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Salience and Cooperation Among Rational Egoists

by

Raul V. Fabella

School of Economics, University of the Philippines
and
Max Planck Institute for Tax Law and Public Finance, Munich, Germany

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Raul V. Fabella[1]

UP School of Economics
University of the Philippines
Diliman, Quezon City 1101
Philippines

and

Max Planck Institute for Tax Law and Public Finance
Munich, Germany

Email: raulfabella@yahoo.com.ph; teena.fabella@yahoo.com
Telephone: (632) 920-5463;
Mobile: (63917) 814-9545
Fax: (632) 931-4287

Abstract

We fuse a social dilemma game and a game pitting the group against nature, where the group's probability of avoiding disaster depends on the resources it raises from members. The result is the Nederlander-Prisoner's Dilemma Game where the cost of failure is equally shared. We introduce the concept of the Ostrom threshold, the failure cost in excess of which cooperation is best reply to itself. We give the condition for the existence of the Ostrom threshold in the Nederlander-Prisoner's Dilemma Game. For high enough cost of failure, cooperation among rational egoists is sustained. The Ostrom threshold first rises and then falls as the fury of nature rises.

Key Words: social dilemma, rational egoist, cooperation, Ostrom threshold

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[1] Permanent Address: 104 Berlin Street, Capitol Homes, Diliman, Quezon City 1121, Philippines

1. Introduction

Elinor Ostrom and her group (Ostrom, 1990, 2000; Ostrom et al., 1994) have amply demonstrated that the "tragedy of the commons" − contrary to expectations − need not always be the fate of collectives facing a common pool resource. In the usual social dilemma games among rational egoists, the players' pursuit of their individual self-interest inevitably leads to the sacrifice of the dividends of cooperation. Among the conditions the Ostrom group identified as contributive to cooperation are: face to face communication, small number of participants, relative homogeneity of members, information of past actions, limited exit possibility, the institutional link among members and how much the proper management of the contributes to well-being (Ostrom, 1990, 2007). We will refer to these as the "Ostrom conditions." We will especially exploit the last of these conditions which Ostrom also calls "salience" (e.g., Ostrom, 1999). Ostrom (2000) and others (e.g., Fehr and Fischbacher, 2002) favor using pro-social tendencies, reciprocity or conditional cooperation to explain cooperation in common pool resource management. This in keeping with Charles Darwin's observation in *The Descent of Man* (1871): "Selfish and contentious people will not cohere, and without coherence, nothing can be effected." While this may be true, the Ostrom conditions and especially salience may already be able to foster cooperation among "rational egoists."

In most real world circumstances, players are members of a "social group." The games they play within the group are composite ones. The success or failure of the group affects the well-being of the individual members. When a group is in some form of contest for survival – either with other groups or with "nature" – the welfare of the individual depends also on the success of the group which, in turn, depends on the degree of coherence among members within the group. This coherence may be attained among agents with selfish calculus.

In this paper, we investigate how a contest with nature inhibits member opportunism among rational egoists. In Section 2, we imbed a social dilemma represented by a symmetric Prisoner's Dilemma Game (PDG) into a composite game that encompasses the contest with nature. We define the contest with nature by a success probability that responds positively to resources assessed on group members' payoffs. We introduce the concept of the "Ostrom threshold" a failure cost level, in excess of which cooperation is best reply to itself. A large enough cost (salience) of failure makes every member a critical decision maker. In Section 4, we conclude.

2. The Base Social Dilemma

In a Prisoner's Dilemma game environment, two players A and B interact, each with strategy set (C, NC). They may be two farmers who extend help to one another at harvest time when produce not harvested with dispatch gets spoiled. Each agent exists (i.e., decides and harvests) in only one cycle to isolate the mechanism of interest. Both players are "rational egoists" and expected utility maximizers. The payoffs are of the familiar symmetric PDG as shown in **Table 2.1** below, with $a > b > c > d$. The Nash equilibrium of the game is (NC, NC). Purely individual member utility or fitness consideration points to universal non-cooperation. The repeat game version of this game produces the same grim result.

Table 2.1. Payoff interaction of players A and B: PDG.

A \ B	C	NC
C	b,b	d,a
NC	a,d	c,c

3. Group Fitness: The Nederlander Game

Suppose the farm area of the group consisting of A and B is low-lying and protected from flooding by a barrier (dike). The dike requires continuous tending which, in turn, requires the expenditure of resources or effort to be provided by the area farmers. Whether the dike holds or not is a stochastic event that depends partly on the resources deployed by the farmers for the dikes' upkeep. Let P be the probability that the dike holds, and (1 – P) the probability that it breaks. If the dike holds, the status quo is upheld, i.e., no negative exactions. But if the dike breaks, the cost to the community of failure is $X > 0$ assumed shared equally by A and B, i.e., the cost to each member is X/2, which no member can evade by flight following the Ostrom condition of difficult exit.

Resources to upkeep the dike is raised through a tax rate t, $0< t <1$, assessed against individual member (e.g., farming) payoff. We assume no member can evade the assessment or can lie about their payoff using the Ostrom conditions of relative homogeneity, small group and face-to-face interaction. The aggregate tax revenue, R, increases the success probability P of the dike holding. Letting R0 be the known fixed parameter representing the "fury of Nature," we adopt a simple Tullock structure for probability of success:

$$P = R/[R + R0]. \quad (1)$$

We call the collection {P, X, R, R0, t}, the "Nederlander Game" (NG) played against "Nature." It is a non-strategic game: X is raised by the farmers and applied to the dike; nature challenges the integrity of the dike. If the dike breaks, each farmer pays X/2. Game ends. This is the type of game that the Dutch ("Nederlanders" literally means "lowlanders") have been playing for centuries against the North Sea.

We can fuse the PDG and NG into one composite game by defining the tax revenue R as assessed against the payoff of each member:

$$R(i, j) = t(UA(i, j) + UB(i, j)), \; i, j = C, NC \quad (2)$$

Thus, the tax revenue is proportional to individual payoff. From Table 2.1, for example, R(C,C) = t(b + b) for (C,C) and R(C,NC) = t(d + a), for (C, NC), etc. Then the probability of the dike holding is:

$$P(i, j) = R(i, j)/[R(i, j) + R0]. \quad (3)$$

Definition 1: The strategic composite game where the member payoffs are determined simultaneously by the combined PDG and NG we call the Nederlander-Prisoner's Dilemma Game (N-PDG).

The N-PDG implicitly incorporates most of the Ostrom conditions for cooperation. Ostrom's concept of "salience" emerges in the form of the size of X:

Definition 2: The Ostrom Threshold of the N-PDG is the failure cost Xo, where $0 < Xo < \infty$, such that (i) if X = Xo, C is a weakly best reply to C for both players and (ii) if X > Xo, C is strictly best reply to C.

Remark: In general, the Ostrom threshold demarcates the social space where cooperation is the dominant strategy.

The expected utility of A under (C, C) in the N-PDG is:

$$EUA(C, C) = UA(C, C)(1-t) - (X/2)\ [1 - P(C, C)]. \quad (4)$$

Now P(C, C) = t(2b)/[t2b + R0]. Thus,

$$EUA(C, C) = b(1 - t) - (X/2)[1 - (2bt/(2bt + R0))]. \quad (5)$$

Here, b(1 – t) is individual member's own fitness net of tax and (X/2)[.] is his share in the collective fitness under (C, C). This is analogous to the concept of "inclusive fitness" in evolutionary biology (Bowles, 2004; Wilson and Wilson, 2008). Under (NC, C), A's expected payoff:

$$EUA(NC, C) = a(1 - t) - (X/2)[1 - (t(d + a)/(t(d + a) + R0)]. \quad (6)$$

Note that A's expected fitness is in each case a composite of the individual payoff and his share of the group payoff. Equating (4) and (5), we have:

$$(X/2)\{t(d + a)[t(d + a) + R0]-1 - t(b + b)[b + b) + R0]-1\} = (1 - t)(a - b). \quad (7)$$

This equality condition ensures that C is a weakly best reply to C or (C, C) is a weak Nash equilibrium. The main result concerns the existence of the Ostrom Threshold for the game in question:

Proposition 1: (Existence of the Ostrom Threshold) The N-PDG has an Ostrom threshold if and only if (b+b) > (a+d) in the original PDG.

Proof: (if) Consider the following:

$$X0 = - 2(1 - t)(a - b)[H2/H1], \quad (8)$$

where H1 = tR0[(d + a) – (b + b)] and H2 = (t(d + a) + R0)(t(b + b) + R0). H2 is clearly positive but less than ∞, since (1-t) > 0 and (a-b) > 0 by N-PDG. Since (d + a) – (b + b) < 0, H1 < 0, so X0 > 0 but less than ∞, as required for an Ostrom threshold. Now X0 solves above which ensures that C is weakly best reply to C for A. By symmetry, it also does the same for B. Furthermore, for every X > X0, EUA(C, C) > EUA(NC, C) or C is strictly best reply to C for all players. Thus, X0 is clearly the Ostrom threshold for the N-PDG. (Only if) Suppose the inequality condition does not hold for the N-PDG. Suppose an Ostrom threshold X exists. Then X = X' makes C weakly best reply to itself and X > X' makes C strictly best reply to itself. But X' is exactly Xo in (8). Then X' ≤ 0 which violates the definition of the Ostrom threshold. QED

We have shown that when the group faces cost of disaster X in excess of the Ostrom threshold, the social dilemma character of the interaction among rational egoists can dissolve to allow for "cooperation" to become a best reply to itself. The necessary and sufficient condition is that the social welfare at (A, A) exceeds that of (A, B) or (B, A) in the original PDG. The threat must be severe enough to have such an effect. Cooperation is thereby sustained without resorting to other-regarding preferences. How does the prospect for cooperation (reflected by X^o) behave in response to a rise in the " fury of Nature" (R^o)? We have the following:

Proposition 2: The prospect of cooperation among rational egoists rises (stays the same, falls) (that is, X^o falls (stays the same, rises)) as the fury of Nature R^o rises if R^o < (=,>) t^2((d+a)(b+b).

Proof: We have $X^o = C[A + R^o][B + R^o]/[B – A]R^o$ where C = 2(1+t)(a-b), A = t(d+a), B = t(b+b). The first derivative with respect to R^o is $(dX^o/dR^o) = [A-B]C[R^{o2} – AB]/[[A-B]R^o]^2$ > (=,<) 0 as R^o > (=,<) $(AB)^2$ as claimed. The second derivative with respect to R^o is $(d^2X^o/dR^{o2}) = 2C[A-B]^3AB/[(A-B)R^o]^4 < 0$ since A < B. QED

Thus, the prospect for cooperation first rises with R^o for small values of the latter but falls as R^o exceeds a threshold value, $(AB)^2$. This is as intuition would have it: as the situation becomes increasingly hopeless that is, the threshold is breached, it becomes harder to forge cooperation among rational egoists.

4. Conclusion

We imbed a social dilemma game (PDG) into a game (the Nederlander Game or NG) pitting the group against nature to construct a composite game, the N-PDG. We believe that the game most agents play with others in his/her group is a composite or interlinked one rather than stand alone. The NG involves maintaining a public good (e.g., a dike) requiring resources that improves the probability of success. Resources for the public good are collected as a proportional tax assessed on individual payoffs in the PDG. The cost of failure is equally shared. The institutional assumptions required are precisely the Ostrom conditions of small group, relative homogeneity, face to face interaction and difficulty of exit. We introduce the concept of the "Ostrom threshold" which is the level of failure cost (Ostrom's "salience") in excess of which cooperation is a best reply to itself. We give the necessary and sufficient condition for the existence of the Ostrom threshold for the N-PDG. Thus, a high enough cost of group failure forces cooperation among rational egoists. There is no need for a group-oriented preference among the members to sustain cooperation. We also show that the response of the Ostrom threshold to the fury of Nature is non-monotonic, first rising and then falling.

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