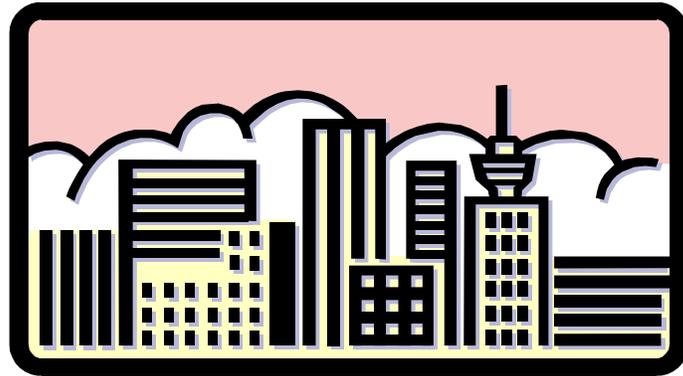


## Hedonic price method – A Concept Note



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## **Introduction**

Environmental protection is one of the principal concerns in the 21<sup>st</sup> century and is likely to dominate political interest in the coming years. Environment is a good, which belongs to “everybody” but belongs to “nobody”. The two important features “nonexcludability” and “jointness of production” leading to “non-enforceability” of property rights are the main causes of environmental degradation resulting in increased air, water, noise pollution etc. They can be the silent killers if unchecked now. This supports the concern why we need to protect the environment. But as costs of protecting the environment can be quite huge for some environmental programmes, the next issue that comes to our mind is who pays for these costs and how to raise resources for protecting the environment? This is clearly the job of Environment minister. However, due to limited budget and competing priorities, before investing in environment protection he has to ascertain that the costs incurred is worth the benefits that the citizens receive. If the net benefits are not positive the resources can be directed somewhere else.

The costs are clearly measurable but how do we measure the benefits of protecting the environment? Environment provides several goods and services, many of which cannot be measurable. How can we have a meaningful measure for the benefits of environmental protection? If individuals want to buy a consumer good say “car”. The benefit derived from using a car will be at least equal to or more than what the individuals are willing to pay for the car, which is revealed through the market price. In this case the individual is expressing his willingness to pay for the benefits he will derive for using the car through the market price. Suppose, after some years he decides to sell the car. He would be willing to sell the car only if he receives in compensation some value for the car, which is not less than some reservation price. In this case he is expressing his willingness to accept as compensation for foregoing his utility from the car. Thus in this case the market price can be used to calculate the individual’s willingness to pay or willingness to accept, and hence the economic value of the good to that individual. In case of environmental goods and services, there are no well-enforced property rights and hence, we cannot have well-established markets and market clearing prices. We need to have some market or nonmarket valuation techniques, which can be based on the same principle of individual’s willingness to pay for the environmental gains or willingness to accept compensation for some environmental losses.

**The objective of this concept paper is to introduce one of the techniques for valuation of environmental goods and services.** The paper is structured as follows. In section 2, a brief overview of various techniques to value environment goods and services is discussed. Section 3 discusses the hedonic price method in particular. Section 4 looks into applications of hedonic price method and Section 5 concludes with limitations of hedonic price technique.

## **2. Brief Overview of Methods for valuing the environment**

A number of techniques are available to value the environmental goods and services. These can be categorized into revealed preference and stated preference techniques. In revealed preference methods individuals indirectly reveal the willingness to pay for environmental good through market and surrogate market prices. In stated preferences, the individuals are directly asked what their willingness to pay is. These techniques can be classified according to the method used for valuation i.e. market based, surrogate market or non-market based. A very brief description of different methods is given below:

### **Market Based Methods:**

These methods are based on direct observable market interactions. For example, soil is a natural asset. However, the soil is integrated in land and no separate market exists for soil alone. However, if we want to know the value of fertile soil (to know whether or not to invest in some soil conservation project), then we can use market-based method called as production function approach. Here soil is treated as input into the production function and the impact of soil degradation will be reflected in loss in output. Similarly, the amount individuals spend to defend themselves (known as defensive expenditures) from adverse health impacts can also be used as a proxy.

### **Surrogate Markets**

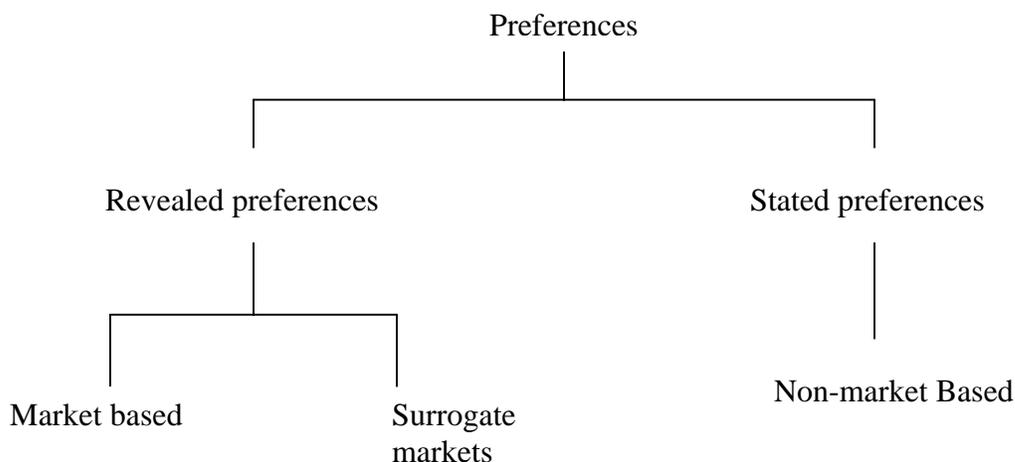
When direct market prices for environmental good or services cannot be directly observed it is sometimes possible to find a good or service related to the non-marketed environmental good that is sold in market. For example, if we want to know the value placed by an individual on an elephant, or we want to place a value for clean air, we do not have direct observable market prices. In this situation the individual may reveal his or her preferences indirectly through some

other marketed good. In case of tiger, he may reveal his preference by the amount of time and money he spends to view an elephant. This is termed as travel cost method. Similarly in the case of clean air, he may reveal his preference by locating his house in a very clean locality and paying an extra premium for this known as hedonic price method. Using this method it is possible to separate out the environmental component of value from the observed market price and use this component of market price as a surrogate for the environmental value.

**Non-market based methods**

In certain cases it is not possible to use any market or surrogate market based methods. For example, if we want to estimate the non-use values and just value the environment for its existence, we need to have some alternative way to do it. In such cases people are directly questioned to determine their willingness to pay to preserve the environment or species. Such method is referred to as contingent valuation method. A detailed description of the good under consideration is provided and interviewees are then asked what they would be willing to pay (WTP) for a hypothetical environmental improvement or to accept (WTA) as compensation for an environmental deterioration. The contingent valuation approach may in principle at least capture the total economic values (use and non-use components) whereas other techniques may only provide estimates of direct or indirect use value. However, CVM also has a number of shortcomings through biases of preferences, questionnaire design and survey practices. Figure 2 presents some of these techniques and classifies them according to the basis of the monetary valuation, either market-based, surrogate market, or non-market-based.

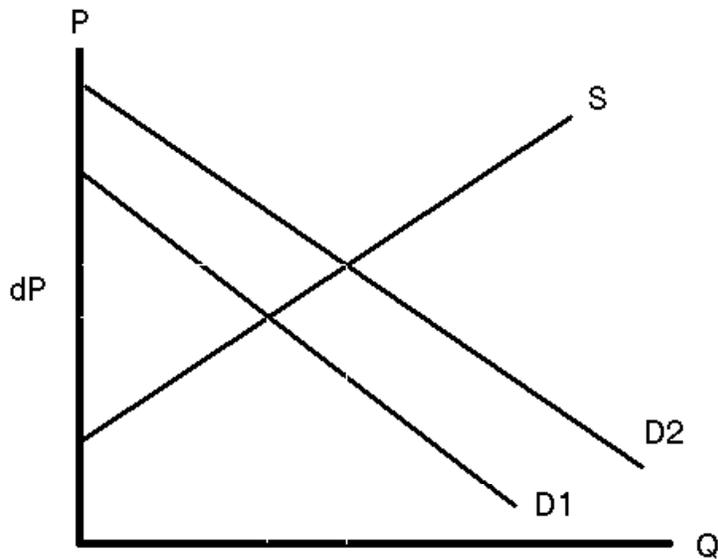
**Figure 1: Techniques to value environmental goods and services**



### **3. Hedonic Price Method**

The Hedonic Price Method (HPM) is a revealed preference method of valuation. The hedonic price method of environmental valuation uses surrogate markets for placing a value on environmental quality. The real estate market is the most commonly used surrogate in hedonic pricing of environmental values because the word “hedonic” comes from a Greek origin, which means, “pleasure”. Hence, the hedonic pricing method relies on information provided by households when they make their location decisions. People derive pleasure by living in nice places. As the demand for land and housing increases, the price of housing increases (e.g., the cost of living in nice places is relatively high). The method can also be used in to estimate the premium placed in nice ‘jobs’. The higher housing prices reveal how much people are willing to pay for the amenities in nice places. Air, water, and noise pollution have a direct impact on property values. By comparing properties with otherwise similar characteristics or by examining the price of a property over time as environmental conditions change and correcting for all nonenvironmental factors, information in the housing market can be used to estimate people's willingness to pay for environmental quality.

For example, consider two houses located in localities A and B. Locality A is located near an industrial complex and highly polluted. Locality B is a residential area and is less polluted. Demand 1 represents the demand for housing in polluted area and Demand 2 represents demand for housing in a clean area. After considering all other factors, which influence the price of a house, the house in locality A will fetch a higher price than the house in locality B. The price differential,  $dP$ , is the marginal willingness to pay (in higher housing prices) for the difference in air quality. These price differentials can be estimated using regression methods.

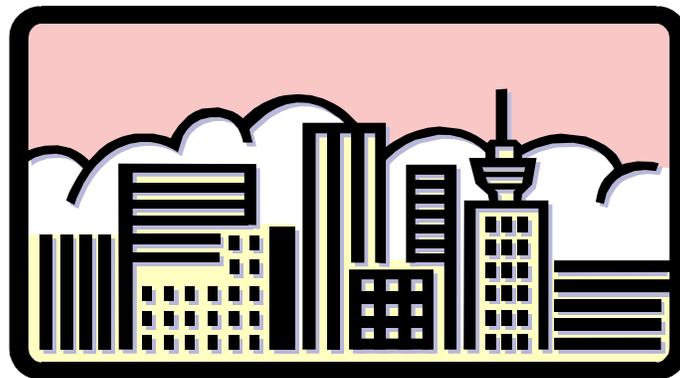


**Figure 2. Figure showing the differential price between the localities with different environmental quality**

Another example can be to know the welfare losses of an airport expansion project due to increased noise to the residents in that locality. Suppose our objective is to estimate the value of this nuisance so that the residents staying around the airport can be compensated for their discomfort. As there are no markets to trade quietness, how do we know the value of quiet surroundings? Though quietness does not have explicit markets, they are implicitly traded along with one marketed good i.e. house. Individuals express their preference for quietness by purchasing a house in a quiet locality, which may have a different price compared to an identical house in very noisy locality. The extra premium paid to the house in a quiet surrounding can be taken as the value of quietness. So the residents in the locality may be offered this extra premium so as to compensate them for bearing the nuisance. Similarly, we can also apply this to estimate the value of scenic beauty, beaches, watching sunrise, national park etc. Houses by the side of beach or lake fetch higher value because of their scenery than identical house three or four lanes away from a beach/lake. Such price differentials have been detected in the property market for road traffic noise; air pollution; aircraft noise; and proximity to land fill sites. The hedonic price method can also be used to estimate the value of avoiding risk of death or injury by looking for price differentials between wages in risky and non-risky jobs.

Hedonic price method can also be used to estimate the value of fresh water in a coastal region. In coastal regions, the location of house with respect to its proximity to the sea, defines the quality of ground water supplies accessible to residents of the house. Over extraction of ground water beyond a particular extent would result in instability of the interface between the saltwater and freshwater, resulting in salt water replacing the fresh water. As ground water sources are contaminated, if other sources of drinking water are not readily available (which often happens in summer season in India), new wells must be drilled, or the residents in that house have to buy water for their needs etc, which imply an additional cost and inconvenience to the residents. However, if the house is further away from the sea, the quality of ground water may be better. Thus, in this case the salinity in ground water supplies can influence household's preferences to reside in that house or not. In this case the structure of house rents and prices will reflect these preferences. Hence, by using data on house rent/value for different properties the contribution made by water quality to the value of (willingness to pay for) the traded good, i.e. land or house can be identified. This identifies an implicit or shadow price for value of fresh water.

Let us illustrate the application of hedonic price method using ground water in a water scarce city. Suppose our objective is to find the value of ground water. As the price paid by the individuals does not reflect the total value, we need to find individuals' willingness to pay for getting ground water.



We make an assumption that the price of a house is determined by the particular combination of characteristics it displays, i.e. properties possessing larger quantities of goods qualities command a higher price and those with larger quantities of bad qualities command lower price. This function known as the Hedonic Price Function, explains a house price in terms of the quality and

quantity if these features. This involves collecting information on the actual sale/rental prices of individual properties and detailed characteristics of the house. When we describe a house it is usually described by the quality or characteristics of its structure, environment and locality. The structural attributes can be the number of rooms, number of bath rooms, area of the house, age of the house, the floor in which house is located, the type of the house (whether it is independent, flat, bungalow or a hut), area for car parking etc. The environmental attributes can be the quality of air in the locality, whether the house is located by the side of the beach /national park/airport/highway/dumping yard, or the quality and availability of water etc. The location variables include whether the area is posh (i.e. if it belongs to high income group, middle income or low income), quality of roads, schools, how far it is from hospital, bus stop, city center, railway station, airport etc.

The analysis proceeds through two stages. In the first stage, regression techniques are employed to estimate the hedonic price function of the property. This function relates the selling prices of a large number of properties in the same housing market with the characteristics of the houses, including the availability of good quality ground water i.e. assume that the price of housing is a function of its attributes  $P = f(s_1, s_2, s_3, \dots, s_i; n_1, n_2, n_3, \dots, n_j; e_1, e_2, e_3, \dots, e_j)$  where  $s_1, s_2, s_3$  are the structural variables of the house;  $n_1, n_2, n_3$  are the neighbourhood variables and  $e_1, e_2, e_3$  are environmental variables. The functional form can be linear or non-linear. Using regression analysis it is possible to estimate the relationship between the level of any one housing characteristic and the price of the property. Differentiating the hedonic price function with respect to any one of the characteristics yields the implicit price function for that characteristic. It is termed implicit price because it is revealed to us indirectly through the amounts the people are prepared to pay to get good quality water.

In the second stage, these implicit prices are regressed against the actual quantities/qualities of water chosen by households and different socio-economic characteristics of the household to obtain marginal willingness to pay for water. As is well known the relationship between price and quantity is the demand curve (see Figure 1). These demand curves trace how much the individuals are willing to pay for a given quantity/quality of water. Or it can be thought as how much a household is willing to pay for getting extra unit of water/extra quality water. This

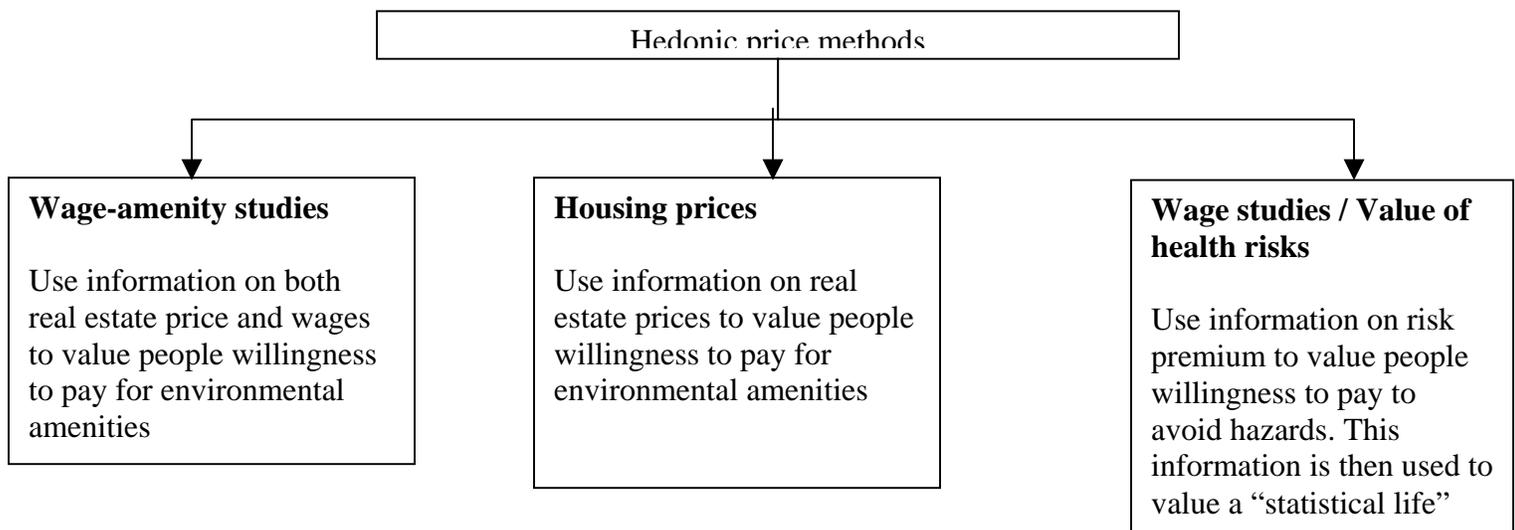
relationship will not be same for every household as individuals differ in income and other socioeconomic characteristics, which might influence household's demand for water. The area under the demand curve for a given quality/quantity of water gives the welfare benefit to the household for improving the quality/quantity of water supply.

However, still these consumer surplus estimates can be biased if we are considering a single market. Substitutes exist for the houses in this market. People can move to other cities. If we examine different hedonic price functions in different cities, we will have an implicit price in each city, the average quality, income and etc. in each city. The locus of the individual demand functions would give the equilibrium price.

#### 4. Applications of Hedonic Price Method

Ridker (1967) and Ridker and Hening (1967) provided the first empirical evidence that air pollution affects property values by regressing median census tract property values on a measure of sulfate air pollution. They argued that the coefficient on the air pollution variable in the regression equation could be used to predict the change in the price of any residence conditioned on a change in its air pollution level, and that the sum of all such changes could be taken as a measure of the benefit of improving air quality in an urban area. Since then Hedonic price (HP) technique has been used for estimating the effect of air quality on residential prices and is used in numerous settings to estimate the value of different attributes. Based on the literature review, the application of the method can be categorized under three heads: 1) wage-amenity studies 2) housing prices; 3) valuation of health risks using differences in wages.

**Figure 3. Applications of hedonic price method**



The HP method has also been used to estimate the value of selected water resources such as Bays, lakes and reservoirs, building of a new harbor, river views, restoration of urban stream, noise, landfills, dumping sites etc. on nearby property values. In India, hedonic price method has been employed in evaluating the relation between land prices and surface and ground water access (both in quality and quantity) (see Gundimeda and Kathuria, 2005) and benefits if air quality improvement in India (see Murty and Gulati, 2006).

## **5. Some important issues in Hedonic Price Method**

- 1) The hedonic price method is very data intensive. In order to estimate hedonic price function for a particular market, one requires a large number of observations describing both the selling prices and numerous characteristics of properties in that market.
- 2) One of the fundamental assumptions of the HPM is that households have perfect information. If households are not aware of the prices and characteristics of all the properties in the market then it is likely that the prices and the implicit prices they pay for properties with different characteristics will vary from sale to sale.
- 3) Transaction costs in the property market are varied and not inconsiderable.
- 4) Given the prevailing market prices, a household may want to live in a property with a different set of characteristics than their current residence. However, if the transaction costs are sufficiently high, they may negate the benefits of moving. The household will stay where it is and the housing market will remain out of equilibrium.
- 5) The hedonic price schedule does not adjust instantaneously to changes in demand or supply conditions in the housing market. In the real world many factors like imperfect information and transaction costs will result in the process of adjustment taking some time.
- 6) One problem with the estimation procedure is multicollinearity. Frequently, environmental characteristics will be collinear (e.g. properties near to roads have greater noise pollution and higher concentrations of air pollutants). This means it is frequently difficult to separate the independent effect of these two forms of pollution on the price of the property.
- 7) More serious problems occur if data used in the hedonic analysis is taken from more than one property market. Since the conditions of supply and demand will be different in

every property market we would expect a different set of implicit prices in each market. Estimation of the hedonic price function for one property market will be biased by including data on house prices determined in a second market.

- 8) All the above factors tend to violate the assumption that housing market is in equilibrium. It is unlikely that a housing market will be in a state of perfect equilibrium at any one point in time. However, this may not be a general shortcoming of the hedonic price method. In a state of disequilibrium we would expect the prices to fluctuate rapidly levelling off at the end. So estimation of hedonic price schedule is still possible.

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