

## *The Long-Term Requirement for Clean Development Mechanism Forestry and Economic Liability*

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*The Clean Development Mechanism (CDM) of the Kyoto Protocol allows developed countries to gain greenhouse gas emission reduction credits by sponsoring projects in developing countries. The CDM requires such credits to be granted only to projects that produce long-term benefits to climate change. However, countries that host CDM projects may be reluctant to engage in long-term projects for fear of sacrificing national sovereignty, a concern particularly acute in land-use efforts such as forest conservation. One solution is to use economic liability in CDM contracts, delaying payments to parties to encourage long-term contracting. We evaluate CDM-sponsored forest conservation using several types of economic liability schemes. We find that seller liability has intrinsic advantages over other types of liability contracts. We then propose a modified seller liability contract for CDM forestry that is more profitable to host countries than is pure seller liability, while still providing sufficient long-term incentives.*

**T**he Clean Development Mechanism (CDM) is an instrument of international cooperation within the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC, 1997). The primary purpose of the CDM is to assist developing countries, called Non-Annex-1 countries in the protocol, to achieve sustainable development while stabilizing greenhouse gas concentrations in the atmosphere. The CDM's second purpose is to assist industrialized countries (Annex 1 countries) achieve the emission reduction commitments that they agreed to under the terms of the protocol. Under the CDM, Annex 1 parties may fund emission reduction projects in amenable Non-Annex-1 countries and get credit for Certified Emission Reductions (CERs) from these projects. These CERs can then be used to meet the commitments of the Annex 1 countries. Due to the "flexible" nature of CDM, most CERs will probably cost less than domestic Annex 1 reductions. As such, these CERs will likely lower the cost of meeting the Kyoto Protocol's target reductions.

A major field of application for the CDM is tropical forest conservation. Tropical deforestation causes approximately 20% to 30% of worldwide greenhouse gas (GHG) emissions (Brown, Sathaye, Cannell, &

Kauppi, 1996; Houghton, 1999). Stopping or slowing the rate of deforestation compared to a business-as-usual scenario will reduce emissions of GHGs into the atmosphere. In this regard, forest conservation is quite different from forestry sequestration activities (such as replanting) that increase the uptake of carbon from the atmosphere.<sup>1</sup> Due to the relatively low cost of forest conservation and reforestation in the tropics (Halsnaes et al., 1996), CDM forestry is a topic of considerable debate.<sup>2</sup> Other probable applications of the CDM will be in areas of energy efficiency, power-plant upgrades, transportation projects, and other activities that verifiably reduce GHG emissions.

One of the unique legal stipulations of the CDM is that emission reduction projects must achieve "real, measurable and long-term environmental benefits" if they are to be credited (and therefore be valuable). A few problems arise out of this "long-term" requirement that are unique to land-use projects. First, host countries may be reluctant to commit to forest protection for long periods of time. A developing country might want to leave its land use options open to accommodate future changes in its national development priorities or to be able to respond to changes in commodity prices, land tenure, or social conditions. A second problem is that a forest protected one year (over a baseline scenario) may easily be degraded the following year. Consequently, emission reductions in land use programs may be more transitory than emission reductions in technology-based programs. Long-term forest protection is particularly at risk if the CERs and the host-country payments are granted early in a project. In this case, neither party has a substantial interest in sustained forest protection because credits and payments would already have been collected. These concerns and others have led some people to suggest that the CDM should not allow forest conservation as a project type, or at least the CERs generated by forest protection should be discounted. Yet the CDM, if it leads to real and lasting increased tropical forest conservation, could be a powerful new way to finance sustainable development. Investors from wealthy countries would be teamed up with developing countries that want to conserve their natural resources but are unable to give up the income associated with logging or agriculture (Kremen et al., 2000). Because the Kyoto Protocol requires that CERs be real, additional, and independently

1. Although both source prevention (i.e., stopping deforestation) and sink enhancement (growing new forests or increasing the biomass of existing forests) achieve the same net result on the balance of GHGs, we discuss only source prevention. We do this in part due to the language of Article 12 of the protocol ("certified emission reductions") as well as to avoid the ethical issue of Annex 1 countries buying entitlements to pollute by growing large plantations in developing countries.

2. In addition to the accounting-based issues discussed here, there are considerable ethical and legal issues that are discussed elsewhere (see Brown & Kete, 1998; Cullet & Kamari-Mbote, 1998; Goldberg, 1998; Mulongoy, Smith, Alirol, & Witthoft-Muehlmann, 1998; Niles & Schwarze, in press; Vine & Sathaye, 1997).

monitored, this will in essence make actual on-the-ground forest conservation profitable. This is a dramatically different approach to traditional aid-based financing that does not explicitly tie financing to measured results. Perhaps this is the reason that despite more than 100 international efforts and agreements, tropical forests continue to be lost at the tragic rate of 15 million hectares per year (Food and Agriculture Organization, 1999).

There are other benefits to conserving tropical forests as well. In terms of mitigating climate change, forest protection not only prevents GHG emissions, but it also maintains a land surface at the equator with a stabilizing impact on many climate parameters (Niles & Schwarze, *in press*). Additionally, vast amounts of endangered biological and cultural diversity are located in tropical forests.

Thus, an important challenge facing parties that want to stall climate change is how to design contracts within the Kyoto Protocol to reward long-term tropical forest protection.<sup>3</sup> If specific accounting and macroeconomic tools can be developed that foster long-term forest conservation, the CDM could emerge as a potentially powerful new way to finance sustainable development. These contracts would be paid for by wealthy countries and carried out in poorer countries that want economic assistance to safeguard forests that would otherwise be degraded.

#### LEGAL LIABILITY

One solution is to allow the courts or other legal channels to decide the consequences of contract failure. If a CDM project to protect a forest fails after a short period, one party could sue the other, invoke trade sanctions, or pursue other legal remedies to either force compliance or collect a fine. Legal liability and sanctions, however, are difficult to implement in global environmental regulation (Wiener, 1999). Additionally, legal liability imposes some measure of lost decision making at the national level and could create some land-tenure uncertainty in general. Some developing countries have pointed out that courts or other multilateral institutions could try to force adherence to a CDM contract. Although this infringement on national decision making is applicable to all CDM project types, the problem is potentially more acute in land use. Thus, although both a host country and a donor country must agree to start conserving a forest under the auspices of the CDM, they may object to a legal framework to force long-term contracting. Moreover,

3. The problem of achieving lasting emission reductions from CDM projects is actually not a specific problem of CDM forestry but applies to other mitigation activities as well (e.g., energy efficiency projects). The reasoning in this article could be easily generalized to these other cases if the long-term requirement of Article 12 of the Kyoto Protocol is interpreted in the same way it is in this article, that is, as a minimum period of contract duration.

international legal liability could cause high litigation and other transaction costs.

#### ECONOMIC LIABILITY

Another way to encourage long-term conservation is to delay the payments to either the host or the sponsor country. By having its benefits withheld until long-term protection has been achieved, a party has an economic incentive to sustain forest conservation. We refer to this procedure as assigning *economic liability*, which is the focus of this article.<sup>4</sup> Economic liability encourages long-term participation but does not demand it legally. If one of the parties in a contract wants to disengage from a CDM project, it can look at what was being withheld from it and what it can gain by breaking the contract; it can then determine which is better. In this regard, economic liability makes the consequences of a broken or failed contract clear and transparent. Under economic liability, for example, host countries can change their development priorities (e.g., by selling logging rights to a forest they had previously placed under CDM conservation). In doing so they will not face any legal challenges to their decision. What they will give up is the portion of the proceeds that they were to receive had they kept their forest in long-term protection.

Economic liability conceptually resembles an assurance bonding system, which has been discussed as a flexible tool to enforce environmental liability (Constanza & Perrings, 1990; Perrings, 1989) and labor contracts (Akerlof & Katz, 1989; Becker & Stigler, 1974).<sup>5</sup> In contrast to this general principal-agent literature, this article is concerned with a specific enforcement problem, that is, contract duration, in the legal setting of Article 12 (the article that defines the CDM) of the Kyoto Protocol. Under the CDM, two questions must be answered before economic liability can be used. First, who is held responsible (liable) for an emission reduction contract? Second, when should the benefits from the contract be disbursed to the different parties? This article examines these two issues through a series of discussions, examples, and analyses.

We begin in the following section by discussing the question of how long should "long-term" be for climate change mitigation projects? From a variety of perspectives, we conclude that a 30-year to 50-year time frame is reasonable. Next, we introduce and define three basic types of contracts that can foster sustained emission reductions, that is, buyer liability, seller liability, and double liability. We then develop a

4. Most of our results also apply to an accounting procedure based on certification. Certification rules, however, are less suitable as an incentive scheme compared to crediting rules because, unlike crediting rules, they cannot be easily disintegrated to have a piecemeal approach.

5. We are grateful for an anonymous referee of this journal who made us aware of this pertinent stream of literature.

hypothetical model forest conservation project undertaken under the auspices of the CDM that uses these different liability schemes. In the next section, we show that one type of economic liability (seller liability) has a fundamental efficiency advantage over other types of liability. We explain how this is caused by the “no borrowing” provision of the protocol and by the fact that only certain countries agreed to specific emission reduction targets. In the subsequent section, we propose a hybrid type of seller liability that we call a forest-secured escrow account. This contract type increases the internal rate of return to potential sellers without unduly diluting the incentive to maintain long-term forest conservation. The final section summarizes our results and discusses the implications of applying an escrow account, or any form of economic seller liability, to enforce the long-term requirement of the CDM.

### *The Long-Term Requirement of the CDM*

How long should “long-term” be in the case of CDM forestry projects? Article 12 (4) of the protocol only states that emission reductions under the CDM “shall be certified on the basis of real, measurable and long-term benefits to the mitigation of climate change.” The protocol does not provide any further guidance on what is meant by long-term—but it does clearly require that emission reduction projects must have some long-term assurance. Thus, it seems unlikely that year-to-year CDM projects will be certifiable, because they fail the durability litmus test. It is also possible that long-term contracts will be intrinsically more efficient because individual year-by-year contracts would probably have relatively higher transaction costs.

But what exactly does long-term mean? Does the CDM’s long-term requirement imply permanence? As discussed in the introduction, permanent conservation could be unacceptable to potential CDM host countries. The permanent protection of a forest could be perceived by developing countries as a de-facto expropriation, or at least a forfeiture of control. Several key developing countries such as Brazil have expressed exactly this objection to the CDM, arguing it would limit their ability to make domestic decisions domestically (Ministério da Ciência e Tecnologia, 1999).

From a scientific point of view, long-term could be logically interpreted to suggest a project should endure the minimum time that it takes for a GHG emission to decay in the atmosphere, for example, 50 to 200 years for carbon dioxide (Intergovernmental Panel on Climate Change [IPCC], 1994). Whereas delaying emissions would be financially advantageous for Annex 1 countries (because they can use CERs to offset their

duty to reduce emissions domestically), postponed emissions will not necessarily help stabilize atmospheric greenhouse gas concentrations.

Less than permanence, however, could be sufficient if we approach this question of duration from a sociopolitical point of view. If GHG emissions are reduced for a period of time while alternative abatement strategies become widespread, delayed emissions will provide an important bridge to future atmospheric GHG stabilization. In this sense, the long-term requirement is justified and defined by the expectation that structural changes in the world economy and technology will arise at a later date. These changes could be the emergence of new technologies or an increased valuation of forests outside of their role in climate change mitigation. Widespread adoption of low-carbon technologies such as solar or wind power will be cheaper in the coming decades (see Wigley, Richels, & Edmonds, 1996). Thus, even semipermanent reductions now will help the transition into more lasting reductions later. Alternatively, the value of tropical forests may rise in the future such that deforestation is no longer an economically attractive activity. This increase could either be in the form of domestic values (e.g., watershed protection) or external values (e.g., biotechnology companies paying higher amounts for natural genetic biodiversity). Thus, forest conservation under the CDM could help stall global warming by delaying emissions until the incentive to deforest is lost or low carbon technologies develop and become widely adopted.

Another way to establish the minimum amount of time for the long-term requirement is to consider the precedent that was established in the pilot phase of Activities Implemented Jointly (AIJ; see UNFCCC, 1995). Both AIJ and the CDM mandated "real, measurable and long term environmental benefits." According to our study, the average duration of AIJ forestry projects is 39 years with a median duration of 32.5 years.

Together, these arguments suggest that a minimum period of 30 to 50 years would be a practical period of time for the CDM's long-term requirement. To summarize, this suggestion is based on the minimum amount of time for carbon dioxide to begin decaying in the atmosphere, the expectation that new technologies will become cost effective in a few decades, and on the precedent that was established under AIJ, which also required long-term benefits for climate change.

### *Basic Types of Economic Liability Contracts*

We can think of a CDM-project as having four distinct contractual procedures (see Figure 1).

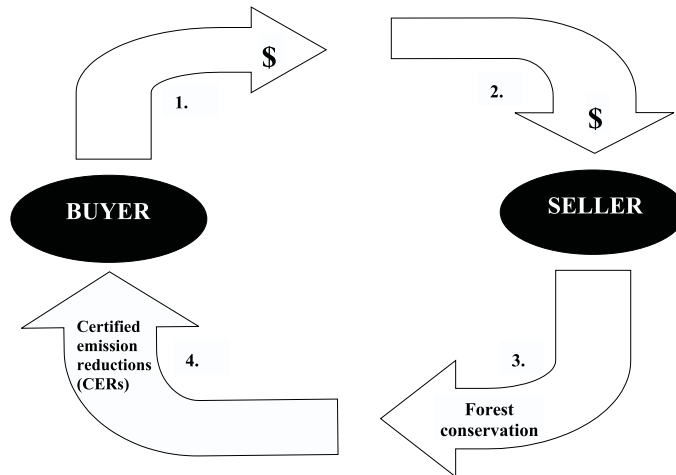


Figure 1: CDM Contractual Procedures

1. The donor country (*buyer*) funds a project according to some specified payment schedule.
2. The host country (*seller*) receives payments from the fund established for this purpose according to a specified schedule.
3. In exchange for this payment, the host increases forest conservation over a baseline rate, thus preventing the emission of greenhouse gases.
4. The donor country is credited for these emission reductions in the form of CERs.

For the purpose of establishing economic liability, any of these contractual procedures can be decoupled from one another and tied to a stipulation. For example, any of these four actions can be explicitly tied to long-term forest conservation, mandating that the procedure only happen once sustained protection is verified. From these contractual procedures then, we can distinguish four contract types to assign liability (see Table 1).

A *service contract* credits the host and the donor continuously. This “pay-as-you-go” scheme does not impose any kind of economic liability. In fact, under such a scheme, a long-term contract is separated into a sequence of single service contracts, each in the amount of annually reduced emissions. All other contracts impose some kind of economic liability to one or both of the parties. Let us examine each of these contract types (or schemes) in more detail with particular consideration for CDM forest-conservation.

**Table 1**  
**Basic Contract Types**

<i>Host</i>	<i>Donor</i>	
	<i>Continuous Crediting</i>	<i>Terminal Crediting</i>
Continuous crediting	No liability (service contract)	Buyer liability
Terminal crediting	Seller liability	Double liability

*Buyer liability* is when the buyer of emission reductions, in this case a developed Annex 1 country, does not receive CERs until the end of the long-term period. In other words, buyer liability uncouples the donor's payment to the host from the donor's receipt of CERs (see Figure 1). Because of discounting and a decreasing value of money with time, payments that are delayed reduce the net present value of the emission reductions being organized. Under buyer liability, this decrease in value is born solely by the purchaser of emission reductions (i.e., the buyer). Meanwhile, under buyer liability, the seller of the credits (the host country) receives its payment for forest conservation without delay. Because it is paid as forest conservation ensues, the host country realizes the full, undiscounted value of its potential gain.

*Seller liability* is the mirror image of buyer liability. Here, the seller of emission reductions, a developing Non-Annex-1 host country, is not compensated for forest conservation until the long-term requirement is satisfied, for example, 30 to 50 years. Under seller liability, payments to a host country for sponsoring forest conservation are withheld even while actual forest conservation is increasing in an area. Again, because of discounting, seller liability reduces the value of the payments for forest conservation to the host country. Because the income from the donor is not immediately accessible by the host, a fund arises that would need managing. Presumably this fund would be managed by a third party, possibly the Global Environmental Facility (GEF) at the World Bank or some other body appointed by the CDM's executive board.

*Double liability* is an odd form of holding both parties responsible until the contract is fully performed. It foresees a continuous funding of tropical forestry by the donor and a continuous effort by the host to preserve forests. However, both countries are only rewarded for their efforts after the project is completed. Double liability, because it imposes high costs on both parties, will tend to lower the value of the CDM-sponsored forest conservation so that, in practice, very little forest conservation would occur. As such, it is not discussed in detail in this article.

To illustrate important differences between liability contract types, we constructed a hypothetical model of a CDM forest preservation project. In this example, we envision a forest conservation project that is

sponsored by a CER buyer (an Annex 1 country) and hosted by a seller (a Non-Annex-1 country). The buyer of the emission reductions pays the seller U.S. \$30 per ton of carbon (tC) for each of the 150tC per hectare (ha) that are prevented from entering the atmosphere each year via forest conservation. We used the following assumptions:

- Project area: 30 ha.
- Baseline deforestation: 1ha/yr.
- Deforestation rate under the CDM project: 0 ha/yr.
- Project period: 30 yr.
- Carbon stock: 150 tC/ha.
- Market price paid for carbon reductions in the project: U.S. \$30/tC.
- Donor's opportunity cost (i.e., the cost of domestic mitigation): U.S. \$50/tC.
- Host's opportunity cost (i.e., revenue foregone if the forest is conserved): U.S. \$1,500/ha = U.S. \$10/tC.
- Discount rate: 3%.

We used these values because we think they are roughly representative of actual costs and benefits possible under CDM forest conservation. We also purposefully pegged the market price of carbon (U.S. \$30/tC) half way between the seller's opportunity cost of carbon (U.S. \$10/tC) and the cost of the buyer's domestic compliance (U.S. \$50/tC). We selected these values to highlight structural asymmetries between the liability schedules. For example, the host country will receive U.S. \$20 more per ton of carbon if it chooses to place its forest in protection instead of exploiting the land and collecting the opportunity cost (U.S. \$30/tC – U.S. \$10/tC). The sponsoring country also stands to gain U.S. \$20 for every ton of carbon it prevents from entering the atmosphere under the project because it is paying U.S. \$30/tC instead of the next cheapest form of mitigation of U.S. \$50/tC. Given that the two parties both stand to gain U.S. \$20/tC from a CDM project, we eliminate any variation in the value of different contracts that derives solely from different potential gains used in our model.

To evaluate how different liability schemes affect the overall value of the contract, we employed two equations. First, we estimated the net present value (NPV) of the opportunity costs faced by both potential parties. A net present value is simply the discounted sum of future costs or benefits. For the host, this value was calculated as the lost income from the forest if it were not exploited commercially (U.S. \$10/tC). For the buyer, this value is calculated from the discounted stream of costs it would face reducing emissions domestically (U.S. \$50/tC).

The second equation used was the total economic value (TEV) of the project, calculated as the difference between the two parties' opportunity costs. This difference is actually the net potential gain by the world from international trade in emission reductions. A higher TEV signifies a

more efficient (and therefore more profitable) contract, whereas a lower TEV indicates that some of the efficiency achievable by world trade is compromised by a particular contract type. Based on these assumptions, we estimate the total economic value (TEV) of this project as U.S. \$117,962. This was calculated as the difference of the NPV of opportunity costs to the donor (U.S. \$147,003) and to the host (U.S. \$29,041). This can be thought of as the maximum potential of a contract to both parties given that no benefits are withheld. Naturally, for the host to agree to any project, it must be compensated at a value greater than the current opportunity cost of the land. In our example, the host country is paid three times the opportunity cost of the land (U.S. \$4,500 per hectare of forest conserved vs. U.S. \$1,500/ha if exploited).

The value of the contract to the parties depends on the specification of the liability rule as specified in Table 2. A spread sheet for our model that shows our calculations is provided in the Appendix.

From Table 2 we see that economic liability lowers the value of the project to any party that has its benefits withheld. With double liability, both the buyer and the seller of the emission reduction credits have their net present values diminished compared to a no-liability contract. In the case of seller liability, the seller's NPV is reduced from U.S. \$58,801 to U.S. \$24,598. Because the buyer's benefits are not withheld under a seller liability contract, its net present value is unchanged at U.S. \$58,801. Under buyer-seller liability, the buyer's NPV is reduced from U.S. \$58,801 with no liability to U.S. \$1,795. Again, the seller's NPV under buyer liability remains unchanged. Given that we had constructed our example with equal potential gain for the two parties (i.e., both parties will benefit by U.S. \$20/tC under the project), the difference between buyer and seller liability may come as a surprise. However, this is only on first sight. Under buyer liability, a buyer incurs a higher annual cost (U.S. \$30/tC) in the withholding period than a seller would (U.S. \$10/tC) under seller liability. This higher cost carries a higher weight as a stream of negative income for the purpose of present value calculation, resulting in the observed difference in efficiencies for the two contract types.

### *The Efficiency Advantage of Seller Liability*

The efficiency of liability regimes has been analyzed in the law and economics literature. This literature is concerned with regimes of legal liability, that is, legal sanctions attached to some kind of contract failure or general misbehavior. In the context of contract law (or legal liability), a general result is that seller and buyer liability have identical efficiency

**Table 2**  
**Net Present Values (NPV) of Contract Net Benefits (in U.S. \$)**

<i>Liability Type</i>	<i>Host's NPV</i>	<i>Seller's NPV</i>	<i>Total NPV</i>
None	58,801	58,801	117,602
Seller	24,598	58,801	83,399
Buyer	58,801	1,795	60,596
Double	24,598	1,795	26,393

properties in a world without transaction cost (see Polinsky, 1989). A different result arises in economic liability under the CDM. The withholding of contract benefits is different from legal liability for contract failure because it actually interrupts the contract in the withholding period. By contrast, legal liability does not interrupt contract performance but only penalizes contract failures *ex post*.

One way to see how this interruption of benefits differentially impacts the efficiency of the liability types is to compare the TEV of the various contracting schemes to the economy as a whole. As discussed previously, the TEV is the present value of the difference of opportunity cost to the host and to the donor, and in our example, it amounts to U.S. \$117,962. The PV of net contract benefits in the case of seller liability is only 71% of the TEV of a contract with no liability, or U.S. \$83,399 (U.S. \$24,598 + U.S. \$58,801). Under seller liability, there is a loss of contract value to the seller, expressed in a lower PV of contracting (U.S. \$24,598) compared to the no-liability regime (U.S. \$58,801). However, this financial loss is exactly made up by gains of the fund where the money is held (U.S. \$34,204). Thus, the TEV to the economy as a whole is U.S. \$117,962 (\$58,801 + \$24,598 + \$34,204), which implies there is no economic loss incurred due to economic seller liability. In the case of buyer liability, this TEV is reduced to 51% of the possible TEV, or U.S. \$60,596, as a result of the low economic value of the contract to the buyer (U.S. \$1,795) and no equivalent fund to make up the difference, as in the case of seller liability. Double liability results in only 22% (U.S. \$26,393) of the contract potential being realized.

This asymmetry of economic seller versus economic buyer liability essentially arises from the particular legal setting of the CDM. The CDM does not allow Annex 1 I countries to use future emission reductions to offset the commitments they agreed to meet in the years 2008 through 2012. This provision is commonly referred to as *no borrowing*. In the case of buyer liability, the buyer still has to fulfill its Kyoto commitments, that is, to reduce its emissions domestically. This comes at a higher cost than buying this service from the seller. Thus, a liable buyer of CERs has to

fulfill its actual duties during the withholding period by other means, for example, domestic abatement.<sup>6</sup> This missing time flexibility of the CDM limits the efficiency of the place flexibility. The no-borrowing rule, combined with the fact that only buyer's have undertaken commitments to reduce their emissions, results in a net economic loss under buyer liability that does not arise with seller liability.

There is no economic loss under seller liability because withholding the income from a host country (for agreeing to protect its forest) does not force the host country to go out and buy alternate credits. Remember, under the Kyoto Protocol, only Annex 1 countries (the buyers in any CDM transaction) agreed to reduce their emissions or pay for reductions elsewhere. Of course, the seller is worse off in the withholding period compared to a no-liability or a buyer-liability scheme. However, as noted previously, the financial loss to the seller is exactly compensated by the accrual of interest in the fund held by a third party. Thus, there is no loss incurred under seller liability to the economy as a whole. Consequently, our results indicate an intrinsic difference in the efficiency of seller versus buyer liability for the CDM. Differences in transaction costs and other differences between these two systems could override the asymmetry described here. Nonetheless, it is interesting to note this a-priori advantage for seller liability compared to buyer liability in the CDM's no-borrowing setting.

### *The CDM Forest-Secured Escrow Account*

So far, we have discussed only pure types of liability contracts to establish some general properties. As we discovered, seller liability appears to have an intrinsic advantage over buyer liability. Given this, however, it should be apparent that sellers under seller liability still stand to receive less money than they would if there were no liability. Withholding benefits to the seller to encourage long-term protection results in the seller realizing a lower present value. In some cases, this lower value may deter potential hosts from conserving their forests, because they will make less money. There is, however, an interesting "impure" type of seller liability that increases the present value and the internal rate of return of contracting to the seller, making CDM forest protection more profitable. We refer to this idea as a *forest-secured escrow*

6. At some future date, when the long-term requirement is satisfied and the credits for the emission reductions are validated and transferred to the Annex 1 buyer, it will be able to use these credits. Thus, the Kyoto Protocol's no-borrowing principle would not necessarily negate any CDM-sponsored forest conservation even under buyer liability.

*account.* This scheme resembles escrow accounts used in the United States to enforce mortgage contracts. An escrow account is a special savings account required of a mortgagor to cover future costs such as real estate taxes, home insurance, or minor repairs. Escrow accounts secure the lender's investment, not the mortgagor's, because the mortgagor has to prepay into the escrow. The mortgagor still legally owns the principle and the interest in any escrow account. It is refunded to the mortgagor if he repays the loan or meets the conditions established to retrieve the escrow.

Under the CDM, a forest-secured escrow account could be established wherein the donor country establishes a savings account on behalf of the host country with the funds from the contract. Placing the money into an escrow would be done to secure continued protection of a forest. In the case of this proposed forest-secured escrow account, both the principle and the interest are a legal entitlement to the host. The principle would be handed over to the host country if after 30 to 50 years the forest is still standing. Practically speaking, satellite measurements and ground truthing could be used to verify the actual forest protection. Meanwhile, the interest from the escrow account would be distributed to the host on a continuous or semicontinuous basis. This would give the host some income during the project, an important consideration if developing countries are being asked to safeguard their forests for long periods of time.

Looking at the long-term incentives of a forest-secured escrow, one finds that it provides sound incentives for long-term contracting. A convenient way to do this is to analyze the time distribution of net benefits to contracting parties (see Figure 2).

The time distribution of contract benefits measures the percentage of accessible contract benefits at any point in time during the contract period. It is obviously different for service contracts (no liability) and economic liability contracts. In the case of a service contract, contract benefits are immediately accessible to both parties at any point in time. The donor is credited with CERs as it pays, and the host is credited this payment as it protects the forest. Using our model project outlined previously, 50% of the benefits of a 30-year contract would be accessible to both parties after 15 years of contract duration.

In the case of pure buyer or pure seller liability, all contract benefits are withheld from one party until the contract is completed. In our example, no contract benefits are accessible in the years 1 to 29 to the liable party or parties (in the case of double liability), and full crediting only occurs at the end of year 30. The forest-secured escrow account is a hybrid between no liability and pure seller liability. A major part of contract benefits—the principle—is withheld for 30 years. The interest, however, can be accessed as it accrues. Looking at Figure 2, the proportion of contract benefits available with a forest-secured escrow account

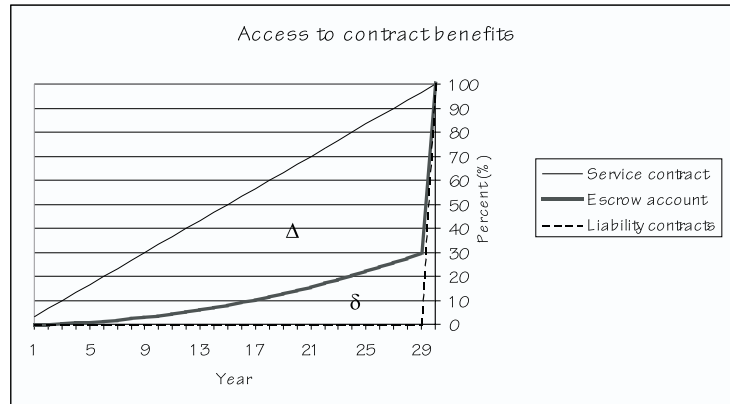


Figure 2: Time Distributions of Contract Benefits

during the project would be  $\delta/\Delta + \delta$ , or about 25% in our example.<sup>7</sup> This secures a significant incentive to ensure contract durability while making some of the proceeds available to the host country during the forest conservation project.

This forest-secured escrow account provides a higher internal rate of return to the seller (12% in our numerical example) compared to a pure seller liability (6% in our numerical example).<sup>8</sup> This higher rate of return would make the escrow account more acceptable to potential sellers than pure seller liability and would presumably lead to increased rates of forest conservation. (These calculations can be found in the last row of the Appendix.)

Although a forest-secured escrow account would make it more profitable to engage in CDM activity, it also establishes two independent economic incentives to sustain long-term forest conservation. On one hand, as a form of economic seller liability, the forest-secured escrow account withholds the principle payment from the host until obligations are fulfilled. On the other hand, the interest is increasing with time because the principle on which the interest is paid is increasing over time. So, even during the withholding period, contracting is more rewarding the longer it is sustained. Last, as a type of seller liability, the escrow system is efficient, and the awarding of some payments up front does not affect this property.

7. In our figure, this is the ratio of the area ( $\delta$ ), which is the cumulative income available in from the escrow account, to the total area ( $\delta + \Delta$ ), which is the cumulative income of a no-liability contract. This is an application of the Gini coefficient, a technique used to compare the equality of income distributions.

8. The internal rates of return (IRRs) for our numerical example of the economic liability contracts are given in the last row of the appendix.

### *Conclusion*

In this article, we showed that seller liability is economically more efficient than buyer liability. This asymmetry derives from the prohibition of borrowing and unequal commitments under the Kyoto Protocol. Then, we proposed a hybrid scheme of seller liability, an escrow account secured by long-term forest conservation. This hybrid accounting method would be more acceptable to potential CDM hosts than pure seller liability while still providing incentive for long-term forest conservation. Essentially, the escrow approach attempts to balance long-term assurances with short-term economic incentives that developing countries will need in order to agree to not exploit their forests. Other modifications of pure economic seller liability could be suitable as well. One example would be to release portions of the principle as a function of time.

Our findings so far have only discussed the efficiency of various contract types. Throughout our analysis, we have not considered issues of equity or fairness. On first sight, seller liability appears to harm potential host countries disproportionately. After all, given that most GHG emissions have been caused by the developed countries, why should developing countries agree to be held liable for an effort to reduce GHG emissions? We suggest that seller liability may give a developing country more control over its land than buyer liability.

Given that both a sponsor and a host country must agree to start a CDM forest conservation project, which form of liability would give the host country the most freedom to change its plans along the way? Buyer liability could result in arm twisting of a developing nation by a developed nation to adhere to the contract. If the developed country were held liable, it might engage in behind-the-scene maneuvers to make the developing country fulfill its contract. For example, if a developed country was liable for a project in a country that was receiving World Bank loans, it might try to tie the loans to the continuation of the contract. Another possibility would be that the developed country might threaten to withhold humanitarian aid or block private investments if a developing country was considering defaulting on the CDM contract.

Seller liability would not be as prone to such activities. Because the developing country would be the one liable, it would decide whether to stay in a contract based on the relative costs and benefits it perceives from the various choices. Because the buyer would be receiving its CERs, it would not be as likely to manipulate compliance by the developing country.

Another implication of seller liability is that it will give rise to a substantial worldwide fund being held and possibly supplemented to maintain long-term forest conservation. This will require an international body with experience and skills managing large international

funds and handling international projects. This body could be located at the GEF of the World Bank or under the guidance of the CDM executive board. It would act as a trustee comparable to the trustee holder of an escrow account or a trust fund. Moreover, it could act as a clearinghouse for bids and offers of CDM projects and generally guide interested parties in establishing CDM contracts.

This body may also have an opportunity to supplement the escrow account or another form of seller liability. For example, because a seller-liability system rewards long-term forest conservation at the expense of short-term gain realized by developing countries, incremental funding from the GEF could compensate host countries for the economic loss associated with seller liability (GEF, 1999). The GEF's goal is to reduce GHG emissions and maintain biodiversity by paying incremental costs associated with running a development activity sustainably versus unsustainably. GEF funds are typically leveraged with five times their amount in private investments. In these regards, paying costs (borne by developing countries) associated with seller liability to achieve long-term forest conservation seems an appropriate target for the GEF sponsorship. This supplement should be designed not to diminish the incentive for long-term contracting but rather to compensate developing countries for the costs associated with seller liability.

The fund manager could also serve as an authority to tax the proceeds of CDM activities in accordance with Article 12 (8) of the Kyoto Protocol. Article 12 (8) calls for developing countries particularly vulnerable to the adverse effects of climate change to be helped to meet the cost of adaptation to the change with a tax from CDM activities.

Last, a fund such as will arise under seller liability could potentially bridge the two divergent views on the institutional character of the CDM (Farhana, 1998). One view, shared by many Annex 1 countries, stresses a market-based CDM similar to the Activities Implemented Jointly pilot phase. In this view, the CDM would facilitate the monitoring, verification, and assignment of emission reductions, whereas the contracts and prices would be set by the parties. The other view emphasizes a multilateral character for the CDM as a fund fed by CER proceeds and proceeds from the adaptation tax of Article 12 (8) of the protocol. This feature is proposed by many developing countries and would be a more managed process where bids and contracts are actively facilitated by the CDM. A forest-secured escrow account, as well as a pure seller liability, would blend the two ideas on the nature of the CDM. As the manager of the seller-liability fund, the CDM would be a market-based institution watching over money from contracts that individual countries agree to jointly establish. At the same time, as a trustee holder of several accounts and with the ability to leverage additional monies or institute other procedures (such as subsidizing interest rates or facilitating risk hedging), a

seller-liability accounting system would have a multilateral face that involved managing and facilitating.

Although there are numerous disagreements and discussions about the ultimate shape of the CDM, we believe that a form of seller liability has some intrinsic advantages. Structuring the CDM in this manner may resolve other challenges, namely, how to encourage long-term emission reductions in an efficient and equitable manner, how to maximize the amount of early mitigation via the CDM, and what form the CDM's executive board should take. The resolution of its nature will impact climate change mitigation, tropical forest conservation, and the fair allocation of the costs and benefits of sustainable development.

*Manuscript submitted September 17, 1999; revised manuscript accepted for publication May 14, 2000.*

### *Acknowledgments*

Financial support from the Thyssen Foundation, the Morrison Institute for Population and Resource Studies, the Heinz Foundation, and the Stanford Center for Conservation Biology is gratefully acknowledged.

### **Appendix**

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In this appendix, we provide the computations for our example in the text. We computed separately for each party the present value of contract net benefits as benefits minus costs under different liability schemes (including no liability). To do this, we used the simple net present value formula,  $NPV = \text{Sum } (B_j - C_j) / (1 + r)^j$ .

In this formula,  $B$  stands for benefits,  $C$  for costs,  $r$  for the rate of discount and  $j$  for the length of the investment period. The total economic value of the contract to the society is calculated as the difference of the present value of opportunity cost to the donor and to the host, that is, U.S. \$147,003 minus U.S. \$29,401. These figures were calculated by applying the same NPV formula as for contract net benefits to the stream of annualized costs, that is, U.S. \$7,500 in the case of the buyer, and U.S. \$1,500 in the case of the seller, using the 3% discount rate. The internal rates of return figures were computed by setting the NPV formula effectively at zero and solving the equation for  $r$ , the discount rate, using Excel's procedure (explained in any Microsoft Excel assistant program).

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**Appendix [AU: PLS CONFIRM CORRECT APPENDIX]**

t	<i>Buyer</i>				<i>Seller</i>						
	OC	Pay go	<i>Net Benefits</i>		OC	Pay Go	Interest	<i>Net Benefits</i>			Fund
			Pay Go	Buyer Liability				Pay Go	Seller Liability	Escrow	
1	7500	-4500	3000	-4500	-1500	4500	0	3000	-1500	-1500	4500
2	7500	-4500	3000	-4500	-1500	4500	135	3000	-1500	-1365	4500
3	7500	-4500	3000	-4500	-1500	4500	270	3000	-1500	-1230	4500
4	7500	-4500	3000	-4500	-1500	4500	405	3000	-1500	-1095	4500
5	7500	-4500	3000	-4500	-1500	4500	540	3000	-1500	-960	4500
6	7500	-4500	3000	-4500	-1500	4500	675	3000	-1500	-825	4500
7	7500	-4500	3000	-4500	-1500	4500	810	3000	-1500	-690	4500
8	7500	-4500	3000	-4500	-1500	4500	945	3000	-1500	-555	4500
9	7500	-4500	3000	-4500	-1500	4500	1080	3000	-1500	-420	4500
10	7500	-4500	3000	-4500	-1500	4500	1215	3000	-1500	-285	4500
11	7500	-4500	3000	-4500	-1500	4500	1350	3000	-1500	-150	4500
12	7500	-4500	3000	-4500	-1500	4500	1485	3000	-1500	-15	4500
13	7500	-4500	3000	-4500	-1500	4500	1620	3000	-1500	120	4500
14	7500	-4500	3000	-4500	-1500	4500	1755	3000	-1500	255	4500
15	7500	-4500	3000	-4500	-1500	4500	1890	3000	-1500	390	4500
16	7500	-4500	3000	-4500	-1500	4500	2025	3000	-1500	525	4500
17	7500	-4500	3000	-4500	-1500	4500	2160	3000	-1500	660	4500
18	7500	-4500	3000	-4500	-1500	4500	2295	3000	-1500	795	4500
19	7500	-4500	3000	-4500	-1500	4500	2430	3000	-1500	930	4500
20	7500	-4500	3000	-4500	-1500	4500	2565	3000	-1500	1065	4500

*(continued)*

## Appendix Continued

t	Buyer				Seller						
	OC	Pay go	Net Benefits		OC	Pay Go	Interest	Net Benefits			Fund
			Pay Go	Buyer Liability				Pay Go	Seller Liability	Escrow	
21	7500	-4500	3000	-4500	-1500	4500	2700	3000	-1500	1200	4500
22	7500	-4500	3000	-4500	-1500	4500	2835	3000	-1500	1335	4500
23	7500	-4500	3000	-4500	-1500	4500	2970	3000	-1500	1470	4500
24	7500	-4500	3000	-4500	-1500	4500	3105	3000	-1500	1605	4500
25	7500	-4500	3000	-4500	-1500	4500	3240	3000	-1500	1740	4500
26	7500	-4500	3000	-4500	-1500	4500	3375	3000	-1500	1875	4500
27	7500	-4500	3000	-4500	-1500	4500	3510	3000	-1500	2010	4500
28	7500	-4500	3000	-4500	-1500	4500	3645	3000	-1500	2145	4500
29	7500	-4500	3000	-4500	-1500	4500	3780	3000	-1500	2280	4500
30	7500	-4500	3000	-4500	-1500	4500	3915	3000	-1500	2415	4500
31				225000			4050		135000	139050	-135000
Sum	225000	-135000	90000	90000	-45000	135000	62775	90000	90000	152775	0
NPV	147003	-88202	58801	1795	-29401	88202		58801	24598	58801	34204
IRR			infinite	3%				infinite	6%	12%	

Note: In this appendix, we provide the exact figures and their way of computation for our example in the text. We computed the present value of contract net benefits to the parties as benefits minus costs separately for each party under different liability schemes (including no liability) using the simple net present value formula  $NPV = \sum (B_j - C_j) / (1+r)^j$ . The total economic value of the contract to the society is calculated as the difference of the present value of opportunity cost to the donor and to the host, i.e. \$147,003 minus \$29,401. These figures were calculated by applying the same NPV formula as for contract net benefits to the stream of annualized costs, i.e. \$ 7500, in the case of the buyer, and \$1500, in the case of the seller, using the 3% discount rate. The IRR figures in Tab. 4 were computed by using the Excel procedure to set the NPV formula equal to  $3.6 \times 10^{-8}$ , which is effectively zero, and solving the equation for  $r$  with the given numbers of contract cost and benefits.

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