The Costs of Reduction Emission from Deforestation and Forest Degradation (REDD): Concepts and Issues

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Abstract:

This study examines the concept of REDD costs by using the existence costs of Boucher (2008) such as opportunity costs, transaction costs, implementation costs, stabilization costs, and administration costs. In addition, it provides some actual issues of REDD. The study proves that global simulation models yield far higher REDD prices than empirical models, however, they can be criticized for their use of aggregated data and other simplifications. Moreover, adding implementation, administration, stabilization costs into transaction costs could potentially lead to double-counting problem. Finally, REDD is an inexpensive option compared to reducing emissions in the energy sectors of industrialized countries and has a potential to generate substantial benefits in addition to the reduction of greenhouse gas emissions. Yet, it is important for countries to manage these issues that can be potentially defect REDD adoption.

Keywords*:* Costs; Emissions; Deforestation; Forest Degradation

JEL Classification: Q010; Q230; Q540

1. Introduction

There is still no consensus regarding on the concept of deforestation. According to FAO (2001 cited in Schoene et al., 2007), deforestation is the permanent loss of forest cover, and its transformation into another land-use. In contrary, UNFCCC (2001 cited in Schoene et al., 2007) claimed that it is the direct human-induced conversion of forested land to non-forested land.

The same problem could arise on defining forest degradation. FAO (2001 cited in Schoene et al., 2007) believed that forest degradation is the changes within the forest which negatively affect the structure or function of the site and therefore, it can lower the capacity to supply products and services. In contrast, IPCC (2003 cited in Schoene et al., 2007) stated that it is a direct human-induced loss of forest values (particularly carbon), likely to be categorized by a reduction of tree cover where its routine management is not included.

It is widely recognized that deforestation and forest degradation are among the most important single sources of emissions of greenhouse gases (GHG), which contribute to about 20 percent of total emissions annually, given the associated losses of livelihoods, biodiversity, environmental services, and cultural patrimony (Pagiola and Bosquet, 2009). Ramankutty et al. (2007) suggested that the development of systems of payments in reduction emissions from deforestation and forest degradation (REDD) is very essential for sustaining its implementation.

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To address this issue, Pagiola and Bosquet (2009) stated that countries need information on the future costs and the benefits to perform REDD program. However, the cost of some programs to reduce deforestation might exceed the benefits on the behalf of the expected payments for REDD. Thus, there are two key variables that determine the profitability of a REDD program as follows (Pagiola and Bosquet, 2009): Firstly, the costs associated with the program; Lastly, the payment per ton of emission reduction.

Numerous studies attempted to estimate the aggregate cost of REDD. The Stern Review estimated that the cost of avoiding deforestation entirely in eight countries was collectively responsible for 70 percent of land use emissions at between US$1-2/tCO2 (Stern, 2006). Meanwhile, Kindermann et al (2008) predicted that halving emissions from deforestation between 2005 and 2030 would require a payment of US$10-21/tCO2.

The costs of REDD fall into two categories (Boucher, 2008) as follows: Firstly, the opportunity costs (i.e. the cost of forgone earnings from alternative land uses which correspond to the minimum price to be paid for REDD services); Finally, the other costs which can be derived into transaction costs, implementation costs, administrative costs, and stabilization costs. In this paper I use these existence costs of Boucher (2008) to investigate the concept of REDD costs. In addition, I ascertain the issues which could affect its adoption.

This paper is organized as follows: Section 2 describes alternative approaches used to estimate the opportunity costs of REDD; Section 3 reports how other costs are estimated in REDD cost calculations; Section 4 resolves the issues relating to the execution of REDD; and Section 5 comprises concluding remarks.

2. Costs of REDD

Deforestation can also bring benefits where timber can be used for construction and cleared land can be used for crops or as pasture and thus, reducing deforestation could forgo these benefits. Similarly, in the case of forest degradation, selective logging, fuel-wood collection, and grazing of animals could contribute to these benefits while avoiding this degradation foregoes these benefits. The cost of forgone benefits, known as the opportunity cost and usually the most important category of costs, would incur if a country reduced its rate of forest rate loss to secure REDD payments (Pagiola and Bosquet, 2009). Therefore, this cost could be central problem in estimating the costs of REDD.

The estimations from local-empirical models are based on detailed studies (surveys) in a particular area. Both the per-area cost estimates ($/ha) and the carbon density estimates (ton/ha) are specific to the particular region studied, and the division of per-area opportunity costs by carbon density gives the opportunity costs on a per ton basis (Boucher, 2008). However, Grieg-Gran (2006) argued that the generalization of the results can be problematic since they are specific to a particular region.

Based on a review of 29 regional empirical studies, Boucher (2008) found that the data points of opportunity costs are quite low with the mean of $2.51/tCO2eq and 18 out of 29 estimates are less than $2/tCO2eq. He claimed that this condition refers to the likely position of these data points in the early stages of the respective supply curves. In addition, these two data points proved that converting tropical forest to other uses (e.g. agriculture on forest land) are very unprofitable.

On the contrary, there are more sophisticated empirical studies at local level (see Table 1). These studies differ in several aspects including scope (deforestation, forest degradation), study area, constraints, level of analysis, data sources, level of discount rate, degree of spatial disaggregation (accounting for geographic variation of key determinants, especially carbon densities), inclusion of transaction costs, practicability that related to replication of methods, and accuracy.

Table 1: The Difference in Characteristics of Local-Empirical Models

Characteristics	Nepstad et al. (2007)	Swallow et al. (2007)	Borner and Wunder (2008)
Area of Study	Brazilian Amazon region	Five sites across the tropics in which three in Indonesia and one each in Peru and Cameroon (the results does not available in this country)	Two Brazilian states in the Amazon region: Amazonas and Mato Grosso
Scope of Study	Deforestation and Forest Degradation	Deforestation	Deforestation
Limitation of Study	The cost calculation assumes zero deforestation after the first 10 years of the programme with baseline of 20,000 km^2 per year	No assumption	The study only considered private landholdings

Characteristics	Nepstad et al. (2007)	Swallow et al. (2007)	Borner and Wunder (2008)
Level of Analysis	Pixel level (with resolution of 4 km^2) and the results were aggregated into province/regional level	Pixel level (with no resolution) and the results were aggregated into province/regional level	Municipal level
Spatial Heterogeneity	High where the study estimates all variables of costs except transaction costs	Medium where there is no spatial variation of prices	Low where the study does not capture variation within municipal and there is linear transportation costs
Sources of Data	The combination of high-resolution remote sensing data and secondary data	The combination of medium-resolution remote sensing data and survey (primary) data taken from extensive field work	The combination of medium-resolution remote sensing data and secondary data taken from existing surveys
Discount Rate	5%	10% for private and 3% for social	10%
Calculation of Value of Carbon Density	Spatially explicit rent models for high-carbon (timber) and low-carbon (agriculture and ranching) developed by Saatchi *et al* (2007)	Time-averaged carbon stocks (t-ave C) for the major land uses	Carbon biomass value were used from Houghton *et al* (2001) lowest estimates
Opportunity Costs	\$1.49/tCO2 for reducing 100% deforestation and \$0.76/tCO2 for reducing 94% deforestation	\$5/tCO2 for majority of deforestation in Indonesia (64-92%) and Peru (90%)	The so-called choked price in which one that allows compensation of all avoided deforestation gave \$12.34/tCO2 for Mato Grosso and \$3.24/tCO2 for Amazonas
Transaction Costs	Partly included by adding the cost of implementing an REDD scheme	Not included	Not explicitly integrated into analysis but discussed
Level of Accuracy	High due to the use of bottom-up modelling	High due to robust methodology	Low due to the use of aggregate data
Strength of Analysis	• Spatially-explicit model of land use change • Measures degradation • Considers transaction costs • Prospective approach	• Province-level supply curve • Consistent with IPCC guideline • Retrospective analysis • Full-accounting approach	• State-level supply curve • Straight-forward framework • Rapid assessment • Prospective Approach
Weakness of Analysis	• Strong assumption of zero deforestation after 10 years • High data for land use models	• No estimation on forest degradation • No estimation on transaction cost • The need of extensive data • The use of time-averaged carbon stock rather than actual carbon stocks • Insufficient estimation on spatial price variations	• No estimation on forest degradation • Limited estimation within municipal variation • Limited estimation on private landholders only
Replicability of Analysis	Difficult due to the use of complex model	Difficult due to the high of data needs	Easy due to the use of secondary data sources

Source: Compiled from Many Authors

Although approaches that give particular attention to the spatial heterogeneity of land-use change determinants (e.g. Nepstad et al., 2007) or its ground measurements (e.g. Swallow et al., 2007) are likely to yield more accurate estimates, they are more difficult to replicate in other parts of the tropics precisely because of their data and capacity requirements. Approaches that are only based on secondary data (e.g. Borner and Wunder, 2008) are therefore likely to be used at initial level.

Global-empirical models use local-empirical estimates and aggregate them to global per-area costs of reducing deforestation (Boucher 2008). Although it essentially ignores carbon density variation across space, this permits data on per-area opportunity costs to be used for regions where no per-ton-carbon costs exist. This method applied in the Stern Review was analyzed by Grieg-Gran (2006) which gave the opportunity cost of \$5-15 billion/year for 46% reduction in deforestation.

Furthermore, Boucher (2008) converts 390 tCO2eq/ha to the Grieg-Gran's estimates which give a range of \$2.76-8.28/tCO2eq, with the midpoint (\$5.52/tCO2eq), meaning that 46% higher than the mean of his local-empirical estimates. This condition implies the uncertainty in the estimation of deforestation and carbon density (Boucher 2008).

In the simulations on the cost of REDD, such models take into account the depth on the cost of reducing emissions and the variety of over-time supply curves (Wertz-Kanounnikoff, 2008). Currently, there are three main global partial equilibrium models that have been used (Kindermann *et al*, 2008), known as GTM (Global Timber Model), DIMA (Dynamic Integrated Model of Forestry and Alternative Land Use) and GCOMAP (Generalized Comprehensive Mitigation Assesment Process Model). Boucher (2008) stated that these three models differ in various details including the sectors included, how their dynamics are simulated, how they divide up the globe spatially, and the data sets used (see Table 2).

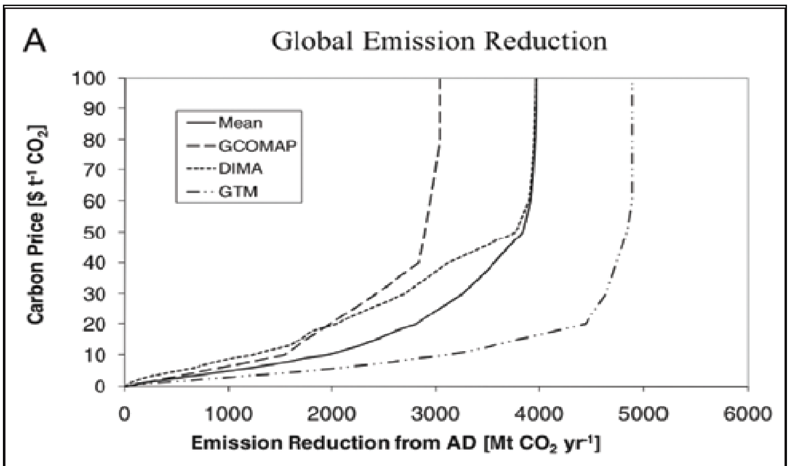
Table 2: The Difference in Characteristics of Global Simulation Models

Characteristics	GTM	GCOMAP	DIMA
The Data Used	146 timber types globally	Country-specific activity, demand, and costs of mitigation options and land-use change regions in 10 world regions	0.5 degree grid cells across the globe
Level of Analysis	Optimizes the land area, age class distribution, and management of forestlands	Analyses afforestation in short-run and long-run species, and reductions in deforestation	Assesses land-use options in agriculture and forestry
Simulation of the Model	Maximizes the NPV of consumers' and producers' surplus in the timber markets	Simulates the response of the forestry sector to changes in future carbon prices	Predicts deforestation in forests where land values are greater than agriculture than in forestry and, vice versa

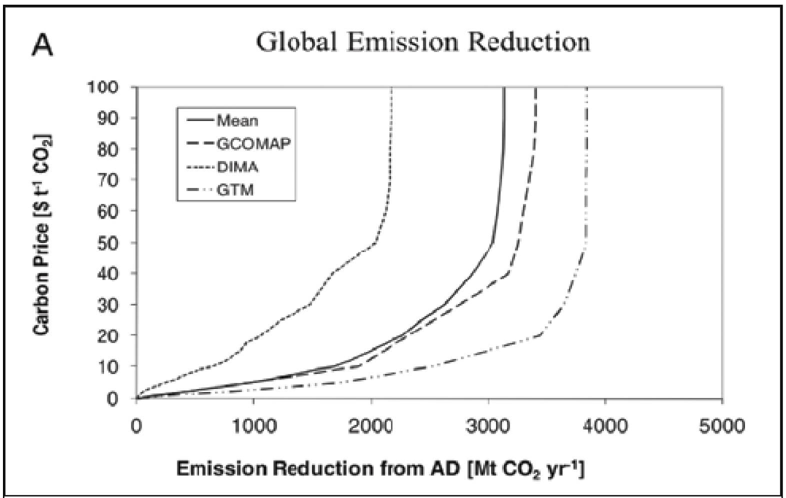
Source: Kindermann et al., 2008

To determine the marginal costs of carbon storage resulting from avoided deforestation, additional simulations were conducted in the three models and were assuming that constant carbon prices ranging from US\$0/tCO2 to US\$100/tCO2 (Kindermann et al., 2008). Figure 1 highlight marginal costs tend to rise over time because the principal of the lowest opportunity costs are adopted and the rates of deforestation decline (meaning that the opportunity costs of using agriculture in forestlands rise). Figure 1 also shows that the GTM model tends to predict the greatest emissions reductions for a given cost in 2010 and 2030, whereas the position of the GCOMAP and DIMA models vary over time.

Figure 1: The Development of Supply Curve from 2010 to 2030



Supply curves in 2010



Supply curves in 2030

Source: Kindermann et al., 2008

There are various comments pertaining to the validity of global simulation models. On the one hand, Nepstad et al. (2007) argued that these models are often simplifying assumptions about potential rents from agriculture and livestock on tropical forestlands. In line with this view, Kindermann et al. (2008) proved that the exclusion of transaction costs and other institutional barriers raise the costs in practice. On the other hand, Boucher (2008) claimed that these models shared a common approach which is based on the opportunity costs of different land uses. Moreover, they were able to capture within-sector and cross-sector interactions that can have important implications for REDD costs (Sohngen, 2008).

All three of the above approaches are very useful to estimate the cost and the potential of REDD in the perspective of opportunity costs. Boucher (2008) argued that opportunity cost are not the only costs of REDD. There are also a number of other costs relating to establishing baselines, planning programs, building capacity, measuring and monitoring the results, and carrying out the transactions which are necessary to receive compensation.

Transaction costs referred to the costs that arose in making an economic exchange and could exist as a result of limited knowledge and information (Wertz-Kanounnikoff, 2008). In addition, it obtained various empirical approaches, which further differ whether government agency cost or only individual costs are considered (Antinori and Sathaye 2007). According to Milne (1999 cited in Wertz-Kanounnikoff, 2008), there were several key features of transaction costs which comprised information and procurement, scheme design and negotiation, implementation, monitoring, and verification and certification.

Information on the transaction costs of REDD schemes remains limited where most of the discussions tend to build from other experiences, such as payments for environmental services (PES) schemes or forestry Clean Development Mechanism (CDM) projects (see Table 3). Moreover, transaction costs are reported either in the form of total costs or as percent-share of the entire budget.

Table 3: The Difference in Characteristics of Other Costs

Study	Coverage	Cost Category	Data Source	Costs ($/tCO2eq)
Cacho *et al* (2005)	6 tropical countries	Transaction costs	AIJ projects	0.14-1.07
Grieg-Gran (2006)	8 tropical countries	Administrative costs	Expert consultation, PES schemes	0.01-0.03
Nepstad *et al* (2007)	Regional (Amazon)	Implementation costs	Expert consultation, existing schemes	0.58
Antinore and Sathaye (2007)	11 forestry projects	Transaction costs	Climate projects	0.66-16.4 with weighted average of 0.38
Da Fonseca *et al* (2007)	11 High Forest Cover Low Deforestation (HFLD) countries	Stabilization costs	CDM projects	No estimation

Strassburg *et al* (2008)	20 most forested developing countries	Stabilization costs	FAO study	5.63
Kindermann *et al* (2008)	Global	Transaction costs	CDM projects	0.3-4.05 with weighted average of 0.26

Source: Compiled from Many Authors

Wertz-Kanounnikoff (2008) believed that there is no consistent methodology for collecting data on transaction costs could be found and transaction costs are often difficult to measure directly. As a result, there are few studies that have quantitative analyses of transaction costs. For example, Antinori and Sathaye (2007) found that transaction costs for forestry offset projects averaged \$0.38/tCO2eq and general forest projects had lower transactions costs than non-forest ones. Another example is Kindermann *et al* (2008), which used different coverage and data source from the previous one, proved that transaction costs for forestry are in the average of \$0.26/tCO2eq.

Insights from PES and CDM schemes suggest that transaction costs tend to be particularly high in early stages of a scheme, and when the size of the scheme is small. Cacho et al. (2005) showed that in the case of four carbon projects in Indonesia, the startup costs can be quite large whereas running costs tend to be more manageable. However, Wertz-Kanounnikoff (2008) underlined that such schemes will produce high transaction costs if the institutions and rights are not well-defined and well-functioning. This means that the need of careful selection of projects at practical level is very crucial.

According to Pagiola and Bosquet (2009), implementation costs are one that directly involved in implementing the REDD program, which is the cost of the actions needed to reduce deforestation and forest degradation. These costs include measuring and monitoring, capacity building, planning and goal setting, and a wide variety of costs that stimulate deforestation and REDD deployment such as confirming indigenous land rights, modifying plans for the road network, integrated conservation and sustainable development projects, and establishment of national parks (Boucher, 2008).

There is dilemma to distinguish implementation cost and transaction cost. Pagiola and Bosquet (2009) believed that the latter costs do not reduce deforestation and forest degradation because they are just the cost of indentifying REDD program. While Pfaff et al. (2008 cited in Boucher, 2008) argued that these cost are somewhat overlap with the transaction costs where there is an additional issue which should not be included in these costs such as real costs as opposed to simply transfer payments among the citizens of a country.

Regarding on the effectiveness of implementation costs at the national-level, Nepstad et al. (2007) proved that once the program is fully implemented at the tenth years, countries would only to spend \$0.58/tCO2eq (see Table 3). In the proponent view, Tattenbach et al. (2006 cited in Pagiola and Bosquet, 2009)) estimated that PSA, one of nationally large-scale program under PES schemes, reduced deforestation by about 50 percent. However, Pfaff et al. (2008 cited in Boucher, 2008) opposed that Costa Rica's PSA program has only reduced deforestation by about 1 percent.

Grieg-Gran (2006) calculated administrative costs of REDD programs based on 8 tropical countries that would range from \$4/ha to \$15/ha converted to just \$0.01-0.03/tCO2 using Houghton's (2007) carbon density values (see Table 3). Pagiola and Bosquet (2009) claimed that administrative costs should belong to implementation and transaction cost. In compliance with this view, Boucher (2008) stated that these costs would create the so-called double-counting if they added to them.

Pertaining to the implementation of administrative cost at the large-scale projects under government-financed schemes, these costs were limited by the law at 4 percent (in Mexico) and at 7 percent (in Costa Rica) of their respective budget (Wunder et al., 2008). In parallel with this view, Pagiola (2008) alleged that administrative costs are slightly under-estimated since some of the transaction costs were covered outside the legally designated agencies. For example, in Costa Rica private transaction costs are reported to be in the range 12-18 percent of the environmental service payments (Wunscher et al., 2008).

Da Fonseca et al. (2007) recognized the issue of stabilizing the large amounts of forest carbon in high-forest-cover-low-deforestation (HFLD) countries such as Suriname, Gabon, and Belize. They believe that these countries have low potential of RED credits and reforestation payment under CDM schemes. Boucher (2008) highlighted this issue with the danger of international leakage where other drivers of deforestation could simply move from countries with REDD programs to those with HFLD if these nations have no incentive for keeping emissions low. Nevertheless, in a view of getting strong stabilization plan, it would cost \$1.8 billion annually for the 11 HFLD countries (Da Fonseca et al., 2007).

Meanwhile, Strassburg *et al* (2008) developed a mix of incentives which would compensate both HFLD countries and REDD countries to curb their emissions from deforestation while including important guaranties to the financing community. Boucher (2008) took a view with this matter where this incentive does not require any separate funding for stabilization and is financially attractive for countries with wide range of deforestation rates. The results showed that an incentive of $5.63/tCO2eq for the 20 most forested developing countries could reduce 90% of global deforestation and could lessen their emission at an aggregate level of 94.5%. However, Boucher (2008) pointed out that stabilization costs could lead to the double-counting problem and it cannot be directly converted to $/tCO2eq since they are only maintain low emission rates, instead of emissions reductions.

3. Issues Related to Costs of REDD

It is widely recognized that there is increasing in marginal costs of REDD (Boucher, 2008). In other words, the further advanced along the REDD supply curve, the more has to be paid for one additional unit of REDD until no more reductions can be made. This implies that reducing emissions from deforestation and forest degradation to nearly zero requires far higher costs than would be needed when those emission reductions can be achieved at lower costs. It has been argued that REDD costs will be significantly lower if almost all emissions are abated, but not all of them. Nepstad et al. (2007 cited in Boucher, 2008) found that 1.49 US$/tCO2 would have to be paid to abate 100% of emissions versus 0.76 US$/tCO2 to abate 94 per cent of emissions.

The costs of REDD depends on the ultimate payment design. Borner and Wunder (2008), for example, showed that uniform payments increase the total costs of REDD by about 4 (from US$ 680 to US$ 2,745 million) and by nearly 2.5 (from US$ 143 to US$ 363 million) respectively in the Brazilian States of Mato Grosso and Amazonas for reducing total deforestation. Uniform payments predominate in current national PES schemes as they are easier to implement, while differentiation payments predominate in private sector PES schemes worldwide (Wunder *et al*, 2008). Because alternative payment schemes have different cost implications, and provided differentiated landowner payments are considered feasible in REDD schemes, it could be useful to stake out cost benefit analyses of alternative REDD payment schemes (Wertz-Kanounnikoff, 2008).

REDD is potentially a low-cost option for mitigating climate change and is depend on carbon price (Stern, 2006). If forest carbon credits are included in global emissions trading, the estimated cost of halving net global carbon dioxide emissions from forests by 2030 is USD 17-33 billion annually (Eliasch, 2008). In addition, Tavoni et al. (2007) estimated that global implementation of REDD and changes in forest management would delay deployment of some technologies and reduce investment in energy research and development by about 10%, for a fixed emissions reduction target. In parallel with this view, Anger and Sathaye (2006) found that a 40% carbon price reduction from introducing REDD into a market allows unlimited credits for developing country mitigation through CDM.

According to Eliasch (2008), introducing REDD credits along with modest quantitative limitations on REDD has a negligible estimated effect on the European Union's carbon price, even if countries can satisfy 50-85% shares of their abatement through international credits, depending on the stringency of the European Union target.. Meanwhile, Piris-Cabezas and Keohane (2008) estimated a global REDD programme would lower the global carbon price by 14%, while using all forestry mitigation options would reduce the price by 31%, for a fixed emissions reductions target.

Carbon leakage is a similar off-site effect and is a fundamentally economic process in REDD (Angelsen, 2008). Therefore, there is little reason to believe that REDD projects should have higher leakage. In the proponent view, Sathaye and Andrasko (2007) concluded that avoided deforestation has a much wider range of leakage in analyses up to date (0-92%), and appears to increase as the region of analyses is expanded. While Wu (2000 cited in Angelsen, 2008) found that leakage effects in the U.S. Conservation Reserve Program's land-retirement programme were around 20%.

In contrary, Da Fonseca et al. (2007) argued that international REDD leakage into HFLD countries may occur if these countries do not receive moderate preventive incentives to protect their large forest stocks. In addition, Gan and McCarl (2007) predicted international leakage as high as 42-95% in the forestry products industry due to inconsistent incentives for REDD across countries.

An effective REDD mechanism must provide continuous incentives for landowners to monitor and maintain their forestlands (Angelsen, 2008). Without mitigation from forestry, the world is unlikely to get the emissions reductions at the maximum target of 2 degree Celsius (Stern, 2006). Thus, before REDD countries accept full liability for reductions achieved, the risks need to be securitized.

Two well-known options for securitizing permanence in terrestrial carbon management are the following: Firstly, the so-called ton-year-approach that was discussed in IPCC (Watson et al., 2000). It departed from the ideas that the present value of mitigation is higher today than the same mitigation effect tomorrow and there is a limited residence time of CO2 in the atmosphere.

Lastly, shared liability or forest compliance partnership (FCP) which is a proposal for managing national-level liability under land use accounting between developed countries and developing countries (Dutschke and Wolf 2007). Under this scheme, developed countries would bear a negotiated share of the liability for the permanence of REDD credits once they are certified. The FCP suggests that a developed country receives preferential access to REDD credits for compliance if it shares the liability.

However, Angelsen (2008) analyzed that the latter option would give additional incentives to build capacity in REDD. In the case of efficiency, it will make REDD insurable as political risk minimized. Moreover, in terms of equity, this option may contribute to foster investment in high-risk countries. On the other hand, Angelsen (2008) criticized that the former option has limited incentives and tends to avoid a clear allocation of liability. In terms of efficiency, it leads to heavy discounts in credits that cause cash-flow problem for adopted countries. Furthermore, this option excludes poorer countries due to high financing costs.

4. Conclusion

This paper reveals that various approaches to estimate REDD opportunity costs and other costs exist. The suitability of these approaches depends on the objective of the analysis. One striking observation is that the cost of REDD differs substantially across model approaches in which global simulation models gain much higher REDD prices than empirical models, including the Stern estimate.

This means that global simulation models not only consider the opportunity costs, but also the costs arising from interrelations with other sectors. Furthermore, land users are likely to be paid a uniform price, instead of differentiated price based on their opportunity costs. However, global models can be criticized for their use of aggregated data and other simplifications where the true cost estimate lies in between the values provided by the local-empirical models and global simulation models. Regarding on the other costs, adding implementation, administration, stabilization costs into transaction costs could potentially lead to double-counting problem.

In order to develop REDD program, countries must analyze the cost accurately. Overestimating the costs of providing emissions reductions would make REDD less attractive and thus, would lower the benefit of reducing deforestation. In contrast, underestimating the costs of providing emissions reductions would make REDD more attractive and would improve the benefit of avoiding deforestation.

If we concern to curb climate change and limit the rise in global temperature to no more that 2ºC, then REDD in developing countries should be a pioneer in the next global climate regime. In addition, REDD is clearly an inexpensive option compared to reducing emissions in the energy sectors of industrialized countries. As a note, the costs per ton of reducing current carbon dioxide emissions from deforestation by half, even with including not only opportunity costs but also the additional implementation, transaction, administration and stabilization costs of REDD, are less than a third of current carbon market prices.

To sum up, REDD has a potential to generate substantial benefits in addition to the reduction of greenhouse gas emissions. These include positive impacts on biodiversity and sustainability development, including poverty reduction and strengthening indigenous people rights. However, countries should manage issues such as carbon price, carbon leakage, liability of REDD, emission abatement, payment designs, and transaction costs that could deter widespread adoption of REDD.

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