

The Models for Internalization of Environmental Costs in Tech-Eco Assessment

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Abstract The internalization of environmental costs of projects is the key-step to integration of economic profits and environmental protection. It is also of great importance for sustainable development of society, economy and environment. This paper analyzes the phenomena of ignoring environmental costs in projects tech-eco assessment at present, and thinks that the total costs of projects contain project direct cost and external environmental cost. Environmental cost comprises environment resource consumption cost, maintaining environment quality investment and environment damage cost. And the paper puts forward calculation method of environment resource consumption cost, maintaining environment quality investment and environment damage cost. Based on the classification of enterprises' environmental costs, the authors induce and discuss some practical models to evaluate environmental values.

Key words Economic feasibility assessment; Environmental costs; Internalization; Model

1 Introduction

In some sense, the development of social economy and material enjoyment of human beings were at the expense of environment and natural resource in the past. Obviously, some environmental problems, such as environmental pollution, natural resource depletion, ecological crisis, acid rain and ozone layer decrease, are the results of neglect of the value of natural environment. These environmental problems have already restricted the development of economy in many countries, and even would threat the health and subsistence of human beings.

Fortunately, people are attaching more importance to harmonious development of economy and environmental protection. In the economic assessment of project (EAP), the environmental effects of the project are frequently taken into account, and to achieve the assortative development of economy and environment become a main object. British economist Pigou early mentioned internalization of environmental costs theory. Pigou means lay stress on important of the dominant function of government and levy environment taxes in order to internalize environmental costs. At a later time, economist Coase established a means which exertive market function to cope with external environment uneconomic effect, this means called "Coase means", for example, emissions trade. In 20 century 90 years, some new environment economy methods such as environment marks system and ISO14000 were appeared. Some domestic scholars research into internalization of environmental costs. At present, some economic assessment models and index try to embody the environmental effects, such as the product's Life Cycle Assessment, green National Product Account (GNPA), and Environmental Costs Account (ECA). These models or index system emphasize the inter-impact of economy activities and natural environmental quality. In practice, the calculation of environmental costs is a key factor for reflection the change of environmental quality. Therefore, the internalization of external environment costs is a fundamental work to fully embody the value of environment resource in project economic assessment. We induced and discussed some useful models in this article aiming to help to internalize external environment costs in project economic feasibility analysis.

2 The Definition of Projects' Environmental Costs

According to United Nation International Accounting and Report Experts Committee's Environmental accounting and financial report announcement, "In the term of the principles of responsibility for environment, environmental costs is the investment that manage to avoid the environmental influence caused by the project, and that enterprises pay for up to par of environment." Environmental costs include reduce and dispose of waster, maintenance and improvement of environmental quality, research and development of green products, environmental inspect and audit.

Another definition of environmental costs is the total economic losses caused by the change of

natural environment and society owing to the enterprise's activities. It includes environmental resource consumption costs, environment maintenance costs and environment losses costs. Environmental resource consumption costs are the value of environment resource that consumed by enterprises. Environment maintenance costs refer to the investments of all kinds of protective measurements that can reduce man-made damage to environmental resource and maintain environmental quality to reach specific level. The costs embrace those costs that treatment and disposition of "three wastes", waste effluent charge, environment management and monitoring, investment in equipment for pollution control, environmental protection R&D expenditure, and environmental tax or fare. Environment losses costs are the costs to restore the environmental pollution and natural resource damage caused by enterprise activities. Environment losses costs also are called Marginal External Costs (MEC).

3 The Significance of Internalizing Environmental Costs

Economic Feasibility Analysis (EFA) is a method to analyze the economic profits of a certain investment activity, and a measure to ensure obtaining the maximal economic profits. At present, a popular method of project economic feasibility analysis is Costs-Benefit Analysis (CBA). CBA uses the Investment Return Date (IRD), Net Present Value (NPV) and Internal Income Rate (IIR) as main indexes in project's economic evaluation. The calculation of these indexes is based on the cash flow of the year. However, there is a serious deflection in the calculation: ignoring the external environmental cost that caused by environment pollution. As we all know, environment bears externality and pollution will cause external economic inefficiency. When enterprises activities lead to environmental pollution, ecological damages and other forms of environmental problems, the activities must bring environmental costs. But, because the difficulties in figuring out the external environmental costs, CBA can not exactly enlist environmental costs caused by the enterprise practically. Therefore, the report of CBA does not reflect the real condition of projects, and even draw a more optimistic conclusion than reality. Lets take Egyptian - dam for instance, according to this project's CBA completed at beginning, the dam would had great economic profits owing to agriculture irrigation and generation electricity. But the actual state of affairs is quite pessimistic that the project induced much more eco-environmental damage cost than the economic profits.

According to the present investment project management regulation, it is obligatory to complete the Environmental Impact Assessment (EIA) and the Economic Feasibility Analysis (EFA) at the first stage of project. EIA assess projects' feasibility on behalf of natural and social environment, but EFA analyze project' feasibility for the enterprise' economic profits, so the two methods have different aspect and profit. Because the present EFA only count pollution abatement investment and workers' medical care fee, and ignore the external environmental costs, the results of EFA will departure the reality and lead to conflict of interest between enterprise and society. This situation is harmful for the harmonious development of economy and environment.

Therefore, it is necessary for realizing sustainable development of modern society to internalize the environmental costs in project's EFA. Internalization of environmental costs will modify the results of CBA. The more environmental costs, the lower profits the enterprise can gain, vice versa. Thus, when enterprises' incentive of pursuing maximum profits becomes consistent with the interest of environmental protection, the project tech-eco assessment will be the junction of economy development and environmental protection.

4 The Models for Internalization of Environmental Costs

Modern economics hold that the rootstock of environmental problems is people neglecting the value of environmental resource in human economic activities, because the environmental problems have external traits. Now more and more economists and environmentalist suggest that enterprises should calculate the environmental costs of resource consumption and environmental pollution caused by enterprises' economic activities, and debit these costs in the enterprises' account. Factually, it intend to introduce environmental costs to the normal CBA.

4.1 The total environmental costs

Environmental costs involve the value of environmental resource consumption, investments for maintain environmental quality and environmental loss costs. Some kinds of environmental costs are effortless to measure, for instance, a stope's expenditure for wastewater, exhaust and waste residue, investment of backfill, earth up and virescence, investment of environmental equipment, fee. But it is difficult to measure or calculate the environmental loss costs caused by the environmental pollution.

The total environmental costs need number in the EFA:

$$EC_i = ER_i + EW_i + ED_i \quad (1)$$

In there EC_i - the total environmental costs in i year;
 ER_i - the value of environmental resource consumption in i year;
 EW_i - investments for maintain environmental quality in i year;
 ED_i - environmental loss costs in i year.

Let's take the concrete factories for example, the factory must pay mineral resources tax for the limestone used as raw material. The factory discharge wastewater that contained acid, alkalis and BOD, other pollutants, such as TSP (total suspend particulates), S_2O , NO_x , in the process of milling, feeding and calcine. The factory has to defray for these pollutants as discharge fee. Discharge fee and mineral resources tax are the direct investment and easy to measure.

4.2 The costs of maintain environmental quality (EW_i)

The costs of maintain environmental quality is the investments for maintain environmental quality. Enterprise's payments for pollution control include purchase, run, maintain of treatment and monitoring equipment, environmental management expenditure, technician' train up and salary, and expense for land restore. The costs of maintain environmental quality can be calculated using the cost function.

The cost function is a kind of mathematical expression for showing the relationship of environmental maintains costs and some variable. There already have some research in environmental cost function, and have built systemic database of fundamental data and cost function, even provide some parameters of cost function modification. Some popular environmental maintain costs function list as follow:

Linear cost function:

$$EW(Q) = a + bQ \quad (2)$$

Exponential function:

$$EW(Q) = a \times Q^b \quad (3)$$

Composite function:

$$EW(Q) = a + bQ^c \quad (4)$$

In there: EW - The costs of maintain environmental quality;
 Q - The quantity of disposed pollutant;
 a 、 b 、 c - constant modulus.

The wastewater control costs can calculate using these functions. Exhaust gas and solid waster costs may use formula (2) and (3) to calculate. If there are have enough fundamental data, the constant modulus can be estimated. For instance, to the municipal sewage disposal plants:

Investment cost function:

$$EW_i = 208.7Q^{0.75} \quad (5)$$

Operation cost function:

$$EW_o = 24.3Q^{0.90} \quad (6)$$

Total control cost function:

$$EW = 9Q^{0.657} + 22Q^{0.657}\mu^{1.7} \quad (7)$$

In formula μ - the treatment efficiency.

4.3 The environmental loss costs

The environmental loss costs are the price that enterprise pay for offset, maintain and improvement of natural environmental quality and social welfare which possibly be endangered by the pollutants from enterprise. Environmental loss costs have the trait of externality differed it from other costs. A project can produce some aspects of environmental loss, such as air, water, soil, plant, crop, health of people and longevity. The environmental loss costs can be cataloged as the loss of natural environmental resource and the loss of social welfare.

The environmental loss costs:

$$ED = ED_e + ED_s, \quad (8)$$

In there ED_e - the loss of natural environmental;

ED_s - the loss of social welfare.

Using the environmental damage function can numerate ED_e . The environmental damage function may reflect the relation of the pollution and impact, and count the environmental loss costs.

The environmental damage function:

$$ED_e = \sum F(i) \quad (9)$$

$$F(i) = F_i(a, t, P_i, K_t, V_i) \quad (10)$$

In there: ED_e - the loss of natural environmental;
 $F(i)$ - the damage costs of I pollutant;
 a - the condition of contact with environment;
 t - the time of contact with environment;
 P_i - the damage intensity of I pollutant;
 K_t - the characters of environment accommodating pollutants;
 V_i - the quantity of pollutants.

As we know from formula (10), the environmental damage function is related to four factors. Therefore, when we analyzed sufficient monitoring and rogatory data, we can model the environmental damage function.

The loss of social welfare (ED_s) is external costs of enterprise, and difficult to exactly calculate. In order to measure the loss of social welfare, appraisal survey is a popular approach. The common methods of appraisal survey are direct market method, substitute market method and willing survey.^[3]

4.4 Total project costs including environmental costs

By internalizing the environmental costs, the total project costs unfold: the traditional project economic costs and external environmental costs. The external environmental costs can discount in the project economic assessment.

The project's total present costs:

$$GPC = \sum (C+S+P+EC)_i (1+I)^{-t} \quad (11)$$

In there : GPC - total present costs;
 C - project's investment of fixed assets and current assets;
 S - salary and related expense;
 P - the operate expenditure except for salary;
 EC - project's environmental costs;
 I - present interest rate;
 t - year.

5 Conclusions

The internalization of environmental costs has quite significant in project's economic assessment. It is a useful work for the harmonious development of economy and environment. This paper classified enterprises' environmental costs and presented some practical models to internalize the environmental costs. However, to internalize environmental costs in EFA is a systemic project, and need the reform of correlative economic policy and the health administration institution.

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