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Revision of three-stakeholder signaling game for environmental impact assessment in China

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ABSTRACT

Since environmental impact assessment (EIA) regulations were adopted in China 30 years ago, the implementation rate of EIA policies for development projects has been steadily increasing while national environmental quality keeps deteriorating. This contradiction prevents achievement of the goals that the regulations were originally created for, raising concerns regarding the EIA implementation process. One of the objectives of EIA is the evaluation of socio-economic costs introduced by various commercial activities. However, independent economic entities are inclined to break away from these cost related responsibilities, making it necessary for government agencies and EIA organizations to participate in the evaluation process. The practice of avoiding costs may also bring forth other issues, such as rent-seeking behavior and conspiracies. Reducing private costs and the tendency of the three EIA stakeholders to evade social responsibility are intertwined in every EIA process. Their activities are as follows: The government is the lawmaker whose attitude toward the EIA organization determines how business owners react in the EIA process. The government inclination can be interpreted as a signal from which enterprises can determine the nature of the government, which helps the enterprise owners formulate their future actions. A similar relationship also exists among the government, EIA organizations, and enterprise entities. Fundamentally, the correlations between the EIA stakeholders are determined by their socio-economic situation, namely, the economic costs and benefits they encounter. In this article, signaling game theory derived from the classic game theory is applied to describe the EIA process in China by analyzing the activities of the stakeholders and searching for game equilibrium solutions. The optimal reaction schema for stakeholders was obtained by transforming the equilibrium.

1. Introduction

In the implementation of the EIA system in China, the four participants are the government, EIA organizations, enterprise entities, and the general public; the active participants are the previous three because the public usually plays a silent role (Cheng et al., 2007). The present environmental legislation system serves as an extrinsic guide for all EIA stakeholders, but a high level of variance is presented in the actions of these stakeholders when implementing EIA regulations. As three distinguished economic institutions, a straightforward deduction from the theory of microeconomics is that the ultimate objective of the stakeholders is to minimize cost and maximize profit (Samuelson and Nordhaus, 1998; Callan and Thomas, 2006). The existing environment legislation system in China does not create sufficient constraints to restrict the three stakeholders from pursuing their own economical goals; thus, the ultimate result of the EIA system would be significantly influenced as an inevitable consequence.

The microeconomic principle of profit maximization states that enterprises, as an economic entity in the market, possess the sole objective of pursuing profit while in operation, which does not include responsibility for any by-products, such as environmental pollution and deterioration (Friedman, 1953; Tirole, 1988; Williamson, 1996; Dosi, 2000). The government is the agency for social affairs; therefore, it clearly has to be responsive to social incidents and events aside from exerting effort to keep itself in healthy operation (Formby, 1987). As a representative of the public and social benefits, the government is to be held accountable for any exterior nonproductive related cost from the enterprises, such as environmental pollution. If the cost exceeds revenue from the enterprises, then as a consequence, the government would rather reduce environmental pollution by slowing down development to offset social and public losses (Johnston and McCartney, 1991; Brugmann, 1996). This would present conflict of interests between the government and enterprise, and position them in an antagonistic relationship. Development plans that will impose more mitigation costs on society rather than their projected economic

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benefits (i.e. heavy contamination makers) can hardly be given approval under the current EIA system. Thus, EIA regulations target plans with an insignificant amount of difference between costs and benefits (Slanina, 2000; Saunders and Bailey, 2009). However, these types of projects are usually complicated enough that they can be accorded approval or work around EIA regulations because of arbitrary mistakes in judgment during the analysis phase. In fact, many business owners deliberately choose to neglect socio-economic responsibilities by evading the evaluation in the early stage of launching the projects. These actions put the government, the overall representative of the general public, in the uncomfortable position of facing the dilemma of economical benefits and social costs. This may explain why EIA is nonexistent or lagging behind in some development projects (Leknes, 2001; Saunders and Bailey, 2009). As a result, EIA can only take on a passive role in development initiatives.

The public is supposed to be the beneficiary of public welfare and delegate of public affairs, with the intention of supervising the EIA process and revising the activities of the other three participants to ensure the validity of an impartial evaluation. From a practical perspective, the general public is unable to be fully involved in EIA processes (Palerm, 1999; Bond et al., 2004). In most cases, its participation is a mere formality where the government acts as an agency for the people. Moreover, most people prefer not to take the initiative to be actively involved in the EIA evaluation process (Cheng et al., 2007). Within the present EIA system, the general public can hardly be a genuine participant in EIA procedures. In this paper, this concern is addressed and the need to investigate flaws in the current EIA system is introduced so that suggestions for future revision can be made. For the purpose of analyzing the actual EIA procedures at the present time, the participation of the general public is eliminated and focus is directed only on examining the activities of the remaining three stakeholders. The signaling game is used in the analysis, and it is also used to calculate change of costs and benefits of stakeholders after the participation of the general public.

2. Methodology and feasibility analysis

2.1. Methodology

The signaling game model provides the analysis functionalities of message transmission mechanism. A basic characteristic of the model is that there are two types of game participants, the signal senders and signal receivers. Under different circumstances, however, these two game participants are not always absolutely defined. In cases wherein there are three game participants, the receiver of the previous signal transmission process may become the sender of the subsequent signal (Fudenberg and Tirole, 1991; Carlsson and Dasgupta, 1997; Cooper and Kagel, 2003; Ahmed and Hegazi, 2006). Messages in the signaling game model have two basic characteristics: incompleteness and directional transmission. Game participants are often aware of their own messages as these could facilitate their capacity to become more profitable. Therefore, each game participant poses a partial message in relation to the entire picture. On the other hand, the direction of message transmission among game participants is usually specific (Monsuwé et al., 1997; Jacobsen et al., 2001; Feinberg, 2005). The message is always passed on from the sender to the receiver.

Signaling game falls into the category of partial message dynamic transmission model, also referred to as the dynamic Bayesian game, and can be transformed into a completed but imperfect gaming process (Fudenberg and Tirole, 1991). Suppose there is a game participant G, who randomly picks a possible type from the type space according to the probability distribution. The participant informs the sender about the selected type, and then selects an action from the action space to send a message. Based on the action of the sender, the receiver would then act accordingly and attempt to achieve the most profit. Now, let us use S to represent the signal sender and R as the signal receiver. $T=\{t_1,t_2,\ldots,t_n\}$ is the action type space of S; $M=\{m_1, m_2,\ldots,m_n\}$ is the action space of S; and $A=\{a_1,a_2,\ldots,a_n\}$ is the action space of R. Meanwhile, μ_S and μ_R are the possible profits of S and R, respectively. Suppose the probability distribution of choosing S by game participant G is $\{p(t_1),\ldots,p(t_n)\}$, then a signaling game may be expressed as follows:

- Game participant G chooses a type t_n for signal sender S has the probability $p(t_n)$, and S completely knows its own action;
- S choose an action m_n from the action space;
- Signal receiver R receives a signal of action m_n and chooses the action a_n which would make R to obtain the most profit;
- The profits of S and R μ_S and μ_R are related to t_n, m_n, a_n.

2.2. Feasibility analysis

Within the boundary of the legislated EIA procedures, the operating actions of the three stakeholders are sequential in a certain way so that the messages are transmitted in a specific direction (Kolev and Prusa, 1999; Kaya, 2009). For example, the enterprise would interpret the information from the government on EIA and act accordingly if no double-dealing exists. Thus, the message transmission among EIA participants can be seen as a game process. In this paper, the activities of EIA stakeholders were described using signal game theory. Then, a model of perfect Bayesian equilibrium was set up and the balanced solutions were derived by adding the public as the fourth EIA party. The game theory explanations for equilibrium transformation were used to derive necessary requirements for the solutions (Aoki, 1998; Aoki, 2001; Slanina, 2000). The purpose of the article is to illustrate how signaling game explains the procedures of the three stakeholders. The perfect Bayesian equilibrium was examined and equilibrium was achieved by adding the general public as the fourth participant to deduce the interpretation of the equilibrium transformation while reaching the conclusive necessary conditions.

3. Construction and analysis of signaling game model for the EIA stakeholders

3.1. Signaling game process among three stakeholders in EIA

In this section, the signaling game process between the government and enterprises is analyzed. The government, the initiator and carrier of the EIA system, can be taken as the signal sender S. The enterprises receive the signal from the government, speculate on the type of signal, and then determine further actions. Thus, the enterprises are the signal receiver R. At the start of the gaming process, the government may be categorized in any type $t\in T$, and sends a certain message $m\in M$ (Fig. 1) (Fudenberg and Tirole, 1991; Manelli, 1997). For simplification, the types of governments referred to in this paper are economic development-friendly (t_1) and environment-friendly (t_2). The corresponding messages are either a strictly enforced EIA (I) or a loose enforcement that makes it possible for the enterprises to evade EIA

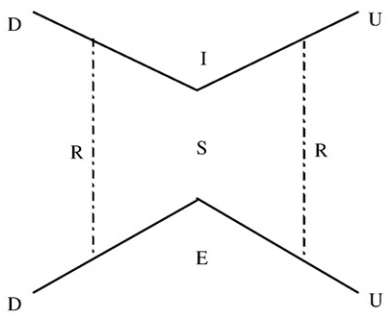

Fig. 1. Actions of two sides in signaling game.