Payments for Environmental Services as an Alternative to Logging under Weak Property Rights: The Case of Indonesia

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Abstract

Decentralization reforms in Indonesia have led to local communities engaging in logging agreements with timber companies for relatively low financial payoffs and at high environmental costs. This paper analyzes the potential of payments for environmental services (PES) to provide an alternative to logging for these communities and to induce forest conservation. We apply a game-theoretical model of community-firm interactions that explicitly considers two stylized conditions present in the Indonesian context: (i) the fact that community rights to the forest remain weak even after decentralization, and (ii) the presence of logging companies interested in the commercial exploitation of the forest. Conventional PES design suggests that there should be a focus on those communities with the lowest expected payoffs from logging. However, it is shown that those communities with low expected payoffs may not be able to enforce a PES agreement, i.e., they may not be able to prevent logging activities by timber companies. Moreover, some communities would conserve the forest anyhow; in these cases PES would not induce additionality. Most importantly, the introduction of PES may impact on expected payoffs

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from a logging agreement by raising the communities' reservation utility in negotiations. A failure to consider this endogeneity in expected payoffs would lead to communities opting for logging agreements despite PES, simply allowing communities to negotiate better logging deals. We use a graphical analysis to derive the conditions for effective and efficient PES design. The results indicate that in our context PES design is a complex task, and that the costs of an effective PES system could potentially be much higher than expected from considering currently observed logging fees.

Using data collected in Indonesia on actual logging fees received by communities, we illustrate how the theoretical results could be used in empirical analysis to guide PES design. Our results are likely to be useful in other cases where local people make resource use decisions but have weak property rights over these resources, and where external commercial forces are present.

Key words: payments for environmental services, property rights, opportunity costs, self-enforcement

1. Introduction

This paper is motivated by the case of Indonesia, where decentralization reforms have resulted in the acknowledgement of local communities' forest rights (Palmer, 2004). Although formal community rights remain weakly defined and rarely enforced by the government, communities have exercised such rights by negotiating logging agreements with timber companies. The outcomes from these agreements were characterized by pervasive environmental damages, with communities receiving a relatively small proportion of actual timber rents (Palmer, 2005). Payments for environmental services could potentially provide an alternative source of income to rural communities while maintaining environmental services provided by the forest, through the capitalization of non-market forest values. As we will show, however, designing PES in a context like the Indonesian one, where communities' property rights are still weak and commercial interests such as logging companies are present, is a complex task. It requires an improved understanding of the interactions between the local communities ('resource owners') and the logging companies ('commercial actors').

We focus particularly on effectiveness and efficiency in PES design. Effectiveness requires that PES leads to an actual increase in environmental services as compared to the situation that would result without PES. Efficiency refers to maximizing environmental services with a given budget. This requires, for example, an estimation of communities' opportunity costs. That is, an understanding is needed of the levels of expected payoffs to local communities from logging deals. In Indonesia, fieldwork revealed wide variation in communities' payoffs under logging agreements (see Palmer and Engel, forthcoming). What are the sources of this variation, and how can we estimate the expected payoffs for a community being considered for PES? And are these expected payoffs really the relevant payoffs to consider in PES design? Conventional wisdom would suggest that, for a given environmental service per hectare, PES should focus on those communities with the lowest opportunity costs, i.e., the lowest expected payoffs from logging deals. As we demonstrate, in a context like the Indonesian one the issue is far more complex. First, those communities with low opportunity costs may not be able to enforce a PES agreement, i.e., they may not be able to prevent logging activities by timber companies. Second, some communities would conserve the forest anyhow; in these cases PES would not induce additionality. Finally, and perhaps most importantly, the introduction of PES may impact on expected payoffs from a logging agreement by raising the communities' reservation utility in negotiations. A failure to consider this endogeneity in expected payoffs would lead to communities opting for logging agreements despite PES, by enabling communities to negotiate better logging deals. In all of these cases the PES scheme would not be effective.

To shed light on the above issues, we present the intuition behind the results of a game-theoretic model presented in Engel, López and Palmer (forthcoming). The model combines conflict and bargaining theory to analyze the interactions between communities and logging firms. An empirical application based on data collected in Indonesia is also presented. While the analysis is motivated by, and discussed in the context of community-firm logging agreements in Indonesia, the results are likely to be useful in other cases. In particular, where local people make resource use decisions but have weak property rights over these resources, and where external forces interested in the commercial exploitation of community resources are present.

The remainder of this paper is structured as follows. Section 2 presents further background on the Indonesian setting and the data collected. The game-theoretic model is presented in section 3. Lessons for PES design are drawn in section 4. Section 5 briefly discusses the empirical implementation of the model. Section 6 concludes.

2. Background on the Indonesian context and data collection

This section combines evidence from existing literature with data from fieldwork conducted by the authors and described in detail in Palmer (2005). In particular, 62 communities involved in logging agreements in East Kalimantan province were surveyed during 2003-2004 through the use of community- and household-level questionnaires[1]. A large amount of data were also collected on community characteristics and experiences. These data are used in some of the subsequent sections of this paper to illustrate how the theoretical model could be empirically implemented.

The rapid expansion of commercial logging under ex-President Suharto resulted in Indonesia's forest coverage declining by 40 percent from 1950 until 2000 (FWI/GFW, 2002). The rate of forest loss has increased in recent years, with approximately two million hectares lost each year (ibid). A recent survey predicts that lowland forests will have vanished from the islands of Sumatra and Kalimantan by 2010 if current trends continue (Holmes, 2000, as cited in FWI/GFW, 2002). The consequence is a loss of local environmental services, carbon sinks, and habitat for the country's disproportionately high share of world biodiversity.

Since the fall of Suharto's centralized government during 1997-98, Indonesia has undergone rapid decentralization, resulting in changes to the institutions and processes

[1] These were taken from a total of 65 community-level and 687 household interviews.

relating to natural resource management (Barr and Resosudarmo, 2002). Forest governance has shifted haphazardly, from a centralized system of logging concessions and protected areas to one informally controlled by district governments (Palmer, 2004). Consequently, newly empowered forest-dependent communities exerted property rights over customary (*adat*) forest, leading in many cases to communities negotiating directly and legitimately with logging companies in exchange for access to financial and social benefits (Casson and Obidzinski, 2002). Moreover, district heads were permitted to issue small-scale forest conversion licenses for these concessions.[2]

Community rights are, however, still weakly defined in a legal sense (Wollenberg and Kartodihardjo, 2001). Coupled with endemic corruption in the Indonesian forestry sector and a general decline in state law enforcement, this means that local government rarely, if ever, enforced community-firm logging agreements. About 84 percent of communities sampled claimed that the government played no role whatsoever in contract enforcement (Palmer, 2005). Consequently, communities came to depend more on self-enforcement rather than the state to enforce their property rights (Palmer, 2004). For example, community-company conflicts due to firm non-compliance occurred in 50 percent of cases surveyed. Companies could claim property rights by making agreements that are not complied with later (Barr et al, 2001; Palmer, 2004) or simply logging without community consent (Engel, López and Palmer, ibid).

In exchange for access to commercially valuable timber on land claimed by the communities, timber companies typically agreed to pay a fee per cubic meter (m^3) of

[2] These are either known as Timber Extraction and Utilization Permits (Izin Pemungutan dan Pemanfaatan Kayu or IPPK) or Rights to the Harvesting of Forest Products (Hak Pemungutan Hasil Hutan or HPHH). Although central government banned these permits in 2000, many districts continued to issue them until 2002-03 and they continued to be perceived as ‘legal’ at least from the local perspective.

timber harvested in addition to the provision of social developments. Figure 1, from Engel and Palmer (forthcoming), illustrates the variation in actual financial payments and financial payments plus the value of social provision received by communities (all amounts are per m^3 of timber harvested).[3] The mean level of financial payments alone was IDR 31,834 (USD 3.54)[4] per m^3, and for financial plus non-monetary benefits, IDR 32,789 (USD 3.64) m^3. The minimum and maximum levels for both measures were identical: IDR 2,500 (USD 0.28) and IDR 106,322 (USD 11.81), respectively. By contrast, average timber prices in the domestic market were between USD 30 and 70 per m^3, and in Malaysia, between USD 80 and 125 per m^3, for the common Meranti species over the period 1999-2002 (see Palmer and Obidzinski, 2002).

[Figure 1 here]

Logging resulted in substantial environmental damage. Over 70 percent of the sampled communities indicated a decline in drinking water quality and over 65 percent indicated an increase in flooding as a consequence of logging (Palmer, 2005). Furthermore, Wollenberg (2004) reports on research by Iskander and his colleagues on the environmental impacts of small concessions, which shows that forest damage has led to a decline in wildlife habitats and a decreased potential for forest regeneration. Resosudarmo (2004) notes that the Ministry of Forestry estimated the total area of Indonesian forest allocated for small-scale concessions by district governments since the system was established, to be in the order of two million hectares in January 2003.

[3] We value these crudely as the cost of provision and do not consider for example, the flows of future benefits from developments such as schools and health clinics. Due to the fact that relatively few companies complied with such provisions, there is very little difference between the sum of financial payments and the value of social provisions, and financial payments considered alone.

[4] Using IDR 9,000 = USD 1.00.

However, data on the proportion of these concessions that were operationalized and the quantities of logs harvested from these are unavailable.

The opportunities for communities in Indonesia to utilize their forest claims for income generation have thus far concentrated on the timber values of the forest at the cost of a decline in the value of forest environmental services. An alternative to logging agreements, would be for communities to negotiate agreements for environmental services in exchange for benefits. While there are currently no formal PES schemes established in Indonesia, they have been increasingly discussed as a policy option (see Iwan, 2004, on one initiative). Given the tremendous scope of logging in Indonesia, PES is a potential alternative to communities deciding on forest use. Moreover, given the relatively low amounts of logging fees received by communities (starting at little more than a quarter USD per m^3), it would appear that PES could achieve forest conservation at low cost. As we will show below, however, this intuition is quite misleading.

3. Conceptual model

The design of an effective and efficient PES scheme as an alternative to logging benefits requires an understanding of the interactions between communities and logging companies. In this section, we present the intuition behind a game-theoretic model of these interactions, following Engel, López and Palmer (forthcoming).[5] We simplify this model in that we do not allow for endogenous policy interventions and by considering logging areas as exogenously given. Rather, in this paper, we focus on community payoffs and analyze the impacts of a specific intervention, PES, on community-firm interactions.

[5] A more general version of the model is developed in Engel and López (2004).

The model links conflict and bargaining theory. We argue that in a context of weak property rights, the community's ability to self-enforce its rights over the forest is crucial for understanding its performance in negotiating a logging agreement. Conflict theory, by modeling what would happen in the absence of negotiations, sheds some light on this self-enforcement ability. The results are then incorporated into bargaining theory to analyze why some communities receive higher payoffs from logging agreements than other communities, and to predict under which conditions negotiations will succeed or fail. In what follows we present the model and its main results in intuitive terms; formal derivations are presented in Engel, López and Palmer (ibid). We then use graphical analysis to consider the impacts of PES.

3.1. Conflict theory and property rights formation

In Engel, López and Palmer (ibid), *de facto* property rights are modeled as the outcome of a war of attrition between a logging company (referred to as 'the firm' hereafter) and a community. Logging requires a specific factor (capital) that is available to the firm but not to the community.[6] The possibility of bargaining arises from the complementarity between the firm and the community in terms of access to the factors of production required for logging, with the community potentially controlling access to the forest. For simplicity it is assumed that both actors have perfect information about each other's parameters.[7] Because the model assumes weak community property rights, each of the actors can in principle obtain *de facto* rights over the forest, e.g. the firm may

[6] Communities tend to have low savings and a disadvantage in the credit market *vis-à-vis* the firm, associated with capital market imperfections (see Bose, 1998).

[7] This implies that the player that would lose the conflict withdraws immediately. With imperfect information, actual conflict is possible, but the outcome will generally depend on the same parameters listed here (see Burton (2003) for a related model with imperfect information).

unilaterally exploit the forest if it has enough power to win a potential conflict with the community, or the community may prevent that if the power conditions are reversed.

Each period the community is able to stop firm operations it obtains use and nonuse values from the undisturbed forest. If, however, the firm wins the conflict it receives profits from logging unilaterally.[8]

In general, the war of attrition is won by the party that is able to stay in a potential conflict longer. First, consider the case where the costs of setting up a blockade for even just one period already exceed the present value of benefits obtained from the standing forest forever. Here, the community will never fight and the firm will simply go ahead and log as long as net profits from doing so are positive. Now consider the case where the benefits from protecting the forest for just one period already outweigh the costs of blockading in that period. Thus, the community will always fight, and the firm, knowing this, will withdraw. For intermediate values of the present value of benefits obtained from the forest, the boundary condition is derived by computing for each player the maximum time that he can stay in conflict and still receive a non-negative payoff, and by then equating these maximum times. The boundary condition can be seen as a line in figure 2 (line '*BC1 (War of attrition)*').

[Figure 2 here]

For points above and to the left of the boundary condition, the firm is able to stay in conflict longer than the community and thus wins the conflict. In this case the firm effectively has access to both the forest and capital and thus is able to exploit the forest unilaterally without community consent. For points below and to the right of the

[8] One could also incorporate a minimum payment received by the community in this case (see Palmer, 2005).

boundary condition, the community is able to stay in conflict longer than the firm, and thus is able to self-enforce its property rights over the resource. In this case, two outcomes are possible. The community may prevent logging altogether, or it may bargain with the firm over a logging agreement.

Engel, López and Palmer (ibid) show how the outcome of the attrition war depends on model parameters. It can be seen immediately from figure 2 that the community is more likely to win a potential conflict with the firm (and thus obtain *de facto* rights over the forest) if logging profits are low or if the community's valuation of the standing forest is high. Intuitively, an increase in an actor's benefits from winning (profits for the firm, and benefits from the standing forest for the community) allows this actor to stay in conflict longer, and thereby raises the likelihood that he is able to win the conflict. Moreover, Engel, López and Palmer (ibid) show that the community is more likely to win the attrition war if blockading costs and the community's discount rate are low, and/or if logging costs and the firm's discount rate are high. All of these conditions effectively shift the location of boundary condition *BC 1* in figure 2 to the left. These results are quite intuitive as well. An increase in fighting costs (logging costs for the firm, blockading costs for the community) lowers the ability of an actor to stay in conflict. Similarly, an increase in a player's discount rate induces him to value the immediate fighting costs more than the long-run benefits from winning and thereby reduces the maximum length of time this actor would stay in conflict and thus his chances of winning.

3.2. Community-company bargaining over a logging agreement

Note that negotiations over a logging agreement are only feasible if the community is able to win a potential conflict with the firm. Otherwise (in area I in figure 2), the community would effectively lose its property rights over the forest; the firm would have access to both factors of production (capital and forest) and would have no incentive to share logging profits in a negotiated agreement.[9] We now focus on the case where the community is able to enforce its property rights over the forest by winning a potential conflict with the firm. In this case, there is scope for bargaining over a joint logging agreement, because the firm has access to capital while the community effectively controls the resource base. Engel and Palmer (forthcoming) present a simplified version of Engel, López and Palmer's (ibid) model of community-firm bargaining. The negotiation outcome can be presented in the form of an asymmetric Nash Bargaining Solution (NBS) (Muthoo, 1999). The asymmetric NBS implies that each player obtains his reservation utility, and the remaining surplus is divided in proportion to bargaining power. Thus, community payoffs are increasing in the 'size of the cake' (in our case given by the net profits from logging), the community's bargaining power, and the community's reservation utility. Community payoffs are decreasing, however, in the firm's bargaining power and the firm's reservation utility. The community's bargaining power vis-á-vis the firm is generally increasing (decreasing) in the firm's (community's) discount rate, but may also depend on other factors associated with higher bargaining power. Reservation utilities on the other hand are the outcomes that would result in the

[9] In reality, a *pro forma* agreement may still be negotiated and a minimum payment made to the community in order for the firm to maintain political capital with the local government (Palmer, 2005). This could be easily incorporated in the model of Engel, López and Palmer (ibid), but would not affect the qualitative results that are of relevance for our purposes.

absence of negotiations. This is where the conflict outcomes come in. When the community is able to win a potential conflict, in the absence of negotiations the community would protect its property rights to the forest and prevent any logging by the firm. Thus, the community's reservation utility would be its valuation of the standing forest, while the firm would only receive whatever are its net profits from using its capital in the next-best alternative activity. Thus, community payoffs in a negotiated agreement are likely to be increasing in the community's valuation of the standing forest and decreasing in the firm's profits from its next-best activity.

3.3. Combining results

Engel and Palmer (ibid) combine the results of the two stages and use data on payoffs and on proxies for the various model parameters collected in Indonesia to test the resulting hypotheses through econometric analysis. In general, their analysis supports the theoretical model's predictions. Most importantly for our context of PES, they find that communities that value the forest more, in particular those that derive a large proportion of their income from the forest, are more likely to obtain higher payoffs, both because they have a greater ability to self-enforce property rights and because they request more compensation for environmental losses.

The theoretical results and the empirical analysis presented in Engel and Palmer (ibid) help to understand the observed variation in actual community payoffs received from logging. One approach for PES design would be to use these results to predict communities' expected payoffs from logging deals, and to use these predictions as a proxy for communities' opportunity costs. Thus, given data on model parameters for potential PES communities, we could use the results of Engel and Palmer (ibid) to predict where on the observed range of USD 0.28 to 11.81 per m^3 of timber extracted the communities' expected payoffs under a logging agreement would be likely to lie. Payments under a PES scheme should then be at least as large as these expected payoffs. Moreover, if the objective of the scheme is to maximize environmental service provision with a given budget, and if we assume that environmental services per hectare are approximately equal across communities, we might find it most efficient to choose those communities for PES that have the lowest expected payoffs from a potential logging agreement, i.e., those communities with expected payoffs at the lower end (around USD 0.28 per m^3).[10] However, as we will see in chapter 4, such an approach would be neither effective nor efficient. To consider effective PES design, we need to go one step further and consider corner solutions to the bargaining game, i.e., conditions for negotiations to fail. These are discussed next.

3.4. Negotiation failure

As Engel, López and Palmer (ibid) argue, if the sum of both players' reservation utilities exceeds the 'size of the cake' to be divided in a negotiated agreement, then negotiations will fail and the players simply obtain their reservation utilities. (Again, we consider here the case where bargaining is feasible because the community can win a potential conflict over *de facto* property rights.) As explained in the previous section, the reservation utility of the firm is given by its net profits from employing its capital in the next best option. The community's reservation utility is given by its valuation of the

[10] Of course, in practice environmental services provided by a hectare of standing forest may differ according to geographic and ecological conditions. This aspect is beyond the scope of this paper.

standing forest. As Engel, López and Palmer (ibid) show, the boundary condition determining the success or failure of logging negotiations can be represented by the line '*BC 2 (Negotiation failure)*' in figure 2. Again, this line is only relevant in the case where the community can win a potential conflict with the firm. Mathematically, this line represents all points where the sum of both players' reservation utilities just equals the 'size of the cake' (net logging profits).

In summary, our boundary conditions yield three potential outcomes of community-firm interactions. First, the firm may be able to effectively control both capital and the forest resource, resulting in unilateral logging without community consent and no or little community payoffs (area I in figure 2). Second, the community may be able to self-enforce its rights over the forest and this may result in a negotiated logging agreement between the community and the firm (area II in figure 2). In this case, community payoffs are increasing in the community's valuation of the standing forest. Third, the community may be able to self-enforce its rights over the forest, but its valuation of the standing forest may be so high, or logging profits so low, that there is no negotiated outcome that both players would agree to. In this case, negotiations would fail and forests would be preserved (area III in figure 2).

4. Implications for PES design

4.1. Effective PES design

How does PES affect the outcomes of community-firm interactions, and what does this imply for PES design? In the absence of PES, the communities valuation of the standing forest may include direct uses of the forest (e.g., the collection of fuelwood and non-timber forest products); it may also consider ecological services from the standing forest (e.g., erosion prevention, water retention) as well as non-use values (e.g., the cultural value of living near forest). The introduction of PES adds an additional value to the standing forest for those communities receiving PES. This value may reflect all or part of the benefits from the forest obtained by society at large. For simplicity, in our discussion, we assume that PES is simply made for conservation of the standing forest and not for any specified service such as carbon or biodiversity. Thus, the per-period payment made under PES is conditional on the conservation of the forest. Let us now consider a number of examples of PES introduction in graphical terms and what they imply for PES design.

Case 1: Unenforceable PES

Consider first a community initially located at point A in figure 3. Introducing PES would induce a horizontal shift to the right, say to point B, as the community's valuation of the standing forest increases through PES. The length of the horizontal shift gives the per period amount of PES. The community would now prefer conservation over a negotiated agreement (since point B is located to the right of boundary condition *BC 2*). However, since point B is still located in area I, the community is unable to win a potential conflict with the firm and hence cannot enforce the PES contract. Therefore, the logging firm logs unilaterally and PES is ineffective. This case highlights the fact that any PES contract, to be effective, needs to be enforceable. In the absence of external enforcement, this implies that PES needs to induce a shift to the right of boundary condition *BC 1*, i.e., to a situation where the community is able to self-enforce property rights over the forest and prevent the firm from logging unilaterally.

[Figure 3 here]

Case 2: PES leads to community-firm logging agreement

Now consider a community initially located at point C in figure 3. Thus, as before, the community cannot enforce its rights over the forest prior to PES implementation. Suppose PES is introduced to shift the community to point D in the figure. Then, the introduction of PES enables the community to self-enforce its property rights over the forest. Nevertheless, PES fails to induce forest conservation (since point D is located in area II). The community uses its newly achieved self-enforcement ability to negotiate a logging agreement and take part in the financial benefits from logging. Thus, PES leads to a community-firm logging agreement, but is ineffective in achieving forest conservation.

Case 3: PES raises community payoffs from logging

A third case considers a community initially located in area II, i.e. being able to self-enforce its property rights over the forest (point E in figure 3). Suppose PES induces a shift to point F. Then, PES raises the community's reservation utility leading it to negotiate a better logging deal (since point F is still located in area II and we have seen in section 3.2. that community payoffs are increasing in the community's valuation of the standing forest). In other words, the introduction of PES simply results in the firm offering a better deal than it would have done in the absence of PES. Again, PES is ineffective in achieving forest conservation.

Case 4: No additionality

Figure 4 illustrates two further conditions for effective PES. First, logging needs to be profitable for otherwise the forest would be conserved anyway. In other words, where logging is unprofitable (e.g., point A in figure 4), PES would not provide additionality. Second, the same holds for communities initially located in area III (e.g., point B in figure 4); these communities, in the absence of PES, already value the forest so highly in comparison to logging profits that they would have successfully resisted any logging agreement anyhow. Therefore, there is no point in providing PES to communities that would conserve the forest regardless of external commercial interests. Instead, to achieve additionality, environmental service buyers should focus on communities that, prior to PES introduction, are located in areas I or II.

Conditions for effective PES

The above cases illustrate that PES, by raising the community's valuation of the standing forest has two effects in our setting. First, it raises the community's ability to win a potential conflict with the firm, thereby increasing its ability to self-enforce property rights to the forest. This effect is consistent with our findings in section 3.1. Second, as shown in section 3.2., the increase in the community's valuation of the standing forest through PES raises the community's reservation utility and thereby its expected payoff in negotiations over a logging agreement. Essentially this happens because firms, realizing that the community's reservation utility has improved, will also raise their offer to the community. Note that the firm is able to raise its offer as long as it can still retain enough logging profit to be better off than under its next-best activity. Thus, the attempt to use PES to compensate the community for the lost payoffs from a potential agreement with the firm is futile unless the PES amount is large enough to outbid the highest potential offer by the firm. Moreover, we have shown that additionality requires that PES focuses on communities initially located in areas I or II, i.e., communities where logging is likely to take place in the absence of PES.

Graphically, this can be seen in figure 5. For PES to be effective in terms of forest protection, two conditions need to be satisfied. First, the community, given PES, has to be able to effectively enforce its property rights over the forest. Second, the community needs to be better off under PES than under the most favorable potential logging agreement. Thus, to be effective, PES needs to induce a shift into area III, irrespective of the community's starting point. In area III, the community is able to self-enforce its rights over the forest (*PES is enforceable*), and the community's reservation utility is high enough to induce logging negotiations to fail, i.e. 'the cake' from logging becomes too small to compensate both actors for the loss of their reservation utilities (*PES induces conservation*).

[Figure 5 here]

The conditions for effective PES can be summarized as:

i. ***The community, given PES, needs to be able to win a potential conflict with the firm (Boundary condition 1). Otherwise the firm can log despite PES agreement.***

ii. ***PES needs to induce a breakdown of any potential logging agreement – (Boundary condition 2). Otherwise PES would only raise community payoffs from logging.***

iii. ***PES needs to focus on communities where logging is likely to occur in the absence of PES (i.e., communities initially located in areas I or II). Otherwise PES fails to induce additionality.***

Note that condition *ii* implies that the level of PES is not the expected payment according to what we observed in terms of actual logging payments in figure 1 (an average of approx. USD 3,60 per m^3 in our sample). Orienting PES amounts towards currently observed logging fees may only allow communities to negotiate better logging deals, but may not be effective in achieving a real increase in environmental service provision. Rather, the payment required depends on the maximum that the logging firm would ever offer because the firm realizes that PES increases the community's reservation utility and hence will offer more so long as it retains positive profits from logging. This maximum possible offer by the firm is likely to be unobserved and may substantially exceed the maximum payment observed in the field (USD 11.81 per m^3 of timber).

4.2. Achieving efficiency

Let us now turn to the issue of efficiency, i.e. how a PES scheme can maximize environmental service provision with a given budget (figure 6). Let us again assume for simplicity that the environmental services provided by a hectare of forest protected is the same in all communities. As discussed earlier, conventional wisdom would suggest focusing on those communities with the lowest expected payoffs from a logging agreement. We will show now that this intuition is once again misleading.

As we have seen above, inclusion in a PES scheme will shift a particular community to the right, because it raises the community's valuation of the standing forest. Moreover, the size of the shift indicates the size of the per-period PES made. To be effective, the change has to be large enough to induce a shift into area III. It is easy to see from figure 6 that such a shift could be achieved at low cost for communities close to, but to the left of the thick line reflecting the binding condition among the two boundary conditions (conditions (i) and (ii) for effective PES). These communities are marked by a circle in figure 6. Note, however, that the communities close to and to the left of the thick line are not necessarily the communities with the lowest expected payoffs from a negotiated agreement. In fact, at least within area II, these are the communities with the highest expected payoffs prior to PES. Points in area I do reflect communities with lowest expected payoffs, but unless located close to the thick line a small payment would fail to induce effective PES for the reasons explained in cases 1 and 2 in section 4.1.

[Figure 6 here]

5. Empirical application

In this section, we illustrate how the theoretical results can be combined with empirical analysis to guide PES design. As we have shown in section 4, PES design would require an understanding about the location of communities in terms of the areas in our figures. In particular, we need an estimate of the two crucial lines delineating these areas: the boundary conditions for the war of attrition and for negotiation failure.

Our Indonesian data can be used to estimate the first of these lines. Palmer (2005) used data on the financial payments received by the 62 communities surveyed to analyze the probability of these communities falling in areas I and II. A minimum payment of Rp. 15,000 per m^3 of log production was established as the cutoff point on the basis of this being the lowest payment negotiated in the sample. Thus, any actual payment received falling below this threshold was assumed to indicate that the community was unable to self-enforce property rights. 19 communities (31 percent of the sample) received a fee level that came below this threshold, while the remainder received Rp. 15,000 or more per m^3. A sensitivity analysis varying the level of the threshold was conducted to test the robustness of the results to this assumption. Given the discrete nature of the dependent variable, a logit model was run on a combination of proxies for the theoretically relevant parameters. Table 1 below shows the results of the econometric analysis.

The results generally confirm the theoretical hypotheses presented in section 3.1. Community blockading costs were proxied by the proportion of households participating in community organizations and the proportion of households containing members of dominant ethnic groupings (both variables proxies for social capital), the proportion of households with government employees and distance to the market (both proxies for opportunity costs).[11] The directions of the effects in table 1 are in accordance with the predictions of the theoretical model, i.e., the probability of a community being able to enforce its rights over the forest is decreasing in the community's blockading costs. Only household participation in community organizations and market distance are statistically significant, however. Community discount rates were proxied by the proportion of households holding savings before the onset of negotiations, with poorer communities

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[11] In the Indonesian context, where all households go to the market regularly to sell excess produce for cash income regardless of distance, and where other market opportunities for work are negligible, opportunity costs are likely to increase with distance to the market (Palmer, 2005). This is in contrast to other contexts where household participation is elastic to distance from market and therefore greater distance implies lower opportunity costs.

expected to have higher discount rates. The results indicate a significant positive effect on the ability for communities to enforce its property rights, supporting the theoretical hypothesis that lower discount rates are associated with an improved ability to fight. Average household incomes derived from forest products proxied for community valuation of the standing forest. As expected the effect was positive, although not significant. This may be due to the fact that the variable reflects a percentage of total income rather than the absolute value of the forest. Finally, the probability of a community being able to enforce property rights significantly increases if the community's forest was logged before and is significantly decreasing in the size of the area logged. Both of these factors are proxies for logging profitability. A relatively high proportion of outcomes, over 70 percent, are predicted accurately by the model.

While our analysis illustrates an empirical estimation for the boundary condition for the war of attrition in figure 6 and confirms the theoretically derived hypotheses, a few words of caution are in order. Most importantly, the communities sampled in this survey had all involved in negotiations with logging companies leading to an agreement between the parties. Thus, it is likely that area I communities were undersampled and additional data would be required to improve our analysis. Moreover, proxies used were often not ideal (as, for example, in the case of community valuation of the standing forest) or missing altogether (as was the case for firm discount rates and logging costs). The latter could potentially introduce omitted-variable bias, although it is not unreasonable to assume that in our context firm parameters did not vary much across the sample.

Nevertheless, the analysis illustrates how boundary condition *BC 1* can be estimated using empirical data. What about boundary condition *BC 2*? Unfortunately, due to the focus of our fieldwork on negotiated agreements, data was not available on communities falling into area III, although there was anecdotal evidence for at least two communities that had declined all offers for logging agreements, opting for forest conservation instead (for one of these cases, see Iwan, 2004). Similar to the analysis on areas I and II, which yields the boundary condition for the war of attrition, the collection of data on communities falling in area III would allow us to estimate the boundary condition for negotiation failure. The results in section 3.4. indicate that relevant explanatory variables should include proxies for net logging profits, the community's present value of the standing forest (which itself depends on the community's per-period valuation of the standing forest and its discount rate), and the firm's alternative investment opportunities (which may be proxied by market interest rates).

If more complete data were collected to permit an adequate estimation of the two boundary conditions in figure 6, the following procedure could be used in PES design. Data on the empirically relevant independent variables for all communities that could be potentially included in a PES scheme would need to be collected. Alternatively, communities could be required to self-report these characteristics when applying for PES.[12] The econometric results on the two boundary conditions could then be used to estimate each community's predicted probabilities of (a) winning a war of attrition, and (b) opting for forest conservation. We would then want to consider those communities for PES that satisfy two conditions. First, they should have one of the two predicted probabilities greater than 0.5 (indicating that they lie on the right of one of the boundary conditions). Second, the other predicted probability should be below, but close to 0.5

[12] Of course, self-reporting may induce problems of asymmetric information. This is an important issue that is beyond the scope of this paper.

(indicating that the community lies close to and to the left of the other boundary condition). In summary, these conditions imply that the communities lie to the left, but close to the thick line in figure 6.

Estimating the payment required to induce the selected communities to opt for PES and forest conservation is an even more complex task. Our results indicated that this minimum payment depends on model parameters.

In practice, there are obvious logistical and financial constraints in collecting all the data required for the design of the PES scheme. Perhaps more promisingly, an approach like the one described above could be used to estimate the boundary conditions and to identify communities predicted to lie in area III. These communities should not be considered for PES design to assure additionality. For the remaining communities under consideration, auction or contract design could be used to elicit their opportunity costs (see article by Ferraro in this volume).[13]

5. Conclusions

We have analyzed PES design in the context of Indonesia, where community property rights over the forest are weak and logging companies interested in the commercial exploitation of the forest are present. Our starting point was the conventional wisdom that PES should compensate communities for their expected logging payoffs, and that an efficient PES design should focus on those communities with the lowest expected logging payoffs. Based on the observation from fieldwork that actual payoffs vary greatly among communities involved in logging agreements, we presented a game-theoretic

[13] Auction design would, however, require that communities are aware of the firm's potential to raise its payments.

model of community-firm interactions that provides a potential explanation on the causes of this variation.

We then analyzed the model's implications for effective and efficient PES design. The results indicate that the conventional wisdom is misleading in the Indonesian context. There are two main reasons. First, communities with very low expected payoffs from negotiations tend to also be those that are not able to self-enforce property rights and prevent unilateral forest exploitation by firms. Therefore, PES agreements with these communities may not be effective. Second, the introduction of PES affects communities' valuations of the standing forest. This will not only impact on the communities' ability to self-enforce its property rights, but it may also affect their expected payoff from a negotiated agreement. If this endogeneity of community payoffs is ignored, the implementation of PES may only result in better logging deals for local communities, without achieving forest conservation. Thus, the relevant logging payment to be considered is the best possible offer by the firm (unobserved). Once these complexities are taken into account, policy recommendations are quite different from the common intuition, and in fact, designing an effective and efficient PES scheme becomes a very complex task. Moreover, the costs of an effective PES could potentially be much higher than expected from considering currently observed logging fees.

We have also illustrated how the theoretical results could be used in empirical analysis to guide PES design. Further research on how to reduce transaction costs in such an endeavor is needed. In particular, auction design may be an alternative to solicit opportunity costs. The theoretical and empirical results presented here could guide such design, for example in helping to ensure additionality. Our results are likely to be useful for other cases and countries where local people deciding upon land uses have weak property rights over natural resources and where external forces interested in the commercial exploitation of community resources are present.

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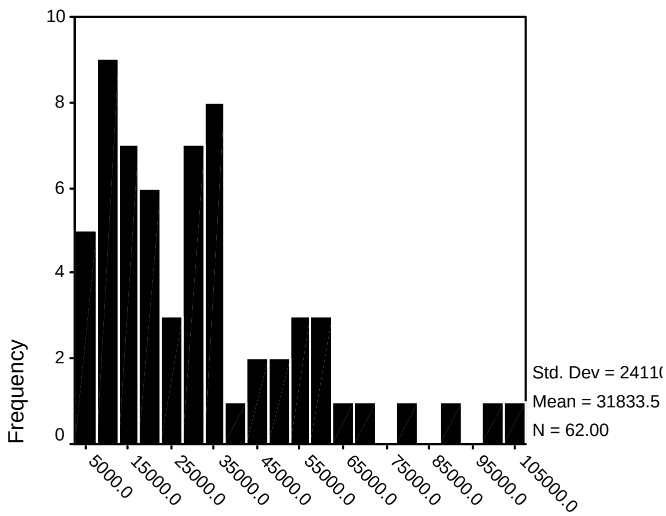
Table 1: Econometric results on probability of community being able to enforce property rights

Variable	Coeffi-cient	Std. Error	t-stat.	P[|T|>t]
Constant	-3.2680	2.6455	-1.235	0.2167
Average proportion of household incomes derived from sale of forest products	0.1587	0.2272	0.698	0.4850
Forest quality: area logged before by commercial operation (Yes=1, No=0)	2.1276	1.1978	1.776	0.0757*
Actual area logged (ha)	-0.0096	0.0044	-2.154	0.0312**
Proportion of households containing at least one government employee	-0.7598	0.5081	-1.495	0.1348
Proportion of households that participate in community organizations	0.7434	0.3270	2.273	0.0230**
Proportion of households containing members of dominant ethnic grouping	0.3034	0.2534	1.198	0.2311
Distance to nearest market (km)	-0.2566	0.1570	-1.635	0.1021
Proportion of hhs holding savings before agreement	0.1267	0.5515	2.298	0.0216**
No. of observations		62		
Restricted log likelihood		-38.2		
Chi-squared		37.8		
% of outcomes predicted correctly		71.0		

Source: Palmer (2005)
Note: *significant at 0.10 level; **significant at 0.05 level. All results corrected for heteroskedasticity

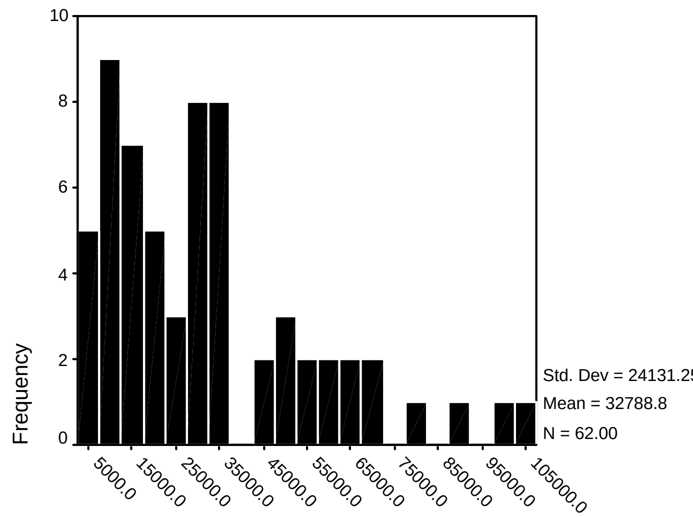
Figure 1: Variation in community financial and social benefits from logging agreements

i. Financial payments



Actual fee paid to community only

ii. Financial payments and social developments



Actual fee paid to community plus value of social developments

Source: Engel and Palmer (forthcoming)

Figure 2: Outcomes of community-firm interactions

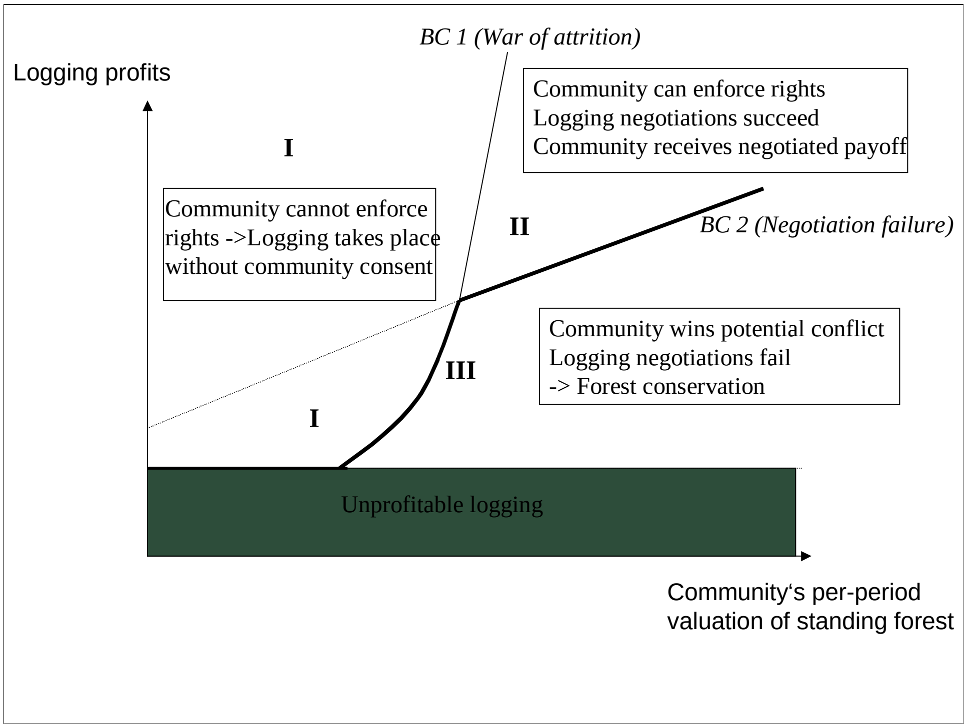


Figure 3: Ineffective PES

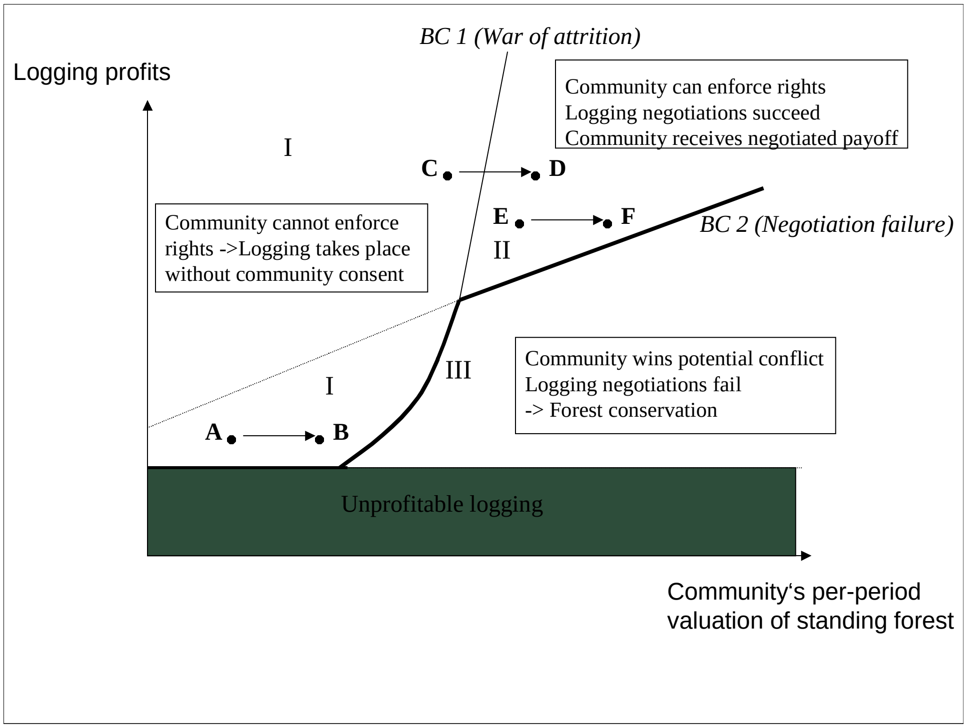


Figure 4: Lack of Additionality

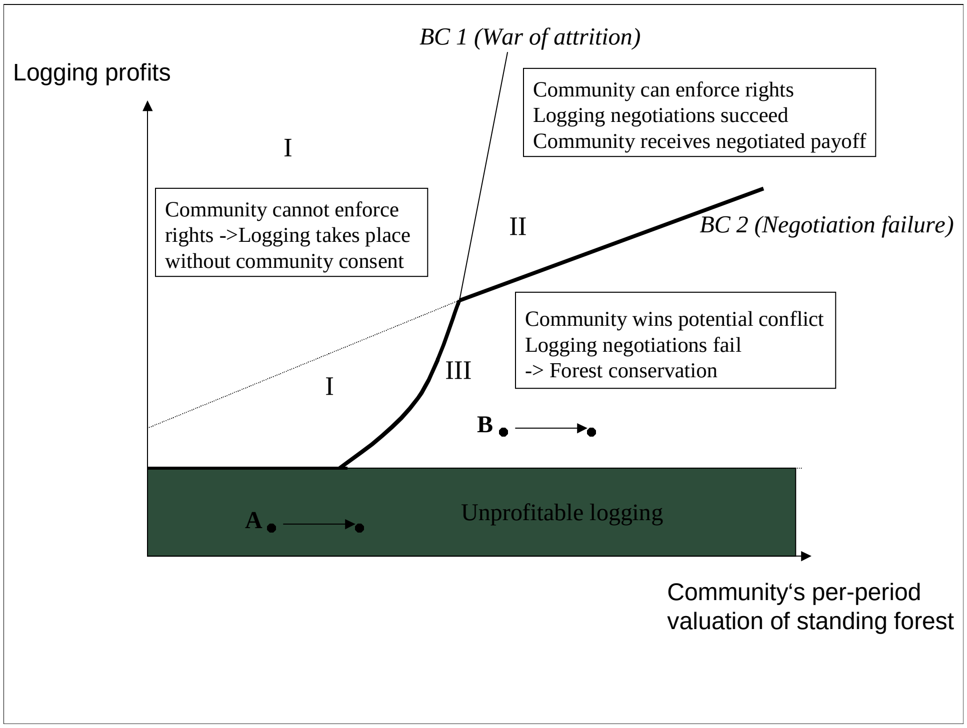


Figure 5: Effective PES

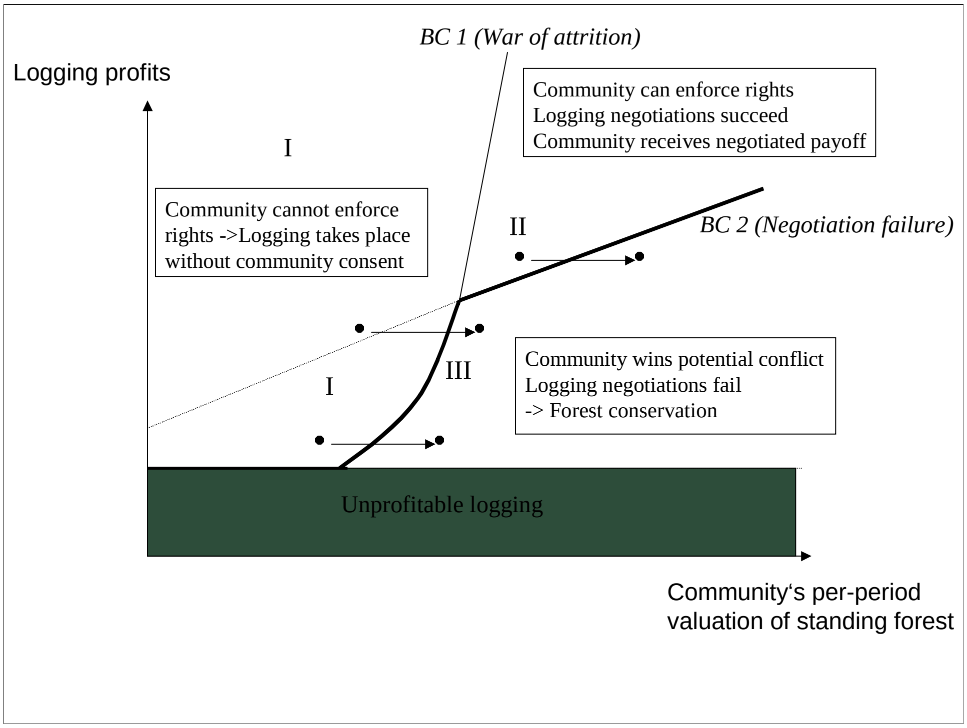


Figure 6: Efficient PES