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Incentive modes and reducing emissions from deforestation and degradation: who can benefit most?

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ABSTRACT

An incentive mechanism is key to succeed the investments in Reducing Emissions from Deforestation and Degradation programs. However, the diversification of determinants makes it difficult to establish one mode to best incentive stakeholders. This paper compares various incentive modes in benefiting stakeholders by simulating dynamic game models. It analyzes the profit-making of developers and landholders based on four incentive modes. The modes are preferential tax for developers, incentive of carbon offsets for developers, investment incentive for developers, and incentive of reducing emissions for landholders. This paper compares the effects of incentive modes on benefit distribution of stakeholders and contributes to a new dynamic game framework. The results show that: (i) the effects of incentives of carbon offsets for developers and incentives of reducing emissions for landholders are almost same for the stakeholders; (ii) a preferential tax can only make developers unilaterally benefit, and will not change landholder welfare; (iii) investment incentives for developers can make landholders' profits be increased, while the effects of incentives on developers' profits are uncertain. Finally, the numerical simulation is used to verify these hypotheses. The core implication is that for the design of REDD+ incentives, the government should combine various incentive modes to fulfill different objectives in policy making.

1. Introduction

Carbon emissions caused by deforestation and degradation have accounted for 10–17 percent of the total carbon emissions caused by anthropogenic factors. It has been the main source of carbon emissions in many tropical countries with rainforest (Metz et al., 2007; van der Werf et al., 2009; Harris et al., 2012). Therefore, a mechanism named "Reducing Emissions from Deforestation and Degradation (REDD+)" is introduced at the Bali Climate Change Conference to suggest incentives for developing countries to reduce emissions from the forest sector (UNFCCC, 2007). REDD+ is a global response to climate change mitigation working towards the lowest cost and highest efficiency (Stern, 2007). In the past, a variety of methods have been proposed to restrain the loss of forestry, yet failed to achieve expectations (Wunder, 2005; Forner et al., 2006; Skutsch and Trines, 2008). REDD+, however, is an effective one that provides a new framework for emissions reduction from deforestation and degradation. The framework supports not only forest protection, but also sustainable forest management, biodiversity conservation, and forest carbon storage (UNFCCC, 2009). In order to reduce atmospheric greenhouse gases (GHG), REDD+ employs appropriate incentives for local residents in developing countries to change deforestation-related behavior (Gregersen et al., 2010). Therefore, incentives as a core of REDD+ have attracted attentions increasingly and deeply (Irawan et al., 2013; Duchelle et al., 2014; Loaiza et al., 2015). The incentive scheme is often regarded as an efficient policy tool to internalize forest carbon externality and promote REDD+ in developing countries (Angelsen, 2010; Pattanayak et al., 2010).

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Although some stakeholders view REDD+ as a ready-made panacea to treat climate change, it is actually just one component of total mitigations to cut down emissions in developing countries. Even so, REDD+ can provide essential financial support to countries which are willing and able to reduce emissions caused by deforestation (Scholz and Schmidt, 2008). Kameyama et al. (2015) find that investment towards low-carbon development could be realized in Asia associated with an estimated investment of US$ 125–149 billion per year by 2035. So far, many have focused on international-to national-level design issues (Irawan and Tacconi, 2009). To approach appropriate Reference Levels of emissions and address carbon leakage, developed countries are relocating their carbon emission activities in developing countries (Allevi et al., 2015). In this regard, key to successful implementation of REDD+ programs is to develop an incentive mechanism for investments, to encourage developing countries to protect forest areas to reduce emissions from deforestation and degradation (Busch et al., 2009; Olander et al., 2008). Developing countries can obtain "carbon credits" for emissions reduction of CO_2 in accordance with an agreed baseline or reference emissions level. It is a fundamental usage of incentives that the "carbon credit" trading would make up the cost caused by emissions reduction (Borrego and Skutsch, 2014). There are three main types of the cost:

(i) opportunity costs caused by foregone revenues that deforestation would have generated for livelihoods and national economy, including forgone benefits from land use change (LUC), as well as social-cultural and indirect costs (Ghazoul et al., 2010);
(ii) implementation costs to reduce deforestation and forest degradation, for example the costs of land use planning, job training, administration, etc.; as well as
(iii) transaction costs of a REDD+ program's establishment and operation, for example the costs of implementing robust measuring, reporting and verification (MRV), REDD+ program development, negotiating agreements, etc (Gregersen et al., 2010; Karky and Skutsch, 2010).

Implementation costs and transaction costs can be regarded as a generalized transaction cost. Lots of time and money are required in the negotiation and management of REDD+ programs, hence the transaction cost would be significant. Incentives, however, can effectively reduce transaction costs (Mahanty et al., 2013). Skutsch et al. (2011) also find that communities which are skilled in negotiation and experienced in tapping government incentives would have a greater probability to join REDD+ programs. Moreover, REDD+ can also improve ecological and environmental welfare to the society by other means and actions. Such external benefits, however, are not fully reflected in the value of "carbon credits." Pigou (1920) suggests the following remedy: "… In the case of external benefits, the economic unit generating the spillover should receive a unit incentive equal to the value at the margin of the spillover benefits it creates." The existence of incentives, therefore, should not only reduce transaction costs of REDD+ programs, but also make up for external benefits of REDD+ programs.

Most studies on incentives of REDD+ programs, however, treat it as a type of policy instrument, like a tax or another market-oriented tool, to internalize the social costs of REDD+ programs accompanied with social and private benefits (Nasi et al., 2011). It is generally recommended that incentives should be provided for stakeholders to encourage the implementation of REDD+ programs (Phelps et al., 2010; Cronkleton et al., 2011). Moriizumi et al. (2010) suggest the utilization of incentives for REDD+ should balance the conflicting goals of various stakeholders in mangrove management. Exploring the influence of climate governance on corporate social responsibility in Zambia, Leventon et al. (2015) find that economic development opportunities can provide incentives to preserve the forest. Previous studies have emphasized the important role of incentives in REDD+ from the perspective of compensation payments for opportunity costs (e.g. Delacote et al., 2014; Borrego and Skutsch, 2014). Many indicate that incentive schemes can change deforestation-related behavior by reducing key selling points of cost-effectiveness compared to other policy tools (Ferraro and Simpson, 2002; Muller and Albers, 2004; Groom and Palmer, 2010). However, a variety of incentive modes, for example market-based mechanisms and subsidies, have influenced deforestation activities differently (e.g. Kinzig et al., 2011; Landell-Mills and Porras, 2002; Muradian et al., 2010). These incentive modes need to be further analyzed and compared (Strassburg et al., 2009; Torres et al., 2013).

Qualitative methods are frequently employed to illustrate the role of incentives (e.g. Palmer, 2011; Karsenty and Ongolo, 2012; Duchelle et al., 2014), yet little has been studied about dynamic games among stakeholders in REDD+ programs. In fact, many actors have participated in REDD+ programs, including developers, landholders, national governments, etc. The developers who are the specific executants of REDD+ program, may be state governmental authorities, international environmental NGOs and financial institutions (Kanowski et al., 2011). The *y* are driven by environmental outcomes, rather than profit. Actually, most of the developers describe themselves as "non-profitable" as they are not profit-seeking per se, or rather not seeking profits in maximization. National governments are playing critical roles in transaction processes between REDD+ program developers and landholders. It as an important stakeholder, as well as the final decision-maker, can decide the incentive mode which will influence the benefit sharing between landholders and developers.

Since the effects of incentive modes are different on stakeholders, it is necessary to explore the benefits to each stakeholder in different incentive modes. As an effective analytical tool, the dynamic game model is widely used in the research on the incentive for resource recycling (e.g. Savaskan et al., 2004; Zhang et al., 2014). Ollivier (2012) used a dynamic game model with open-loop symmetric Nash equilibrium to analyze the efficiency of incentive scheme on a finite number of stakeholders. The dynamic game model can simulate the dynamic interactive relationships among different stakeholders, and provide an optimal equilibrium solution (Tian et al., 2015). Using dynamic game models, this paper analyzes the effects of various incentive modes on profits of developers and landholders in the REDD+ program. Different from previous research which has focused more on the role of incentives for the stakeholders in REDD+ programs (e.g. Ezzine-de-Blas et al., 2011; Huettner, 2012; Irawan et al., 2013), this paper emphasizes the effects of different incentive modes on the benefit distribution of stakeholders. We develop a new dynamic game framework to reflect the relationship between incentive modes and stakeholders' benefits in REDD+ programs. Four types of REDD+ incentive modes are compared, through policy simulations in the models to help national governments seek equilibrium solutions.

The structure of the paper is as follows: Section 2 establishes the dynamic game models including developers and landholders in REDD+ programs to hypothetically analyze the effects of incentive modes on stakeholder profits. Section 3 uses policy simulation to analyze changes in profits of developers and landholders under various incentive scenarios. Implications for REDD+ are given in Section 4, followed by the conclusion in Section 5.

2. Method

The dynamic game model is employed to compare the effects of incentive modes on the profits of REDD+ stakeholders. There are