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Pauline Grosjean*

*University of San Francisco, pagrosjean@usfca.edu

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Maintenance Costs, Outside Options and Optimal Ownership of a Public Good*

Pauline Grosjean

Abstract

There has been much attention recently to public-private partnerships and the involvement of NGOs in public good provision. This paper re-examines the effect of ownership of a public good on investment incentives when contracts are incomplete. In the presence of maintenance costs, it is shown that the leading result in the literature by Besley and Ghatak (2001) does not carry through. In some circumstances, project ownership should be allocated to the party that values the project relatively less. The model is applied to the case of environmental conservation and investigates the advantages of Payments for Environmental Services from the point of view of investment incentives in conservation.

KEYWORDS: biodiversity conservation, maintenance costs, public good, ownership

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1. Introduction

The extent to which the private sector should own public projects is a highly topical question. The difficulty in fully specifying the quality of many public goods and services[1] entails contractual imperfections, which, as shown by the literature on the theory of the firm (Grossman and Hart 1986 and Hart and Moore 1990, hereafter GHM) makes the allocation of ownership rights matter. Ownership of a private good is defined as the right to exclude others from using the good, to reap the benefits that can be derived from it and to destroy it. In the case of a pure public good however, non-excludability and non-rivalry imply that only the third of these properties is meaningful. Ownership of a pure public good thus rests upon the right it confers to the owner to decide what to do with the good and possibly to destroy it. This paper illustrates how this property may confer some bargaining power to the owner so as to extract other players' willingness to pay for the public good and hence help alleviate the free riding problem in public good provision.

I depart here from most of the existing literature on the boundaries of public firms[2] in that I consider the case in which some private agents contribute voluntarily to the provision of public goods.[3] Francois and Vlassoppoulos (2008) review how pro-social motivation affects the delivery of public services. In particular, the presence of output-oriented or pure altruism, when agents care about the value of the public goods to which they contribute, has important implications for the type of organizations that should be delivering the services. Besley and Ghatak (2001) (hereafter BG) illustrate the free riding that occurs when the value created by investments of different parties has a public good dimension and when agents are altruists. They conclude that the party with the highest valuation should be the owner, irrespective of technological advantages in the production of the good or service. However, crucial to this result is an assumption of some excludability of the benefits of the good when one party quits the relationship (assumption 1, BG).[4]

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[1] Such contractual imperfections in the case of public goods have been discussed namely in education (Acemoglu et al. 2003, Adnett 2004), health care (Chou 2002) or prisons (Hart, Shleifer and Vishny 1997).

[2] See Hart (2003), Hart, Shleifer and Vishny (1997), Shleifer, (1998). For a review, see Martimort et al. (2005). This literature investigates how contractual relationships between public and private firms affect public good provision but relies on the assumption that the private sector is purely profit-motivated and only the government internalizes social welfare.

[3] Such agents have been described as altruistic organizations (Rose-Ackerman 1996), value driven (Ghatak 2003) or motivated agents (Besley and Ghatak 2005).

[4] Assumption 1 in BG ensures that the marginal return to a given type of investment is highest in the event of disagreement when the party that made the investment is the owner. "Following Hart, Shleifer, and Vishny (1997), this assumption could be interpreted as saying that a part of the return

This paper extends BG to explore how the allocation of control rights affects players' investment incentives in the presence of maintenance costs and when agents are pure, output-oriented altruists. As in BG, the analysis considers a situation of incomplete contracting, which stems from the non-contractible quality dimension of investments. It is shown that the presence of maintenance costs flips the result of BG under some conditions on the size of maintenance costs relative to investors' respective valuations of the project. This result derives from the existence of a credible threat of termination of the public project, which reduces free riding incentives. Since the termination threat is more credible when the low valuation party owns the project, ownership by the low valuation party may be socially optimal.

The intuition is the following. Because of incomplete contracting, parties cannot specify their respective levels of investments ex-ante and they bargain over project continuation ex-post, once their investments are sunk. At that stage, because maintenance costs have to be paid for in order to maintain the value of the public project, two possibilities emerge. Either the owner of the project gets enough utility from project continuation to cover the maintenance cost and is willing to continue with the project; or the maintenance cost is so large that the owner prefers to abandon the project. In the first case, the other player anticipates that the owner will carry on with the project and cannot be forced to share the maintenance cost after investment has taken place. At this free riding equilibrium, allocating ownership to the low valuation party preserves the incentives of the high valuation party and ensures a higher level of provision. In the second case, when the maintenance cost is so large that the project owner would rather abandon the project, the parties have to reach an agreement and share the surplus from continuation of the project. Surplus sharing gives rise to ex-ante inefficiencies (Hart 1995) but under some conditions, such inefficiencies are lower than those associated with free riding. This is the case if the difference in the parties' valuations over the public project is large relative to maintenance costs. Since the threat of termination is more credible when the low valuation party owns the project, bargaining over project continuation is more likely when the low valuation party owns the project, which is optimal in this case.

The main contribution of this paper is to formally take into account the presence of maintenance costs associated with public projects. Lack of maintenance has been identified as one of the major obstacles to public good provision in developing countries. Easterly (2003) and Miguel and Gugerty (2005) highlight the neglect of maintenance that leads to deteriorating public good quality. Easterly (2003) reports that "schools lack operating funds for salaries and teaching materials and agricultural research stations have difficulty keeping up

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of the investment of a player is embodied in her human capital and cannot be realized if she is fired" (BG, page 1351).

field trials. Roads, public buildings, and processing facilities suffer from lack of maintenance […] in country after country, highways are falling into disrepair, if not disuse, from inadequate funding of maintenance" (Easterly 2003, p. 45). The lack of maintenance is particularly stringent in the case of environmental conservation projects, which will be the leading application of the model developed in this paper. Illegal forest clearing, habitat destruction and wildlife poaching are the main threats to forestry and biodiversity conservation projects and are notoriously difficult to prevent due to monitoring and enforcement difficulties (Barrett et al. 2001). Most of the costs involved in the maintenance of environmental conservation projects are realized ex-post and often have a non contractible dimension due to natural variability and the complexity of describing ex-ante all the natural contingencies that may affect a conservation area as well as what investment should be taken in every state of the world. Faced with the shortcomings of traditional command and control mechanisms, such as national parks, in enforcing conservation, the integration of local users in Payment for Environmental Services schemes (hereafter PES) has become increasingly popular over the last decade, both in developed and developing countries (Engel, Pagiola and Wunder 2008). PES consist in compensating local users of natural resources, such as farmers, loggers or local governments for conservation services, thereby making them internalize the full externality of conservation practices. In PES, property rights remain in the hands of the local users of the resource. The literature has discussed the implications of such an ownership structure from the point of view of distributional or informational issues, but never, to the best of my knowledge, from the point of view of investment incentives. The model in this paper bears novel implications in that respect, which are discussed in the final section of the paper.

The rest of the paper proceeds as follows. Section 2 reconsiders the example provided in the introduction of BG with the addition of maintenance costs and shows intuitively how their result is flipped. Section 3 presents the model. Section 4 discusses the bargaining solution, and Section 5 solves the investment game. Section 6 discusses the main result and its application to environmental conservation and concludes.

2. Example

Let us reconsider the example provided in the introduction of BG in the presence of maintenance costs that are necessary to maintain the quality of a public project. A Non Governmental Organization (hereafter NGO) is deciding how much to invest in improving the quality of a public project, here an environmental conservation project. There are three levels of investment, low (L), medium (M) and high (H), with costs 0, 1.5 and 3 respectively. In the case of environmental conservation, the investments consist, for example, in the effort allocated to the selection and rehabilitation of protected areas and to the reintroduction of specific species. The investment cost consists in the cost of such efforts. The benefits to the NGO from the different investment levels are, respectively, 0, 8 and 14. Another party, either local resource users or a local government, also values the public good dimension of the project but to a lesser extent than the NGO and derives a payoff from the respective investment levels of 0, 6 and 11. Because of the complexity of the project and because investments have a non-contractible quality dimension, the parties cannot contract on project quality and on investment levels ex-ante. In order to maintain the quality of the investment project, for example to protect species against poaching and prevent deforestation, the owner of the project has to incur some maintenance costs. Interestingly, in the case of PES, the maintenance costs are the payments for environmental services themselves: they are the costs that have to be paid in order to make local users internalize the externalities of resource exploitation. If such maintenance costs are not paid, local users revert to socially suboptimal exploitation practices and the value of the conservation project is lost. Maintenance costs occur at the post investment stage and depend on the quality of the investments. The exact nature of the maintenance cost is thus only realized once the uncertainty concerning the realized project quality is resolved, so that maintenance costs are not contractible ex-ante. Maintenance costs are assumed to be increasing in the level of quality of the investments, and amount to 0, 5 and 10 for the low, medium and high investment respectively.

Joint local users-NGO surplus is highest when the high investment level is chosen. However, because quality is non contractible, the investment level cannot be guaranteed by an upfront payment between the parties. Bargaining over the surplus occurs once the investment is sunk, and influences ex-ante investment incentives. Ownership determines who has to pay for the maintenance cost in the event of break down in negotiation and hence affects investment incentives.

If the NGO, who is here the high valuation party, owns the project and chooses the high investment project, she receives a continuation payoff of 14 (her payoff from the project) minus 10 (the maintenance cost that she has to pay as the owner of the project): 4. She also has to pay the investment cost (3), so that her overall surplus is 1. If the NGO chooses the medium investment, she gets a continuation payoff of 3 (8-5), and an overall surplus of 1.5 (3-1.5). The NGO thus prefers the medium investment project. Anticipating that the NGO will carry on with the project in any case, the local users have no incentive to contribute anything to the project. Even though local users' free riding payoff is higher in the high investment case, a promise to make a payment to the NGO if she chooses H will not be kept and, similarly, even if the local users made an upfront payment to the NGO in order to induce her to chose H, the NGO will not keep her promise.

If local users own the project, their continuation payoff from either M or H is not sufficient to cover the cost of investment.[5] They thus choose not to invest (L) and both parties receive 0. The parties have to cooperate in order to reach a positive level of investment. Section 4 shows formally that in this case, under a Rubinstein alternative offer protocol, the parties reach the 'share-the-surplus' solution and share the continuation surplus equally. The local users then get a continuation payoff of 4.5 [(8+6-5)/2] and an overall surplus of 3 from choosing M, and a continuation payoff of 7.5 [(14+11-10)/2] and an overall surplus of 4.5 from choosing H. H is thus chosen. In this example, low valuation party ownership forces parties to share the surplus and enables them to reach the optimal solution. On the contrary, when the high valuation party is the owner, the other party prefers to free ride on the owner and investments levels are sub-optimal.

In this setting, because of the pure public good nature of the project and of the presence of maintenance costs, free riding payoffs are higher than contribution payoffs for one of the parties. This is only true as long as the owner chooses to go ahead with the project, that is to say agrees to pay for the maintenance cost on her own. If this is not the case, free riding payoffs are zero and the parties have to reach an agreement over project continuation. Surplus sharing boosts the ex-ante investment incentives of the owner but depresses those of the other party. If the increase in one player's incentives outweighs the decrease in the other player's, surplus sharing increases investment and welfare. The next section formally shows that this holds when the difference in parties' valuations of the public project is large relative to maintenance costs. This gives rise to different predictions according to the scope of maintenance costs of public project, which are then discussed.

3. Model Set-Up

Two agents, local resource users: L and a NGO: N, invest in a public project. The investments increase the benefits generated by the project through quality improvements that are not fully contractible. There is a single time period in which the project is carried out. Contrary to BG, the agents are output-oriented – pure - altruists and the benefits of the project are non-excludable and non-rival, regardless of the identity of the party who has undertaken the investment. Investment levels by agents L and N are denoted by $Y = (y_L, y_N)$. The benefit of the project is denoted by $V(Y)$ with V an increasing, twice differentiable, symmetric and strictly concave function satisfying Inada endpoint conditions. The

[5] In the medium investment case, the continuation payoff of local users is 1, which is insufficient to cover the cost of investment (1.5). In the high investment case, the continuation payoff is also 1, which is insufficient to cover the cost of investment (3).

positive marginal benefit for each player $i \in \{L, N\}$ is denoted by: $V_i(y_L, y_N) = \frac{\partial V(y_L, y_N)}{\partial y_i}$. In addition, it is assumed that $\frac{\partial^2 V(y_L, y_N)}{\partial y_L \partial y_N} \geq 0$, i.e. investments are weak complements.

The two agents have different valuations over the project, denoted by $\theta_i V(y_L, y_N), i = L, N$. Without loss of generality, it is assumed that the NGO is the high valuation party, i.e. $\theta_N > \theta_L$. This is for example the case if international NGOs internalize the global effects of a public project and not just local effects as local users do.

Payoffs are quasi-linear in project benefits and money. Investment in the project generates two types of costs. The first type of cost is the cost of investment itself, which is assumed to be linear for simplicity. The second type of cost is a maintenance cost, denoted by $B(y_L, y_N)$, which emerges once investments have taken place and has to be paid for in order for the investors to enjoy the benefits of the project. $B_i(y_L, y_N)$ denotes the positive marginal cost with regards to investment by agent $i \in \{L, N\}$.

Players are assumed to be risk neutral and there is no discount rate. The timing of the game is the following:

At **date 0**, the players decide who should own the project that is to say who should have residual control rights over the project. It is assumed, as in BG, that ownership cannot be transferred in subsequent stages of the game without cost. In other words, ex-ante ownership provides some form of commitment to maintain the ownership structure ex-post. However, monetary transfers are possible at that stage to make both parties agree on the ownership structure.

At **date 1**, investments are realized.

At **date 2**, the maintenance cost has to be paid and the owner decides whether to continue with the project. The players may bargain at this stage of the game and monetary transfers are possible.

In the absence of contractual imperfections, the players chose the investment levels that maximize their net joint surplus:

$$max[\,0, (\theta_L + \theta_N)V(y_L, y_N) - y_L - y_N - B(y_L, y_N)] \quad (1)$$

The joint surplus maximizing vector of investment (y_L^*, y_N^*) solves the following Lindahl-Samuelson type rule:

$$(\theta_L + \theta_N)V_i(y_L^*, y_N^*) = B_i(y_L^*, y_N^*) + 1 \text{ for } i \in \{L, N\} \quad (2)$$

Let us now consider that investments are so complex that they cannot be specified completely in an initial contract between the two players. For example, it is impossible to describe ex-ante all the natural contingencies that may affect a conservation area and which investment should be taken in every state of the world. The benefits of the project ("better quality"), the investments needed to achieve such benefits of "higher quality" as well as the maintenance costs (how to maintain "higher quality") cannot be fully described and contracted upon ex-ante. However, following GHM, it is assumed that once the state of the world has been realized, the different aspects of the maintenance cost become clear and the parties can negotiate about these. Once uncertainty is resolved at date 2, any agreement about the sharing of maintenance responsibilities is enforceable.[6]

It is noteworthy here that in the absence of a maintenance cost the ownership structure is irrelevant. Indeed, without maintenance costs, continuation is costless so the owner always chooses to continue with the project. Irrespective of the ownership structure, free riding always occurs and investment levels are below their first best level. BG depart from this by considering a condition of asset monotonicity of investment: it is assumed that the marginal return to investment is highest in the event of disagreement when the party that made the investment is the owner (assumption 1, BG). Giving ownership to the high valuation party thus increases her investment incentives (as in the private good case). Meanwhile, the investment incentives of the low valuation party are also higher since she gets half of the joint surplus, which is higher than the low valuation party's surplus. However, this assumption by BG implies some degree of excludability of the project and hence some "impurity" of the public good and is modified in this paper. In the model developed in this paper, maintenance costs impact negatively the investment incentives of the owner. It is shown that in that case, it may be preferable to give ownership to the low valuation party because it increases the likelihood of surplus sharing between the parties and, even if free riding occurs, it is preferable to preserve the investment incentives of the high valuation party. However, before studying the investment game, one needs to study first the outcome of the bargaining game between the two players. This is done in the next section.

4. Outcome of the Bargaining Game

The model of bargaining between the two players is the Rubinstein's alternating-offers protocol (1982). At date 2, agents bargain over a division of the joint continuation surplus, which is denoted by $M = (\theta_L + \theta_N)V(y_L, y_N) - B(y_L, y_N)$. Ownership is not transferable at this stage of the game.[7] Bargaining takes place

[6] Since at the post investment stage, any agreement about the sharing of maintenance responsibilities is enforceable, it is not directly relevant whether the parties provide for the maintenance themselves or contract out maintenance operations to private operators.

[7] In the example of environmental conservation in general and Payments for Environmental Services (PES) in particular, this assumption is not farfetched. In PES Schemes, land property

over a number of periods, $t = 0,1, \ldots$. At the beginning of each period, each player is alternatively selected to be a proposer. The respondent can either accept the proposal, in which case the bargaining ends; reject the proposal, in which case the bargaining proceeds to the next round, or choose to terminate the bargaining process, in which case the players obtain their outside options. Outside options are defined by Binmore et al. (1989) as the best income flows available to each agent if partnership ends. They are denoted by: s_j for $j = 1,2$ with player 1 being the owner and player 2 the other player in the game. The outside option for the owner is: $s_1 = max[0, \theta_1 V(y_L, y_N) - B(y_L, y_N)]$ while that of the other party is simply her free riding payoff: $s_2 = \theta_2 V(y_L, y_N) - B(y_L, y_N)$.

Let x and $1 - x$ be the expected equilibrium payoffs to the owner and the other player, respectively, in this bargaining game. The following well known solution ensues, e.g. Sutton (1986):

$$x = 1 - x = \frac{1}{2}M \text{ when } s_1, s_2 \leq \frac{1}{2}M \quad (3)$$

$$x = s_1, 1 - x = M - s_1 \text{ when } s_1 > \frac{1}{2}M \quad (4)$$

$$x = M - s_2, 1 - x = s_2 \text{ when } s_2 > \frac{1}{2}M \quad (5)$$

At the stage of the game where bargaining takes place, the owner decides whether to continue with the project. There are two possible cases. Either the owner gets sufficient utility from project continuation and she carries it on; or her continuation surplus is negative and she prefers to abandon the project. Let us first consider the case where the owner's continuation payoff is positive. Because in this game $s_1 + s_2 = M$, then in the generic case either $s_1 > \frac{1}{2}M$, or $s_2 > \frac{1}{2}M$. The solution of the bargaining game is thus either (4) or (5) depending on the relative size of the players' outside options. The share-the-surplus solution (1) never emerges. This situation corresponds to the free riding equilibrium. The equilibrium payoffs of the game are for the owner and the other party, respectively:

$$\theta_1 V(y_L, y_N) - B(y_L, y_N) - y_1 \quad (6)$$

rights remain in the hands of the local users and they are thus the owner of the project as defined in this paper, since land property rights confer them "the right […] to decide what to do with the good, and possibly to destroy it" (page 1). It indeed rests upon them to enforce the conservation arrangements and keep the benefits from environmental conservation, which necessitates for example abstaining from over exploiting the resources and protecting the area from illegal poaching and logging – that is to say paying for the maintenance cost. Ownership of the project is not easily transferable to the NGO, as it would require for her to buy the property rights to the land. In addition, as, in general, several local users are involved, ownership transfers would be very difficult and involve substantial transaction costs.

$$\theta_2 V(y_L, y_N) - y_2 \tag{7}$$

Now, in the case where the owner prefers to abandon the project, outside options are nil: $s_1 = s_2 = 0$. The game then reduces to the standard Rubinstein game, the solution of which is the share-the-surplus solution (1). The equilibrium payoffs of the game are identical for both players and given by:

$$\frac{(\theta_L+\theta_N)V(y_L,y_N)-B(y_L,y_N)}{2} - y_i \text{ for } i = L, N \tag{8}$$

The share-the-surplus solution thus only emerges when outside options are minimized, that is, when the owner prefers to abandon the project. Hence, it is more likely to emerge under ownership by the low valuation party. Lemma 1 ensues:

Lemma 1: *Bargaining over project continuation occurs more often when the low valuation party owns the project.*

Proof. There is no investment level such the continuation payoff of the high valuation party (when she is the owner) is non positive while that of the low valuation party (when she is the owner) is positive, whereas the reverse is not true. Indeed, suppose there is a level of investment (y_L', y_N') such that the continuation payoff of the high valuation party *N* is non-positive:

$$\theta_N V(y_L', y_N') - B(y_L', y_N') \leq 0 \tag{9}$$

Then, since $\theta_L < \theta_N$, at that level of investment, the continuation payoff of the low valuation party L must also be non-positive. On the contrary, there exists a level of investment such that the continuation payoff of L is non-positive whereas that of *N* is positive.

The next question is whether the share-the-surplus solution leads to higher levels of investment and welfare. This is considered in the next section.

5. The Investment Game

The investment game has strategies (y_i^i, y_j^i) and payoffs denoted by $U_i^i(y_i^i, y_j^i)$ and $U_j^i(y_i^i, y_j^i)$ for players *i* and *j* respectively under ownership by *i*, for $i \in \{L, N\}$.

In order to compare the equilibrium investment levels under alternative ownership structures, let us partition the space of feasible investment into three regions:

$$C_0 = \{y_L, y_N | \theta_L V(y_L, y_N) - B(y_L, y_N), \theta_N V(y_L, y_N) - B(y_L, y_N) > 0\} \quad (10)$$
$$C_1 = \{y_L, y_N | \theta_L V(y_L, y_N) - B(y_L, y_N) \leq 0, \theta_N V(y_L, y_N) - B(y_L, y_N) > 0\} \quad (11)$$
$$C_2 = \{y_L, y_N | \theta_L V(y_L, y_N) - B(y_L, y_N), \theta_N V(y_L, y_N) - B(y_L, y_N) \leq 0\} \quad (12)$$

This partition covers all feasible investment levels (see Lemma 1). In region C_0, both players' continuation payoffs are positive, so that the share-the-surplus solution never occurs. Payoffs are given by (6) and (7). In C_1, the low valuation party's s continuation payoff is non positive while that of the high valuation party is positive, so that the share-the-surplus solution prevails under low valuation party ownership while the free riding equilibrium prevails under high valuation party ownership. Payoffs are given by (8) under low valuation party ownership and by (6) and (7) under high valuation party ownership. In C_2, the continuation payoff is non-positive for either player, so that the share-the-surplus solution prevails regardless of the ownership structure.

The solution of this game is hard to characterize because of the presence of discontinuities in the players' payoffs. Furthermore, because of the non-excludable nature of the good, the equilibrium does not correspond to the maximum of a unique function, which is ensured under, for example, Assumption 3 in Hart and Moore (1990) or Assumption 1 in BG. The purpose of this paper is to illustrate how BG's generic result that the high valuation party should own the project fails in the presence of maintenance costs. I therefore restrict my attention to a specific case where the equilibrium of the investment game is easy to characterize and consider a specific functional form that makes the results tractable. Let us consider that the payoff function has the following form: $V(y_L, y_N) = \ln(y_L y_N)$.

Let us consider the investment levels under alternative ownership structures in the three regions defined above. At this point, to make the analysis more tractable, let us consider a constant marginal maintenance cost, denoted by c.[8] In C_0, investments equilibrium levels are given by the maximization of (6) and (7). Under ownership by agent *i*, the Nash equilibrium investment level by the owner and the other player are respectively:

$$y_i^i = \frac{\theta_i}{c+1} \quad (14)$$
$$y_j^i = \theta_j \quad (15)$$

Summing these two terms, it is easy to see that the total investment level is higher under low valuation party ownership.

[8] The presence of fixed maintenance costs does not alter the result.

In C_1, the share-the-surplus solution prevails under low valuation party ownership. The Nash equilibrium levels of investments under low valuation party ownership are identical for both parties and given by:

$$y_i^L = \frac{\theta_L+\theta_N}{c+2} \text{ for } i = G, N \quad (16)$$

By contrast, the free riding solution prevails under high valuation party ownership, and Nash equilibrium levels of investments are given by (14) and (15): $y_L^N = \theta_L$ and $y_N^N = \frac{\theta_N}{c+1}$.

The total investment level is higher under low valuation party ownership if:

$$2\frac{\theta_L + \theta_N}{c+2} \geq \frac{\theta_N + (c+1)\theta_L}{c+1}$$

That is, if:

$$c \leq \frac{\theta_N-\theta_L}{\theta_L} \quad (17)$$

This condition holds if the parties differ a lot in their valuation for the public good or if maintenance costs are low enough.

In C_2, investment levels do not depend on the ownership structure and are given by the share-the-surplus condition (16).

Let us consider the following assumption:

Assumption 1: The marginal maintenance cost is small relative to the parties' valuation differences: $c \leq \frac{\theta_N-\theta_L}{\theta_L}$

Under this assumption, the following proposition ensues:

Proposition 1 *Under Assumption 1, ownership by the low valuation party is optimal.*

Indeed, under Assumption 1, investment levels and welfare are strictly higher under low valuation party ownership in C_1. It has been shown in what precedes that investment levels and welfare are strictly higher under low valuation party ownership in C_0. Since in C_2, the ownership structure is irrelevant, Proposition 1 follows.

If Assumption1 does not hold, high valuation party ownership is optimal in C_1, although still dominated by low valuation party ownership in C_0. The analysis is greatly complicated in this case because of discontinuities in the payoff functions. Since the main purpose of this paper is to illustrate that BG result may be reversed when maintenance costs are considered, this case can be ignored here.

Proposition 1 states that low valuation party ownership is optimal under Assumption 1 and increases social welfare. Nevertheless, it could be the case that one party is made worse off by such a transfer of ownership. At date 0, when the parties decide on the ownership structure, monetary transfers are possible. The following Proposition ensures that a transfer always exists so that both parties are better off under the optimal ownership structure.

Proposition 2: *There always exists an incentive compatible transfer such that the optimal ownership structure is chosen*.

Proof. See Appendix.

6. Discussion and Conclusion

To sum up, the presence of maintenance costs together with the non rivalry and non excludability of the benefits of a public project imply that outside options are higher than surplus sharing payoffs for the party that does not own the project when the owner agrees to continue with the project, which leads to free riding. At the free riding equilibrium, investment incentives of the owner are sharply reduced by the maintenance costs that she has to bear on her own. Allocating ownership to the low valuation party preserves investment incentives of the high valuation party, which results in higher equilibrium investment. Investors in the public project will reach an agreement that may improve the efficiency of public good provision when outside options are minimized. Bargaining and surplus sharing imply some inefficiency. However, under some conditions, such inefficiency is lower than that arising from free riding. Outside options are minimized, so that free riding is less likely, when the low valuation party owns the project. Allocating ownership to the low valuation party is optimal in that case.

The share-the-surplus solution dominates under a condition on the relative size of maintenance costs compared to the difference in investors' valuations of project benefits. This leads to different predictions according to the scope of the maintenance costs and the relative valuations by different investors. If the difference in agents' valuations of the project is large relative to the marginal maintenance cost, bargaining is efficient. Biodiversity conservation fits this example well, since NGOs generally value the project to a much greater extent than local resource users. One reason for this is that international NGOs internalize the global effects of biodiversity conservation and not just the local effects as local resource users do. In this case, the model predicts that allocating project ownership to the local users leads to a higher investment level. Interestingly, keeping ownership in the hand of local users has been the organizational structure that has been increasingly favored for environmental conservation projects over the last couple of decades (Engel, Pagiola and Wunder 2008). The case of environmental conservation in general and PES in particular fits the model discussed in this paper well. Firstly, although many benefits derived from environmental protection are club goods, for example water quality or erosion prevention, many others, in particular the benefits derived from biodiversity conservation and carbon sequestration, are pure public goods. Secondly, maintenance costs are of crucial importance. The lack of adequate maintenance and the associated illegal poaching and logging, have been the major obstacle to the success of environmental conservation projects (Baland and Platteau, 1996). Thirdly, such maintenance costs are difficult to contract upon ex-ante. Engel, Pagiola and Wunder (2008) indeed note that: “ It must be possible to […] establish a baseline against which additional units ‘provided’ can be measured. This requires understanding causal pathways (‘processes’), recognizing spatial extent and distribution (‘patterns’), developing ‘proxies’ or ‘indicators’ for easy recognition and monitoring, and simplified, yet accurate and validated measures of environmental services provided” (page 668). PES are often presented as a promising mechanism for conservation. The literature describes the distributional advantages of having local resource users directly benefiting from conservation and the informational advantage of making them the party responsible for enforcement. This is especially advantageous under the weak governance structure that characterizes many biodiversity hotspots in developing countries. The model in this paper illustrates another advantage of PES. Indeed, the model in this paper predicts that having the low valuation party – here the resource users – own the project in PES schemes decreases free riding incentives and enables the high valuation party to extract part of the low valuation party’s willingness to pay, leading to higher overall investment in the conservation project.

A limitation of this paper is the simplistic view of agents’ preferences, which are assumed to differ only in their valuation of the public good’s benefits. Different organizations may have different incentives to invest in maintenance costs, due for example, to different political or financial cycles. Further research is needed to give a more precise account of the incentives of the different parties involved in public good provision, such as local users, states, international organizations or NGOs.

7. Appendix

Proof of Proposition 2:

Proposition 1 states that, under Assumption 1, ownership by the low valuation party is optimal, so that social welfare is higher under low-valuation party ownership.

Let us consider that the players use Nash bargaining at date 0 of the game to decide on the ownership structure. The Nash bargaining solution must satisfy:

$$t = \text{argmax}_z [U_L^L(Y) + z - U_L^N(Y)]\,[U_N^L(Y) - z - U_N^N(Y)] \quad \text{(A1)}$$

$$t = \frac{U_N^L(Y) - U_L^L(Y) + U_L^N(Y) - U_N^N(Y)}{2} \quad \text{(A2)}$$

One can check whether this mechanism respects participation constraints for both players. Individual rationality for L requires that the following equation be positive:

$$U_L^L(Y) + t - U_L^N(Y) = \frac{U_N^L(Y) + U_L^L(Y) - U_L^N(Y) - U_N^N(Y)}{2} \quad \text{(A3)}$$

The second part of this equation is positive when social welfare is higher under low-valuation party ownership.

In turn, this ensures that the following individual rationality constraint for N holds:

$$U_N^L(Y) - t \geq U_L^N(Y) \quad \text{(A4)}$$

Proposition 2 ensues.

8. References

Acemoglu, D., Kremer, M. and Mian, A., 2003. Incentives in Markets, Firms and Governments. NBER Working Paper No. W9802.

Adnett, N., 2004. Private Sector Provision of Schooling: an economic assessment. Comparative Education 40, 385-399.

Baland, J.M., Platteau, J.-P., 1996. Halting Degradation of Natural Resources: Is There a Role for Rural Communities? Clarendon Press, Oxford.

Barrett, C. B., K. Brandon, C. Gibson and H. Gjertsen, 2001. Conserving Tropical Biodiversity Amid Weak Institutions. Bioscience, Vol. 51, No. 6, 497-502.

Besley, T. and Ghatak, M., 2001. Government versus Private Ownership of Public Goods. The Quarterly Journal of Economics 116, 1343-1373.

Besley, T. and M. Ghatak, 2005. Competition and Incentives with Motivated Agents. American Economic Review, 95, 616–636.

Binmore, K., Shaked, A. and Sutton, J., 1989. An Outside Option Experiment. The Quarterly Journal of Economics 104, 753-770.

Chou, S., 2002. Asymmetric Information, Ownership and Quality of Care: an Empirical Analysis of Nursing Homes. Journal of Health Economics 21, 293-311.

Easterly, W., 2003. The Cartel of Good Intentions: The Problem of Bureaucracy in Foreign Aid. Policy Reform 00, 1-28.

Engel, S., S. Pagiola and S. Wunder, 2008. Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues. Ecological Economics, Vol. 65, pp. 663-674.

Francois, P. and M. Vlassoppoulos, 2008. Pro-Social Motivation and the Delivery of Social Services. CESifo Economic Studies, 2008, 54: 22-54.

Ghatak, M., 2003. Who Should Provide Public Goods? A Perspective from the Theory of Organizations. In: S. Marjit and N. Banerjee (Eds.). Development, Displacement and Disparity - India in the Last Quarter of the Century. Centre for Studies in Social Sciences, Calcutta.

Grossman, S. J. and Hart, O., 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. Journal of Political Economy 94, 691-719.

Hart, O., 1995. Firms, Contracts and Financial Structure. Clarendon Lectures in Economics, Oxford University Press.

Hart, O., 2003. Incomplete Contracts and Public Ownership: Remarks, and an Application to Public-Private Partnerships. The Economic Journal 113, C69-C76.

Hart, O. and Moore, J., 1990. Property Rights and the Nature of the Firm. Journal of Public Economics 98, 1119-1158.

Hart, O, Shleifer, A., and Vishny, R. 1997. The Proper Scope of Government: Theory and an Application to Prisons. The Quarterly Journal of Economics, CXII, 1119-1158.

Martimort, D., De Donder, P. and Billette de Villemeur, E. 2005. An Incomplete Contract Perspective on Public Good Provision. Journal of Economic Surveys 19, 149-180.

Miguel, T. and M. K. Gugerty, 2005. Ethnic Diversity, Social Sanctions, and Public Goods in Kenya. Journal of Public Economics, 2005, 89 (11-12), 2325-2368

Rose-Ackerman, S., 1996. Altruism, Non Profit and Economic Theory. Journal of Economic Literature 34, 701-728.

Rubinstein, A., 1982. Perfect Equilibrium in a Bargaining Model. Econometrica 50, 97-109.

Shleifer, A. 1998. State versus Private Ownership. Journal of Economic Perspectives 12, 133-150.

Sutton, J., 1986. Non-Cooperative Bargaining Theory: An Introduction. The Review of Economic Studies, 53, 709-724.