TREATY FORMATION AND STRATEGIC CONSTELLATIONS

A COMMENT ON *TREATIES: STRATEGIC CONSIDERATIONS*

*Katharina Holzinger**

I. INTRODUCTION

In his article, *Treaties: Strategic Considerations*, Todd Sandler analyzes the conditions that influence the formation of international treaties and adherence to treaties by their signatories.[1] He presents this article as an extension of Goldsmith and Posner's paper, *A Theory of Customary International Law*,[2] which analyzes customary international law from an empirical and rationalist perspective based on the strategic considerations of actors driven by self interest. As far as the *formation* of treaties is concerned, Sandler analyzes the conditions facilitating or impeding international cooperation. As Sandler correctly notes, the situation of international treaty formation usually concerns the provision of international public goods. Externalities between states, problems of coordination, and free-rider problems are all barriers that must be overcome to achieve international cooperation—that is, treaty formation.

The strategic constellation of potential signatories or member states determines the conditions that facilitate or impede cooperation and treaty formation. The strategic constellation, in turn, depends on a whole range of properties of the situation in question. In a situation regarding provision of international public goods, these properties are

* Professor of International Relations and Conflict Management at the University of Constance, Germany. Her main fields of research are the provision of international public goods and global governance, particularly in the environmental field, as well as the theory of conflict and conflict resolution. She has been published in, among others, EUROPEAN UNION POLITICS, EUROPEAN JOURNAL OF POLITICAL RESEARCH, EUROPEAN LAW JOURNAL, PUBLIC ADMINISTRATION, and POLITICAL COMMUNICATION. Her most recent book is ENVIRONMENTAL POLICY CONVERGENCE IN EUROPE: THE IMPACT OF TRADE AND INSTITUTIONS (Katharina Holzinger, Christoph Knill & Bas Arts eds., 2008).

1. Todd Sandler, *Treaties: Strategic Considerations*, 2008 U. ILL. L. REV. 155.

2. *See* Jack L. Goldsmith & Eric A. Posner, *A Theory of Customary International Law* (Chicago Working Paper Series, John M. Olin Law & Econ. Paper No. 63, 1999), *available at* http://www.law.uchicago.edu/Lawecon/WkngPprs_51-75/63.Goldsmith-Posner.pdf.

manifold: they may relate to the good itself, to the actors concerned, i.e., the countries, or to an already existing legal or institutional environment. Sandler deals with such properties more or less explicitly. He treats the aggregation technology of public goods explicitly, and he implicitly assumes certain types of public goods and certain cost-benefit configurations. Sometimes he mentions the heterogeneity of the actors—which might be helpful in overcoming the cooperation problem in his example (see figure 4 in Sandler).[3] Sandler shows the effects of some variation with respect to these properties, but—with the exception of aggregation technology—he does not treat them systematically. Moreover, situations of international treaty formation have many more attributes. For example, the strategic constellation of countries in some trade policy problems will be different in situations with a strict free trade regime than in situations where the erection of trade barriers is permitted.

As an extension to Sandler, this comment deals with a number of such properties more explicitly. Because there are a potentially infinite number of such properties and combinations of properties, I choose four rather basic properties that will play a role in almost any situation of international treaty formation: (1) costs and benefits of the pursued public good for the interested countries; (2) demand-side properties of the public goods; (3) supply-side properties, i.e., their aggregation technology; and (4) the homo- and heterogeneity of the concerned countries. I will extract some systematic effects of variation of such properties, holding others constant. In so doing, I rely on the same technology as Sandler, applying matrix game analysis.

The line of argument is as follows. Certain attributes of a situation regularly lead to certain strategic constellations which pose a typical problem or problem combination for international collective action. Section II introduces the four basic properties to be examined. Sections III through VI discuss the systematic effects of variation in these properties and propose some typical solutions. Section VII presents some general conclusions on the effects of certain properties on the possibility and difficulty of international cooperation and on the chances of finding solutions for the problems posed in treaty formation.

II. INTERNATIONAL TREATY FORMATION: FOUR PROPERTIES OF THE SITUATION

To analyze each and every combination of properties of situations of international public goods provision would be impossible and pointless. Nevertheless, single factors can be systematically varied while other factors are kept constant. This will be done for the cost-benefit configuration, the demand-side and supply-side properties of public goods, and

3. Sandler, *supra* note 1, at 170.

for the homo- or heterogeneity of the actors. However, not even all values in these factors can be taken into account. Possible variations are manifold and depend very much on the actual problem to be modeled. Only a limited number of these variations produce critical differences in strategic constellations. These will be systematically varied below.

A. Cost-Benefit Relation

It is the relation of the individual costs of contribution to the individual benefits derived from the good that determines the incentives for individuals in a public goods provision situation. For example, even when a good shows some of the characteristics of a public good (e.g., nonrivalry or nonexcludability), its provision does not necessarily pose a dilemma or other kind of collective action problem. Sometimes, the provision of a good is not even collectively desirable, given the individual cost-benefit relation. It is then not only individually, but also collectively, rational not to contribute to the good. In order to be a public good, something must not only exhibit attributes of *publicness*; it must also be valued as a *good* by the individuals and the collective. The cost-benefit configuration is not really a property of the good; however, it makes a thing desirable or undesirable, and thus a good or a bad.

Therefore, a situation cannot be taken for a public goods dilemma, and thus a problem for international cooperation, simply because a good has such characteristics. An analysis of individual contribution costs and benefits from a good is necessary before a certain strategic constellation like the prisoner's dilemma can be diagnosed. As Cornes and Sandler put it, "The configurations of benefits and costs are behind the payoff configuration assumed by a given game situation."[4] Each analysis of the strategic constellation in a public goods provision situation, thus, has to start by making reasonable assumptions about the individual costs and benefits in a concrete situation and by making assumptions about how these add up to the payoffs achieved in the interaction of the players. While the latter depends on the kind of the good, the former depends on the valuations of the actors.

B. Classical Demand-Side Properties

The two seminal contributions to public goods theory by Paul Samuelson[5] and Garrett Hardin[6] use two different criteria for defining the problematic goods: nonrivalry of consumption and nonexclusion from consumption. In fact, both definitions extend to different phenom-

4. RICHARD CORNES & TODD SANDLER, THE THEORY OF EXTERNALITIES, PUBLIC GOODS, AND CLUB GOODS 310 (1996).
5. Paul A. Samuelson, *The Pure Theory of Public Expenditure*, 36 REV. ECON. & STAT. 387, 389 (1954).
6. Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1248 (1968).

ena, although both criteria may apply to the same good. The criteria are called demand-side properties of public goods, because they relate to their consumption. The following classification of goods, which uses both criteria, was first introduced by Musgrave and Musgrave, and can now be found in most textbooks on public goods.[7]

TABLE 1
TRADITIONAL TAXONOMY OF PUBLIC GOODS

	Excludability	*Nonexcludability*
Rivalry of consumption	private goods	common-pool resources
Nonrivalry of consumption	marketable public goods	pure public goods

Whereas purely private goods are characterized by both rivalry in and excludability from consumption, purely public goods show properties of nonrivalry and nonexcludability. All other goods between these two extremes are usually called impure public goods.[8] Two important subclasses of impure public goods are common-pool resources and marketable public goods. Whereas private goods can be provided efficiently by the market, this is not possible with pure public goods. Usually, there will be a problem of underprovision of the good. Marketable public goods, however, can be provided by the market, although they pose some difficulties. Common-pool resources, on the other hand, are problematic for the market. Usually, they pose a problem of overuse of a resource. This shows that there should be a difference in the strategic constellation, depending on the exact combination of the basic demand-side properties of a good.

C. Supply-Side Properties

The supply-side properties of a public good pertain to its production—that is, the way the individual contributions to the good aggregate to the overall amount. The aggregation technology of public goods is dealt with extensively in Sandler's article. Thus, the basic distinction needs only to be briefly introduced here. Traditionally, it has been assumed in public good models that the total amount, X, of a public good available to the collective is the sum of the individual contributions, x_i. Hirshleifer points out that this "summation technology" ($X = \sum_i x_i$) is not

7. RICHARD A. MUSGRAVE & PEGGY B. MUSGRAVE, PUBLIC FINANCE IN THEORY AND PRACTICE 54 (1973).
8. CORNES & SANDLER, *supra* note 4, at 9.

the only possibility of an aggregation technology.[9] He treats two cases of other production technologies where the good can only be provided as a fixed total amount whose level is determined by a single contribution. For "weakest-link technology" goods, the total quantity is determined by the smallest contribution ($X = min_i (x_i)$); for "best-shot technology," it is determined by the largest contribution ($X = max_i (x_i)$). These two aggregation functions are extreme cases. Although other functions in between are also possible,[10] only the three extreme aggregation technologies shall be examined below.

D. Heterogeneity of Actors

Homo- or heterogeneity is an attribute of the collective of countries aiming at international cooperation. Keohane and Ostrom distinguish three dimensions of heterogeneity: actors' capabilities, their preferences, and their information and beliefs.[11] Heterogeneous capabilities may include differences among the actors with respect to property rights or other rights that are relevant for public goods production, physical endowments, or the size of possible investments into public goods production. Heterogeneous preferences may stem from different valuations of the public good, from different benefits derived from the good (for reasons other than pure valuation), and from different costs of contribution.

The effect of heterogeneity on the strategic constellation of actors, however, is not directly related to the causes of heterogeneity. Heterogeneity implies that the actors have different preference orders regarding the outcomes of the game. The introduction of heterogeneity of actors in matrix game analysis tends to transform symmetric games into asymmetric ones. Whatever the causes of these different preference orders may be, a systematic variation of preference orders over the four outcomes of a two-by-two matrix game can reveal typical effects of heterogeneity on the strategic constellation in public goods provision.

In the following sections, the results of systematic variation in the four properties will be summarized. While one property is varied, the other four are kept constant at a certain value. These values are selected to be as neutral as possible, meaning that they are set to a standard assumption, or to a value more natural than another variation, or to an extreme case. The usefulness of doing this can, of course, be disputed. However, the values selected are consistent with the usual assumptions in public goods analysis. These values are as follows:

9. Jack Hirshleifer, *From Weakest-link to Best-shot: The Voluntary Provision of Public Goods*, 41 PUB. CHOICE 371 (1983).

10. *See* CORNES & SANDLER, *supra* note 4, at 186 fig.6.12.

11. Robert O. Keohane & Elinor Ostrom, *Introduction to* LOCAL COMMONS AND GLOBAL INTERDEPENDENCE: HETEROGENEITY AND COOPERATION IN TWO DOMAINS 1, 7 (Robert O. Keohane & Elinor Ostrom eds., 1995).

(1) The cost-benefit configuration is set to the standard condition that leads to a prisoner's dilemma, given a pure public good with summation technology and homogeneous actors—that is, $2b>c>b$.

(2) The demand-side properties are nonrivalry and nonexcludability—that is, a pure public good is assumed.

(3) The production function of the good follows the summation technology.

(4) The actors are fully homogeneous.

(5) No specific legal or institutional factors apply to the situation of public goods provision.

III. COST-BENEFIT CONFIGURATION

This section demonstrates that the relation of costs and benefits significantly influences the strategic structure of a public goods game. Which strategic constellations does a variation of different cost-benefit configurations yield, given that conditions (2) through (5) apply? Under certain cost-benefit configurations, voluntary provision is possible even if the good has the properties of a public good. Under other configurations, voluntary provision will not happen because the public good is not collectively desirable. In this case, it is not a "good," strictly speaking. Whether an entity is valued as a good by an individual or by a collective, whether it is judged to be a "bad," or whether its net benefit is negative, is a consequence of the cost-benefit configuration, irrespective of the properties that determine that entity's "publicness." Which cost-benefit configurations are possible depends on the exact circumstances.

TABLE 2
COST-BENEFIT CONFIGURATIONS

(i)	$c > 4b > b$	$\Rightarrow C > B$	negative net benefit, individual costs exceed collective benefits
(ii)	$4b > c > b$	$\Rightarrow C < B$	positive net benefit, individual costs exceed individual but not collective benefits
(iii)	$c = b$	$\Rightarrow C = B$	individual and collective net benefit is 0
(iv)	$2c > b > c$	$\Rightarrow C < B$	positive net benefit, total costs exceed individual benefits
(v)	$b > 2c > c$	$\Rightarrow C < B$	positive net benefit, total costs less than individual benefits

b	individual benefit	B	collective benefit = 4b
c	individual cost	C	collective cost = 2c

Under conditions 2 through 5, five different configurations can be distinguished in a game of two players and two strategies of providing or not providing the good. The game assumes fixed costs for an indivisible unit of a public good. With regard to a pure public good (i.e., one characterized by nonrivalry and nonexcludability), two units of the good provide four units of total benefit (two units for each player). Configurations (iv) and (v) are strategically equivalent, because in both cases, the individual benefit is greater than the individual cost. We thus need only consider configurations (i) through (iv). Table 3 gives the payoff functions, given conditions 2 through 5, as well as the preference orders of the outcomes for the four cost-benefit configurations. The strategies are to provide (P) or not to provide (nP) a unit of the good. As usual, the row player's payoff is given on the left, and the column player's payoff is given on the right. The ordinal payoffs for all four cost-benefit configurations are given in columns (i) through (iv). Nash equilibria are underlined.

Cost-benefit configuration (i), where the individual contribution costs are higher than the individual benefits, yields a harmony game. The dominant strategy for both actors is to not provide the good, for it is not beneficial for them. Cost-benefit configuration (ii), in which the individual contribution costs are higher than individual benefits but lower than the total benefits if both players are providers, leads to a prisoner's dilemma. The good is not provided, although it would be beneficial. In configuration (iii), individual costs and benefits are the same. Both actors are indifferent to their strategies—which leads to the so-called degenerate coordination game, a game with four Nash equilibria. Any of them could be the outcome: provision, nonprovision, and unilateral provision are possible. In configuration (iv), the individual benefits are higher than the individual costs of contribution. This leads to a harmony game with the dominant strategy for both actors of providing the good.

TABLE 3
COST-BENEFIT CONFIGURATIONS IN PUBLIC GOOD PROVISION

	configuration (i) configuration (ii)		*c > 2b > b* *2b > c > b*			configuration (iii) configuration (iv)		c = b b > c	
	Strategy combination		*Benefits*	*Costs*	*Payoff*	*Ordinal, configuration*			
						(i)	*(ii)*	*(iii)*	*(iv)*
Actor A	A: P	B: P	2b	c	2b-c	2	3	2	4
	A: P	B: nP	b	c	b-c	1	1	1	2
	A: nP	B: P	b	0	b	4	4	2	3
	A: nP	B: nP	0	0	0	3	2	1	1

All factors are identical for actor *B*.

TABLE 3—*Continued*

Game Matrices

(i)

Actor A \ *Actor B*	*P*	*nP*
P	2, 2	1, 4
nP	4, 1	3, 3

Harmony

(ii)

Actor A \ *Actor B*	*P*	*nP*
P	3, 3	1, 4
nP	4, 1	2, 2

Prisoner's Dilemma

(iii)

Actor A \ *Actor B*	*P*	*nP*
P	2, 2	1, 2
nP	2, 1	1, 1

Degenerate Coordination

(iv)

Actor A \ *Actor B*	*P*	*nP*
P	4, 4	2, 3
nP	3, 2	1, 1

Harmony

Thus, it is only cost-benefit configuration (ii) that produces a collective dilemma. If individual benefits are higher than individual costs, the good is harmoniously provided. If individual costs are higher than the total benefits achievable given that all contribute, the good is harmoniously not provided. The following variations rest on the assumptions of configuration (ii).

IV. DEMAND-SIDE PROPERTIES: NONRIVALRY AND NONEXCLUDABILITY

What happens when we vary the demand-side properties of public goods, given conditions 1, 3, 4 and 5? Employing the same method as above, we end up with three different types of games. In the case of a private good, we end up with a harmony game in which the good will be provided (see table 3, game 4). As has been shown in the last section, the provision of a pure public good puts the players into a prisoner's dilemma, given that cost-benefit configuration (ii) applies (see table 3, game 2). The provision of a marketable public good leads to an assurance game. That is, marketable public goods lead into coordination games and, thus, do not pose a strong collective action problem. Coordination games that do not involve conflict (like assurance or pure coordination games) can usually be resolved without the intervention of an exogenous power, provided there is some mechanism that can coordinate the strategies. This is why these goods are marketable and need not be provided by the state or by international cooperation involving treaty formation and sanctions. Finally, the exploitation of a common-pool resource is a prisoner's dilemma, at least in a phase of exploitation where individual marginal benefits are still positive but collective marginal benefits are negative.

Demand-side properties are thus responsible for two effects. First, the property of nonrivalry allows cost sharing and the common use of a good. This is basically a positive property, although the players may wait for others to provide the good or for some signal that tells them others will also pay their share. As long as nonrivalry is not combined with nonexcludability, this does not cause a very large problem. Nonrival goods provided by nature do not imply any problem. The examples of marketable public goods show that these goods can be provided in a noncooperative environment. Second, the property of nonexcludability allows for free riding. This is the most problematic property in the production of public goods. Whether it is combined with rivalry or with nonrivalry, it leads to collective dilemmas, which can only be solved by cooperation, that is, by the conclusion of binding and enforceable treaties.

V. SUPPLY-SIDE PROPERTIES: AGGREGATION TECHNOLOGY

Because the aggregation technology of public goods is treated by Sandler, this section will discuss them only briefly. The three extreme cases of aggregation technology result in different strategic constellations. In a two-strategy matrix, players can only choose to contribute or not to contribute (or between high and low levels of contribution, respectively). In a two-player game, two contributions is the maximum: each player can make zero, one, or two contributions to the public good. In symmetric games, it is also generally assumed that the contributions are equal (the players contribute "one unit"). In an environment of two players, two strategies, and of equal contributions, the equivalent to a weakest-link technology is the requirement that *both* players must contribute in order to provide the public good. In an environment with more than two players, the equivalent is that *all* or *at least n* players contribute. The equivalent to a best-shot technology is that the contribution of *one* player is sufficient to provide the good. If there are more than two players, the equivalent is that *n* players' contributions are sufficient for provision. In the case of summation technology the contributions are restricted to a maximum of two in a two-by-two game, and to a maximum of *n* in the *n*-by-two game.

In terms of matrix games, and given conditions 1, 2, 4, and 5, summation technology leads to a prisoner's dilemma, weakest-link technology leads to an assurance game, and best-shot technology leads to a chicken game.[12] More generally, if contributions are fully additive, the game is a prisoner's dilemma. If there is some upper or lower threshold for contributions, a coordination game will arise. This becomes obvious in Sandler's examples of treaties which require a minimum number of signatories in order to come into force.[13]

VI. HOMO- AND HETEROGENEITY OF ACTORS

This section deals with the effects of heterogeneity of actors on the strategic constellation. As before, other properties are set to the basic conditions 1, 2, 3, and 5. Introducing heterogeneity tends to transform symmetric games into asymmetric ones, because players order the outcomes of the games differently. However, there are also examples in which games with heterogeneous actors prove to be perfectly symmetric.

The type of game that results if players are heterogeneous depends on the game played and on exactly how the players are heterogeneous. More precisely, it depends on which kinds of different preference orders are combined in a two-by-two game involving heterogeneous players. Because each kind of preference order can be combined with every other kind, there are as many possibilities as there are strategically distinct asymmetric games in ordinal terms.

This comment will not present all of the games that imply heterogeneity. Instead, it will examine what happens to some symmetric games if heterogeneity is introduced. These games are the prisoner's dilemma, the symmetric harmony game, the assurance game, and the chicken

TABLE 4
PREFERENCE ORDERS OF FOUR SYMMETRIC GAMES

	Strategy combination		*Harmony*	*Prisoner's Dilemma*	*Assurance*	*Chicken*
Actors A and B	A: P	B: P	4	3	4	3
	A: P	B: nP	3	1	1	2
	A: nP	B: P	2	4	3	4
	A: nP	B: nP	1	2	2	1

12. TODD SANDLER, GLOBAL CHALLENGES: AN APPROACH TO ENVIRONMENTAL, POLITICAL, AND ECONOMIC PROBLEMS 46–50 (1997).
13. *See* Sandler, *supra* note 1, at 162–63.

game. These obviously play a role in public goods provision, as their recurring appearance above has shown. Table 4 gives the preference orders of homogeneous players for the four games.

Heterogeneous players have six possible combinations of preference orders—"hybrids" of games, as Taylor calls them[14]—which can be formed by these four games and which are strategically distinct.[15] The matrices in table 5 show which games the six hybrids represent. The six hybrids are produced by the combination of four preference orders:

(1) Harmony and Assurance

(2) Harmony and Prisoner's Dilemma

(3) Harmony and Chicken

(4) Assurance and Prisoner's Dilemma

(5) Assurance and Chicken

(6) Prisoner's Dilemma and Chicken

In three cases, the hybrid games are Rambo games,[16] and the combination of an assurance game and prisoner's dilemma produces an asymmetric dilemma. This supports the claim that asymmetric games result if the players are heterogeneous. However, the combination of harmony and assurance produces a symmetric harmony game, although this one looks a little different from the standard harmony game. The reason for this is that neither harmony games nor assurance games involve conflict between the players' preferences. The combination of assurance and chicken games produces a game that has no Nash equilibrium: players have an incentive not to coordinate their strategies, which is the reason why these games are often called discoordination games. This game has no stable outcome; thus, it poses a problem of instability.

Basically, the heterogeneity of actors can lead to any of these kinds of game, depending on which kinds of preference orders are combined. The inequalities involved in the actors' heterogeneity and present in their initial positions in a game are also usually mirrored in the structure and the outcomes of the game. Most, but not all, games with heterogeneous actors are asymmetric. In most cases there is inequality in the Nash equilibrium of the game. This is not true, however, for games 1 and 4 in table 5. Asymmetric games can lead to equality in equilibrium, as in game 4.

14. MICHAEL TAYLOR, THE POSSIBILITY OF COOPERATION 39 (1987).

15. In fact, there are twelve possible combinations, because the players' positions can be reversed. This, however, does not change the basic strategic structures, although in Rambo games, it is now the other player who has the distributive advantage.

16. Rambo games are games with Pareto-optimal and unique equilibriums, but with unequal payoffs in the equilibrium. They pose no problems in terms of efficiency and stability. There is, however, a distributional problem: the "Rambo" player is able to push his or her preferences through at the cost of the other player.

Usually, however, asymmetric games reveal inequality in the Pareto-optimal outcomes.[17] This shows that there is a distributive problem involved. However, to add another complication, distributive problems are

TABLE 5
SIX "HYBRID" GAMES WITH HETEROGENEOUS PLAYERS

(1) Harmony

Player A \ Player B	P	nP
P	4, 4	3, 3
nP	2, 1	1, 2

(2) Rambo

Player A \ Player B	P	nP
P	4, 3	3, 4
nP	2, 1	1, 2

(3) Rambo

Player A \ Player B	P	nP
P	4, 3	3, 4
nP	2, 2	1, 1

(4) Asymmetric Dilemma

Player A \ Player B	P	nP
P	4, 3	1, 4
nP	3, 1	2, 2

(5) Discoordination Game

Player A \ Player B	P	nP
P	4, 3	1, 4
nP	3, 2	2, 1

(6) Rambo

Player A \ Player B	P	nP
P	3, 3	1, 4
nP	4, 2	2, 1

also implied in some perfectly symmetric games with homogeneous actors: the chicken and battle of the sexes games have two equilibria, and there is distributional conflict among the players regarding which equilibrium should be chosen.

17. An outcome of a game is *Pareto optimal* if there is no other outcome "which would give both players higher payoffs, or would give one player the same payoff but the other player a higher payoff." PHILIP D. STRAFFIN, GAME THEORY AND STRATEGY 68 (1993).

VII. CONCLUSION

What general lessons can be drawn from this analysis? The first point is obvious: the simplistic conclusion—i.e., that the provision of international public goods necessarily poses a collective dilemma—is not valid. There are so many factors influencing the social situations in which public goods are provided that it is impossible to draw general conclusions about the strategic constellations and the cooperation problems posed by public goods provision. The models presented above are extreme simplifications compared to empirical situations, given that just a small number of factors have been varied, yet they produce a variety of strategic constellations. This is not encouraging, because it implies that each problem of international public goods provision has to be analyzed individually and in some depth—if rash generalizations are to be avoided.

However, the fact that differentiated analysis is needed to avoid overgeneralization does not imply that we are left with only the alternative of analyzing individual cases. Some more general conclusions can still be drawn. Identical combinations of the characteristics of a situation will yield an identical strategic structure. It is therefore possible to conclude, given the presence of certain attributes in a public goods problem, that certain kinds of cooperation problems will be present and will have to be solved. As this comment has shown, the variation in single factors has systematic effects, provided that other factors are kept constant. Variation in certain properties changes the games in a systematic way.

Only one of the five basic cost-benefit configurations poses a cooperation problem: the one that produces a prisoner's dilemma with a pure public good or a common-pool resource. Of the two defining demand-side properties of public goods, only nonexcludability implies a strategic structure that is difficult to solve, namely the prisoner's dilemma. Marketable public goods provide coordination problems which are easier to handle. As shown by Sandler, weakest-link technology and minimum thresholds leads to coordination problems as well. Best-shot and summation technology, however, result in chicken and prisoner's dilemma games. Finally, heterogeneity implies in most cases that distributional problems play a role: Rambo games and asymmetric dilemmas arise from heterogeneous actors. In some cases, efficient outcomes may be achieved with inequality; in others, distributional problems are combined with defection incentives, as in asymmetric dilemmas. In general, heterogeneity makes international cooperation more difficult.

The strategic constellations determined by various combinations of properties include a limited number of different two-by-two games: harmony and dilemma games, chicken and assurance games, Rambo and discoordination games. These games entail different kinds of cooperation problems. Some of them are defection problems—that is, the actors have an incentive to defect from the collectively optimal solution (i.e., prisoner's and asymmetric dilemmas). Others represent coordination problems, where the actors face the risk of not being able to coordinate their strategies for a desirable outcome (i.e., assurance and battle of the sexes); still others involve inequality and distributional problems (i.e., Rambo and chicken). Further, some produce no stable outcome (i.e., discoordination). Finally, some of the games represent several problematic aspects or several kinds of cooperation problems: the chicken or battle of the sexes game combines a coordination problem with a distributional problem (i.e., problems of finding agreement), or a defection problem with a distributional one (i.e., asymmetric dilemma).