that when the i'th consumer's inclination towards the focus on environmental protection is supplemented with an additive index amounting to an environmental tax, then it leads to the validation of the conditions for i'th consumer's willingness to pay as stated by the equation (2). The proposition of possibility 2 fits the deduction of the social costs of pollution which indicate that WTP for containing environmental pollution by the individual consumer

is the determinant of improvement in the state of environmental degradation when compounded by government interventions.

Validation of the conditional parameters defining WTP toward controlling pollution

In the context of the derived possibilities for willingness to pay concerning corrective measures for environmental degradation, it is pertinent to validate these propositions regarding the assessment of the willingness to pay model constructed for the ith consumer for his share of environmental pollution. With this objective, a survey was administered with a sample of 164 respondents in the urban parts of the city of Ranchi in Jharkhand through a purposive sampling method. The purpose was to get their opinions on the stated issue, whether the conditional possibilities developed in expression (2) are applicably valid.

Table 1: Summary of willingness to pay (WTP) survey

Levels of income	(X_i) Annual Income ('000)	(N_i) No. of individuals at income X_i	(n_i) No. of individuals willing to pay (WTP)
1	600	18	3
2	800	21	6
3	1000	25	11
4	1200	32	20
5	1400	28	15
6	1600	15	11
7	1800	7	4
8	2000	10	8
9	2200	3	3
10	2400	5	4

Source: *Author's survey.*

Table 1 expresses the response of the individual's willingness to pay towards the corrective environmental efforts by the government agencies to contain the steep environmental degradation occurring as an aftermath of large-scale human consumption activities and efforts to improve the state of the environment in their area. To interpret the data collected toward our objective, logit regression was assessed:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \alpha_1 + \alpha_2 X_i + \varepsilon \qquad \ldots (5)$$

In the expression (5), i refer to the ith individual, ε is the stochastic term, α_2 is the coefficient of the explanatory variable X_i for individuals i and P_i is the probability of WTP and $(1-P_i)$ is the probability of non-adherence to WTP. For estimation purposes, the given logit was:

$$\hat{L}_i = 1n\left[\hat{P}_i / \left(1-\hat{P}_i\right)\right]$$

whereas, to resolve the issue of heteroscedasticity, eq. (5) was transformed to:

$$\sqrt{w_i}L_i = \alpha_1\sqrt{w_i} + \alpha_2\sqrt{w_i}X_i + \sqrt{w_i}\varepsilon_i \qquad \ldots (6)$$

where $w_i = N_i\hat{P}_i\left(1-\hat{P}\right)$. The necessary data and relevant calculations necessary to implement grouped logit model are given in Table 2. Using the statistical software suite SPSS, the results of the weighted least-squares regression eq. (6) based on the data in Table 2 are expressed as:

$$\hat{L}_i^* = -1.923\sqrt{w_i} + 0.002X_i^*$$

where $\hat{L}_i^*$ is $\sqrt{w_i}L_i$ and X_i^* is $\alpha_2\sqrt{w_i}X_i$. For the odds interpretation of this model, an antilog for the estimated logit is obtained:

$$\frac{\hat{P}_i}{1-\hat{P}_i} = e^{-1.923\sqrt{w_i}+0.002X_i^*} = e^{-1.923\sqrt{w_i}}.e^{0.002X_i^*}$$

where $e^{0.002} = 1.002$ which interprets that for a unit increase in weighted income, the odds in favor of an individual's WTP increases by 2 percent suggesting that an increase in income of the ith individual may not significantly induce them to willingly contribute towards corrective efforts towards reducing environmental degradation. Therefore, it becomes pertinent for government to intervene and coerce corrective human actions that go in favor of containing the environmental degradation process. This assessment validates conditional possibility 2 that upholds equation (2).

Willingness to pay and sustainability

Establishing a willingness to pay helps achieve the larger objectives of conservation and sustainable development. Designing conservation techniques and regulations that are both economically feasible and environmentally advantageous is made possible by knowing how people value environmental resources. The incorporation of environmental concerns into development plans is aided by a framework for determining willingness to pay, ensuring that economic expansion coexists peacefully with the preservation and sustainable use of natural resources. An approach for including stakeholders and the general public in environmental decision-making is to estimate willingness to pay. It develops a sense of ownership and gives communities the power to have a role in environmental management by involving people in the valuation of environmental products and services. Transparency, accountability, and democratic decision-making are encouraged by this strategy, which results in more inclusive and successful environmental policies and programs.

Designing and implementing market-based instruments for environmental protection requires a framework for determining willingness to pay. Accurate assessments of people's willingness to pay are necessary to set pricing, provide incentives, and promote sustainable behavior in market-based initiatives like pollution taxes, and eco-labeling. A strong framework facilitates the efficient application of market-based tools, promoting environmental stewardship and motivating organizations and people to adopt eco-friendly practices.

DISCUSSION

To improve policy allocation in the context of environmental conservation, the current research sought to build a framework for WTP for environmental protection measures. The framework for deriving WTP allows for the estimation of the economic value individuals place on environmental goods and services. By understanding the monetary worth attributed to these resources, policymakers, and environmental practitioners can better prioritize conservation efforts, allocate resources, and design policies that align with public preferences. The derived WTP values provide a quantifiable measure that can be integrated into cost-benefit analyses, aiding decision-making processes and promoting the sustainable management of natural resources.

The value-action gap, where people may express positive attitudes towards the environment but fail to transfer them into concrete acts, is one of the

Table 2: Data to estimate the Logit Model

X_i in '000	N_i	n_i	$\hat{P}_i$	$1 - \hat{P}_i$	$\dfrac{\hat{P}_i}{1 - \hat{P}_i}$	$\hat{L}_i$	w_i	$\sqrt{w_i}$	$\sqrt{w_i}\hat{L}_i$	$\sqrt{w_i}\hat{X}_i$
600	18	3	0.17	0.83	0.20	-1.61	2.50	1.58	-2.54	948.68
800	21	6	0.29	0.71	0.40	-0.92	4.29	2.07	-1.90	1656.16
1000	25	11	0.44	0.56	0.79	-0.25	6.16	2.48	-0.62	2481.93
1200	32	20	0.63	0.38	1.67	0.51	7.50	2.74	1.39	3286.34
1400	28	15	0.54	0.46	1.15	0.14	6.96	2.64	0.37	3694.59
1600	15	11	0.73	0.27	2.75	1.01	2.93	1.71	1.73	2740.32
1800	7	4	0.57	0.43	1.33	0.29	1.71	1.31	0.37	2356.75
2000	10	8	0.80	0.20	4.00	1.39	1.60	1.26	1.75	2529.82
2200	3	2	0.67	0.33	2.00	0.69	0.67	0.82	0.57	1796.29
2400	5	4	0.80	0.20	4.00	1.39	0.80	0.89	1.24	2146.63

Source: *Author's computation.*

ongoing difficulties in environmental conservation. The conceptualization of the WTP in the present study provides a workable solution to this gap by assessing people's WTP. Individuals are more likely to take into account their WTP while making purchasing decisions, supporting environmental efforts, or adopting sustainable behaviors if the economic worth of environmental protection is made obvious.

Even though the framework offers a useful tool for determining willingness to pay, it is important to recognize its limits. The calculated WTP values are a moment in time and could be affected by several contextual factors. Furthermore, the framework makes the unavoidable assumption that people make fully informed, logical decisions. Future studies should examine the changes in WTP over time, take into account the impact of various informational and framing settings, and look at the influence of non-financial elements on people's decision-making.

CONCLUSION

The agenda of sustainable development fosters economizing the use of natural resources and redefining the growth patterns to ensure that the developmental aspirations do not exhaust the environment. The assessment in this study indicates the need for an aggressive intervention by the government to attenuate the environmental usage patterns coercing an individual to alter their environmental usage habits. However, the indication of the possibility 2 in this study for an increased governmental involvement to enforce the willingness to pay will be remotely possible if the paying capacity of the individuals does not match with the mandate for the willingness to pay to counter environmental pollution. The willingness among the members of the society in India with high inequalities of income is based not on absolute income, rather it is a determinant of the level of personal disposable income of the households. The uncertainty among average-earning Indian households over the rising living cost is compelling them to save more. This inflation-driven saving tendency may act as a stiff barrier in inducing individuals towards willingness to pay for corrective environmental measures. A cohesive governmental criterion in rationalizing the rising living cost as a first step towards regulating the willingness to pay framework to curb the speeding environmental degradation may reach out fairly to the individuals and will lead to prudent measures to attain sustainable consumption.

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