

Ecological Economy Men Behavior Base on Human's Cognition on Natural Environment Change

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Abstract—As the global natural environment is on the slide, human have improved their cognition on natural environment changes in varying degrees in the aspects of environment attention, environmental awareness and environmental protection behavior. Since Adam Smith, the mainstream economists have regarded homo economy as the basis of economic research. This simplistic assumption has encountered great difficulties in the interpretation of altruistic behavior of humans. Based on human's cognition status on natural environment changes and the model of limited-rationality, the concept of "ecological economy men" has been proposed. The developing dynamic model of "ecological economy men" has been established and the origin and evolution of "ecological economy men" behavior have been analyzed theoretically.

Keywords-Natural Environment Changes; Cognition; Ecological Economy Men; limited rationality ; Homo economy

I. INTRODUCTION

"Global natural environment change has become a fact of no dispute." Each area in the world will be influenced by the change of natural environment. It is recognized from the perspective of science in IPCC report, STERN report, UN millennium ecology report, global environment expectation and IGBP report that natural environment deterioration has become a great challenge in the face of human society sustainable development, which will bring giant threaten to human production and life [1]. Global natural environment changes are a series of biophysics changes in land, ocean and atmosphere driven by a system which is mutually mingled with human activities and natural process, mainly including global warming, ozone hole, acid rain, forest deterioration and biodiversity decrease, desertification and water resource shortage, marine pollution and trans-boundary movement of dangerous materials.

The global earth surface average temperature has risen by 0.74°C from 2005 to 2010, which is the hottest time of the latest 10 recorded years. In the second half of the 20th century, the average temperature in the Northern Hemisphere was the highest of that in the latest 1300 years. Global warming caused the obvious decrease in the area of

North Pole sea ice and of snow on the Northern Hemisphere, the accelerated melting of mountain land and glacier and Greenland ice sheet, and the melting of years' tundra on the Northern Hemisphere. Ocean warming causes seawater expansion. The global mean sea level in the 20th century raised about 0.17m. The extreme climate events caused by global warming are increasing and worsening. Since 1950s, heat wave phenomenon have frequently occurred many areas in the world, and the same with local flood frequency and storm intensity. Especially since 1970s, drought in tropic and subtropic areas has occurred more frequently, lasting, severe with continuously extension of range of influence. The intensity of typhoon and hurricane and the frequency of violent typhoon are increasing, adding from less than 20% in the early 1970s to more than 35% in the early 21st century [2]. In the past 20 years, global warming effect has caused the reduction, even extinction, in the main agricultural production. From 2005 to 2010, the global output of wheat, corn and barley reduced about 50 million tons in yearly amount due to climate warming. Desertification and water resources shortage has caused severe water and soil loss in some areas in the world where there are big drinking water problems.

The reason the natural environment changes is because of the human activities, which threatens the ecology construction in China and even in the world, makes great changes to human's production and life and increases the risk of human production and life [3,4]. With the background of the worsening deterioration of global natural environment, "adaptation will be the only way for human being if they can't deal with the inevitable natural environment changes"[1]. Meanwhile, the influence of cognitive natural environment change on human is to discard the "Economic Man" thought with economic benefit maximization preference to human activities. It is the necessary requirement in human's reaction to environment changes to build "ecological economy man" with ecology awareness, ecological conscience and ecological rationality. This paper based on the status of human's cognition on natural environment changes, the emergence and development of "ecological economy man" behavior shall be further analyzed and human natural

environment protection issues shall be discussed from behavior consciousness level in order to promote the further consideration of natural environment protection issues.

II. ECOLOGICAL ECONOMY MAN'S BEHAVIOR BASED ON COGNITION

Based on the analysis of human's cognition on natural environment changes, people's cognition on natural environment changes, no matter in the aspects of environment attention degree, environment awareness and environmental protection behavior, has been improved in varying degrees, but the public environmental awareness shall still be further improved to promote people's behavior of environmental protection (Yan et al 2008). All of this shows that the traditional "economic man" who takes the maximum economic interest as the purpose shall transform to the "ecological economy man" with ecology awareness, ecological conscience and ecological rationality, so that human damage to the natural environment can be under restraint fundamentally [6]. Now the transform from "economic man" to "ecological economic man" is analyzed as follows.

A. *The comparison between "economic man" and "ecological economic man"*

Before the industrial revolution, the productivity is weak but it's good to the nature. Simple instruments of labor and small group can hardly do any harm to the nature, so the uneducated people take these natural resources as endless fortune with greed grab and wanton waste, which is also the objective economic environment Adam Smith proposed the "economic man" threshold hypothesis[7].

Nowadays the giant changes made by the industrial revolution to the human society and ecological environment are obvious to all, and the social change led by "economic man" threshold hypothesis gave people abundant material satisfaction. However, the industrial revolution also gave people a knife to slaughter the nature, causing people to face the most severe natural environment deterioration crisis throughout history. If human want to keep their survival and development, it is necessary to make a profound social revolution whose chief culprit is the "economic man" idea. Today people's living environment is surrounded by fog and haze, sewage, radiation and pollution, so the desperate pursue of material interests is obviously unwise. People are increasingly realizing the inseparable essence between human and nature environment. More and more people are willing to change their behavior and improve their cognition [8].

Therefore, a new thought that can cause a fresh social development is getting out from the shell, which is called ecological economy. With the ecological economy thought, it is necessary to both pursue the maximum of human activity economic targets and explore human ecological environment sustainability, so this paper proposes "ecological economy man" thought under the influence of the thought. Different from the previous "economic man" which is an accounting entity in market economy, taking the self-interest maximization as purpose in economic activities with the feature of self-interest, the "ecological economy man" is an "economic man" with ecology awareness, ecological conscience and ecological

rationality. It will consider the outer influence on natural environment and other people with altruism when it pursues self-interest maximization [9]. "Economy man" is aimed at meeting its own need of material goods, and "ecological economy man" is the self-survival and development on the basis of looking for natural environment protection and economic development. Both of the two conceptions are different in essence, the former is to pursue material benefits satisfaction regardless of destroying the ecological balance, the latter is to pursue self-satisfaction on the basis of natural environment protection.

The traditional economics theory ignores the fundamental decisive effect of natural environment on the economy, therefore, its basic defect is rootless: economy without nature, a root without natural ecosystems; "economic man" without ethic man, no root with subsistence ethic [10]. These fundamental defects would mislead the industrial economy and market economy so as to damage the natural ecological system, which may cause unsustainable economic growth. This shall be exceeded from the bottom and build "ecological economic man" behavior matched with new circular economy. During the efficiency calculation of input and output in human behavior, damage to the natural environment and price or costs of the influence to others shall be taken out. At the same time of pursuing the economic interests, ecology awareness, ecological conscience and ecological rationality shall be kept to transform human's behavior from "economic man" in traditional economics to "ecological economic man".

B. *"Ecological economic man" forms dynamic models*

Specifically, the formation of "ecological economic man" can be discussed in two points: first, how "ecological economic man" appeared and developed; second, the stability of "ecological economic man". In this paper, based on the bounded rationality model proposed by Simon, a dynamic model is used to explain the appearance and development of "ecological economic man" behavior.

1) *Model assumption*

Let us suppose that there are two kinds of people, "economic men" and "ecological economic men". Other people can get the benefit b by the behavior of "ecological economic man" who should cost c [11]. Assume that $b > c$, that means the total revenue to the society by "ecological economic man" behavior is greater than the total cost, which can just be beneficial to the society and should be encouraged [12,13,14].

When two individuals of people meet each other, their pay off matrix can be shown by Table 1.

2) *The assumption of "Economic Man" can't explain "Ecological Economic Man" behavior*

First, make analysis to the game under the assumption of "economic man". In this game, the selection of "economic man" S is a dominant strategy, so the only pure strategy nash equilibrium is (S, S) . However, if both parties choose "economic man" behavior, their revenues are both 0, which will be smaller than the revenue $(b - c)$ when they both choose "ecological economic man" behavior. This is what we often called "prisoner's dilemma" game[15].

TABLE I. THE PAY OFF MATRIX OF “ECOLOGICAL ECONOMIC MAN” BEHAVIOR

	A (Ecological Economic Man)	S (Economic Man)
A (Ecological Economic Man)	$(b-c, b-c)$	$(-c, b)$
S (Economic Man)	$(b, -c)$	$(0, 0)$

Let us suppose that the proportion of “ecological economic man” in t stage in the group is q_t , after the random pair game, the expected revenues of “ecological economic man” and “economic man” are respectively as follows:

$$\text{Revenue of “ecological economic man”} = q_t(b-c) + (1-q_t)(-c) = qtb - c;$$

$$\text{Revenue of “economic man”} = qtb + (1-q_t)0 = qtb$$

It is observed that the revenue of “ecological economic man” is smaller than that of “economic man”. According to the suppose of “economic man”, people will only choose the behavior which can maximum their economic benefit. Even if a percentage of the “ecological economic men” exist in the society, they will die out little by little because they can’t compete with the “economic men”. Therefore, in the discourse of mainstream economics, the existence of “ecological economic man” can’t be explained.

3) The bounded rationality and the stability of ecological economy behavior

A model based on the bounded rationality is established below to explain the ecological economy behavior of human existence. People are not always pursuing self-benefit maximum but improving their own behavior by imitate others’ behavior due to the bounded rationality. Assume that after each stage of the game, some people will imitate other people’s behavior and change their own behavior selectively. Assume that the proportion of the people with imitancy in the group is β . In these people, the proportion of people who are likely to imitate the behavior of most people in the group is α ($\alpha > 0.5$), and that of people who are likely to imitate the highest revenue behavior in the group is $(1-\alpha)$.

Under this assumed condition, the initial proportion q_0 of the “ecological economy man” in the group has great influence on the dynamic evolution of the model. The discussion of q_0 is as follows:

$$q_0 < 0.5 :$$

At this time the “ecological economic man” behavior is neither the behavior in majority nor the one with highest revenue. Therefore, people with altruism who are likely to imitate others would imitate the behavior of “economic man” and become a self-interested “economic man”. For:

$$q_1 = (1-\beta)q_0 \quad (1)$$

and then

$$q_{t+1} = (1-\beta)q_t \quad (2)$$

Calculate the difference equation and we can get:

$$q_{t+1} = q_0(1-\beta)^t \quad (3)$$

In this situation, the proportion of “ecological economy man” in the group is smaller and smaller and finally tends to zero.

$$a) \quad q_0 \geq 0.5 :$$

At this time the “ecological economic man” behavior is the behavior in majority but not the one with highest revenue. The proportion of people with altruism in the next stage can be represented as:

$$q_1 = q_0 + \beta[(1-q_t)\alpha] - \beta[q_0(1-\alpha)] \quad (4)$$

And then

$$q_{t+1} = q_t + \beta[(1-q_t)\alpha] - \beta[q_t(1-\alpha)] \quad (5)$$

So we can get:

$$q_t = (q_0 - \alpha)(1-\beta)^t + \alpha \quad (6)$$

Under the function of epigonism, there are some “economic men” changing into “ecological economic men” in each stage, and also some “ecological economic men” changing into “economic men”. When $q_0 \geq \alpha$, the ratio of “economic men” is declining gradually; when $q_0 < \alpha$, the ratio of “ecological economic men” is increasing gradually. No matter what q_0 is, the ratio of “economic men” will level off to α as time goes on. The two cases are shown in Fig .1.

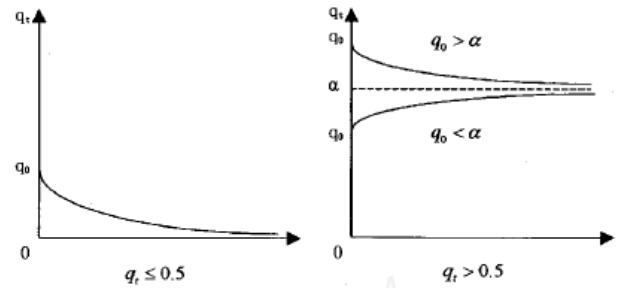


Figure 1. The two cases are shown in figure

In conclusion, if the ratio of “economic men” in the group dominates, it will be stable gradually as time goes on driven by conformity, which shows that “economic men” behavior in the model has stability and can defense the invasion of a few variations. But the model also tells us the ratio of “ecological economic men” will decline gradually and finally tend to die out when the “ecological economic men” are rarely in the group. That is to say, this model can only solve the second issue mentioned above, but can’t explain how “ecological economic men” behavior develops in an unfavorable environment.

Let us suppose there are a few “ecological economic men” in a group consist of “economic men” because of factors such as government rewards and punishment. What kind of mechanism can gradually raise the ratio of “ecological economic men” in the group?

4) Models added with punishment mechanism and the appearance and development of “ecological economic man” behavior

Let us suppose that there is an organization similar to government in a group which observes people’s behavior and gives punishment to the “economic man” behavior. The punishment behavior will make “economic man” lose

p and $p > c$ (make sure the punishment to “economic man” is more than his behavior revenue).

Now the revenues of “ecological economic man” and “economic man” are as follows:

Revenue of people with altruism
 $= q_t(b-c) + (1-qt) = q_t b - c$

Revenue of self-interest people
 $= q_t b + (1-q_t)0 - p = q_t b - p$

Now the revenue of “ecological economic man” is higher than that of “economic man”.

Equally, the initial ratio of “economic man” in a group is discussed below:

a) If $q_0 < 0.5$

the revenue of “economic man” behavior is the highest, but not the behavior of most people. There is:

$$q_1 = q_0 + \beta(1-q_0)(1-\alpha) + \beta q_0 \alpha \quad (7)$$

then:

$$q_t + 1 = qt + \beta(1-q_t)(1-\alpha) + \beta q_t \alpha \quad (8)$$

We can get:

$$qt = (q_0 - 1 + \alpha)(1 - \beta)^t + (1 - \alpha) \quad (9)$$

As time goes on, the ratio of “economic man” will tend to 0.

b) If $q_0 \geq 0.5$

the “economic man” behavior is both the behavior with highest revenue and the behavior in majority. There is:

$$q_1 = q_0 + \beta(1-q_0) \quad (10)$$

And then:

$$q_{t+1} = q_t + \beta(1-q_t) \quad (11)$$

We can get:

$$q_t = 1 - (1 - \beta)^t (1 - q_0) \quad (12)$$

It is known by the model analysis that when the ecological economic awareness of people in the society is relatively low, the government shall punish the selfish economic behavior to offset the disadvantage situation of “ecological economic man” comparing with “economic man” to increase the ratio of “ecological economic man”. If the ratio of “ecological economic man” in the society has reached a certain degree, it will maintain highly under the function of imitation mechanism even if there is no punishment mechanism.

III. CONCLUSION

The formation dynamic model of “ecological economic man” tells us the government shall increase the

punishment on the natural environment vandalism when human have low natural environment protection awareness to promote the citizens’ natural environment protection awareness and behavior. If human’s natural environment protection awareness has reached a certain degree and under the function of conformity behavior, their natural environment protection awareness and behavior will remain a relatively high level, and the “ecological economic man” behavior will be gradually stable in the group.

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