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Nature of Human Capital, Technology and Ownership of Public Goods

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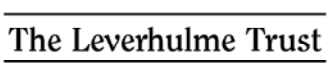

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In this paper we relax their assumptions in a natural way by allowing the agents to be indispensable and show that relative valuations are not the sole determinant of optimal ownership structure but also nature of human capital and technology matter.

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JEL Classification D23, H41, L33

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Nature of Human Capital, Technology and Ownership of Public Goods[1]

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Abstract

Besley and Ghatak (2001) show that public good should be owned by the agent who values the public good most – irrespective of technological factors. In this paper we relax their assumptions in a natural way by allowing the agents to be indispensable and show that relative valuations are not the sole determinant of optimal ownership structure but also nature of human capital and technology matter.

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1 Introduction

Besley and Ghatak (2001) extend the property rights theory of Grossman and Hart (1986) and Hart and Moore (1990) to analyze the ownership of public goods. Their main result is that the agent who has the highest valuation for the public good should be the owner irrespective of who is the key investor or other technological factors. We relax their assumptions in a natural way by allowing the agents to be indispensable and show that although the valuation of public good is an important determinant of the optimal ownership structure, technology – and particularly the nature of human capital – matter too.

Default payoffs determine the bargaining position of the parties and their incentives in the property rights theory. The only determinant of the default payoff that Besley and Ghatak (2001) (BG) examine is spillovers: how much of an agent's human capital is sunk in the project. We look more carefully into another characteristic of human capital: the indispensability of an agent. If an agent is indispensable or very important as a trading partner, the *owner's* human capital does not have any value without the worker. BG assumptions imply that the agents are relatively dispensable. We relax their assumptions and show that the valuation for the public good is not the sole determinant of the optimal ownership structure.

Suppose two agents are involved in producing the public good. The agents differ in how they value the public good: h's valuation is higher than l's. Suppose also that only agent l makes a project-specific investment. Since they are producing public good everyone can consume it even if the agents cannot reach an agreement in bargaining. The main insight of BG is that when l increases his investment, h's default payoff is increased by more than l's default payoff (because of his higher valuation) resulting in worse bargaining position for l. To minimize this negative effect it is better to choose an ownership structure where l's investment contributes least to the default payoffs. This is the case when h is the owner: then only the part of l's investment that is sunk in the project contributes to the default payoffs. The main result of BG is that the high-valuation agent should own the public good even when the low-valuation agent is the key investor.

However, there is also a role for the nature of human capital. Suppose that h is indispensable: without h in the team l's human capital is not productive. Suppose also that there are spillovers from l's human capital. Now the ownership structure that minimizes the negative effect on l's incentives

is l-ownership. If l owns the public good and cannot reach an agreement with h, l's investment does not contribute at all to the public good since l's investment is unproductive without h in the team. While under h-ownership l's investment worsens his bargaining position to the extent that it is sunk in the project. Ownership by the low-valuation agent is optimal because of the nature of human capital.

Now suppose that both agents have an investment. Then also a role for technology in determining the optimal ownership structure can emerge. When the agents have asymmetric roles so that h is indispensable and l is dispensable, then each agent has better incentives if he owns the public good. The high-valuation agent has the best incentives if he owns the public good as his investment is fully productive without dispensable l and therefore improves his bargaining position maximally. While the low-valuation agent has highest investment when he is the owner because his investment is unproductive without indispensable h and therefore does not worsen his bargaining position. Then the key investor should own the public good and therefore technology matters in determining the optimal ownership structure.

This paper shows that optimal ownership of public good is not solely driven by the relative valuations but the same factors that drive optimal ownership of private goods are important also in the public goods case. However, the nature of human capital and technology play a different role in the public goods case. Providing the key investor with the best incentives may require taking ownership away from him. This is the case when h is the key investor and l is indispensable. h's higher investment does not improve his bargaining position if he is the owner because he is unproductive without l. While under l-ownership any spillover from his investment improves his bargaining position and incentives. Furthermore, it is not always the case the the indispensable agent should be the owner – as in the private goods case. When is h indispensable l-ownership is optimal if l is the key investor – as shown in the previous paragraph.

By now we have established how introducing indispensability changes BG results. Interestingly, the results furthermore depend on which agent is indispensable. If it is the low-valuation agent that is indispensable (and the high-valuation agent is dispensable), then l should always have an ownership stake; either l-ownership or joint ownership is optimal. While when it is the high-valuation agent that is indispensable, then they key investor should be the owner. Indispensability can arise not only from nature of human capital but also from lack of ex post competition. For example, when the government

is the only purchaser for the service, then government is indispensable. Our results indicate that the governance structure appropriate for a developing country (where a pro-poor NGO is likely to be the high-valuation party) should differ from that of a developed country (where government typically is the high-valuation party).

Relatively few papers have been exploring directly the model by Besley and Ghatak (2001). Rasul (2006) applies their model to child custody and introduces a continuum of ex post custodial schemes and endogenous probability of marital breakdown. Francesconi and Muthoo (2010) introduce impurity of public goods and show, among other things, that technology determines optimal ownership structure when degree of impurity is large enough. In our paper even with pure public goods technology matters. Halonen-Akatwijuka and Pafilis (2009) analyze a repeated version of BG and show that elasticity of investments, in addition to the relative valuations, determines the optimal ownership structure. In this paper technology matters even in the static game. Grosjean (2003) applies BG model to a conservation project and introduces an opportunity cost paid to a third party. Also in this setup low-valuation ownership can emerge.

The incomplete contracting literature on privatization (e.g. Hart et al. (1997) and Schmitz (2000)) and on public-private partnerships (e.g. Hart (2003), Bennett and Iossa (2006) and Martimort and Poyet (2008)) are related. We differ in allowing also the private providers to be value driven and modelling explicitly the public good nature of the projects.

The rest of the paper is organized as follows. Section 2 introduces the model. Section 3 compares investment incentives under h- and l-ownership while Section 4 includes joint ownership in the analysis and analyzes the case of indispensable government. Section 5 concludes.

2 The model

We build on Besley and Ghatak (2001) and take a closer look at the nature of human capital embedded in their assumptions. In our basic model there are two agents, l and h, with project-specific investments in human capital, y_l and y_h. Public good is produced and the benefit from the project is $b(y_l, y_h)$. The agents value the project differently: l's utility from the public good is $\theta_l b(y_l, y_h)$ and h's utility is $\theta_h b(y_l, y_h)$. We assume that $\theta_l \leq \theta_h$, that is l is the low-valuation agent and h is the high-valuation agent. Investments are

measured by their costs: $c(y_i) = y_i$.

We assume that ex ante contracts can only be written on the ownership of the project. We firstly compare ownership by l and h and in Section 4 analyze joint ownership. The timing is the following:

1. l and h contract on the ownership of the project
2. l and h invest in project-specific human capital
3. l and h bargain over completion of the project and produce the public good

Default payoffs play an important role in the analysis. If bargaining breaks down and i is the owner, the benefit from the project is $B^i(y_l, y_h)$. Producing together is efficient: $B^i(y_l, y_h) < b(y_l, y_h)$. Each agent values this benefit differently: l's utility is $\theta_l B^i(y_l, y_h)$ and h's utility is $\theta_h B^i(y_l, y_h)$.

Denote $b_i(y_l, y_h) = \frac{\partial b(y_l, y_h)}{\partial y_i}$ and $B_i^j(y_l, y_h) = \frac{\partial B^j(y_l, y_h)}{\partial y_i}$. We assume that the benefit functions are increasing, concave with $b_{ij}(y_l, y_h) = B_{ij}^k(y_l, y_h) = 0$ for $i, j, k = l, h$ and $i \neq j$ and satisfy the Inada endpoint conditions.

We furthermore make an assumption about marginal investment returns that is weaker than Assumption 1 in Besley and Ghatak (2001).

Assumption 1. $b_i(y_l, y_h) \geq B_i^i(y_l, y_h)$ and $b_i(y_l, y_h) \geq B_i^j(y_l, y_h)$ for $i, j = l, h$ and $i \neq j$.

If bargaining breaks down, the owner can exclude the non-owner from taking part in the *production* of the public good but cannot exclude him from *consuming* the public good. Therefore non-owner's investment has less effect on the benefit from the project if bargaining breaks down. This explains $b_i(y_l, y_h) \geq B_i^j(y_l, y_h)$. The gap between $b_i(y_l, y_h)$ and $B_i^j(y_l, y_h)$ depends on how much of the non-owner's investment is sunk in the project. We call this spillover.[1] The gap is small when investment is e.g. about designing and organizing the project implementation and plans are already adopted or written down. In this situation spillover is large and when the worker leaves, a large part of his investment is already sunk in the project. The gap is largest when all of the investment is embedded in the person e.g. charismatic leadership. Then there is no spillover and if the agent leaves, he takes the investment with him and $B_i^j(y_l, y_h) = 0$.

[1] De Meza and Lockwood (2004) explore spillovers in the private goods case.

$B_i^i(y_l, y_h)$ depends on how the value of the owner's human capital investment is affected by the presence of the other agent. If the other agent is dispensable, the owner's marginal value of investment does not depend on whether the worker is in the same coalition or not. Then $B_i^i(y_l, y_h) = b_i(y_l, y_h)$. While if the owner's human capital is productive only in presence of the other agent – the worker is indispensable – we have $B_i^i(y_l, y_h) = 0$. Therefore $b_i(y_l, y_h) \geq B_i^i(y_l, y_h)$.

BG assume that $b_i(y_l, y_h) \geq B_i^i(y_l, y_h) > B_i^j(y_l, y_h)$. However, spillovers and indispensability are clearly different properties of the human capital. There is no clear link between spillovers from agent i's investment and agent j's indispensability, which is why we make a weaker assumption than BG. Suppose for instance that agent h is indispensable. Without h in the team l's human capital is not productive: $B_l^l(y_l, y_h) = 0$. Suppose also that some of l's human capital is sunk in the project: $B_l^h(y_l, y_h) > 0$. Such a situation violates BG assumption since $B_l^h(y_l, y_h) > B_l^l(y_l, y_h)$ and yet can occur naturally. Agent h's indispensability does not in any way imply that there should be no spillovers from l's investment. We explore how relaxing this assumption affects the optimal ownership of public good.

2.1 First best

Joint surplus equals

$$(\theta_l + \theta_h) b(y_l, y_h) - y_l - y_h$$

Therefore the first best investments are characterized by

$$(\theta_l + \theta_h) b_l(y_l^*, y_h^*) = 1 \tag{1}$$

$$(\theta_l + \theta_h) b_h(y_l^*, y_h^*) = 1 \tag{2}$$

Due to incompleteness of contracts we cannot obtain first best. In what follows we examine which ownership structure gives second best incentives.

3 Ownership and incentives

When l owns the public good (denoted by superscript l) Nash bargaining gives the following payoffs to the agents.

$$\begin{aligned} u_l^l &= \theta_l B^l(y_l, y_h) + \frac{1}{2}(\theta_l + \theta_h)\left[b(y_l, y_h) - B^l(y_l, y_h)\right] - y_l \\ &= \frac{1}{2}(\theta_l + \theta_h) b(y_l, y_h) + \frac{1}{2}(\theta_l - \theta_h) B^l(y_l, y_h) - y_l \end{aligned}$$

$$u_h^l = \frac{1}{2}(\theta_l + \theta_h) b(y_l, y_h) + \frac{1}{2}(\theta_h - \theta_l) B^l(y_l, y_h) - y_h$$

Optimal investments are then given by

$$\frac{1}{2}(\theta_l + \theta_h) b_l(y_l, y_h) + \frac{1}{2}(\theta_l - \theta_h) B_l^l(y_l, y_h) = 1 \tag{3}$$

$$\frac{1}{2}(\theta_l + \theta_h) b_h(y_l, y_h) + \frac{1}{2}(\theta_h - \theta_l) B_h^l(y_l, y_h) = 1 \tag{4}$$

The first term in (3) and (4) shows that each agent shares 50:50 his marginal contribution to the total value of the public good. The second term is negative for the low-valuation agent and positive for the high-valuation agent. It shows how an increase in investment affects the agent's bargaining position. Since this is a public good both parties can consume it even if they cannot reach an agreement. Therefore higher investment increases both parties' default payoffs. Since h values the public good more, his default payoff increases more than l's default payoff. That is why the second term is negative for l. l's higher investment improves h's bargaining position relative to l. While h's higher investment increases both the size of the pie and his share of it and therefore the second term in (4) is positive. Comparing the incentives to (1) and (2) we can verify that there is a familiar holdup problem.

It is straightforward to derive the incentives under h-ownership:

$$\frac{1}{2}(\theta_l + \theta_h) b_l(y_l, y_h) + \frac{1}{2}(\theta_l - \theta_h) B_l^h(y_l, y_h) = 1 \tag{5}$$

$$\frac{1}{2}(\theta_l + \theta_h) b_h(y_l, y_h) + \frac{1}{2}(\theta_h - \theta_l) B_h^h(y_l, y_h) = 1 \tag{6}$$

Comparing how incentives depend on the ownership structure boils down to comparing the second terms in $(3) - (6)$. Both agents have higher incentives under h-ownership if and only if

$$B_l^l(y_l, y_h) > B_l^h(y_l, y_h) \tag{7}$$

$$B_h^h(y_l, y_h) > B_h^l(y_l, y_h) \tag{8}$$

These are the assumptions made by BG. Then indeed ownership of the high-valuation agent gives the best incentives to both agents. h-ownership maximizes the positive second term for h and minimizes the negative second term for l. But some properties of human capital are embedded in these assumptions. To make our case clear we first discuss an example with one investment and then come back to the general setup of the model.

3.1 One investment

Suppose only l invests. Then we only need to examine equation (7). Suppose h is indispensable, $B_l^l(y_l, y_h) = 0$. Without h in the team l's human capital is not productive. Suppose also that some of l's human capital is sunk in the project and so $B_l^h(y_l, y_h) > 0$. In this case ownership by the low-valuation party is optimal since $B_l^l(y_l, y_h) < B_l^h(y_l, y_h)$. Therefore relative valuations are not the only determinant of optimal ownership structure but also the nature of human capital plays an important role. Spillovers and indispensability are different characteristics of human capital. Assuming that h's indispensability implies that there can be no spillovers from l's human capital is restrictive.

Ownership by l is optimal – not because l is the only investor (as it would be in the private goods case) – but because the optimal ownership structure minimizes the negative second term in l's incentives. His investment has minimal effect on default payoffs when he himself is the owner. Since h is indispensable l's investment is unproductive without h and higher investment is not going to worsen his bargaining position under l-ownership.

3.2 Two investments

Now we come back to the two investments case. From (7) and (8) we can see that the optimal ownership structure depends, in addition to relative valuations, on $B_i^i(y_l, y_h) - B_i^j(y_l, y_h)$. We have four possible cases.

If both $B_l^l(y_l, y_h) > B_l^h(y_l, y_h)$ and $B_h^h(y_l, y_h) > B_h^l(y_l, y_h)$, then ownership by the high-valuation agent gives higher incentives for both agents. These are the BG assumptions.

If both $B_l^l(y_l, y_h) < B_l^h(y_l, y_h)$ and $B_h^h(y_l, y_h) < B_h^l(y_l, y_h)$, then both agents' incentives are improved by ownership of the low-valuation agent.

It is interesting to allow for the agents to have asymmetric roles so that $B_i^i(y_l, y_h) > B_i^j(y_l, y_h)$ and $B_j^j(y_l, y_h) < B_j^i(y_l, y_h)$. In this case also the relative importance of investments plays a role. Agent i has better incentives under h-ownership while agent j's incentives are improved by l-ownership. Which ownership structure gives the best overall incentives depends on the relative importance of investments.

Proposition 1 summarize our results.

Proposition 1 *(i) Ownership by the low-valuation agent gives higher incentives for both agents than ownership by the high-valuation agent if and only if* $B_i^i(y_l, y_h) < B_i^j(y_l, y_h)$ *for* $i, j = l, h$ *and* $i \neq j$.

(ii) Ownership by the high-valuation agent gives higher incentives for both agents than ownership by the low-valuation agent if and only if $B_i^i(y_l, y_h) > B_i^j(y_l, y_h)$ *for* $i, j = l, h$ *and* $i \neq j$.

(iii) If $B_i^i(y_l, y_h) > B_i^j(y_l, y_h)$ *and* $B_j^j(y_l, y_h) < B_j^i(y_l, y_h)$ *for* $i, j = l, h$ *and* $i \neq j$*, then agent* i *has better incentives under h-ownership while agent* j*'s investment is higher under l-ownership.*

Proof. In the Appendix.

The sign of $\left[B_i^i(y_l, y_h) - B_i^j(y_l, y_h)\right]$ plays a key role and it depends on the nature of human capital. There are two clear cases when $\left[B_i^i(y_l, y_h) - B_i^j(y_l, y_h)\right]$ is positive. Firstly, if agent j is dispensable, then $B_i^i(y_l, y_h) = b_i(y_l, y_h) \geq B_i^j(y_l, y_h)$. Secondly, if there are no spillovers from agent i's investment, then $B_i^j(y_l, y_h) = 0 \leq B_i^i(y_l, y_h)$. In other words if it is easy to find good replacements for the agents in the spot market, then ownership by the high-valuation agent is beneficial – just as in BG. Alternatively, if the investments are fully embedded in the agents, the same is true. Then ownership by the high-valuation agent maximizes the positive second term for h and minimizes the negative second term for l.

But $\left[B_i^i(y_l, y_h) - B_i^j(y_l, y_h)\right]$ may also be negative. Firstly, if agent j is indispensable, agent i is unproductive on his own and $B_i^i(y_l, y_h) = 0 \leq$

$B_i^j(y_l, y_h)$. Secondly, if there are full spillovers from agent i's investment, then $B_i^j(y_l, y_h) = b_i(y_l, y_h) \geq B_i^i(y_l, y_h)$. In both cases an agent's investment increases the default payoffs more when he is not the owner. Therefore to maximize the positive second term for h we have to remove ownership from him. While to minimize the negative second term for l we have to give him the ownership. Therefore low-valuation ownership provides stronger incentives.

Proposition 1 shows that optimal ownership structure depends on three factors.

(i) The relative valuations for public good. Higher investment improves the bargaining position of high-valuation agent but worsens it for the low-valuation agent. Therefore optimal allocation of ownership is about maximizing this positive effect for h and minimizing the negative effect for l. This is the mechanism identified by BG.

(ii) Nature of human capital. It determines under which ownership structure the agent's investment has greatest effect on the default payoffs (the sign of $\left[B_i^i(y_l, y_h) - B_i^j(y_l, y_h)\right]$). For the high-valuation agent we wish to maximize the marginal productivity of the default payoff while for the low-valuation agent we wish to minimize it. Relative marginal productivities depend on spillovers and indispensability.

(iii) Technology. In some cases there is a trade-off between providing good incentives for h or l. Then the importance of investment determines the optimal ownership structure.

We have shown that indispensability opens a door for low-valuation ownership. We examine this effect more in detail in Proposition 2.

Proposition 2 *If agent i is indispensable, then agent j has (weakly) better incentives under ownership by the low-valuation agent than under ownership by the high-valuation agent.*

Proof. In the Appendix.

Proposition 2 says that if an agent is indispensable, then the other agent has best incentives under ownership by the low-valuation agent. When h is indispensable, giving ownership to l removes l's negative second term because he is unproductive without h. Therefore l's incentives are maximized

under l-ownership. While when l is indispensable, h's positive second term is maximized by removing the ownership from h and allowing for potential spillovers from his investment. In both cases ownership by the low-valuation agent improves the incentives of the other agent.

It is also interesting to compare this result to the private goods case. In Hart and Moore (1990) an indispensable agent should be the owner. How is it with public goods? Proposition 2 shows that although the nature of human capital matters for ownership of public goods, its role is different than in the private goods case. With private goods ownership (weakly) improves the owner's bargaining position and incentives. Therefore if an agent is indispensable, he should be the owner because ownership cannot improve any other agent's bargaining position since the asset is unproductive without the indispensable agent.[2] With public goods it remains to be true that ownership has zero effect on any other agent's bargaining position. But this is a benefit when we talk about l's incentives (and h is indispensable). The change in relative bargaining position is least harmful for l when he is the owner. While when it is l who is indispensable, then l-ownership is beneficial for h because potential spillovers (which can occur only when h is not the owner) improve h's bargaining position most.

Full spillover is another characteristic of human capital that gives an edge to ownership by the low-valuation agent. This result is stated in Proposition 3.

Proposition 3 *If there is full spillover from agent i's investment, then he has (weakly) better incentives under ownership by the low-valuation agent than under ownership by the high-valuation agent.*

Proof. In the Appendix.

[2]Hart and Moore (1990) actually assume that there are no spillovers. If we include spillovers, we do not get unambiguous result. But we can say that the more indispensable an agent is, the more likely it is that he owns the asset. In their notation if we have 2 agents and one asset a, the incentives under ownership by agent 1 are: $\frac{1}{2}v^1(12,\{a\}) + \frac{1}{2}v^1(1,\{a\}) = c'(I_1)$ and $\frac{1}{2}v^2(12,\{a\}) - \frac{1}{2}v^2(1,\{a\}) = c'(I_2)$. $v^2(1,\{a\})$ measures the spillover of 2's investment. While the incentives under 2 ownership are $\frac{1}{2}v^1(12,\{a\}) - \frac{1}{2}v^1(2,\{a\}) = c'(I_1)$ and $\frac{1}{2}v^2(12,\{a\}) + \frac{1}{2}v^2(2,\{a\}) = c'(I_2)$.

Now suppose 1 is indispensable $\left(v^2(2,\{a\}) = 0\right)$. 2's incentives under his ownership are weaker and therefore ownership by indispensable 1 is more likely. We do not get unambiguous result because ownership by agent 1 worsens agent 2's incentives due to spillovers that improve agent 1's bargaining position.

Suppose there is full spillover from h's investment. The positive second term for h is maximized when we allow for the full spillover by taking ownership away from h. Alternatively, if the full spillover is from l's investment, then the negative second term for l is minimized when we remove the full spillover by giving the ownership to l. In both cases the agent whose investment is fully sunk in the project has better incentives when low-valuation agent is the owner. Ownership by the low-valuation agent allows spillovers for h and removes them from l. Full spillover can result e.g. from investment in physical capital.

Propositions 2 and 3 show that indispensability and full spillovers favour ownership by the low-valuation agent. Conversely it is true that dispensability and no spillovers would favour ownership by the high-valuation agent.

We have shown that the nature of human capital matters also for the ownership of public goods although its role is different than in the private goods case. In the same way the role of technology is different. With private goods ownership by a key investor is optimal because ownership improves bargaining power and focus should be on key investor's incentives. With public goods tradeoff between providing good incentives exists only when the agents have asymmetric roles: the agents differ either in indispensability or in spillovers. Only in this asymmetric case we should concentrate on providing good incentives for the key investor at the cost to the other agent's incentives. But that may be accomplished by taking ownership away from the key investor. For example suppose h is a key investor and his investment is in physical capital (full spillover). Then large investment by the key investor is guaranteed by removing ownership from him since higher investment improves h's relative bargaining power most when investment has full effect on the default point (full spillover under l-ownership).

4 Indispensable government

We have examined indispensability as a property of human capital; an agent can be so important that without his contribution to the team the other agent is unproductive. Indispensability can also result from lack of ex post competition. This is often the case when a government and a supplier collaborate to provide a public service and the government is the only purchaser (e.g. defence, prisons and, in many economies, health and primary education services). In such cases the government is indispensable. The supplier, on the

other hand, can be dispensable because there are plenty of alternative suppliers. In this Section we focus on this relevant case where the government is indispensable while the supplier can be dispensable.[3]

Section 3 concentrated on comparing ownership by the high-valuation and the low-valuation agent. We now include joint ownership in the analysis and can therefore determine the optimal ownership structure. Under joint ownership the default payoffs are zero as the project cannot go ahead without approval of both agents.

The incentives under joint ownership are

$$\frac{1}{2}\left(\theta_l + \theta_h\right) b_l\left(y_l, y_h\right) = 1 \tag{9}$$

$$\frac{1}{2}\left(\theta_l + \theta_h\right) b_h\left(y_l, y_h\right) = 1 \tag{10}$$

Joint ownership provides the best incentives for the low-valuation agent as higher investment cannot worsen his bargaining position when default payoffs are zero. The high-valuation agent on the other hand has the worst incentives because higher investment does not improve his bargaining position.

In this Section we assume that the government is indispensable but we allow the government to be either the high-valuation or the low-valuation party. In a developed country the government typically has a high valuation for the public good and collaborates with a more private-minded supplier. In a developing country the roles can be different when a government and a pro-poor NGO collaborate in public good provision. Then the NGO is the high-valuation party. Interestingly, our results depend on whether the indispensable government has high or low valuation for the public good.

We first examine the case where the high-valuation agent is indispensable. Proposition 4 gives our result for this case. Note that while Propositions 1 - 3 compared l- and h-ownership, we can now determine the optimal ownership structure as we also examine joint ownership.

[3]If both agents are dispensable, then BG assumption is satisfied and h-ownership is optimal. While if both agents are indispensable, then l-ownership is optimal. Proposition 2 shows that l-ownership weakly dominates h-ownership. Furthermore, l-ownership weakly dominates joint ownership because potential spillovers under l-ownership improve h's incentives and l's negative second term is removed under both joint ownership and l-ownership (due to h being indispensable).

Proposition 4 *Suppose the high-valuation agent is indispensable.*

(i) *Joint ownership is weakly dominated.*

(ii) *Key investor should own the public good if the low-valuation agent is dispensable and the spillovers are intermediate.*

Proof. (i) When h is indispensable ($B_l^l(y_l, y_h) = 0$), l has the same incentives under l-ownership (equation (3)) and under joint ownership (equation (9)). Joint ownership (weakly) reduces h's incentives ((4) vs. (10)). Therefore joint ownership is weakly dominated by l-ownership.

(ii) Assume l is dispensable $\left(B_h^h(y_l, y_h) = b_h(y_l, y_h)\right)$, spillovers from l are positive $\left(B_l^h(y_l, y_h) > B_l^l(y_l, y_h) = 0\right)$ and spillovers from h are not full $\left(B_h^h(y_l, y_h) = b_h(y_l, y_h) > B_h^l(y_l, y_h)\right)$. Then Proposition $1(iii)$ shows that h has higher incentives under h-ownership and l has better incentives under l-ownership. Therefore if one agent is a key investor, i.e. has very important investment relative to the other agent, then he should be the owner. Q.E.D.

If h is indispensable, l has (weakly) best incentives when he owns the public good. Since he is unproductive without indispensable h, his negative second term is removed under l-ownership. Therefore l's incentives cannot be improved by joint ownership while joint ownership leads to (weakly) lower investment by h. This is why joint ownership is dominated when h is indispensable.

When the high-valuation agent is indispensable, the optimal ownership structure is either h- or l-ownership since joint ownership is dominated. Furthermore, h has the best incentives when he owns the public good when l is dispensable as he can realize the full marginal value of his investment without l.[4] While agent l's investment is higher under l-ownership since higher investment does not worsen his bargaining position when h is indispensable.[5] Therefore there is a tradeoff and each agent has the best incentives if he owns the public good. This is why the key investor should own the public good.

[4] h's incentives are strictly greater under h-ownership than under l-ownership assuming spillover's from h's investment are intermediate (not full).

[5] l's incentives are strictly greater under l-ownership than under h-ownership assuming spillover's from l's investment are intermediate (positive).

When it is the low-valuation agent who is indispensable, the results are quite different as Proposition 5 shows.

Proposition 5 *Suppose the low-valuation agent is indispensable.*

(*i*) *Ownership by the high-valuation agent is weakly dominated.*

(*ii*) *Joint ownership is optimal if there are no spillovers from high-valuation agent.*

(*iii*) *If the high-valuation agent is dispensable and there are spillovers from agent h, joint ownership (ownership by the low-valuation agent) is optimal if the low-valuation (high-valuation) agent is the key investor.*

Proof. (*i*) When l is indispensable ($B_h^h(y_l, y_h) = 0$), h has the same incentives under h-ownership (equation (6)) and joint ownership (equation (10)). Joint ownership weakly increases l's incentives ((5) vs. (9)). Therefore h-ownership is weakly dominated by joint ownership.

(*ii*) When there are no spillovers for h ($B_h^l(y_l, y_h) = 0$) and l is indispensable ($B_h^h(y_l, y_h) = 0$), h's incentives do not depend on the ownership structure. Joint ownership is then optimal since it maximizes l's incentives.

(*iii*) Optimal ownership structure is either joint ownership or l-ownership since h-ownership is dominated. l has strictly higher investment under joint ownership when l is dispensable ($B_l^l(y_l, y_h) = b_l(y_l, y_h)$); compare equations (3) and (9). While h has strictly better incentives under l-ownership when there are spillovers from h $\left(B_h^l(y_l, y_h) > 0\right)$; compare equations (4) and (10). Therefore joint ownership is optimal if l is the key investor and l-ownership is optimal if h is the key investor. Q.E.D.

Now ownership by the high-valuation agent is weakly dominated. Since l is indispensable, h is unproductive on his own. Therefore h has the same incentives under h-ownership and joint ownership while l has weakly better incentives under joint ownership. Therefore the optimal ownership structure is either joint ownership or l-ownership.

The benefit of joint ownership is that l's investment is higher while the cost of joint ownership is that h's investment is lower. The cost of joint ownership is the higher, the higher are spillovers from h's investment because spillovers motivate investment under l-ownership. When there are no spillovers, there is no cost of joint ownership – only the benefit of l's higher investment – and joint ownership is optimal.

Furthermore, if l is the key investor, joint ownership is optimal as l's negative second term is then removed. Whereas when h has the most important

investment, l-ownership is optimal because the only way to have a positive second term for h is to allow for spillovers from his investment. This can be accomplished by taking ownership away from him.

We have shown that the results depend importantly on whether the indispensable government has high or low valuation for the public good. In many developed countries the government can be assumed to have high valuation for the public good. Proposition 4 shows that the optimal ownership structure resembles the private goods case of Hart and Moore (1990): the key investor should be the owner and joint ownership is dominated.

In many developing countries it can be assumed that it is the pro-poor NGO that has a high valuation for the public good. Our Proposition 5 shows that ownership by the high-valuation NGO is dominated when the government is the only purchaser for the service. Despite its low valuation for the public good, the government should always have an ownership stake. Furthermore, joint ownership (which is dominated in a developed country context) can emerge optimally.

5 Conclusions

In this paper we show that the optimal ownership of public good is not solely driven by relative valuations. With public goods higher investment improves everybody's default payoffs and therefore the high-valuation agent's bargaining position is improved relative to the low-valuation agent. Allocating ownership optimally is about maximizing this positive default payoff effect for h and minimizing the negative effect for l as identified by Besley and Ghatak (2001). But it is the nature of human capital that determines whether giving or removing ownership strengthens the effect of investment on default payoffs. Removing ownership from h allows for spillovers from his investment and strengthens the positive investment effect when l is indispensable. While giving ownership to l minimizes his negative incentive effect when h is indispensable and there are spillovers from l's investment.

Finally we relate our results to public-private partnerships where the government as the only purchaser is indispensable. Our model abstracts from the benefits of bundling build and service provision usually emphasized in the incomplete contracting literature on public-private partnerships (Hart (2003), Bennett and Iossa (2006) and Martimort and Poyet (2008)). But contrary to this literature we allow the providers to care about the project

benefits to the recipient – as is natural in a developing country context or in "caring" sectors (Francois (2000) and Besley and Ghatak (2005)). Ownership by the supplier can be interpreted as PPP; private supplier owns the project assets and contracts with the government to supply the public service. Furthermore, joint ownership is a special type of PPP where both the government and the supplier have veto power. Our results indicate that the optimal governance structure for a developing country differs from that of a developed country. In a developed country where the government is usually the high-valuation party PPP is optimal when the supplier is the key investor. While in a developing country context PPP where the high-valuation supplier is the sole owner is weakly dominated. However, it is exactly in developing countries that the government is not necessarily the only purchaser for e.g. health and primary education services. In such cases ownership by the high-valuation NGO can be optimal as predicted by Besley and Ghatak (2001). Furthermore, we have shown that a joint ownership type PPP is weakly dominated in a developed country but can arise for a wide parameter range when a high-valuation NGO collaborates with an indispensable government.

A Appendix

Proof of Proposition 1.

Equations (4) and (6) imply

$$\frac{1}{2}(\theta_l+\theta_h)\,b_h\left(y_l^l,y_h^l\right)+\frac{1}{2}(\theta_h-\theta_l)\,B_h^l\left(y_l^l,y_h^l\right)=\frac{1}{2}(\theta_l+\theta_h)\,b_h\left(y_l^h,y_h^h\right)+\frac{1}{2}(\theta_h-\theta_l)\,B_h^h\left(y_l^h,y_h^h\right) \tag{11}$$

where y_i^j denotes i's investment under j-ownership. Now if $B_h^l(y_l,y_h) > B_h^h(y_l,y_h)$ for given investments (11) does not hold for $y_h^l = y_h^h$. The left-hand-side would be greater than the right-hand-side. Since the benefit functions are concave (and $b_{ij}(y_l,y_h) = B_{ij}^k(y_l,y_h) = 0$ by Assumption 2) equality requires $y_h^l > y_h^h$. Conversely, if $B_h^l(y_l,y_h) < B_h^h(y_l,y_h)$ for given investments, we have to have that $y_h^l < y_h^h$.

Similarly, equations (3) and (5) imply

$$\frac{1}{2}(\theta_l+\theta_h)\,b_l\left(y_l^h,y_h^h\right)+\frac{1}{2}(\theta_l-\theta_h)\,B_l^h\left(y_l^h,y_h^h\right)=\frac{1}{2}(\theta_l+\theta_h)\,b_l\left(y_l^l,y_h^l\right)+\frac{1}{2}(\theta_l-\theta_h)\,B_l^l\left(y_l^l,y_h^l\right) \tag{12}$$

Again if $B_l^h(y_l,y_h) > B_l^l(y_l,y_h)$ for given investments (12) does not hold for $y_l^l = y_l^h$, now the right-hand-side would be greater than the left-hand-side. Equality requires $y_l^l > y_l^h$. Conversely, if $B_l^h(y_l,y_h) < B_l^l(y_l,y_h)$, we have $y_l^l < y_l^h$.

In sum, agent i has better incentives under l-ownership if and only if $B_i^i(y_l,y_h) < B_i^j(y_l,y_h)$ where $i \neq j$.

Q.E.D.

Proof of Proposition 2.

Suppose h is indispensable. Substituting $B_l^l(y_l,y_h) = 0$ in (11) gives:

$$\frac{1}{2}(\theta_l+\theta_h)\,b_l\left(y_l^h,y_h^h\right)+\frac{1}{2}(\theta_l-\theta_h)\,B_l^h\left(y_l^h,y_h^h\right)=\frac{1}{2}(\theta_l+\theta_h)\,b_l\left(y_l^l,y_h^l\right) \tag{13}$$

Since the second term in the left-hand-side is negative, it follows that $y_l^l > y_l^h$.

Then suppose l is indispensable. Substituting $B_h^h(y_l,y_h) = 0$ in (12) implies:

$$\frac{1}{2}(\theta_l+\theta_h)\,b_h\left(y_l^l,y_h^l\right)+\frac{1}{2}(\theta_h-\theta_l)\,B_h^l\left(y_l^l,y_h^l\right)=\frac{1}{2}(\theta_l+\theta_h)\,b_h\left(y_l^h,y_h^h\right) \tag{14}$$

Therefore $y_h^l > y_h^h$.

In both cases when agent i is indispensable, agent j has best incentives under l-ownership. Q.E.D.

Proof of Proposition 3.

Suppose there is full spillover from h's investment. Substituting $B_h^l(y_l, y_h) = b_h(y_l, y_h)$ in (12) implies:

$$\frac{1}{2}(\theta_l + \theta_h) b_h\left(y_l^l, y_h^l\right) + \frac{1}{2}(\theta_h - \theta_l) b_h\left(y_l^l, y_h^l\right) = \frac{1}{2}(\theta_l + \theta_h) b_h\left(y_l^h, y_h^h\right) + \frac{1}{2}(\theta_h - \theta_l) B_h^h\left(y_l^h, y_h^h\right)$$

Since $b_h(y_l, y_h) \geq B_h^h(y_l, y_h)$ we have $y_h^l > y_h^h$.

While when the full spillover from l's investment ($B_l^h(y_l, y_h) = b_l(y_l, y_h)$) we have:

$$\frac{1}{2}(\theta_l + \theta_h) b_l\left(y_l^h, y_h^h\right) + \frac{1}{2}(\theta_l - \theta_h) b_l\left(y_l^h, y_h^h\right) = \frac{1}{2}(\theta_l + \theta_h) b_l\left(y_l^l, y_h^l\right) + \frac{1}{2}(\theta_l - \theta_h) B_l^l\left(y_l^l, y_h^l\right) \tag{15}$$

Since $b_l(y_l, y_h) \geq B_l^l(y_l, y_h)$ we have $y_l^l > y_l^h$. Q.E.D.

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