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COLLECTIVE ACTION IN COMMONS:
ITS DIVERSE ENDS AND CONSEQUENCES

Hannu Autto

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Abstract in English:

Collective Action in Commons: Its Diverse Ends and Consequences explores new ways in which collective action theories can contribute to our understanding of natural resource management, especially the management of common-pools. Combining classical collective action theories and lessons from earlier empirical works, the study shows that cooperation among resource users is not only a possible solution to "the tragedy of the commons", but it can be a part of the problem as well. That is, successful cooperation may increase the likelihood of resource depletion, for example, through more effective resource utilization or collusion against sanctioning and monitoring systems. The study also explores how analytic narratives can be used to tell the story behind problems of resource use and their solutions, including the diverse roles of cooperation.

Key words: commons, resource management, collective action

Suomenkielinen tiivistelmä:

Väitöskirjassa *Collective Action in Commons: Its Diverse Ends and Consequences* esitetään uusia tapoja soveltaa kollektiivisen toiminnan teoriaa luonnonvarojen, erityisesti yhteisvarantojen, hallintoa käsittelevässä tutkimuksessa. Yhdistämällä klassisia kollektiivisen toiminnan malleja ja aiempien empiiristen tutkimusten löydöksiä tutkimuksessa osoitetaan, että varannonkäyttäjien yhteistyö ei ole ainoastaan ratkaisu "yhteisvarantojen tragediaan", vaan se voi myös olla osa yhteisvaranto-ongelmaa. Onnistunut yhteistyö voi nostaa varannon ylikäytön todennäköisyyttä esimerkiksi, koska se mahdollistaa varannon tehokkaamman käytön tai varannonkäyttöä säätelevien valvonta- ja rankaisujärjestelmien kiertämisen. Tämä tutkimus myös osoittaa miten analyyttisia narratiiveja voidaan soveltaa ylikäyttöongelmien syiden ja ratkaisujen jäljittämiseksi, yhteistyön erinäiset roolit mukaan lukien.

Asiasanat: yhteisvaranto, luonnonvarojen hallinta, kollektiivinen toiminta

CONTENTS

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My fascination with social sciences started with a computer game. Therefore, it seems appropriate to dedicate this work to Sid Meier and to *Civilization* developer teams through the years. It just so happens that the latest version of the game is being released today. In its release, a new game of the series has always been full of bugs and balance issues. But each of them has also contained promising ideas, which have made it worthwhile to wait for patches and fixes. I hope that the same applies to this work: may the thesis serve as a platform for future projects.

Turku, 24th of October 2014

Hannu Autto

1. INTRODUCTION

An old proverb says: “Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime.” However, this wisdom will soon be obsolete and the reason is simple: we are running out of fish.

We are running out of other things, too. The oil has peaked, wars are being waged over fresh water and unpolluted air is becoming a luxury. There is a gyre of plastic debris in the North Pacific Ocean, the exact size of which is unknown, but it seems that the most convenient point of comparison is not a football field but rather a large country. Technological solutions to resource use problems either buy us time or too often, keep us waiting.

But despair not! The social sciences are fighting back!

For this fight, an interesting brigade has emerged from amongst social scientists. Students of commons and collective action aim to show instances where people are able to manage their shared resources sustainably by working together for their common goal. There is often a fine line between success and failure, and it is of great practical importance to know where the line goes. Once we know where the line goes, we are able to implement the right kinds of policies to foster the necessary cooperation among resource users, that is, to ensure the system is on the right side of the line. Thus far, results have been promising: studies have identified several factors that play crucial roles for collective action and for the emergence of regulative institutions that are able to change destructive behaviours into sustainable ones. But more work remains to be done.

In this dissertation I ask: which are the roles of collective action in common-pool resource problems? Consequently, do we have more to learn from classical collective action theories than previously thought? Unfortunately, the role of cooperation in commons is often treated too simplistically. I show that we should be using a plural instead of a singular form: cooperation plays multiple roles in the drama of the commons, some of which are not those of a hero. Consequently, collective action theories have new lessons to teach students interested in common-pool resource problems. This requires that we place common-pool resources into their places as parts of larger, evolving production systems with multiple goods. Once these lessons are learned, we will have taken a step forward in identifying the distinction between success and failure and in finding solutions to a variety of common-pool problems.

In the following introduction, I will briefly go through the history and key concepts of contemporary common-pool resource studies, as well as the main motivations behind them. Below, I introduce the main results of the existing literature and its shortcomings. Finally, I discuss the ways in which this work serves to tackle some of these shortcomings, and how it contributes to our understanding of the problem.

1.1 Motivation behind common-pool resource studies: a short historical take

The last two centuries, the 19^{th} and the 20^{th}, witnessed an unparalleled intrusion of human intentionality into the rest of nature. Population growth, together with rapid technological development, contributed both to increasing demands on natural resources and an increasing ability to utilize them. And utilized they were: grazed, pumped, logged, fished, farmed, mined, killed and drilled to an extent that would have amazed earlier generations. A major contributor to population growth and technological development was the spread of modern scientific methods. The accumulation of knowledge and a better understanding of causal laws governing reality greatly contributed to our ability to control reality.

New discoveries – or, to use modern business jargon, innovations – created considerable profits for those pioneering their use, and later efficiency gains for the masses. Despite the increase in population numbers, today we live on average considerably longer and happier[1] than before. For a long time, the world seemed to be on a Benthamian utilitarian track. It seemed that we were able to give "the greatest good for the greatest number", as Jeremy Bentham (1748-1832) intended we do. This is not to say that innovations were without losers: comparable innovations were not achieved in the field of social justice. When old modes of production became obsolete, those unable to adapt to new ones lost their livelihoods. Neither did having a livelihood necessarily imply the ability to escape absolute poverty; in fact, it still does not. For many who lacked basic political rights and the ability to bargain for a larger share, these innovations represented little more than exploitation in new forms.

During the previous decades, even more profound questions have emerged. In a report to the Club of Rome, Meadows et al. (1972) suggested three possible scenarios for the future, using dynamic system modeling techniques developed by Jay Forrester. Two of these scenarios suggested that during the 21st century, food and industrial output per capita, as well as population numbers, would collapse. The third scenario, by contrast, suggested that growth in food and industrial output, and population growth would stop but not collapse.

The report was called *Limits to Growth*, and 12 million copies were distributed in 37 languages. 'Limits' in the title refers, broadly put, to material- or resource limitations. It was argued that human activities might meet these limits either via direct consumption or via the indirect effects of our activities upon them. Garrett Hardin, four years earlier, essentially reached the same conclusion in his brilliant "Tragedy of the Commons (1968)". He gave two reasons why the utilitarian track of Bentham would not continue forever: (1) it is mathematically not possible to maximize for many variables at the same time, and (2) a finite world cannot produce the energy for an infinite number of people or, at least (if an infinite source of energy were discovered), does not allow an infinite dissipation of energy. Ever increasing numbers would eventually lead to a greater misery.

This was, of course, a well-known worry since at least the time of David Hume (1711-1766), Thomas Malthus (1766-1834) and William Forster Lloyd (1795-1852).[2] Hardin concluded

[1] At least from purely materialistic point of view.

[2] Hume's essay "On the Populousness of Ancient Nations (1742)" explains population in terms of economic conditions and social institutions. Although Malthus criticizes some of Hume's views in "An Essay on the Principle of Population (1798)", he states that the principles of his own argument are already present in Hume's writings. Malthus wrote his essay largely to criticize his contemporaries who held very optimistic views on the improvement of human condition (e.g. William Godwin and Marquis de Condorcet). According to Malthus (1998[1798]): "Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. […] This implies a strong and constantly operating check on population from the difficulty of subsistence. This difficulty must fall somewhere and must necessarily be severely felt by a large portion of mankind." Lloyd's "Two Lectures on the Checks to Population (1833)" continued Malthus's population theory by considering in a detailed manner checks to population that were independent on the scarcity of food, and using the externality presentation of the problem. The latter is the core of Hardin's "Tragedy of the Commons (1968)" and many contemporary presentations of the problem.

that in order to prevent this scenario we must not allow for the freedom to breed. He criticized a passage in the declaration of human rights by the United Nations for explicitly leaving family planning in the hands of individual families. Indeed, if we do not limit the growth ourselves, nature (our limited world) will do it for us and decrease our quality of life in the process. Two pessimistic scenarios in *Limits to Growth* complemented this argument by suggesting that the process need not be linear, that is, we may not experience a steady decline of quality and quantity of our lives, but a Malthusian catastrophe during a period of just a few decades. This questioned what could be called the layman's wisdom: because everything is going fine today, everything is going to be fine tomorrow. But perhaps even more importantly from the perspective of political impact, *Limits to Growth* placed the catastrophe within a foreseeable future and emphasized the urgent need for preventive measures. Soon after the Green movement began. Non-governmental organizations (NGOs) such as Greenpeace and ideologically green political parties were established. They defied the conventional left–right dimension in politics. Their case no longer concerned distributive conflicts (e.g. between 'winners' and 'losers', or 'capitalists' and 'working class', etc.) but a Pareto improvement, that is, an improvement without losers. Surely, they maintained, the prevention of environmental catastrophe was in the interest of everyone (bypassing intergenerational questions).

If it is the case that the scientific method contributed to population growth and was therefore part of the problem, it must also be credited for the discovery of the problem. But does it offer a solution? Hardin (1968) is very sceptical, at least if we follow a rather narrow definition of science that includes only natural sciences. Hardin claims that there is no technological solution to the problem. Instead, solutions must be sought in our values and morality. We must accept that some actions should be regulated for the benefit of everyone. We may not like it but we may learn to recognize its necessity. In the last section of his article, Hardin suggests that this recognition has spread from one sub-system to another as we have abandoned the freedom in commons one-by-one:

> *Perhaps the simplest summary of this analysis of man's population problems is this: the commons, if justifiable at all, is justifiable only under conditions of low-population density. As the human population has increased, the commons has had to be abandoned in one aspect after another.*
>
> *First we abandoned the commons in food gathering, enclosing farm land and restricting pastures and hunting and fishing areas. These restrictions are still not complete throughout the world.* (Hardin 1968).

Three things are worth emphasizing in connection to the passage above: (1) The background of Hardin's points also explains the increasing demand for resource management studies. (2) This passage probably provides the background for the modern discussion of common-pool resource management – to which this dissertation contributes as well. (3) The passage raises interesting questions concerning the role of social sciences in solving "the commons problem". Next I will explain these points.

Point 1: Increasing demand for resource management studies

The first point is rather obvious by now. As we have become more numerous and better able to utilize resources (not just because of new technology, but also because of institutional arrangements such as markets that fostered demand), many resources have become depleted or over-utilized. In addition to local problems, the awareness of some truly global-scale problems, such as the ozone depletion and global warming or even the Malthusian catastrophe itself, has greatly contributed to the demand for studies on resource management. There is an obvious need to understand these problems better in order to propose viable solutions to them.

Point 2: Background for modern common-pool resource studies

Hardin (1968) clearly sees and states the commons problem. But many grew to believe that the passage quoted above is not the whole truth, that is, it is not the case that “the commons, if justifiable at all, is justifiable only under conditions of low-population density” or that “the commons has had to be abandoned in one aspect after another” or that this process is not yet “complete throughout the world” implying that it will inevitably be completed and also implying (taking into account the context of the quote) that this process is desirable. The implied desirability makes a normative- rather than empirical point. It seems that Hardin (1968) is suggesting that not only in family planning but also in all other cases “commons” should be abandoned for the benefit of everyone.

The point is clear, broad, and controversial enough to have stimulated a big and important discussion. Hardin has been challenged in his more precise point about population growth and his more general point about “all commons”. Population growth, many have argued convincingly, comes to near stagnation when the standard of living increases and parents no longer need children for labour and for security in old age. Or near stagnation follows when the emancipation and empowerment of women continues: women now participate in working life, have less time to tend to and raise children and also have more intriguing alternative options. Therefore, we do not need to take away individual freedom in family planning. People are going to choose socially better outcomes on their own. Be that as it may, it is Hardin’s more general point about the inevitable abandonment of “the commons” that provides the background for the contemporary discussion about the management of common-pool resources.

Hardin’s argument invoked two important and interlinked lines of critique: a conceptual and empirical one. The term “commons” and, therefore, the empirical scope of the argument seemed to be imprecise. The scholarly work that followed made a distinction between the physical properties of the good and the (social) property management system. The term “common-pool resource” is now used to refer to a type of good in which it is hard to exclude users and in which the principle of scarcity applies, that is, one user’s consumption reduces others’ possibilities to consume the resource (see Figure 1).

		Subtractability	
		Low	High
Exclusion	Difficult	Public Goods	Common-pool Resources
	Easy	Toll Goods	Private Goods

FIGURE 1: A Classification of Goods.

Because the principle of scarcity applies (one person's use of a good reduces others' possibilities to enjoy that good), users' actions affect the welfare of each other. This locks the users into a system of (negative) externalities. This is problematic especially because it is difficult to exclude users. But Hardin's point was not that all common-pool resources are going to be overutilized or "abandoned", whatever the latter might mean. Rather, his point concerned the property regime that was used to manage the resource. By "commons" he referred to a state of no regime, which has also been called a state of open access. If his argument were given this empirical scope, few would disagree with him. But the main problem concerns what alternatives there are to open access; open access has been frequently equated with "common property", usually implying merely that there were many owners or users of the resource. Broadly put, the alternatives to open access were considered to be either private or state ownership.

Feeny et al. (1998, 79; see also Ostrom et al. 1999) define open access as the absence of well-defined property rights. Under private property, they argue, exclusion rights belong to an individual or an individual-like entity (e.g. a firm) and these rights are usually enforced by the state. Under state property, exclusion rights are vested in the government and it is the government that makes managerial decisions about the access to and the management of the resource. But Feeny et al. (1998) also define communal property, under which "the resource is held by an identifiable community of interdependent users (1998, 79)".[3] It was a common mistake to associate communal or common property with open access, because only the latter means that the resource is unmanaged. In his later work Hardin (1998) states that the biggest mistake in Hardin (1968) was the omission of an adjective "unmanaged", but he still does not address communal property arrangements (instead he maintains that "managed" commons describe either the socialism or the privatism and that they can both fail to manage the resource sustainably). If we grant that communal property can lead to managed commons, there is not much disagreement left concerning the scope of his argument. It is open access that leads to undesirable outcomes, not the absence of state or private property.

The second line of critique against Hardin was that unlike he implies, common-pool resources can be managed sustainably also by communal property arrangements. It was then a critique against conventional policy recommendations, which were partly justified by conclusions like Hardin's. This line of critique was empirical: an accumulating number of case studies did show that local resource user groups were able to manage their resources sustainably over long periods of time. This meant that the absence of private or state property did not necessarily mean undesirable outcomes. But it did not mean that the users were always successful in managing the resource either. Like private and state property arrangements, communal property too could lead to success or failure. Elinor Ostrom has summarized this wisdom by stating that there are no blueprint solutions that work in every imaginable instance (Ostrom 1990; Ostrom et al. 1999). Indeed, "the devil is in the details" as Hardin (1998) himself, noted.[4]

[3]More precise conceptualization is given by Schlager and Ostrom (1992). They make distinctions concerning the type of rights, which include access and withdrawal rights, management rights, exclusion rights, and alienation rights. A full owner holds all these rights, a proprietor lacks only the right to alienate, a claimant has access- and withdrawal rights as well as management rights, and an authorized user only has access and withdrawal rights. Usually state or private property means that the government or an individual is the full owner. But after the introduction of more precise terminology, it is easy to see that property arrangements can be more complex than the usual socialist/private dichotomy seems to suggest.

[4]I do not offer here a detailed history of common-pool resource studies. Such an effort would be superfluous as rather recent overviews are already available (especially Dietz et al. 2002; a bit older but still relevant read is

One explanation for the omission of communal property arrangements by Hardin may be his primary focus, which has consistently been on overpopulation. If anything, overpopulation is a problem of global scale. In the 1960' it would have been difficult to find a user-based solution to global problems not relying on nation states. Indeed, finding such a solution even today seems difficult, even with the advances in transnational communication. Ostrom et al. (1999) mention several challenges that global problems bring, including problems in enforcement, organization, cultural diversity and information. But again, this is not to say that users should be treated as passive recipients of policy experiments, who must be saved from their own actions. Users and their organizations play a crucial role e.g. in gathering information about the state of the resource, in finding possible working solutions to problems, and in policy enforcement.

From the point of view of political science, it is also useful to continue to question the trichotomy of property (private, state, communal). A liberal ideal of democratic governance includes “government for the people, by the people”. The state can be seen to offer a political arena in which resource users can use their political influence (if they have any) to solve their collective action problems. In addition, the collective action problems faced by resource users and the possible solutions offered by political entrepreneurs may lead to mutually beneficial deals (Frohlich et al. 1971).

Point 3: The role of social sciences in solving the problem

Given that the reader and I now have more or less the same understanding of the problem, that is, the problem is open access and common property does not necessarily constitute *de facto* open access, I want to raise a final point concerning the previously quoted passage by Hardin. According to him, commons (open access in our understanding) is not *justifiable*, save perhaps under low population density. This is an interesting point given its context: Hardin maintains that solutions to the problem must be sought drawing on our morality because no technological solution exists. The normative power of the statement stems from the Pareto-inferior outcome to which *laissez-faire* policies lead us, as Hardin claims (again, intergenerational questions set aside). If an outcome is Pareto-inferior it means that there are Pareto-improvements to be made, i.e. at least someone is better off and nobody is worse off than before. So *laissez-faire* policies that produce bad outcomes for everyone are morally questionable, at least if we think that moral judgements should have something to do with the outcomes. Something ought to be done, or more precisely in this case, freedom to breed should be abandoned.

In the beginning of this introduction I pointed out how the scientific method is partly responsible for the population problem, and as a consequence, also indirectly responsible for many more localized overuse problems. I also pointed out how it helped in discovering the problem.[5] However, Hardin (1968) sheds doubt over the capacity of the scientific method to solve the problem, and scenarios presented in *Limits to Growth* (of which the only sustainable one utilizes both technological and moral/political solutions) give further reasons to consider

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Ostrom 1990; see also Laerhoven and Ostrom 2007 and literature cited there). My interpretation of the history of CPR studies in this introduction does not differ much from that of Dietz et al. (2002).

[5]This should be true at least at the global level, beyond the observation capacity of any single community. Users of more localized resources often had some understanding, often a sufficient one, of the externality problem since “time immemorial” – as proved by local institutions that were crafted to tackle the overuse problem (see Ostrom 1990).

its role. In this short take I will concentrate on the role of social sciences, although in research problems like these, distinctions between the sciences do not come easily as the problem is multidisciplinary almost by definition.

Usually the social sciences are interested in the behaviour of individuals and of their aggregates. If the social sciences could present accurate enough descriptions and models of individual behaviour given some initial conditions, this knowledge could inform policy makers how to manipulate the set of conditions under their power in order to create desired outcomes (benevolent ones, if the policy maker is benevolent). This ideal, resembling the manipulative theory of causality by Georg Henrik von Wright (1972), does not differ much from the ideal of many natural sciences, especially if they are concerned with practical applications.[6] When Hardin emphasizes the need for a *moral solution*, he is acknowledging that interfering with the freedom to breed is against the moral values of many. His normative argument, indeed his insistence that freedom to breed is not *justifiable* because it leads to bad outcomes, tries to change these moral intuitions. This would include family planning to a set of conditions that can be manipulated via political processes. Even though sciences say nothing about the content of normative principles that guide our judgment on which issues can be manipulated via political processes and which must be treated as "givens", sciences can help in judging whether the conditions described by these normative principles apply or not. This is the "when"-question: when is it appropriate to meddle at all? The next question is a "how"-question: how to meddle in order to achieve the desired results?

Because practical solutions to resource use problems would be warmly welcomed, social scientific work has often made policy recommendations and analysed the consequences of potential or already implemented policies. The modern understanding of the lack of blueprint solutions also implies that there is a need to understand causal mechanisms at work under different conditions, and then to find out which conditions apply in empirical cases. The following chapters further discuss and tackle some aspects of the problem of complex causality in this field of study. The complexity, of course, blends "when"- and "how"-questions: one must ask *how* to meddle, and if to meddle at all, *when* conditions are as they are.[7] [8]

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[6]I do not suggest that this ideal is anywhere close of being the hegemonic view in social sciences. Some classics in the political science, e.g. *the Prince* by Niccoló Machiavelli, follow this tradition, and so does a big part of classical economics. There are, of course, considerable differences between natural and social sciences, most notably because in social sciences the research subject is capable of reflexive thinking and, therefore, her behaviour is not invariant as more research is conducted. In my opinion this does not threaten the ideal: nothing in human nature, reflexivity included, seems to imply that her behaviour is unpredictable in principle (I certainly hope my behaviour is predictable – at least by me, if not so much by my opponent in badminton – and I consider myself capable of reflexive thinking.). However, it does suggest a great caution in applying theoretical wisdom, expressed e.g. by optimal policies with the help of theoretical models, to a real-world use. But yet again, also engineers usually run a pretty heavy set of tests to new appliances before they are introduced to markets. Unfortunately, the difference between experiments and the reality is quite substantial in social sciences and attempts to close the gap often meet serious ethical limitations.

[7]Not all individual studies need to address the overall question. Usually they address some parts of it, e.g. by describing conditions or outcomes in a single case, or making theoretical arguments that link certain conditions to certain outcomes. However, most of the studies aim to somehow contribute to the overall question. This also applies to the rest of this dissertation.

[8]In this chapter (1.1.) I have described what I consider to be the most important motivation behind the (social) scientific literature on CPRs. There are other motivations to study CPRs as well. For example, there may be interesting cases among CPRs from the point of view of theories whose goals are completely removed from policy formulations.

Key concepts:

- **common-pool resource:** a scarce good with a difficult exclusion of users.
- **property regime:** a set of implicit or explicit rules that assign rights to a set of actors to access, manage, exclude and/or alienate the resource.
- **open access:** the state of no property regime.
- **communal property:** a property regime that assigns important rights to manage, exclude and/or alienate the resource to an identifiable group of resource users.
- **private property:** a property regime that assigns important rights to an individual or a firm to manage, exclude and/or alienate the.
- **state property:** a property regime that assigns important rights to the state to manage, exclude and/or alienate the resource.

TABLE 1

1.2 Collective action theory, shortcomings of the literature and contributions of this dissertation

Meddling with the intention to change the outcome requires some idea of causality. Unfortunately – and unlike their consequences – causal mechanisms are not observable as such. Theories are needed to describe them and guide empirical work. Collective action theory is one theory possibly applicable to common-pool resources. In short, collective action theory is interested in strategic situations where some outcomes are worse than others for all individuals. The question is then; will the decisions of individuals lead to socially good or bad outcomes? The theory can help in answering questions concerning “meddling”, if it successfully points out conditions that lead to socially good outcomes (and it is possible, at least in principle, to manipulate these conditions). Classical instances of the theory are built on the axioms of rational choice theory and, in particular, on the branch of rational choice theory interested in strategic environments, namely game theory. In this chapter I will show why collective action theory can be applied to CPR problems and what the theory entails.

The applicability of collective action theory to CPR problems

I argue here that common-pool resource problems fall under the sphere of applicability of collective action theory. Luis Fernando Medina (2007, 23) gives a useful definition of models of collective action:

> *Whatever else we want it to represent, a model of collective action should capture the essence of situations that*
> *(a) involve more than one, preferably many, agents who*
> *(b) have to decide whether to take a costly action that, in turn,*
> *(c) increases the likelihood of a goal that is*
> *(d) desirable by all the agents.*
> *Remove any of these, and the situation at hand stops being a collective action problem.*

Conditions (a)-(d) are meant to describe the domain of applicability of collective action theory, i.e. its necessary conditions. Yet there is more buried in these words than meets the eye. Below, I will first discuss whether CPR-problems fall in the domain defined by conditions (a)-(d) and then discuss an alternative point of view from which to consider the relevance of collective action theory for CPR problems.

Conditions (a) and (b) apply well to most common-pool resource cases. There are (a) almost always more than two individuals involved, and (b) because they value the resource in question, refraining from its use or reducing one's own share of the yield typically results in private costs.[9]

The applicability of condition (c) is rather uncontroversial, if the reader is benevolent: less intensive resource use, though costly, normally contributes to more sustainable yields. A possible bone to pick here is that actions of a single actor may be futile. When a single actor refrains from resource use, this may have only a negligible effect on the status of the resource. A user's refrainment may either have insignificant effects or the effects of their refrainment may be undermined by action taken by others as a consequence. For example, the system might be so large as to make the effects of the user's refrainment hardly noticeable; or newcomers to the system might exploit her refrainment. Luckily, collective action theory is able to account for these cases (readers familiar with collective action theory may already have, for example, non-monotonic success functions in their mind). Perhaps condition (c) could be worded in a broader manner in order to account for these cases. Thus, condition (c) could read "…a costly action that, in turn and given some behaviour of others, increases the likelihood of a goal…"

In condition (d), information has a crucial role. The applicability of condition (d) is far less apparent than the previous three conditions. Here it is sufficient to note that the desirability of an outcome implies not only an interest in the outcome, but also an awareness of this interest. Individuals may not be aware of some of the negative consequences of their actions (e.g. how fishing or hunting affects stocks) or they may not care about these consequences (e.g. a user may feel that it is not in their interest to maintain a steady stock because they discounts future heavily or plans to leave the business soon in any case). Again, these are problems that can be covered using some modified versions of collective action theory (e.g. with games of imperfect information and Bayesian learning). Although far from perfect, additional CPR-problems could be brought under this definition if condition (d) was rephrased as "…that would be desirable by all the agents had they perfect information of the situation."

All in all, collective action theories are applicable to common-pool problems. These theories aim to explain and predict success and failure in collective action problems, an aim particularly interesting from the point of view of resource management studies. Collective action theory promises to answer precisely the kinds of questions discussed above. *When* is meddling needed, if collective action problems are to be solved, and *how* can one meddle so that conditions become favourable for collective action?

Shortcomings in the literature and contributions of this dissertation

Despite what has been said, the applicability of collective action theory in commons should not be restricted to the overuse problem. Rather, it is necessary to widen the perspective to

[9]I use moderating terms (almost, usually), because it is possible to construct plausible (but from the empirical point of view rather uninteresting) examples of cases where these conditions do not hold. E.g. when the common-pool resource is overused its yield may stabilize to the same level individuals would receive from their private alternatives. Refraining from the use of CPR in favour of a private alternative would then not come with a private cost [condition (b)].

other parts of the production system and to the interaction between various kinds of collective action undertaken by the individuals in question. For example, collective action may be a necessary condition for an overuse problem to exist in the first place. In other words, institutionalized solutions to collective action problems faced by the group in the past may affect their ability to tackle the overuse problem. A practical example, considered later in this dissertation, is offered by Sami reindeer herders: their institutional solutions to collective problems of capital security also affect their capability to solve the problem of overgrazing.

More broadly, common-pools are always parts of larger production systems that include not only the common-pool but also other material and institutional elements. In fishing, for example, a stock of fish alone is of no value without fishing gear; it is only of limited value without access to markets. Such elements give rise to further collective action problems (as conditions a-d also apply for them): some production factors are collective goods and their provision requires cooperation and institutions for cooperation; some institutional arrangements create new possibilities and problems for collective action. One of the major shortcomings of the existing literature is the inability to draw links between the sustainable use of the common-pool and other kinds of collective action that surround the common-pool. In this dissertation, I take the following steps to fill the gap:

- I show that solving a supply-side collective action problem is often a necessary condition for a common-pool problem to exist. Furthermore, institutions that emerge as solutions to the supply-side problem have direct consequences for the ability of resource users to sustainably manage their common-pool.

- I show that some property regimes suffer from having too many regulatory institutions that do not complement, but supplant each other. This occurs especially when a formal agency is not fully aware of the existence of informal collective action institutions.

- I show that some property regimes are vulnerable to a specific type of collective action (collusion) that has adverse effects on sustainable resource management. The possibility for collusion also makes it difficult for users to commit to the property regime. Therefore, collective action is not always and unambiguously a good thing.

All of these points have one thing in common: the sustainable use of the common-pool is affected by collective action that precedes or succeeds the regulatory institutions. In other words, the nature of the resource use problem, and consequently the appropriate property regime, depends on prior collective action and on the possibilities of collective action that the property regime provides for resource users. I also discuss the conditions under which these factors are likely to create problems and how these problems can be avoided.

This dissertation contributes to addressing the complexity of the problem of the commons. As previous literature has shown, finding blueprint policies that work in every case may not only be impossible but also counterproductive. In the following chapters, I tackle this complexity by showing how local conditions affect the outline of the problem at hand. Although this work draws from empirical cases, its main contribution is theoretical: it introduces concepts that allow the problem to be described more precisely and proposes theoretically sound causal mechanisms that play an important role in the problem.

All in all, these results show that we need to place common-pools in their rightful place as parts of larger production systems where people face various types of collective action problems. Succeeding in this task allows for taking into account a new set of factors to explain the success and failure of sustainable resource use. Below, the chapters to follow are introduced in a more detailed manner.

Outline of the chapters

In chapter 3 I discuss Sami reindeer herding as an example of a production system in which an important factor of production – capital security – is a collective good. I argue that before any pasture limitation could have been met, herders must have solved a collective action problem in supplying capital security. Capital security is an example of a club good, and the emergence of clubs – or *siida*s as they are called in Sami reindeer herding – is therefore a necessary condition for the overuse problem to emerge. Furthermore, I make a distinction between the overuse problem of individuals (the conventional story) and that of clubs, and discuss differences between the two, using Sami reindeer herding as an example. It turns out that institutions that emerge to solve supply-side problems have consequences for the ability of resource users to solve over-investment problem as well.

In chapter 4 I discuss the limits of a conventional meddling tool: formal sanctions. I explain what appears to be a paradox in the use of formal (negative) sanctions in various common-pool resource systems. Formal sanctions are frequently used, but their level is typically low or moderate (although it is often increased gradually). It seems then that formal sanctions are useful, but from the point of view of classical decision theory, their deterrence effect is not used to its full potential. These seemingly contradictory observations are explained by identifying both positive and negative mechanisms between sanctions and cooperation rates in collective action games. It seems that in environments that resemble traditional common-pool resource systems, conditions are favourable for the existence of negative mechanisms between formal sanctions and cooperation rate. This is the case, because formal sanctions often interact with informal controls and norms. Therefore, I am going to argue that agencies (should) rather aim to complement informal controls with low level of formal sanctions than take the risk of supplanting them.

Chapter 5 aims to show that not every collective action is beneficial for everyone and that the drama of the commons continues also after regulatory institutions have been successfully provided. I introduce the term ‘anti-norm agreement’ and show that if the deterrence effect of a sanctioning mechanism is dependent upon peers monitoring (or sanctioning), a sub-group of the population may find it beneficial to cease monitoring (sanctioning) each other. This increases the welfare of the sub-group, but (due to negative externalities to outsiders) decreases the welfare of others. Therefore, a successful cooperation, which in this case leads to collusion, may be counterproductive for the population as a whole.

Chapters 3-5 aim to contribute to our understanding of the drama of the commons in its various phases and the different roles of collective action involved. In order to better address the complexity of dynamic and evolving production systems, chapter 2 introduces an analytic narrative that tracks down how the drama of the commons unfolds. Analytic narratives are a quite recent addition to the methodological toolbox of social scientists, although implicitly similar kinds of ideas have been in use for a long time. The primary aim of analytic narratives is to link theoretical models and a small-*n* case analysis. I use collective action theories to create such a narrative, which also means that the vocabulary used in the narrative is familiar to everyone with some knowledge of rational choice theory. The narrative consists of phases and turning points, and can be used to construct theory-based and, therefore, comparable historical stories of single cases. This narrative serves my purposes by making it easier to discuss different roles of collective action in commons. But it may also be useful for researchers of common-pool resources more generally as most of the empirical research in the field has been, and continues to be, conducted using small-*n* case studies. This has created a problem of comparability between cases. Easy-to-use analytic narratives hopefully help in bridging the gap between individual studies.

2. HOW DOES THE DRAMA OF THE COMMONS UNFOLD? AN ANALYTIC NARRATIVE AND ITS TURNING POINTS

The short history of the modern study of the commons can be phrased as a transition from tragedy (Hardin 1968) to drama (Ostrom et al. 2002). Poets aiming to describe the life in commons, i.e. academic scholars interested in common-pool resources, have continued to become more receptive to the multifaceted nature of that life. In the process, it has become evident that the tragedy is only one among many genres of drama, although an exceptionally fascinating one. The question has turned from 'tragedy or not?' to 'when does the tragedy occur?' and still to more nuanced empirical and theoretical attempts to tackle problems of complex causality (Agrawal 2002). Examples of the former include the collection of large datasets, laboratory- and field experiments, as well as dynamic system analysis. Examples of the latter include frameworks such as the institutional analysis and development (IAD) -framework and the social ecological systems (SES) -framework[10], as well as game theoretic applications, and agent-based modeling.

The task of a poet, one could contemplate, is to capture something essential from life and turn it into a piece of art that leads to a better understanding of something, or at its best, to catharsis. This task is not far removed from that of a scholar, although as scholars, we are more constrained by analytical clarity than poets and less rewarded for mere aesthetical value of our work. Complex causality brings a trade-off that is visible in many methods of analysis. On the one hand, we must take into account as much complexity as possible, but on the other hand we are supposed to maintain analytical clarity. For example, the influential work of Ostrom (1990) achieves the trade-off by looking for the answer to good governance in commons, on the level of general principles rather than on the level of individual variables. The logical next step is to downscale the question of good governance to the level of empirical variables (see Agrawal 2002). This is a step towards a more accurate understanding of what separates success and failure.

Making progress in this task is challenging to say the least, and progress is incremental by nature. Yet I believe (as do many others) that this project is an important step forward. Even if the goal would prove to be unattainable (and it always will be, if standards are set high enough), the project itself is a powerful tool for generating new questions, hypotheses, and eventually, knowledge. For the project to have any value at all, principles or laws that govern the system are furthermore believed to be, at least to some extent, generalizable. Finally, it is believed to be possible to describe these general principles in the form of theories, the usefulness of which can be judged by their explanatory leverage and the coherence of their hypotheses in accordance with the observed reality. As studies on commons have been multi-disciplinary from early on[11] and as leading authors in the field have continued to stress the importance of multiple approaches (e.g. Poteete et al. 2010) it is no wonder that frameworks, most notably the IAD-framework, have been developed to ease evaluation, comparison and cross-fertilization of different theories. Although the IAD-framework may not be

[10] Both of these frameworks are metatheoretical constructions that identify an action situation and attributes of the system that generate the outcome. Frameworks, however, neither go into the level of variables nor suggest causal effects between variables and the outcome. (see Poteete et al. 2010, 40-41, 234-235.)

[11] In fact, commons as a separate field of study, although still nurturing many approaches, was established by combining existing work already done in different disciplines (e.g. history, social anthropology, economics, political science).

incompatible with other approaches, its intellectual roots are clearly in methodological individualism.[12]

Historically speaking, the most influential individualist approach in social sciences is rational choice theory. For the study of commons, an especially important sub-field in rational choice theory is collective action theory, that is, game theoretic approaches to tackle the question 'when do people successfully engage in mutually beneficial action'.

The main task of this chapter is to explore how classical collective action theories can continue to contribute to the project described above. I take the drama metaphor seriously by introducing an analytic narrative on how the drama of the commons unfolds. To a great extent the narrative is based on the properties of different collective action models. A special emphasis is placed on the turning points of the drama that change the nature of strategic interaction among users (i.e. the game). I argue that collective action theorists are able to continue to contribute to this field of study, if they can show connections between domain assumptions of different collective action models and the empirical reality. The narrative also reveals two related challenges facing the project more generally: (1) not all cases are fully comparable because socio-ecological systems may be in different phases, and (2) effects of individual variables are not necessarily invariant as the system transfers from one phase to another. These points make tackling the complex causality issues on the level of individual variables even more challenging and should be taken into considered (for example in case selection).

2.1. Analytic narratives: why?

What do analytic narratives mean? How are narratives supposed to help a researcher? A natural starting point for answers is the book, *Analytic Narratives* by Bates et al. (1998). In *Analytic Narratives* authors make no claim to methodological originality, on the basis that many comparativists and economic institutionalists had already been using similar types of ideas before their book was published.[13] However, Bates et al. (1998) try to systematize and further explore how one can use analytic narratives to combine theoretic reasoning and particular empirical cases. One of the motives behind their use of analytic narratives lies in case selection. They are critical towards the conventional theory-driven wisdom behind case selection as the only possible alternative, i.e. one selects empirical cases based on how interesting they are from a given theoretical point of view. Rather, their case selection resembles that of historians. Empirical cases (historical processes), like the French revolution, can be interesting in their own right, and this is a good enough justification to study them. Instead of mere empirical narratives, however, authors insist on analytic narratives: a researcher should identify key mechanisms in work behind historical processes and build a parsimonious rational choice[14] model to explicate a small number of variables that are able to produce comparative static results.

Analytic narratives promise nothing spectacularly new nor do they aim to displace other methodological practices. Analytic narratives are yet another tool in a social scientist's

[12] Naturally, so are those of Hardin (1968). For most economists this statement may seem too obvious to be worth writing down. The same may not apply to sociologists, political scientists, and social anthropologists.
[13] Most notably Douglass North to whom the authors also dedicate their book.
[14] I suppose analytic narratives could be based on other approaches as well, but all authors in Bates et al. (1998) use rational choice. As there is no disagreement here between them and the current author, I will not discuss the use of rational choice further (but see footnote 16).

toolbox that can be used to combine abstract theories and empirical particulars. Users of analytic narratives believe in a constant dialogue between theory and particulars during research. Therefore, research is seen as an iterative process in which the researcher starts with an initial model and continuously refines it to better fit the case in hand. This more inductive approach is likely to lead to more compelling models than deductive approaches, thereby offering a partial rebuke to the criticism that rational choice models lack realism.

But better descriptive fit comes with a price that not all are willing to pay. Margaret Levi (2004, 218) gladly admits: "The Achilles' heel of analytic narratives […] is in the capacity to generalize. These are, after all, efforts to account for a particular puzzle in a particular place and time with a model and theory tailored to that situation." However, she finds reasons to be hopeful. Analytic narratives do rely on general theories. Furthermore, they require a rather specific account of causal mechanisms behind phenomena under study. These mechanisms are believed to be generalizable, that is, not unique to the case in hand. Same mechanisms and general laws may be operating in many cases, although differing initial conditions may lead to different outcomes (Goldstone 1998). Levi expresses a hope that even though individual studies and narratives cannot deliver generalizable conclusions, a larger set of narratives, when compared, may reveal generalizable patterns between similar types of cases (Levi 2004, 218-220).

The hope expressed by Levi resembles, yet does not echo, the hope of scholars who systematically read through existing case studies on commons during the 1980s and tried to find commonalities between successful cases, as well as between unsuccessful cases. Like authors such as Bates et al. (1998), their approach was case- or problem driven (inductive) rather than guided by a theory (deductive). The crucial difference between these two sets of scholars is that Bates et al. (1998) suggest a theoretical standard – rational choice as it happens – on which explanations must be based, but for early commons scholars this was not possible because the empirical research had already been conducted according to a variety of different scientific practices. For practical comparative purposes the latter group adapted the IAD-framework. But a framework is not a substitute for a theory. The former does not produce hypotheses. The latter must do so in order to be falsified.[15] In addition, a theory must be able to state when the hypothesis is likely to hold and when it is not, that is, it must give out comparative statics. Without a general enough theory and its comparative statics, I believe, it is not possible to address issues of complex causality, like the one that researchers on commons currently face. It is also clear that small-*n* studies remain an important part of commons literature next to other study methods, not least because the effort invested in fieldwork and in-depth studies on – often rather unstructured and unofficial – local conditions tends to favour specialization of researchers. Under these circumstances, goals, and assumptions analytic narratives offer an interesting method of study.

However, there is a difference between studies in Bates et al. (1998) and my work concerning the emphasis between deductive and inductive methodology. Empirical interests of studies in Bates et al. (1998) are diverse (from the *podestà* system in 12th century Genoa to US federalism and to international coffee market) and theoretical constraints loose (rational choice[16]) and therefore, the common denominator between their works as well as between

[15] This falsificationist requirement for a scientific theory is shared at least by Popper (1963), Kuhn (1962) and Lakatos (1970). I do not want to imply that the use of rational choice, as defined in the footnote 16, guarantees testability (for further discussion, see Herne and Setälä 2004, 71).
[16] I refer to 'thin rationality', i.e. acceptance of basic axioms that allow us to treat an individual as utility maximizer (Nurmi 2006, 17-42). Another candidate for common denominator is game theory, especially

their audiences is methodological (rather than empirical or theoretical). This work, however, is addressed to scholars who share either a common empirical interest (production systems comprising common-pool resources), or a theoretical background (collective action theories). The intended contribution here is to suggest how classical collective action theories can contribute to the complex causality issues in the study of commons by using analytic narratives, and therefore I deem it best to provide first a general theoretical narrative that can later be applied to empirical cases. I am also a bit sceptical about how the inductive approach, even though tied to a loose general theory, can deliver comparisons and eventually, generalizability. My concern is not that it would be an impossible approach in its own right, but I find it unlikely that the approach would lead to a coherent study program (accumulation of cases analysed with similar enough theories) given the practical limitations of academic life.

To me, much of the appeal of analytic narratives derives from practical matters. However, the rules governing theory development may present some practical problems. The main problem in applying rational choice models to empirical cases concerns the language, both grammar and vocabulary. By the grammar I mean the structure of explanation in theoretical (rational choice) models and development of scientific theories: they consist of a set of conditions concerning the state of the world, *explanans*, that lead to certain (macro-level) outcomes: *explananda*.

For example, let **a** and **b** be two variables that can take values (a1, a2,…) and (b1, b2,…). All the possible states of this theoretical world, antecedents, are then given by a matrix **a**X**b** (a1b1, a1b2,…, a2b1, a2b2,….). Let **y** be the outcome that can take values (y1, y2). A full model of this world could assign either y1 or y2 to each possible antecedent, thus providing (exhaustive) comparative statics. But theory development is incremental by nature, and the scope of its comparative static results is, for practical reasons alone, limited. When theories are developed further, they come to cover more antecedents either by introducing new variables or covering more values of the old ones. This has also happened in collective action theories.

Garrett Hardin (1968), for example, applies the same logic on commons as Gordon Tullock (1971) does for revolutions and Mancur Olson (1965) for collective action more generally. Their logic is compelling. If decisions of individuals are independent (say that variable **a** refers to the dependency and its value a1 to total independence between individuals' decisions, so we can write **a**=a1) rather than somehow dependent (**a**≠a1) and if the benefits of successful cooperation go to everyone (say that variable **b** refers to the distribution of benefits and its value b1 to the fact that spoils go to everyone, so we can write **b**=b1) and not just to those who cooperated, then collective action would not occur (say that **y** refers to the outcome of the collective action and y1 to a failure, so we can write **y**=y1) assuming the absence of other incentives. An individual then has a dominating strategy not to cooperate: she is not going to cooperate if others cooperate, and she is not going to cooperate if the others do not cooperate. This is a fine theoretical result, but rather uninteresting for empirical

extensive form games, as Bates et al. (1998, 3, 9) sometimes claim. But as also Jon Elster (2000, 687-689) points out, not all chapters in their book use game theory – at least not explicitly. I do not find this inconsistency in a book of five authors particularly troubling. Authors do express a belief that other types of games are also useful for analytic narratives (Bates et al. 1998, 655), although not all share their view (see Carpenter 2000, 655). I am using strategic form games, so I am one of the believers. Given that decision theory is merely game theory for a solitary man, the theoretical constraint seems to be thin rationality rather than extensive form games. I find this constraint very loose.

researchers who observe collective action on a daily basis. Jack Goldstone (1998, 840) formulates the twofold reaction to Tullock's results: "Economists championed the result as a triumph of logic and a fascinating result. Historians and sociologists who actually studied revolution ignored it, since they knew full well that revolutions do occur, and their goal was to explain this social fact, not to posit conditions under which it would not be possible."[17]

The logic of Hardin, Olson and Tullock applies only under rigid conditions. They posit a material conditional concerning the antecedent (a1,b1), namely (a1,b1)→y1. They also often refer to the possibility that introducing selective incentives for individuals is *ceteris paribus*, sufficient for collective action. Olson emphasizes that heterogeneity can have the same effect if the group is "privileged" in the sense that someone is willing to bear the costs of public good provision alone.

These further developments expand the theory to cover more antecedents, yet maintain some assumptions that form the "hard core" of it (Lakatos 1970). In our examples, the "hard core" includes forward-looking, utility-maximizing behaviour, but does not include the specific interaction structure or incentives. As far as I see it in light of Lakatos (1970), every theory needs a set of fundamental assumptions (the empirical accuracy of which is not put under scrutiny for time being) to allow incremental not revolutionary theory development. In this sense, all incremental theory development is thus theory-guided: when empirical anomalies occur, the core of the theory necessarily influences how anomalies are explained. If several theories were to encounter the same empirical anomaly, they would most likely use different explanations (additions to antecedents) to explain it.

While this may be true enough, descriptions of antecedents must be compatible with the core of the theory and with each other (for theoretical coherence). Given that all theories and their core assumptions are merely partial representations of reality, the theoretical description of antecedents (a) does not fully correspondent with our empirical observations and (b) linking them to empirical observations may become more difficult as the theory develops further. In other words, theories are able to mature and start a life of their own without clear connection to empirical observations. This means that the problem of grammar becomes the problem of vocabulary: it becomes more difficult to give empirical content to theoretical antecedents. This lack of empirical content is one of the main points raised by critics of rational choice theory (Green and Shapiro 1994). It threatens the testability of theory and its ability to explain and predict new empirical phenomena. Some may find it worth pointing out that, if one follows Lakatos (1970), these are the hallmarks of a degenerate research program. Bridging this gap – a practical problem – with the help of analytic narratives is the aim of this chapter. As a result, antecedents hopefully become more transparent and easier to associate with empirical content. Of course, there will always be a gap of some sort. Theories will always use assumptions that can not be empirically validated. Our tolerance to this gap often depends on our practical interests.

Many, of course, have explored other research programs. Well-known examples in the field of commons include Amy Poteete, Marco Janssen and Elinor Ostrom (2010), who are in favour of behavioural theory of human beings, i.e., the idea of individuals as somehow bounded rational beings. These approaches no longer treat individuals merely as forward-

[17] Almost the same could be said about Hardin's conclusions, but with a notable addition. For a long time this logic pervaded the main stream economic thought and also had considerable political implications, which provided a good reason to be interested.

lookers and utility-maximizers, but instead study e.g. heuristic choices, imitation and learning. In other words, they abandon the conventional "hard-core" of *homo economicus*, and create new explanations by exploring mechanisms absent under full rationality. Yet many of them are at least comparable to, and sometimes also compatible with the studies that assume full rationality, as in applications of quantal (learning) responses where the assumption of full rationality assumption usually gives a limit result.[18] This is hopefully the case here too. It is easy to agree that people are not completely forward orientated and that our cognitive abilities are limited in many ways, but it is more difficult to describe exactly *how* or *to what extent* this is the case (Poteete et al. 2010, 174-175). Yet this is not a defence for *homo economicus* because full rationality is hardly the right approach either. It is likely that contextual factors partly determine the extent and nature of our rationality. We may be little more than responsive automata during a family breakfast, but much more calculative and forward orientated while buying a house. For a better empirical fit, agent-based modellers as well as dynamic system analysts have relied not only on their intuitions but also to empirical observations using experiments and role-games.[19]

Abandoning full rationality means opening up a new layer of questions concerning complex causality. Continuing to rely on full rationality is just one way to reduce complexity.[20] If this reduction throws the baby out with the bath water, i.e. neglects the mechanisms that are driving the system in reality, then a better way to reduce complexity – a new core – should be found. Many rational choice theorists seem to share this point of view (see e.g. Kiser and Hechter 1998, 810-812; Nurmi 2006, 188-190).

2.2. An analytic narrative on commons

The main thesis of this chapter is this: not all common-pool resource systems are fully comparable at a given time as systems may be in different phases. A concept borrowed from dramatics is helpful here: as the drama unfolds, *peripeties*[21] occur. A *peripety* is a sudden change in the logic of the play, perhaps brought on by new information, such as when Oedipus finds about his true linage, or by external circumstances like when a hero is struck by illness. As such, *peripeties* are turning points in the drama that may change the genre altogether – to a great surprise for both the characters and the audience. Characters now adjust their responses, and the audience sees the change in the role of a character.

The analogy is hopefully clear enough. As the system of individuals interacting with each other reaches various turning points, be they informational, technological, or institutional, the nature of the interaction can change dramatically, and the systemic responses may change as well. This also alters the relative importance of variables, or even their qualitative effects. In a very important sense, there are cases-within-a-case. For that reason it is important to recognize both potential turning points and different stages of the system. When are two CPR-systems, in fact, comparable? When is the dynamic in a CPR-system likely to change? Should we look into different aspects of the system when it is in different phases? Beginning

[18] This is because their "cores" are largely overlapping: both full- and bounded rationality cohere with methodological individualism, for example.
[19] Being aware that one is being observed is, of course, a possible contextual factor that may affect the type of rationality one employs.
[20] This is something all theories must do. Otherwise they would not be needed.
[21] The concept dates back to Aristotle. But then again, most of them pretty much do.

to answer these questions is the main task of this chapter. I also believe that speaking of phases gives a useful new concept for users of analytic narratives.[22]

A turning point, described by the antecedent condition, occurs as the outcome variable changes its value or a new mechanism starts to play a role. By **a mechanism** I mean a (theory-described) causal connection between an antecedent condition and the outcome. For example, a mechanism underlying "Duverger's law" (a plurality voting leads to a two-party system) is that voters do not want to waste their votes for candidates with no hope of getting elected and, therefore, only the major parties get votes. The domain assumptions of a theory describe when (under which conditions) a mechanism is supposed to work. In the case of Duverger's law these include at least the following: (1) in each voting district a plurality voting system is used that elects only one winner, (2) an outcome orientated mindset of voters, (3) and rather homogeneous distribution of parties' supporters between districts. If these conditions apply, small parties are unlikely to get representation and voters' are likely to concentrate their votes on major parties. Turning points are primarily theoretical concepts. Turning points break a narrative into different phases. **A system phase**, not a system itself, is the comparable unit of analysis. At the same system phase same mechanisms are operational and same outcomes are expected. Election system might turn from a multiparty system into a two party system, for example, if supporters of a regional party become more dispersed between several voting districts, which would be one possible turning point. This turning point divides the election system into two phases that could be called multiparty phase and the two-party phase.

Unlike mechanisms, **historical processes** are empirical. By a process I merely refer to observed changes in exogenous or endogenous variables. Theory is silent about the former and suggests the latter. Continuing our election system example we could note that a more dispersed distribution of supporters could follow, because of migration or because of rearranging borders of electoral districts. In this case these two historical processes have the same theoretical meaning. **Analytic narratives**, then, consist of phases and turning points, and are 'analytic' in the sense that they are theoretically defined.

Analytic narratives are not temporal as such – the system may return to its previous phase as historical processes unfold – but they can be used to construct temporal narratives. Finally, narratives have "zooming" -property (Ostrom 2005): as long as compatible and more fine-grained theories are available narratives can go to ever-smaller details. This means that we can identify (arbitrarily) many causal mechanisms and define turning points by antecedents for their existence and/or by antecedents describing when certain mechanisms become

[22] While discussing "presence of multiple equilibria", Bates et al. (1998, 233-236) recognize the problem concerning comparative statics that cases-within-a-case entails, but – I think – fail to be specific about it. Using their example: As Bates analyses the 20th century coffee market he divides the timeline into different periods and uses different models to explain market behaviour in each period. Quoting authors (*ibid.* 233): "In the absence of global political tensions, a neoclassical model of market competition worked: the cartel was unstable and subject to free riding. When […] global security was threatened […] [t]hird party enforcement became rational and facilitated collusion among producing nations." Allegedly, hence (*ibid.* 233-234): "An obvious implication is that propositions derived from a model of the coffee market prior to the cold war period could not be tested with the data drawn from that period. […] It is therefore difficult to test explanations employing data from outside the original sample." But "outside the original sample" should probably read "outside samples that are theoretically similar". Clearly Bates suggests that different market periods are not comparable, because different mechanisms are driving the behaviour. But it does not follow that markets, where similar mechanisms are active, are not comparable. Proper definition of a case should make comparative statics possible. The case is not 'market', but 'market period' or alike. To repeat my thesis: it is imperative that the theory is able to suggest turning points between phases, and that they are also confirmed empirically.

dominant in the sense that they force an outcome. The appropriate level of zooming depends, I think, on the research interest at hand. I also suspect that our ability to pinpoint turning points theoretically often exceeds our ability to operationalize them in practice.

Next I construct a broad narrative for commons. After that, I spotlight interesting phases from the point of view of collective action theories.

2.2.1. Grand narrative for commons

The broad narrative for commons proposed here has the following phases and turning points (Figure 2). I sketch the narrative below and work through the details in the following sub-chapters.

Turning point:	Phase:
	Ecological Phase
Demand for CPR emerges	
	Supply of production factors
Economic feasibility attained	
	Modest utilization
Optimal yield lost	
	Overinvestment
Demand for regulation emerges	
	Supply of regulatory institutions
Regulatory institutions emerge	
	Institutionalized resource use phase
	(FIGURE 2)

At some point of time all CPRs have been part of ecological- but not socio-ecological systems. It is only after the emergence of demand that CPRs become interesting for social sciences. But demand itself is not sufficient for resource use (extraction). Other factors in the production system must be affordable enough before any extraction is economically feasible. At the modest utilization phase the demand remains relatively low in comparison to extraction costs so that externalities are either non-existent or modest. After excessive extraction, when optimal yield is clearly lost, users have an overinvestment problem. If there is some level of understanding that this is the case,[23] a demand for regulation should emerge following, hopefully, more-or-less explicit attempts to supply regulatory institutions. After some level of success in this supply-side problem, the system enters into an institutionalized resource use phase during which the resource use is regulated either informally or formally.

Next I will give possible formalizations that support the grand narrative of commons and collective action narratives. The idea is to illustrate how turning points and phases can be defined with some rigour. The idea is not to suggest that this formalization and assumptions behind it enjoy any special empirical appeal. What follows is a series of simple conditions written down and explained. Do not let the apparent simplicity fool you: this is much more

[23] This is not obvious in complex ecological systems.

difficult than rocket science – not mathematically, but because it is often very difficult to empirically assess these simple conditions. One of the things we do is to translate the text-book "commons story" into the language of collective action theories. This alone reveals some interesting aspects.

Grand narrative: a possible formalization

Let us assume n potential resource users, who each can invest x tokens (representing their capital or labour) either on the common-pool or on a private alternative. Assume also a common-pool with a yield function, $Y(X)$, where X is the aggregated amount of tokens invested on the common-pool. Assume that the private alternative gives individuals a zero yield for each unit of investment and that there is a cost associated with investing on the common-pool. Further assuming that these costs are linearly increasing and identical among potential resource users, we can represent them using an aggregated (linear and increasing) cost function, $C(X)$, which gives us total costs for each value of total investments on the common-pool.

Ecological phase: $Y(X) < 0$ for all values of X.

The system is in ecological phase as long as individuals get a better yield from their private alternatives than they could get from the common-pool. Having fixed this private alternative to zero we can say that the system is in ecological phase as long as $Y(X) < 0$ for all values of X. The first turning point, the emergence of demand, occurs when $Y(X) = 0$ for some values of X. This means that either the yield function or the value of the private alternative has changed. In our exercise it is the former as we have already fixed the value of the private alternative. Figure 3a illustrates an ecological phase.

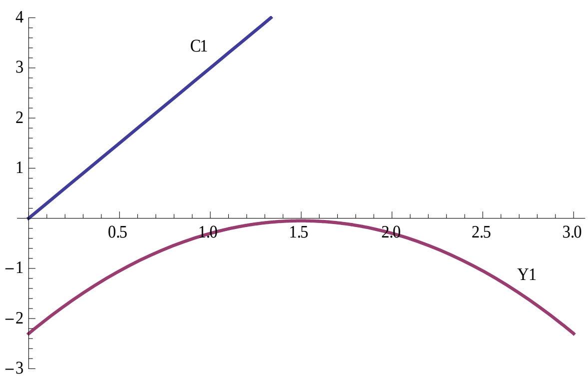

FIGURE 3a

It is worth noting that here we assume that there is no difference between objective conditions (as things are) and subjective conditions (as individuals think things are) – this difference is expanded a bit further in the main text. It would be possible to formalize the narrative while maintaining this distinction. Subjective assessments explain actions of individuals, but these assessments are constrained and shaped by objective conditions.

Supply of production factors: $Y(X) > 0$, and
$C(X) > Y(X)$ for all values of X.

So, it now holds that $Y(X) > 0$ for some values of X meaning that utilizing the common-pool is a viable option. We can now formalize the next phase, the supply of production factors, with the help of the cost function. As long as costs outweigh yields, that is when $C(X) > Y(X)$ for all values of X, the system is in the supply of production factors -phase, where first common-pool related collective action problems may occur (also known as supply side problems). In our example, potential users now have an incentive to decrease costs associated with the common-pool utilization. In case of a quadratic yield function, that is $Y(X) = aX^2 + bX$, where $a < 0 < b$, the system is in the supply phase, if the cost function increases faster than the yield function when $X = 0$. We have assumed a linear and increasing cost function, so it can be written as $C(X) = dX$, where $d > 0$. After short calculus we can conclude that the system is in this phase, if $d > b$. The economic feasibility – our next turning point – is barely attained (or lost) when $C(X) = Y(X)$ for some value of X in the general case, or $d = b$ in case of a quadratic yield function. Figure 3b illustrates the supply of production factors: if people find a way to decrease costs from $C1$ to $C2$, they push the system to the modest utilization -phase.

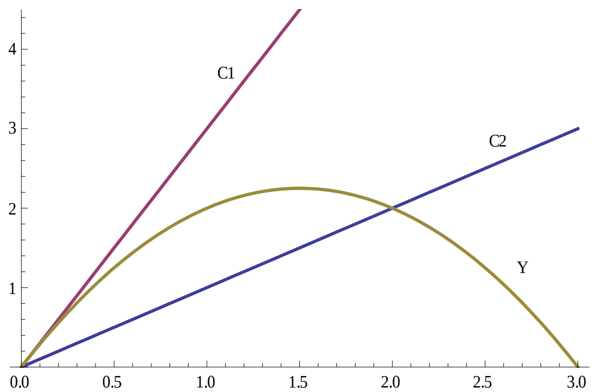

FIGURE 3b

Modest utilization: $Y(X) > 0$ for all values of X, and
$C(X) < Y(X)$ for some values of X, and
$X^t < X^*$.

Consider next that either the yield function or the cost function changes so that rather than $C(X) > Y(X)$ for all values of X it now holds that $C(X) < Y(X)$ for some values of X. This means that there are real gains to be had from investing on the common-pool. Utilization kicks off, but it is modest in the sense that overinvestment is not a problem. The total level of investments, X^t, stays under the optimal level of investments, X^*, that is, $X^t < X^*$. The next turning point – when the optimal yield is lost – occurs when $X^t = X^*$. There are many reasons why the turning point might not be met, but the obvious one is that the maximal potential amount of investments, say X^p, does not exceed the optimal one (it naturally holds that $X^t \leq X^p$). Consider, for example, n identical individuals who each have x tokens to invest. If it holds that $nx < X^*$, there is no overinvestment problem. This type of system could exceed the turning point through population growth (n increases), or through technological changes leading to an increase in productivity of individuals (x increases) or through technological, ecological and economical changes leading to a decrease in the optimal level of investments (X^* decreases). Figure 3c illustrates the transition: As long as the total level of investments is below X^*, such as X_1 , there is no overinvestment problem. Levels such as X_2 finally create the overinvestment problem.

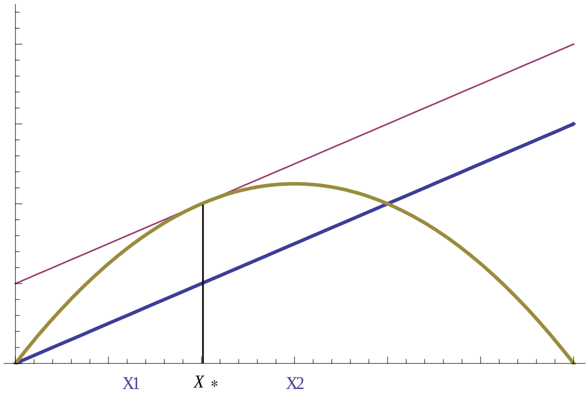

FIGURE 3c

Overinvestment: $Y(X) > 0$ for all values of X, and
$C(X) < Y(X)$ for some values of X, and
$X^t > X^*$.

If the total amount of investments on the common-pool exceeds the optimal one, that is $X^t > X^*$, the system has entered the overinvestment phase. Some part of the total yield is now lost, and there are strategy vectors (specifying individual investment levels) that would be Pareto-improvements to the current situation. This means that the lost yield could be divided among resource users in a way that would leave everyone better off. In case of a quadratic yield function, the condition $X^t > X^*$ translates to $Y'(X) < C'(X)$ and finally to $X > \frac{d-b}{2a}$.

A part of the maximal yield is also lost in the modest utilization phase, but note that unlike in the overinvestment phase there are no Pareto-improvements to be had by changing individual investment levels. This is because investment levels can only be decreased and lower investment levels give smaller yields.

Recalling that we assume that there is no difference between the objective and subjective conditions, the same condition, $X^t = X^*$, defining the previous turning point (the loss of optimal yield) also defines the next turning point (demand for regulation emerges). This assumption then also equates two phases – overinvestment and the supply of regulatory institutions. The next turning point (the emergence of regulatory institutions) must be defined using collective action theories. Next we will take a look on a possible formalization of collective action narratives.

The collective action theorists should primarily have something to say about two phases of the grand narrative (indicated in bold in figure 1): **supply of production factors** as far as some of these factors are collective[24] rather than private goods; and **supply of regulatory institutions** tackling the overuse problem. These two phases can be offered a common collective action narrative (Figure 4).

[24] By collective goods I refer to both public- and club goods.

2.2.2. Collective action narratives

Implicit solutions

All collective action narratives start with a demand for collective good. They concern either the supply of some production factor or the supply of regulatory institutions (see Figure 4). Theories suggesting implicit solutions (the left column in Figure 4) point out conditions that create a cooperative equilibrium or equilibria in a collective action game. These include e.g. non-linear success-function, repeated interaction or particular incentives, such as altruism, conformism, or success-contingent benefits for co-operators. It is, of course, an empirical question whether these conditions correctly describe the situation at hand and whether they are sufficient for a cooperative equilibrium. They also raise questions about historical processes that lead to the turning point, that is, to the existence of a cooperative equilibrium. After this turning point, a new set of mechanisms, called here belief mechanisms, become active. When several equilibria exist, the problem becomes that of equilibrium selection: players do not anymore have dominant strategies, but their best actions depend on the actions of others. This implies that beliefs about others' likely actions play a crucial role in the equilibrium selection phase. Factors like signalling now make a crucial difference. Usually the turning point between these two phases can be defined explicitly as a function of game parameters. Unfortunately this theoretical precision is hard to translate into empirical precision (information about the relative values of parameters or about their distributions is often missing). Here the dialogue between the empirical case and the theory, strongly emphasized by users of analytic narratives, comes in handy: a researcher can construct an argument for transition from one phase to another by pointing out that the behaviour of the system changes as theory predicts it would.[25]

The common denominator amongst implicit solutions is that there is something inherent in the situation itself that makes cooperation possible, and that mechanisms driving the equilibrium selection (such as signalling, belief updating or tradition) produces cooperative equilibrium given some initial conditions. These solutions follow the *institutions-as-equilibrium* approach: institutions are not explicitly created, but follow directly from individual actions (and change accordingly). At the minimum, implicit solutions can work even if there is nothing but the physical properties of the resource connecting users.[26]

Explicit solutions

Institutions are often explicitly defined e.g. in the form of rules, positions, and organizations (Ostrom 1990), yet they are primarily crafted by the user group, not by external actors (see Figure 4). A requirement for these solutions is that users can communicate, in other words, that they have an access to a communication arena on which they can address the supply problem. The first turning point in the narrative after the phase of non-cooperation is bringing the problem to the collective choice level. Not all problems make it and sometimes the delay is considerable (as in global carbon emissions). Communication is usually costly and fragmented, and the spread of ideas and awareness of the problem may be slow.

[25] These are not *ad hoc* -explanations, because they do not explain single anomalies. Rather, they tackle imprecision. For example, theory predicts that there is a turning point after which belief mechanisms become active, and it is easier for us to observe empirical consequences of belief mechanisms than the turning point itself. Our theory-guided conclusion is then that the system must have passed the turning point.
[26] This is the case e.g., if the strategy space of players contains only harvesting levels.

IMPLICIT SOLUTION		EXPLICIT SOLUTION		EXTERNAL SOLUTION	
Turning point:	Phase:	*Turning point:*	Phase:	*Turning point:*	Phase:
Demand for collective good		*Demand for collective good*		*Demand for collective good*	
	Non-cooperation		Non-cooperation		Non-cooperation
		Problem raised to collective choice level			
			Policy formulation		
		Sufficient agreement reached		*External actor gets involved*	
			Institutional supply problem		Policy implementation
Cooperative equilibrium becomes feasible		*Contributive equilibrium becomes feasible*		*Cooperative equilibrium becomes feasible*	
	Equilibrium selection		Equilibrium selection		Equilibrium selection
Coordination to a cooperative outcome		*Coordination to a contributive outcome*		*Coordination to a cooperative outcome*	
	Collective good by informal institutions		Collective good by formal institutions		Collective good by formal institutions

FIGURE 4

However, once the problem is raised at the collective action level users have the possibility to change the outset of their collective action problem. The structure of the collective action arena affects the range of possible strategies that policy proposers have at their disposal, as well as processes that lead to sufficient agreement. Successful policy formulation may create incentive schemes that foster cooperation, for example by introducing success-contingent benefits (e.g. the creation of agency that blocks non-participants from extraction) or by changing the success-function and risks of cooperation (e.g. at the collective action level plurality decisions may bind everyone to contribute, and initiators risk only the costs of bringing the problem forth and crafting a policy proposal). What I suggest here is that people can change parameters of the collective action game once they are able to craft policy proposals at the collective action level. The access to such an arena is essential. In small settings characterized e.g. by a small number of users and their dense geographical dispersion, the access is relatively easy.

There is not much a collective action theorist can say about which policies make it to the agenda in widely dispersed empirical settings where users' ingenuity plays a crucial role. But their ability to agree on the policy strongly influences the institutional supply problem that they finally face. In this phase, necessary resources for institutional supply (contributions) are finally raised. The narrative continues as before and I do not repeat it here in detail: the next turning point is the existence of a contributive equilibrium, which is then followed by an equilibrium selection phase. If a sufficient amount of coordinated effort is given for the formal institutions to become operative (e.g. the organization gets necessary funding and labour), the system finally enters the institutionalized resource use phase where formal institutions aim to tackle the problem. Rules and enforcement change the logic of the system once again by changing the incentive structure at the operational level, which gives rise to new mechanisms absent in previous phases (concerning sanctions, monitoring, information flow from the field to the regulating organizations, principal–agent relations, and so on). Unlike in implicit solutions, in explicit solutions institutions make the cooperation possible. Explicit solutions are then a part of the *institutions-as-rules* approach at the operational level. However, the creation and maintenance of these rules is based on equilibrium behaviour.[27]

External solutions

Both broad narratives discussed above (implicit and explicit) lead to internal solutions, that is, solutions stemming from the users themselves. But often, external actors have a role to play in the emergence of regulatory institutions. The first turning point after the non-cooperation phase is the involvement of an external actor, which possesses both interest and possibility for intervention. If its policy manages to ensure cooperative equilibrium among users (or if it decides to provide the collective good single-handedly), the collective good is provided via an external solution.

Analytically, and by relying on collective action theories, it is possible to distinguish three ways in which an external actor can help in collective good provision. First, it can provide the collective good itself. This means that some amount of collective good is provided even though the cooperation rate among the population is zero. But this may be an expensive strategy for the external actor. Its second option is to change the incentive structure (payoffs)

[27] My conjecture is that rational choice theories must at some level rely on *institutions-as-equilibrium* -approach in order to answer questions like 'why rules and organizations do exist'. This breaks the potentially infinite hierarchy of rules, which would be silly.

of the collective action game. Numerous policies are available for that purpose e.g. selective incentives, success-contingent benefits, and insurance policies that promise compensations for co-operators if the provision fails. The actor's third option – and most likely the cheapest one – is to change beliefs of individuals about the likely behaviour of others. This strategy, however, works only when the system is already in the equilibrium selection phase, that is, cooperation is feasible, yet not the only possible outcome. In between these ideal policies there are many hybrids. The external actor, for example, may aim to change both incentives and beliefs.

The role of an external actor may vary greatly and often it is not possible to make a clear distinction between internal and external solutions. The main reason for this is that the user group may exercise its (collective) power over external actors, e.g. by lobbying political actors. This normally requires collective action by the user group even though external actors are involved. Yet there is a reason to maintain the analytic distinction. In principle, external solutions do not require successful collective action by resource users. Instead, they require that an external actor is interested in providing a collective good. Examples of these types of good are markets, courts and roads. These goods may profoundly change the incentives of resource users even though their demand and provision may be for all purposes external to the group.

A possible way to differentiate between implicit-, explicit-, and external solutions in collective action games is to take a look on what cooperation means. In simple collective action games the available strategies (or the strategy space) of players consists of cooperation and defection – or a continuum between them. By implicit solutions I understand that these strategies refer directly to investment levels of players: investments on the common-pool extraction (overinvestment phase) or investments on collective good provision (supply of production factors -phase). This also means that material incentives of the game are given by the resource- or good technology, e.g. by the yield- and cost function in the overinvestment phase. Sanctioning is possible, but limited to these strategies. This leaves e.g. trigger and tit-for-tat -strategies possible, if the game is repeated. Nothing rules out immaterial incentives though. Arguments that explain cooperation by referring to innate attributes of humans, such as altruism, empathy, conformism, and expressive behaviour, quite easily fall into implicit solution narratives.

In explicit solutions, however, incentives are no longer confined to material incentives which are given by the resource- or good technology (although they usually play a crucial role) and immaterial incentives which are invoked. One way to make the distinction is to use Ostrom's (2005, 58-64) idea of multiple levels of analysis. Ostrom distinguishes between operational-, collective-choice-, and constitutional level situations. At an operational tier, players "generate outcomes directly in the world (*ibid.,* 60)". Decisions at the collective-choice level, on the other hand, affect the structure of operational level, e.g. by introducing new roles (monitors) for players and attaching sanctions to certain operational level strategies (defection). Monitoring and sanctioning system that is generated at the higher-level to solve the operational level problem is a collective good itself, but its provision and maintenance technology does not necessarily follow the technology of the operational level collective good. Nor are the immaterial incentives invoked at the operational level necessarily the same as those in the collective-choice level. In explicit solutions "cooperative strategy" refers to investing on the higher-level collective good. These solutions to operational level collective action problems require that people have access to collective-choice level.

Now we hopefully have some kind of a picture what is meant by implicit- and explicit solutions and narratives. These are both internal solutions in the sense that players are users of the collective good. External solutions, on the other hand, require involvement of one or more external players. The distinction is important for a student of rational choice (who most often explains actions of individuals by referring to their beliefs and preferences), because motivations of users of the collective good and external actors are likely to differ. The involvement of an external actor must be explained from the point of view of her interests. The state, for example, may be interested in enhancing and securing tax income from the resource use. Or a politician may be interested in advancing demands from the local business in hope of gaining votes.

Real-world solutions to collective good problems are often a mixture of many above-mentioned elements (this becomes apparent in Chapter 4 where joint effects of formal sanctions and community norms are considered). But this does not make analytic distinction useless – at least to anyone with basic understanding of concepts like “continuum” and “fuzzy sets”. In what follows we will go through one possible narrative and its formalization. On the way some interesting theoretical observations are presented.

Collective action narratives: a potential formalization

Consider a one-shot game for illustration (following Medina 2007; also see chapter 4 in the current work). For each of the n (still identical) players there are four possible outcomes that are worth distinguishing for current purposes. These outcomes are: (1) player cooperates, and the collective action is successful, (2) player does not cooperate, and the collective action is successful, (3) player cooperates, but the collective action is not successful, and (4) player does not cooperate, and the collective action is not successful. Denote payoffs for our identical players associated with these outcomes using w_1 for outcome (1), w_2 for outcome (2), etc. If the rate of co-operators in the population is denoted by γ, the likelihood that the collective action is successful (or alternatively, the percent of collective good produced) can be given by an increasing function $F(\gamma)$. Following expected utility calculation (see Medina 2007, 26; also see chapter 4 in the current work), we can give the following condition for cooperation:

$$(w_1 - w_3)F\left(\gamma + {}^{1}\!/_{n}\right) - (w_2 - w_4)F(\gamma) \geq w_4 - w_3 \qquad (1a)$$

The condition above may generate many narratives. Consider, for example, our poor and still identical resource users in the overinvestment phase with a quadratic yield function. Not only are they poor, but they also face an unfortunate combination of numbers, investment power and technology: in their maximum total investment level, X^t, almost all yield from the common-pool is lost. By almost we mean that they receive some small positive total yield, $e[= Y(X^t) - C(X^t)]$, whose role will be specified and studied soon. If a resource user chooses to play cooperatively, she sets her investment level to her share of the optimal total investments, that is, to ${X^*}/{n}$. If she plays defectively, she sets her investment level to ${X^t}/{n}$.[28]

[28] We could also define a third option, a private alternative, and set the payoff from it to 0. But as long as e is positive, the smallest yield from the common-pool is still strictly positive and, therefore, the private alternative is a strictly dominated strategy and can be excluded from the analysis.

Can we say something about the success function? It turns out that we can say a lot. A reasonable estimate for the success-function could be drawn using the percent of collective good produced as a function of the rate of cooperative players in the population. The percent of collective good produced gives us the following success function:

$$F(X) = \frac{Y(X)-C(X)}{Y(X^*)-C(X^*)}, \text{ where} \quad (2)$$

$$X = (1-\gamma)X^t + \gamma X^*,$$
$$X^* = \frac{d-b}{2a},$$
$$X^t = \frac{-b+d-\sqrt{(b-d)^2+4ae}}{2a}.$$

The quadratic $Y(X)$, the linear $C(X)$, and the corresponding X^* have already been defined in earlier. At the total investment level, X^t, only a small positive yield, e, is received – the equation for X^t is derived using that insight. However, as e approaches zero, X^t approaches $\frac{d-b}{a}$, and at this limit the success function becomes independent of a, b, c, and d. This means that with the above mentioned definitions (most importantly the strategy space of individuals) all quadratic common-pool problems have the same success function. I do not write that they have the *same type of* success functions. In fact, they have *exactly the same* success function irrespective of the exact form of yield- and cost functions in question. In other words, take any common-pool with a quadratic yield function and a linear cost function, and the estimated success function F of the corresponding collective action problem is the following:

$$F(\gamma) = -\gamma^2 + 2\gamma. \quad (3)$$

This is not only a neat result for approximation purposes, but also an interesting fact from the point of view of collective action theories. Take another look at the inequation (1a) that gives the cooperation threshold. Assuming that a single cooperative decision has almost no effect on the outcome, $F(\gamma + 1/n) \approx F(\gamma)$, which could mean a large population in our example, the threshold becomes

$$F(\gamma) \geq \frac{w_4-w_3}{w_1-w_2+w_4-w_3}. \quad (1b)$$

There are two things that matter for a collective action theorist: the success-function (on the left-side) and the incentive structure (on the right-side). Many a tree has fallen since Mancur Olson's *Logic of Collective Action* so that numerous studies on either one of these properties could have been printed out. Most often mentioned continuous success-functions are the linear function, the concave function, the convex function, and the S-shaped function (see Figure 5). The result above suggests that one specific concave function, $-\gamma^2 + 2\gamma$, has a special status as long as conventional common-pool technology is considered.

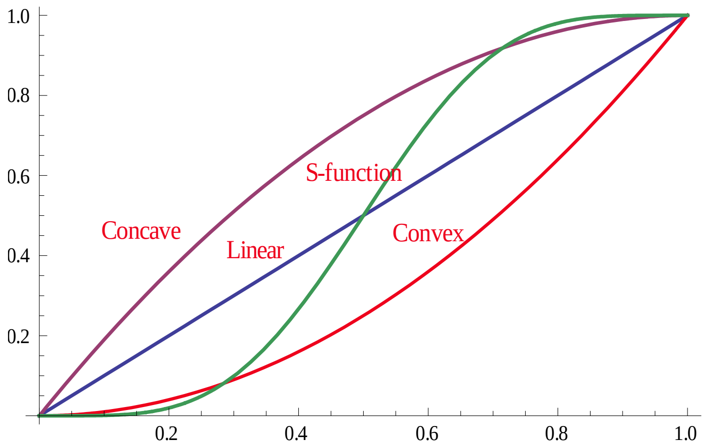

FIGURE 5

What does a concave success function do? Well, it basically stands for the easiest type of collective action problem! – At least if we compare it *ceteris paribus* to other functions listed above. The reason for this easiness is readily available in inequality (1b). The success-function must give values above the incentive threshold before individuals start cooperating. Concave functions give always higher values than linear- and convex ones, and do well against most S-shaped functions (as long as we conventionally consider functions that run through [0,0] and [1,1]). So perhaps our poor resource users are not without chances after all?

Let us leave the left-side of (1b) for a moment and turn our eager eyes to the right-side of it. This side is all about incentives. We know by now that the left-side of (1b) can never give a value above 1, and the inequality is true iff there is a higher value on the left-side than on the right-side. So if the right-hand side is above 1 for all values of γ, the inequality (1b) is not true and people will not cooperate. One soon realizes that it all comes down to whether $w_1 > w_2$ holds, which is the condition for the right-side to be less than 1 and, thus, for cooperation. (The realization is imminent with the help of Medina 2007.) Let us next take a look on the incentives surrounding people in our example. We will see rather unsurprisingly that despite the easy success-function, the situation is still a Prisoner's Dilemma if the common-pool technology alone dictates the incentive structure. This is good news for many trees! No need to reprint earlier text-books! Unfortunately, they should be revised to accommodate a sub-chapter that shows how the "commons story" can be translated into and approximated by standard collective action game elements.

Materialistic payoffs, or more specifically payoffs dictated by the common-pool technology, can be given as shares of the total yield. A resource user's share of the total yield is given by her investment share, that is, the number of her investments divided by the total amount of investments. With these definitions we can give following collective-action game payoffs:

$$w_1 = \frac{Y(X^*) - C(X^*)}{n}$$

$$w_2 = \left[Y\left(\frac{(n-1)X^* + X^t}{n}\right) - C\left(\frac{(n-1)X^* + X^t}{n}\right)\right] * \frac{X^t}{(n-1)X^* + X^t}$$

$$w_3 = \left[Y\left(\frac{(n-1)X^t + X^*}{n}\right) - C\left(\frac{(n-1)X^t + X^*}{n}\right)\right] * \frac{X^*}{(n-1)X^t + X^*}$$

$$w_4 = \frac{e}{n}$$

We give one more caveat by assuming that people do not distinguish the effect of a single cooperative decision in total net yields.[29] This assumption echoes our earlier assumption that single cooperative decision has almost no effect on the outcome. Another interpretation of this assumption is that, when defecting, people only consider increasing their share of the current yield, but do not take into account the decrease in total net yields that their own decision causes. In my opinion, this sounds right enough for current purposes.

When these incentives are fed into the right-side of (1b), and the critical condition $w_1 > w_2$ is considered, a couple of lines of simple algebra reveal that the right-hand side of (1b) is always higher than 1. This makes the threshold condition unattainable for any success-function. People do not cooperate.

But a bad place to live is often a nice place to start a story. People live poor and die young in the overinvestment phase at least as long as a cooperative equilibrium becomes feasible. Using this formalization, the turning point can be given a specific meaning with the help of (1):

$$F(\gamma) > \frac{w_4 - w_3}{w_1 - w_2 + w_4 - w_3} \text{ for some value of } \gamma. \qquad (1c)$$

Many implicit solutions are not compatible with this formalization (e.g. those based on repetitive interaction), but those that are include immaterial motivations making it better for individuals to cooperate than to defect in success ($w_1 > w_2$). If this also means that inequality (1c) is satisfied, the population is facing a coordination problem and the system is in the equilibrium selection phase.

Given that people have access to a collective action level and they are able to formulate policies that tackle the problem explicitly, either side of the inequality (1c) is subject to changes. The material technology of proposed solutions, e.g. establishing and maintaining monitoring and sanctioning institutions, is only loosely connected to the common-pool technology. This also means that our earlier conclusion about the applicability of the specific concave function, $-\gamma^2 + 2\gamma$, for estimation purposes of quadratic common-pools, is of limited value.

The following simple narrative illustrates how phases and turning points could follow one another. For brevity, denote the right-hand side of (1c) with W and let subscripts denote different F-functions and values of W.

Non-cooperation: $F_1(\gamma) < W_1$ for all values of γ.

Non-cooperation phase has already been discussed above. Figure 6a illustrates.

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[29] This means that we assume $Y(X^*) - C(X^*) \approx Y\left(\frac{(n-1)X^*+X^t}{n}\right) - C(\frac{(n-1)X^*+X^t}{n})$ and $e \approx Y\left(\frac{(n-1)X^t+X^*}{n}\right) - C(\frac{(n-1)X^t+X^*}{n})$.

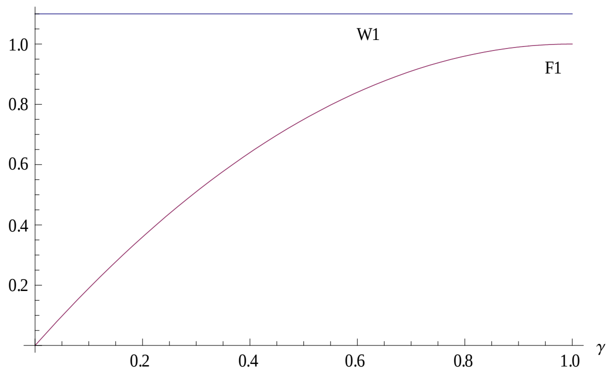

FIGURE 6a

The system remains in this phase until cooperative equilibrium becomes feasible. The three narratives (implicit, explicit and external) are distinguished by different processes that lead to this change. Let us assume here that resource users have low cost access to a communication arena where they can craft solution proposals. Which proposal is actually chosen by the collective depends on deliberation, bargaining and social choice rules, which would require new formalization if one was asked for. People may also fail to come up with a feasible solution. However, assume that resource users agree on setting up a monitoring agency that is hoped to solve the problem. Assuming that the new provision technology can be described by F_2 and W_2 people are able to enter the equilibrium selection phase, if the inequality below holds.

Equilibrium selection: $F_2(\gamma) > W_2$ for some values of γ.

In this phase two equilibria are possible depending on the beliefs of players about the likely actions of others (see Figure 6b).

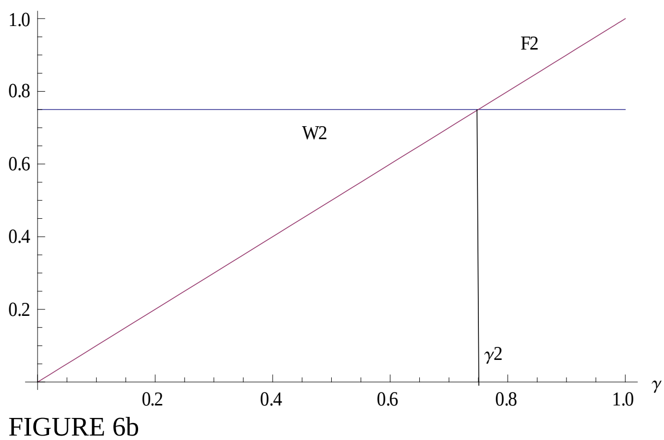

FIGURE 6b

If people expect that more than $\gamma_2 n$ people are going to cooperate, they will cooperate as well. The resulting equilibrium is that of full cooperation. If people expect fewer than $\gamma_2 n$ co-operators, they will not cooperate. The resulting equilibrium is that of full defection. Assume that despite their noble efforts resource users fail to coordinate to the Pareto-optimal equilibrium (perhaps they formed unfortunate beliefs about others behaviour during the policy formulation phase). An external actor interested in the common-pool yields may promise to provide half of the funds needed for the monitoring agency. One way to describe this change would be to modify the success-function (from F_2 to F_3; compare Figures 6b and 6c). The new collective action problem could then be described by the figure below. Note that $\gamma_3 < \gamma_2$ which means that less optimistic expectations on others' cooperation can now result to the Pareto-optimal equilibrium.

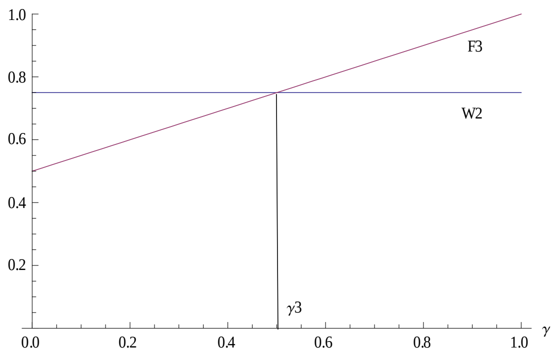

FIGURE 6c

According to our illustrative formalization, if the individuals' expectations are above the threshold, a cooperative equilibrium is selected and the collective good is provided by a mixture of explicit and external solutions.

Narratives, collective action theory, and remaining chapters

As already stated above, collective action theories can primarily contribute to understanding the supply of production factors (if they are collective goods), and to the supply of institutions regulating the resource use. It is usually the case that the former precedes the latter: only after a cheap enough supply of factors of production, it becomes beneficial for individuals to extract so many units from the commons that its very yield is threatened. Examples of these factors, which may be cheaper to provide collectively rather than privately, include fences and security of animals (pastoral systems), irrigation canals and their maintenance (agriculture), storage- and processing facilities (fishing).

Whether and in which manner individuals have solved their previous collective action problems can be very consequential for their ability to solve the overinvestment problem: institutional arrangements established for previous purposes (e.g. a committee deciding on fences, guards who monitor canal maintenance) can considerably lower the costs of further collective action, an external actor can continue to play a role in the business (e.g. state authorities trying to secure tax income), or a successfully solved coordination problem may enhance trust between participants and create expectations about each other's future behaviour (e.g. tacit and working agreement about fence maintenance can create expectation of cooperative behaviour in the future as well). Systems exhibit path dependencies and analytic narratives can help in revealing them. For collective action theorists this provides interesting further questions. In chapter 3 I will argue that common-pool users who have had the need to provide club goods in the supply of production factors phase are in better position to solve their collective action problem in the overinvestment phase than populations who have not had the need to provide them. At the same time it becomes obvious that collective action theories have something to contribute for students of common-pool resources well before the overinvestment phase.

Chapters 4 and 5 concentrate on institutionalized resource use phase. Chapter 4 reviews the role of formal sanctions and interaction effects between them and informal norms. A useful way to place chapter 4 into the bigger narrative is to note that it analyses joint consequences and limitations of two parallel solutions, implicit- and explicit ones, to the collective good provision problem. In chapter 5 I show an example of how people continue to face collective action problems in institutionalized resource use phase and how collective action of some may hurt the collective.

All in all these chapters illustrate how collective action in commons has diverse ends and consequences. Narratives, as discussed above, offer one possible way to analyse, make sense and draw connections between these ends and consequences in empirical cases.[30]

[30] A reader may benefit to know that following chapters are written with the aim that they are understandable also as independent texts. I suggest that the reader consults the summary of the work given here, if she finds herself wondering how certain points in the remaining chapters relate to the overall work.

3. THE OVERINVESTMENT PROBLEM OF CLUBS IN COMMONS

State intervention, often justified by the well-known “tragedy of the commons” argument (Hardin 1968), is familiar in many cases of common-pool resources (Ostrom 1990). Scandinavian, particularly Sami, reindeer herding is not an exception as governmental authorities have imposed restrictions on pasture use in all Scandinavian countries despite the lack of evidence on overgrazing before the intervention (Bjørklund 1990).

There seems to be a consensus among researchers that this lack of evidence is, at least partially, due to a local institution called *siida* (e.g. Bjørklund 1990; Riseth and Vatn 2009). *Siida* is a community that consists of several households and of their reindeers. This kinship based community herds privately-owned reindeers collectively. It enforces members’ private property rights over their animals, thus securing members’ private capital. It also mediates between different factors of production (labour, reindeers, pasture) to the extent that it can be called a management system: *siidas* are under constant restructuring as herders try to find a balance between available pasture, required labour and the number of animals (Bjørklund 1990, 2003). In this article I give a theoretical explanation for the success of *siidas* using the economic theory of clubs (Buchanan 1965) and rational choice theories on norm emergence (Coleman 1990).

Clubs are needed in cases of common-pool resources, e.g. when private investments are not secure and it is expensive or utterly impossible for an individual investor to secure them alone. More generally, clubs may emerge when there are mutual benefits from cooperation in the creation of some factor of production. If this type of factor limits the resource utilization, the overinvestment problem may not even be possible without clubs; e.g. if private investments of users are under risk of being lost, there is less incentive to invest in the commons in the first place. I make an analytical distinction between the overinvestment problem of individuals and that of clubs, and argue that the latter is easier to overcome. My interpretation is that Sami reindeer herders had never encountered an individualistic overinvestment problem before state intervention.

Why is the overinvestment problem of clubs easier to solve than that of individuals? Clubs go a long way in solving the boundary problem in respect of who is allowed to harvest (Ostrom 1990, 90). But they also guarantee that there is a possibility to communicate and some amount of accumulated trust among resource users and, finally, enough interdependency that makes mutual sanctioning possible. These are all either necessary conditions for club emergence or by-products of it, and they all foster further collective action. In other words, using the concept of James Coleman (1990), there is a social closure between resource users, at least within a club (local social closure).

But despite local social closure, clubs might end up overinvesting. Clubs would be in a better position to solve their overinvestment problem if there was a social closure also between clubs (global social closure). Interestingly, *siida* members have incentives to maintain relations with other *siidas* in order to secure their own position in the constant restructuring of *siidas*. As a by-product of this a social closure is also established and maintained beyond a single *siida* – a characteristic that might be lacking in more rigid systems.

But the existence of clubs might help even without extended social closure. If clubs are internally strong enough to be called corporate actors, i.e. they can claim authority over their members’ decisions, the overinvestment problem of individuals and that of clubs is of a different scale. This may fundamentally change the social dilemma at hand from a single equilibrium Prisoner's Dilemma to a multiple equilibria collective action game: a contribution of a single individual may be insignificant, but a contribution of a club (an aggregation of individuals) may very well be significant (Taylor and Ward 1987; Heckathorn 1996; Medina 2007). To summarize: this chapter tackles the complex causality problem in the CPR-literature by suggesting that the need for clubs explains some important factors repeatedly associated with successful self-governance (Agrawal 2002; Ostrom 1990; Baland and Platteu 1996; Wade 1994).

The rest of the chapter is organized as follows: section 3.1. makes an analytical distinction between the overinvestment problem of individuals and of clubs; section 3.2. discusses the role of *siidas* in Sami reindeer pastoralism; section 3.3. explicates the positive implications of clubs to norm emergence; and section 3.4. discusses the overinvestment problem of clubs more specifically and touches upon the effects of privatization in the presence of clubs.

3.1.The overinvestment problem of individuals and of clubs

In pastoral systems three factors of production are necessary: labour, animals, and pasture. The stock of animals forms the capital on which the pastoralist seeks return. Like in case of any other private capital, property rights over animals must be created and enforced. In pastoral systems enforcing private property rights can be challenging, but this is especially tricky in reindeer herding because reindeers are only semi-domesticated animals. This reduces human control over the animals and makes reindeers a somewhat risky form of capital. Risks are twofold and can come from the nature (natural losses) or from other human beings (thefts). Unless the capital is secure enough, individuals will not invest in it: large-scale herding is possible only after a functioning property system. The same observation holds for other common-pool resources as well. A fisherman laying a net expects to find it afterwards. A farmer sowing the field expects to be able to reap the benefit later.

I first redefine the classical overinvestment problem for insecure environments. Then I apply the economic theory of clubs by James Buchanan (1965) to the security provision problem. We will see that the individualistic overinvestment problem, where individuals invest beyond the social optimum (Gordon 1954; Hardin 1968), is possible only if individuals can secure their capital with low cost or if it is secured for them by an outside actor (such as a state). Otherwise, the overinvestment problem must be that of clubs. I concentrate here on the provision of capital security. Some other factors of production might also be easier to provide collectively and their existence might very well limit individuals' ability to extract or enjoy the common-pool resource. This generalization is left for later work.

Let the resource limitation in units of investments be L after which the aggregated marginal cost of an additional investment exceeds its marginal benefit for the investor. Classically, the overinvestment occurs, if the sum of individual investments ($m_i, i = 1,2...n$ where n is the number of individuals) exceeds L, that is, if $\sum_{i=1}^{n} m_i > L$.[31]. This, however, assumes that investments are secure. In some environments a better measure would take into account capital insecurity. If p_i is a probabilistic measure of security per a unit of investment by an

[31] An individual investment has an upper limit ($m_i \le m_{\max}$).

individual i, a simple overinvestment condition for insecure environments is $\sum_{i=1}^{n} p_i m_i > L$.

Lost capital, $\sum_{i=1}^{n} (1 - p_i) m_i$ units, neither provides a yield to investors nor exhausts the common-pool. These are e.g. animals eaten by predators or stolen and consumed by human beings. Assuming identical investors ($m_1 = m_2 ... = m_n = m$ and $p_1 = p_2 ... = p_n = p$) an overinvestment problem can theoretically occur, if $p * m * n > L$, that is, if

$$p \succ \frac{L}{n * m} \tag{1}$$

The overinvestment problem becomes more likely, when (1) there are very many resource users, high n (oceanic resources), (2) the resource is fragile, low L, (3) investments are cheap, high $m_{\max}$, or (4) the environment is secure, high p, or security provision is cheap for an individual as explicated later. For the current purposes the overinvestment problem in insecure environments can be phrased as follows: given the number of individuals n, the individual investment m, and the resource limitation L, how much security, p, are individuals willing to provide for their investments?

The answer obviously depends on how the security can be provided. A reasonable assumption is that the capital security is a club good (Buchanan 1965). First of all, securing the investment is not free of costs as suggested by our herding example. In addition, under certain conditions and up to a certain point there is "safety in numbers" in provision of capital security. Because of camaraderie, individuals can provide capital security more efficiently in groups of size $k \succ 1$ than alone, that is, the marginal utility derived from additional members is positive (Sandler and Tschirhart 1980, 1484). It is natural to think that this also depends on the amount of investment. A high level of security for small investments can be provided by individual effort alone, but cooperation of many individuals is needed to provide the same security for large investments and, furthermore, there are efficiency gains in doing so. It might be easier e.g. for two herders to secure one hundred animals together than if each secured fifty animals separately.

There is, however, a potential for congestion that might stem from the need for more coordination (e.g. greater organization), from the type of labour needed (e.g. already enough hands for every task), from the characteristics of the underlying common-pool resource (e.g. pasture limitation), or from the type of investment in question (e.g. very large herds could invite diseases, etc.). Due to congestion, efficiency gains from "ganging" cease to exist at some point, that is, the marginal utility derived from additional members eventually turns negative. This should be a rather general phenomenon.

To put it in formal terms; assume that the provision cost of security $C(p, k, m)$ has the following properties:

- $C(p=0,k,m)=0$, for any k,m (no provision, no cost)
- $\lim_{p \to 1} C(p,k,m)=\infty$ (full security is impossible)
- $\frac{dC}{dm}>0$ (larger investments harder to secure)
- $C(p,k=1,m)>C(p,k'>1,m)$, at least for some p,m,k' (clubs bring efficiency gains)

Further assuming that the cost function is continuous and monotonic in p and m[32], it is possible to depict Figure 7 fixing $k=1$:

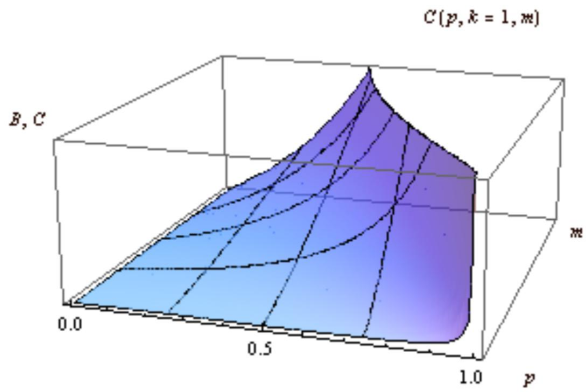

FIGURE 7

It is also natural to assume that the benefits $B(p,m,k)$ have at least following properties:

- $B(p,m,k)=0$, when $p=0$ or $m=0$ (no capital, no gain)
- $B(p_1,m_1,k_1)=B(p_2,m_2,k_1)$, when $p_1 * m_1 = p_2 * m_2$ (only the surviving capital matters)
- $\frac{dB}{dp}>0, \frac{dB}{dm}>0$ for low p,m, but not for high values (the common-pool property)

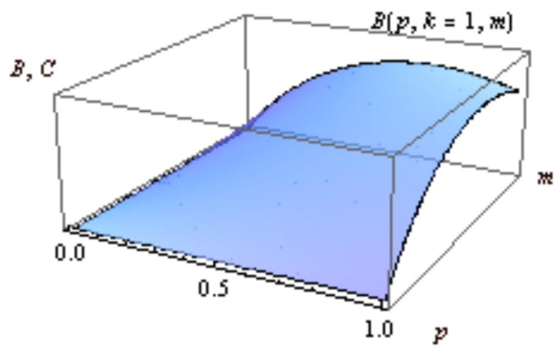

FIGURE 8

[32] Together with earlier assumptions this implies that costs are increasing and convex in p.

In order to illustrate the most important implication of the theory consider Figure 9 in which the utility of an individual is drawn by subtracting her costs from her benefits. The meshed area points out the overinvestment area as given in (1). As the group size is fixed to 1, individual investors do not find it beneficial to invest to the resource and secure their investments to the extent that overinvestment could occur (the highest utilities are not above the overinvestment area). The high cost of security restricts investments.

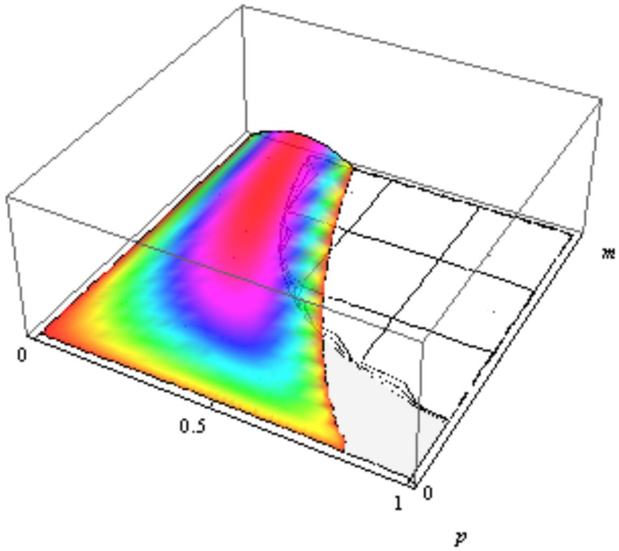

FIGURE 9

It is possible to finally summarize the relevant information in Figure 10 in which Curve 1 gives the optimal security provision for our example. However, as clubs $(k \succ 1)$ could secure the capital more efficiently (i.e. lower the cost of security provision) they may end up overinvesting. The optimal security provision curve could then resemble Curve 2 making the overinvestment possible.[33] In environments that are described by these curves the overinvestment problem of individuals does not occur. Rather, the problem before the emergence of clubs is the underinvestment problem because of the risky environment. It is only after the emergence of clubs that overinvestment can occur.

[33]It is possible that the utility peak (p^*, m^*, k^*) is located in the overinvestment area, because externalities are not internalized in the utilities of the investors. The space here does not allow the discussion of the optimal combination (p^*, m^*, k^*), or necessary conditions for its existence. The graphical method of Buchanan (1965) for obtaining one can be used in principle, but it requires adding the third dimension (for m). We finally end up having three planes, each depicting the optimal value of one parameter as a function of two others. For an equilibrium (following the within-club approach of Buchanan) it is then necessary that these three planes intersect and, furthermore, that the intersection point is stable.

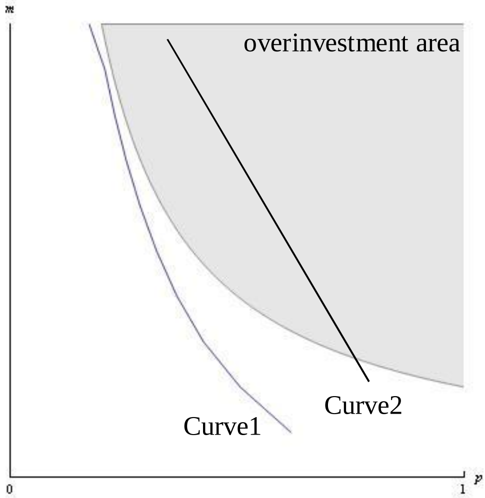

FIGURE 10

My hypothesis is that this description fits better for many examples of commons than the classical story of individualistic overinvestment. In cases of other club goods (not capital security) there are, of course, other technologies as well. Other classical examples include maintaining irrigation systems, providing access to markets, and making use of sophisticated hunting methods. On a bigger scale, capital owners form clubs known as firms that need lots of initial capital to start the production, and which are also primary users of the sink services of the atmosphere. But the general story always remains the same: clubs are needed before any overinvestment is possible. Important questions follow concerning e.g. the conventional policy prescriptions of privatization and state intervention. An analysis that fails to take into account clubs in these environments is likely to make wrong predictions on the effects of these policies. Later I discuss how one governmental intervention in Scandinavian reindeer herding destroyed the existing club structure and made it impossible for herders to enforce their private property rights over animals.

3.2.The theory of clubs applied to *siidas* in Sami pastoralism

The economic theory of clubs offers an analytic narrative for *siidas* in Sami reindeer herding. The Sami people lived in kinship-based bands already before reindeer pastoralism developed some 400 years ago. Usually these bands, consisting of some families, had exclusive rights to hunt or fish in certain areas, and state officials as well as other bands recognized these rights. The term *siida* then referred to an area and a band performing short migrations in the area depending on the availability of game and fish (Riseth 2006, 558-559). Presumably they enforced their rights of fishing and hunting grounds against others (see Pedersen 2002, 72), and importantly, provided social security for their members. Therefore, the *siida* system was not formed for pastoralism, but adapted to it. No doubt there were similar types of gains for “hunting stag” as described by the economic theory of clubs also before pastoralism.[34]

Before pastoralism, individuals usually had some reindeer that they used for transportation or as decoys while hunting wild deer. But deer and other game grew fewer. This was perhaps

[34] This becomes evident while reading on traditional Sami hunting methods, many of which required extensive cooperation (Vorren and Manker 1962, 67-81).

because of the introduction of firearms and migration from the south (Kortesalmi 2008, 22), or because of increased demand for furs in the European market (Riseth 2006, 558). The pastoral adaptation also coincides with a more general transition to monetary economy. Pastoralism offered better income via sales of meat and skins. (Vorren and Manker 1962, 81.) As a result, some of the Sami people adapted pastoralism. Interestingly, pastoral adaptation also created a feedback loop: large herds of reindeer made it harder to sustain the wild deer population.

In broad terms[35] the pastoral adaptation took place in the west and the north of Scandinavian Lapland, while in the east and the south, reindeer remained a secondary, yet important, source of livelihood next to fishing, hunting and small-scale farming. Swedish tax officials seemed to have recognized this. They collected taxes based on owned reindeer in the western areas already in 1692. In the east the taxes were based on game (such as moose, wild deer, bear, seal, and beaver) and fish (most importantly salmon). A famous 18th century botanist, Carl von Linné, noted in 1732 that the property of a Sami is his reindeer: according to Linné's estimation, a poor person had 50-100 animals, a well-off individual had 300-700 animals, and rich ones owned more than a thousand animals. It seems that the western adaptation was successful: in the east hunger became familiar as game decreased, and to some extent the Sami people gave way to farming migrants or assimilated to them. (Kortesalmi 2008, 20-30.)

Adaptation of pastoralism was not the end of *siidas*. On the contrary, they became the institutional backbone of the new system of production. In fact, the term nowadays refers to both herders that migrate together and to their animals. As before, a *siida* is a kinship-based organization and its migration patterns are more or less recognized by other *siidas* – although disagreements over pasture are possible. *Siida* members herd reindeer collectively, utilizing natural migration patterns, i.e. they collectively enforce one another's private property rights against nature and other human beings.[36] Natural threats included predators (e.g. wolverine, wolf, lynx, eagle, and bear), insects and diseases, reindeers simply wandering away, and also the scarcity of pasture. The latter can occur not only after overuse, but also during harsh winter conditions when pasture is under ice or heavy snow cover. The temporal variations of all of the above affect the costs of security provision, and change the optimal size of the *siida*. Ivar Bjørklund provides an illuminating example of this process:

> *As the herds differ in size through the year according to the varying grazing conditions, so also does the demand for herding task and labour. Consequently, the siida changes size and composition through the year, as the pastoralists divide and regroup their herds. Today in Finnmark, this may take place up to three times a year, the implication being that the pastoralists constitute three different sets of organizations: winter, spring and summer/fall. (Bjørklund 1990, 80-81.)*

Figure 11 illustrates how the *siida* is divided into smaller units when seasonal pasture does not allow a large herd or when there is no need for extensive labour. In the summer and fall *siidas* are large, as the summer pasture allows this (during the summer reindeers eat dozens of different plants): herders group their animals in large herds in order to save in labour. In doing so, herders also utilize the natural tendency of reindeers to defend themselves against

[35] It is not possible here to cover much of the spatial and temporal variations. For a more detailed survey, see Vorren and Manker (1962).
[36] Two remarks should be made: (1) Semi-domestication implies that animals retain some of their natural habits despite human interference making them a somewhat unpredictable form of capital. (2) The presence of state authorities (formal monitoring) is very limited as reindeer herding utilizes large tracks of land and, mostly, in remote areas.

insects (gadfly among many others) by clustering together. During the long winter season insects are not a factor (the average winter temperature is between -5 and -15 °C depending on the region), but the pasture is covered with snow and, occasionally, with ice. The consequences of the latter can be severe. Reindeers dig their way through the snow to eat vegetation, of which the lichen is particularly important during the winter. On a lesser scale reindeers also eat beard-moss. It is no longer possible to keep large herds and, on the other hand, most labour extensive tasks (e.g. counting of reindeers, slaughter, and marking new calves for their respective owners) are already taken care of in the fall. During the winter, unnecessary trampling of pasture must also be avoided as tightly pressed layers of snow makes it harder for reindeers to dig through the snow later in the season. *Siidas* divide themselves into smaller units for winter and spring seasons, only to be united for the summer in order to again reap the benefits of shared work.

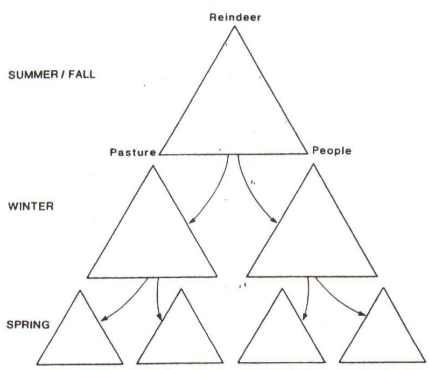

FIGURE 11: Siida constitution through the year (Bjørklund 1990, 81)

In short, the cooperation of club members allows them to maintain and secure larger herds than would be possible by an individual effort. The seasonal variations in the amount of work, pasture, herd size, etc. affect the underlying cost and benefits of ganging (as illustrated in Figures 7 and 8). Pastoralists seek to restructure their clubs accordingly.

However, restructuring is not always just seasonal, so that the *siida* always recovers its original form. If the herd is out of proportion to the pasture, "individual owners will withdraw their animals from the common herd and join other herding units according to kinship relations and available pasture." (Bjørklund, 1990, 81) Restructuring might involve harsh competition as s*iidas* can welcome a limited number of newcomers. Sometimes this leads to migration to new pastures, or forces people to change their livelihoods altogether (Bjørklund 1990, 81-82). There are, for example, Sami fishing settlements along the Norwegian coastline that were formed by people who had to abandon pastoralism (Vorren and Manker 1962, 53). Kin relations reduce the transaction costs of constant renegotiations among *siida* members, as well as the potential conflicts.

Sometimes restructuring also leads to the emergence of new *siidas*. Examples from the north-west of Finnish Lapland, Enontekiö, suggest that a new *siida* is usually founded by a merited herder, i.e. a herder in whose abilities others trust. In two of the most notable new *siidas* that emerged during the 20th century the entrepreneur originally came from outside the area (see Linkola 1972). A partial explanation could be that an outsider with less kin connections in the area might be at a disadvantage during restructuring. Therefore, he (it always was he) might have had less to lose by taking the risk of "going rogue". In some occasions the new entrepreneur left the old *siida* after a conflict. The fate of a new *siida* crucially depends on its ability to attract members. If enough manpower is readily available, a new *siida* can eventually claim part of the pasture and secure its members' capital. For a political scientist, the comparison to the emergence of new parties is clear: a distribution of pasture over physical space is replaced by a distribution of voters over political space: parties replace clubs and political entrepreneurs replace herders.

It is now hopefully clear how clubs play a role in Sami reindeer herding. Recalling the earlier discussion (Figure 4) it is possible to formulate the role of *siidas*. The adaptation of large-scale pastoralism can be seen as a coordination game of identical[37] players, where players can take care of some reindeer individually and receive the utility of optimal p, m-pair on the $k=1$-curve, or play cooperatively which allows them to increase their herds and receive the utility of optimal p, m-pair on the k^*-curve (see Figure 12). The *siida*, finally, is the consequence of a successful coordination of the mutually beneficial equilibrium, as well as a (then-emerged) set of institutional statements (Ostrom 2005) that maintain the coordinated outcome over time.

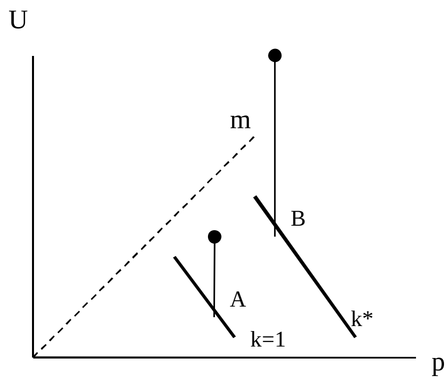

Figure 12

The *siida* system provided the institutional frame that enabled the western areas to make a beneficial transition from point A (few reindeers, less cooperation) to point B (many reindeers, more cooperation), or rather, to the surroundings of point B. The seasonal- and other variations in the natural conditions and available technology affect the cost- and benefit functions and change the optimal solution.

My understanding is that an individual overinvestment problem was not even a theoretical possibility given pre-modern technology and the pastoralist population. In short, it was not possible for an individual to secure so many animals that pasture limitation could have been met. *Siidas*, however, were able to provide security with high enough efficiency. The overinvestment problem, if any, must have been that of clubs. But why is this situation better than the overinvestment problem of individuals? And why does the *siida* system in particular

[37] Identical players are assumed for ease of presentation. In reality *siidas* consist of heterogeneous individuals, e.g. when measured in owned reindeers. Heterogeneity greatly affects the optimal size considerations, but this question is left for future work.

seem to offer an example of robust self-governance? For the answer I turn to the implications of clubs to the overinvestment problem.

3.3.The positive implications of clubs to norm emergence

An overinvestment problem is a problem of negative externalities. Some set of institutional statements, however originated, could ensure a better outcome for all resource users (Ostrom 2005). In classical rational choice–based sociological literature this task is given to norms (Ullman-Margalit 1977; Hechter 1987; Coleman 1990).

It fulfils my purposes here to define norms as collective action level public goods that ensure a Pareto-optimal move (although not necessarily Pareto-optimality) by changing the incentive structure in the operational level. Simply put, some actions (such as investing above a certain quota) are forbidden and deviators should expect to be sanctioned. The second-level (public good) problem concerns the supply of these sanctions.

I argue that "ganging together", or club formation, has the following positive side effects for norm emergence: (1) Clubs guarantee that resource users already have an arena for communication. (2) There is some amount of accumulated trust between club members as they have already solved one collective action problem – that of jointly providing the club good (e.g. capital security). (3) Resource users are in control of actions that their peers hold of some value, that is, mutual sanctioning is possible. (4) Clubs may also help to solve problems of boundaries and of monitoring.

The importance of these points could be – and has been – justified with the backing of many theories. I would like to stress that the conclusion is not restricted either to any single rational choice account on norm emergence, or (tentatively) even to the rational choice theory more generally. In order to illustrate this, I exercise theoretical triangulation. However, points 1-3 can be summarized using a single rational choice account on norm emergence, linking them to a concept of social closure, which proves to be useful for further analysis (Coleman 1990).

(1) The importance of a communication arena, firstly, can be linked to deliberative processes and to the spread of ideas shaping resource users' understanding of the situation. Political scientists, in particular, are sensitive to the role of ideas when speaking about discourses, paradigms and identities. The importance of a communication arena can then be justified outside rational choice theory, which is not as much a predominant theory in political science or sociology as it is in economics (Hovi et al. 2011, 395-398). Secondly, one could justify the importance of communication by a mere layman account. It is unlikely that any form of conscious collective action, such as institutional design, could occur without communication, unless the problem is very simple.[38]

A third justification is found in Ostrom's (1990, 90) design principles for successful governance. Two of them directly involve communication arenas. One principle states that individuals, who are affected by rules, should be able to participate in their crafting. This crafting requires a collective choice arena. Another principle states that individuals should have low cost access to a conflict-resolution arena. If these public goods have already been established for the purposes of clubs, they can also serve as communication arenas for other problems.

[38] Ruling out unconscious designs, e.g. through evolution.

(2) The importance of mutual trust for norm emergence and collective action seems self-evident. Because club members might value trust vested in them, it enables them to make further credible promises. The importance of trust is also justifiable outside a classical concept of rationality as discussed next. The classical idea of rationality in strategic environments, inherent e.g. in the Nash equilibrium, would not advise the play of a strictly dominated strategy. In the Prisoner's Dilemma this excludes the Pareto-optimal mutual cooperation. A big part of the appeal of the PD is that the mutual defection "should" not be the outcome of the game. This "should" includes the idea that players might convince each other that they are each willing to play a strictly dominated strategy. Assuming that conditions for none of several analytic solutions to the PD are satisfied there is a need for individuals to be irrational in the sense of "preferring A, having a choice, and choosing not A (Howard 1987, 12)". Howard (1987, 12), while using game theory to analyse its own deficiencies, argues that we have a need for this type of behaviour and that "the function of inter-personal emotions [is] to make such irrational intentions credible (*ibid.*)". An important ingredient of many positive inter-personal emotions, such as love and caring, is mutual trust. Therefore, at its best mutual trust can lead to something more than mutually beneficial exchanges in markets, as suggested by many rational choice accounts (Hirshleifer 1984).

(3) Interdependence concerns interests and control, and therefore, implies power relations. Interdependence between two individuals is here defined as one having control over actions in which the other has an interest (Coleman 1973; 1990). In comparison to (1) and (2) this point is probably more difficult to justify outside rational choice theory (see also Hovi et al. 2011, 399-403). The link between interdependency and self-governance is in sanctioning. If resource users are able to (threaten to) sanction each other, they are better able to enforce norms and rules. They then have access to sanctions, which are again among the design principles of Ostrom (1990, 90). The most extreme case of sanctioning is probably ostracism (Hirshleifer and Rasmusen, 1989), which in this case can lead to loss of private capital in addition to social inconvenience. Note that private property is a social institution. If others do not recognize your property rights, but treat your possessions as nobody's property, you are most likely in serious trouble. This is also the reason why capital security can be called an access good.

(4) Clubs also help to solve the problem of borders – at least in respect of defining the resource users (Ostrom 1990). It should also be mentioned that as private capital is secured jointly, club members are in an excellent position to monitor each other. Accountable monitoring, again, is one among the eight design principles by Ostrom (*ibid.*), because it makes sanctioning possible. Club formation seems to help solve the monitoring problem if not between clubs, then at least within a club.

The three first points above – communication, trust, and interdependence – are necessary conditions for what Coleman (1990) calls social closure. Coleman (1990, 667-951) uses an extended version of a classical barter economy model to draw a condition for norm emergence. The model treats a social system as an exchange system, where individuals have control over certain events[39] that can then be traded. Coleman (1990, 785-829) introduces events with negative (positive) externalities distinguishing two regimes, regime A and regime B. Under regime A, actions producing negative externalities are taken (or actions producing positive externalities are not taken), and their joint value in competitive equilibrium (v_a) is

[39] We speak of events rather than goods.

calculated.[40] Under regime B producing actions producing negative externalities are not taken (or actions producing positive externalities are taken), and their value in competitive equilibrium (v_b) is calculated.[41]

The condition for norm emergence is then v_b-$v_a>0$, that is, the joint value of externalities is higher than the value of action itself. At its face value this condition seems to tell us nothing more than that a Pareto-optimal move is possible and that it serves as a threshold condition for instrumental proposition (see Opp 2001), i.e. a sufficient demand for the norm exists. This means that people who are affected by the externalities are jointly willing to provide enough incentives to individuals in control of the action to effectively either ban or oblige the action. But Coleman (1990) also provides several extensions to the model including communication channels and trust.

Restrictions to communication channels, either transaction costs or total incapability to communicate, decrease beneficiaries' capability to operate sanctions. The extreme case is when every individual forms her own partition in the exchange system being totally unable to communicate with anyone. Naturally, the end result is no exchange at all: people must hold the resources they already control. Target actors also remain in control of the externality producing action. The lack of social closure due to communication difficulties is one story behind Prisoner's Dilemma. When some communication is possible, but it remains expensive, it effectively reduces the willingness of individuals to exchange resources. It is then more expensive for beneficiaries to apply the necessary sanctions.

The same logic applies to interpersonal trust in an exchange network. A successful exchange between two people requires traders to trust each other. If one trader mistrusts the other, they obviously take into account the possibility that the other will not deliver their part of the bargain. As traders weigh in the trust factor it affects the set of deals within their reach. Again, as in the case of no communication, complete mistrust ruins any possibility of a trade leaving both traders with their original possession. Mistrust in general makes it more expensive for beneficiaries to raise the necessary resources for efficient sanctions.

Finally, interdependency implies that traders have something to trade, i.e. as previously said, individuals are in control of actions in which others have an interest. If this condition is not met, there are obviously no beneficial trades to be made. This is also a basic definition of power, and necessary for (both positive and negative) sanctioning. If beneficiaries do not have control over anything that target actors consider to be of some value, they are unable to sanction them. In cases of common-pool resources this would mean that individuals' only interests in others is through the resource they are using. Securing capital is one reason why individuals might be interdependent also through channels other than their shared resource.

It is now hopefully clear why the concept of social closure is a necessary condition for norm emergence in Coleman's theory, and how communication, trust, and interdependency are linked to it. We are then able to analyse the overinvestment problem of clubs further, using the concept of social closure.

[40] Disregarding interests over externalities produced by the action.
[41]Taking only interests over externalities into account.

3.4. How to tackle the overinvestment problem of clubs?

After the discussion above, it seems that there are theoretical reasons to believe that clubs might favour norm emergence and, thus, robust self-governance. Of course, this is not necessarily so. Consider, for example, the most fundamental of all clubs, the family (henceforth, the household). The household is an aggregation of individuals, and it can be said to enjoy a high form of social closure. Because of this, the household is in a good position (at least in comparison to other entities) to solve its internal social dilemmas. But local social closures of separate households, though encouraging, are not sufficient for cooperative outcomes in a general level: separate households might very well end up overinvesting. The club structure, their sizes and relations become crucial. Here I sketch two roads for a cooperative outcome using *siida* system as an example.

From local to global social closure

In the Sami culture the equivalent of a household was a *baiki*: *siidas* consisted of several *baikis* (Riseth and Vatn 2009, 90). This implies that there was local social closure beyond the level of households. However, when evaluating reasons for the long-term success of Sami pastoralism, it is not sufficient to note that *siidas* enjoyed local social closure. The question of global social closure must also be assessed, and for this the *siida* system provides an illuminating example.

The answer lies in the flexibility of *siidas*. Bjørklund (1990, 81) describes how individual herders leave a *siida* when the herd grows beyond the pasture limits, and joins other units that seem to be more viable. This restructuring is possible because kinship relations spread over *siida* boundaries. Individuals have family members in several *siidas*, and these family connections give them a possibility to join other units. Assuming that kinship relations positively contribute to communication possibilities, trust and interdependency, the social closure expands well beyond individual *siidas*. Furthermore, linkages to many *siidas* are probably of benefit for an individual – the access to other units gives them possibilities for voice and exit (Hirschman 1970). This provides the individual a good position in the competition and bargaining that obviously results from regroupings as already discussed earlier.

In other words, there were incentives for individuals to establish and upkeep their connections beyond *siida* borders. In this respect 19th century herders are not unlike modern workers. Modern workers serve their interests by occasionally having lunch with colleagues from other firms. These connections might be beneficial for the worker in the future by making it easier for them to leave their job. The same rationale makes some married people suspicious of their partner's connections. The constant need to restructure, presumably not encountered in marriage, made *siidas* less suspicious of their members' outside connections. As a by-product this also ensured social closure between *siidas* and gave *siidas* a better ability to solve joint social dilemmas.

The social closure goes a long way to explain why pasture demarcation between *siidas* was closer to discreet negotiations than open conflicts (Linkola 1972). *Siida* members would have undermined their future interests by engaging in an open conflict with other *siidas*. Note that this need not be the case generally: the relation between different clubs can very well be hostile limiting the social closure to that of an individual club.

No doubt the biggest and most difficult restructuring in Sami pastoralism took place at the turn of the 20th century. It was not initiated by *siida* structure or by natural conditions, but by treaties between states (Sweden, Norway and Russia). In these treaties governments closed the borders for Sami pastoralists, who before had freely crossed the national borders migrating from summer pastures to winter pastures.[42] Martti Linkola (1972, 53-57) describes its effects on Sami reindeer herding in the northernmost parts of (then) the grand duchy of Finland using words "turbulence" and "crisis". As people tried to find new pastures, they migrated to new areas with reindeers and old cooperation networks had to be abandoned. Some people lost their capital; some got rich. Thefts were common, and some families descended into raids on one other. In other words, the club structure shattered due to external pressure, private property rights were not enforced, and trust between *siidas* eroded. This counts as evidence of how provision of capital security was in the hands of herders. When they were not able to provide it, private property rights were immediately under threat. It goes without saying that the government policies (border closures) were not supporting the local institutions – quite the contrary. Even though the *siida* system had been successfully restructuring itself seasonally and, to some extent, also in response to economic- and environmental challenges, its institutions (norms and rules) were not able to maintain coordinated, cooperative outcomes in a new situation. Despite these difficulties, which originating externally, the *siida* system is a fine example of how individuals can produce social closure between clubs as a by-product, while aiming to secure their own interests. The story is essentially the same as that of social closure within a club. It is also a by-product of individual actions aimed at something else.

Clubs as corporate actors: rescaling the dilemma

If clubs are understood as corporate actors, i.e. macro-level entities where individuals have vested authority (Coleman 1990, 325-531), this rescaling might fundamentally change the collective action game at hand from a single equilibrium Prisoner's Dilemma to a multiple equilibria game. One of the assumptions making a collective action game a Prisoner's Dilemma is that not one single cooperative decision has a significant effect on the success of cooperation (Taylor and Ward 1987; Heckathorn 1996; Medina 2007). This assumption might not hold if the dilemma is rescaled to the level of clubs. Clubs are aggregations of individuals and their decisions might have considerable impact. After rescaling the game, cooperative equilibria may emerge and the game be transformed into a game of Chicken or Assurance depending on the exact technology (for a good overview, see Heckathorn 1996).

For example, Michael Taylor and Hugh Ward (1987, 357-360) are operating on the level of clubs when they discuss the history of whaling from the point of view of states, and cautiously suggest that the modern history of whaling resemblances the game of Chicken. Whichever multiple equilibria model we are left with after rescaling, it is for the better: unlike Prisoner's Dilemma, all of them have equilibria in which at least some players are cooperating. The question, of course, is: when it is appropriate to change the level of analysis from individuals to clubs? When should clubs be treated as corporate actors? Obviously these questions require a separate study (Coleman 1990). It is sufficient to note here that this usually requires established authority relations, an organization that enforces the will of a

[42] Several reasons for border closures have been suggested including rise of nationalism, desire for better border security, and governments' willingness to promote agriculture over pastoralism and colonization over indigenous population. An interested reader should consult Pedersen (2002). The treaty between Norway and Finland was crafted in 1852 and the treaty between Sweden and Finland in 1888. It, however, took several years until formal treaties had any practical effect.

corporate actor, as well as some system of forming one. Of course, in authoritarian systems these could all be embodied in one person.

It is then interesting to look into authority relations in a *siida*. The *siida* has a chief, who has "absolute authority on all matters, particularly when they concern reindeer management – as long as he manages to hold on to his authority. This is automatically his as long as he owns the greatest number of reindeer and has the greatest experience or ability" (Vorren and Manker 1962, 144-145). The position of a chieftain is not only a respected one, but also a desired one. Entrepreneurs starting a new *siida* must enjoy a level of chieftain reputation in order to attract new members. The important point is that the position of a chieftain, even though based on tradition rather than formal institutions, is a step towards *siida* as a corporate actor. As long as the corporate actor is able to make decisions on behalf of individuals, the dilemma is rescaled and the nature of the problem may change fundamentally. Note that when all users form only one club, which is internally strong enough to be called a corporate actor, the situation strongly resembles a monopoly.

This theoretical discussion suggests the following hypothesis for environments where some important factor of production is a club good: the likelihood of successful self-governance tackling the overinvestment problem is increasing in the ratio of optimal club size and the total number of resource users.

Clubs, privatization and state management

A final note concerns the policies of resource privatization and state management, which have often been suggested as solutions for the overinvestment problem (Ostrom 1990, 8-15). The effects of either of them, however, have not been studied extensively enough in cases where some other factor of production must be produced collectively. Both policies change the incentive structure in which clubs operate. At their worst these policies can have adverse welfare effects for resource users in a similar manner as border closures had for reindeer herders via the inability of *siidas* to maintain capital security. It becomes crucial to know how the club structure adapts to the new situation. The experience of *siidas* suggests that a non-cooperative game theory may be a promising tool in that analysis as the breakdown of cooperation is a very real possibility. However, each case must be analysed separately as the club structure can take many forms.

Recapturing main points of the chapter

The main point of this chapter has been to suggest that there are important differences between the overinvestment problem of clubs and the classical overinvestment problem of individuals. When some important factor of production is a club good, the existence of clubs may very well be a requirement for any overinvestment. But clubs also seem to imply several conditions that facilitate successful self-governance and norm emergence, i.e. the necessary condition for the problem also provides some elementary tools for its solution. The distinction between environments where clubs are needed and where they are not will hopefully allow more nuanced discussion on complex causality issues in the commons.

In this chapter some humble steps are also taken to test the empirical usefulness of the theory by applying it to groups of herders, *siidas*, in Sami pastoralism. *Siidas* provide security over their members' private investments collectively in a risky environment. I propose that the Sami did not face the problem of individuals before the state intervention, but – if anything –

they faced the overinvestment problem of clubs. Interestingly, earlier literature on *siidas* suggests that individual herders had clear incentives to maintain good relations to neighbouring *siidas* due to constant restructuring of clubs. This restructuring was needed because the external conditions (seasonal and other) changed the optimal club size over time. As a by-product, the social closure also extended beyond a single club. Interestingly also, authority relations in *siidas* seem to suggest that the club could claim authority over its members' decisions concerning herding. When this observation holds, it is possible to re-scale the problem to the level of clubs (clubs can be treated as decision makers). After this re-scaling, the nature of the collective action game may change fundamentally, allowing (more) cooperative equilibria.

4. FORMAL SANCTIONS IN CPRs: WHY SO OFTEN, BUT SO LOW?

Formal negative sanctions lie at the core of two classical solutions to the common-pool resource problem: state intervention and privatization (Ostrom 1990, 8-15). State intervention could change the incentives of resource users in the assumed Prisoner's Dilemma, e.g. by providing the disincentive of sanctions for users who exceed the quota. Similarly, formal sanctions also play a key role in enforcing private property rights against thefts and against frauds in trading. Sanctions, however, are not important only to external solutions, but also to robust self-governance.

Many systems of robust self-governance have rules that also assign sanctions for those who break them. This observation suggests that formal sanctions play a positive role in self-governance. From the point of view of classical decision theory, however, sanctions are often low (although gradually increasing if the offence is repeated [Ostrom 1990, 90]). One could argue that once a system of sanctions has been established, more deterrence could be achieved with little extra effort merely by increasing sanctions. But this type of harsh regime is rarely encountered. One possible response would be to argue that formal sanctions do play a positive role in self-governance, but not necessarily as a deterrent.[43] Here I explore an explanation compatible with the deterrence hypothesis by also identifying negative causal mechanisms between formal sanctions and collective action as suggested by earlier literature. These negative mechanisms could set boundaries for the use of formal sanctions in collective action dilemmas.

In what follows I first identify two positive mechanisms (direct mechanism, belief mechanism) through which sanctions operate. Using a model of collective action I study the interaction effects between deterrence and other institutions that favour robust self-governance. More specifically, I study how conformism – a concept closely linked to 'tit-for-tat' and reciprocity – interacts with deterrence. The main point is that the positive effect of deterrence prevails, although changed, notwithstanding the number of equilibria in the collective action game.

Secondly, I point out negative causal mechanisms between formal sanctions and collective action and point out conditions under which they are likely to occur. Formal sanctions may reduce resource users' regulatory interest in each other's actions and, therefore, reduce peer monitoring, which helps to maintain formal deterrence. They may also reduce other types of informal control. In addition, increased formal deterrence could lead to a loss of conformism because of motivation crowding-out. Depending on the characteristics of the system, an increase in formal sanctions may not succeed in increasing either the formal deterrence or the overall deterrence. Furthermore, in those cases where it does succeed in both, it may still be that the loss of conformism outweighs the deterrence effect. The problem is complex causality (Agrawal 2002), and there is clearly a need to study the relative importance of these mechanisms.

[43] For example: Income from sanctions can be used to maintain monitoring, and the real deterrence is informal (e.g. the loss of reputation). This type of explanation would still need to explain why people are not deterred by more severe formal sanctions.

4.1. Formal sanctions and other institutions sustaining cooperation

Sometimes institutions create interesting interaction effects. Here I study interaction effects between formal sanctions and other institutions in the collective action. By "other institutions" I mean institutions that can sustain cooperative equilibria in a classical collective action game.

While discussing sanctions, Elinor Ostrom (1990, 94-100) links them to quasi-voluntary compliance (Levi 1988). Margaret Levi clarifies the concept of quasi-voluntary compliance in the context of taxation:

> *It is* voluntary *because taxpayers choose to pay. It is* quasi-*voluntary because the noncompliant are subject to coercion – if they are caught. […] Taxpayers are strategic actors who will cooperate only when they can expect others to cooperate as well. The compliance of each depends on the compliance of the others.* (Levi 1988, 52-53, emphasis in the original)

The most important point is that compliance of this sort is contingent upon others' behaviour. Interestingly, Edna Ullman-Margalit's (1977) definition of conformism captures much of the same logic. According to Ullman-Margalit (1977, 93; emphasis in the original) "the conformist […] regards the majority of the situations in which he has to make a decision about action *as if* they were co-ordination problems. […] the conformist perceives his preferences as conditional upon the actions of others […]" More generally, the conformist is an imitator who does not want to stand out.

In game-theoretic terms, quasi-voluntary compliance or conformism may change a single-equilibrium game (a PD) into multiple equilibria game (coordination game, see Cooper 1999). But concepts such as 'quasi-voluntary compliance' or 'conformism' are not the only concepts with that power. Other well-known examples are 'trigger'- and 'tit-for-tat'-strategies, the norm of reciprocity and success-contingent benefits for cooperators.

General feasibility theorems[44] say that in an infinitely repeated PD trigger strategies can support cooperative equilibria, i.e. make them possible outcomes (Rubinstein 1979; Medina 2007, 70-79). Trigger strategies are punishing strategies: a player punishes other players' earlier defections by defecting herself. An important sub-class of punishments, which also attains an elementary sense of fairness, is 'tit-for-tat'. In repeated PDs the 'tit-for-tatter' gives the other player the benefit of the doubt by cooperating in the first round and imitating the other player's earlier move in the subsequent rounds. The relative success of 'tit-for-tatters' might explain why some people seem to have internalized the norm of reciprocity: be nice, if you observe nice behaviour; be bad, if you observe bad behaviour. Yet another set of institutional statements that can support multiple equilibria is success-contingent benefits for cooperators (Medina 2007). If players expect that their nice behaviour is going to be rewarded if the collective action succeeds, they might find it better to behave nicely if the likelihood of success is sufficiently large. In general this likelihood depends on the behaviour of others.

Quasi-voluntary compliance, conformism, punishing strategies, reciprocity and success-contingent benefits for cooperators all share a simple common denominator, which can be

[44] These are still better known as folk theorems.

expressed using the vocabulary of institutional grammar (Ostrom 2005). The grammar identifies five parts that an institutional statement usually contains, thus making their comparison easier. One of these is the Condition giving the information about the conditions under which the statement applies. For example, the 'tit-for-tat' strategy could be expressed as "one cooperates, if it is the first round or the other player cooperated in the previous round", and here the Condition refers to the sentence starting with "if". The common denominator is that the Condition of each of these statements refers to the behaviour of other players (usually, but not necessarily, of similar type than the *ego*). Success-contingent benefits do that via the likelihood of success, others more directly. More detailed comparison can be found in Figure 13. The last entry also gives the definition of how formal sanctions are understood here: they are contingent only on the *ego*'s own action, not on the behaviour of others.

Syntax part	Attribute	Deontic	AIM	Conditions	Or Else
Content of the part	to whom the statement applies	a modal verb	describes actions to which the deontic is assigned	defines when and where the statement applies	d. the institutionally assigned conseq. of not following
Tit-for-Tat	*Ego*		cooperates	first round; the other player cooperated in the previous round	
Reciprocity (direct)	*Ego*	must	cooperate	the player that *ego* faces cooperated previously	
Compliance (general)	*Ego*	must	take an action A	at least *k* % of others take an action A	
Success-contingent benefits	*Ego*	must	cooperate	the collective action is successful	*ego* receives no benefit
Conformism (general)	*Ego*	must	take an action A	at least *k* % of others take an action A	
Formal sanctions	*Ego*	must	cooperate	always	*ego* receives a negative sanction *s*

Figure 13: Comparison of some well-known institutional statements

Interestingly, the existence of these types of statements opens up a second mechanism for formal sanctions to operate: the *ego*'s behaviour is not only affected by possible sanctions directed at it, but also by possible sanctions directed *at others*. The first mechanism is here called the direct mechanism, and the second mechanism is here called the belief mechanism. It is rather obvious that other institutional statements therefore mediate the effect of sanctions. Studying these connections at a theoretical level, hopefully offers a partial answer to the call of Arun Agrawal (2002) who stresses the importance of finding interaction effects between variables that seem to foster robust self-governance in CPRs. We are also combining two rational choice approaches to collective action: single- and multiple equilibria models (Taylor and Ward 1982, Heckathorn 1993, Medina 2007).

4.2. A collective action model with formal sanctions and conformism

Next I study conformism in a more detailed manner using one-shot game, but it should be clear that the choice of the contingent statement is a question of convenience – not of content. By now there is both theoretical (e.g. 'tit-for-tat' in repeated games) and empirical (e.g. cheap talk effect in PD experiments) evidence suggesting that many people have internalized the norm of conformism to some extent and that there may be a clear rationale for doing so. This implies that it is worthwhile to study the effect of formal deterrence in a population where some are conformists. I follow the convention in Ostrom (2005), and represent the norm of conformism by delta-parameters (δ). The formalization of the general collective action game follows Medina (2007), but the model differs from those considered there.

Consider *N* players, each arbitrary player i having a possibility to either cooperate C_i or defect D_i. The payoff from the successful collective action is denoted by b_i, the cost of cooperation by l_i, and sanctions for defection by s_i. Sanctions refer to overall deterrence meaning that it captures both the severity of formal- and informal sanctions and the likelihood monitoring. Possible payoffs for a player i are then as follows:

- i cooperates, collective action succeeds, k-majority cooperates: $w_{1i} = b_i - l_i + \delta_i$
- i cooperates, collective action succeeds, no k-majority: $w_{2i} = b_i - l_i$
- i cooperates, collective action succeeds, k-majority defects: $w_{3i} = b_i - l_i - \delta_i$
- i cooperates, collective action fails, k-majority cooperates: $w_{4i} = -l_i + \delta_i$
- i cooperates, collective action fails, no k-majority: $w_{5i} = -l_i$
- i cooperates, collective action fails, k-majority cooperates: $w_{6i} = -l_i - \delta_i$

- i defects, collective action succeeds, k-majority cooperates: $w_{7i} = b_i - s_i - \delta_i$
- i defects, collective action succeeds, no k-majority: $w_{8i} = b_i - s_i$
- i defects, collective action succeeds, k-majority defects: $w_{9i} = b_i - s_i + \delta_i$
- i defects, collective action fails, k-majority cooperates: $w_{10i} = -\delta_i - s_i$
- i defects, collective action fails, no k-majority: $w_{11i} = -s_i$
- i defects, collective action fails, k-majority defects: $w_{12i} = \delta_i - s_i$

Denote the likelihood of a successful collective action by $\Pr(Succ)$ and the likelihood of a failure by $\Pr(Fail)$. I assume $1 - \Pr(Succ) = \Pr(Fail)$. Denote the likelihood of the event that k-majority cooperates by $\Pr(Maj \quad C)$, the event that k-majority defects by $\Pr(Maj \quad D)$, and the event that there are no *k*-majority by $\Pr(No \quad Maj)$. Naturally, $\Pr(No \quad Maj) = 1 - \Pr(Maj \quad C) - \Pr(Maj \quad D)$. All the probabilities depend on the strategy vector, and more specifically, on the rate of cooperating players, $0 \prec \gamma \prec 1$. Denote conditional probabilities as in $\Pr(Succ|C_i, \gamma)$, which refers to the probability of success given that γN others are cooperating, and player i cooperates. Recalling that the k-majority is defined as a proportion of others (*ego* not included), it holds that e.g. $\Pr(Maj \quad C|C_i,\gamma) = \Pr(Maj \quad C|D_i,\gamma)$. It is convenient to write $\Pr(\gamma < 1-k)$ instead of awkward $\Pr(Maj \quad D|C_i,\gamma)$, $\Pr(1-k<\gamma<k)$ instead of $\Pr(No \quad Maj|C_i,\gamma)$, and $\Pr(k<\gamma)$ instead of $\Pr(Maj \quad C|C_i,\gamma)$.

Let the function $v_i(C_i,\gamma)$ denote the payoff for player i after her cooperation given a certain rate of cooperating players, and $v_i(D_i,\gamma)$ the corresponding payoff after her defection. Any arbitrary player i then cooperates, iff

$$v_i(C_i,\gamma) > v_i(D_i,\gamma), \tag{1a}$$

where

$$\begin{aligned} v_i(C_i,\gamma) = {} & w_{1i}\Pr(Succ|C_i,\gamma)\Pr(k<\gamma) + w_{2i}\Pr(Succ|C_i,\gamma)\Pr(1-k<\gamma<k) + w_{3i}\Pr(Succ|C_i,\gamma)\Pr(\gamma<k) + \\ & w_{4i}\Pr(Fail|C_i,\gamma)\Pr(k<\gamma) + w_{5i}\Pr(Fail|C_i,\gamma)\Pr(1-k<\gamma<k) + w_{6i}\Pr(Fail|C_i,\gamma)\Pr(\gamma<k) \end{aligned}$$

and

$$\begin{aligned} v_i(D_i,\gamma) = {} & w_{7i}\Pr(Succ|D_i,\gamma)\Pr(k<\gamma) + w_{8i}\Pr(Succ|D_i,\gamma)\Pr(1-k<\gamma<k) + w_{9i}\Pr(Succ|D_i,\gamma)\Pr(\gamma<k) + \\ & w_{10i}\Pr(Fail|D_i,\gamma)\Pr(k<\gamma) + w_{11i}\Pr(Fail|D_i,\gamma)\Pr(1-k<\gamma<k) + w_{12i}\Pr(Fail|D_i,\gamma)\Pr(\gamma<k) \end{aligned}$$

It is assumed conventionally that no single contribution has a significant effect on the possibility of success, therefore, $\Pr(Succ|C_i,\gamma) \approx \Pr(Succ|D_i,\gamma)$. Condition (1a) then simplifies to

$$\Pr(\gamma>k) - \Pr(\gamma<1-k) > \frac{l_i - s_i}{2\delta_i}. \tag{1b}$$

Note that the decision in this model does not depend on the likelihood of success (for that to be the case, there should be success-contingent benefits). I visualize how the decision making problem of a single player depends on parameters and her beliefs in Figure 14. Recall that l_i here captures the initial temptation and s_i the deterrence.

		i believes that it is more likely that k-majority	
		cooperates	*defects*
Temptation vs. deterrence	*temptation is higher*	depends on δ_i	defects always
	deterrence is higher	cooperates always	depends on δ_i

Figure 14: Determinants of player *i*'s decision

I consider a population that is homogeneous in respect of l_i and s_i so that the temptation is higher, that is, $l_i > s_i$, but heterogeneous in respect to $\delta_i \in [0,\infty)$. This means that some people have internalized the norm of conformism to a greater extent than others. Irrespective of the beliefs about what the *k*-majority will do, player i defects, if

$$\delta_i < \frac{l_i - s_i}{2}. \quad (2)$$

This means that they have a dominant strategy. For convenience denote $\delta^* = \frac{l_i - s_i}{2}$. As it is possible to eliminate all the strictly dominated strategies, it is also clear that all the others know that they are not going to cooperate. As I assume that the distribution f of delta parameters in the population is common knowledge among the players, it is possible to calculate the number of players who are going to defect unconditionally. I call these players 'Prisoners' and refer to their number with m. The rest $n = N - m$ players are 'Conformists'. Figure 15 illustrates.

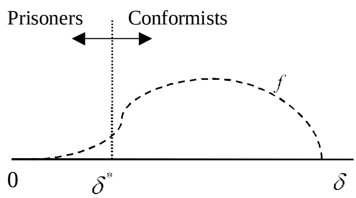

FIGURE 15: Prisoners and Conformists

Now we are ready to consider how the role of sanctions depends on the spread and strength of conformism in the population. Consider the first two initial populations of Prisoners. For the first population let $\delta_1 = \delta_2 ... = \delta_N = 0$. This population cooperates only, if the deterrence is higher than the temptation, and defects otherwise. In either case we have a single equilibrium, either mutual cooperation or mutual defection, and the sanctions operate only via direct mechanism. This implies that (increased) deterrence is a necessary and sufficient condition for any cooperation to occur.

For the second initial population of Prisoners let $\delta_1, \delta_2 ..., \delta_N < \delta^*$ and, at least for some subset J of players, $\delta_J \succ 0$. The only equilibrium for this population is mutual defection, until the sanctions are increased to a level where a sufficient number of players no longer have a dominant strategy to defect. This requires *k*-majority, that is, when conformists think that a sufficient number of other players do not have a dominant strategy to defect. Then at least two strategy vectors are Nash equilibria: the final outcome depends on conformists' beliefs about others' likely behaviour. Before this limit is reached, deterrence is a necessary, but not sufficient, condition for any cooperation to occur. After this limit is reached, further deterrence is no longer a strictly necessary condition for any cooperation occurring, but it does continue to increase the expected amount of cooperation. This is studied in a more general population below using an exogenously given belief condition.

Consider again just some distribution f of delta parameters in the population. I model the beliefs here simply by assuming that players assign a probability p to the event that a single other conformist is going to cooperate. This probability captures the collective mood among the conformists and I leave it exogenous, which fulfils my purposes for now.

With these assumptions the expected number of cooperators in the system follows a binomial distribution $B(N-m,p)$. Note that the number of trials, and therefore the expected number of cooperators, decreases in the number of Prisoners, δ . Assuming that f is continuous, higher deterrence can decrease the number of Prisoners in the population making it more likely that some *k*-majority is cooperating. The general message is that sanctions looming above *others* send a signal to conformists about their peers' likely behaviour. This causes a conformist to adjust their beliefs about the likely actions of the majority as new equilibria become possible. The rest of this chapter elaborates the quantification put forth here.

$B(n,p)$ can be approximated using a normal distribution $g:N(np,p(1-p))$. After standardization we get the following approximations: $\Pr(\gamma<k)=\Phi\left(\frac{(1-k)N-(N-m)p}{\sqrt{(N-m)p(1-p)}}\right)$ and $\Pr(\gamma>k)=1-\Phi\left(\frac{kN-(N-m)p}{\sqrt{(N-m)p(1-p)}}\right)$. The number of Prisoners, δ , is given by $F\left(\delta_i<\frac{l_i-s_i}{2}\right)N$ (but preferably by its floor). For convenience let us define $\delta^*=\frac{l_i-s_i}{2}$.

The decision making problem of a single player, the condition (1b), can then be re-written as

$$1-\Phi\left(\frac{N\left[k-\left(1-F\left(\delta_i<\delta^*\right)\right)p\right]}{\sqrt{Np(1-p)\left(1-F\left(\delta_i<\delta^*\right)\right)}}\right)-\Phi\left(\frac{N\left[1-k-\left(1-F\left(\delta_i<\delta^*\right)\right)p\right]}{\sqrt{Np(1-p)\left(1-F\left(\delta_i<\delta^*\right)\right)}}\right)>\frac{l_i-s_i}{2\delta_i}. \qquad (3)$$

The left-hand side of (3) is a scalar between -1 and 1. Denote it by y. If $y<0$, that is, if it is more likely that *k*-majority is defecting rather than cooperating, all players are defecting. This conclusion was already drawn in table 2. However, if $y>0$, some people may be cooperative depending on their beliefs about the likely actions of others. We can finally write the rate of defectors in the system as

$$Defecting(\%)=\begin{matrix} F\left(\frac{l_i-s_i}{2y(s_i)}\right) & ,y>0 \\ 0 & ,y<0 \end{matrix}. \qquad (4)$$

For convenience, consider two numerical examples that highlight the role of deterrence and mechanisms through which they operate.

Example 1:

Consider a system of 100 players, $N=100$. Let $l_i=2$ for temptation and $s_i=1$ for deterrence, so that $\delta^*=0.5$. Assume that the delta parameter is uniformly distributed from 0 to 5, that is, $f : U(0,5)$. The percentage of Prisoners in the system is given by $F(\delta^* = 0.5) = 0.1$ as illustrated in the Figure 16:

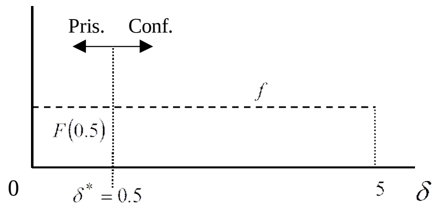

FIGURE 16: Example 1

This means that 10% of the players have a dominant strategy to defect. Set $k = 0.75$ and assume people are pretty confident that the conformists are more likely to cooperate than defect by setting $p = 0.8$. Then $y \approx 0.21$ meaning that it is approximately 21 percentage units more likely that 0.75 -majority will coordinate to cooperation rather than to defection. Finally we derive the defection rate using (4) and attain 0.47. About 47% of the players are now going to defect, which implies that a fair number of Conformists are following the lead of the Prisoners. Note that this model captures an important property of real-life coordination problems: people do play diverse strategies at the equilibrium. The reason is the exogenously given belief condition. Some form of belief updating can very well make conformists' strategies converge to either full (conformist) cooperation or full defection.

Example 2:

Consider now the same system with the following difference: the sanctioning agency is able to increase the deterrence so that $s_i = 1.5$. Then $\delta^* = 0.25$ and the percentage of Prisoners in the system is $F(\delta^* = 0.25) = 0.05$ as illustrated in Figure 17:

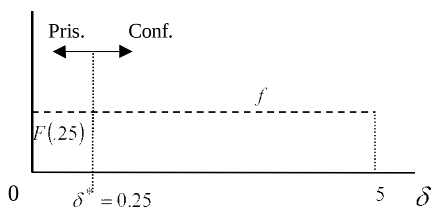

FIGURE 17: Example 2

This means that only 5% of the players now have a dominant strategy to defect. This affects conformists' beliefs about the likely decision of the majority. Now $y = 0.6$, meaning that it is 60% more likely that the majority will coordinate to cooperation rather than to defection. In addition to increasing this probability, sanctions also affect directly the necessary threshold value of δ_i in (4). Finally we derive the defection rate and attain 0.08. About 8% of the population is now defecting as some Conformists still follow the lead of the Prisoners.

To conclude: Notwithstanding the distribution of conformists in the population, formal sanctions are expected to contribute positively to the collective action. However, both the mechanism and the need for formal sanctions depend on the distribution of conformism in the population.[45]

4.3. Why formal sanctions simply can not solve it?

According to the earlier discussion, formal sanctions contribute positively to collective action irrespective of the amount of conformism in the population. This suggestion seems to be in line with the observation that many successful self-governance systems have adapted formal sanctions despite cooperation being possible without them. However, it leaves another question unanswered: why is the level of formal sanctions moderate at best? More deterrence could be achieved with fewer costs by merely increasing sanctions. But harsh and successful regimes do not seem to be a rule. I assume that the observed state of affairs reflects some type of optimality or resiliency. In what follows I try to offer a partial answer by identifying negative mechanisms between high sanctions and collective action as suggested by the earlier literature.

For deterrence the following is necessary: a positive possibility of getting caught and a positive probability of negative consequences after being caught. Increasing probabilities is expensive to an agency. It usually involves hiring more people as monitors, expanding bureaucracy, and improving monitoring techniques. An important part of the incentive structure in CPR-cases is that (due to externalities) individuals have a regulatory interest in others' actions (Heckathorn 1988). This can give rise to diverse types of informal control depending on how individuals' action space is defined. Informal controls interact with formal sanctions.

Note first that extreme sanctions are not an option, if there is a positive probability that either the agency or an individual makes a mistake (an innocent person is convicted, individual mistakenly defects) and the individual is able to take an exit-option or revolt. Both conditions apply very generally. If it is possible for them, individuals vote against extreme and non-perfect agencies with their feet or by revolt. One could give a simple condition for this theoretical upper limit, but it's sufficient to note here that such an anchor point exists. Next I identify negative mechanisms from formal sanctions to collective action.

Passive monitoring

If individuals report others' deviations from the rule (passive monitoring), the regulatory interest fosters formal deterrence. The agency can now partly rely on peer monitoring. However, if individuals are interdependent so that negative sanctions for one also have negative consequences for others (Heckathorn 1988; 1990), then higher sanctions may lead to less passive monitoring. As individuals cannot anymore prevent their peers' deviation, they may be better off not reporting deviation. Moreover, their threats to do so may cease to be credible if they are themselves hurt in the process. Therefore, increasing formal deterrence by stricter sanctions may also decrease formal deterrence due to a loss of passive peer monitoring.

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[45]More generally, deterrence is expected to contribute positively to the collective action notwithstanding the number of equilibria is the collective action game. Cooperative equilibria may also follow, if the assumption that a single contribution does not have a significant effect on the outcome is dropped. (see also Medina 2007.)

Active monitoring

If individuals have a possibility to engage in active monitoring, that is, spend resources to gain information about their peers' behaviour, other mechanisms emerge.[46] Again, regulatory interest rationalizes active monitoring in some cases. However, official guards or tough sanctions may lead to fewer active peer monitors. The reason for this lies in the nature of catch-and-evade games, which do not necessarily have equilibria in pure strategies. Mixed Nash equilibria strategies have the interesting property of being (at least partly) determined by the payoffs of other players. Increasing sanctions does not only affect the behaviour of the potential criminal, but it also affects the behaviour of monitoring agents.

This point was forcefully made by George Tsebelis (1989; 1990a; 1990b; 1991) in a series of papers with a help of two-player games. In two-player games this effect is most striking, because a player's strategy in a mixed Nash equilibrium is completely determined by the payoffs of the other player. A vivid discussion followed Tsebelis' argument, which cannot be covered here in detail.[47] In one line of responses, Weissing and Ostrom (1991a; 1991b; 1993) considered irrigation systems with both peer monitors and official guards. Their results largely confirm that these types of feedback loops are present also in larger games. However, they do not always alone determine the effect (for conditions, see Weissing and Ostrom 1991b) and they are not always dominant factors (Weissing and Ostrom 1991a, 253-254). Interestingly, increasing formal sanctions in hope of increasing formal deterrence may lead to fewer active peer monitors and, therefore, to a decrease in formal deterrence irrespective of whether sanctions have spill-over effects or not. Rather complex game theoretic arguments behind these effects can be simplified for current purposes by saying that the policy decreases peer monitors' regulatory interest: formal sanctions and official guards are already taking care of the deterrence lessening the gains of peer monitoring. Of course, if circumstances are such that passive peer monitoring does not work, we should not expect any active peer monitoring to occur either (if one is not going to report, why should one spend resources for monitoring in the first place).

Informal control

If individuals have a possibility to contribute to informal control affecting others' possibilities to take action, the formal deterrence and the informal control co-exist. The informal control might operate *via* persuasion that affects others' preferences, *via* selective incentives as formal deterrence does, or *via* control of opportunity structures, i.e. limiting players' action space (Heckathorn 1990, 369). When informal control is also an option, increasing the formal deterrence might lead to a decrease in peers' regulatory interest (following the earlier argument) and, therefore, to a decrease in the informal control. The agency might merely substitute the informal control with the formal deterrence.

Sanctions with spill-over effects are again an exception (Heckathorn 1990; 1993). The spill-over actually increases peers' regulatory interest: if one is sanctioned, others are hurt as well. This type of complementary control by collective sanctions can be very efficient as examples from army boot camps and tribal societies illustrate (Heckathorn 1990). It is interesting to

[46] The difference between passive and active monitoring is that in active monitoring the individual chooses to spend resources on monitoring. She does not merely obtain information during her daily routines. Both types of monitoring, of course, occur in real world.
[47] See Bianco et al. (1990), Hirshleifer and Rasmusen (1990), Mayer (1991), Rapoport (1990) and Weissing and Ostrom (1991a; 1991b; 1993).

note how the effects of spill-over depend on how players' action space is defined: Spill-over effects may decrease passive monitoring (that occurs after the deviation), but may foster informal control (that is aimed to prevent the deviation by a complementary control system).[48] The latter effect is contingent on the agency's ability to monitor individuals (without relying on their help) and individuals' ability to exercise informal control on one another. If the agency is unable to monitor them efficiently enough and individuals' are unable to impose informal control on one another, individuals might find it beneficial to rebel against the agency's control attempts. If some of them are going to deviate in any case, suffering the mere externality is a lesser evil (Heckathorn 1988, 553-556).

Motivation crowding-out

Richard T. Titmuss (1970) claims that monetary incentives lessen an individual's sense of obligation, that is, they kill the intrinsic motivation to cooperate. Bruno S. Frey and Felix Oberholzer-Gee (1996), for example, find supportive empirical evidence for the claim while studying the willingness of communities to host locally unwanted projects ("Not in My Backyard" projects, e.g. nuclear facilities). They conclude that there is a need to reconsider the use of monetary incentives in all areas where intrinsic motivation is likely to be important (ibid., 753). From the point of view of rational choice theory, the presence of external incentives may make it impossible for an individual to indulge in altruistic feelings (ibid., 747). But also another rational choice explanation can be suggested that generalizes the type of norms to which the claim applies. Norms are usually maintained by members of the community in social interaction. This persuasion is merely one mechanism suggested by Heckathorn (1990) that enables peers to exercise informal control on one another. In the last chapter we saw how conformism may turn a PD into a multiple equilibria game. If formal sanctions lead to a loss of conformism, they also reduce the number of cooperative equilibria in the game (that can be sustained by some initial belief conditions) and effectively push the original game towards PD, thus making themselves more necessary than they actually were in the first place.

The possible negative consequences of increasing formal sanctions can be summarized in the following questions:

1) Does the increase of formal sanctions lead to a regime failure?
2) Does the increase of formal sanctions actually increase the formal deterrence?
3) Does the increase of formal sanctions actually increase the overall deterrence?
4) Does the increase of formal sanctions lead to a loss of conformism?

The answer to these questions and their relative importance depends on the manner in which people are able to exercise informal control on one another and with what costs, to which extent the agency must rely on informal monitoring, and whether sanctions have spill-over effects or not. In addition, the deterrence effect depends on the spread and strength of conformism in the population and the degree of motivation crowding-out. Broadly put, the straightforward deterrence hypothesis is likely to apply in cases of atomized populations in which players do not develop, or the situation does not invoke conformism (e.g. drop-in communities, communities with heterogeneous roles), in which informal control is either

[48] Another line of research (Kitts 2006; 2008) considers rival incentives. These studies, however, concentrate on positive incentives and their generalization to negative incentives is not straightforward (Kitts 2006, 253).

expensive or impossible for individuals, and in which weak interdependency between individuals implies weak spill-over effects.

These characteristics do not offer a good description of traditional cases of governed CPRs. Usually people are strongly interdependent, they communicate and interact regularly which gives them a chance to exercise informal control and to engage in mutual monitoring, and they face the same situation repeatedly. Informal norms are created and they play a crucial role in determining the social outcome. In other words, the situation is favourable for negative mechanisms between formal sanctions and collective action. Agencies that operate with very limited budgets are not willing to risk the services that peers provide for free. It is perhaps then not surprising that formal sanctions tend to be very far from the theoretical maximum, and that agencies would rather complement informal control with some amount of formal sanctions than take the risk of supplanting it.

Recapturing main points of the chapter

In this chapter I have discussed the role of formal sanctions in collective action in general and in cases of CPRs in particular. Although many successful regimes use formal sanctions, the level of sanctions is moderate at best. From the point of view of rational choice theory, this is somewhat puzzling: the potential for deterrence is created, but it is not utilized to a great extent. I suggest an answer by studying both positive and negative mechanisms between formal sanctions and collective action. It becomes crucial to study the interaction effects between formal sanctions and other types of institutional statements that may sustain cooperation in a collective action game.

There are two mechanisms through which deterrence contributes positively to collective action. Through direct mechanism, the deterrence affects the behaviour of the player who is the subject of the deterrence. But many institutional statements that can sustain cooperation in some form of collective action game (including trigger- and ‘tit-for-tat’-strategies, compliance, reciprocity and conformism) give rise to belief mechanism. Because these statements make a player’s choice contingent on the behaviour of others, the deterrence for a player may also affect the behaviour of others. I studied both mechanisms using a collective action game with deterrence and a norm of conformism and concluded that although the magnitude of the deterrence effect and the degree of its necessity for collective action are contingent on the distribution of conformism in the population, the qualitative effect is not. To some extent this explains why formal sanctions are adapted so often, although cooperation may very well occur without deterrence.

But not all deterrence is formal deterrence. Reviewing and synthesizing the earlier literature it is possible to identify several possible negative mechanisms between formal sanctions and collective action. When CPR-users are able to exercise some type of informal control on each other’s actions, high formal sanctions may be counterproductive as they decrease peers’ regulatory interest. This may reduce peer monitoring and, therefore, undermine formal deterrence, or they may lessen informal deterrence and, therefore, undermine overall deterrence. Interestingly, an increase in formal sanctions may also lead to a loss of conformism. The irony of the last effect is that because of it formal sanctions actually decrease the number of cooperative equilibria in the original game, thus making themselves more necessary than they were in the first place. Many traditional CPR-environments satisfy the necessary assumptions for these negative mechanisms. I argue that the reason for relatively low sanctions in successful CPR-cases is that formal agencies rather complement informal control with some amount of formal sanctions than take a risk of supplanting it.

5. ANTI-NORM AGREEMENTS – COLLUSION AGAINST THE SANCTIONING MECHANISM

This chapter defines anti-norm agreements and proposes hypothesis for empirical study using James Coleman's (1990) economy of actions. By anti-norm agreements I mean agreements of mutual no-sanctioning between some individuals in the norm community. As these agreements make it possible for the agreement parties to deviate from the norm, they are examples of collusion against the public interest and of discrepancy between different levels of rationality. I show that these agreements are never efficient against the norm under perfect social system, i.e. assuming perfect information and no transaction costs. However, in imperfect systems agreements can be efficient against the norm.

I study the robustness of a specific norm enforcing sanctioning mechanism (heroic sanctioning) to these agreements. By a sanctioning mechanism I mean the process of transmission of sanctions. Against heroic sanction mechanism anti-norm agreements can emerge between individuals who are in key position to sanction each other. An interpretation of this is that people take advantage of their structural positions in the sanctioning mechanism. The key theoretical variable behind this type of collusion appears to be the type of population dispersion. If the dispersion is clustered, it is more likely that collusion occurs. As more people observe each others extraction decisions or are able to transmit sanctions to a deviator the less likely it is that anti-norm agreements emerge. Applying this discussion to common-pool resource users I suggest how extraction method and resource characteristics explain some of the population dispersion and, therefore, also enforcement difficulties that stem from collusion. From the point of view of an external monitoring institution this means that there is special need to obtain information from those parts of the system that rely on few peer monitors/sanctioners.

Before studying anti-norm agreements it is necessary to define norms. Literature on norms is wide and there are many approaches to the topic.[49] I do not attempt a review, but merely introduce the approach followed here. Using the syntax for institutional statements of Institutional analysis and development -framework (Ostrom 2005) norms can be defined to be statements that contain the following parts:

(Attribute)	: to whom the statement applies,	*Everyone*
(Deontic)	: a modal verb, i.e. 'may', 'must', or 'must not'	*must not*
(AIM)	: describes actions to which the deontic is assigned,	*fish more than X kg per week*
(Conditions)	: defines when and where the statement applies.	*always, in lake Y.*

An example of a daily expression that contains these components is: "None is allowed to fish more than X kilograms per week in lake Y." This statement is analysed above using the syntax. More specifically, I am interested in (1) conjoint, (2) Prisoner's Dilemma norms which are (3) backed by external sanctions:

(1) Beneficiaries and targets of the norm are conjoint sets (Coleman 1990, 246-249). Beneficiaries are individuals who benefit from the norm and therefore they have incentives to contribute for the norm emergence. Target actors are individuals to whom the norm applies.
(2) Individuals have a temptation to deviate from the norm, which implies that the norm does

[49] For a review, see Horne 2001.

not merely solve a coordination problem. The norm aims to change the incentive structure so that individuals avoid Pareto-inferior outcomes. (Ullman-Margalit 1977.) Finally, (3) the norm changes the incentive structure by introducing external sanctions. People who sanction are assumed to be norm beneficiaries.[50] I take this to be a useful abstraction of common-pool resource situations for current purposes.

As this chapter is about collusion against the norm it is assumed that the norm has already emerged. People have solved the collective level public good provision problem of how to introduce credible and efficient sanctions. Thus, Pareto-inferior outcomes are avoided. The point made here is that there is a possibility for further dynamics. Some sub-groups might find it beneficial to collude against the norm using their ability to hamper the local efficiency of sanctions. This ability stems from individuals' importance for norm enforcement as peer sanctioners and monitors. One of the biggest stories of rational choice is the potential discrepancy between individual and collective levels of rationality. Another well-known discrepancy lies between rationalities of the collective and its sub-groups. This chapter aims to highlight a less studied instance of the latter. This might shed some light on why we observe heterogeneous norm compliance. Not only some individuals but also some sub-groups may be able to deviate from the norm, although it has been successfully established. Stable anti-norm agreements (or simply, anti-norms) might co-exist with the norm.

For the analysis I follow Coleman (1990), who uses an extended version of barter economy model to study norms. In section 5.1., I give informal conditions for anti-norm agreements. In section 5.2., I introduce the model. In section 5.3., I formalize conditions using the model and show why agreements are never efficient against the norm under perfect social system. In section 5.4., I report findings on the robustness of a specific sanctioning mechanism against agreements.

5.1. Defining anti-norm agreements

Let us assume that the norm has been realized, and some sanctioning mechanism is in place. The first observation towards the demand of an anti-norm is that some actors might find it beneficial to agree not to sanction each other. What is there to gain from such an agreement?

The possible gain for actors is that their agreement makes it possible for them to deviate, because their agreement not to sanction each other decreases the capability of the rest of the actors to impose efficient sanctions on them. The possibility to deviate after the agreement is then a necessary condition for its existence. This first condition can be stated as follows:

Condition 1: *Every actor in the agreement is able to deviate after the agreement.*

This type of agreement can be interpreted as an example of Douglas Heckathorn's (1990, 377-378; 1993, 32) 'oppositional control', which refers to actors ability to resist others' control attempts. One way for an actor to reduce others' control attempts is to buy their rights of sanctioning with his right to sanction them.

Condition 1 makes it possible that there is something to gain from the agreement so it may be a good move for actors. But it does not alone guarantee it. By allowing other individuals in

[50] But in some parts I discuss more formal sanctioning agency, which relies on information via peer monitoring. Following IAD-syntax we are then speaking of rules.

the agreement to deviate, any given individual suffers the externalities (or lack of them, if externalities are positive) of others' actions. Therefore, the second condition for the agreement is:

Condition 2: *For every actor in the agreement the benefit from the deviation is bigger than the sum of his lost interests over externalities of other actors in the agreement.*

This condition reduces the maximum number of individuals in the agreement. Anti-norm agreements can be given an intuitive description. A proposal for one could be: "How about you let me do the action X, if I let you do the action X too?" Despite the externalities (that are negative in this case) of other actors executing the action X, the actor may be willing to tolerate them up to some point, if this toleration guarantees that he is able to execute action X himself. Two fishermen, for example, may agree not to act upon each other's catches that are above quotas, because they are then both able to over-fish and enjoy the increased sale benefits. But they would not like every fisherman to do the same, because this would generate too many negative externalities. These agreements might also stem implicitly. If a peer observes her neighbour deviating, she might (instead of sanctioning or reporting) tolerate the behaviour, conclude that the neighbour is not able to sanction or report her, and deviate herself. Mutual no-sanctioning allows now both of them to deviate.

Next I introduce the essentials of the economy of actions in order to formalize previous conditions. The main reason for the use of economy of actions is that it allows us to take into account properties of the social system and differing power of individuals in the system.

5.2. Essentials of the economy of actions

Economy of actions is an extended barter economy model. Following definitions are standard[51], except that a specific utility function is assumed. This is done, because the theory requires that we calculate the competitive equilibrium (see Coleman 1990, 675). Following Coleman, I assume Cobb-Douglas utility function:

$$U_i = c_{i1}^{x_{1i}} c_{i2}^{x_{2i}} \dots c_{im}^{x_{mi}}$$

where $U_i \equiv$ utility of individual i,
$c_{ij} \equiv$ amount of good j held by individual i, where $i = 1,2, \dots n$, and $j = 1,2 \dots m$ with scaling $\sum_{i=1}^{n} c_{ij} = 1$.

and where x_{ji} are parameters expressing the contribution that good j makes towards the utility of individual i. I impose two constraints on x_{ji}:

$x_{ji} \geq 0$, and
$\sum_{j=1}^{m} x_{ji} = 1$, where $i = 1,2 \dots n$, and $j = 1,2, \dots m$.

These constraints imply that each good contributes towards the utility of individual i positively (if at all). They also imply declining marginal utility (except if $x_{ji} = 1$ for one good and 0 for others). Coleman's (1990, 675) insight of how this description of an

[51] Definitions in this chapter follow Coleman (1990).

economical system can be used to analyse a wider social system is to let quantities c_{ij} correspond to control over events, and the quantities x_{ij} to interests to events.

Quantities introduced above can be given in matrix notation:

$C = \|c_{ij}\|$ (an $n \times m$ -matrix), and
$X = \|x_{ji}\|$ (an $m \times n$ -matrix).

It is then possible to calculate values of events in the competitive equilibrium, when people are trying to maximize their utility by exchanging control over events. Let us define the value of the event:

$$v = \|v_j\| \text{ (an } m \times 1 \text{ -matrix).}$$

The total value of individual i's resources is obtained by summing up values of each of the events that he holds:

$$r_i = \sum c_{ij} v_j \qquad (1)$$

This quantity also corresponds to power that the actor holds in the system. Total amounts of power and value in the system are arbitrary, so we introduce a scale of value:

$$\sum_{i=1}^{n} r_i = \sum_{j=1}^{m} v_j = 1$$

The maximization problem that each individual faces subject to his resource constraint is:

$$\max U(c_{i1},...,c_{im}) \text{ subject to } r_i = \sum c_{ij} v_j$$

Using these definitions it is possible to calculate the value of the event k, v_k, in the system:[52]

$$v_k = \sum_{i=1}^{n} x_{ki} \sum_{j=1}^{m} c_{ij} v_j \text{ or in matrix notation} \qquad (2a)$$
$$v = XCv \qquad (2b)$$

For m events there are $m-1$ independent equations of the form (2a). Since the initial distribution of control, C, and interests, X, are assumed to be known, these equations can be solved for the m quantities v_k using (2). Then equation (1) can be used with the known v_k to find the power of individuals, r_i. Finally, the distribution of control, c^*_{ik} at equilibrium can be calculated using (3):

$$c^*_{ik} = \frac{x_{ki} r_i}{v_k} \qquad (3)$$

[52] Proofs are found in Coleman (1990, 682-684).

A short intuitive description of the system could be the following. People have different interests to events, which can be given as the interest matrix X, where each cell contains a parameter telling how much the event contributes to the utility of the individual. Parameters can be compared so that we know which events are more important to the individual than others. People also have different initial controls over events. These can be given in a form of the control matrix C, where each cell contains the amount of control the individual has on the event. If the parameter is zero, he has no control over it, and if it is one, he has full control over it. But the control can also be shared so that the parameter is in between 0 and 1 (events are divisible). People then aim to maximize their utility by exchanging controls of events with other individuals. Each individual's power is not only dependent on his control over events, but also on the value of those events in the system. Events have different values as individuals' prefer some more than others. Control over event that no one is interested in cannot be used in exchange, so it is useless as a power resource. The power in the system could then be defined as person's initial control over events that others are interested in (compare this to a budget).

5.3. Norms and anti-norms in the economy of actions

In order to study a conjoint norm proscribing a set of actions J define two regimes, a and b, for outcomes when actions are taken (a) and are not taken (b). Each action in J causes negative externalities to others, but each actor has an interest to carry out the action.

$a_j \equiv$ regime a for set J of actions: negative interests in actions of set J are set to zero in X, and interests are renormalized.
$b_j \equiv$ regime b for set J of actions: positive interests in actions of set J are set to zero in X, and interests are renormalized.

As interest matrix X is different under these two regimes, we also have regime specific power:

$r_{ai} \equiv$ power of actor i in regime a
$r_{bi} \equiv$ power of actor i in regime b.

Still assuming that norm beneficiaries have solved the collective level problem we can give quantified measures on how much each beneficiary is willing to contribute for sanctioning a deviator and what is the necessary level of sanctions required for them to be effective against a given deviator (the necessary deterrence level). Sums of values of actions in J under regimes are

$v_{a_j} = \sum_{k \in J} x_{kk} r_{ak}$, and
$v_{b_j} = \sum_{k \in J} \sum_{i \neq k} x_{ki} r_{bi}$. (Coleman 1990, 801.)

These sums are useful, because they can be used to compare values of actions to values of externalities. Using a slightly abusive notation we refer to a single element of the sum v_{a_j} as $v_{ai} (= x_{ii} r_{ai})$. This element is merely the value of individual's action to himself, e.g. deploying an additional fishing net. The value of externalities of this same action to others is an element of v_{b_j}, namely $\sum_{\substack{i=1 \\ i\neq j}}^{n} x_{ji} r_{bi}$, and we refer to this element as v_{bi}. Using these definitions we can then give the condition that there are enough power and interest in the system to effectively sanction deviators. This condition is

$$x_{jj} r_{aj} < \sum_{\substack{i=1 \\ i\neq j}}^{n} x_{ji} r_{bi} \text{, for every actor } j \text{ in the system} \qquad \text{(condition 0)}$$ [53]

Condition 0 takes also into account differing power in addition to mere interests. This is one of the reasons why economy of actions is adapted. It allows us to incorporate properties of social system and study how they affect power distribution and norms in the group. When this condition applies sanctions are effective against every individual in the system (assuming no transaction costs in sanctioning, perfect information and solved collective action level problem). We assume that this condition holds, that is, the norm is efficient in the community. Condition 0 also implies that the norm adoption has been a Pareto-optimal move.

Next I define conditions 1 and 2 (introduced in Chapter 2) for anti-norm agreements using the economy of actions. For this I introduce an agreement coalition C. These are actors who have agreed not to sanction each other. Condition 1 can then be written as

$$x_{jj} r_{aj} > \sum_{\substack{i=1 \\ i\neq C}}^{n} x_{ji} r_{bi} \text{, for every actor } j \in C \qquad \text{(condition 1)}$$

When this condition holds each member in the agreement may carry out the action despite the norm, because the agreement reduces norm community's ability to sanction an agreement party. But we also require that the gain for each individual in the agreement is strictly positive. Condition 2 can be written as

$$x_{jj} r_{aj} - \sum_{\substack{i\in C \\ i\neq j}} x_{ij} r_{bj} > 0 \text{, for every actor } j \in C \qquad \text{(condition 2)}$$

This condition reduces the size of the coalition. When conditions 1 and 2 both apply the anti-norm agreement is beneficial for members in agreement. This is a necessary condition for the agreement, but it does not yet guarantee that the agreement is feasible. The rest of the norm community now faces a new collective action problem against the agreement members. In line with earlier discussion I assume here that the second level problem is solved, so it is sufficient to calculate interests and power. For the agreement to be efficient against the norm the sum of value to agreement parties must be higher than the sum of lost value to the rest of the actors. This means that the rest of the community does not have sufficient power and interest to sanction agreement parties. This condition is given by

$$\sum_{j\in C} \left(x_{jj} r_{aj} - \sum_{\substack{i\in C \\ i\neq j}} x_{ij} r_{bj} \right) \succ \sum_{j\in C} \sum_{i\notin C} x_{ji} r_{bi} \qquad \text{(condition 3)}$$

[53] This inequality is the same as inequality (30.6) in Coleman (1990, 803), but extended for every actor in the system.

It is relatively easy to show that condition 3 can not hold in perfect social systems, if the norm is efficient against each individual. Condition 3 is equivalent to

$$\sum_{j\in C} x_{jj} r_{aj} \succ \sum_{j\in C}\left(\sum_{\substack{i\in C\\ i\neq j}} x_{ji} r_{bi} + \sum_{i\notin C} x_{ji} r_{bi} \right). \tag{4}$$

To show the contrary it suffices to show that each element of the sum (over *C*) in left hand side is smaller than each element of the sum (over *C*) in the right hand side. This is given by condition 0. This observation merely states that if no individual is able to deviate from the norm in a perfect social system, no sub-group is able to do that either. The rest of the community is always able to raise enough sanctions in order to make the agreement unbeneficial for parties.

The assumption of “perfect system” in economy of actions comes down to the assumption that each potential deviator faces sanctions with certainty and without transaction costs. The right-hand side of condition 3, for example, summarizes how much norm beneficiaries are jointly willing to contribute for sanctioning the agreement parties. The left-hand side summarizes how much agreement parties are jointly benefiting from the agreement. In theory, anti-norm agreements can be efficient against the norm only if condition 3 holds. When this happens, agreement parties can divide benefits so that sanctions become ineffective against each party. But this can only occur, if the agreement also causes inefficiencies to the sanctioning mechanism. This could be the case e.g. when members are in key positions to sanction or monitor each other. These efficiency losses lower the right-hand side of condition 3 making it possible for some agreements to be efficient against the sanctioning efforts. In what follows, I stop assuming perfect social system. To illustrate some potential imperfectness I study a specific (peer) sanctioning mechanism introduced in Coleman (1990).

5.4. Robustness of heroic sanctioning against anti-norm agreements

How exactly do we expect joint interest and power to turn into effective sanctions? In many common-pool resource cases people have devised some type of formal institutions to take care of monitoring and sanctioning, although in many cases informal sanctioning alone can efficiently secure high level of compliance. Most of the real world governing regimes are mixtures of formal agencies and informal (peer) enforcement. Police forces, for example, are very dependent on the supply of information by citizens in their effort to enforce law. Usually joint interest and power are needed for the establishment and upkeep of any formal institution. The economy of actions framework provides quantified measures on how much beneficiaries are willing to contribute for the regime and what is the necessary deterrence level for each individual. When formal institutions are concerned, it is necessary, at minimum, to define a sanctioning function that maps individuals’ contributions (resources at agency’s disposal, input to the agency) to the achieved level of deterrence (output of the agency).

In informal settings some micro-micro sanctioning mechanism is needed for joint interest and power to turn into sanctions. Following rational choice theory the mechanism needs to guarantee that it is worthwhile for a peer to undertake sanctioning, i.e. an action that involves costs. Coleman (1990, 278-282) describes one such simple mechanism, heroic sanctioning.

Any peer can act as a heroic sanctioner, that is, she can sanction a deviator single-handedly. For this to be rational for her, she needs to be assured that other beneficiaries compensate her for the effort, as she is not single-handedly willing to bear full costs of sanctioning the deviator (supplying a public good). Whether beneficiaries have managed to assure one another is a question of solving the second level public good problem. I assume that this problem is solved. Heroic sanctioning is just one description of how joint interests and power can turn into sanctions, and my intention is only to use it to illustrate how some system characteristics may favour anti-norm agreements.

The set-up is as follows. There are 20 actors in the social system, each having a temptation to undertake an action that creates negative externalities to others (e.g. above-quota extraction in CPRs). The interest matrix for private events is generated using normal distribution with mean 80 and standard deviation 20, which tend to produce power differences of 10-15% between any individuals in maximum. The system is solved using algorithm of Coleman (1990) in *Wolfram Mathematica 7.0* -notebook.

For studying heroic sanctioning with transaction costs I distribute actors inside a circle. The diameter of the circle is .5, so the maximum (Euclidean) distance (d) between any two actors is 1. The transaction coefficient for heroic sanctioning is simply $1-d$. The nearest player always acts as a heroic sanctioner. Figure 18 below illustrates the principle with three players (1, 2 and 3) in one dimension.

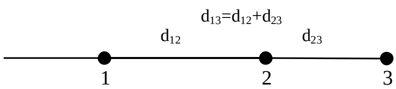

FIGURE 18: An illustration of sanctioning

The closest other player to player 1 is player 2 ($d_{12}<d_{13}$). The norm community can then sanction player 1 with efficiency $1-d_{12}$. Players 2 and 3 are closest to each other, so the community can sanction players 2 and 3 with efficiency $1-d_{23}$. It is now relatively easy to see how anti-norm agreements can be effective in this system. As an agreement is struck the potential of the rest of the community to transmit sanctions to agreement parties may be hampered by increasing transaction costs. If player 2 and 3 above are agreement parties, the rest of the community can sanction the coalition only with efficiency $1-d_{12}$. The maximum sanctioning capacity (if $d_{12}=0$) is calculated from the economy of actions - it is the aggregated value of the externality to other players. Therefore, as externalities get more severe the community is willing to use heavier sanctions.

I set up a *Mathematica* -script to calculate which members (if any) are able to form a feasible coalition against the sanctioning mechanism. Here I give a brief outlook of the script:

(i) The economy of actions -model is solved. *(ii)* Spatial positions are created and sanctioning efficiencies calculated. *(iii)* Players who are able to deviate from the norm are found and excluded from the analysis. The sanctioning mechanism can not create high-enough deterrence against these players. They have no incentive to join any coalition as they are already able to deviate.

(iv) All possible two member coalitions (subsets) of players are found. *(v)* For each coalition the joint positive valuations of members and negative valuations of the rest of the community are calculated. *(vi)* The best sanctioning efficiency of any non-member against any coalition member is found. This is the new (if changed) sanctioning efficiency against the coalition. *(vii)* The positive valuations of members are compared against the negative valuations of the rest of the community. The latter is weighted by the (new) sanctioning efficiency. If positive valuations are higher than the weighted negative valuations, agreement parties are able to share benefits in a way, which makes the sanctioning mechanism not efficient against them. These are feasible coalitions. *(viii)* Players in feasible two member coalitions are excluded from the rest of the analysis. They prefer to deviate with letting only one other player to deviate than letting many players to deviate. *(ix)* All possible three member coalitions are found…

Here I concentrate on effects of two independent variables (interests to externalities, and spatial population dispersion) on the dependent variable (possibility of anti-norm agreements). Empirically, interests to externalities may grow e.g. after an attitude change, resource depletion, or negative changes in players exit-options.[54] Population dispersion may be random or clustered depending on the resource type, extraction method and attributes of the community. In all subsequent tests individuals' interests X_i^a to take the externality producing action follows $X \sim N(90,15)$. To test the interaction between variables I build three treatments. In treatment A population dispersion is random, i.e. drawn form a uniform distribution (see Figures 19a and 19b for illustration). In treatment B population dispersion is loosely clustered (see Figures 20a and 20b) and in treatment C population dispersion is heavily clustered (see Figures 21a and 21b).[55]

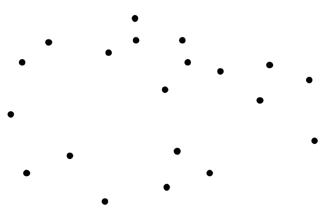

Figure 19a: A homogeneous dispersion

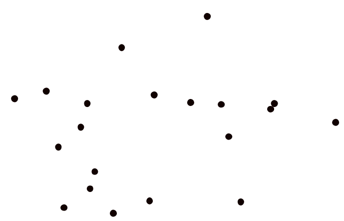

Figure 19b: A homogeneous dispersion

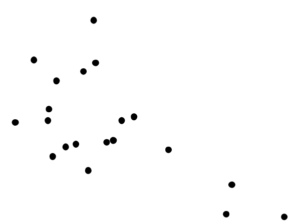

Figure 20a: A loose cluster dispersion

Figure 20b: A loose cluster dispersion

[54]As the sum of interests to externality grows in the system, so does the severity of sanctions against deviators. The interest to externality therefore approximates sanctions.

[55] I use Poisson cluster pattern (see Liu 2001). Concepts 'loose' and 'dense' here refer to average distances from cluster centres. Four cluster centre vectors are randomly picked. The number of offspring for each vector follows Poisson distribution (mean 4). For each offspring two vectors are drawn: distance from cluster centre and a directional one.

Figure 21a: Dense cluster dispersion

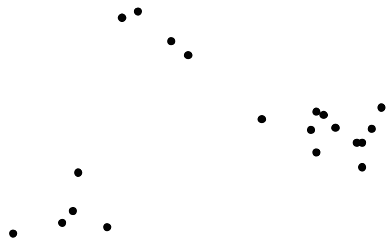

Figure 21b: Dense cluster dispersion

I test how the increasing severity of externalities affects both free-riding (single deviation) and collusion (group deviation) in each treatment. One would expect that as externalities and therefore sanctions get more severe, less free-riding is taking place. This intuition is also confirmed by simulation results here. But results also point out another phenomenon. In clustered populations some individuals are able to change the free-riding strategy to collusion. The same does not happen in homogeneous populations.

Figures 22a, 22b and 22c summarize the simulation results. Horizontal axes capture severity of externality increasing to the right.[56] For each six (discrete) values of externality 100 simulations are run.[57] Box-and-whisker plots show the distribution of *the number of single deviators* in the runs. The box spans from .25 quintile to .75 quintile, and "whiskers" report the span of the whole dataset. Boxes are accompanied with curves, which depict *the probability of collusion* in each set of runs. These probabilities are calculated simply by dividing the number of runs where some form of collusion occurred by the total number of runs in the set. Vertical axes capture numbers of deviators for box-and-whiskers (see left hand side) and probabilities for the curve (see the right hand side).

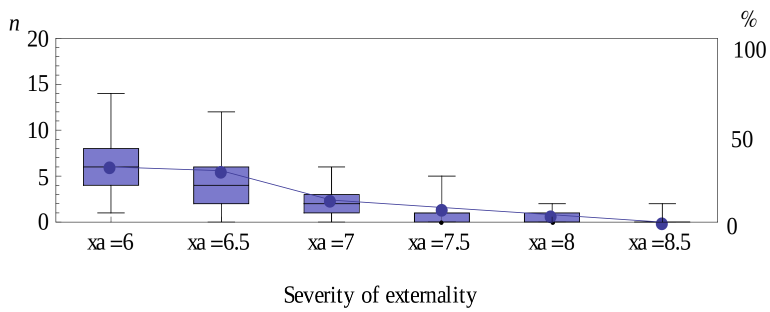

FIGURE 22a

In homogeneously dispersed populations the probability of collusion follows the overall decrease of deviators when externality is getting more severe. This sanctioning mechanism is not particularly vulnerable for collusion in these populations, although results suggest that

[56] The first value is about 7% of the average value of the action itself and the final one is about 10%. In this system it means that it first takes a joint contributions of 15 persons to sanction a deviator, and finally only 10.
[57] Note: only 50 from 4th onwards. These are preliminary tests, please do not cite without permission. Note also that for these preliminary tests, only collusion coalitions up to 6 members were considered. Bigger coalitions are possible (although unlikely), and this might somewhat increase the probability of collusion in clustered communities.

some collusion can occur together with individual deviation. Something very different is going on in clustered populations.

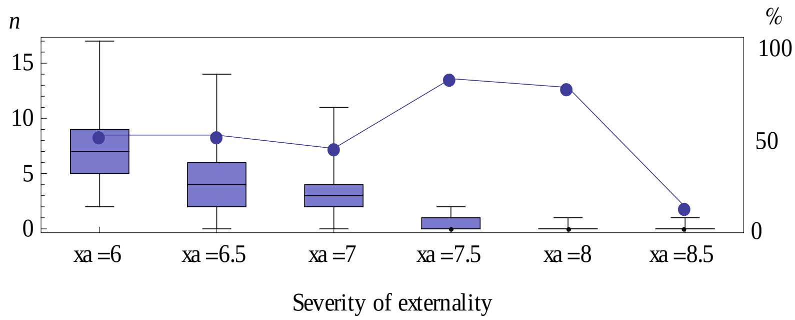

FIGURE 22b

In loosely clustered populations there is an inverse relation between the number of free-riders and collusion. Initially, increasing severity of externality (and severity of sanctions) starts to decrease the number of free-riders, but not the probability of collusion. When the sanctioning mechanism starts to be strong enough to deter individual members more sub-groups find it beneficial to collude against it. Individuals may “adapt” their strategy from individual free-riding to joint collusion. This highlights the fact that we are dealing with two separate phenomena that need not occur together. When xa=7.5 or xa=8 in Figure 22b there is very little free-riding, but a high probability of some sort of collusion. Finally, however, sanctions are strong enough to deter collusion attempts. But in loosely clustered populations this occurs much later than in homogeneously staggered populations.

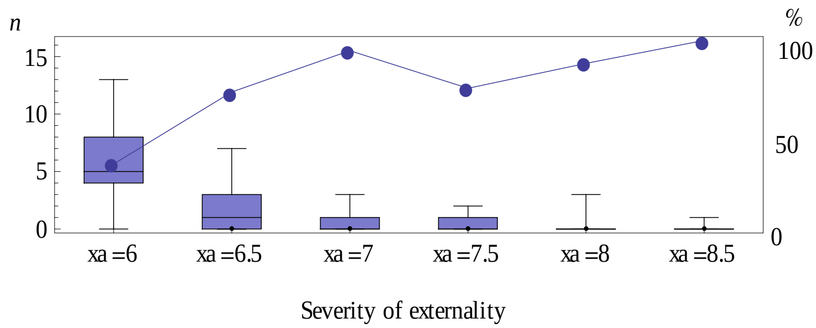

FIGURE 22c

One interesting observation to be made from densely clustered populations is that free-riding converges to zero faster than in other treatments. This is simply because there is always a potential punisher around to transmit the sanction without great transaction costs. But this also creates a good environment for collusion as the number of apt punishers for each potential deviator is low (revisit Figures 21a and 21b). Sub-groups may be far away from each other, and this makes inter-group sanctioning expensive. Intra-group sanctioning, on the other hand, is very fragile to collusion. In these types of communities it is very likely that externality stems from collusion – not individual free-riding. A quick take-away is that the discrepancy between what is rational for a sub-group and what is rational for the whole community occurs more often in communities with heavy clusters.

The assumed sanctioning mechanism is a very simple one – and it is offered only as a starting point. Further research it obviously needed. But note the following. The sanctioning mechanism is imperfect, because it is vulnerable to transaction costs. The analysis could be easily extended to sanctioning mechanism with imperfect monitoring. Consider a formal agency that delivers sanctions to deviators. Assume that the agency has no- or limited monitoring capability of its own and, therefore, it relies on information via peer monitoring (peers monitoring each other and reporting deviations to the agency). Peers gather information on each other's behaviour during their "normal routines". That is, we assume no intentional information gathering, but mere automatic observation during individuals' daily routines. If we further assume that the probability of getting caught depends on how close the next peer is, we have a very similar looking model to the one tested here. This would then suggest that the sanctioning agency may lack reliable information from clustered communities.

Common-pool resource situations are an important set of empirical cases of conjoint norm implementation. This study field has traditionally been rich on small *n*-case studies, which have lead to an identification of rather large number (25+) of relevant variables that explain the success or failure of resource management. Arun Agrawal (2002) among others has addressed the need for theoretical work that could lead to testable hypothesis on the various interactions between key empirical variables. One of the critical enabling conditions for sustainability of commons that Agrawal (2002, 62-63) distinguishes from earlier comparative works is ease in enforcement of rules. Collusion, of course, is counter-productive to this goal. Another set of enabling conditions concerns technology, and one important piece of technology is the extraction method. I would suggest that the extraction method together with some resource and user group characteristics can explain much of the variance in population dispersion (which seems to be a key theoretical variable behind collusion) between cases. In some cases extraction decision is a public act in a sense that a large number of norm beneficiaries are able to monitor it without great costs. This is the case at least when the whole community works and lives in the same geographical area, resource system is small and has a low level of mobility. Villagers extracting wood from local forests might very well fit to this description. But some resources favour extraction strategies that lead to naturally clustered populations. Consider traditional cases of herders, hunters and perhaps also fishermen. Because of characteristics of the resource, it is not a good strategy to maintain homogeneous dispersion as (1) it might be sub-optimal utilization of the resource, and (2) small-scale public goods might need to be provided for the extraction to take place (hunting stag, not hare; secure property rights over herd against other humans and nature; etc.). It might be that the population evolves towards clusters, that is, groups fish at different spots although they do utilize the same resource and share the externalities. According to earlier conclusions on collusion this type of population dispersion might lead to enforcement problems, if the enforcement mechanism relies on peer monitoring and sanctioning.

Recapturing main points of the chapter

I have defined anti-norm agreements and drawn hypothesis for empirical study. Using Coleman's formalization I have shown that anti-norm agreements are never efficient against the norm, if the norm is efficient against individual free-riders. This means that these agreements must utilize imperfectness of sanctioning mechanism. I have studied the robustness of one such sanctioning mechanism, namely heroic sanctioning, against this type of collusion in a conjoint norm environment. More specifically I have studied the interaction between severity of externality, population dispersion, individual free-riding and collusion. The preliminary simulation analysis suggests following hypothesis:

(1) Collusion occurs more often in clustered populations than in homogeneous ones.
(2) Individual free-riding occurs less often in populations with dense clusters.
(3) In homogeneous populations both the likelihood of collusion and the amount of individual free-riding are inversely related to the severity of sanctions.
(4) In clustered populations there is an interaction effect between individual free-riding and collusion in the parameter region where sanctions are enough to deter individual free-riders.
(5) Due to (4) and unlike in homogeneous populations, the likelihood of collusion is not a monotonic function of the severity of sanctions in clustered populations.

These conclusions are discussed in light of studies on common-pool resources. Relying on earlier works a set of empirical variables that may lead to this type of enforcement problems is suggested.

6. COLLECTIVE ACTION IN COMMONS: ITS DIVERSE ENDS AND CONSEQUENCES

I devoted the first two paragraphs of this book to reminding the reader about various ecological problems. They hardly brought new information to anyone connected in contemporary newsfeed. I also repeated one of Garrett Hardin's central theses: some of these problems do not have technological solutions, but solutions must be sought for in our morality, society, and its institutions.

As Elinor Ostrom and her colleagues have repeatedly shown in their empirical work, a plural form is indeed needed. There is no single institutional solution that works in every empirical case. The reason for this is that policies are likely to invoke different behavioural consequences in different environments. This means that it is crucial to know how causes and consequences are connected, that is, which causal mechanisms are relevant in the current environment and which consequences they jointly produce. The role of theoretical work, which also captures the nature of the current study, is to point out these causal mechanisms and characteristics associated with them. A fair question to put forth at the end of any book about the "tragedy of the commons" is not whether it contains a solution, but rather how it has contributed to our understanding of the problems of commons. In the following I answer the question by summarizing the main points of the book.

In this book I have shown different ends and consequences of collective action in commons. The emphasis has been on the diversity of those ends and consequences. Common-pools are merely one factor in complex production systems that practically always contain other collective goods as well. The overinvestment problem, which is the focal problem in the commons literature, may not be the focal collective action problem facing the resource users. I have shown how theory-driven analytic narratives can be used to point out and analyse this diversity. These are first and foremost logical narratives, which merely restate necessary and sufficient conditions of outcomes in theoretical models, but they can be used to tell temporal stories. Further empirical studies will hopefully point out which historical processes most commonly lead to the overinvestment problem. Usual suspects include processes that foster demand (population growth, market integration, increasing prices of substitutive goods) or lower extraction costs (technological and institutional development). In this work I have suggested a collective action narrative at its bare minimum that is characterized by very general (and thus vague) turning points. Once these narratives are applied to cases, more rich descriptions are needed. But as long as these narratives are based on collective action theories, their main turning points are likely to have pretty much the same meaning as in the narrative offered in this work.

I have discussed Sami reindeer herding as an example of a system in which there are supply-side collective action problems concerning an important factor of production (capital security). This problem and institutions created to solve it precede the overinvestment problem. Cooperative institutions securing herders' private capital allowed herds to grow, thus creating the possibility to overinvest. Cooperation for the provision of capital security created a culture of large scale reindeer herding, increased herd sizes and also created the possibility to overuse the pasture. To put it another way: in some cases it is cooperation that enables the "tragedy of the commons".

But this type of collective action may also have indirect consequences to resource users' ability to solve the overinvestment problem. Drawing on previous theoretical work by James

Coleman on social closure and by Elinor Ostrom on boundaries and sanctioning possibilities, as well as on the lessons by collective action theories on the effects of rescaling the problem, I put forth a hypothesis that the overinvestment problem of clubs may be easier to solve than that of individuals. It seems that the presence of clubs implies that some key elements of collective action are present at least among some members of the population. I suggested two ways – narratives if you will – in which this local social closure may turn into global cooperation. The first one relied again on empirical accounts on Sami reindeer herding. It seems that the constant need to restructure clubs created incentives for herders to maintain relations to other clubs as well. These connections between members of different *siidas* are an example of social closure beyond individual clubs. Yet these connections are maintained because of the dynamics of the club structure. These types of incentives are present only when clubs do have the need to restructure and this condition does not apply generally. However, these incentives would not exist at all without clubs, which is sufficient to make my main point once again: Overinvestment problem of clubs differs from that of individuals. Supply-side collective action problems and their solutions influence the overinvestment problem itself.

The second way in which local clubs may result in global cooperation is through rescaling of the problem. Again, I do not suggest that this applies generally. We should not expect general solutions or blueprint solutions, as Ostrom often puts it, to diverse problems. Instead we should pinpoint conditions which play a role in diverse solutions. The problem is rescaled if aggregates of individuals can be treated as unified actors, that is, if aggregates can make decisions on behalf of individuals. A single cooperative decision by an aggregate can then be very significant for the success of collective action and the success function may be nicely captured by a step function. This is likely to create a cooperative equilibrium, which means that one historical process, the consolidation of clubs, driven by supply-side collective action problem, may turn the overinvesting system from a non-cooperative phase into a phase of equilibrium selection. The most famous clubs of all in political science, nation states, are fine examples of aggregates that are often treated as unified actors and for a good reason. They are able to make commitments on behalf of their entire population, whether it is about carbon emissions or species in danger of going extinct. Pointing out the explanatory value of finding connections between collective actions in commons is probably the most important contribution of this dissertation.

I have not attempted to provide a unified formal analysis of club emergence and a common-pool problem where individuals would be simultaneously facing two types of externalities (from the club good and from the common-pool), but have left it for future work. There are two reasons for the exclusion: First, leaving club emergence exogenous is sufficient for my main motivation to bring up the overinvestment problem of clubs. Second, in the case that inspired me to study clubs in the first place – Sami reindeer herding – the clubs and institutions that maintained cooperation emerged well before the overinvestment problem (as there was plenty of available pasture before extensive reindeer herding was developed)." However, studying these problems simultaneously might reveal some interesting causal mechanisms between the two, especially if access to the club good plays a key role in individuals' ability to use the resource, as is the case in the reindeer herding example. Again, I do not expect very general findings mainly because clubs and interaction between them can take many forms creating possibilities for many different causal mechanisms. This conviction merely emphasizes the need for detailed theory and a careful analysis of the relevant causal mechanisms. A good theory is likely to frustrate its student, because it contains many "buts and ifs". Such is the nature of collective action theory. After all, these "buts and ifs" are the marks of theory development and growth of knowledge. What I have argued here is that we should take into account “buts and ifs” concerning clubs in commons and that under some circumstances, local clubs generate possibilities for global cooperation.

There are also “buts and ifs” concerning the role of formal sanctions in commons. In chapter 4 I have explored interaction effects between formal sanctions and informal institutions. This again emphasized the need to know which phase the system is undergoing. Certain informal institutions, like the norm of conformism studied above, can turn the system from a non-cooperative phase to an equilibrium selection phase. The main point of chapter 4 is that the consequences and causal mechanisms associated with formal sanctions are different in these two phases. The reason is simple. In a non-cooperative phase, individuals’ best replies do not depend on the actions of others, but in an equilibrium selection phase, they do. This means that the incentives of others, like sanctions that can be imposed on them, also affect an individual’s decision making. I chose to call these mechanisms belief mechanisms, because they rely on the fact that one’s beliefs about others’ likely actions affect one’s best reply.

In addition to the system phase, the key to understanding the role of formal sanctions in commons is to note that they are merely one part of the total control system. First, they typically rely to some extent on peers monitoring each other. Second, peers also exercise informal control and impose informal sanctions on each other. Not only is the formal deterrence often dependent on peers monitoring each other, but it is only one leg of the total deterrence system. The “bad news” is that increasing formal sanctions may undermine peers’ willingness to monitor each other and maintain informal deterrence systems. One of the crucial factors behind these effects is the interdependency of peers, created for example by club membership, who are supposed to monitor and sanction each other. Furthermore, formal sanctions may diminish individuals’ willingness to cooperate voluntarily. All in all, this means that the role of formal sanctions is mixed in systems where the overinvestment problem has been partly solved by informal institutions. Because many common-pool cases, especially small-scaled ones, are beneficial for the emergence of informal institutions, I argued that low formal sanctions could be a good strategy to complement informal controls without the risk of supplanting them. The fact that formal sanctions are often gradually increasing as the offence is repeated is an interesting observation: repeated offences tell that the offender is not in the reach of informal controls. The negative consequences of increasing formal sanctions on repeated crimes are then unlikely to have negative secondary effects via informal controls.

Sanctioning systems that rely on peer monitoring also create collective action possibilities in the institutionalized resource use phase. These possibilities are not beneficial for the whole population.[58] Collusion is an example of collective action that can be counter-productive to the sustainable resource use. In chapter 5 I pointed out that sanctioning systems that rely on peers monitoring each other may create collusion possibilities for sub-groups. This is an especially relevant observation for populations in which monitoring possibilities are heterogeneous and clustered. In these populations there are likely to be sets of individuals who are in a good position to monitor one another, and making an agreement not to do so effectively decreases the deterrence directed to members of these groups. In these types of systems free-riding is more likely to stem from collusion than from individual free-riding. Collusion is yet again an example of a collective action, and the main point in Chapter 5 is

[58] For an interested reader, a very throughout study of possibly bad consequences of collective action is Hardin (1995).

that some sanctioning mechanisms create incentives for further collective action. Supposedly people in same clusters are also in a good position to solve their collective action problems.

It is probably worth pointing out that clubs are one possible reason for both the interdependency of resource users, which proved to be an important variable as far as effects of formal sanctions are considered, and for clusters in monitoring possibilities. Again, previous collective action may create conditions that are very relevant for the overinvestment problem and its solutions.

In this dissertation I have explored different ends and consequences of collective action in commons and showed how this diversity can be studied using analytic narratives. It has become obvious that its ends are not restricted to solving the overinvestment problem. Yet collective action aimed at different ends has consequences to resource users' ability to solve the overinvestment problem and to the efficiency of institutions designed to do so. In this work I have highlighted some of these consequences and tried to pinpoint the conditions under which they are likely to occur.

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