Bulletin of Economic Research 56:1, 2004, 0307–3378

COLLECTIVE GOODS, COMMON AGENCY, AND THIRD-PARTY INTERVENTION

Kevin Siqueira and Todd Sandler

School of Business, Clarkson University and School of International Relations, University of Southern California

ABSTRACT

Voluntary contributions to multiple public goods may involve many contributors (principals) who condition their payments to a single provider (agent) based on realized provision. If the agent's efforts on these goods are unobservable, then a common agency problem results with a third-best outcome owing to agency costs, free riding, and competitive interests. The latter manifests itself in the principals punishing the agent for providing an alternative public good (for which they have no interest) to a different set of principals. Remedies may require multiple policy instruments unlike the standard prescription for the public good or common agency problem in isolation. Moreover, the sequence of actions is essential for addressing the combined problems.

Keywords: Public goods, common agency, principal-agent analysis, fiscal federalism, third-party intervention
JEL classification numbers: D78, D82, H41

Correspondence: Todd Sandler, School of International Relations, University of Southern California, Von Kleinsmid Center 330, Los Angeles, CA 90089-0043, USA. Email: tsandler@usc.edu. Siqueira is an Assistant Professor and Sandler is the Robert R. and Katheryn A. Dockson Professor of International Relations and Economics. We gratefully acknowledge the helpful comments of an anonymous referee.

I. INTRODUCTION

The canonical model for private or voluntary provision of a public good assumes that contributions simply add up to the overall level of the public good and that contributions do not divert provision efforts. The former assumption means that individual contributions are perfectly substitutable, while the latter implies that there are no intermediary parties with opposing and competing interests involved in the provision process. Of these assumptions, the former may not hold owing to impure publicness or other considerations (Cornes and Sandler, 1996), while the latter ignores how other parties influence costs or introduce competing influences. That is, the presence of different parties (players) raises the possibility of transaction or even agency costs due to asymmetric information between contributors and a *providing* agency. Moreover, conflicting interests among diverse contributors and/or an agent can require novel institutional designs to align incentives to promote public good provision.

We are, particularly, interested in a common agency scenario in which a single agent must serve the public good needs of two or more interests (principals). Moreover, alternative groups of principals cannot observe the efforts of the agent to supply their respective public good, and must design a mechanism to motivate the agent in regards to their *competing* demands. As a representative example, consider California as the common agent for two counties, where one (Ventura) cares about the suppression of forest fires given its extensive forest cover and the other (Los Angeles) wants new schools given its poor schools. Obviously, efforts by California to provide one of these public goods come at the expense of the other. Ventura may not only reward California for better fire suppression but punish it for better schools elsewhere as the state's energies and resources are diverted from Ventura's main concern. The same goes for Los Angeles County, but with the public goods switched. Another instance of common agency and multiple public good provision involves foreign assistance given by two sets of donor nations (the principals) to a recipient country (the agent). One set may be interested in bolstering the recipient's health sector owing to a fear of communicable diseases, while the other set may be worried about the recipient's security owing to potential refugee spillovers and collateral damage from conflict. With mission creep, multilateral organizations (e.g., the World Bank, the United Nations) serve as a common agent to competing public good needs and this competition can limit the design of incentive mechanisms by the principals (e.g., donor countries and donor institutions), resulting in a third-best outcome unless institutional innovations are uncovered.

The primary purpose of this paper is to synthesize the common agency framework with the study of the provision of public goods. For institutions supplying public goods, a common facilitator or agent (e.g., a higher level of government, a multilateral institution, a club) typically provides two or more public goods to diverse clients (principals), who can only indirectly observe the agent's efforts through output. Rather than being the exception, common agency is the rule in many public good scenarios. Such a common-agency/public-good setting is rich with collective action problems: (i) between the providing agent and the contributing principals (i.e., agency cost); (ii) between the opposing preferences of the different sets of principals (i.e., *common* agency costs); and (iii) among the principals within the same set (i.e., free-riding inefficiency). A secondary purpose is to investigate institutional innovations – e.g., firewalls between opposing sets of principals, subsidy schemes, third-party interventions – to address these collective action concerns. The need for such innovations arises, because common agency leads to a third-best outcome when compared with principal-agent instances where principals act as a seamless unit (Bernheim and Whinston, 1986; Dixit, 1996, 1997).

By combining common agency and public goods concerns, we discover that judicious combinations of policy instruments are necessary, for which the sequence of actions is an essential consideration. In short, the joined problems may need novel policy and institutional prescriptions. Although subsidies to principals may, for example, bolster their contributions to the agent to counter free riding, we show that aggregate subsidies may exceed the principal's valuations of the public good, so that this standard remedy may be undesirable. Moreover, simple restrictions on payments to the agent in order to prevent the adverse consequences of competing influences (as recommended by Dixit, 1996, 1997) may also fail in certain circumstances owing to the perverse synergy of the joined problems.

II. The Basic Model

To set the stage for our voluntary contribution game with a third party, we use an altered version of a simple multi-principal, multi-task, single-agent model developed by Dixit (1996). We assume that there are two types of principals (types A and B) drawn from sets a and b with n^k ($k=A$, B) members, respectively. In total, there are n contributors, where $n=n^A+n^B$. Within each set of principals, all individuals are identical with the same tastes and endowments. When convenient, we shall exploit this symmetry within each set of principals by scaling up individual actions by the relevant n^k to reflect the actions of the group. There are also two types of public goods ($j=1$, 2) for which type A principals only care directly about the provision of public good 1, g_1, while type B principals only care directly about the provision of public good 2, g_2. The provision of g_j is imperfectly linked to the common agent's effort, a_j ($j = 1, 2$), which is unobservable to the principals. In essence, each public good provides non-rival benefits to a particular type of principal while being private to the other type of principal. Thus, each type A principal experiences and enjoys the same level of g_1 as any other individual of this type, but the provision of g_1 does not enter type B principals' utility. Voluntary provision faces three impediments. First, there are conflicting interests or objectives between principals of different types owing to the multi-task setting. Second, the problem of hidden action by the agent means that principals must condition payments (contributions) on variables correlated with the agent's efforts such as the public good provision. Third, given the public nature of the goods provided by the agent, free riding among like principals is a concern.

Principals are assumed to be risk neutral in addition to having the following utility functions: $U^{Ai} = \Phi_1^{Ai} g_1 + y^{Ai}$ for type A principals and $U^{Bi} = \Phi_2^{Bi} g_2 + y^{Bi}$ for type B. Individual principals of either type are indexed by the superscript i. The first term in each of these utility functions, $\Phi_j^{ki} g_j$ ($k = A, B$, where if $k = A$, then $j = 1$, and if $k = B$, then $j = 2$), consists of a principal's marginal evaluation of output (Φ_j^{ki}) times the pertinent output, whereas the term y^{ki} is the numéraire private good for each principal ki.

The agent imperfectly controls observable output, for which the principals must conclude their contract with the agent. The technological relationship governing output and effort for the j^{th} public good is $g_j = a_j + \varepsilon_j$, where ε_j represents the random variable, which is normally distributed with zero mean, variance σ_j ($j = 1, 2$), and zero covariance. Furthermore, the agent is assumed to be risk averse and possesses the following constant absolute risk averse (CARA) utility function, $u(W) = -\exp(-rW)$, where r is the agent's coefficient of risk aversion and W is the agent's net wealth. This net wealth is the difference between the aggregate payment, T, that the agent receives from the principals, and the agent's quadratic cost function, $C(a_1, a_2) = ½(a_1)^2 c_1 + ½(a_2)^2 c_2$. Each c_j ($j = 1, 2$) is a positive parameter of the cost function. When, at a later point, we allow for economies of scope, the common agency's cost function can be specified as $C(a_1, a_2) = ½(a_1)^2 c_1 + a_1 a_2 c_{12} + ½(a_2)^2 c_2$ where $c_{12} < 0$.[1] Unless otherwise indicated, we ignore economies of scope except when we generalize the model at key points to introduce an opposing influence to common agency issues. If the principals are assumed to implement a linear payment scheme, the aggregate payment to the agent takes the following form: $T = Q + P_1 g_1 + P_2 g_2$, where Q represents the *fixed fee* portion of the incentive scheme and P_j, the

[1] Economies of scope arise from reduced per-unit cost when two or more public goods are provided together. These cost savings arise from common cost shared by the jointly provided public goods.

aggregate variable fee per unit for output j. Given our previous assumptions, the agent's expected utility has the certainty equivalent (CE) form:

$$CE = Q + P_1 a_1 + P_2 a_2 - (1/2)r[(P_1)^2\sigma_1 + (P_2)^2\sigma_2] - (1/2)(a_1)^2 c_1 - (1/2)(a_2)^2 c_2. \qquad (1)$$

In (1), the $1/2r[(P_1)^2\sigma_1 + (P_2)^2\sigma_2]$ term represents the agent's risk premium, while the three terms before it denote the agent's expected payments from the two principals. For the earlier California example, the state (the agent) is anticipated to be more risk averse than its component counties, given the size of the state's budget, the requirement to balance state budgets, and the desire to be reelected. Similarly, a foreign aid recipient is apt to be more risk averse than donors, because ill-perceived actions by the recipient (the agent) can result in it losing funding. Such a loss can spell dire consequences. Donors can always direct their moneys elsewhere and are subject to little risk. Common-agent multilaterals are similarly dependent on donors for their resources and have much to lose if their performance is unfavourably viewed by contributors – e.g, the crisis in the United Nations caused by non-payment of assessments by the United States during the 1980s and 1990s.

When contracting and determining the contributions to the agent, each principal treats the contributions from the other principals to the agent as given. However, each principal assumes a leadership role with respect to the common agent. Principals must not only ensure that the agent has an incentive to participate, but must also ensure that the level of effort chosen is consistent with the solution to the agent's own maximization problem. The participation constraint is represented as $CE \geq 0$ in (1), while the incentive-compatibility constraint can be characterized by the agent's best responses to changes in the aggregate marginal contributions made to the agent by the principals:[2]

$$a_j = a_j(P_j), \quad j = 1, 2. \qquad (2)$$

The latter constraint is derived from the first-order conditions characterizing the solution to the agent's maximization problem: $P_j - C_j = 0$, where $C_j = \partial C(\bullet)/\partial a_j$, $j = 1$, 2. We can also describe how changes in contributions affect the agent's level of efforts:

$$\partial a_j/\partial P_j > 0, \quad j = 1, 2, \qquad (3a)$$

$$\partial a_j/\partial P_i = 0, \quad i,j = 1, 2, i \neq j. \qquad (3b)$$

That is, the agent's action either varies directly with the aggregate payment when this action is in the same dimension as the associated

[2] The specific form for this expression is $a_j = (1/c_j)P_j$.

payment, or the agent's action is independent of the payment when the action is not in the same dimension as the payment. When the common agency exhibits economies of scope, the sign of (3b) is positive. A higher payment with respect to effort directly related to g_1, for example, also results in increased effort devoted to providing g_2.

Given that the principals of each type act as a Stackelberg leader vis-à-vis the agent and a Nash player vis-à-vis all other principals, the problem for a type A principal can then be written as choosing the variable fees, the fixed fee, and the amount of the private good (P_1^{Ai}, P_2^{Ai}, Q^{Ai}, y^{At}) to

$$\text{maximize } EU^{Ai} = \Phi_1^{Ai} a_1 + y^{Ai},$$

$$\text{subject to}: Q + P_1 a_1 + P_2 a_2 - (1/2) r[(P_1)^2 \sigma_1 + (P_2)^2 \sigma_2] - C(a_1, a_2) \geq 0,$$

$$a_j = a_j(P_j), \quad j = 1, 2,$$

$$Q^{Ai} + P_1^{Ai} a_1 + P_2^{Ai} a_2 + y^{Ai} = I^{Ai}. \tag{P1}$$

The third constraint is the principal's budget constraint, where $ET^{Ai} = Q^{Ai} + P_1^{Ai} a_1 + P_2^{Ai} a_2$ is the expected payment to the agent and I^{Ai} is the principal's exogenous income. In this constraint, the price of the private good is normalized to a value of one, which applies throughout the paper. An analogous problem is associated with individual principals of type B. From the solutions to each individual's maximization problem, we can derive the analytical expressions for the agent's aggregate variable fees, P_1 and P_2, paid by the principals and the levels of agent effort, a_1 and a_2.[3] These expressions are derived in Appendix A and equal:

$$P_1 = \frac{\Phi_1^A}{1 + nr\sigma_1 c_1}, \quad P_2 = \frac{\Phi_2^B}{1 + nr\sigma_2 c_2}, \tag{4}$$

$$a_1 = \frac{1}{c_1} P_1 = \frac{1}{c_1} \frac{\Phi_1^A}{1 + nr\sigma_1 c_1}, \quad a_2 = \frac{1}{c_2} P_2 = \frac{1}{c_2} \frac{\Phi_2^B}{1 + nr\sigma_2 c_2}, \tag{5}$$

where $\Phi_1^A = \sum_{i=1}^{n^A} \Phi_1^{Ai}$ and $\Phi_2^B = \sum_{i=1}^{n^B} \Phi_2^{Bi}$. Given these expressions and the agent's binding participation constraint, we can also derive the agent's aggregate fixed fee, Q. The group fees paid by each type of principal for each dimension of output — P_1^A, P_2^A, P_1^B, and P_2^B — are also of interest. They are:

[3] The aggregate variable fee, P_j, is the sum of all marginal fees paid by the principals of both types. Breaking this expression into group types, we have $P_j = P_j^A + P_j^B$ ($j = 1, 2$), where P_j^A, for example, is the summation of the marginal fees for public good j by all type A principals.

$$P_1^A = \frac{\Phi_1^A(1 + n^B r\sigma_1 c_1)}{1 + nr\sigma_1 c_1}, \quad P_2^A = -\frac{\Phi_2^B n^A r\sigma_2 c_2}{1 + nr\sigma_2 c_2}, \tag{6}$$

$$P_1^B = -\frac{\Phi_1^A n^B r\sigma_1 c_1}{1 + nr\sigma_1 c_1}, \quad P_2^B = \frac{\Phi_2^B(1 + n^A r\sigma_2 c_2)}{1 + nr\sigma_2 c_2}. \tag{7}$$

Based on the expressions for P_1 and P_2, our basis of comparison is with the second-best outcome (denoted "*sb*"), where full cooperation among the principals is assumed. For this second-best outcome, the objective is to maximize the sum of the principals' expected utility subject to the relevant participation and incentive-compatibility constraints of the agent. The agent's second-best aggregate variable fees are:

$$P_1^{sb} = \frac{\Phi_1^A}{1 + r\sigma_1 c_1}, \quad P_2^{sb} = \frac{\Phi_2^B}{1 + r\sigma_2 c_2}. \tag{8}$$

A comparison of the expressions in (4) and (8) indicates that $P_j^{sb} > P_j$ for $j = 1, 2$, so that common agency payments are less than those of second best. The difference between the two sets of expressions is reflected by the n in the denominator under common agency, representing the externality generated by the n non-cooperating principals. Thus, common agency leads to weaker incentive contracts and a lower level of agent effort devoted to fulfilling the various agency tasks: $a_j^{sb} > a_j$ for $j = 1, 2$.

These results are a consequence of the effects of free riding and multi-principal competition. In terms of free riding, each principal treats the agent's risk premium in the participation constraint as a private cost and therefore each tends to contribute less than is optimal from a group point of view. With respect to multi-principal competition, the effects are manifested by principals punishing the agent in the dimension that is not of direct concern to them, thereby resulting in the negative expressions for P_2^A and P_1^B in (6) and (7). These "punishments" mean that the agent must compensate each set of principals for the realization of the public good output that is not of direct concern to it. To offset these punishments, each group of principals must pay variable fees that are higher than the final (aggregate) variable fee for a given dimension – e.g., $P_1^A > P_1$ – to counter the harmful effects of P_1^B. Thus, part of the variable fees paid to the agent represents income transferred from one type of principal to another via the agent. Even if the two agency tasks are not technically related within the cost function, principals still have incentives to condition payments on realized output, not of direct concern to them. By punishing the agent, they can effect an income transfer, albeit indirect, between themselves and the other types of principals.

Real-world examples of this punishment are instructive. For foreign assistance, a country that receives aid for population control by one set of donors may have funds for an unrelated subsidized public good withheld by another set of donors, morally opposed to some forms of population control (e.g., abortion). At the fiscal federal level, counties may create negative payments in the form of costly barriers or red tape to the state's pursuit of a public good for which a county has no interest.

Punishment is, however, less of a concern when there are economies of scope because principals take into account some of the beneficial effects of the agent's effort for both public goods, not just the good of direct interest to them. The effect of economies of scope can be seen in the following expression for the aggregate variable fee for public good 1:

$$P_1 = \frac{\Phi_1^A(1 + nr\sigma_2 c_2) - \Phi_2^B nr\sigma_2 c_{12}}{1 + nr[\sigma_1 c_1 + \sigma_2 c_2 + nr\sigma_1\sigma_2\Delta]} \tag{9}$$

where $\Delta \equiv c_1 c_2 - c_{12}^2 > 0$, so that the agent's second-order condition is satisfied. In the second term in the numerator, a negative c_{12} has a reinforcing effect on the variable fee. The presence of economies of scope does not necessarily reduce the inefficiency associated with principals acting independently. This becomes apparent when comparing the expression for P_1 in (9) to its second-best counterpart:[4]

$$P_1^{sb} = \frac{\Phi_1^A(1 + r\sigma_2 c_2) - \Phi_2^B r\sigma_2 c_{12}}{1 + r[\sigma_1 c_1 + \sigma_2 c_2 + r\sigma_1\sigma_2\Delta]}. \tag{10}$$

Because P_1 can be less than, equal to, or even larger than P_1^{sb} for certain parameter values of the common agency problem, it may be misleading to insist on a rigid second- and third-best interpretation based on the agent's payment level. To avoid confusion, we retain the second- and third-best terminology, but we interpret them to refer to outcomes derived under full cooperation and independent action, respectively, in the presence of common agency.

Given the discrepancy between second- and third-best outcomes, we might inquire as to whether some form of collective action is possible among principals. For this to occur, we would anticipate that the appropriate cash transfers are exchanged. As we have seen in the absence of economies of scope, principals engage in "transfers" of sorts, but with the intent to extract income indirectly through the agent. This transfer is at the other type of principal's expense, and far from improving things, it reduces agency effectiveness. In such an environment, full or even partial cooperation is harder to achieve.[5] With economies of scope, *some of the*

[4] If $c_{12} = 0$, then eq. (9) degenerates to (4), and (10) degenerates to (8).

[5] Even partial cooperation can fail – i.e., certain sized groups may not have the incentive to internalize the externalities generated by the combination of free riding and multi-principal competition (Siqueira, 2001). In the absence of asymmetric information and common agency, partial cooperation is problematic as non-cooperators exploit a strategic advantage over cooperators (Buchholz, Haslbeck and Sandler, 1998).

costs of agency are offset, but there may still be a sizable discrepancy between second- and third-best outcomes. This would also be the case in the absence of independent stochastic processes on public good supplies, i.e., where the covariance between g_1 and g_2 is non-zero so that the effect is similar to when c_{12} is non-zero. There appears to be little escape from the need of intervention by outside parties to implement policies to strengthen agency incentives.

III. INTERVENTION I: RULES, FIREWALLS, AND SUBSIDIES TO PRINCIPALS

The first types of policy investigated are determined at the outset of the common agency game and require changing the basic rules of the game. One of the more interesting inferences thus far involves the notion of separation between agency tasks in terms of the agency contract. Even in the absence of any covariance between the noise terms or cross partials with respect to the cost function, principals still attempt to influence the agent's action in the dimension not of direct concern to them, thereby resulting in weaker incentives overall. One means of improving efficiency is sharply to delineate, if not curtail, some of the agency's tasks so as to better align the types of principals with the tasks of the agency. Consider a charitable organization serving as a common agent in providing two public goods to two sets of donors (principals), whose interests are tied to just one of the goods. In this case, the implication is that the cause that the organization serves should be more narrowly focused, perhaps even consisting of only providing a single public good to a specific group of people. Although there may still be some free riding by like-minded donors, incentives and agency effort will be stronger overall than when the organization simultaneously serves various wide-ranging goals. Such an improvement can also be achieved if like-minded donors sort themselves into a single (yet, common) agency.[6]

Similar results would be obtained if it were possible to restrict punishments by alternative types of principals in certain dimensions as suggested by Dixit (1996, 1997). That is, suppose $P_2^{Ai} = 0$ and $P_1^{Bi} = 0$ for $i \in a$ and $i \in b$ at the outset of the common agency game. Conceivably, these rules might have been built into the agency's framework under which the institution operates. Although efficiency improves upon the unrestricted common agency outcome for both dimensions of effort, there nevertheless remain incentives for principals within each type to

[6] This does not mean that agencies that serve multiple goals are inherently inefficient; rather, the remark applies to those common agencies fulfilling the model's assumption (e.g., possessing principals tied to a specific public good).

free ride. This can be seen in the marginal incentives derived under this restricted "R" case:[7]

$$P_1^R = P_1^{A,R} = \frac{\Phi_1^A}{1 + n^A r\sigma_1 c_1}, \quad P_2^R = P_2^{B,R} = \frac{\Phi_2^B}{1 + n^B r\sigma_2 c_2}. \tag{11}$$

In the denominators of (11), the number of principals multiplying the agency parameters is smaller than in (4) and consists only of those principals directly interested in the public good. Thus, effort levels devoted to goods 1 and 2 increase over the third-best case, but still fall short of that of second-best. Although these restrictions eliminate the problem created by negative marginal incentives, they will only restore second-best efficiency when there is a single principal of each type. The overall impact of this approach is to partition an agency based on the particular public good. It is as if a *firewall* has been placed between agency tasks, so that the agency effectively carries on and behaves as two separate, but smaller, common agencies. Olson's (1969) principle of fiscal equivalence can be, in part, justified by this firewall.

Given that the above restrictions break the linkage between the two types of principals via the agent, but *fail* to implement the second-best allocation, *another instrument* is required to strengthen agency incentives. In the literature on the private provision of public goods, a foremost proposal involves subsidizing contributors,[8] which reduces the marginal cost of contributing for each subscriber, prompting them to contribute more. A similar proposal is investigated here. If the subsidies are chosen correctly, the combination of *two* instruments – subsidies and restrictions – can induce levels of effort consistent with the second-best outcome. The proposed scheme has an important potential flaw, not addressed in the literature: the levels of subsidies required to motivate principals to increase their marginal contributions may end up being high relative to the marginal value that principals place on a unit of the agent's output. The cost of the subsidy programme may consequently outweigh any benefit derived from it.

In order for subsidies to be consistent with the imposition of the restrictions, $P_2^{Ai} = 0$ for every $i \in a$ and $P_1^{Bi} = 0$ for all $i \in b$, the unit

[7] These conditions are derived by optimizing (P1), subject to the earlier constraints and the new constraints that $P_2^{Ai} = P_1^{Bi} = 0$ for all i.

[8] See, for example, Cornes and Sandler (1994), Falkinger (1996), and Kirchsteiger and Puppe (1997). Another concern of these papers is neutrality or whether the subsidy/tax scheme succeeds in increasing the overall level of provision. Neutrality indicates that if an outside authority attempts to augment the level of a pure public good through funds collected solely from the contributors, then there will be no increase in the aggregate level of the public good (Cornes and Sandler, 1996). Since strategic behaviour is limited in our model, so that an *unrestricted* Nash equilibrium does not apply, neutrality is not a concern. In the next section where strategic behaviour is no longer restricted, a neutrality result reappears.

subsidy must be provided to individual principals only in the dimension directly pertinent to them. For each unit of the agent's output, the third-party authority, which moves first, pledges to pay a subsidy of s_1^{Ai} to a principal of type A, and a subsidy of s_2^{Bi} to a principal of type B. Other than the imposition of subsidies and restrictions, which are taken as given by principals, each principal solves a similar problem as before. For example, a principal belonging to type A chooses Q^{Ai} and P_1^{Ai} to

$$\text{maximize } EU^{Ai} = \Phi_1^{Ai} a_1 + I^{Ai} - (P_1^{Ai} - s_1^{Ai}) a_1 - Q^{Ai},$$

$$\text{subject to}: Q + P_1^A a_1 + P_2^B a_2 - (1/2) r[(P_1^A)^2 \sigma_1 + (P_2^B)^2 \sigma_2] - C(a_1, a_2) \geq 0,$$

$$a_j = a_j(P_j), \quad j = 1, 2. \tag{P2}$$

Observe that the principal's budget constraint has been substituted into the objective function and that the effect of the restrictions have already been incorporated into the problem (i.e., $P_2^{Ai} = 0$, $P_1 = P_1^A$, and $P_1^{Bi} = 0$, $P_2 = P_2^B$). We ignore government financing conditions for the subsidy, but would obtain similar results if lump-sum taxes finance the subsidies and individuals ignore (or do not see through) the government budget constraint.

If the third-party planner pays a unit subsidy of $s_1^{Ai} = r\sigma_1 c_1 P_1^{A(-i)}$ and $s_2^{Bi} = r\sigma_2 c_2 P_2^{B(-i)}$ to each principal of type of A and B, respectively, the second-best variable fees and effort levels would result. For these subsidies, $P_1^{A(-i)}$ represents the marginal payments paid by all type A principals except for principal i for realizations of output tied to the task along this dimension. $P_2^{B(-i)}$ is the analogous expression for type B principals. When the subsidy expression is substituted into the relevant first-order condition of (P2), and the resulting expression solved for P_1^{Ai}, we obtain:[9]

$$P_1^{Ai,sb} = \frac{\Phi_1^{Ai}}{1 + r\sigma_1 c_1}. \tag{12}$$

If this expression is summed over all i $\in a$, the second-best marginal incentive payment then follows. This, in turn, implements a_1^{sb}, the second-best level of effort. A similar argument holds for the effort level associated with public good 2.

To realize this proper alignment of incentives, the central authority must expend s_1 and s_2 per unit of the agent's expected output, where $s_1 = \sum_{i \in a} s_1^{Ai} = (n^A - 1) r\sigma_1 c_1 P_1^A$, $s_2 = \sum_{i \in b} s_2^{Bi} = (n^B - 1) r\sigma_2 c_2 P_2^B$, and symmetry is exploited. Given the expression for P_1^A and P_2^B at the second

[9] When solving, we use the identity $P_1^{A(-i)} = P_1^A - P_1^{Ai}$.

best-outcome (with superscript *sb* supressed), the government authority will assume a substantial multiple of the aggregate variable fees paid by the two types of principals, regardless of their numbers, when $r\sigma_1 c_1 > 1$ and $r\sigma_2 c_2 > 1$. The likelihood of these inequalities being met depends on three parameters – the degree of agent risk aversion, the extent of uncertainty, and the agent's cost of effort. When both the risk aversion and variance (uncertainty) are large, the premium paid to the agent to share the risk must be great, so that the product of this risk premium and the agent's cost of effort may well exceed 1. In this reasonable scenario, these subsidies will exceed the aggregate value that the principals place on a unit of output in each of the two dimensions (Φ_1^A and Φ_2^B) as long as the number of each type of principal exceeds two. This occurs despite the coupling of subsidies with restrictions.

The traditional subsidy scheme is rendered inefficient in a common agency context when there are no firewalls or restrictions on punishments or implicit transfers, as may be the case when principals resist restrictions to their sovereignty. In such a scenario, there would be two subsidies for a type A principal, $s_1^{Ai} = r\sigma_1 c_1 P_1^{A(-i)}$ and $s_2^{Ai} = r\sigma_2 c_2 P_2$, with similar subsidies for type B principals. With respect to g_1, the aggregate subsidy is now $s_1 = (n-1)r\sigma_1 c_1 P_1^A$. The inefficiency of the subsidy is even more apparent since part of the subsidy now goes to those (type B principals) who do not even value the particular good provided by the common agent. In a sense, the subsidy must provide the offset to the indirect transfers that principals can obtain through the common agency.

When there are economies of scope, restrictions are not necessarily appropriate. Although principals still have incentives to punish the agent for taking actions in the dimension of no direct concern, they also have incentives to moderate these punishments due to benefits from scope economies. Independent action by principals may still fall short of being second best and an intervening party may strengthen incentives by subsidizing contributions to the agency. For example, the unit subsidy for a principal of type A for g_1 has a negative and positive component: $s_1^{Ai} = r\sigma_2 c_{12} P_2^{A(-i)} + r\sigma_1 c_1 P_1^{A(-i)}$. The aggregate subsidies paid to the principals may or may not exceed the aggregate valuation placed on a unit of output by each type of principal. Even with economies of scope, subsidizing principals is complex and may not be the appropriate policy.

IV. INTERVENTION II: RESTRICTIONS AND SUBSIDIES TO THE COMMON AGENT

Rather than paying a subsidy to each principal, suppose that a third party (e.g., a multilateral institution in the case of foreign assistance or a federal government in a fiscal federal system) pays a unit subsidy directly to the agent for each public good,[10] while maintaining the restriction prohibiting negative marginal payments to the agent. With such a payment scheme, the timing of the game is essential if the third-party authority is to avoid becoming yet another principal. To place the authority in a position different from the principals, we assume that third-party subsidies to the agent are paid only *after* the principals have already pledged their contributions.[11] On the surface, this appears to be an institutional design that would encourage the principals to free ride on the third-party subsidies to the agent. If, however, the subsidies must be financed by taxes imposed on the principals, and if the principals fully internalize the financial implications – that increased free riding leads to increased subsidies to the agent and therefore higher taxes on the principals – then the second-best allocation can be achieved. The sequence of the game is as follows:

Stage 1: To implement a second-best equilibrium, the third party restricts payments to the agent, so that $P_2^{Ai} = 0$ for all $i \in a$ and $P_1^{Bi} = 0$ for all $i \in b$.

Stage 2: Each principal chooses Q^{ki} and P_j^{ki} ($k = A, B$; $j = 1, 2$), to maximize its utility, while fully anticipating the responses of both the agent and the third-party authority, and taking the payments of the other principals as given.

Stage 3: Given payments by the principals, the third-party authority makes *additional* variable payments, s_1 and s_2, to the agent. Such subsidies are chosen to maximize the aggregate utility of the principals, subject to the authority's budget constraint, the principals' resource constraints, and the agent's participation and incentive compatibility constraints.

Stage 4: Agent chooses a_1 and a_2, conditioned on the choices made by all principals and the third-party authority.

The subgame perfect solution is found by starting with the agent's choice of actions in stage 4, after it receives additional variable fees (subsidies) from the third-party authority. The agent's certainty equivalent of wealth is:

[10] We could stick to the above approach of subsidizing principals and impose a financing condition, while assuming that principals take this into account when determining their variable contributions to the agent. Instead, we choose to take the more direct and narrow approach of working through the agent.

[11] To avoid the problem encountered in Section III, the central authority must not move prior to the principals when determining the level of incentives. More specifically, one result from such a sequence of play would be the case where the subsidy to the agent is zero and the aggregate subsidy to principals (of a given type) is really a subsidy equivalent to the level derived in Section III.

$$CE = Q + (P_1^A + s_1)a_1 + (P_2^B + s_2)a_2 - (1/2)r[(P_1^A + s_1)^2\sigma_1 + (P_2^B + s_2)^2\sigma_2] - C(a_1, a_2). \tag{13}$$

We can then derive first-order conditions with respect to the agent's actions and the agent's responses to changes in the third party's policy variables (s_1 and s_2) and the aggregate payments chosen by principals. From (13), s_1 and P_1^A are perfect substitutes, so that the agent is indifferent as to the source of funds.

At the third stage, the third party's (TP) problem consists of choosing s_1 and s_2 to

$$\text{maximize}\left\{\Phi_1^A a_1 + \Phi_2^B a_2 + I^A + I^B - Q^A - Q^B - P_1^A a_1 - P_2^B a_2 - t_1^A a_1 - t_2^B a_2\right\}$$

subject to:

$$Q + (P_1^A + s_1)a_1 + (P_2^B + s_2)a_2 - (1/2)r[(P_1^A + s_1)^2\sigma_1 + (P_2^B + s_2)^2\sigma_2] - C(a_1, a_2) \geq 0,$$

$$a_1 = a_1(P_1^A, s_1), a_2 = a_2(P_2^B, s_2), t_1^A = s_1, t_2^B = s_2. \tag{TP1}$$

The third party's subsidy "budget" constraints, $t_1^A = s_1$ and $t_2^B = s_2$, not only ensure that its variable fees to the agent are fully funded, but also that no group is favoured at another's expense – there are no third-party induced transfers among principals. The constraints will also not undo the intent of the prior restrictions on principals that inhibits them from punishing agents. After incorporating all constraints into the objective function, taking derivatives with respect to the two choice variables s_1 and s_2, and rewriting the first-order conditions, we can solve the resulting expressions for s_1 and s_2 respectively and derive the third party's best-response functions to changes in P_1^A and P_2^B:

$$s_1 = \frac{\Phi_1^A - (1 + r\sigma_1 c_1)P_1^A}{1 + r\sigma_1 c_1},\ s_2 = \frac{\Phi_2^B - (1 + r\sigma_2 c_2)P_2^B}{1 + r\sigma_2 c_2}, \tag{14}$$

$$\text{with } \frac{\partial s_1}{\partial P_1^A} = \frac{\partial s_2}{\partial P_2^B} = -1. \tag{15}$$

The expressions for (15) show that subsidies to the agent respond negatively, dollar-for-dollar, to changes in P_1^A and P_2^B. This neutral "crowding out" effect follows from the agent's indifference to the sources of funding.

Implicit in the solution to the third-party's problem is the setting of the individual tax schedules for principals: t_1^{Ai} and t_2^{Bi}. Given that s_1 is a function of P_1^A and s_2 is a function of P_2^B, and given the two budget constraints and the assumption of equal treatment, we specify $t_1^{Ai}(P_1^{Ai})$

and $t_2^{Bi}(P_2^{Bi})$ as the tax schedules confronting each individual principal when solving its maximization problem. Owing to subgame perfection, each principal of a given type takes into account the appropriate responses of the third-party authority when determining its variable payments in the second stage. Thus, principals will not only allow for the fact that s_1 and s_2 will increase for every unit that P_1^{Ai} and P_2^{Bi} decrease, but also that t_1^{Ai} and t_2^{Bi} increase to cover the increased subsidies. One way or another, the marginal incentives for the agent are provided.

Without loss of generality, we focus on the second-stage problem facing a type A principal, whose budget constraint is: $y^{Ai} + Q^{Ai} + P_1^{Ai}a_1 + t_1^{Ai}a_1 = I^{Ai}$. After substituting this constraint and the agent's participation constraint into Ai's utility function, we can write the principal's problem as choosing P_1^{Ai} to

$$\text{maximize}\ \Big\{\Phi_1^{Ai}a_1 + s_1a_1 - t_1^{Ai}a_1 + P_1^{A(-i)}a_1 + Q^{A(-i)} + Q^B + (P_2^B + s_2)a_2$$
$$+ I^{Ai} - (1/2)r[(P_1^A + s_1)^2\sigma_1 + (P_2^B + s_2)^2\sigma_2] - C(a_1, a_2)\Big\},$$
$$\text{subject to}: a_1 = a_1(P_1^A, s_1), a_2 = a_2(P_2^B, s_2), t_1^{Ai} = t_1^{Ai}(P_1^{Ai}), 0 \le P_1^{Ai} \le \Phi_1^{Ai}. \tag{P3}$$

From the first-order conditions (see Appendix B), we obtain the result that $P_1^{Ai} \in [0, \Phi_1^{Ai}]$. Similar arguments concerning type B individuals give $P_2^{Bi} \in [0, \Phi_2^{Bi}]$. These solutions hold for all principals according to type.

The continua of equilibria are somewhat disconcerting as each equilibrium pertains to all principals of a given type for a particular public good output. Within a set of principals, however, the choice of a focal equilibrium is facilitated by the commonality of interests. Two equilibria emerge as focal, insofar as they depict either the principals or the third-party authority as choosing a division of labour by seeing through the perfect substitutability (i.e., neutrality) of their or its actions. For A principals, the two focal equilibria have the following implications:

(i) if $P_1^{Ai} = 0$ for $\forall\ i \in a$,

then $s_1 = \dfrac{\Phi_1^A}{1 + r\sigma_1c_1}$, $P_1^A = 0$, and $s_1 + P_1^A = \dfrac{\Phi_1^A}{1 + r\sigma_1c_1}$;

(ii) if $P_1^{Ai} = \dfrac{\Phi_1^{Ai}}{1 + r\sigma_1c_1}$ for $\forall\ i \in a$,

then $s_1 = 0$, $P_1^A = \dfrac{\Phi_1^A}{1 + r\sigma_1c_1}$, and $s_1 + P_1^A = \dfrac{\Phi_1^A}{1 + r\sigma_1c_1}$.

Analogous equations hold for B principals. In case (i), each principal chooses not to pay the variable fee directly to the agent, so that the third-party authority must tax each principal to finance the agent's subsidy. Principals only pay the agent's fixed fee to ensure the latter's participation. By ensuring a constrained Pareto-efficient solution, the derived outcome reduces to a typical social planning problem. The agent's marginal incentives are directly supported, financed, and provided by the third-party authority with essentially no interaction between principals and the agent. Although the tax-subsidies game is complicated, we obtain a relatively straightforward result that provides justification for a benevolent governmental institution with taxing authority. For scenario (ii), each principal chooses a level of P_1^{Ai} consistent with implementing the second-best outcome and, accordingly, no subsidy payments need to be paid to the agent by the third party. The agency is then completely funded by farsighted principals (assuming that B principals pursue the same type of strategy). In either case, the principals internalize the externality and solve the free-riding problem because of the third-party taxing authority and/or the sequence of moves.

Finally, in the first stage, the third-party authority sets the institutional framework by choosing the restrictions $P_2^{Ai} = P_1^{Bi} = 0$ to implement the second-best allocation. These choices are consistent with the authority's objective.

These two cases illustrate that the desired result can follow without presumption of whom must oversee the final financing of the agent's marginal incentives. Thus, a second-best allocation can be implemented with an appropriate institutional design despite a common agency problem.[12]

V. FISCAL FEDERALISM AND COMMON AGENCY

Since Olson's (1969) seminal paper, fiscal equivalence has been a guiding principle, whereby the economic domain of the public good (i.e., the range of public good spillovers) is matched with the political jurisdiction in charge of provision and financial decisions. Under fiscal equivalence, a single jurisdiction should be assigned to each public good unless two or more public goods have identical ranges of benefit spillovers. Even with matching spillover ranges, the competitive interests of the principals may require that separate jurisdictions (agents) be assigned to each public good, so that coincidence of benefit ranges is not the sole driver for

[12] The allocation of the agent's fixed fee among the principals also involves coordination on what scheme is selected in equilibrium. The principals may be anticipated to converge to some proportional sharing arrangement, where the outcome hinges on the relative bargaining strengths of the principals.

determining jurisdictional size in the presence of common agency. If a single jurisdiction provides multiple public goods, then common agency concerns indicate that either the principals should have similar tastes for *all* jointly provided public goods, or else the third-party authority (the federal government) must adopt institutional rules and financial arrangements as presented in Section IV.

At times, economies of scope have been used to justify a jurisdiction providing multiple public goods even when the ranges of the goods' benefits do not match (Sandler, 1992, pp. 126–8). If common agency costs and economies of scope are both present, then the determination of the jurisdiction's size and provision scope must trade off common agency costs with savings arising from economies of scope. Common agency supports a more focused jurisdictional scope (i.e., few public goods), while economies of scope favour less focused jurisdictional scope. The earlier analysis can be readily extended to demonstrate that common agency costs from *competitive interests and free riding rise as the number of tasks* (public goods) *increases*.

Common agency also raises issues about the accuracy of the Tiebout (1956) hypothesis that *efficiency* can be achieved at the local level when individuals "vote with their feet" and choose a jurisdictional *package*. In practice, a person's jurisdictional choice is dependent on just a few key public goods that are apt to differ among residents. Thus, a role for the federal government at both the local and state level may exist to improve efficiency through rules and subsidies as presented earlier.

VI. CONCLUDING REMARKS

The paper illustrates various ways of remedying the problem of free riding and multi-principal competition within the context of a common agency with public goods. Despite the reliance on a third party to aid the process, the design and means of achieving a second-best outcome cannot rely on the use of traditional methods such as subsidies or simple controls. With respect to multi-principal competition, negative marginal fees for the agent can be eliminated by restrictions on principals' punishments of the agent. The problem of free riding, however, remains, so that these restrictions must be supplemented with two types of subsidies. The first is paid by a third-party authority to the principals, in which the authority moves first, followed by the principals, and then by the agent. Although this subsidy scheme may achieve a second-best outcome, there remains a distinct possibility that the programme's costs may outweigh the benefits that the principals place on the subsidy-induced additional effort of the agent. Even in the presence of economies of scope, the reliance on restrictions or subsidies may be inadequate.

The second kind of subsidy involves a direct payment to the agent from funds collected by a third party from taxes levied on the principals. Taxes raised from each group of principals are earmarked to support only the public good for which the group has an interest – there is no cross-subsidization between groups. The timing of the actions by the three kinds of participants is absolutely essential to the achievement of a second-best outcome. A potential coordination problem arises, because there are a plethora of equilibria, but the presence of two focal equilibria allows this problem to be addressed.

REFERENCES

Bernheim, B. D. and Whinston, M. (1986). 'Common agency', *Econometrica*, vol. 54, pp. 923–42.

Buchholz, W., Haslbeck, C. and Sandler, T. (1998). 'When does partial cooperation pay?' *Finanzarchiv*, vol. 55, pp. 1–20.

Cornes, R. and Sandler, T. (1994). 'The comparative static properties of the impure public good model', *Journal of Public Economics*, vol. 54, pp. 403–21.

Cornes, R. and Sandler, T. (1996). *The Theory of Externalties, Public Goods, and Club Goods*, 2nd Edition, Cambridge: Cambridge University Press.

Dixit, A. (1996). *The Making of Economic Policy*, Cambridge, MA: MIT Press.

Dixit, A. (1997). 'Power of incentives in private versus public organizations', *American Economic Review Papers and Proceedings*, vol. 87, pp. 378–82.

Falkinger, J. (1996). 'Efficient private provision of public goods by rewarding deviations from average', *Journal of Public Economics*, vol. 62, pp. 413–22.

Kirchsteiger, G., and Puppe, C. (1997). 'On the possibility of efficient private provision of public goods through government subsidies', *Journal of Public Economics*, vol. 66, pp. 489–504.

Olson, M. (1969). 'The principle of 'fiscal equivalence': The division of responsibilities among different levels of government', *American Economic Review Papers and Proceedings*, vol. 59, pp. 479–87.

Sandler, T. (1992). *Collective Action: Theory and Applications*. Ann Arbor, MI: University of Michigan Press.

Siqueira, K. (2001). 'Common agency and partial cooperation', *Journal of Public Economic Theory*, vol. 3, pp. 309–39.

Tiebout, C. M. (1956). 'A pure theory of local expenditures', *Journal of Political Economy*, vol. 64, pp. 416–24.

APPENDIX A

Using the principal's budget constraint and solving the agents' binding participation constraint for Q^{Ai}, we can rewrite the individual's problem as choosing P_1^{Ai} and P_2^{Ai} to

$$\text{maximize}\left\{\Phi_1^{Ai}a_1 + I^{Ai} + Q^{-(Ai)} + P_1^{-(Ai)}a_1 + P_2^{-(Ai)}a_2 - (1/2)r[(P_1)^2\sigma_1 + (P_2)^2\sigma_2] - C(a_1, a_2)\right\},$$

$$\text{subject to}: a_j = a_j(P_j), \quad j = 1, 2,$$

where $Q^{-(Ai)}$, $P_1^{-(Ai)}$, and $P_2^{-(Ai)}$ represent the fixed and marginal payments to the agent by all principals except principal Ai. Optimizing with respect to P_1^{Ai} and P_2^{Ai}, while recalling that $P_j = \sum_{i\in a} P_j^{Ai} + \sum_{i\in b} P_j^{Bi}$ for $j = 1, 2$, we derive the first-order conditions (FOCs):

$$P_1^{Ai} : \Phi_1^{Ai}\frac{\partial a_1}{\partial P_1}\frac{\partial P_1}{\partial P_1^{Ai}} + P_1^{-(Ai)}\frac{\partial a_1}{\partial P_1}\frac{\partial P_1}{\partial P_1^{Ai}} - r\sigma_1 P_1\frac{\partial P_1}{\partial P_1^{Ai}} - C_1\frac{\partial a_1}{\partial P_1}\frac{\partial P_1}{\partial P_1^{Ai}} = 0,$$

$$P_2^{Ai} : P_2^{-(Ai)}\frac{\partial a_2}{\partial P_2}\frac{\partial P_2}{\partial P_2^{Ai}} - r\sigma_2 P_2\frac{\partial P_2}{\partial P_2^{Ai}} - C_2\frac{\partial a_2}{\partial P_2}\frac{\partial P_2}{\partial P_2^{Ai}} = 0.$$

Given that $\partial a_j/\partial P_j = 1/c_j$, $\partial P_j/\partial P_j^{Ai} = 1$, and $P_j - C_j = 0$, for $j = 1, 2$, these equations can be rewritten as:

$$\Phi_1^{Ai} - P_1^{Ai} - r\sigma_1 c_1 P_1 = 0, \tag{A1}$$

$$-P_2^{Ai} - r\sigma_2 c_2 P_2 = 0. \tag{A2}$$

Summing expressions (A1) and (A2) over all A principals gives:

$$\Phi_1^A - P_1^A - n^A r\sigma_1 c_1 P_1 = 0, \tag{A3}$$

$$-P_2^A - n^A r\sigma_2 c_2 P_2 = 0. \tag{A4}$$

An identical procedure for B principals yields:

$$-P_1^B - n^B r\sigma_1 c_1 P_1 = 0, \tag{A5}$$

$$\Phi_2^B - P_2^B - n^B r\sigma_2 c_2 P_2 = 0. \tag{A6}$$

Summing (A3) and (A5) and solving for P_1, we get (4) in the text. Similarly, using (A4) and (A6), we derive a similar expression for P_2.

APPENDIX B

For a type A principal, the FOCs of (P3) at the second stage are:

$$\Phi_1^{Ai}\left(\frac{\partial a_1}{\partial P_1^A}+\frac{\partial a_1}{\partial s_1}\frac{\partial s_1}{\partial P_1^A}\right)+s_1\left(\frac{\partial a_1}{\partial P_1^A}+\frac{\partial a_1}{\partial s_1}\frac{\partial s_1}{\partial P_1^A}\right)-t_1^{Ai}\left(\frac{\partial a_1}{\partial P_1^A}+\frac{\partial a_1}{\partial s_1}\frac{\partial s_1}{\partial P_1^A}\right)$$
$$+\left(\frac{\partial s_1}{\partial P_1^A}-\frac{\partial t_1^{Ai}}{\partial P_1^A}\right)a_1-r\sigma_1(P_1^A+s_1)\left(1+\frac{\partial s_1}{\partial P_1^A}\right)-C_1\left(\frac{\partial a_1}{\partial P_1^A}+\frac{\partial a_1}{\partial s_1}\frac{\partial s_1}{\partial P_1^A}\right)$$
$$+\lambda_1^{Ai}-\mu_1^{Ai}=0, \tag{A7}$$

$$\lambda_1^{Ai}P_1^{Ai}=0, \qquad \lambda_1^{Ai}\geq 0, \qquad P_1^{Ai}\geq 0, \tag{A8}$$

$$\mu_1^{Ai}(\Phi_1^{Ai}-P_1^{Ai})=0, \qquad \mu_1^{Ai}\geq 0, \qquad \Phi_1^{Ai}-P_1^{Ai}\geq 0. \tag{A9}$$

The Lagrange multipliers, λ_1^{Ai} and μ_1^{Ai}, are associated with the lower and upper bounds for P_1^{Ai}, respectively. Given that $\dfrac{\partial a_1}{\partial P_1^A}=\dfrac{\partial a_1}{\partial s_1}=\dfrac{1}{c_1}$ and $\dfrac{\partial s_1}{\partial P_1^A}=-1$, (A7) can be expressed as:

$$\left(\frac{\partial s_1}{\partial P_1^A}-\frac{\partial t_1^{Ai}}{\partial P_1^{Ai}}\right)a_1+\lambda_1^{Ai}-\mu_1^{Ai}=0. \tag{A10}$$

If the central authority's policy responses to a change in Ai's variable payment are offsetting, then the first term in (A10) equals zero, so that $\lambda_1^{Ai}=\mu_1^{Ai}$. From (A8) to (A9), we find that $P_1^{Ai}\in[0,\Phi_1^{Ai}]$. Similarly, $P_2^{Bi}\in[0,\Phi_2^{Bi}]$ for type B principals.