DRAFT May 10, 2004

EXPLOITING COMMON RESOURCES WITH CAPITAL-INTENSIVE TECHNOLOGIES: THE ROLE OF EXTERNAL FORCES[†]

Stefanie ENGEL, University of Bonn, Center for Development Research, Walter-Flex-Str. 3, 53113 Bonn, Germany, st.kirchhoff@uni-bonn.de

Ramón López, University of Maryland, Department of Agricultural and Resource Economics, 2200 Symons Hall, College Park, MD 20742, USA, rlopez@arec.umd.edu

Abstract

Many natural resources can be effectively exploited mainly by using capital-intensive technologies. We develop a bargaining model with endogenous inside and outside options to analyze the interactions between local communities having at least some degree of informal claims over natural resources and external agents, particularly firms interested in commercial resource exploitation. We analyze the effects of three general types of intervention by third-party actors: (i) interventions affecting market power or discount rates, (ii) interventions affecting *de facto* property rights, and (iii) interventions affecting the opportunity cost of labor. Our results indicate that the strategy of intervention matters. We show that third party interventions that are responsive to the intensity of resource exploitation may have counter intuitive effects. In particular, improvements in the community's bargaining power vis-á-vis the firm are likely to increase resource extraction and thereby harm the environment. Moreover, an increase in the wage rate may increase environmental degradation.

Key words: conflict, negotiations, bargaining, natural resources, devolution, community-firm interactions

[†] Funding for this research was provided by the Robert-Bosch Foundation.

EXPLOITING COMMON RESOURCES WITH CAPITAL-INTENSIVE TECHNOLOGIES: THE ROLE OF EXTERNAL FORCES

Table of Contents

1. Introduction

Many natural resources can be effectively exploited mainly by using capital-intensive technologies. Dense forests, oil and natural gas, hydraulic resources for electricity generation, mines and others, mostly need large capital investments for their commercial exploitation (Bohn and Deacon, 2000)). Even if these natural resources are under some degree of control by local communities, the latter usually have to rely on specialized firms for their commercial exploitation because capital market failures and poverty prevent communities from borrowing enough funds to obtain the technology and capital necessary for commercially exploiting these resources by themselves (Bose, 1998). This paper focuses on the interactions between local communities having at least some degree of informal claims over natural resources and external agents, particularly firms interested in commercial resource exploitation. In addition, we also consider the *endogenous* participation of a third type of agent that is increasingly more important in affecting the interactions between the two main agents: NGO's and international donors who usually focus on the welfare of the local communities and the environmental consequences of resource exploitation.

Over the last decade, about 60 countries worldwide have decentralized at least some aspects of the management of their natural resources (Ribot, 2002; Kaimowitz, 2002a).

Decentralization in many cases has led to some degree of control over natural resources by local (usually poor) communities, a process frequently referred to as "devolution". For example, countries such as Indonesia, South Africa and Mexico, among many others, now require that firms interested in exploiting natural resources get involved in some form of negotiation with local communities. Devolution introduces the possibility for communities to bargain with other agents interested in exploiting the resources (referred to hereafter as "the firm"), but does not necessarily preempt other, potentially more conflictive, forms of interactions. Three features characterize the devolution process in most countries. First, the transfer of authority to local communities is often incomplete; legal rights are diffused and difficult to enforce (Ribot, 2002; Palmer, 2003; Feder and Feeney, 1991). Second, as mentioned earlier, there is external participation by NGOs, donor agencies and others affecting the community-firm relationships at least in an indirect way. Third, in most countries firms cannot purchase land or other communal resources either because communities do not have legal titles or because government regulations impede it (Kaimowitz, 2002b). This means that firms have to rely on bargaining with communities, or alternatively, on exploiting the resource unilaterally using force and other illicit means.

The nature of community-firm interactions over natural resources, in particular, whether or not communities are able to enforce their informal property rights, varies dramatically across countries and across communities (Mayers and Vermeulen, 2002). Even in cases where communities do enforce their rights, so that bargaining with the firm actually takes place, contracts differ significantly in their financial and environmental provisions. The objective of this paper is to shed light on the causes of this variability in outcomes, and at the same time to provide insights on the most effective way by which third parties (NGOs, donor agencies) can influence the community-firm interaction.

Though we are not aware of the existence of studies that analyze community-firm interactions, in principle there are two approaches that can be used in modeling these interactions. The first approach emphasizes conflicts over property rights, including Burton (2003) who models conflicts between firms and environmentalist groups, as well as Alston, Libecap and Mueller (1999a, b), Hotte (2001), and Angelsen (2001) who model conflicts between landowners and squatters, landowners and potential encroachers, and state and local communities, respectively. This literature focuses exclusively on conflict issues without allowing for the possibility that actual or potential conflict may lead to negotiation or

bargaining. A second approach may consist in analyzing such interactions through a pure bargaining model.

This paper makes three contributions to the existing literature. First, unlike the literature on devolution and communal resource management which focuses on *internal within-community* governance issues[1], we extend the analysis to examine interactions between the community and outside agents. Second, unlike both the literature on conflict and bargaining, we integrate these two strands of the literature, so that we can endogenously derive the conditions under which community-firm interactions result in conflict or, alternatively, in bargaining agreements. Third, to the best of our knowledge, this is the first study that formally models the endogenous participation by third parties that may attempt to support communities in the process.

We postulate a two stage bargaining process. In the first stage, the community and the firm decide over the division of profits derived from the extraction of the resources, conditional on a given level of exploitation, and in the second stage, the level or intensity of exploitation of the resource is negotiated. We argue that the inside options, defined as the parties payoffs while in the process of bargaining (Bulow and Rogoff, 1989) are endogenous to the bargaining process. Whether bargaining succeeds or conflict prevails depends crucially on the two parties' outside options, defined as the parties payoffs available when the bargaining fails (Binmore, 1985). In the context of weak property rights, however, outside options are not exogenous. Thus, we explicitly model these outside options as the outcome of a (potential) war of attrition between the community and the firm over *de facto* property rights.

We show that third party interventions that are responsive to the intensity of resource exploitation may have counter intuitive effects: In particular, if third parties tend to increase their support to communities where the environmental threat is large (e.g., NGOs intervening more intensively in "hot spot" areas where resources may be exploited most intensively) and communities and firms build this response into their expectations, the outcome of the firm-community bargaining may be one that potentially involves a more intense resource exploitation and, therefore, greater environmental damage. The community and the firm may have incentives to increase resource extraction so that NGOs will be enticed to provide more

[1] See, for example, Bardhan (1993a/b) and Ostrom (1990). For a review of this literature see Baland and Platteau (1996) and Agrawal (2001).

payments to the communities, thus increasing the size of the "cake" available to be distributed between the firm and the community. Whether or not this disturbing potential outcome occurs, however, in part depends on the specific way in which NGOs intervene: there are certain types of intervention that make this outcome more likely than others.

We analyze the effects of three general types of intervention by third-party actors: (i) interventions affecting market power or discount rates, (ii) interventions affecting *de facto* property rights, and (iii) changes in the opportunity cost of labor. Our results indicate that the strategy of intervention matters. We also show that the explicit modeling of the linkages between conflict and bargaining outcomes leads to non-trivial changes in the comparative static analysis. Specifically, improvements in the community's bargaining power vis-á-vis the firm are likely to increase resource extraction and thereby harm the environment. Moreover, an increase in the wage rate may have continuous or discontinuous effects on the environment, depending on initial conditions. We show that the continuous effect generally corresponds to the standard comparative static intuition (i.e., an increase in the wage rate reduces environmental degradation). The discontinuous effect, however, can be paradoxical and counter-productive.

The remainder of the paper is structured as follows. Part 2 presents the model. Part 3 examines the effect of alternative strategies of intervention by third-party actors on the environment. Part 4 concludes.

2. Modeling community-firm interactions

2.1 Conflict and outside options

In what follows we model the process of community-firm negotiations over a logging contract through a bargaining model. We use the terms 'forest' and 'logging' as metaphors for the more general problem, which could be expressed in terms of 'resource', and 'resource extraction' and once in a while remind the reader that the problem is really more general. Similarly, the term 'community' stands for any entity that may have access to a natural resource, but cannot exploit it as a consequence of, for example, poverty or credit market imperfections. The term 'firm' is used to denote any entity that does not have automatic access to the resource, but has the capital to exploit it.

The feasibility of bargaining depends on outside options. These are the payoffs obtained by the players if they choose to permanently stop bargaining and to not reach an agreement

(Muthoo, 1999). We argue that, in the context of weak property rights, outside options depend on the *de facto* property rights that may emerge in the absence (or breakdown) of a logging agreement.

We assume that logging requires a specific factor, capital, that is available to the firm, but not to the community, forest area, and variable inputs. Let the firm's profits from logging be defined as $v(w;L,K)$, where K is the exploitation capital, L is the area logged, and w is a vector of wages, other variable input prices and output price. The firm's profit function is assumed to satisfy all the properties of a well-behaved variable profit function including monotonicity and convexity in w (Diewert, 1973) and to satisfy other plausible assumptions, such as being increasing and concave in L and K. For simplicity of exposition we will omit arguments other than L from v, except when needed for comparative static purposes.

The assumption that logging requires a specific factor that is available only to the firm implies that the firm has the ability to exploit the resource while the community may under some conditions be able to prevent unilateral exploitation of the resource by the firm. Thus, *de facto* property rights can be considered as the outcome of a conflict between the community and the firm. We now proceed to model this process in more detail.

One common way to model conflict is that of an attrition war[2]. Most attrition models assume that competing agents follow a strategy to gain property rights (or win other types of conflicts). In our case, the strategy for the firm involves unilateral logging attempts (without sharing the benefits with the community), while for the community it consists of setting up blockades to prevent the firm from logging. The attrition element is related to the fact that the agent that is potentially able to persist the longest, wins the war. If the community can win the attrition conflict the firm may be forced to bargain and thus to share the benefits of the exploitation with the community. Naturally this means that the cost of the conflict strategy, as well as the benefits to each agent from winning the war, and their respective discount rates (due to the time dimension) play a role in defining the winner.[3]

We now consider the boundary conditions that determine who can win the firm-community attrition conflict (Burton (2003) derives a similar condition using a discrete rather than a continuous framework for a related problem). First we determine the critical attrition

[2] See, for example, Dixit and Nalebuff, 1991; Bulow and Klemperer, 1999

[3] Attrition wars do not need to be actual wars. Rather they are often virtual, particularly in the absence of information asymmetries, as we assume here, i.e., with perfect information, the agent that would lose the war simply withdraws.

points, i.e., the maximum length of time that each participant can afford to be in conflict. For each player the conflict involves different costs including the cost of time (the discount rate) and the actual disbursement to finance the standstill. The critical point of each player is thus defined as the maximum length of the conflict that would allow a non-negative net present value. For the firm this condition is represented as,

$$exp\{-r_F t_F\}v(\hat{L}) - \int_0^{t_F} c\, exp\{-r_F t\}dt = 0, \quad (1)$$

where r_F is the firm's discount rate, t_F is the maximum time length that the firm can stay in conflict, $\hat{L}$ is the level of logging that maximizes *v*, *c* is the fixed cost to the firm of staying in conflict in a given period (of an unilateral logging attempt by the firm). The solution to (1) is thus,

$$t_F = -\frac{1}{r_F}\ln\left(\frac{c}{r_F v(\hat{L}) + c}\right). \quad (2)$$

Similarly, the community's critical condition is,

$$h_0 B(\overline{L}) - \int_0^{t_C} s \exp\{-r_C t\}dt = 0, \quad (3)$$

where *s* is the per-period cost incurred by the community in trying to prevent the firm from exploiting the resource unilaterally (e.g., the cost of setting up road blockades and other means), $\overline{L}$ is the total forest area, $B(\overline{L})$ is the true total present value of the standing forest prior to its exploitation, $h_0 \in [0,1]$ is the proportion of this total value considered by the community in the absence of negotiations[4], and r_C and t_C are the community's discount rate and critical length of time for which it is able to afford the conflict, respectively. We assume that the true *ex-post* value of the standing forest, $B(\overline{L} - L)$, is an increasing and concave function of the level of standing forest remaining. The standing forest usually has values that the community does not necessarily consider. These include the regional and global services provided by the standing forest, e.g.—at the regional level—water retention, flood prevention, erosion control, etc., and—at the global level—carbon retention and biodiversity preservation.

[4] Externalities and lack of awareness or knowledge may cause the community to internalize only part of the environmental value of the forest. The intuition and role of h is explained in more detail in section 2.2.

Depending on the community's level of awareness, it may also not even consider all the local environmental values of the forest to the community. Thus, we usually will have that $0<h_0<1$.

The solution of (3) is,

$$t_C = -\frac{1}{r_C}\ln\left(1-\frac{h_0 B(\bar{L})r_C}{s}\right). \qquad (4)$$

A boundary condition is given by the tie point at which $t_C = t_F$. Using (2) and (4) we have that the boundary condition is,

$$v(\hat{L}) = \frac{c}{r_F}\left[\left(1-\frac{h_0 B(\bar{L})r_C}{s}\right)^{-\frac{r_F}{r_C}} - 1\right] \equiv \Lambda . \qquad (5)$$

A few remarks are important concerning (5). First, if the present value of the benefits of the standing forest to the community are less than the cost of blockading for a single period, $h_0 B(\bar{L})<s$, the community will never oppose any resistance to the firm's actions. The firm knows that the community would never attempt to fight in this case. That is, as long as $v>c$, the firm always wins the attrition conflict. Second, condition (5) does not apply if the rental value of the community benefits of the standing forest (the value of the standing forest to the community in a single period) is higher than the per-period cost of blockading, $\frac{h_0 B r_C}{s} > 1$. In this case, the community always wins the attrition war because it would be willing to fight indefinitely.

For the case in which $s < h_0 B < \frac{s}{r_C}$ the intuition is the following. If the present value of the standing forest to the community is greater than the blockading cost, the community may put up a fight. In this case, the firm has to consider the additional cost involved in such a fight. That is, having a positive net profit out of logging is not sufficient to allow the firm to win the attrition war. The net profit should be sufficiently large to pay for the additional cost required to win a potential endurance fight with the community. The right hand side in (5) represents this additional cost, which is increasing in the firm's discount rate and the value of the standing forest to the community, and decreasing in the community discount rate and blockading costs.

Thus, if $v(\hat{L}) > \Lambda$, the firm would win a potential conflict. This can be interpreted as the case where the community is not able to effectively enforce its property rights. If the firm cannot acquire permanent legal property rights, this amounts to a situation of open access. If, however, $v(\hat{L}) < \Lambda$ (e.g., if h_0 is large or s is low), then the community is able to establish effective property rights on the resource.[5]

The possible property right outcomes discussed above and the potential for bargaining arising from the conflict game are shown in Figure 1. There are two necessary conditions for bargaining to take place. First, there needs to be complementarity between the firm and the community in terms of access to the factors of production required for logging. The firm has access to capital, while the community may be able to control the natural resource. The second condition for bargaining is that the community has to be able to enforce its property rights (i.e., the community is in a situation of winning the attrition war). Otherwise, the firm would effectively have access to both factors of production and simply log unilaterally.[6]

Thus, the outcome of the community-firm interaction is asymmetric: If the firm is able to win a potential conflict ($v > \Lambda$), the community will effectively lose property rights to the resource and hence, since by assumption the firm is not allowed to acquire formal property rights, the firm will exploit it unilaterally as an open access resource. This case is represented by area I in the figure. If, however, the community is able to win the war of attrition ($v < \Lambda$), then it effectively is able to exert property rights over the resource. This corresponds to area II in the figure. In this case, bargaining between the community and the firm is possible. (In section 2.4, we will show that the community actually always at least weakly prefers bargaining over the alternative of conserving the forest unilaterally.)

From the previous analysis, we have the following proposition,

Proposition 1 (Bargaining vs. conflict): The ability of the community to establish de facto property rights is a necessary condition for a negotiated solution to the resource exploitation problem to emerge. This is more likely if the profitability of timber (v), blockading costs (s), and the community's discount rate (r_C) are low, and if logging costs

[5] If there is imperfect information on the part of either or both players, then actual rather than virtual conflict is possible. But the final outcome of the conflict will be ruled by the same parameters considered in the perfect information case.

[6] In reality, this may also take the form of the firm exploiting the community through poor deals or non-compliance with agreements.

(c), the value of the standing forest to the community ($h_0 B(\overline{L})$), and the firm's discount rate (r_F) are high. □

2.2 Inside options in bargaining

Inside options (denoted here as d^C and d^F for the community and firm, respectively) are defined as the payoffs obtained by each player while parties temporarily disagree and negotiations are ongoing. We assume that inside options can be written as

$$d^F = \overline{d}^F \text{ and } d^C = hB(\overline{L}). \quad (6)$$

where $\overline{d}^F$ denotes the firm's exogenous returns from temporarily using the firm's capital (available for the exploitation of the resource) in other activities, and $h \in [0,1]$ is the proportion of this total value considered by the community in the case of negotiations ($h \geq h_0$). Thus, the firm's inside options are assumed exogenous. But, as explained next, in the case where the community is able to establish de facto property rights, the community's inside option is likely to be endogenous.

The community's inside option is given by its valuation of the standing forest in the absence of logging. As argued above, negotiations will only take place if the community is able to establish *de facto* property rights. In this case, we argue that the inside option of the community is endogenous because the degree to which the community considers the true value of the standing forest (h) is likely to be affected by the level of logging negotiated (L). Specifically, we assume that h is increasing and concave in the level of logging proposed in the contract, L. That is, $h'(L)>0$ and $h''(L)<0$. The argument is that, if the logging plan is too aggressive, it may attract more attention from NGOs, donor agencies, and others concerned about the environment (below we refer to these as *third-party actors*). Outside sources may thus be more willing to provide technical support, education, and conservation payments to the communities in order to raise environmental values and awareness.[7] Such third-party interventions improve the communities' bargaining position by increasing its inside option.[8] This idea and the impact of different strategies of intervention are discussed in detail in part 3.

[7] For example, conservation groups such as Conservation International focus their activities on global 'hotspots', i.e. areas that are under high pressure of deforestation and at the same time rich in biodiversity.

[8] Note that we assume that third-party actors will not intervene on the basis of the firm's logging extent in the case where the firm wins the attrition war. Given the assumption that firms will not be able to obtain legal rights

2.3 Bargaining over a logging contract

We now analyze the outcomes of community-firm bargaining when the community wins de facto property rights. Denote the payoffs assigned to the community and the firm negotiated in the logging contract by Π_C and Π_F, respectively. We assume a Rubinstein-type bargaining where community and firm make alternating offers to define a mutually agreed logging contract. As discussed earlier, this is a bargaining game with inside and outside options. We assume that bargaining takes place in two stages. First, the two players bargain over a distribution of the total net benefits from logging conditional on a level of logging. Second, bargaining over the level of logging takes place.

Bargaining over payments

Muthoo (1999) has shown that the solution to the alternating-offers bargaining game with inside and outside options can be presented in form of an asymmetric Nash Bargaining Solution (NBS). Thus, the payments to the community and firm solve the following Nash bargaining problem

$$\max_{\Pi^F,\Pi^C} \left[\Pi^F - d^F\right]^{\tau} \left[\Pi^C - d^C\right]^{1-\tau} \qquad (7)$$

s.t. $\Pi^F \geq d^F, \quad \Pi^C \geq d^C, \quad \Pi^F + \Pi^C = \Gamma(L),$

where $\tau \equiv \frac{r^C}{r^F + r^C}$, and $\Gamma(L)$ are the total net benefits to the two players under the logging agreement ('the size of the pie'). The latter include the firm's logging profits as well as the value of the remaining forest to the community, i.e.,

$$\Gamma(L) = v(L) + h(L)B(\bar{L} - L). \qquad (8)$$

In addition, as argued above, $d^C = h(L)B(\bar{L})$. The constraints in (7) imply that each player has to obtain at least the value of his inside option, and that total payments have to add up to the total net benefits to be divided, in our case, the logging profits. These conditions are discussed further in section 2.4.

---

in that case, a situation of open access will emerge. Third-party actors then are not likely to gear their interventions to the level of logging intended by the firm because under open access any agent other than the particular firm can access the resource, at least once the firm is not interested in costly attrition wars to defend *de facto* rights. Assuming that the firm understands this, its choice of logging area is not affected by the potential of outside interventions when the community is not able to exert its property rights.

Assuming an interior solution, and using (6), equilibrium payments can be written as

$$\Pi^F = \bar{d}^F + \tau G(L) \qquad (9.1)$$

and $$\Pi^C = h(L)B(\bar{L}) + (1-\tau)G(L), \qquad (9.2)$$

where $$G(L) = \Gamma(L) - \bar{d}^F - h(L)B(\bar{L}). \qquad (10)$$

G(L) is the surplus left after paying both players their inside options. Thus, each player obtains the value of his inside option plus a share of the surplus (*G(L)*) that is inversely proportional to the player's discount rate.

Note that if $\tau = 1$ (the firm has perfect bargaining power), the firm extracts all surplus and the community receives only the value of its inside option. Similarly, if $\tau = 0$, the firm receives only its inside option and all surplus is obtained by the community. In the standard game-theoretic approach τ measures the relative size of the discount rates of the community vis-á-vis the firm. Alternatively, one could interpret τ in terms of market power. $\tau = 1$ can be seen as the case where there is one firm and many communities, so that the firm can simply act as a Stackelberg leader. Similarly, the case of one community and many firms, in which the community acts as a Stackelberg leader, is equivalent to the result when $\tau = 0$. Thus, in this sense, τ can be thought of as relative market power of the firm. Therefore, we will use the terms 'bargaining power' and 'market power' indistinctly below.

Bargaining over logging area

We now consider bargaining over logging area, assuming that the distribution of the net benefits has been decided as discussed above. Note that from equations (9), the payments to both players depend on the level of logging. This is because both the total net benefits to be divided (given by equation (8)) and the community's inside option ($d^C(L)$) depend on *L*. The firm's preferred choice of *L* (denoted by L^F) is the one that maximizes its own payoffs under the logging agreement. From (9.1), this is equivalent to the level of *L* that maximizes the surplus (*G(L)*), i.e., L^F is defined by

$$\Gamma'(L^F) = h'(L^F)B(\bar{L}). \qquad (11)$$

Thus, the firm would want to equate the marginal benefit of logging to the marginal cost of logging implied by the idea that more logging attracts more attention from outside parties, which increases the community's inside option and thereby its payment. We would expect this to be the level of logging resulting when the firm has perfect bargaining or market power ($\tau = 1$).

By contrast, the community's preferred level of logging (L^C) is the one that maximizes Π^C, given by (9.2). Thus,

$$\Gamma'(L^C) = -\frac{1-\tau}{\tau} h\left(L^C\right) B\left(\overline{L}\right). \tag{12}$$

Contrary to the firm, the community considers the effect of logging on its own reservation utility as a benefit. However, the community will only be able to fully impose its optimal level of logging (L^C) if it has full bargaining or market power This would be the case if $\tau = 0$. In that case (12) becomes

$$\Gamma'(L^C\Big|_{\tau=0}) = 0. \tag{13}$$

When the community has perfect bargaining or market power, it receives all surplus beyond the firm's inside options, and therefore, does not consider the effect on its own inside options. Therefore, concavity of *v* and *h* in *L* implies that $L^C\Big|_{\tau=0} > L^F$.

The bargained level of *L* will generally lie somewhere inbetween the values preferred by the two players. The bargaining outcome can be represented as the following Nash bargaining problem[9]:

$$\max_L \left[\overline{d}^F + \tau G(L)\right]^{\tau} \left[h(L)B(\overline{L}) + (1-\tau)G(L)\right]^{1-\tau}. \tag{14}$$

Thus, the community and the firm bargain over the level of logging, with each player trying to maximize the level of payment agreed upon in the previous stage. The first-order condition can be written as

$$\Gamma'(\widetilde{L}) = \kappa\, d^C{}'(\widetilde{L}), \tag{15}$$

where $\kappa = \left[\dfrac{\left(\dfrac{\widetilde{\Pi}^C}{\widetilde{\Pi}^F} + 1\right)\tau^2 - \tau}{\tau^2 \dfrac{\widetilde{\Pi}^C}{\widetilde{\Pi}^F} + (1-\tau)^2}\right]$, $\widetilde{L}$ denotes the equilibrium level of logging emerging from bargaining, and $\widetilde{\Pi}_i$ is the equilibrium payment to player *i*, defined by equations (9) and evaluated at $\widetilde{L}$.

Lemma 1: For $0 \le \tau \le 1,\ 0 \le \kappa \le 1$ ***and*** $\kappa(\tau = 0) = 0$ ***and*** $\kappa(\tau = 1) = 1$. □

[9] All proofs are provided in the extended version of this paper.

Lemma 1 implies that the cases where the firm or the community has perfect bargaining or market power ($\tau = 1$ or $\tau = 0$, respectively) are borderline cases of equation (15). That is, for $\tau = 1$, condition (15) reduces to equation (11), and the firm's preferred level of logging emerges ($\widetilde{L} = L^F$). The firm exploits the fact that increasing L raises the community's inside options, and thus reduces its level of forest cutting below the unilaterally optimal level ($\hat{L}$, given by $v'(\hat{L}) = 0$). Similarly, if $\tau = 0$, the equilibrium level of logging is $\widetilde{L} = L^C\Big|_{\tau=0}$, as defined in equation (13). The community, in this case, does not allow the firm to exploit its endogenous reservation utility. If both parties truly bargain ($0 < \tau < 1$), they will never consider the full effect of the endogeneity of the community's inside option (i.e., for $0 \le \kappa \le 1$). Moreover, we have

Lemma 2: For $0 \le \tau \le 1$, $L^F \le \widetilde{L} \le L^C\Big|_{\tau=0}$. ***Moreover,*** $\dfrac{\partial \widetilde{L}}{\partial \tau} > 0$. □

Lemma 2 implies that the higher the bargaining power of the firm, the lower the level of logging negotiated. This is because the more bargaining power the firm has, the more of the endogeneity effect of the community's inside options will be considered.

2.4. Outside options revisited

There are two ways in which outside options matter for bargaining results. First, the NBS presented above is only valid if the resulting payment to player i ($\widetilde{\Pi}_i$) is at least as large as the value of player i's outside option. Otherwise, player i will simply obtain the value of his outside option in bargaining and the other player will receive the residual net benefits from bargaining (Binmore, 1985). Second, if the sum of outside options exceeds the total net benefits from bargaining, bargaining will fail and players will simply obtain their outside option.

Our analysis in section 2.1 implies that the community's and the firm's outside options in bargaining (denoted as R^C and R^F, respectively) depend crucially on which of the two parties is able to establish *de facto* property rights. In the case considered here, where the community wins the war of attrition ($v(\hat{L}) < \Lambda$), outside options are given by:

$$R^C = h_0 B(\overline{L}) \text{ and } \quad R^F = \overline{R}^F = \overline{d}^F, \tag{16}$$

and where $\overline{R}^F$ are the exogenous firm profits in the next most profitable activity ($\overline{R}^F < v(\hat{L})$). Our formulation assumes that these profits are independent of whether bargaining takes place or not, so that the firm's inside and outside options are identical.[10]

Now note that $G(\tilde{L}) \geq 0$ (there are gains from bargaining) the payment to the community derived under the NBS always at least weakly exceeds the value of the community's outside option:

$$\Pi^C = h(\tilde{L})B(\overline{L}) + (1-\tau)G(L) > h_0 B(\overline{L}), \qquad (17)$$

since $h(\tilde{L}) \geq h_0$. This happens because the community's inside and outside options are closely related; they both reflect the value of the standing forest in the absence of logging. The only difference is that inside options may be positively affected by greater third-party interventions in response to negotiations. Therefore, the community can never loose, but may in fact gain, from negotiations in terms of both an increase in its inside option and a share of logging profits.

Because the firm's inside and outside options are identical, namely the value of the firm's capital in the next best alternative activity, ($\overline{d}^F = \overline{R}^F$), the payment to the firm under the NBS also always at least weakly exceeds the value of the firm's outside option:

$$\Pi^F = \overline{d}^F + \tau G(L) > \overline{R}^F. \qquad (18)$$

By the same argument, we have

Lemma 3: If $\overline{d}^F = \overline{R}^F$***, and the community can establish de facto property rights (i.e.,*** ***v<Λ),*** $R^F + R^C \leq \Gamma(\tilde{L})$***. Thus, bargaining always takes place.*** □

Lemma 3 states that, by the same arguments as above, the sum of outside options will always at least weakly exceed the total net benefits from bargaining, i.e. $R^F + R^C \leq \Gamma(\tilde{L})$.[11] Thus,

---

[10] The assumption that $\overline{R}^F = \overline{d}^F$ may be stronger than it appears. It states that negotiation does not impose costs on the firm.

[11] In the case where the firm wins the war of attrition, outside options are given by $R^C = h_0 B(\overline{L} - \hat{L})$ and $R^F = v(\hat{L})$. Note that in this case third parties do not have an incentive to intervene in response to specific logging threat (because of the open access situation). Thus, the condition for bargaining to occur is that $v(\hat{L}) + h_0 B(\overline{L} - \hat{L}) < v(\tilde{\tilde{L}}) + h_0 B(\overline{L} - \tilde{\tilde{L}})$, where $\tilde{\tilde{L}}$ is the negotiated level of logging in this case. This could only be satisfied if the environmental gains from reduced logging are large enough to compensate the firm

when the community can establish property rights, negotiation will always take place. Since bargaining assures that players are always compensated for their inside options, and inside options in our model always are at least as high as outside options, both players cannot lose by bargaining. To the contrary, they may gain in two respects. First, they may achieve an extra income through logging. And, second, they may obtain extra income through attracting third-party intervention. Of course, the case where logging area is zero is a possible corner solution.

2.5 Market outcomes in comparison to the social optimum

The overall socially optimal level of logging (L^*) is the one that equates marginal profits from logging to the true marginal environmental damages.

$$v'(L^*) = B'(\overline{L} - L^*). \tag{19}$$

This needs to be distinguished from the optimum for the community-firm complex, which is given by the level of logging resulting if the community and the firm could coordinate to maximize the total net benefits from an agreement, $\Gamma(L)$. The latter is identical to L^C and is given by

$$v'(L^C) + h'(L^C)B(\overline{L} - L^C) = h(L^C)B'(\overline{L} - L^C). \tag{20}$$

There are two differences between the social optimum and the optimum for the community-firm complex. First, as is well-known, the community-firm complex does not generally consider externalities beyond the local level ($h<1$) and thus undervalues environmental damages from logging. Interestingly, if outside interventions are responsive to logging, there is an additional effect: The community and the firm, by increasing the area logged, can induce third-party interventions that increase the value of the remaining forest. That is, they can increase the size of the pie to be divided. This implies an additional marginal benefit of logging to the two actors in negotiations. Thus, as inspection of (19) and (20) shows, they will choose a level of logging that is above the social optimum, i.e. $L^C > L^*$. When the firm has some positive bargaining power ($\tau > 0$), the above effects are counteracted by the fact that the firm considers the effect of logging in increasing the community's inside option. Formally, we have

---

for a corresponding reduction in profits. Since environmental benefits are not marketed, however, the community could never compensate the firm for its losses. Thus, the firm always prefers to act unilaterally.

Proposition 2 (Role of interventions on environmental distortion):

(a) Without intervention, bargaining will lead to a solution that implies $\widetilde{L}_{NI} > L^*$ ***(where*** $\widetilde{L}_{NI}$ ***is the bargaining solution in the absence of intervention).***

(b) With intervention sensitive to logging:

(b.1) If $\tau = 0$***, then*** $\widetilde{L} > L_{NI}$***, i.e., the initial distortion is worsened by intervention.***

(b.2) If $\tau = 1$***, then*** $\widetilde{L} < L_{NI}$***, i.e., the initial distortion is at least partially counteracted by intervention.***

(b.3.) If $0 < \tau < 1$***, then the effect of intervention on the distortion is ambiguous.*** $\widetilde{L} > L_{NI}$ ***if and only if*** $v'(\widetilde{L}) - h(\widetilde{L})B'(\overline{L} - \widetilde{L}) < 0$. □

Proposition 2 implies that the greater the bargaining power of the community, the more likely it is that the distortion is worsened by intervention ($\widetilde{L} > L_{NI}$). Also, part (b.3) of the proposition implies that the distortion is more likely to be worsened by intervention where intervention is most needed. To see this, note that $v'(\widetilde{L}) - h(\widetilde{L})B'(\overline{L} - \widetilde{L})$ is the true social marginal value of forest to the community-firm complex (or the effect of logging on total net benefits when interventions are not sensitive to logging). If this is negative, further deforestation is immiserizing. This can be considered the case where interventions are most needed. However, the proposition shows that in this case, interventions that are sensitive to logging make things worse (i.e., they increase the initial distortion).

3. The effect of alternative strategies of third-party interventions

We now discuss the environmental impacts of different types of third-party interventions. In particular, we discuss three general types of intervention: (i) interventions affecting bargaining power, (ii) interventions affecting *de facto* property rights, and (iii) changes in the opportunity cost of labor.

3.1 Interventions affecting bargaining power

One way in which third-party actors can try to influence the outcome of community-firm interactions is by changing the effective relative bargaining power in favor of the community. For example, third parties can attempt to lower the community's discount rate through anti-

poverty measures, subsidized credit lowering the marginal cost of capital, or by improving tenure security or increasing economic stability. Since such interventions reduce the level of τ, it follows directly from lemma 2 that they will raise the equilibrium logging level. Thus, our results imply that interventions improving the community's bargaining power harm the environment!

3.2 Interventions affecting de facto *property rights*

Another intervention may consist in exogenously affecting the level of h_0 and s through, e.g., conservation payments by NGOs to the communities or improving the capacity of communities to blockade, respectively.[12] From proposition 2, we know that such interventions, if strong enough, may change the outcome of the property rights game from area I (open access and unilateral logging by the firm) to area II (community property rights and negotiation) in figure 1.

Proposition 3 (Unilateral vs. bargained logging):

Define the local value of the forest to the community as

$$M(L) \equiv h(L)B(\bar{L} - L).$$

Then, $\tilde{L} \leq \hat{L} \quad \forall \tau \in [0,1]$ ***if and only if M(L) is non-increasing.*** □

The condition that *M(L)* is non-increasing is eminently plausible. It implies that the local value of the environment (here referred to as 'forest') cannot increase with greater resource extraction ('deforestation'). Thus, interventions shifting the outcome of the attrition war from unilateral logging to a situation where the community can enforce its property rights are expected to reduce resource extraction.

3.3 Interventions affecting the opportunity cost of labor

We can distinguish two types of changes affecting the opportunity cost of labor. First, local interventions may increase the marginal product of labor in a segment of the labor market, affecting the opportunity cost of labor of the community, but not of the labor used by the firm. For example, intervention may improve access to improved agricultural or

[12] The national government could also improve the legal definition of the community property rights to the resource and the enforcement of legal rights. Where enforcement depends on formal registration of ownership, third parties can help the communities in this process, e.g., through mapping exercises and/or legal assistance.

processing technologies or provide alternative employment opportunities within the community, in a setting where the firm does not hire community labor for resource extraction activities. Second, economic growth or macro-level interventions directed to the labor market may change wages faced by both the firm and the community labor.[13]

The effect in the first case is straightforward. Assuming the firm draws its labor out of the general labor market and not from the community, the only effect of an increase in the community members' opportunity cost of time ($\tilde{w}$) is to raise the cost of blockading (s). This means that communities will be less likely to win the attrition war, and thus, it is more likely that the outcome be a loss of property right for the community (the size of area I in figure 1 is increased). Thus, bargaining is less likely to take place, and communities are less likely to benefit out of the exploitation of the resource. By analogy to the discussion in section 3.2., a shift from area II to area I in figure 1 amounts is likely to induce an increase in the extent of logging!

The impact of interventions that increase market wages faced by community members and the firm is more complex. From equation (5) and figure 1 it follows that the boundary condition for the outcome of the property right game may shift to the right or to the left, depending on the strength of the wage effect upon firm's profit and community's blockading cost. If the firm's operation is very capital-intensive, and hence, less labor-intensive, and the blockading process is labor-intensive, then it is more likely that the latter effect will dominate. In this case the net effect will be to shift the boundary condition to increase area I, i.e., the community is less likely to acquire property rights. If, as a consequence, the change in market wages induces a shift from an outcome where the community wins de facto property rights (area II) to an outcome of unilateral logging (area I), the effect on logging is exactly as discussed in the case of a more local change in the opportunity costs of labor. If, however, the bargaining equilibrium emerges before and after the change in market wages, then the wage effect in a bargaining context will under plausible conditions be in the expected direction, i.e., less logging.[14]

We present the main effect of labor market interventions in Proposition 4 below.

---

[13] An example of the second type of intervention is a job creation program supported by the government and of sufficient magnitude to affect the economy's market wage.

[14] Inspecting the first-order conditions it can be shown that a sufficient condition for this result is that $d^2P_i/dLdw$ be negative. Using Hotelling's Lemma, $d^2P_i/dLdw$ is equal to $-dm_F/dL$, where m_F denotes the optimal level of labor use by the firm. That is, employment by the firm should be increasing in the area logged.

Proposition 4 (Effects of increases in opportunity costs of labor): Interventions that increase the community's opportunity costs of labor cause an increase of blockading costs. If blockading costs are very sensitive to the opportunity costs of labor, this may prevent the community from achieving property rights. In this case, the result may be counterproductive as logging may increase. □

4. Conclusions

Consider a community that satisfies all the desirable conditions for collective action that have been emphasized in the literature on the management of local commons. In the view of this literature, this would be good news, in the sense that the theory would predict that the resources would be subject to efficient management. If, however, this community is subject to sufficiently powerful external interests, its desirable collective action characteristics would not prevent the community from losing effective property rights and would not protect the common resource from excessive degradation. The reason for this is clear. While collective action may influence certain aspects of the strength of a community's ability to face conflict with external riders, there are other factors, generally ignored by the collective action literature, which will determine the final outcome of a potential conflict. Even if the community is able to stand outside challenges it may still be in need of negotiating joint exploitation of the resource with outside agents. Once again, the theory of collective action gives little guidance on how such bargaining would take place and what would be its consequences.

In this paper we have developed a framework that emphasizes important community interactions with external agents ignored by the collective action literature. We have shown that the nature of these interactions critically affects the management of natural resources. Interactions are important not only because communities may unwillingly be faced with external agents (e.g., commercial interests demanding communal resources, especially during times of commodity booms). Cooperation with external agents may also be the most effective way of exploiting certain resources, particularly those requiring large capital investments for their exploitation. We have derived a conceptual approach that naturally leads to endogenizing the birth of effective property rights or to explain their abortion. Conditional on the development of property rights, we have shown important factors that determine the outcomes of negotiations between communities and external agents. In addition, we have

shown some unexpected results concerning the effect of third-party interventions on the environment that could be important to be considered by NGOs and government agencies interested in mitigating the negative environmental consequences of resource exploitation.

References

Agrawal, A. (2001). "Common property institutions and sustainable governance of resources." *World Development* 29(10):1649-1672.

Alston, L.J., Libecap, G.D., and B. Mueller. (1999a). "A model of rural conflict: Violence and land reform policy in Brazil". Environment and Development Economics 4(2): 135-60. May 1999.

Alston, L.J., Libecap, G.D., and B. Mueller. (1999b). *Titles, conflict, and land use. The development of property rights and land reform on the Brazilian Amazon Frontier.* The University of Michigan Press, Ann Arbor.

Angelsen, Arild (2001). "Playing games in the forest: State-local conflicts of land appropriation." Land Economics 77(2):285-300. May 2001.

Baland, J.M., and J.P. Platteau. (1996). *Halting degradation of natural resources. Is there a role for rural communities?* Food and Agriculture Organization of the United Nations (FAO) and Clarendon Press, Oxford.

Bardhan, P. (1993a). "Analytics of the institutions of informal cooperation in rural development." *World Develo*pment 21(4): 633-39.

Bardhan, P. (1993b). "Symposium on management of local commons*." Journal of Economic Perspectives* 7(4): 87-92.

Binmore, K. (1985). "Bargaining and Coalitions." In A. Roth (ed.), *Game-theoretic models of bargaining*. Cambridge University Press, Cambridge.

Bohn, H., and R.T. Deacon (2000). "Ownership risk, investment, and the use of natural resources." *American Economic Review* 90(3): 526-549.

Bose, P. (1998). 'Formal-Informal Sector Interaction in Rural Credit Markets'. Journal of Development Economics'. Vol.56:2, pp.265-80.

Bulow, J., and P. Klemperer (1999). "The Generalized War of Attrition." *American Economic Review* 89(1): 175-89.

Bulow, J., and K. Rogoff (1989). "A constant recontracting model of sovereign debt." *Journal of Political Economy* 97: 155-178.

Burton, P. (2003), 'Hugging Trees: Claiming *de facto* Property Rights by Blockading Resource Use'. *Environmental and Resource Economics*, forthcoming.

Diewert, W.E. (1973). "Functional forms for profit and transformation functions." Journal of Economic Theory 6: 284-316.

Dixit, A., and B. Nalebuff (1991). *Thinking Strategically*. New York: Norton. Chapter 8.

Feder, G., and G. Feeny (1991). "Land tenure and property rights: Theory and implications for development policy." *The World Bank Economic Review* 5(1): 135-53.

Hotte, L. 2001. Conflicts over property rights and natural-resource exploitation at the frontier. *Journal of Development Economics* 66: 1-21.

Kaimowitz, D. (2002a). "When you decentralize, democratise." Center for International Forestry Research. CIFOR-POLEX electronic newsletter, October 15, 2002.

Kaimowitz, D. (2002b). "In good times & bad: Community-company partnerships." Center for International Forestry Research. CIFOR-POLEX electronic newsletter, July 30, 2002. http://www.cifor.cgiar.org/

Mayers, J. and Vermeulen, S. (2002). 'Company-community forestry partnerships: From raw deals to mutual gains?' Instruments for sustainable private sector forestry series." International Institute for Environment and Development, London.

Muthoo, A. (1999). *Bargaining theory with applications.* Cambridge University Press, Cambridge.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action.* Cambridge University Press, Cambridge.

Palmer, C. (2003). 'Cooperation and conflicts over the benefits from IPPK logging concessions: a case study from Sekatak, East Kalimantan.' Mimeo, Center for Development Research, Bonn, Germany.

Ribot, J. (2002). 'Democratic Decentralization of Natural Resources, Institutionalizing Popular Participation'. World Resources Institute, Washington D.C.

Figure 1: Possible outcomes of the pre-bargaining property right game