Semester-VI

Environmental Economics

What is environmental accounting?

Environmental accounting is a managerial tool used for many purposes, such as: improving performances in relation with the environment, inventory and controlling costs, more efficient technologies with less pollution, nonpolluting products, etc. The three major elements of accounting are: Assets, Liabilities, and Capital. These terms are used widely in accounting so it is necessary that we take a close look at each element. It is a structure for systematically identifying, measuring, and communicating environmental conservation cost and the economic benefit of environmental conservation measures; this is the financial performance portion of environmental accounting, representing the activities of companies and other.

What are the importances of measuring the benefits of environmental improvement?

If environmental changes result in individuals feeling "worse off," then one would like to have some measure of the loss of economic value to these individuals. Alternatively, if the changes make people "better off," one would like to estimate the resulting value gain. Economic valuation does not capture all sources or types of value (e.g., intrinsic values on which the notion of rights is founded), it is much broader than usually presumed. It recognizes that economic value can stem from the use of an environmental resource (use values), including both commercial and noncommercial uses, or from its existence even in the absence of use (nonuse value). The role of economic valuation in environmental decision-making depends on the specific criteria used to choose among policy alternatives. If policy choices are based primarily on intrinsic values, there is little need for the quantification of values through economic valuation. However, if policymakers consider trade-offs and benefits and costs when making policy decisions, then quantification of the value of ecosystem services is essential.

Write in brief about the different methods for measuring environmental quality

Environmental quality — a commodity that, over the past several decades, has emerged as one of the most powerful forces acting on the economic landscape of the United States and other developed nations — is not traded in conventional markets, so its value can only be estimated, never measured directly. Estimation, which requires knowledge of a demand function describing the relationship between price and the quantity consumed, is achieved through either stated or revealed preference approaches (Freeman 2003; Mäler and Vincent 2005).

Stated-preference approaches examine individuals' direct responses to hypothetical changes in environmental goods. The most common of these is the contingent valuation method, in which respondents are asked to state their willingness to pay or, as the case may be, to accept compensation for changes in the quality and/or quantity of the commodity of interest. These responses are then used

to construct demand functions that, in turn, are used to estimate the benefits of marginal and non-marginal changes in consumption.

Revealed preference approaches, examine actual behavior within housing and labor markets to get at the value of environmental quality. The most common of these approaches is the hedonic price method which has consistently shown that households pay higher (lower) housing prices and/or are compensated with lower (higher) wages in environmentally desirable (undesirable) locations. The so-called marginal implicit prices that come out of hedonic analysis can be used to construct implicit demand functions describing household willingness to pay for environmental quality. There is, however, a major barrier to doing this, which is information: the hedonic function is a composite of unique, individual demand and supply, so the implicit prices it yields are also composites and, for this reason, it is difficult to identify and estimate a structural demand function. The bottom line for this strategy is that it requires that different consumers pay different prices for the same quantity/quality of a given environmental good — that is, the identical commodity must be priced differently from place-to place or time-to-time. This paper employs the latter strategy to develop estimates of environmental improvement based on a two-stage hedonic price analysis of the single-family housing market in the Puget Sound region of Washington State.

The analysis involves four steps: (i) ten hedonic price functions are estimated year-by-year, one for each year of the 2000s; (ii) the hedonic estimates are used to compute the marginal implicit price of distance from air release, superfund, and toxic release sites; (iii) the marginal implicit prices, which vary through time, are used to estimate a series of implicit demand functions describing the relationship between the price of distance and the quantity consumed; and, finally (iv) the demand estimates are compared to those obtained in other research and then used evaluate the potential scale of benefits associated with some basic environmental improvement scenarios.

Define Hedonic Pricing

Hedonic pricing is a model that identifies **price** factors according to the premise that **price** is determined both by internal characteristics of the good being sold and external factors affecting it. **Hedonic value** is defined as that **value** a customer receives based on the subject experience of fun and playfulness.

Non-market values of environmental improvement

As it is well known there is a substantial gap between the rigorous and elegant definition of welfare change and benefits derived from theoretical welfare economics and their empirical estimate. This holds especially in the case of public goods such as, e.g., environmental improvements originating in reduced air or water pollution and noise reduction, all of them characterized by non-divisibility and non-rivalness in consumption. Consequently, there are no markets, no customers, no sales and, thus, no cheap information on the benefits of environmental improvement. However, it is important for decision makers in the public sector to have an idea about individual demand of such public goods and their

related benefits. This information is necessary to undertake benefit-cost analysis, which is the major tool for evaluating and selecting those policy alternatives which contribute to more effective resource utilization.

Environmental quality — a commodity that, over the past several decades, has emerged as one of the most powerful forces acting on the economic landscape of the United States and other developed nations — is not traded in conventional markets, so its value can only be estimated, never measured directly. Environmental valuation, not to be confused with environmental evaluation, is the process of putting monetary values on environmental goods and services (G&S), many of which have no easily observed market prices. In order to value these G&S, economists have developed a whole "tool box" of valuation techniques. Placing a value on changes in the environment is an important part of socio-economic impact assessment. This means that the benefit of using a measure needs to be greater than the cost for society of taking the measure.

Environmental valuation can be used to assess the relationship between benefits and costs. Economic valuations serve as common language used to portray environmental loss and degradation value to decision makers, helping in future environmental rehabilitation and degradation prevention. Examples of this include beach visits, wildlife viewing, or snorkeling at a coral reef.

Ways to Value the Environment

1. Aesthetic Value Appreciating beauty through the senses.
2. Cultural Value Maintaining the attitudes and practices of a specific group of people.
3. Ecological Value Maintaining the integrity of natural systems.
4. Economic Value Exchanging goods and services for money.
5. Educational Value Benefitting from learning and instruction

Methods used to measure environmental valuation

The following methods are used for environmental valuation:

A) Expressed Preference Methods

B) Revealed Preference methods

C) Cost-based Methods

D) Other Methods

(A) Expressed Preference Methods:

The demand for environmental goods can be measured by examining individuals' expressed preference for these goods relative to their demand for other goods and services. These techniques avoid the need to find a complementary good (travel or house), or a substitute good (compensating wage rate), to derive a demand curve and hence estimate how much an individual implicitly values an environmental good. Moreover, expressed preference techniques ask individuals explicitly how much they value an environmental good.

Contingent Valuation Method (CVM):

Analytic survey techniques rely on hypothetical situations to place a monetary value on goods or services. Most survey-based techniques are examples of contingent valuation method. Contingent valuation frequently elicits information on willingness to pay or willingness to accept compensation for an increase or decrease in some usually non-marketed goods or services. This method puts direct questions to individuals to determine how much they might be willing to pay for environmental resources or how much compensation they would be willing to accept if they were deprived of the same resources. This method is more effective when the respondents are familiar with the environmental good or service and have adequate information on which to base their preferences. We will discuss trade-off game method, costless-choice method, and Delphi method as part of contingent valuation approach.

(1) Trade-Off Game Method:

This method relates to a set of contingent valuation techniques that rely on the creation of a hypothetical market for some good or service. In a single bid game the respondents are asked to give a single bid equal to their willingness to pay or willingness to accept compensation for the environmental good or service described. In an iterative (repeating) bid game the respondents are given a variety of bids to determine at what price they are indifferent between receiving (or paying) the bid or receiving (or losing) the environmental good at issue.

The trade-off game method is a variant of the bidding game wherein respondents are asked to choose between two different bundles of goods. Each bundle might, for example, include a different sum of money plus varying levels of an environmental resource. The choice indicates a person's willingness to trade money for an increased level of an environmental good. When no money is involved, the approach becomes similar to the costless-choice method.

(2) Costless-Choice Method:

The costless-choice method is a contingent valuation technique whereby people are asked to choose between several hypothetical bundles of goods to determine their implicit valuation of an environmental good or service. Since no monetary figures are involved, this approach may be more useful in settings where barter and subsistence production are common.

(3) Delphi Method:

The Delphi method is a variant of the survey-based techniques wherein experts, rather than consumers, are interviewed. These experts place values on a good or service through an iterative process with feedback among the group between each iteration. This expert-base approach may be useful when valuing very esoteric resources.

This is really a specialized survey technique designed to overcome the speculative and isolated nature of expert opinions. A sufficiently large sample of experts is presented individually with a list of events on which to attach probabilities and to which other events, with probabilities may be added. Some recent Delphi exercises have been recreation-specific. But testing the accuracy of their forecasts is not yet possible, especially since the predictions are only meant to be general perspectives.

(B) The Revealed Preference Methods:

The demand for environmental goods can be revealed by examining the purchases of related goods in the private market place. There may be complementary goods or other factor inputs in

the household's production function. There are a number of revealed preference methods such as travel- cost method, hedonic price method and property value method.

(1) Travel-Cost Method:

The travel-cost method is a widely used surrogate market approach that relies on information on time and travel costs to derive a demand curve for a recreational site. This curve is in turn used to estimate the consumers' surplus or value of the site to all users. This approach is widely used to value the recreational benefits of public parks and other natural areas.

This method seeks to determine the demand for a recreational site (i.e. number of visits per year to a park) as a function of variables like price, visitors' income, and socio-economic characteristics. The price is usually the sum of entry fees to the site, cost of travel, and opportunity cost of time spent. The consumers' surplus associated with the demand curve provides an estimate of the value of the recreational site in question.

The most common forecasting technique for a specific site is the Clawson- Knetsch-Hotelling method. It is a technique commonly associated with benefit estimation in recreation cost-benefit analysis. This method uses information on travel costs to generate a final demand curve for a recreation outlet. Hence it is most appropriate for those outlets where travel cost is a major component of total visit costs typically to free countryside outlets.

According to Clawson and Knetsch, outdoor recreation activities satisfy individual needs, such as physical, social or psychological. It is necessarily a kind of package deal involving anticipation, travel to the site, the activity itself, the return travel and finally recollection.

The travel-cost method is explained in Figure 50.1. Suppose there is a single lake in a city, where the entry fee is OP which is fixed per visit. Initially, recreational demand for the lake is shown by the demand curve BD_o and the environmental quantity level is E_0.

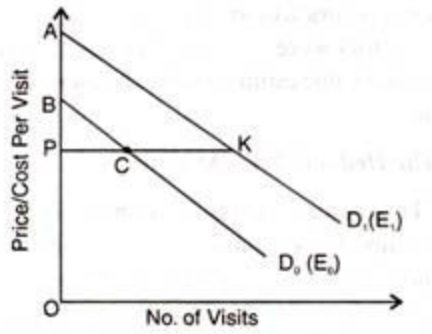

FIGURE : 50.1

If there is an improvement in environmental quality of lake, then the demand curve will shift outward as AD_1 and environmental quality level to E_1. With this effect, there is an increase in the number of visits to PK. The gain in consumers' surplus is equal to the area PAK. The net gain in consumers' surplus after improvement in environmental quality of the lake is shown as: PAK – PBC = ABCK.

The travel-cost approach looks at the pattern of recreational use of a lake and uses this information to derive a demand curve to estimate the total amount of consumers' surplus. To do this, visitors are divided into a number of origin zones of increasing distance from the lake. Then a survey is used to determine the time and monetary cost involved in reaching to the lake.

Its Criticism:

1. This approach is most successful where there is wide variation in the travel cost of various users and where recreation at the site in question will be the primary objective of visits. But wide variations in tastes and preferences and substitute availability at different distances from the site, distort demand estimates.

2. The travel-cost method is of limited value if congestion is a problem. Small changes affecting recreational quality may be difficult to evaluate using this method.

3. The basic assumption of travel-cost method is that consumers treat increase in admission fees as equivalent to increase in travel cost. This is subject to question.

4. Another problem associated with this method is that it assumes recreational quality remains constant over the range from zero use to full present use at the going admission fee. This is highly hypothetical.

5. Bateman is of the view that the travel-cost method measures only the use value of recreation sites. Underestimation of site value due to the truncation of non-visitors would be made worse if the non-use value of both visitors and non-visitors were relevant. This method is not capable of producing any total economic value estimate in that it cannot estimate non-use items such as existence value.

(2) The Hedonic Price Method:

The underlying assumption of the hedonic price method is that the price of a property is related to the stream of benefits to be derived from it. The method relies on the hypothesis that the prices which individuals pay for commodities reflect both environmental and non-environmental characteristics. The implicit prices are sometimes referred to as hedonic prices, which relate the environmental attributes of the property.

Therefore, the hedonic price approach attempts to identify how much of a property differential is due to a particular environmental difference between properties, and how much people are willing to pay for an improvement in the environmental quality that they face and what the social value of improvement is.

The hedonic price method is based on consumers which postulates that every good provides a bundle of characteristics or attributes. Again, market goods can be regarded as intermediate inputs into the production of the more basic attributes that individuals really demand.

The demand for goods, say housing can, therefore, be considered as a derived demand. For example, a house yields shelter, but through its location it also yields access to different quantities and qualities of public services, such as schools, centres of employment and cultural activities etc. Further it accesses different quantities and qualities of environmental goods, such as open space parks, lakes etc.

The price of a house is determined by a number of factors like structural characteristics, e.g. number of rooms, garages, plot sizes etc. and the environmental characteristics of the area. Controlling the non-governmental characteristics which affect the demand for housing, permits the implicit price that individuals are willing to pay to consume the environmental characteristics associated with the house to be estimated.

The hedonic price function describing the house price Pi of any housing unit is given below:

$Pi = f [S_{1i}\ldots\ldots\ldots\ldots S_{ki}, N_{1i},\ldots\ldots\ldots\ldots\ldots N_{mi}, Z_{1i}\ldots\ldots\ldots\ldots Z_{ni}]$

Where, S represents structural characteristics of the house i i.e. type of construction, house size and number of rooms; N represents neighbourhood characteristics of house i, that is accessibility to work, crime rate, quality of schools etc. It is assumed that only one environment variable affects the property value i.e. air quality (Z).

For example, if the linear relation exists, then the equation becomes

$P_i = [\alpha_0 + \alpha_1 S_{1i} + \ldots.. + \alpha_K S_{Ki} + \beta_1 N_{1i} + \ldots\ldots. + \beta_m N_{mi} + \gamma_a Z_a]$

and $y_a > 0$.

There is a positive relation between air quality and property price as shown in Figure 50.2. The figure indicates that house price increases with air quality improvement.

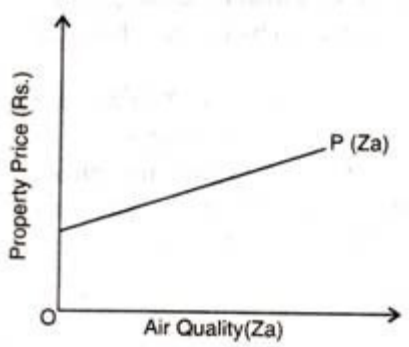

FIGURE : 50.2

Figure 50.3. indicates that the implicit marginal purchase price of Z_a (air quality) varies according to the ambient level (Z_a) prior to the marginal change.

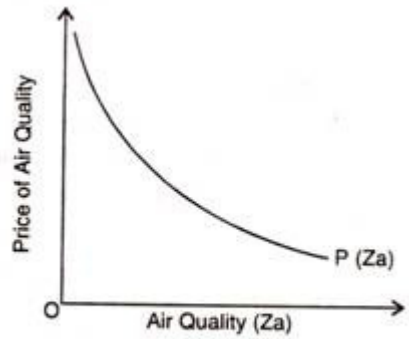

FIGURE : 50.3

The hedonic price method has become a well-established technique for estimating the disaggregated benefits of various goods attributes. In the case of housing, these attributes include not only basic structural and amenity characteristics but also environmental characteristics such as clean air, landscape and local ecological diversity. Thus, when a particular policy is implemented which will have a very great effect on the local environment, the hedonic method offers a useful way of estimating the change in amenity benefits.

Its Criticism:

1. This method is of no relevance when dealing with many types of public goods i.e. defence, nation-wise air pollution and endangered species, etc., as it prices are available for them.

2. The hedonic price method may be used to estimate the environmental benefits provided to local residents by an area as it exists today. But in fact, it cannot reliably predict the benefits which will be generated by future improvements because those improvements will have the effect of shifting the existing function.

3. Another problem is whether an individual's perceptions and consequent property purchase decisions are based upon actual or historic levels of pollution and environmental quality. If expectations are not the same as measured by present pollution estimate, then there are clearly problems relating to values derived from purchases.

4. Moreover, expectations regarding future environmental quality may bias present purchases away from that level dictated by present characteristic levels.

5. This method has been criticised for making the implicit assumption that households continually re-evaluate their choice of location.

6. Further, there is considerable doubt that such an assumption can hold in the context of spatially large study areas. If people cluster for social or transportation reasons, the results of this method will be biased.

(3) Preventive Expenditure Method:

The preventive expenditure method is a cost based valuation method that uses data on actual expenditures made to alleviate all environmental problems. Often, costs may be incurred to mitigate the damage caused by an adverse environmental impact. For example, if drinking water is polluted, extra purification may be needed. Then, such additional defensive or preventive expenditure could be taken as a minimum estimate of the mitigation of benefits beforehand.

In the preventive expenditure method, the value of the environment is inferred from what people are prepared to spend to prevent its degradation. The averting or mitigating behaviour method infers a monetary value for an environmental externality by observing the costs people are prepared to incur in order to avoid any negative effects.

For example, by moving to an area with less air pollution at a greater distance from their place of work thus incurring additional transportation costs in terms of time and money. Both of these methods are again, conceptually closely linked.

These methods assess the value of non-marketed commodities such as cleaner air and water, through the amount individuals are willing to pay for market goods and services to mitigate an environmental externality, or to prevent a utility loss from environmental degradation, or to change their behaviour to acquire greater environmental quality.

(4) Surrogate Markets:

When no market exists for a good or service and therefore, no market price is observed, then surrogate (or substitute) markets can be used to derive information on values. For example, travel-cost information can be used to estimate value for visits to a recreational area; property value data are used to estimate values for non-marketed environmental attributes such as view, location or noise levels.

The effects of environmental damages on other markets like property values and wages of workers are also evaluated. Valuation in the case of property is based on risks involved in evaluating the value of property due to environmental damage. Similarly, jobs with high environmental risks will have high wages which will include large risk premiums.

(5) Property-value Method:

In the property-value method, a surrogate market approach is used to place monetary values on different levels of environmental quality. The approach uses data on market prices for homes and other real estates to estimate consumers' willingness to pay for improved levels of environmental quality, air, noise etc.

In areas where relatively competitive markets exist for land, it is possible to decompose real estate prices into components attributable to different characteristics like house, lot size and water quality. The marginal willingness to pay for improved local environmental quality is reflected in the increased price of housing in cleaner neighborhoods.

(6) Wage-differential Approach:

The wage-differential approach is a surrogate market approach that uses information on differences in wage rate for similar jobs in different areas to estimate monetary values for different levels of environmental quality. This approach has been used to estimate values for such environmental variables as different levels of congestion, air pollution and aesthetics.

Wages also vary in response to various factors such as education and training, natural dexterity, experience, demand and supply in each labour market area, occupational risks to health, probability of death, and associated living conditions including environmental ambience etc.

The hedonic wage approach has also been used in the wage-risk analysis to determine the value of life and limb in relation to the hazards faced at work. The general hedonic wage equation can be expressed as

$P = P (J, R, S)$

Where, P is the payment rate for a given job, Y is a vector of another job- related attributes e.g. working hours, holiday, sickness benefits etc., R is the risk of death and S is a vector of skills required to do the job. The hedonic wage approach has traditionally been used to measure employment attributes, principally risk of death or injury in particular labour markets. However, by observing variations in wage levels over space, and netting out the influence of other attributes, they have also been used to value the quality of life over large areas such as countries or continents.

(C) Cost-Based Methods:

Cost-based methods are discussed below:

(1) Opportunity Cost Method:

This method values the benefits of environmental protection in terms of what is being foregone to achieve it. This forms the basis of compensation payments for the compulsory purchase by the government of land and property under eminent domain laws. Further, it assumes that the land owner or user has property rights over the use of the land or the natural resource, and that to restrict these rights the government, on behalf of the society, must compensate the owner.

The opportunity cost method is useful in cases where it is difficult to enumerate the benefits of an environmental change. For example, rather than comparing the benefits of various alternative conservation schemes in order to choose between them, the method can be used to enumerate the opportunity costs of foregone development associated with each scheme with the preferred option, being the one with the lowest opportunity cost.

The opportunity cost method does not include non-marketed public good values of land. The fact that land and its attributes produce externalities is explicitly recognised in regulatory land-use planning controls, which seek to minimize external bads through development control and land-use class orders, by separating externality producing land uses spatially.

Thus planning controls seek to preserve amenity benefits by restricting the development of land. However, by imposing such restrictions, the price of land, such as green belt land, has a lower financial value than its opportunity cost value.

(2) Relocation Cost Method:

This is a cost-based technique used to estimate the monetary value of environmental damages based on the potential costs of relocating a physical facility that would be damaged by a change in environmental quality. This method relies on data on potential expenditures.

(3) Replacement Cost Method:

This is a Cost-based technique that measures the potential expenditures that would be required to replace or restore a productive asset that would be damaged by some project or development. These costs are then compared to the costs of preventing the damage from occurring to determine which is more efficient.

If an environmental resource that has been impaired is likely to be replaced in future by another asset that provides equivalent services, then the cost of replacement may be used as a proxy for the environmental damage, assuming that the benefits from the original resources are at least as valuable as the replacement expenses.

A shadow project is usually designed specifically to offset the environmental damage caused by another project. For example, if the original project was a dam that inundated some forest land, then the shadow project might involve the replanting of an equivalent area of forest elsewhere. It

values an environment good by the cost incurred in restoring the environment to its original state of level after it has damaged.

In Figure 50.4, the benefits and costs per unit are measured on the vertical axis while the level of restoration is at the horizontal axis. The restoration level means to replace the lost environmental good. The slope of curve B indicates that with the increase in restoration level, benefits increase at a decreasing rate.

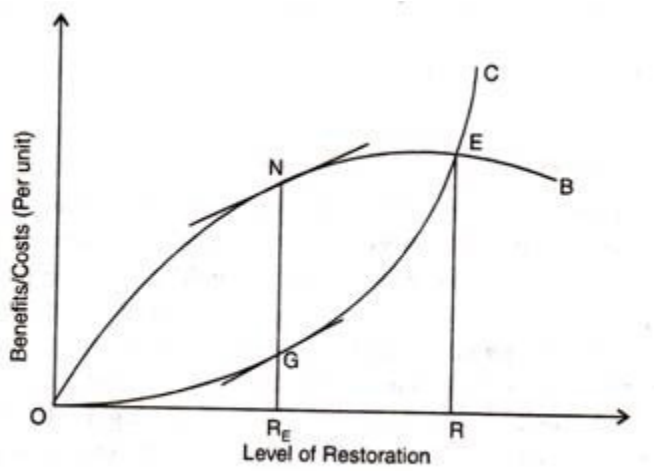

FIGURE : 50.4

The slope of curve C indicates that the restoration costs are an increasing function of the level of restoration. The economic efficiency is achieved at the restoration level OR_E where the difference between curve B and curve C is the maximum. The net gain is NG at this level of restoration.

(D) Other Methods:

There are some other methods of valuing the environment.

(1) Dose-Response Method:

This method requires information on the effect that a change in a particular chemical or pollutant has on the level of an economic activity or a consumer's utility. For example, ground levels of air pollution, such as ozone, affect the growth of various plant species differentially. Where this results in a change in the output of a crop, the loss of output can be valued at market or shadow (adjusted or proxy) market prices.

Dose-response relationships or production function approaches, are perhaps the most familiar valuation techniques. Essentially, a link is established between say, a pollution level and a physical response, for example, the rate at which the surface of a material decays. The decay is valued by applying the market price (costs of repair) or by borrowing a unit valuation from non-market studies.

Notable examples include the valuation of health damage. Once air pollution is linked to morbidity and morbidity is linked to days lost from work, the days lost can be valued, perhaps using a market wage rate. The main effort of the analysis is devoted to identifying the link between dose and the response.

(2) Human Capital or Foregone Earning Approach:

The human capital approach values environmental attributes through their effects on the quantity and quality of labour. The loss earnings approach focuses on the impact which adverse environmental conditions have on human health and the resultant costs to society in terms of income lost through illness, accidents and spending on medical treatments.

The principle involved in this approach is that of valuing life in terms of the value of labour. Given adequate data regarding lifetime earnings, participation rates in the labour force mortality rates, etc., it is possible to estimate the value of the expected future earnings of individuals in any age- group.

On the assumption that wage rates are a precise indicator of productivity, the same measure with some adjustment to allow for social preferences being different from private preferences can be used as a measure of the value of the future output of the individual to society.

The social values emerging are usually referred to as the economic value of life. The other being non-economic or intangible aspects which are additional to that part of life which the method has been able to measure. This type of valuation system is the one most commonly found in practice.

The adjusted stream of life-time earnings has to be discounted to convert it to present value terms. This present value stream of future earnings with these various adjustments made, represents the human capital value of life span. In some cases, the measurement of lost output is taken net of consumption and in others a gross figure is used.

The reasoning behind the adoption of a net of consumption estimate is that when a worker dies due to an accident that occurs in a factory, the earnings of the workers will be stopped. The society loses the difference between what he would have produced and what he would have consumed.