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Comparing and Explaining the Success of a Common Endowed with Different Degrees of Sanctioning

Axel Ostmann[1], Beate Wojtyniak[2], and Martin Beckenkamp[3]

1. Commons

Commons are institutions that induce a kind of social dilemma, a "situation in which private interests are at odds with the collective interests" [LLM]. Often a group of members manage a common pool resource like fish, meadow, forest or water. The members of a common are competitors in use: What one user takes affects the chances for other users. Under the assumption of rational actors game-theoretical analyses of such commons prescribe an overuse of the resource for a large and relevant class of situations. There are static and dynamic environments. In the static environment the state of the underlying resource is the always the same in every period, whereas in the dynamic environment the state changes. In the latter case typically the new state depends on the usage in the previous periods and on the natural regeneration, growth or inflow of the respective resource. It has been argued that the management task in a dynamic environment introduces additional difficulties[4] for the actors. Indeed it has been shown in

[1]Environmental Research Center (FZU), University of Karlsruhe

[2]SFB 303, University of Mannheim

[3]Dept. of Psychology, University of Saarbrücken

[4] Platt's main thesis ("social trap", [P]) is that the central problem of a dynamic common is not that members show an individualistic orientation but the way how rewards and damages are arranged in time: Individuals tend to orient themselves more toward actual, noticable, and visible stimuli than toward future

experiments that the observed performance in exhaustible resource environments is rather poor if compared with static scenarios (cp. [GMW]). A similar effect has the introduction of a stochastic development of the resource ("environmental uncertainty"). In the article [SR] the stochastic development of the pool size is seen as a central and characteristic feature of many resource management tasks found in the field. The problem to act within such an environment can be seen as adding a further uncertainty to the simpler task of a static or dynamic common. Even for static environmental uncertainty (time invariant uncertainty, in every period the group faces the same probability distribution for the pool size) it has been shown that the management performance is remarkably lowered if the incertainty increases (cp. [RBSW], [SR], [SBR]).

We conclude that in the simplest management tasks for commons - with all environmental incertainty and time-dependent resource development removed - the most favourable conditions are found for a prosperous development of a common. In corresponding scenarios we can focus on social uncertainty alone: For an actor there is no need to consider the resource in change, the only concern is how the partners will influence the own chances. A game-theoretic model of such a task of self-management for a common can be constructed by using the basic paradigm introduced by [OGW] and adding the focal institutions used.

The basic paradigm refers to a repeated (non-cooperative, strategic) game specifying the one-period structure as given below:

1. n members of a common (the group size usually set is eight) can independently decide on their individual usage x of the resource within their capacity or limits of endowment (we set: $0 \leq x \leq 25$);

2. dependent on their own choice x and on the total usage of their partners y they receive an individual payoff of u(x,y);

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possible developments. Payoff advantages by a large individual harvest are directly noticable whereas the damage by overuse can only be seen in the next period.

3. the individual payoffs consist of an individual part representing the cost of "harvesting" and a proportional share of the common "product" of the total usage s=x+y;

4. actions are hidden; at the end of each period every actor gets to know the total usage s and his or her own payoff.

The payoff function used in this contribution is the following:

$$u(x,y) = -5x + (x/s)\, s(23-0.25s) = x(18-0.25s)$$

Beside the individual payoffs we will also consider the joint payoff:

$$U(s) = s(18-0.25s).$$

A formal analysis reveals that the maximum joint payoff is attainable for a total usage WO = 36, whereas the (unique) non-cooperative solution Nash-equilibrium prescribes an individual usage of 8 for every actor and a total usage of 64. The (Nash-)**equilibrium** is defined as the vector of individual choices for which every (individual) choice is a best reply to the vector of all other choices. In this sense the equilibrium is a self confirming solution arising from the given incentive structure. The fact that the equilibrium means an overuse factor of about 1.78 can be seen as representative for the whole class of games deriving from "open-access" or "institution-free" commons. Hardin's verdict on the commons is based on corresponding incentive structures. The more economic view of the disproportion of the Nash-equilibrium EQ and the so-called welfare optimum WO focuses on payoffs instead of the action or the state of the resource. In economic terms the **efficiency** of a result is the quotient of the joint payoff divided by the maximum payoff (formally eff(s) = U(s)/U(WO)). In our specific case incentives lead to an impressive effiency loss if we assume that the equilibrium and/or the best reply is the valid standard of behaviour. We get eff(EQ) = 0.395.

From the field it is known that people often add mechanisms and institutions more or less successful and adequate to insure a sustainable management of the common. Some of these mechanisms (like several forms of social control) are not easy to implement into a laboratory scenario. Others more formal mechanisms and institutions like communication facilities or sanctioning regimes can more easily be handled in an experimental setting. In several laboratory experiments it was observed that subjects reach results superior and more cooperative than game-theoretically explained if communication facilities can be used repeatedly. Moreover it is near at hand to add a monitoring and sanctioning regime whenever either communication facilities are not at hand or partners fear that communication alone may be not sufficient for protecting the common pool resource. In our contribution let us focus on sanctioning regimes only.

2. Sanctioning regimes

Early experiments with sanctioning in commons focus on internal and blind sanctioning [OGW]. Internal means that sanctioning is an activity of a member upon another member. The sanctioning is blind if there is no valid information on previous or actual activities of the sanctionee on which the respective sanction can be based. The sanctioning activity is costly and there is no payoff advantage that can be drawn out of the sanctioning: The sanction is nothing but doing harm to the respective person. Corresponding mechanisms induce equilibria in which no sanction takes place and correspondingly usage is not reduced. Nevertheless empirically can be found that both sanctions are applied and efficiency is improved for blind sanctioning if enriched with a one-shot communication (cp. [OGW], p.192f). Another mutual sanctioning institution has been examined by Moir [Mo]. In his setting the sanctioning has to be justified by a monitoring activity providing the information of an offence; the monitoring activity causes additional costs and again the inspecting member can get no payoff advantage by monitoring.

The situation changes completely when the institution creates an advantage for the sanctioneer. Assume that a limit λ is set for the indiviual usage x. By costly inspection a member of the common may detect another member's x is above the limit. An easy rule combining sanctioning and compensation for the inspector is to confiscate the amount exceeding the limit and to give it fully or in part to the inspector. Such an institution generates redistribution of income between members based on their inspection and use activity. Experiments with such an institution are reported in [O1] and [O2]. The respective (symmetric) incentive structure prescribes an equilibrium with a certain inspection probability and an adapted mixture of conform and extremely greedy usage. Under the observed non-equilibrium defection behaviour the inspecting member makes sacrifices to the group.

We conclude that under the institutions of mutual sanctioning a need for a rule designating a person responsible for monitoring may evolve. In the next section we introduce a scenario for a common that employs an inspection agency for guaranteeing that enough control is performed.

3. External Inspections

Employing an external inspector in order to implement justified sanctions is costly (assume that inspection costs are a fixed amount κ). For this reason the members of the common should balance the loss from the deviation from the planned with the inspection cost. In case of minor losses it would be inadequate to search for the defectors. A corresponding simple rule to implement in an external inspection scenario is to call for inspection only if a certain maximum total usage tolerated η is surpassed. In the following we add the control and sanctioning regime to the base line scenario given in section 1. For the corresponing base line game the following parameters are adequate: λ=5, κ=40, η=46. In terms of efficiency an inspection cost of 40 means an efficiency loss of 0.123 if the agency is called for inspection.

Let us assume that the inspection contract also specifies the extent of inspection activities in such a way that a fixed and equal probability p for being inspected is set. Sanctioning is carried out in case it was detected that an user goes beyond the limit λ. In approximation to usual practices perceived as fair we assume that the sanctions comprise two parts. First a defector detected has to pay the inspection costs κ and secondly a compensation fee proportionate to the deviation from the limit. Whereas the inspection cost means a welfare loss for the group the sanctioning can be considered as redistribution of income. Formally we may assume that every (undetected) member receives from the compensation fee a share $\sigma(x-\lambda)$, σ being a fixed **sanctioning factor**. Theoretically both high control probability and high sanctioning factors lower the incentives to deviate from the limiting standard.

For judging the performance of a sanctioning system we first have to find out in what a way the incentive structure is changed by the institution introduced. In our case the changes induce multiple asymmetric equilibria, that (in a large range) exhibit increasing efficiency for both more inspection and higher sanctioning. From an rational actor perspective the interval of the total usages in equilibrium can be identified with the policy **target** associated with the respective sanctioning regime. As reported from other social dilemma experiments people in many setups tend to act more cooperatively than prescribed by equilibria. Let us call **cooperation shift** (in short: cosh) the efficiency gain above the target's efficiency, or to be more precise the signed distance to the efficiency interval of the equilibria. Then, we can describe the empirical performance of an institution by the composition of the target - that part that can be explained by the incentive structure - and the additional cooperation shift.

In this terminology the costless communication setups and mutual sanctioning regimes of [OGW] and [Mo] refer to "null target" institutions that do not alter the unfavourable equilibrium. Nevertheless we find remarkable cooperation shifts for repeated communication, for one-shot communication with a self-imposed blind sanctioning regime and for the justified sanction regime. The external inspection regimes introduced in this section show remarkably "enhanced targets" (see table 1). We now have to deal with the empirical question how external inspection regimes perform and how the performance varies with the sanctioning factor.

Table 1. Enhanced targets

sigma	0	0.5	1	1.5	2	2.5
lower bound	60.25	58.94	55.67	55.00	53.33	52.17
upper bound	62.50	61.04	58.80	57.40	55.00	53.69

Note that σ=0 stands for a regime with fixed sanctions meaning that the detected defector has to pay only the inspection costs and no compensation fee; for this weak sanctioning regime the upper bound of the target means an efficiency loss if compared with the equilibrium of the institution-free common (s=64, no inspection cost).

4. Experiments

Since the beginning of our experiments we are confronted with performances of external inspection regimes that are below the values usually expected. In a preliminary experiment (one trial only) there was no incentive to offend the agreement. Nevertheless offences never died out, even after a break for communication. Designing more carefully in a first experiment [O3] admitting a (second) equilibrium above the total tolerated η it was observed that the observed experimental result shows a negative cooperation shift. What was the reason for such a low performance?

Table 2. Experimental series

experiment	p	σ	trials	reports
no.1	0.25	1	9+1	[O3], [BO1]
no.2	0.125	0,1,2	3x3	[BO2], [OWB]
no.3	0.125	0,1,2	3x3	[BO2], [OWB]
no.4	0.125	0.5,1.5,2.5	5+5+7	[WO]

In three consecutive experiments we tested how people react to an increasing strength of the sanctioning regime (see table 2). Consistently we observed that the central tendency of observation (significantly) was within target for small sanctions, better than target for a medium sanction, and **worse than target for high sanctions** (see table 3). What are the causes for such a bad performance of the strong regimes? In the nect sections we refer to a pooled data set comprising experiment 2, 3, and 4 with one trial (σ=2) excluded[5].

Table 3. Pooled data set

sigma	0	0.5	1	1.5	2	2.5
decisions	960	800	960	800	800	1120
trials	6	5	6	5	5	7
total usage (s.d.)	60.8 (12.3)	59.4 (12.9)	53.5 (9.1)	61.7 (11.7)	59.3 (9.7)	55.3 (9.7)

[5] In this trial the subjects became aware that two other groups have two pass the same task. They restricted their usage in order to belong to the most successful group (cp. [BO2]).

5. Balancing two forces?

Two different forces seem to shape the behaviour, interacting and partially compensating each other. The first force - we can analyse game-theoretically - is the force of incentives. This force moves the amount of overuse downward when sanctions are increased. The other force is some kind of counter force not very well understood. Refering to the **reactance** hypothesis of [Br] we may conceptualise the second force as reactance, re-establishing the feeling of personal freedom by increasing the frequency of small overuses when the sanctioning factor is increased. For extremly high sanctioning factors resistance will increase the losses to such an extend that in the end people are forced to an increasing compliance. The most efficient sanctioning regime uses only modest sanctions (σ=1). This regime is the only one with a (slightly) positive cooperation shift and shows maximum compliance.

Table 4. Performance

sigma	0	0.5	1	1.5	2	2.5
efficiency	0.30	0.34	0.61	0.28	0.49	0.52
cosh	-0.06	-0.13	0.09	-0.31	-0.13	-0.13
compliance	0.55	0.52	0.61	0.55	0.51	0.59

It can be argued that in a sanctioning regime with external inspection the personal responsibility is undermined, so that no (larger) cooperation shift as in other social dilemma scenarios can be expected. The resistance against a regime with sanctions perceived as too high and unfair adds further losses. An indication for the lack of acceptance of the regime is also that individuals after defecting in one period in 49% of the cases do not reduce their usage in the next period too (in 20% of the cases a further increase is observed). Also according to this view the moderate regime is the only exception. It seems to be the most accepted one (cp. table 5).

Table 5. No decrease in usage after defection

sigma	0	0.5	1	1.5	2	2.5
rel.frequency	0.47	0.57	0.40	0.43	0.51	0.54

6. Regression models

For deciding on the individual usage x a "rational" actor should chose a best reply. For a partners' usage y above 62 the our introduced sanctioning regime has changed the best reply function, for large values of y compliance is best, whereas for lower values the optimal individual usage is lowered by an amount proportional to the sanctioning factor (see [BO2]). In a part of our experiments subjects have been asked to make predictions on total usage. In some cases the subjects gave no response. This is why the variables "predicted partners' total usage" Y and "predicted total usage" S=Y+x exhibit for s=0,1,2 a high proportion of missing values (see table 6, last row). It has been found that many decisions are far from best reply (see [OWB], and [O3] for experiment 1). Comparing the predition S with the realised values s (the mean of s-S is 3.84, s.d. 14.05), we detect that most subjects seem to assume that their partners are slightly more greedy as themselves. Taking into account that the prediction is used for deciding on the own action we can interpretate this finding also as that the population of subjects is more inclined to take less than the assumed usage of the average partner would be. And again there is one important exception: for the moderate sanctioning regime (s=1) the mean error is nearly zero.

Table 6. Predicted total S and error s-S

sigma	0	0.5	1	1.5	2	2.5
mean S (s.d.)	57.0 (11.7)	54.7 (11.4)	53.4 (10.9)	57.2 (10.8)	55.6 (12.9)	53.2 (8.7)
mean error	3.1	4.7	0.1	4.5	3.7	2.1
missing data	0.51	0.10	0.51	0.16	0.64	0.12

In [O3] and [BO2] a hierarchical model of the decision process based on the prediction is considered. In a first step the actor decides on compliance ($x \leq 5$) or even not to participate[6] ($x=0$). In case of a planned defection in a second step the decision is made on the extent of defection. For corresponing regression analyses we define the two binary variables D "defection" ($D=1$ in case of $x>5$) and N "no participation" ($N=1$ in case of $x=0$). In table 6 three regression results for our data set are reported (last three columns). The first model can be compared with the regression results reported in [O3] and [BO2]. Compared with the slope of the best reply (in the y-sensitive part: -0.5 in the base game and $-0.5-1.75\sigma$ for the sanctioning game) the regression parameter found for Y is rather small.

Table 7. Regression results[7]

	[O3]	[BO2]	model 1	model 2	model 3
const	6.29 (0.29)	6.47 (0.38)	7.40 (0.25)	2.88 (0.12)	6.05 (0.30)
Lx				0.37 (0.01)	0.21 (0.01)
LLx				0.24 (0.01)	0.14 (0.01)
σ					-0.26 (0.06)
Y	-0.18 (0.01)	-0.04 (0.01)	-0.05 (0.01)		-0.06 (0.01)
D	5.83 (0.21)	5.67 (0.17)	5.40 (0.11)		4.67 (0.11)
N	-4.25 (0.94)				

[6]No participation is a best reply for $Y \geq 72$

[7]All parameters with the only exception of the value for variable N are significant for $p<0.0001$.

r^2	0.56	0.46	0.45	0.27	0.54
s.e.(res)	3.34	3.18	3.16	3.79	2.92
# decisions	1380	1380	3597	4896	3238

An extreme alternative hypothesis on the decision process is that individual behaviour primarily evolves in an autonomous way. Model 2 considers the part explainable by an autonomous evolution. The explaining variables are the previous individual usage Lx and the usage before LLx. Model 3 combines both models and adds the design variable σ. In comparison to the slope of the best reply the regression parameters for Y and s are rather small. Nevertheless both parameters are negative as expected. Residuals and r^2 values indicate that for explaining the individual usage other determining factors should be introduced. Before we care for individual differences let us consider how subjects react to control events.

7. Reactions to control

In case of a known and constant probability for being inspected for a rational actor the is no difference between a decision after being detected and after being not detected. Nevertheless defections are remarkably more frequent after a previous detection event (61% instead of 44% after no detection). For the moderate sanctioning factor (σ=1) there is the only exception from this pattern (see table 8). Is it unrealistic to say that under the moderate sanctioning regime a defector more easily can accept the loss in case of detection?

Table 8. Conditional propensities to defect (5168 cases)

sigma	0	0.5	1	1.5	2	2.5

after detection	0.67	0.66	0.40	0.69	0.60	0.63
else	0.44	0.47	0.40	0.40	0.49	0.41

The increased relative frequency to defect after detection undermines the performance of the sanctioning regime. A possible rationale for repeating the defection after being detected is that the loss by being sanctioned has to be balanced by a new possible extra profit. That even in situations where the (expected) average gain by defection is negative actors often prefer to chose the risky defection may be motivated from the perceived unfairness of the sanction or simply by emotional reactions like anger. Starting with identical actors the process of resistance against losses from being sanctioned may initiate an evolution of different behavioural types[8]: One actor may evolve to a more persistent offender, the other may chose a high rate of compliance. If individual can "learn" such different behaviour by adapting to control event, then it is also possible that our subjects in the laboratory have "learnt" such different personal standards previous to our experiments. In case such differences would evolve in the experiment we would rather interpret the different types of subjects as "states" and not as "traits" (or personality factors) like in the other case often assumed.

8. Types of individuals

For defining types of individuals we do use only data revealed in the experiments as described before. We do not use personality tests or attitude measurements. The types discussed here only refer to usage and prediction variables. In principle a subject will be called "of type T" if the majority of his or her single decisions is "of type T". For this reason let us first discuss some types of individual decisions.

[8]In [OB] a variety of agent models are tested that charge aggression after being hurt, and restrain when crisis alerts; when reaching a certains aggression the decision to defect causes a discharge ("katharsis"). Simulation studies are used to derive the long-run consequences of such type of rules.

An individual decision can be called **aggressive** if $S < 8x$ (equivalent to $Y < 7x$); in [O3] such a decision is interpreted as plan to gain an advantage over the partners. The restraint behaviour $S > 8x$ can be seen as an invitation to cooperation. The latter behaviour is comparable with the measure-for-measure strategies introduced in [SMU] (cp. [Se], [GOW]). Refering to the variable Ly, the previous usage of the partners, a measured reaction is defined by $7x < Ly$. The measure-for-measure strategies use simple **measured reactions** to induce a reduction of usage until a set target is reached. By repeated reactions such a "teaching behaviour" or "invitation to cooperation" can lead a population to remarkable efficiency improvements if enough measured strategies and not too many destructive strategies are present in the population.

Table 9. Aggresive decisions and measured reactions

sigma	0	0.5	1	1.5	2	2.5
aggressive	0.41	0.45	0.32	0.35	0.40	0.32
measured	0.61	0.60	0.66	0.63	0.65	0.63

In case of defection about 84% of the decisions are aggressive. These defection cannot by justified by arguments like "I only do what others do". The proportion of aggressive decisions is only reduce for the moderate and for the extremly strong regime.

Let us now define the types of subjects refering to the expectation Y. The type "aggressive" is assigned to a subject if in at least 75% of the respective decisions (with Y information available) an aggressive decision was made. Correspondinigly a subject is called "restrained" if in at least 75% of the cases the decision was not aggressive.

Table 10. Types according to usage and prediction

sigma	0	0.5	1	1.5	2	2.5
restrained	10	11	14	17	5	28
aggressive	5	7	2	4	1	6
unclassified	9	20	8	16	9	20

In our data no clear pattern of interaction of types can be revealed. It also may be that the large number of missing data for Y reduces the validity of the type distributions found. One way to deal with this problem is to redefine types by using a proxy variable that is available for all or nearly all decisions. Let us now simply define a restrained decision by $x<7$ and a greedy decision by $x>10$. Setting the majority of cases to 14 or more of the 20 decision we calculate the following new table of types (table 11):

Table 11. types according to decisions

sigma	0	0.5	1	1.5	2	2.5
restrained	28	24	36	23	26	38
greedy	6	4	2	2	4	6
unclassified	14	12	10	15	10	12

As before the maximum proportion of restrained types is attained for the moderate regime, as well as the second highest proportion for the extremely strong regime. Greedy types do not vanish with the strong regime. Instead the intermediate unclassified types are reduced either by acceptance (σ=1) or by force (σ=2.5). In these both cases we observe only 21% of subjects showing the intermediate behaviour.

Conclusion

Sanctioning regimes are often proposed to protect endangered common pool resources. Despite the fact that the introduction of external inspection and sanctions can alter the unfavourable incentive structure in a way that may lead „rational" (i.e. optimising purely self-interested) actors to prosperity the observation in experiments shows that people sometimes resist the set incentives. Our result questions the efficiency of monetary sanctions for the objective to ensure sustainability. Sustainability can also be endangered by fines which surpass a certain limit of acceptance. The sanctions introduced may weaken the feeling to be responsible and may disrupt in-group solidarity especially in the case the sanctioning is perceived as inadequate, unfair or unacceptable. Probably the acceptance of the rules introduced is one reason for successful self-responsible government of commons over centuries which is described by Ostrom [Os]. In any case, the hope that drastic fines may lead to non-defective behaviour is an illusion. It seems more that drastic fines lead to ingenious solutions how to defect without fearing to be detected. There are warnings that state:

„The use of incentives aggravates the problem: We become dependent on immediate rewards ... and are prevented from developing the farsighted viewpoint which is necessary to produce voluntary constraint." ([SK] p.12)

Limiting policies that rely only on the force of incentives may lead to resistance and ineffient management. We think that without effective communication of targets and evolution of adequate values that people wish to live by the prosperity of a common is not likely to be attained.

References

[BO1] Beckenkamp, M. & Ostmann, A. (1996). A member's view of a common: Cognitive and socio-cognitive factors. In Christine Roland-Lévy (Ed.): Social and Economic Representations (pp. 1203- 1220). Paris: IAREP 1996; Université René Descartes.

[BO2] Beckenkamp, M. & Ostmann, A. (1999). Missing the target? Sanctioning as an ambiguous structural solution. In Smithson et al. (Eds.): Resolving Social Dilemmas. Philadelphia: Taylor & Francis.

[B] Brehm, J. W. (1995). Reactance. In A. S. R. Manstead, & M. Hewstone (Eds.), Blackwell Encyclopedia of Social Psychology (pp. 466-468). London: Blackwell.

[GMW] Gardner, R., Moore, M. R. & Walker, J. M. (1994). Racing for the Water: Laboratory Evidence on Subgame Perfection (Research Report). Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington.

[GOW] Gardner, R., Ostrom, E., & Walker, J. (1994). Social capital and cooperation: Communication, bounded rationality, and behavioral heuristics. In [SAM] (pp. 375-411).

[H] Hardin, G. (1968). The Tragedy of the Commons. The Population Problem has no Technical Solution; It Requires a Fundamental Extension in Morality. Science 162, 1243-1248.

[HBB] Harvey, M. L., Bell, P. A,. & Birjulin, A. A. (1993). Punishment and type of feedback in a simulated commons dilemma. Psychological Reports, 73, 447-450.

[LM] Liebrand, W. B. & Messick, D. M. (Eds.). (1996). Frontiers in Social Dilemmas Research (1st). Berlin: Springer.

[LMW] Liebrand, W., Messick, D. & Wilke, H. (Hrsg.). 1992. Social Dilemmas. Theoretical Issues and Research Findings. Oxford: Pergamon

[LLM] Liebrand, W. B., van Lange, P. & Messick, D. M. (1995). Social Dilemmas. In A. S. R. Manstead, & M. Hewstone (Eds.), The Blackwell Encyclopedia of Social Psychology (1st, pp. 546-551). Oxford: Blackwell.

[Me] Meinhardt, H. (1999): Common Pool Games are Convex Games. Journal of Public Economic Theory 1, 247-270

[MO] Meinhardt, H. & Ostmann, A. (1999): Resolving commons' dilemmas by cooperative games. Working Paper in Game Theory and Experimental Economics 10. ISMW. University of Karlsruhe.

[Mo] Moir, R. (1996). The Effects of Costly Monitoring and Sanctioning upon Common-pool Resource Appropriation. Ph.D. Thesis. McMaster University, Hamilton, Ontario.

[MV] Muller R. A. & Vickers, M. (1996): Communication in a Common Pool Resource Environment with Probabilistic Destruction. McMaster University, Dept. of Economics, Working Paper 96-06

[O1] Ostmann, A. (1994). An Experimental Fishing Coop. Diskussionspapier, FR Psychologie, Universität des Saarlandes. Saarbrücken

[O2] Ostmann, A. (1996). When to Defect in Commons. In P. Kleinschmidt et al. (Eds.): Operations Research Proceedings 1995 (pp. 505-510). Berlin: Springer.

[O3] Ostmann, A. (1998). External control may destroy commons. Rationality and Society, 10, 135-154.

[O4] Ostmann, A. (1999). Grenzen ökonomischer Anreize für Umweltgemeingüter. Gaia 7, 286-295.

[OB] Ostmann, A. & Beckenkamp, M. (1997). Agentenmodelle zum Umgang mit vollständig erneuerbaren Gemeingütern. In C. G. Jung, K. Fischer & S. Schacht (Eds.): Distributed Cognitive Systems - Proceedings of the VKS'97 Workshop (p. 19-31). Saarbrücken: DFKI (German Research Institute for Artifical Intelligence).

[OPFH] Ostmann, A., Pommerehne, W. W., Feld, L., & Hart, A. (1997). Umweltgemeingüter? Zeitschrift für Wirtschafts- und Sozialwissenschaften 117, 107-144.

[OWB] Ostmann, A., Wojtyniak, B., & Beckenkamp, M. (1997). Control and sanctions may destroy commons. Experimental Results and some microanalytic explications. ISMW Working Paper 7. University of Karlsruhe.

[Os] Ostrom, E. (1990). Governing the Commons (The Evolution of Institutions for Collective Action). Cambridge: Cambridge University Press.

[OGW] Ostrom, E., Gardner, R. & Walker, J. (1994). Rules, Games and Common Pool Resources. Ann Arbor, Mich.: University of Michigan Press.

[OW1] Ostrom, E. & Walker, J.M. (1989): Communication in a Commons: Cooperation Without External Enforcement. Bloomington: Workshop in Political Theory and Political Analysis

[OW2] Ostrom, E. & Walker, J. (1997). Neither Markets nor States: Linking Transformation Processes in Collective Action Arenas. In D. Mueller (ed.), Perspectives on Public Choice: A Handbook. S. 35-72. Cambridge: Cambridge University Press.

[OWG] Ostrom, E., Walker, J. & Gardner, R. (1992). Covenants with and without a Sword: Self-governance is Possible. American Political Science Review 86, 404-17.

[P] Platt, J. (1973). Social Traps. American Psychologist 28, 641-51

[RBSW] Rapoport, Am., Budescu, D.V., Suleiman, R., & Weg, E. (1992). Social dilemmas with uniformly distributed resources. In Liebrand, W., Messick, D.M. & Wilke, H. (Eds.): Social Dilemmas. Theoretical Issues and Research Findings (pp. 43-57). Oxford: Pergamon

[Sch] Schroeder, D. A. (Ed.). (1995). Social Dilemmas (Perspectives on Individuals and Groups). Westport, CT: Praeger Publ.

[SAM] Schulz, U., Albers, W. & Müller, U. (Hrsg., 1994). Social Dilemmas and Cooperation. Berlin: Springer.

[Se] Selten, R. (1997). Descriptive Approaches to Cooperation. In S. Hart & A. Mas-Colell (ed.): Cooperation: Game-Theoretic Approaches, NATO ASI Series, Series F: Computer and Systems Sciences, Vol. 155 (pp. 289-326). Springer.

[SMU] Selten, R., Mitzkewitz, M., & Uhlich, G.R. (1997). Duopoly Strategies Programmed by Experienced Players . Econometrica 65, 517-555.

[SK] Stern, P.C. & Kirkpatrick, E. (1977). Energy Behavior. Environment 19, 10-15.

[SBR] Suleiman, R., Budescu, D., & Rapoport, Am. (1994). The role of a player's serial position in a resource dilemma game. In [SAM] (pp. 55-73).

[SR] Suleiman, R. & Rapoport, A. (1989). Environmental and social uncertainty in single-trial resource dilemmas. Acta Psychologica, 68, 99-112.

[WG] Walker, J. & Gardner, R. (1992). Probabilistic Destruction of Common Pool Resources: Experimental Evidence. Economic Journal 102, 1149-1161.

[WMR] Wilke, H.A., Messick, D.M., Rutte, C.C. (Hrsg., 1986). Experimental Social Dilemmas. Frankfurt: Lang.

[WO] Wojtyniak, B. & Ostmann, A. (1999). Limits to accept - accepting the limits. Experimental tests of reduction policies for collective goods. Submitted to: Environment & Behavior.