

Transaction and abatement costs of carbon-sink projects: An analysis based on Indonesian agroforestry systems¹

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ABSTRACT. The problem of global warming, together with the creation of the United Nations Framework Convention on Climate Change and associated institutions, has sparked intense interest and research in the energy and forestry sectors. Projects in the forestry sector, and land-use change and forestry projects (LUCF) more generally, have the potential to help mitigate global warming by acting as sinks for greenhouse gasses, particularly CO₂. However, concerns have been expressed that participation of LUCF projects in mitigation markets may be constrained by high costs. Of particular concern are the transaction costs incurred in measuring, certifying and selling the carbon-sequestration services generated by LUCF projects. This paper addresses these issues by reviewing the implications of transaction and abatement costs for integrating LUCF projects in carbon-sequestration markets. In addition, an approach to estimating the abatement costs of such projects is demonstrated through four case studies of agroforestry systems located in Sumatra, Indonesia.

Keywords: Global warming, carbon sequestration, abatement costs, transaction costs

1. Introduction

Concerns over global warming have led to proposals for the establishment of markets for greenhouse gas emissions. Although formal markets have not emerged, a number of international exchanges have occurred and a number of pilot projects have been designed. Tree-based systems are a convenient way of sequestering carbon from the atmosphere to reduce net emissions. Through the process of photosynthesis, trees absorb carbon dioxide (CO₂) which remains fixed in wood and other organic matter in forests for long periods. This is particularly relevant for tropical countries, such as Indonesia and Brazil, with large areas of rainforest as well as deforested degraded land.

The demand for climate mitigation will have to be met largely by the energy sector, the main emitter. However, land-use change and forestry (LUCF) projects may also have an important role to play, partly because of cost differentials with other forms of mitigation and partly

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because of asset fixity; since adopting new technologies for efficient use of fossil fuels may require scrapping existing infrastructure and require considerable capital investment.

Under the Clean Development Mechanism (CDM) of the Kyoto Protocol, greenhouse-gas emission offsets are measured in tonnes of CO₂ equivalents and are called “Certified Emission Reductions” (CERs). Different sources of supply of CERs, such as energy projects, large-scale forestry or small-scale agroforestry, will exhibit different abatement costs, expressed as costs per CER. They can be expected to differ also in the transaction costs of integrating them in a market. These include the costs of monitoring and certifying carbon sequestration rates and any other costs required to give investors confidence that the good they are purchasing actually exists. Additional transaction costs may occur at the market level, some borne by sellers and some by buyers.

In this paper, we focus on LUCF projects involving smallholder agroforestry or industrial plantations. Energy sector projects are not considered. Section 2 presents a brief overview of the use of biomass as a carbon sink and the potential of tropical countries like Indonesia to contribute to greenhouse gas (GHG) emission reductions. In section 3, a brief review of problems associated with accounting for carbon in sequestration projects is presented. In section 4, a simple economic model is used to explain the influence of abatement and transaction costs on landholders’ supply of CERs. Four case studies of agroforestry systems in Sumatra, Indonesia, are presented in Section 5 to illustrate how the abatement costs of landholders participating in the CER market can be estimated. Section 6 is concerned with the influence of transaction costs of landholders’ supply of CERs, and discusses a typology of such costs that can be used to structure their measurement. Strategies for reducing the transaction costs of carbon-sink projects in developing countries are considered in section 7. Section 8 summarises the paper and presents conclusions.

2. Biomass accumulation as a carbon sink

Biological mitigation of global warming can occur through three strategies: (i) conservation of existing carbon pools; (ii) augmenting CO₂ sequestration by increasing the size of existing pools; and (iii) increased dependence on sustainably-produced biological products (e.g., using wood instead of energy-intensive construction materials, or using biomass to replace energy production from fossil fuels). Options (i) and (ii) result in higher carbon stocks but can lead to higher carbon emissions in the future (e.g., through fires or land clearing for agriculture), whereas (iii) can continue indefinitely (McCarthy *et al.*, 2001).

The global potential of biological mitigation has been estimated at 100 Gt C (cumulative) by 2050, equivalent to about 10 to 20 per cent of projected fossil fuel emissions during that period (IPCC, 2001). The largest potential is in the subtropical and tropical regions, but realisation of this potential will depend on land and water availability and rates of adoption (Watson *et al.*, 2000; McCarthy *et al.*, 2001).

The large opportunities for biological mitigation in tropical countries cannot be considered in isolation of broader policies in forestry, agriculture and other sectors. Barriers to reaching the potential level of mitigation include: (i) lack of funding and human and institutional capacity to monitor and verify mitigation efforts and outcomes, (ii) food supply requirements, (iii) people subsisting from the natural forests, (iv) existing incentives for land clearing, (v) population pressure, and (vi) conversion of forests to pastures because of demand for meat (McCarthy *et al.*, 2001).

Afforestation and reforestation of degraded forests and wastelands offers attractive opportunities. However, the mitigative capacity – namely, the social, political and economic structures, and other conditions, required for effective mitigation – may be weak, and enough land and water may not be available (McCarthy *et al.*, 2001). Also, much of the land in the tropics is managed by semi-subsistence farmers and shifting cultivators, so their willingness to participate in biological mitigation projects may be an important factor (de Jong *et al.*, 2000). Since the CDM requires sustainable development (including poverty alleviation) goals to be met as well as sequestration goals, these types of land users (referred to below as smallholders) are likely to be an important focus of this mechanism. Nevertheless, projects must also be consistent with the sustainable development objectives of the host country. Hence, LUCF projects involving large plantations may still qualify under the CDM if the employment they generate for local people contributes towards the host country's sustainable development objectives.

Carbon sequestration services do not need to be transported in order to be sold, hence obstacles faced by smallholders in remote areas are lessened in carbon markets relative to markets for other commodities. Another attractive feature of carbon is that a molecule of carbon is the same independently of where it resides, so the problem often faced by smallholders in not being able to achieve the quality required by international markets in agricultural commodities (e.g., see Glover and Kusterer, 1990) does not apply here.

3. Accounting for carbon sequestration

Carbon sequestration in LUCF projects can be monitored using well-established sampling techniques (MacDicken, 1997). In order to receive certification and enter the CER market, however, a project will have to demonstrate that it is reducing net emissions compared with its absence. In other words, emission reductions must be additional to a business-as-usual scenario. Consequently, project proponents will have to estimate a baseline and demonstrate "additionality". Also, the project will have to account for possible "leakage" as well as the problem of "permanence". These various aspects of accounting for carbon sequestration are explained briefly below.

Additionality

Under the Kyoto Protocol, projects that qualify for credits have to satisfy the *additionality* requirement that "reductions in emissions must be additional to any that would occur in the absence of the project". This means that "sequestration projects, such as reforestation, qualify only if the project is not financially viable without CDM, or if CDM funding is required to overcome other barriers to implementation" (Smith *et al.*, 2000).

Additionality can be established by showing that reforestation would be less profitable than the land use systems it replaces, or by showing there are barriers to tree establishment. Adoption may be limited by lack of finance for establishment costs, access to planting materials, or lack of technical assistance and marketing infrastructure (Smith and Scherr, in press). Additionality could also be expressed in terms of higher risk than a conventional investment (Moura Costa *et al.* 2000). In order to establish additionality, it is necessary to establish a baseline. Only those emission offsets above the baseline will be eligible in the CER market.

Baselines

The baseline over the period of a proposed project could be static, if the project replaces a stable system such as a pasture, or dynamic, when expected trends on deforestation and land-use changes must be accounted for. In general, baselines should be easier to establish for reforestation and afforestation projects on degraded land, as opposed to forest protection projects that require assumptions about future rates of deforestation in the absence of the project. The baseline is an important area of uncertainty and may need to be revised as the project progresses.

Establishing baselines will require information such as pressures on the land and its resources, history of land use in the project area, soil types and topography, and socio-economic activities (Brown, 2001) and the likely evolution of these factors through time. Possible approaches to baseline estimation range from a case-by-case basis to a generic estimate based on sectoral and regional characteristics (Moura Costa *et al.*, 2000).

Permanence

The problem of permanence arises because LUCF projects tend to be temporary in nature, since CO₂ captured during forest growth is released upon harvest. In contrast, projects in the energy sector that reduce emissions are permanent, in the sense that an avoided emission will never reach the atmosphere.

The problem of permanence must be addressed before LUCF projects are acceptable in a CER market. Proponents of LUCF projects point to several advantages of temporary sequestration, such as (i) some proportion of temporary sequestration may prove permanent, (ii) deferring climate change has benefits, (iii) temporary sequestration ‘buys time’ while affordable energy technologies are developed, and (iv) temporary sequestration projects have value in saving time to gain information on the process of global warming (Lecocq and Chomitz, 2001). Many authors believe that permanence is not an unsurmountable problem (e.g., see Sedjo, 2001; Sedjo and Toman, 2001). Sedjo (2001, p. 17) argues “carbon sequestration should be viewed more as a temporary activity like the parking of a car than a long-term activity like the purchase of a parking space”. He advocates the development of rental markets for carbon.

Leakage

Leakage “occurs when the emission reduction achieved within the project causes increased emissions outside the project boundary, or at a later period of time. Leakage could occur for example if local communities agree to preserve a forested area, with the intention of increasing deforestation in other areas, as compensation” (Smith *et al.*, 2000). Leakage may work through the price system, as reduced wood supply may lead to price increases and hence provide incentives to increase forest clearing elsewhere. Leakage is not unique to LUCF projects. It can arise in the energy sector as well.

According to McCarthy *et al.* (2001), leakage of between 5 per cent and 20 per cent may occur through relocation of carbon-intensive industries from developed to developing countries. Almost all tropical forests have people living in or around them, so failure to compensate communities for forest protection projects can lead to leakage. To prevent leakage in LUCF reforestation projects, productivity of agricultural land will have to be increased (Smith and Scherr, in press) to ensure that food supply is not reduced. It may also be necessary to promote labour-using technologies (such as agroforestry) to provide employment for those displaced from forests.

4. Abatement costs, transaction costs and the supply of CERs

The supply of CERs depends on the availability and costs of relevant technologies and resource endowments, and these will be partly determined by location. In China, for example, CDM projects in the energy sector (particularly clean coal-burning technologies) may be the favoured (least cost) option. In Brazil, in contrast, the preferred option may be forest conservation. In Figure 1, the potential supply function (S_P) represents the marginal abatement costs of providing different cumulative levels of emission reduction through feasible projects in both the energy and the LUCF sectors.

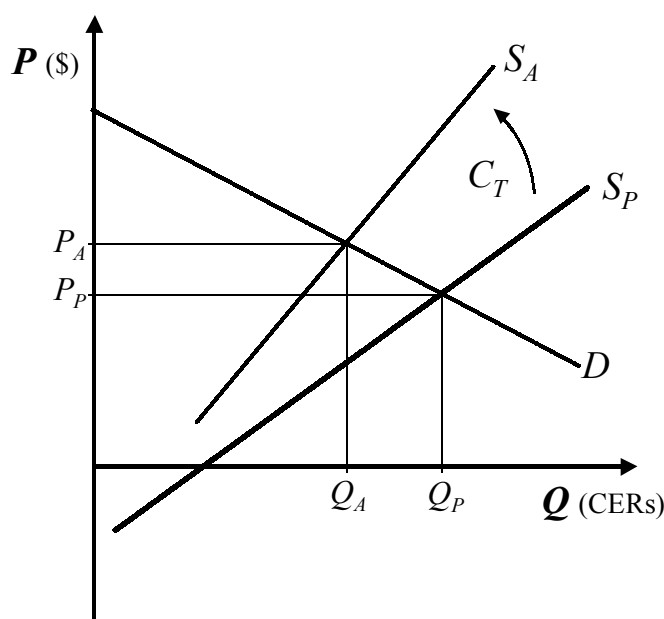


Figure 1. *The market for CERs*

For a given potential supply function, as determined by current technology and resource endowments, the equilibrium levels of price and quantity (Q_P, P_P) depend on the demand function (D). The position and slope of the demand function will depend to a large extent on the success of international mitigation agreements, regulations imposed by individual governments, channelling of overseas development assistance funds, and the extent to which the private sector is required to offset emissions. The rules of the game are by no means resolved, but we can expect a demand function sloping downwards from left to right.

Whatever the demand turns out to be, we need to understand the options available and their ancillary benefits and costs. Here we will focus on the supply side, with emphasis on carbon sequestration projects involving reforestation or afforestation. The curve S_P shows the prices that would be required to motivate different levels of abatement, or mitigation, of atmospheric carbon in a perfectly competitive world of zero transaction costs.

In this paper, abatement costs are defined as the costs of producing one unit of (uncertified) carbon sequestration services, or the cost of producing one unit of biomass carbon. In any given location, abatement costs can be estimated as the opportunity cost of undertaking a carbon-sequestration activity rather than the most profitable alternative activity, or the cost of switching from the previous land use to the proposed land use. This cost includes the present

value of the stream of revenues foregone as a result of participating in the project. It may also include additional risk exposure or loss of food security arising from this participation.

The assessment so far assumes implicitly that the participation costs for landholders consist only of abatement costs. In the real world, however, landholders can be expected to incur significant transaction costs (as defined in section 6.1) in addition to abatement costs (e.g., in obtaining certification of the abatement services they provide). Purchasers and investors will also incur transaction costs, but these are ignored here due to the present focus on the supply side of the CER market. To the extent that transaction costs (C_T) are positive, the supply function illustrated in Figure 1 (S_P) shifts upwards (e.g., to S_A), and equilibrium level of trade in CERs declines accordingly (e.g., to Q_A). If the transaction costs are sufficiently high, the market will not develop at all.

5. Case studies of abatement costs

Some simple case study analyses are presented here to illustrate how abatement costs can be estimated. The analysis focuses on agroforestry systems that are common on the island of Sumatra, Indonesia: rubber, cinnamon, damar and oil palm. The data for the oil palm system is based on an actual plantation-run project covering 10,700 hectares, whereas the data for the other three systems is based on actual smallholder-run projects. The analysis is from the standpoint of landholders. Hence, private prices are used and performance is measured in financial terms.

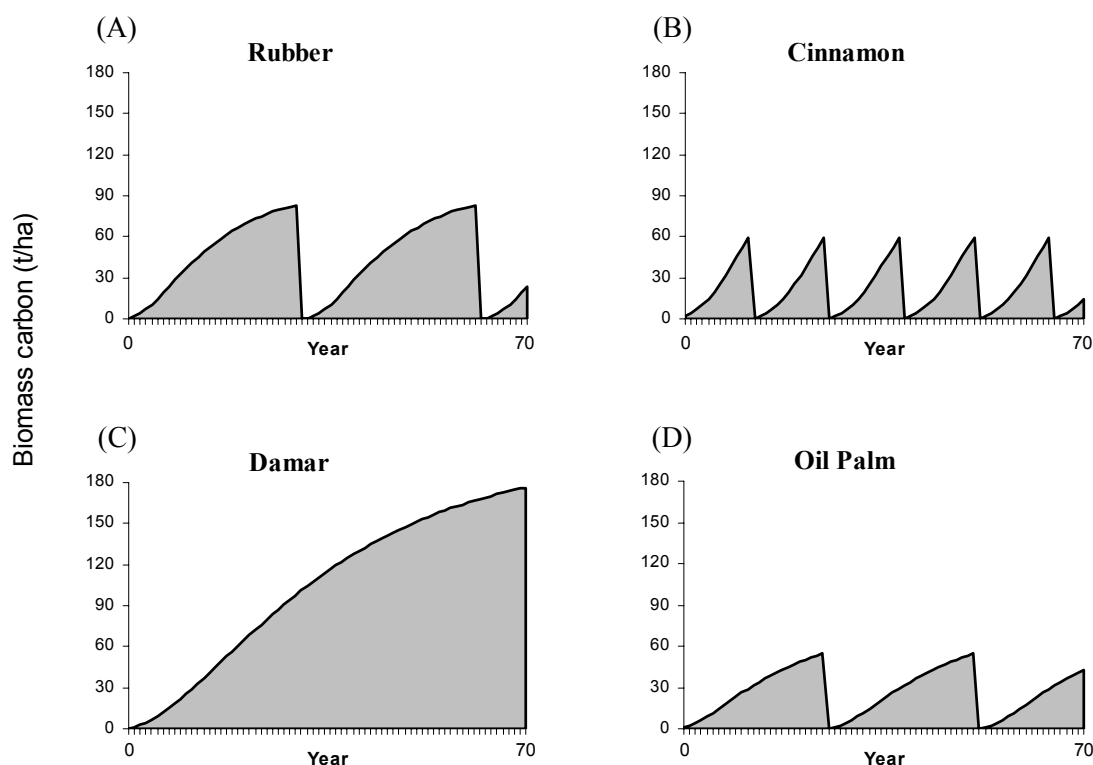


Figure 2. Carbon sequestration trajectories of selected agroforestry systems: simulated results for southern Sumatra, Indonesia

The amount of carbon sequestered by aboveground biomass for each of these systems assuming good-quality land was estimated with simple growth models based on available data and using allometric equations from Brown (1997) and Ketterings *et al.* (2001). The simulated growth in carbon stocks of the four agroforestry systems over 70 years is presented in Figure 2. A planning horizon of 70 years was used, based on the age of damar systems sampled by Vincent *et al.* (2002). The carbon sequestration rates driving the simulation assume a baseline of zero. This is a good enough approximation if the agroforestry system replaces an annual crop, such as the cassava monoculture system that is assumed below to be the most profitable alternative to the agroforestry systems. If agroforestry were to replace a forest, however, the baseline carbon stock would then need to be subtracted from the new system's average biomass to ensure realistic estimation of the net increase in carbon sequestration due to that system.

The average stock of carbon in each system can be calculated by dividing the area under the corresponding curve in Figure 2 by 70 years. This is an estimate of the 'permanent' increase in carbon stocks, assuming that the land-use will not change and land productivity does not decrease with subsequent production cycles.

Good-quality land is likely to be recently deforested and therefore not eligible for a CDM project. Our case studies therefore focussed on reforestation of degraded land, which may be an acceptable CDM activity under both sustainability and additionality criteria. The productivity of degraded land, and hence its carbon sequestration capacity, will be considerably lower than that of good-quality land. In our case studies we assumed that the yields of the four agroforestry systems on degraded land are one half of those obtained on good-quality land.

The financial analyses of the four agroforestry systems, assuming a discount rate of 20 per cent, are summarised in Table 1. Further details on the assumptions and methods used in the analyses can be obtained from Ginoga *et al.* (2000). The results of the financial analysis for degraded land indicate that adopting only the cinnamon system would be financially attractive to landholders, as the net present values (NPVs) of the other three systems are negative.

Table 1. *Financial performance and costs of selected agroforestry systems: modelling results for Sumatra, Indonesia*

	Agroforestry System			
	Rubber	Cinnamon	Damar	Oil Palm
NPV (US\$/ha)	-96.35	114.99	-36.46	-91.10
Opportunity cost ² (US\$/ha)	132.35	-78.99	72.46	127.10
Average biomass carbon (t C/ha)	21.18	11.35	51.34	13.31
Sequestration cost (US\$/t C)	6.25	-6.96	1.41	9.55

The opportunity cost of changing to a particular agroforestry system was calculated by deducting the NPV of that system from the NPV of the most profitable alternative land use.

² This is the cost in terms of foregone NPV of switching land use from cassava to each agroforestry system.

Common land uses in the peneplains of Sumatra are upland rice/bush fallow rotation, and cassava monoculture degrading to *Imperata* grassland (Tomich *et al.*, 1998). The former land use is unprofitable, whereas the estimated NPVs of the latter range from –US\$7.1/ha to US\$36/ha depending on the amount of fertiliser used. The higher value (US\$36/ha) was used in the analyses reported here as the return from the most profitable alternative to agroforestry systems. Calculating the opportunity cost of changing to an agroforestry system helps to answer the question “given existing prices, how much do we need to pay landholders to entice them to change land-use practices?” The positive opportunity costs for all systems other than cinnamon suggest that the landholder would not adopt those systems in order to supply to the CER market unless he or she were paid an inducement not less than the opportunity cost in each case.

A measure of the average cost of sequestering carbon in each system – namely, its average abatement cost – over the planning horizon is presented in the last row of Table 1. These values were obtained by dividing the opportunity cost of changing to a system by its average biomass carbon. Aside from cinnamon (with a negative sequestration cost), damar is the cheapest option for sequestering carbon (US\$1.41/tC), with oil palm the most expensive (US\$9.55/tC), and rubber intermediate (US\$6.25/tC). For agroforestry projects to compete in carbon markets, their sequestration cost needs to be lower than the market price of carbon. The lower the cost at which the carbon can be sequestered, the greater the profit to the project partners (Smith and Scherr, in press). Smith *et al.* (2000) cite a range of carbon prices from US\$5/tC to US\$23/tC. The sequestration costs for cinnamon and damar are less than the lower of these price bounds, while the sequestration costs for rubber and oil palm fall well below the higher of these bounds.

Since the sequestration cost of the cinnamon system is negative, it would not meet the additionality requirement unless other barriers to establishment (such as lack of credit) can be established. Provided that cinnamon satisfies the additionality criterion, a rational investor faced with the options in Table 1 would therefore select it first, followed by damar, rubber and oil palm.

As shown above, it is possible to estimate abatement costs associated with agroforestry-based carbon sequestration projects through fairly simple economic analysis. This can be useful as a screening device to identify potential agroforestry systems for a particular site. The actual costs of a project must be estimated based on local data, as the opportunity costs and baselines can vary considerably between sites.

6. Transaction costs

The assessments in the previous section of the financial inducements required to encourage landholders in the case study setting to supply to the CER market by participating in agroforestry projects are incomplete in so far as they do not account for the transaction costs of this participation. Due to a lack of relevant data, it was not possible in this study to estimate these transaction costs. Nevertheless, a number of studies have highlighted transaction costs as a potential impediment to landholders, and particularly smallholders, participating in this market (e.g., Baumert *et al.*, 2000; McCarthy *et al.*, 2001; Smith, in press). This section therefore reviews the kinds of transaction costs likely to arise in agroforestry projects targeting the CER market. Prior to doing so, however, transaction costs are defined and their nature discussed.

6.1. Defining transaction costs

The tradition of transaction cost economics descends from Coase (1937). However, only recently have consequences of transaction costs begun to be considered systematically by resource economists when comparing environmental policy options. Transaction costs are the costs of “of arranging a contract to exchange property rights ex ante and monitoring and enforcing the contract ex post, as opposed to production costs³, which are the costs of executing a contract” (Matthews 1986, p. 906). A property right is an enforceable authority to undertake particular actions related to a specific domain (Commons, 1968).

In addition to the costs of establishing and maintaining property rights, transaction costs are also incurred at a deeper level in creating, changing and applying the institutions upon which the establishment and maintenance of property rights depends (Furobutn and Richter, 1992). Institutions are “set of ordered relationships among people which define their rights, exposures to the rights of others, privileges, and responsibilities” (Schmid, 1972 p. 893). Some institutions are established and maintained formally (e.g., laws and regulations), and others informally. Informal institutions include social norms, which are shared understandings about actions that are obligatory, permitted or forbidden (Crawford and Ostrom, 1995).

The immediate focus of policy interventions, including those concerned with establishing a market, tends to be on formal institutions. Nevertheless, the cost-effectiveness of any such intervention will depend on how well these formal institutions, and the processes of establishing and maintaining them, fit with prevailing social norms (Singleton, 1998). North (1990) explained that prevailing norms evolved gradually as extensions of previous formal institutions, and that they will change only gradually once those formal institutions are changed. Since the legitimacy of changing formal institutions depends on how well the change meets with prevailing norms (ibid.), the transaction costs of enforcing such a change will escalate to the extent that the change transgresses those norms and thus becomes “infused with the rectitude of civil disobedience” (Singleton 1998, p. 129).

6.2. The agency problem

The source of transaction costs is bounded rationality (Williamson, 2000). Due to the limited cognitive competence of individuals referred to by this term, their calculations account for only immediate and readily assimilated information. The complexities of actual economic transactions cannot therefore be completely dealt with when specifying contracts. It follows that contracts are open inevitably to opportunism, or “self-seeking with guile” (Williamson, 1985, p. 47). Jensen and Meckling (1976) characterised this kind of indeterminate relationship as an agency relationship, in which a ‘principal’ delegates some rights to an ‘agent’ who is bound by a contract to represent the principal’s interests in return for a reward of some kind. The total cost of agency is the sum of investments made by the principal in limiting opportunistic behaviour by the agent plus the costs associated with the residual opportunism (Eggertsson, 1990).

³ In the context of projects ‘producing’ abatement of some environment-harming emission like excess atmospheric carbon, production costs are equivalent to abatement costs.

This framing of economic transactions leads to a focus on identifying ways of structuring contracts in order to reduce agency or transaction costs. For instance, one strategy might be to design contracts where the interests of principal and agent overlap (e.g., by sharing profits). Another is to introduce an accounting system for monitoring agent behaviour. A further option is for agents to offer the principal some collateral as security against them acting opportunistically. Contracting in ways that involve competition between agents might also, by increasing the cost of their opportunistic behaviour, lessen a principal's agency costs (Wallis *et al.*, 1999).

6.3. Classifying the transaction costs of carbon-sink projects

Williamson (1985) distinguished the costs of contracting as *ex ante* and *ex post* transaction costs. These correspond with activities undertaken in the processes of achieving an agreement and then continuing to coordinate implementation of the agreement, respectively. Hanna (1995) identified four stages of the process of changing policy or institutional structures for natural resources: description of resource context, policy design, policy implementation, and policy enforcement. The first two and last two stages were classified as incurring *ex ante* and *ex post* transaction costs, respectively.

Various detailed transaction cost typologies intended to structure the process of accounting for transaction costs in choosing natural resource policy options have been developed in recent years (e.g., McCann and Easter, 1999; Thompson, 1999). Dudek and Wienar (1996) developed a typology intended specifically to facilitate measurement of transaction costs incurred in projects designed to mitigate emissions of atmospheric CO₂. The typology comprises six categories of transaction costs, viz. search costs, negotiation costs, approval costs, monitoring costs, enforcement costs and insurance costs.

We propose a typology for LUCF projects that is based on that of Dudek and Wienar (1996) but add a category called 'implementation costs'. Also, we refer to verification and certification costs rather than approval costs. Each of the categories in the modified typology is discussed below.

Search costs

Search costs are incurred as investors and hosts seek partners for mutually advantageous projects. They include the costs of investors and hosts surveying a range of alternatives prior to making a decision. Examples of search costs are brokers' fees, charges for information services, costs of advertising a willingness to engage in a transaction, and delays experienced while seeking a suitable partner (Dudek and Wienar 1996). In projects involving smallholders, search costs would also include gathering agricultural, social and economic information about their region, and contacting and establishing relationships with individual smallholders and any associations they may have formed. Some of these costs will relate to establishing the baseline.

Negotiation costs

Negotiation costs are the costs of interested partners coming to an agreement. They include: the costs of deciding the details of: project design; the responsibilities of each partner; assignment of benefits (e.g., payment in cash or technology, or in GHG abatement credits); and the schedule over which benefits will be paid. Legal costs may also be incurred in specifying the terms of the contract. Delays caused by negotiations can also be costly. Negotiation costs may be incurred internally to each interested partner (e.g., between the

directors of a company considering becoming an investor), as well as between the partners (Dudek and Wienar, 1996). With smallholders, the cost of negotiating with individuals, including farm visits and establishment of personal relationships can be high. Also, the cost of writing contracts when literacy is limited, and legitimisation of contracts through a village committee or headman, can be important (Simmons, 2002). Costs of negotiating with plantations may sometimes be high for other reasons, including their greater use of lawyers or their greater access to political influence.

Verification and certification costs

Verification and certification costs fall within the *approval costs* category of Dudek and Wienar (1996). These occur when the negotiated exchange must be approved by a government agency. For instance, they will be incurred when the GHG abatement credits earned by a project are presented to an accredited agency for certification. The host government, and possibly also the investor government, may also require advance approval of the project. Approval costs are likely to be mostly experienced in terms of delay and uncertainty, although they might also arise as out-of-pocket costs involved in generating and compiling the information required in an application for approval (Dudek and Wienar 1996).

Verification refers to checking the validity of the claims of a project and it is a necessary but not sufficient condition to enter the market. Certification, on the other hand, occurs *ex post*, once sequestration has occurred. Certification is given only on real accomplishments (Moura-Costa *et al.* 2000).

Implementation costs

Implementation costs are associated with the resources expended in administering the translation of a project design, as developed in the negotiation stage of a transaction, into practice. They are defined here to include the costs of negotiating refinements to projects as new knowledge becomes available indicating that such refinements are advisable. Examples of the kinds of transaction costs likely to be incurred by carbon sequestration projects in this category are: keeping records of project participants, administration of payments, and dealing with problems and disagreements. These activities may require the establishment of a project office in close proximity to the site.

Monitoring costs

Monitoring costs are the costs of the efforts partners need to make to observe the transaction as it unfolds, and to verify compliance with the agreed terms of the transaction (Dudek and Wienar 1996). Monitoring will also be required to measure the GHG abatement actually achieved by the project in real time (as opposed to forecasts). MacDicken (1997) points out that projects that fix less than two or three tons of carbon per hectare per year cannot be monitored in a cost-effective way, because the cost of measuring these quantities is similar to the cost of measuring 10 to 15 tons of carbon per hectare per year.

Enforcement costs

Enforcement costs are the expenses of insisting on compliance if monitoring detects divergences from the agreed terms of the transaction. They may be incurred in the form of litigation or administrative proceedings (Dudek and Wienar 1996). Enforcement of contracts is possibly one of the most important transaction costs. When dealing with developing country smallholders, there may be limited legal recourse to enforce contracts due to the

slowness of court proceedings and the difficulty and cost of recovering small debts. So the project needs to provide smallholders with credible prospects and sufficient incentives to prevent abandonment (Simmons 2002). Strategies to reduce risk of contract default include channelling loans through farm groups, monitoring within the community, and strict rules and harsh penalties for dealing with defaulters (Eaton and Shepherd 2001).

Insurance costs

Insurance costs arise from the risk of project failure. Project failure might occur if, for instance, fire destroys trees planted as part of the project, the host fails to carry out its responsibilities under the contract, or if the host carries out its responsibilities but the investor fails to pay. Dudek and Wienar (1996) suggested that the riskiness of a transaction would depend to large extent on the credibility of the proposing nation. Various insurance options may be exercised to reduce the perceived riskiness of transactions, including purchase of a financial insurance policy, development of contingency plans in case of transaction failure, deduction of a risk premium from the price paid to the host, purchases on spot markets, and diversification of the projects an investor is involved in. Some of these strategies can also be used to deal with leakage. Project design could alter who bears the risk or insurance costs among buyers, sellers and producers.

6.4. Fixed transaction costs and economies of scale

Dudek and Wienar (1996) observed that the various categories are likely to differ in the degree to which they represent fixed costs vis-à-vis variable costs. For instance, they suggested that approval costs (included above within the category of certification and verification costs) may be relatively fixed since the task of seeking approval is unlikely to be affected much by whether the proposed project is small or large. On the other hand, they suggested that monitoring and insurance costs would be relatively variable, increasing with the size of the transaction.

Concerns have been raised that the fixed transaction costs of agroforestry projects participating in the CER market may make plantations more competitive, due to economies of scale, than smallholders in undertaking such projects (e.g., Wexler *et al.*, 1994). To the extent that this is true, the potential of such projects to contribute to poverty alleviation among smallholders will be lessened. However, any pessimism in this regard needs to be tempered by recognition of possibilities that variable costs may be lower for smallholders than for plantations. For instance, the opportunity cost of labour may be lower for smallholders than for plantations due to greater poverty among smallholder communities and less choice of employment locally (Otsuka and Place, 2001). If this is the case, then variable transaction costs associated with self-monitoring compliance with project conditions may be lower for smallholders than for plantations. A further reason for tempering pessimism is the scope that exists to devise strategies that reduce disadvantages smallholders face vis-à-vis plantations in terms of economies of scale. Some of these strategies are discussed in the following section.

7. Reducing transaction costs

A way to reduce the disadvantage of smallholders vis-à-vis plantations in terms of fixed costs and economies of scale may be to develop projects with groups of smallholders rather than with them individually. In the language of property rights, the projects would be run as

common property rather than individual property. By thus spreading the fixed transaction costs of designing and implementing a project over a group of smallholders, any economies-of-scale disadvantage this class of landholders may otherwise face in participating in CER-related projects may be lessened.

Furthermore, there is now considerable evidence from research into common property systems that arrangements of this kind can, in many circumstances, reduce total transaction costs compared with systems of individual property (e.g., Baland and Platteau, 1996; Ostrom, 1990). A key finding of this research is that the sustainability of common property systems tends to depend on their members exploiting their local biophysical and cultural knowledge in order to devise formal institutional arrangements that complement rather than substitute for pre-existing informal institutional arrangements, including social norms and customs, developed to address prior collective action challenges (Ostrom, 1990). Monitoring and enforcement of social norms and customs often occurs as a by-product of a group's normal day-to-day social interaction. Piggy-backing on these informal arrangements, therefore, can lessen considerably the need for external imposition of formal institutional arrangements (McCarthy *et al.*, 2001), the monitoring and enforcement of which typically comes with formidable transaction costs.

Groups of smallholders will differ in how much their histories have developed their capacities for collective action required to successfully run systems of common property (Knox and Meinzen-Dick, 2001). A possible implication of a group-based strategy for engaging smallholders in projects may be that cost-effectiveness concerns will lead much of the attention on developing projects to be directed at groups already possessing much of the capacity required to manage such projects. This implication is of concern to the extent that the CDM would then tend to neglect groups and associated communities least able to help themselves and most in need of outside intervention to alleviate their problems of poverty.

The benefits of smallholder-based common property systems will arise only to the extent that local knowledge is incorporated adequately in the choice of formal arrangements. A well-established strategy for integrating local knowledge, including of beliefs and preferences, in policy making is to facilitate inclusive participation of all stakeholders in the decision process.

By building formal institutional arrangements as far as possible on a foundation of local knowledge, and thereby strengthening smallholders' perceptions of the legitimacy of those arrangements, the propensity for them to cooperate voluntarily in the implementation of those arrangements can also be expected to be greater. The transaction costs of monitoring and enforcing the new arrangements will be reduced accordingly. However, facilitating inclusive participation in institutional choice can also be expected to increase the transaction costs of reaching agreement on the new arrangements. In other words, facilitating participation is likely to reduce the *ex post* transaction costs of institutional change, while increasing the *ex ante* transaction costs (Hanna, 1995). It is important therefore to think through the likely effects on transaction costs over the entire planning horizon before concluding prematurely that facilitating participation only adds to costs.

Nevertheless, making participation genuinely inclusive is not as simple as often presumed (Agrawal and Gibson, 2001). Unless pro-active steps are taken to engage the members of a smallholder population who do not participate usually in policy deliberations, the participation process may come to be dominated by the same individuals and groups that usually have the greatest local say over policy choices. It is unlikely in such circumstances that the outcome will be a greater share of the local population perceiving the institutional choices made as fair. Rather, “the substantive content [of the institutions emerging from a non-inclusive participation process] is likely to favor the powerful . . . , while shirking, foot-dragging, and other ‘weapons of the weak’ will be deployed by the less powerful in an effort to shape the process by which formal rules are deployed in local practice” (Singleton, 2001 p. 142). It is important therefore in designing a participation process to first identify the barriers to all local stakeholders engaging in that process and then take pro-active measures to dissolve these barriers as far as possible.

8. Summary and conclusions

This paper was motivated by opportunities in some developing countries for emerging markets for carbon sequestration services to help achieve their sustainable development goals. Its focus in this context was on agroforestry and tree plantations. After briefly reviewing the significant potential of such activities to sequester carbon, and noting that carbon sequestration is a product that smallholders might trade in markets more easily than many other products open to them, a number of challenges particular to operationalising such carbon-sink projects were discussed.

The need to consider both abatement and transaction costs when assessing the viability of landholders undertaking agroforestry projects in order to supply to the CER market was emphasised. Four case studies of agroforestry systems in Sumatra, Indonesia, were presented to illustrate how the abatement costs of such projects might be estimated. The estimated abatement costs of the four systems ranged from a high of US\$9.55/t C to a low of US\$-6.96.

The influence of transaction costs on the competitiveness of landholders in developing countries supplying to the CER market was then explored. After defining transaction costs and discussing their origins, a typology of such costs in the context of landholders supplying to the CER market was discussed. The typology consists of seven cost categories, namely search costs, negotiation costs, verification and certification costs, implementation costs, monitoring costs, enforcement costs, and insurance costs. Such a typology is a prerequisite for systematically estimating the transaction costs of alternative institutional strategies for carbon-sink projects, and thus for identifying the institutional arrangements most likely to promote the competitiveness of projects in specific circumstances. The significance of fixed transaction costs for the competitiveness of smallholder-based projects vis-à-vis plantation-based projects was also considered. Finally, strategies for reducing transaction costs through common-property regimes and community participation were discussed.

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