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GOVERNMENT VERSUS PRIVATE OWNERSHIP OF PUBLIC GOODS: THE ROLE OF BARGAINING FRICTIONS†

Abstract

The government and a non-governmental organization (NGO) can invest in the provision of a public good. Who should be the owner of the public project? In an incomplete contracting model in which ex post negotiations are without frictions, the party that values the public good most should be the owner, regardless of technological aspects. However, under the plausible assumption that there are bargaining frictions, the optimal ownership structure depends on technological aspects and on the parties' valuations. We show that the differences between incomplete contracting models with public goods and private goods are thus smaller than has previously been thought.

JEL Classification: C78, D23, D86, H41 and L31
Keywords: bargaining frictions, incomplete contracts, investment incentives, ownership and public goods

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1 Introduction

Public goods are often produced by partners who care about the benefits of the public good. The partners may be different public entities (say, federal and local government agencies), or there may be a "public-private partnership" in which the responsibility for the delivery of public goods and services is shared between the state and the private sector. Following Besley and Ghatak (2001), as a lead example we consider a partnership between the government and an NGO which directly cares about a public project. Should the government or the NGO own the public project? In this paper, we provide a new perspective on how ownership matters in public good provision when contracts are incomplete. Specifically, we argue that in the presence of bargaining frictions the qualitative differences between incomplete contracting models with public goods and private goods may actually be smaller than has previously been thought.

It is by now widely appreciated that the property rights theory based on incomplete contracting, which has been developed in the seminal contributions by Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995), provides a very useful framework for investigating the implications of ownership allocations in various contexts.[1] Specifically, consider two parties that at some future date 2 can collaborate to generate a surplus. Collaboration cannot be contractually specified before date 2. At date 1, the parties have to make relationship-specific investment decisions. Ownership determines the parties' default payoffs (i.e., what the parties would get if they did not collaborate at date 2). In the property rights theory, it is usually assumed that at date 2 there are no frictions at all, so negotiations always lead to ex post efficiency, regardless of the ownership structure. Specifically, the date-2 negotiations are modelled by the Nash bargaining solution. Ownership matters, because it increases (the owner's default payoff and hence) the fraction of the collaboration surplus that the owner will get at date 2, thereby improving the owner's investment incentives at date 1. As a

[1] See Segal and Whinston (2013) for a comprehensive survey of the literature on property rights. Legros and Newman (2014) provide a recent literature review with a focus on applications in the field of industrial organization.

consequence, the optimal ownership structure depends on the investment technology. In particular, the party whose investments are more important should be the owner, and joint asset ownership (where each party has veto power) is suboptimal.

The standard property rights theory was motivated by the analysis of the pros and cons of vertical integration and has thus been developed in a private-good framework. In an important contribution, Besley and Ghatak (2001) have pointed out that the conclusions of the standard property rights theory do no longer hold in the context of public goods. They explore whether the government or an NGO should own the physical assets needed to provide a public good, and they show that the party who values the public good most should always be the owner, regardless of the investment technology.

In the present paper, we reconsider Besley and Ghatak's (2001) public-good setting. However, while they assume that there are no bargaining frictions at date 2, we allow for ex post inefficienies. Indeed, also Besley and Ghatak (2001, p. 1348) acknowledge that a "model with contracting imperfections" is actually "more realistic" than a model with frictionless contracting. Yet, as in the standard property rights theory, they assume that contracting imperfections exist only ex ante, but not ex post.

In the real world, frictionless bargaining is hard to imagine,[2] and negotiations between the government and an NGO may well fail. For example, consider the recent case of Relationships Aotearoa (RA), a not-for-profit organization with charitable status, which used to be New Zealand's largest professional counselling and family therapy provider. In 2013-2014, the organization delivered more than 50,000 counselling hours to more than 27,000 people, dealing with issues such as parenting, family conflict, and domestic violence. The organization also provided professional training, supervision, and mediation for people working in demand-

[2] See e.g. Baird (2013, p. 59), who argues that we "do not live in this counterfactual world of frictionless bargaining," emphasizing the fact that negotiations sometimes fail. Williamson (1999, p. 316) points out that it is elementary "that frictionless ideals cannot be implemented" in practice.

ing workplaces.[3] RA has closed on June 9, 2015. Negotiations between RA and government agencies failed two weeks earlier. According to RA, the Ministry of Social Development broke good faith provisions,[4] while the Social Development Minister Anne Tolley claimed that RA were "the ones who pulled out of negotiations."[5] RA Spokesperson Cary Hayward argued that "the government was wanting a Rolls Royce service on a Morris Minor fee," while Tolley said that RA "had a pretty unstable chief executive role, four chief executives in a short period of time, I don't think that helps any organisation, specially when they're at a time of change."[6] The example illustrates that ex post haggling and frictions in the sense of Williamson (1985) may well lead to a bargaining breakdown between government and NGO.[7]

Indeed, several authors such as Holmström and Roberts (1998) and Williamson (2000) have criticized the standard property rights theory for neglecting the possibility of ex post inefficiencies. Yet, we will show that the introduction of ex post bargaining frictions does not qualitatively change the central conclusions of the standard property rights theory in the private-good framework. In contrast, in the public-good context, Besley and Ghatak's (2001) finding is not robust once we allow for date-2 bargaining frictions.

Specifically, we introduce a friction parameter $\rho \in (0, 1]$, such that the share

[3] For more detailed information on Relationships Aotearoa, see their Annual Report 2013-2014.

[4] See New Zealand Herald, "Counselling service forced to shut doors this week," May 26, 2015.

[5] See TVNZ, "Anne Tolley tells counselling service to 'calm down' after it confirms closure," May 26, 2015.

[6] See Radio New Zealand, "Take over of Relationships Aotearoa clients," May 26, 2015.

[7] See the Supplementary Material for a detailed description of a similar real-world example in which bargaining frictions have ultimately led to a negotiation breakdown, involving the Northeast Resource Recovery Association (a not-for-profit organization that serves communities in New England) and the Vermont Agency of Natural Resources. In both cases aggrievement seems to have contributed to the bargaining breakdowns; note that the destructive effects of aggrievement have recently also been emphasized in the contracts-as-reference-points literature (see Hart and Moore, 2007, 2008; Halonen-Akatwijuka and Hart, 2013).

$1-\rho$ of the additional surplus that can be generated by the date-2 negotiations will not be realized.[8] Thus, given risk-neutrality, the simplest interpretation of our model is that an ex post efficient agreement is reached with probability ρ, while there is an ex post inefficient bargaining breakdown with probability $1-\rho$.[9] As a consequence, in the presence of frictions the optimal ownership structure is no longer entirely determined by investment incentives, but it also depends on the size of the deadweight loss in the date-2 bargaining stage. We show that for every $\rho < 1$, there are situations in which ownership of the public good should reside with the party that has a technological advantage, even if the other party has a larger valuation of the public good. Hence, our findings show that when contracting imperfections are also present ex post, then the main conclusions of the original property rights theory as developed by Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995) also have bite in the context of public goods.

Intuitively, when there are frictions in the date-2 negotiations, then the parties' investment incentives depend to a larger extent on their default payoffs, which in turn depend on the ownership structure. It is then no longer true that the party who values the public good most should be the owner, since the increased importance of the default payoffs implies that the investment incentives may be stronger if the party with the more productive investment technology is the owner, just as in the standard private-good case. Moreover, ownership by the party with the more productive investment technology can now be optimal even when it does not yield larger investment incentives, since larger default payoffs now imply a smaller deadweight loss in the date-2 bargaining stage.

[8] The linear specification is a shortcut just like the traditional shadow costs of public funds (see e.g. the textbook by Laffont and Tirole, 1993) or the leaky-bucket model introduced by Tirole (1992).

[9] Our formalization of the date-2 bargaining frictions is thus similar to Schwartz and Watson's (2004) model of costly renegotiation. Laffont and Martimort (2002, ch. 9.2) and Kvaløy and Olsen (2015) study related models in which an agreement is enforced with a probability smaller than one. The fact that enforcement of contractual agreements may be imperfect in particular in less developed countries has also been stressed by Laffont and Meleu (2000).

Finally, one might argue that Besley and Ghatak's (2001) result should not be taken literally and that their main insight is that in the context of public goods the optimal ownership structure is not entirely driven by technological aspects. However, also in the context of private goods optimal ownership does not entirely depend on technological aspects. We show that in a straightforward private-good variant of our model the parties' relative valuations of the private good also have an impact on the optimal ownership structure, even in the standard case without bargaining frictions. The presence of bargaining frictions further strengthens the impact of the parties' valuations. Taken together, our results thus show that the qualitative differences between the public-good case and the private-good case are actually smaller than is suggested by the previous literature.

Related literature. Besley and Ghatak's (2001) model has been extended in several directions. Halonen-Akatwijuka and Pafilis (2009) study a repeated-game variant of Besley and Ghatak's (2001) setup and they find that the optimal ownership structure depends on the elasticity of investments.[10] Francesconi and Muthoo (2011) consider impure public goods (i.e., public goods that can be excludable) and they show that the optimal allocation of authority depends on technological factors. Halonen-Akatwijuka (2012) extends Besley and Ghatak's (2001) model by allowing agents to be indispensable and she demonstrates that the nature of human capital is an important determinant of the optimal ownership structure.[11] Yet, none of these papers allow ex post bargaining frictions.

Organization of the paper. The remainder of the paper is organized as fol-

[10] The fact that property rights models are sensitive to repeated interactions has also been demonstrated in the context of private goods by Baker, Gibbons, and Murphy (2002) and Halonen (2002).

[11] See also Rasul (2006), who studies an application to child custody, and Grosjean (2010), who introduces maintenance costs into a variant of Besley and Ghatak's (2001) model. Halonen-Akatwijuka and Pafilis (2014) investigate location choice and find that it can be optimal to separate location from ownership. See also Hart, Shleifer, and Vishny (1997) and Hoppe and Schmitz (2010), who consider optimal ownership structures in models of public-good provision in which (in contrast to Besley and Ghatak, 2001) the private party does not directly care about the public good.

lows. In Section 2, we introduce the model. In Section 3, we derive the outcome of the date-2 negotiations when there are bargaining frictions. In Section 4, the parties' date-1 investments are characterized. The optimal ownership structures are discussed in Section 5. In section 6, we compare the implications of bargaining frictions in the public-good case with a private-good benchmark model. Concluding remarks follow in Section 7. Formal proofs have been relegated to the Appendix.

2 The model

There are two risk-neutral parties, the government (G) and a non-governmental organization (N). The two parties can collaborate at some future date 2 in order to provide a public good. Who should own the physical assets that are needed to provide the public good? The main question of our study is whether ownership by the government ($o = G$) or ownership by the non-governmental organization ($o = N$) leads to a larger expected total surplus.

At date 1, the two parties G and N simultaneously choose observable but non-contractible investment levels $g \geq 0$ and $n \geq 0$, which are measured by their costs. In line with the by now standard incomplete contracting approach, it is assumed that the public good which can be provided ex post is not yet contractible ex ante.[12]

The provision of the public good becomes contractible at date 2. If the two parties G and N agree to collaborate at date 2, then they can together provide the quantity $\alpha_G y(g) + \alpha_N y(n)$ of the public good, where the standard assumptions

[12] The foundations of the incomplete contracting paradigm are still a matter of ongoing research (see Tirole, 1999, for a vivid discussion of this controversial debate). Maskin and Tirole (1999) argue that non-describability of future contingencies can be circumvented by suitable mechanisms (while non-foreseeability of future payoff consequences is incompatible with the incomplete contracting methodology). Yet, Hart and Moore (1999) point out that renegotiation may undermine the effectiveness of subgame-perfect implementation mechanisms. Recently, experimental studies have also cast doubt on the usefulness of such mechanisms (see Fehr, Powell, and Wilkening, 2014).

$y(0) = 0$, $y'(0) = \infty$, $y'(\infty) = 0$, and $y'' < 0$ hold.[13] The parameters $\alpha_G > 0$ and $\alpha_N > 0$ determine whether the government ($\alpha_G > \alpha_N$) or the non-governmental organization ($\alpha_N > \alpha_G$) has a technological advantage.

If the parties fail to collaborate at date 2, then the quantity of the public good is determined by the ownership structure. In particular, if the parties do not collaborate, then the quantity of the public good is only $\alpha_G y(g) + \lambda_N \alpha_N y(n)$ if $o = G$, and it is only $\lambda_G \alpha_G y(g) + \alpha_N y(n)$ if $o = N$, where $\lambda_N \in (0, 1)$ and $\lambda_G \in (0, 1)$. Thus, the owner can always realize the full returns of his own investments. However, if the parties do not collaborate at date 2, then the owner can realize only a fraction of the returns of the other party's investments. In other words, a part of the investment returns is embodied in the investor's human capital and is hence lost when the investor does not collaborate in the provision of the public good (cf. Hart, Shleifer, and Vishny, 1997). Following Besley and Ghatak (2001), we also consider the case of joint ownership ($o = J$), which means that both the government and the NGO have veto power over the use of the physical assets and hence the public good is not provided if the parties do not agree to collaborate at date 2.

Let the government's valuation of the public good be denoted by $\theta_G > 0$, and let the non-governmental organization's valuation be denoted by $\theta_N > 0$. As a consequence, the parties' date-2 payoffs are as shown in Table 1, where t is a (possibly negative) transfer payment from the government to the non-governmental organization.

	payoff of party G	payoff of party N
collaboration	$\theta_G[\alpha_G y(g) + \alpha_N y(n)] - t$	$\theta_N[\alpha_G y(g) + \alpha_N y(n)] + t$
default, $o = G$	$\theta_G[\alpha_G y(g) + \lambda_N \alpha_N y(n)]$	$\theta_N[\alpha_G y(g) + \lambda_N \alpha_N y(n)]$
default, $o = N$	$\theta_G[\lambda_G \alpha_G y(g) + \alpha_N y(n)]$	$\theta_N[\lambda_G \alpha_G y(g) + \alpha_N y(n)]$
default, $o = J$	0	0

Table 1. The parties' date-2 payoffs.

[13] The specification of the production function follows Besley and Ghatak (2001, p. 1355).

2.1 The first-best benchmark

In a first-best world, i.e. in the absence of any contracting problems, the parties would always collaborate at date 2, such that no part of the investment returns would be lost. At date 1, the parties would choose the investment levels g and n that maximize the total surplus $(\theta_G + \theta_N)[\alpha_G y(g) + \alpha_N y(n)] - g - n$. Hence, the first-best investment levels g^{FB} and n^{FB} are implicitly characterized by

$$\begin{aligned}(\theta_G + \theta_N)\alpha_G y'(g^{FB}) &= 1, \\ (\theta_G + \theta_N)\alpha_N y'(n^{FB}) &= 1.\end{aligned}$$

Note that in line with the standard property rights approach (cf. Hart, 1995), ownership does not matter in a first-best world.

3 Ex post negotiations

Following most contributions to the literature on the property rights theory, Besley and Ghatak (2001) model the date-2 negotiations using the regular Nash bargaining solution, where the default payoffs constitute the threatpoint.[14] Thus, in the case of successful negotiations, the parties agree on a transfer payment t such that at date 2 each party gets its default payoff (which it would get in case of disagreement) plus half of the date-2 negotiation surplus (i.e., the additional surplus that is generated by collaboration).

In contrast to Besley and Ghatak (2001), we allow negotiations to be plagued by frictions. Specifically, as explained in the Introduction, we assume that there is a friction parameter $\rho \in (0, 1]$ such that with probability $1 - \rho$ the negotiations

[14] Schmitz (2014) shows that Besley and Ghatak's (2001) results are robust if instead of the split-the-difference rule the deal-me-out solution is applied, where the default payoffs are treated as bounds on the bargaining set (cf. Chiu, 1998, DeMeza and Lockwood, 1998, and Rajan and Zingales, 1998, for applications of the deal-me-out solution in private-good settings). Moreover, Schmitz (2013) shows that Besley and Ghatak's (2001) central insight that the optimal choice between $o = G$ and $o = N$ does not depend on technological aspects is also robust if the generalized Nash bargaining solution is applied. These papers do not allow for ex post bargaining frictions.

fail, which implies that in expectation the share $1-\rho$ of the date-2 negotiation surplus is lost.

Hence, if the government is the owner ($o = G$), then the government's date-2 payoff is

$$u_G^G(g,n) = \theta_G[\alpha_G y(g) + \lambda_N \alpha_N y(n)] + \rho \Delta^G(n)/2$$

and NGO's date-2 payoff reads

$$u_N^G(g,n) = \theta_N[\alpha_G y(g) + \lambda_N \alpha_N y(n)] + \rho \Delta^G(n)/2,$$

where the date-2 negotiation surplus $\Delta^G(n)$ is given by

$$\begin{aligned} \Delta^G(n) &= (\theta_G + \theta_N)[\alpha_G y(g) + \alpha_N y(n) - [\alpha_G y(g) + \lambda_N \alpha_N y(n)]] \\ &= (\theta_G + \theta_N)(1-\lambda_N)\alpha_N y(n). \end{aligned}$$

Thus, when the negotiations are costless, then each party gets its default payoff plus half of the date-2 negotiation surplus (the total surplus given collaboration minus the total default surplus). Yet, when the date-2 negotiations are costly, then only a share $\rho < 1$ of the date-2 negotiation surplus $\Delta^G(n)$ can be realized (or, equivalently, the date-2 negotiation surplus is realized with probability $\rho < 1$ only).

If the non-governmental organization is the owner ($o = N$), then the government's date-2 payoff reads

$$u_G^N(g,n) = \theta_G[\lambda_G \alpha_G y(g) + \alpha_N y(n)] + \rho \Delta^N(g)/2$$

and the NGO's date-2 payoff is

$$u_N^N(g,n) = \theta_N[\lambda_G \alpha_G y(g) + \alpha_N y(n)] + \rho \Delta^N(g)/2.$$

In this case, the date-2 negotiation surplus is given by

$$\begin{aligned} \Delta^N(g) &= (\theta_G + \theta_N)[\alpha_G y(g) + \alpha_N y(n) - [\lambda_G \alpha_G y(g) + \alpha_N y(n)]] \\ &= (\theta_G + \theta_N)(1-\lambda_G)\alpha_G y(g). \end{aligned}$$

Observe that the date-2 negotiation surplus in the case of N-ownership depends on the government's investment g, but not on the NGO's investment n (while the

opposite holds under $o = G$). The reason is that if no agreement is reached under N-ownership, then the fraction $1 - \lambda_G$ of the government's investment return is lost, so the surplus that is generated by the date-2 negotiations depends on the government's investment, but not on the NGO's investment.

If there is joint ownership ($o = J$), then the date 2-payoffs of the government and the NGO, respectively, are given by

$$\begin{aligned} u_G^J(g,n) &= 0 + \rho\Delta^J(g,n)/2, \\ u_N^J(g,n) &= 0 + \rho\Delta^J(g,n)/2. \end{aligned}$$

The date-2 negotiation surplus in the case of joint ownership is

$$\Delta^J(g,n) = (\theta_G + \theta_N)[\alpha_G y(g) + \alpha_N y(n)].$$

Note that under joint ownership, the date-2 negotiation surplus depends on both the government's and the NGO's investment.

4 Ex ante investment incentives

Let us now analyze the parties' date-1 investment incentives. Given the ownership structure $o \in \{G, N, J\}$, the parties anticipate that at date 2 the government's payoff will be $u_G^o(g,n)$ and the NGO's payoff will be $u_N^o(g,n)$. Since the investments are measured by their costs, this means that at date 1 party G chooses the investment level

$$g^o = \arg\max u_G^o(g, n^o) - g,$$

while party N chooses the investment level

$$n^o = \arg\max u_N^o(g^o, n) - n.$$

As a consequence, under G-ownership the investment levels of the two parties are implicitly characterized by the first-order conditions

$$\theta_G \alpha_G y'(g^G) = 1,$$
$$[\theta_N \lambda_N + \rho(\theta_G + \theta_N)(1 - \lambda_N)/2]\alpha_N y'(n^G) = 1.$$

The first-order conditions require that each party's marginal investment returns must be equal to the marginal investment costs, which are one. Analogously, under N-ownership the investment levels are characterized by

$$[\theta_G \lambda_G + \rho(\theta_G + \theta_N)(1 - \lambda_G)/2]\alpha_G y'(g^N) = 1,$$
$$\theta_N \alpha_N y'(n^N) = 1.$$

Under joint ownership ($o = J$), the two parties' investment levels are implicitly given by the conditions

$$\begin{aligned} \rho(\theta_G + \theta_N)\alpha_G y'(g^J)/2 &= 1, \\ \rho(\theta_G + \theta_N)\alpha_N y'(n^J)/2 &= 1. \end{aligned}$$

Observe that under all ownership structures there is always underinvestment compared to the first-best solution, because the marginal private investment returns are always smaller than the marginal social investment returns.

We can now compare the investment decisions that the parties make in the different ownership structures. Specifically, inspection of the first-order conditions shows that the government invests more under G-ownership than under N-ownership ($g^G > g^N$) whenever

$$\theta_G > \theta_G \lambda_G + \rho(\theta_G + \theta_N)(1 - \lambda_G)/2,$$

which is equivalent to $(2 - \rho)\theta_G > \rho\theta_N$. Note that if there are no bargaining frictions ($\rho = 1$), then the government invests more under $o = G$ than under $o = N$ whenever it is the government who has a larger valuation of the public good. Yet, in the presence of frictions, it may well be the case that the government has stronger investment incentives under $o = G$ than under $o = N$ even when it is the NGO who has the larger valuation.

The NGO invests more under G-ownership than under N-ownership ($n^G > n^N$) whenever

$$\theta_N \lambda_N + \rho(\theta_G + \theta_N)(1 - \lambda_N)/2 > \theta_N,$$

which can be rewritten as $\rho\theta_G > (2 - \rho)\theta_N$. Now suppose the government has a larger valuation of the public good than the NGO. In this case, G-ownership

yields larger investment incentives for the NGO than N-ownership if there are no bargaining frictions. However, the presence of bargaining frictions may imply that the NGO has stronger investment incentives under N-ownership.

The government's investment incentives are stronger under G-ownership than under joint ownership whenever $\theta_G > \rho(\theta_G + \theta_N)/2$. Moreover, the government's investment level under N-ownership is larger than its investment under joint ownership whenever $\theta_G \lambda_G + \rho(\theta_G + \theta_N)(1-\lambda_G)/2 > \rho(\theta_G + \theta_N)/2$. Both conditions are equivalent to $(2-\rho)\theta_G > \rho\theta_N$. Analogously, the NGO has stronger incentives under sole ownership (regardless of whether the government or the NGO is the owner) than under joint ownership whenever $(2-\rho)\theta_N > \rho\theta_G$ holds.

The preceding analysis immediately implies the following results.

Proposition 1 *(i) If $\rho < 2\theta_G/(\theta_G + \theta_N)$, then the government's investment levels can be ranked as follows: $g^J < g^N < g^G < g^{FB}$. If $\rho > 2\theta_G/(\theta_G + \theta_N)$, then the government's investments satisfy $g^G < g^N < g^J < g^{FB}$.*

(ii) If $\rho < 2\theta_N/(\theta_G + \theta_N)$, then the NGO's investment levels can be ranked as follows: $n^J < n^G < n^N < n^{FB}$. If $\rho > 2\theta_N/(\theta_G + \theta_N)$, then the NGO's investments satisfy $n^N < n^G < n^J < n^{FB}$.

Corollary 1 *(i) Suppose $\rho = 1$. If $\theta_G > \theta_N$, then both parties choose a larger investment level under $o = G$ than under $o = N$. If $\theta_N > \theta_G$, then both parties choose a larger investment level under $o = N$ than under $o = G$.*

(ii) If $\rho < 2\min\{\theta_G, \theta_N\}/(\theta_G + \theta_N)$, then party G invests more under $o = G$ than under $o = N$, and party N invests more under $o = N$ than under $o = G$. Moreover, joint ownership leads to smaller investments than sole ownership (regardless of whether the government or the NGO is the owner).

To summarize, in the special case of frictionless negotiations ($\rho = 1$), the investment incentives of both parties are always aligned under sole ownership (while under joint ownership, the party with the larger valuation has very weak investment incentives and the party with the smaller valuation has very strong investment incentives). However, when the date-2 negotiations are costly, there may well be a trade-off between the two parties' investment incentives under $o =$

N and $o = G$. The smaller is ρ, the stronger is the impact of the default payoffs on the parties' incentives to invest.[15] As a consequence, under the condition of Corollary 1(ii), a party has larger investment incentives whenever it is the owner (and joint ownership yields only weak investment incentives for both parties), which is in accordance with the standard property rights theory (cf. Hart, 1995).

5 Optimal ownership structures

We can now compare the total surplus levels that are attained under the different ownership structures when the parties choose the investment levels that we have characterized in the preceding section. Specifically, the total surplus under ownership structure $o = G$ is given by

$$\begin{aligned} S^G(g^G, n^G) &= (\theta_G + \theta_N)[\alpha_G y(g^G) + \lambda_N \alpha_N y(n^G)] \\ &\quad + \rho(\theta_G + \theta_N)(1 - \lambda_N)\alpha_N y(n^G) - n^G - g^G, \end{aligned}$$

while the total surplus under the ownership structure $o = N$ is given by

$$\begin{aligned} S^N(g^N, n^N) &= (\theta_G + \theta_N)[\lambda_G \alpha_G y(g^N) + \alpha_N y(n^N)] \\ &\quad + \rho(\theta_G + \theta_N)(1 - \lambda_G)\alpha_G y(g^N) - n^N - g^N. \end{aligned}$$

Under joint ownership ($o = J$), the total surplus is

$$S^J(g^J, n^J) = \rho(\theta_G + \theta_N)[\alpha_G y(g^J) + \alpha_N y(n^J)] - n^J - g^J.$$

Note that the total surplus functions are concave in the investments. Since according to Proposition 1 there is always underinvestment compared to the first-best benchmark, this means that *ceteris paribus* larger investment levels are

[15] For instance, consider the case $\theta_G > \theta_N$ and $\lambda_N = 0$. Then under $o = G$ party N's default payoff does not depend on its investment, while under $o = N$ party N's marginal investment returns with regard to its default payoff are $\theta_N \alpha_N y'(n)$. When $\rho = 0$, such that only the default payoffs are relevant, it is obvious that party N invests more under $o = N$ than under $o = G$. In contrast, if there are no frictions ($\rho = 1$), then party N's marginal investment return is $(\theta_G + \theta_N)\alpha_N y'(n)/2$ under $o = G$, while it remains $\theta_N \alpha_N y'(n)$ under $o = N$, so $o = G$ yields larger investment incentives.

always desirable. Yet, observe that $S^G(g,n) = S^N(g,n) = S^J(g,n)$ holds only in the special case in which there are no bargaining frictions ($\rho = 1$). In this case, the optimal ownership structure is solely determined by the parties' investment incentives. In contrast, when there are bargaining frictions, the optimal ownership structure also depends on the magnitude of the date-2 negotiation surplus that is lost in the date-2 bargaining stage.

The findings summarized in the following proposition are a consequence of the preceding analysis.

Proposition 2 *(i) Suppose $\rho = 1$. If $\theta_G > \theta_N$, then $S^G(g^G, n^G) > S^N(g^N, n^N)$. If $\theta_N > \theta_G$, then $S^N(g^N, n^N) > S^G(g^G, n^G)$.*

(ii) For any $\rho < 1$, there exist $\alpha_N > \alpha_G$ such that $S^N(g^N, n^N) > S^G(g^G, n^G)$ holds despite $\theta_G > \theta_N$.

(iii) For any $\rho < 1$, there exist $\alpha_G > \alpha_N$ such that $S^G(g^G, n^G) > S^N(g^N, n^N)$ holds despite $\theta_N > \theta_G$.

Proof. See the Appendix.

Proposition 2(i) replicates the main finding of Besley and Ghatak (2001), which holds in the special case in which there are no frictions ($\rho = 1$). However, Proposition 2(ii) and (iii) show that this finding is not robust when we allow for bargaining frictions at date 2. No matter how small these frictions are, whenever $\rho < 1$ there are circumstances under which a technological advantage of a party makes ownership by this party preferable to ownership by the other party, which is in accordance with the standard property rights theory as synthesized by Hart (1995). Intuitively, in the presence of bargaining frictions, the investment incentives depend to a larger extent on the default payoffs, which favours ownership by the party who has the more efficient investment technology. Moreover, in the present model ex post efficiency is not always achieved, so the optimal ownership structure is not only determined by the investment incentives, but also by the avoidance of welfare losses due to bargaining frictions ex post. Thus, an ownership structure that leads to larger default payoffs is desirable, since it reduces the losses in the ex post bargaining stage. This effect occurs neither in Besley

and Ghatak's (2001) model nor in the standard property rights model along the lines of Hart (1995), but it ends up strengthening the conclusions of the latter model.

Specifically, there is a critical value $\hat{\rho}$ such that for $\rho < \hat{\rho}$ it is always true that if only one party has a relevant investment decision, then this party should be the owner, and joint ownership is always suboptimal. These conclusions resemble the findings in the standard private-goods setting (see the following section). It should be noted that the critical value of ρ is even larger than the one identified in Corollary 1(ii), because in the presence of bargaining frictions an ownership structure can be optimal even if it yields weaker investment incentives, provided that the ownership structure implies smaller welfare losses at the date-2 bargaining stage.

Proposition 3 *There exists a critical value $\hat{\rho} > 2\min\{\theta_G, \theta_N\}/(\theta_G + \theta_N)$, such that when $\rho < \hat{\rho}$ the following results hold regardless of θ_N and θ_G. (i) If $\alpha_N > 0$ and $\alpha_G \to 0$, then $o = N$ must be optimal. (ii) If $\alpha_G > 0$ and $\alpha_N \to 0$, then $o = G$ must be optimal. (iii) Joint ownership is suboptimal.*

Proof. See the Appendix.

As an illustration, consider Figure 1.[16] In the upper panel on the left-hand side, the case $\rho = 1$ is depicted. In this special case, whether or not $o = N$ is better then $o = G$ does not depend on the technology. Moreover, note that there are relatively large regions in which joint ownership is optimal. The upper panel on the right-hand side shows that even when the bargaining frictions are very small ($\rho = 0.99$), technology becomes a factor in determining whether $o = N$ or $o = G$ leads to a larger total surplus, and joint ownership becomes much less attractive. As can be seen in the lower panel on the right-hand side, in the case $\rho = 0.9$ joint ownership is never optimal and technology is a major factor in determining the optimal ownership structure, just as it is the case in the standard property rights theory.

[16] In the figure, $y(\cdot)$ is given by the square root function, $\lambda_G = \lambda_N = 1/4$, $\theta_G = 2$, $\theta_N \in (1, 3)$, $\alpha_G = 1/2$, and $\alpha_N \in (0, 1)$.

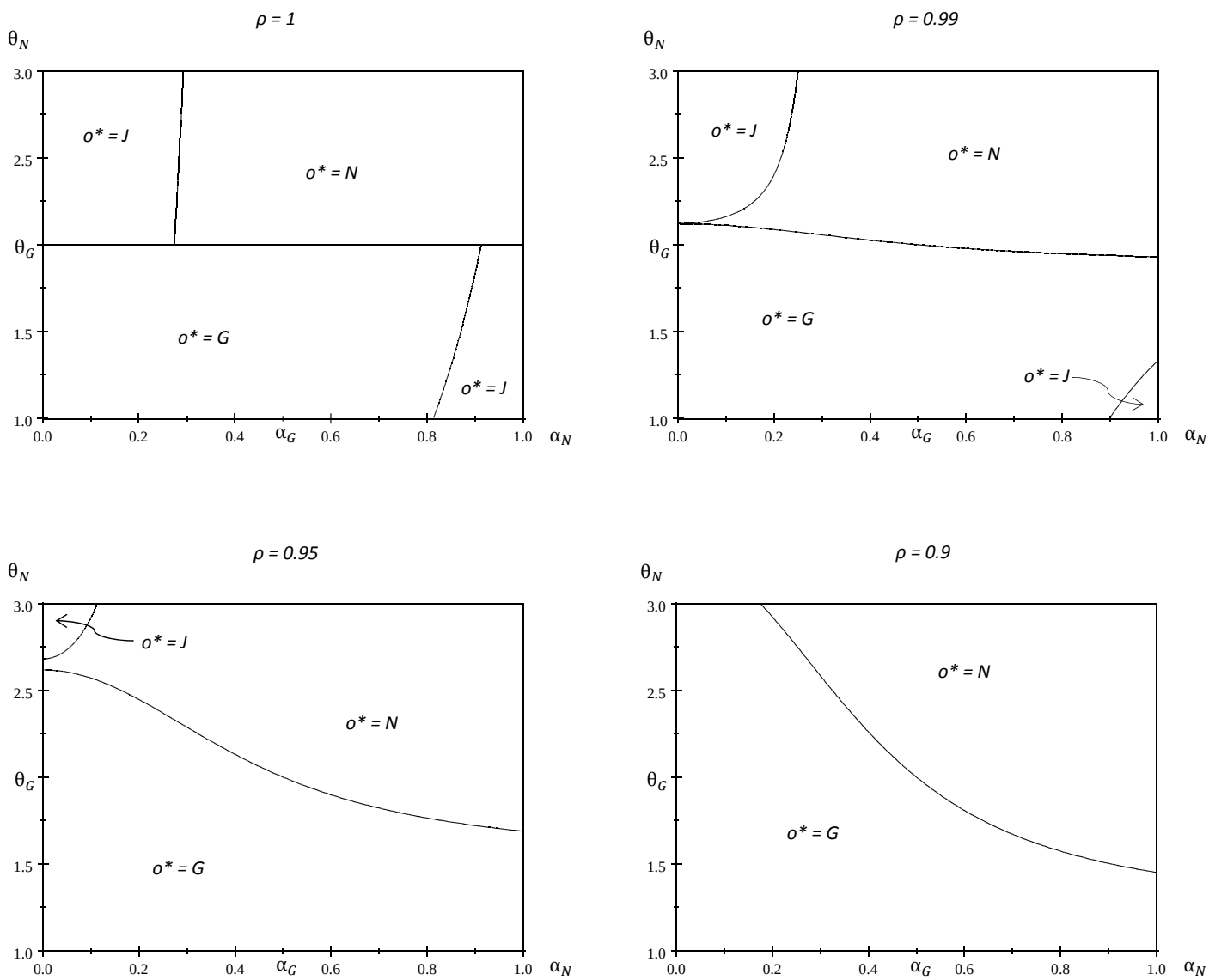

Figure 1. The optimal ownership structure $o^* \in \{G, N, J\}$, depending on the NGO's technology parameter α_N and the NGO's valuation θ_N. In each case, $\alpha_G = 0.5$ and $\theta_G = 2$.

6 Public vs. private goods

In the preceding section, we have seen that Besley and Ghatak's (2001) main finding regarding optimal ownership of public goods is not robust when we allow for bargaining frictions. One might wonder whether bargaining frictions may

also invalidate the main conclusions of the original property rights model with private goods as synthesized by Hart (1995). In this section, we briefly illustrate that this is not the case.

Consider the following straightforward private-good variant of our property rights model. Suppose without loss of generality that $\theta_G \geq \theta_N$, such that if the parties agree to collaborate, party G gets the total quantity of the produced private good and makes a positive payment t to party N (the case $\theta_N > \theta_G$ can be treated analogously). The parties' date-2 payoffs are now as shown in Table 2. Note that the first-best investment levels are characterized by $\theta_G \alpha_G y'(g^{FB}) = 1$ and $\theta_G \alpha_N y'(n^{FB}) = 1$.

	payoff of party G	payoff of party N
collaboration	$\theta_G [\alpha_G y(g) + \alpha_N y(n)] - t$	t
default, $o = G$	$\theta_G \alpha_G y(g)$	0
default, $o = N$	0	$\theta_N \alpha_N y(n)$
default, $o = J$	0	0

Table 2. The parties' date-2 payoffs in the private-good case.

In analogy to the analysis in the preceding sections, it is straightforward to derive the following ranking of the parties' investment levels under the different ownership structures.

Lemma 1 *In the private-good model,* $g^J = g^N < g^G = g^{FB}$ *and* $n^J = n^G < n^N \leq n^{FB}$ *must hold.*

Proof. See the Appendix.

As a consequence, also in analogy to the preceding analysis, we can prove the following findings regarding the optimal ownership structure.

Remark 1 *In the private-good model, the following results hold regardless of the bargaining friction parameter* ρ*. (i) If* $\alpha_N > 0$ *and* $\alpha_G \to 0$*, then* $o = N$ *must be optimal. (ii) If* $\alpha_G > 0$ *and* $\alpha_N \to 0$*, then* $o = G$ *must be optimal. (iii) Joint ownership is suboptimal.*

Proof. See the Appendix.

In the standard property rights theory (cf. Hart, 1995), it is assumed that there are no bargaining frictions ($\rho = 1$). The results reported in Remark 1 summarize the main conclusions of the theory. Specifically, if only one party has a relevant investment decision, then this party should be the owner, and joint asset ownership is never optimal. The proof of Remark 1 shows that these conclusions regarding the optimal ownership structures are only strengthened if there are date-2 frictions ($\rho < 1$), because then the total surplus levels under the ownership structures that are suboptimal are reduced to a larger extent than the total surplus level under the optimal ownership structure.

Finally, while Besley and Ghatak's (2001) result regarding the irrelevance of technology is not robust once bargaining frictions are introduced in the public-good setting, one might argue that a more general implication of their model is that in the public-good case technology is not the only driver of ownership, because the parties' valuations of the public good are also important determinants of the optimal ownership structure. However, it should be emphasized that also in a private-good setting it is true that the optimal ownership structure is not only determined by technology. As an illustration, consider Figure 2.[17] Even if the standard assumption $\rho = 1$ is made, it may well depend on the parties' valuations of the private good whether $o = N$ or $o = G$ is optimal. As a matter of fact, when we introduce bargaining frictions, the impact of the parties' valuations becomes even stronger, as is illustrated in the figure for the case $\rho = 0.9$.[18] Taken together, our analysis thus reveals that the qualitative differences between the determinants of optimal ownership structures in public-good and private-good frameworks are actually smaller than is suggested by the previous literature.

[17] In the figure, $y(\cdot)$ is again given by the square root function, $\theta_G = 2$, $\theta_N \in (1, 3)$, $\alpha_G = 1/2$, and $\alpha_N \in (0, 1)$.

[18] For instance, consider the case $\theta_N < \theta_G$, such that $o = G$ may be optimal even when party N has a technological advantage (i.e., when $\alpha_N > \alpha_G$). When ρ decreases from 1 to 0.9, then party N's technological advantage that is compatible with the optimality of G-ownership becomes even larger.

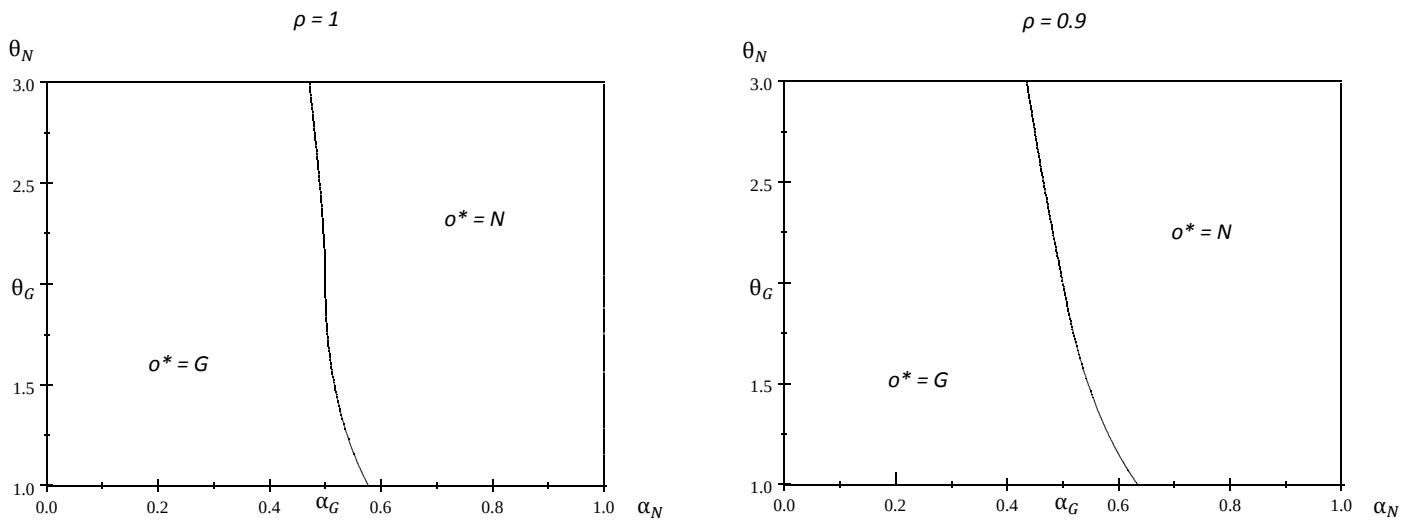

Figure 2. The optimal ownership structure $o^* \in \{G, N, J\}$ in the private-good case, depending on party N's technology parameter α_N and valuation θ_N. In each case, $\alpha_G = 0.5$ and $\theta_G = 2$.

7 Conclusion

Should governments or private organizations be the owners of public projects? This question might be one of the most fundamental problems in public economics.[19] Besley and Ghatak (2001) have argued that in the case of public goods, the party with the higher valuation should be the owner, irrespective of the production technology. Yet, their conclusion crucially relies on a peculiar set of assumptions typically made in the incomplete contracting literature. On the one hand, it is realistically assumed that ex ante there are contracting imperfections, while on the other hand, ex post bargaining is assumed to be without any frictions. When we reduce the tension between these assumptions by the introduction of ex post bargaining frictions, then the main conclusions of the standard property rights theory in the private-good case (as pioneered by Grossman and

[19] See e.g. Donahue and Zeckhauser (2011), Grimsey and Lewis (2004), and Yescombe (2011) for numerous practical examples.

Hart, 1986, Hart and Moore, 1990, and Hart, 1995) still hold. Yet, Besley and Ghatak's (2001) public-good result turns out not to be robust. When there are bargaining frictions, then in the public-good case as well as in the private-good case, optimal ownership is driven by technological aspects as well as the parties' valuations. Hence, the qualitative differences between the determinants of optimal ownership structures in public-good settings and private-good settings are smaller than is suggested in the previous literature.

It might be an interesting avenue for future research to further study other ways of introducing ex post frictions into property rights models and explore whether they may have qualitatively different effects on the optimal ownership structures in private-good and public-good frameworks.[20] Moreover, it might be worthwhile to explore the role of ex post bargaining frictions in models of public-private partnerships, which combine incomplete contracting with the question whether or not the construction of infrastructure projects and subsequent service provision should be bundled.[21]

[20] For example, ex post inefficiencies may be caused by asymmetric information (cf. Schmitz, 2006, and Goldlücke and Schmitz, 2014) or by shading activities if parties do not get what they feel entitled to when contracts serve as reference points (see Hart and Moore, 2007, 2008, and Halonen-Akatwijuka and Hart, 2013).

[21] See e.g. Hart (2003), Bennett and Iossa (2006), Chen and Chiu (2010, 2014), Hoppe and Schmitz (2013), Iossa and Martimort (2012, 2015), and De Brux and Desrieux (2014).

Appendix

Proof of Proposition 2.

(i) Suppose that $\rho = 1$, such that $S^G(g,n) = S^N(g,n)$. Part (i) of the proposition follows immediately from Corollary 1(i), concavity of the total surplus function, and the fact that according to Proposition 1 there is always underinvestment compared to the first-best solution.

(ii) Consider technology parameters $\alpha_N > 0$ and $\alpha_G \to 0$, such that g^N and g^G go to zero. Moreover, consider valuations θ_G and θ_N with $\theta_G > \theta_N$ such that $\rho < 2\theta_N/(\theta_G + \theta_N) < 1$ holds. Then $n^G < n^N$ must hold according to Proposition 1(ii). It follows that $S^G(0, n^G) < S^G(0, n^N)$ must be satisfied, because S^G is concave and $n^N < n^{FB}$. Furthermore, $S^G(0, n^N) < S^N(0, n^N)$ must hold, because $S^N(0, n^N) - S^G(0, n^N) = (1-\rho)(\theta_G + \theta_N)(1-\lambda_N)\alpha_N y\left(n^N\right) > 0$. Taken together, the condition $S^G(0, n^G) < S^N(0, n^N)$ must be satisfied. The claim then follows from continuity.

(iii) Consider $\alpha_G > 0$ and $\alpha_N \to 0$, such that $n^N \to 0$ and $n^G \to 0$. Consider θ_G and θ_N with $\theta_N > \theta_G$, such that $\rho < 2\theta_G/(\theta_G+\theta_N) < 1$. Hence, $g^G > g^N$ must hold according to Proposition 1(i). In this case, $S^N(g^N, 0) < S^N(g^G, 0)$ must be true since S^N is concave and $g^G < g^{FB}$. Moreover, $S^N(g^G, 0) < S^G(g^G, 0)$ must hold since $S^G(g^G, 0) - S^N(g^G, 0) = (1-\rho)(\theta_G + \theta_N)(1-\lambda_G)\alpha_G y\left(g^G\right) > 0$. As a consequence, $S^N(g^N, 0) < S^G(g^G, 0)$ must be true, so the claim follows immediately. □

Proof of Proposition 3.

(i) Consider $\alpha_N > 0$ and $\alpha_G \to 0$. From the proof of Proposition 2(ii) we know that if $\rho < 2\theta_N/(\theta_G + \theta_N)$, then N-ownership leads to a larger total surplus than G-ownership. Since $S^N(0, n^N) > S^G(0, n^N)$, the condition $S^G(0, n^G) < S^N(0, n^N)$ will be satisfied even when $n^G > n^N$, provided that $S^G(0, n^G) - S^G(0, n^N) > 0$ is sufficiently small. Hence, there exists a critical value of ρ strictly larger than $2\theta_N/(\theta_G + \theta_N)$ such that N-ownership leads to a larger total surplus than G-ownership for all ρ that are smaller than the critical value.

(ii) Consider $\alpha_G > 0$ and $\alpha_N \to 0$. From the proof of Proposition 2(iii) we

know that if $\rho < 2\theta_G/(\theta_G + \theta_N)$, then $o = G$ yields a larger total surplus than $o = N$. Since $S^G(g^G, 0) > S^N(g^G, 0)$, the condition $S^N(g^N, 0) < S^G(g^G, 0)$ will be satisfied even when $g^N > g^G$, provided that $S^N(g^N, 0) - S^N(g^G, 0) > 0$ is sufficiently small. Thus, there exists a critical value of ρ strictly larger than $2\theta_G/(\theta_G + \theta_N)$ such that $o = G$ leads to a larger total surplus than $o = N$ for all ρ smaller than the critical value.

(iii) We know from Corollary 1(ii) that if $\rho < 2\min\{\theta_G, \theta_N\}/(\theta_G + \theta_N)$, then joint ownership leads to smaller investment levels than $o = G$ and $o = N$. Suppose $\theta_G > \theta_N$ (the case $\theta_N \geq \theta_G$ can be treated analogously). Observe that $S^G(g, n) - S^J(g, n) = (1 - \rho)(\theta_G + \theta_N)(\alpha_G y(g) + \lambda_N \alpha_N y(n)) > 0$. Thus, $S^J(g^J, n^J) < S^J(g^G, n^G) < S^G(g^G, n^G)$ must hold. Moreover, $S^J(g^J, n^J) < S^G(g^G, n^G)$ will be satisfied even when $g^G < g^J$, provided that $S^J(g^J, n^J) - S^J(g^G, n^G)$ is sufficiently small. Hence, there exists a critical value of ρ strictly larger than $2\theta_G/(\theta_G + \theta_N)$ such that $o = G$ yields a larger total surplus than $o = J$ for all ρ smaller than the critical value. □

Proof of Lemma 1.

Suppose that $\theta_G \geq \theta_N$ (the case $\theta_N > \theta_G$ can be treated analogously). Consider $o = G$. In this case, party G's date-2 payoff is $u_G^G(g, n) = \theta_G \alpha_G y(g) + \rho \Delta^G(n)/2$ and party N's date-2 payoff reads $u_N^G(g, n) = \rho \Delta^G(n)/2$, where the date-2 negotiation surplus is now given by $\Delta^G(n) = \theta_G \alpha_N y(n)$. Next, consider $o = N$. Then the parties' date-2 payoffs are given by $u_G^N(g, n) = \rho \Delta^N(g, n)/2$ and $u_N^N(g, n) = \theta_N \alpha_N y(n) + \rho \Delta^N(g, n)/2$, respectively, where the date-2 negotiation surplus is $\Delta^N(g, n) = \theta_G \alpha_G y(g) + (\theta_G - \theta_N)\alpha_N y(n)$. Finally, if there is joint ownership ($o = J$), then the parties' date-2 payoffs are $u_G^J(g, n) = u_N^J(g, n) = \rho \Delta^J(g, n)/2$, where the date-2 negotiation surplus is $\Delta^J(g, n) = \theta_G [\alpha_G y(g) + \alpha_N y(n)]$.

At date 1, party G chooses the investment level $g^o = \arg\max u_G^o(g, n^o) - g$ and party N chooses the investment level $n^o = \arg\max u_N^o(g^o, n) - n$. Under G-ownership the investment levels are thus implicitly characterized by the first-order conditions $\theta_G \alpha_G y'(g^G) = 1$ and $\rho \theta_G \alpha_N y'(n^G)/2 = 1$. Under N-ownership the investment levels are characterized by $\rho \theta_G \alpha_G y'(g^N)/2 = 1$ and $[\theta_N + \rho(\theta_G - \theta_N)/2]\alpha_N y'(n^N) = 1$. Finally, under joint ownership the investment levels are

implicitly given by $\rho\theta_G\alpha_G y'(g^J)/2 = 1$ and $\rho\theta_G\alpha_N y'(n^J)/2 = 1$.

The first-order conditions and concavity of $y(\cdot)$ immediately imply that $g^J = g^N < g^G = g^{FB}$ and $n^J = n^G < n^N \leq n^{FB}$ must hold. $\square$

Proof of Remark 1.

Suppose again that $\theta_G \geq \theta_N$ (the case $\theta_N > \theta_G$ can be treated analogously). The total surplus levels in the private-good setting are given by

$$S^G(g^G, n^G) = \theta_G \left[\alpha_G y(g^G) + \rho\alpha_N y(n^G)\right] - g^G - n^G$$

in the case of G-ownership,

$$S^N(g^N, n^N) = \rho\theta_G\alpha_G y(g^N) + [\theta_N + \rho(\theta_G - \theta_N)]\alpha_N y(n^N) - g^N - n^N$$

in the case of N-ownership, and

$$S^J(g^J, n^J) = \rho\theta_G \left[\alpha_G y(g^J) + \alpha_N y(n^J)\right] - g^J - n^J$$

in the case of joint ownership. Recall from Lemma 1 that the investments are always weakly smaller than their first-best benchmarks and note that the total surplus functions are concave. Moreover, observe that if $\rho = 1$, then $S^G(g, n) = S^N(g, n) = S^J(g, n)$ holds.

(i) Consider $\alpha_N > 0$ and $\alpha_G \to 0$, such that $g^N \to 0$ and $g^G \to 0$. If $\rho = 1$, then Lemma 1 immediately implies that $S^N(0, n^N) > S^G(0, n^G)$ must hold. Observe that this result is only strengthened if ρ becomes smaller than 1, since party N's marginal investment return is more reduced under $o = G$ than under $o = N$ and $S^N(0, n) - S^G(0, n) \geq 0$ is decreasing in ρ.

(ii) Now consider $\alpha_G > 0$ and $\alpha_N \to 0$. Then $n^N \to 0$ and $n^G \to 0$ must hold. Moreover, if $\rho = 1$ then Lemma 1 immediately implies $S^G(g^G, 0) > S^N(g^N, 0)$. Note that this result is only strengthened if ρ becomes smaller than 1, because g^G remains unchanged, g^N becomes smaller, and $S^G(g, 0) - S^N(g, 0) \geq 0$ is decreasing in ρ.

(iii) If $\rho = 1$, Lemma 1 immediately implies that joint ownership cannot be optimal. This finding is only strengthened if $\rho < 1$, because under sole ownership the non-owner still makes the same investment as under joint ownership, while

under $o = G$ the owner's investment remains unchanged and under $o = N$ the owner's investment incentives are not as much reduced as under joint ownership, and $S^G(g,n) - S^J(g,n) \geq 0$ and $S^N(g,n) - S^J(g,n) \geq 0$ are decreasing in ρ. $\square$

Supplementary Material

As another example of how bargaining frictions may cause a negotiation failure between government and NGO, consider the negotiations between the Vermont Agency of Natural Resources (ANR) and the Northeast Resource Recovery Association (NRRA), a nonprofit that serves communities in New England. The following text summarizes Zach Despart's interesting article "Local recycling firm says state agency broke its own rules" (Addison County Independent, October 24, 2013):

The ANR is required by law to provide a recycling program for certain electronic wastes. The goal of the program is to keep landfills free of materials that are commonly found in electronics and are dangerous to the environment. In May 2013, NRRA was deemed "conditionally selected ... pending contract negotiations" by the ANR, according to a letter ANR sent to Michael Durfor, president of NRRA. Yet, during the summer of 2013, negotiations between the state and NRRA deteriorated. On July 3, the ANR emailed a "final offer," and required a response by July 8. NRRA accepted this final offer by the due date. NRRA requested a draft contract to review several times. ANR sent NRRA a draft contract two weeks after the "final offer" had been accepted. For several weeks after July 23, representatives from the ANR and NRRA negotiated, but could not agree on the details of the contract. On Aug. 13, the ANR requested specific details about NRRA's proposal. On Aug. 14, NRRA complied, but did not receive a response. On Aug. 20, the ANR informed NRRA that it was suspending negotiations. The ANR denied NRRA the contract, but never formally informed them, nor did ANR ever send NRRA anything in writing after the email suspending negotiations.

Typically, while the ANR awards a contract to one company, other recyclers can apply for ANR recognition under what is called an "independent manufacturers plan." In this instance, a recycling company would be permitted to be contracted by electronics manufacturers to recycle e-waste. The ANR denied NRRA's independent plan. In its rejection, the ANR said in an email to NRRA that the proposal "failed to demonstrate that it met regulatory requirements."

That statement contradicts the ANR's appraisal of the NRRA recycling program earlier in 2013, when, in a report to the Legislature, the agency said, "the first program year has been a huge success. The agency and the contractor work collaboratively on the implementation of the program." Teresa Kuczynski, president of the Vermont Solid Waste District Managers' Association, said "We didn't understand what could have went wrong with the negotiations, because of how good the program was the last two years."

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