Cost-benefit evaluation of land development based on logistic regression

Sheng Han

Southwest Minzu University, Chengdu, Sichuan, 610225

1491690240@qq.com

Keywords: Nonlinear Fitting; Logistic Regression Analysis; Neural Network Algorithms; Pearson Coefficient; Environmental Degradation; Cost Effectivenes

Abstract: The additional economic costs caused by environmental degradation are often neglected by land developers, which lead to the fact that the cost of some projects is much higher than the benefit and even cause irreparable damage to the environment. Therefore, our goal is to create a comprehensive evaluation model that incorporates the cost of environmental degradation into the cost-benefit assessment of land development. On this basis, it provides optimal investment suggestions for land use project planners and managers, while maximizing benefits; it also pays attention to the important issue of environmental protection.

1. Introduction

The cost of environmental degradation treatment may be much higher than the profits of the project itself. The more serious problem is that the destruction of biodiversity is irreparable. As early as the 20th century, some scholars have noticed the environmental and economic costs, and put forward some specific solutions, such as Arthur Pigou, a British economist in the 1920s, who theoretically discussed the externalities and proposed that polluters should be taxed according to the harm caused by pollution.[4] In the period of industrial revolution, the need to calculate environmental costs promoted the assessment and calculation of air, water and soil pollution losses. At the same time, the economic theory of environmental quality and public goods emerged.[5] Nowadays, experts of the United Nations Environment Programme (UNEP) put forward the idea that economic development must be limited by ecological laws, and emphasized the sustainable development of the environment.

This paper assesses the environmental cost of land use. We build a model to evaluate the environmental cost, including with and without the environmental degradation factor, and we focus on four typical economic costs for environmental issues: river pollution control cost, air quality protection cost, waste-water treatment cost, climate-change cost. We conclude that it is very likely and necessary to consider the factor of environmental degradation when evaluating a land use project. Otherwise the huge costs of mitigating environmental degradation may make the loss overweight the gain.

2. Environmental Cost Evaluation Model

2.1 Determination of the Possibility of Environmental Cost Evaluation

Traditional economic theories often neglect the impact of their decisions on the biosphere. In order to meet their needs, natural resources and environment are usually assumed to be infinite. This view obviously has some defects. In fact, Li Fengshan (2015) analyzed the marginal cost and benefits the use of land resources and draws a conclusion that the land resource development cost often is not fully considered in land use projects, the cost is narrow. The relative lack of protection of land resources results in serious damaged to ecological environment.[6]Therefore, it is necessary to build a new model of land use evaluation which including environmental cost, in order to gain a comprehensive valuation of the cost-benefit ratio of the project.

For the sub-problem of whether it is possible to evaluate the environmental cost of land use

DOI: 10.25236/issec.2019.147

development projects, we considered using the linear logistic regression model to analyze the correlation between the total cost of environmental protection and the total revenue of land development in the United States from 2000 to 2011, by using SPSS software. We confirmed there is a possibility of assessing the environmental cost of land development projects.

2.1.1 Logistic Regression Analysis

According to our analysis, the environmental cost assessment of land development projects can be regarded as a prediction problem. It is stipulated that if the visible data trend of total land benefit is closely related to the trend of environmental cost, the environmental cost (non-random number), is considered to have the value and possibility of evaluation. Because the existing similar problems often use the Logistic regression analysis model to get accurate results of correlation degree. Therefore, we consider using the linear logistic regression model to analyze the correlation between the total cost of environmental protection and the total benefit of land development in the US from 2000 - 2011.

Logistic regression analysis is a generalized linear regression analysis model, which is suitable for data mining, prediction and other fields, especially for describing the correlation of data. [7] The P value in the result is also called saliency. [8] It is an important index to measure the effect of independent variables on dependent variables. When $P < 0.005$, we think that independent variables are very significant relative to dependent variables. When taking Y as dependent variable and X_1 and X_2 as independent variables, we find that the model has obvious defects. Therefore, we need to modify the model to take Y as dependent variable and X1 as the independent variable.

2.1.2 Assumptions

Because land development projects are affected by many uncertainties, such as federal policies, natural disasters, etc., we neglect some of the small probability factors. We focus on river pollution, air pollution, wastewater treatment and climate change. Considering the stability of the model, we assume that some factors will not change too much. The following assumptions are made:

- Land development projects are mutually independent.
- There are other extreme factors that cause abnormal environmental degradation and affect the normal production and life of human beings.
- The government's land development policy has not changed much during this period.
- Assuming that the period of study is 2000-2011, a total of 12 years

2.1.3 High Correlation

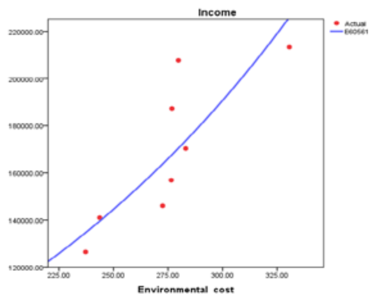

Figure 1 Relativity of Environmental Costs and Land Benefits

Table 1 Relative coefficient

	Non-Standardization Coefficient		Standardization Coefficient	t	Significance
	B	Standard Error	β		
X_1(constant)	0.994	0.002	0.435	662.603	0.000
	0.00002772	0.000		2.398	0.053

Through the coefficient table, we can get P of the model, including environmental degradation factors is 0.000, less than 0.005, indicating that the total cost of environmental protection X_1 is significant for the total income of land development Y. It shows that the cost of environmental protection has a great weight in the total benefit of land development, and decision makers should pay more attention to it in land development projects. To some extent, it proves that it is not proper to neglect environmental costs when valuing a land use project. Therefore, it is very necessary to take environmental costs into account in the evaluation of land use development projects.

2.2 Project Cost Evaluation Including Environmental Degradation

Through the environmental cost assessment model of 2.1, we concluded that it is necessary to consider the role of environmental degradation in land development projects, which can be seen as a combination of classification and prediction problems. In order to solve this problem and obtain the concrete quantitative relationship between the total economic cost and the total land development cost and the cost of environmental degradation, we consider using the non-linear curve fitting model.

2.2.1 Nonlinear Fitting Model Based on Fourier Transform

Nonlinear curve fitting is known input vector xdata and output vector ydata .

The function relationship between input and output is known as $\text{ydata} = \text{F}(\text{x}, \text{xdata})$

But the coefficient vector x is unknown. By curve fitting, x is obtained and the following least squares expression of output is established: $\min \sum(\text{F}(\text{xc}, \text{xdata}) - \text{ydata})^2$

Nonlinear fitting has the advantages of high precision, high reliability, and diversified fitting forms. Through fitting various forms, we find that the fitting accuracy of the non-linear fitting model based on Fourier transform is the highest. Therefore, we carried out the non-linear fitting based on Fourier transform for the total cost of land development and the cost of environmental degradation respectively, so as to get the reasonable solution of the model. Among them, without considering other small probability events, we focused on air pollution, river water pollution, wastewater discharge and climate change as four indicators to reflect the overall level of environmental degradation.

2.2.2 Analysis of Four Typical Economic Cost of Environmental Degradation

(1) Total cost of land development

We searched land price data from 2000 to 2011 in various states of the United States. We made visualization analysis of these scattered large amounts of data. From the result chart, we can see that it is not conducive to a clear and targeted analysis when considering the land benefit difference of each state comprehensively, so we choose the median house price as the representative in this study model analysis.

The discrete point data of total land cost in the United States from 2000 to 2011 are fitted by Fourier cubic fitting with Matlab, and the image and specific function expressions of total land cost varying with time are obtained.

- Total cost of land development

$$\text{W}_t = 80470 - 290.7 \times \cos(0.3876 \times t) - 12210 \cos(2 \times t \times 0.3876) + 6335 \times \sin(2 \times t \times 0.3876) - 3874 \times \cos(3 \times t \times 0.3786) + 1407 \times \sin(3 \times t \times 0.3876)$$

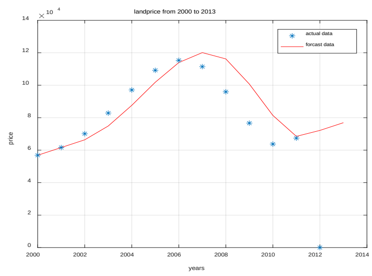

Figure 2 Change of Land Cost

(2) The Economic Costs of Four Typical Environmental Degradations

Under the same conditions, the cost of river water pollution control, air pollution control, wastewater discharge control and climate-change prevention are respectively fitted by Fourier quadratic fitting, and the curves and functional expressions of the four indicators' cost varying with time are obtained.

Cost of river water pollution control (R-square=0.9776)

$$\mathrm{R}_t = 73.62 - 6.204 \times \cos(t \times 0.3118) - 11.54 \times \sin(0.3118 \times t)$$
$$-2.179 \times \cos(2 \times 0.3118 \times t) - 5.022 \times \sin(2 \times t \times 0.3118)$$

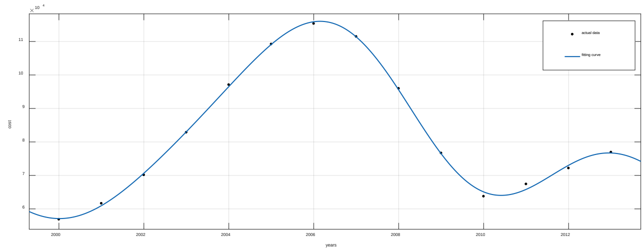

Figure 3 Change of River Water Pollution Control Cost

- Cost of air pollution prevention and control (R-square=0.984)

$$\mathrm{A}_t = 70.49 - 7.129 \times \cos(t \times 0.2886) + 10.3 \times \sin t \times 0.2886$$
$$+6.444 \times \cos(2 \times t \times 0.2886) - 2.205 \times \sin(2 \times t \times 0.2885)$$

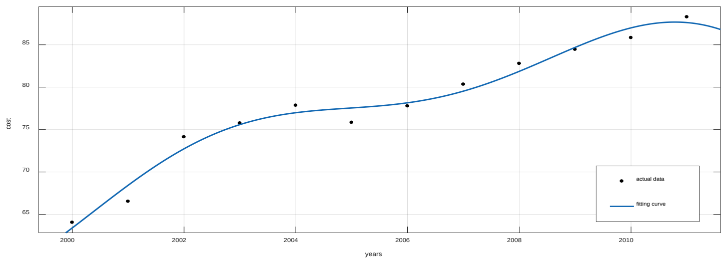

Figure 4 Change of Air Prevention and Control Cost

- Cost of wastewater discharge control (R-square=0.9297)

$$\mathrm{F}_t = 43.66 - 6.418 \times \cos(t \times 0.2831) - 1.278 \times \sin(t \times 0.2831)$$
$$-2.643 \times \cos(2 \times t \times 0.2831) + 4.723 \times \sin(2 \times t \times 0.2831)$$

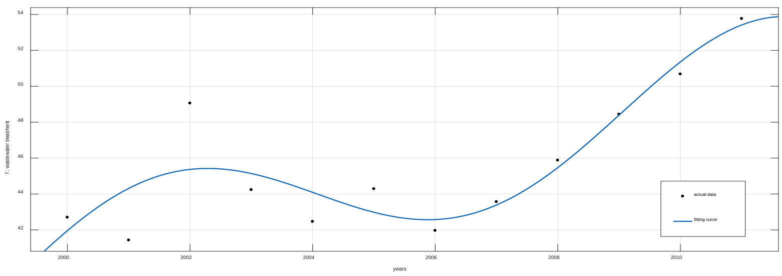

Figure 5 Change of Wastewater Discharge Control Cost

- Cost of climate change prevention (R-square=0.9648)

$$\mathrm{D}_t = 163.6 + 1357.1 \times \cos(t \times 0.2831) - 1.278 \times \sin(t \times 0.2831)$$
$$-2.643 \times \cos(2 \times \mathrm{t} \times 0.2831) + 4.723 \times \sin(2 \times t \times 0.2831)$$

(3) Comprehensive Consideration of Land Cost and Environmental Degradation Cost

According to the hypothesis, we can confirm that there is a certain linear relationship between C_t and W_t , R_t , F_t , A_t and D_t. It can be described as: total economic cost:

$$C_t = W_t + \alpha_1 R_t + \alpha_2 A_t + \alpha_3 F_t + \alpha_4 D_t$$

Among them, $\alpha_1 - \alpha_4$ represents the cost of river water pollution control, the cost of air pollution control, the cost of controlling wastewater discharge and the cost of preventing climate change, respectively, as a percentage of the total environmental protection cost of the federal government. By consulting relevant literature, we can determine the values of $\alpha_1 - \alpha_4$ are :

$$\alpha_1 = 25\% \qquad \alpha_2 = 30\%$$

$$\alpha_3 = 18\% \qquad \alpha_4 = 30\%$$

Then we can get the total economic cost:

$$C_t = W_t + 0.25R_t + 0.3A_t + 0.18F_t + 0.3D_t$$

On the other hand, we introduce the concept of cost-benefit ratio as an evaluation index.

The formula for calculating the benefit ratio is as follows [9]

$$\mathrm{RBC} = \frac{\sum_{t=1}^{n} B_t (1 + i_s)^{-t}}{\sum_{t=1}^{n} C_t (1 + i_s)^{-t}}$$

The basic principle of its application is that for a development project, there are several implementation schemes, using the model results, the cost and benefit of each scheme can be calculated, and the evaluation index value can be calculated by the benefit ratio formula. According to the index value, the optimal design scheme can be designed.

References

[1] Wang Wenbo. Mathematical modeling and its basic knowledge [M]. Wuhan: Wuhan University Press, 2006.5.

[2] Hu Yutong, Ni Guangbiao. Mathematical physics method [M]. Beijing: Higher Education Press, 2002.7.

[3] Si Sukui, Sun Yujing. Mathematical modeling algorithm and application [M]. Beijing: National Defense Industry Press, 2011.1.

[4] Liu Weiguo. MATLAB program design tutorial [M], Beijing: China Water Resources and Hydropower Press, 2005.

[5] Jiang Qiyuan, Xie Jinxing. Selected Cases of Mathematical Modeling [M], Beijing: Higher Education Press, 2006.

[6] Ye Weiguo, Yu Guoxiang. University Physics [M]. Beijing: Tsinghua University Press, 2012.12.

[7] BAI Liang, ZHANG Guang.Existence of Steady Solution of Discrete Heat Conduction Equation [J]. Journal of Qingdao Technological University.2009,30(3):130-136.

[8] Wei Gaosheng, Che Dejing, Liu Haidong. Theoretical Analysis of Thermal Insulation Performance of Multilayer High Temperature Insulation Layer[J]. Proceedings of the CSEE.2013, 33(29):75-79