

The governance of explorative knowledge production

Prof. Dr. Dr. h.c. Margit Osterloh

IOU
University of Zurich
Plattenstrasse 14
8032 Zürich
Tel. +41 44 634 2840
Fax. +41 44 634 4942
Mail: Osterloh@iou.uzh.ch

Prof. Dr. Antoinette Weibel (corresponding author)

University of Liechtenstein
Fürst-Franz-Josef-Strasse
9490 Vaduz
Tel. +423 265 1155
Mail: antoinette.weibel@hochschule.li

The governance of explorative knowledge production

Abstract (100 words)

The generation of new knowledge is crucial for a firm's competitive advantage. We analyze explorative knowledge production in teams as a social dilemma. Such social dilemmas can to some extent be solved by transactional solutions such as activating the shadow of the future or selective incentives. But transformational solutions are more important. Employee's intrinsic initiative to participate in knowledge exploration is crowded-out by certain high-powered incentives and unfriendly monitoring. It is crowded-in by, low-powered incentives, friendly monitoring, communication and institutional framing. We conclude that there exist convincing ideas of how to govern explorative knowledge production which should be tested empirically.

JEL-Classification: D01, D02, D23, J24, L22, M12

Keywords: exploration, exploitation, social dilemma, extrinsic motivation, intrinsic motivation, crowding-out, crowding-in

The Governance of Explorative Knowledge Production

Introduction

Firms' competitive advantage is increasingly seen to accrue from the particular capabilities organizations have for creating and sharing knowledge (Kogut & Zander, 1996; Nahapiet & Ghoshal, 1998). How organizational knowledge is handled, however, is dependent on the type of knowledge production focused on (Grant & Baden-Fuller, 2004). The knowledge-management literature distinguishes two types of knowledge production: knowledge exploration and knowledge exploitation (March, 1991). Knowledge exploration refers to activities that lead to new knowledge, for example activities such as knowledge search, experimentation and discovery (Holmqvist, 2004; Spender, 1992). Knowledge exploitation refers to activities that deploy existing knowledge to create value, for example activities such as routinization and implementation of knowledge (Holmqvist, 2004).

Explorative and exploitative knowledge production differ in both their cognitive and motivational underpinnings. In a recent article Grant and Baden-Fuller (2004) have carefully explained the differing *cognitive underpinnings* and the consequences of these different underpinnings for knowledge management: During the *exploration* phase, knowledge bases should differ sufficiently i.e. the actors should have some degree of cognitive distance (Nooteboom, 2000a). This is the case for two reasons. Firstly, the variety of cognition is a prerequisite to create novelty and to explore the potential of a new technology. Secondly, creative approaches often lie dispersed across distinct technological trajectories (Spencer, 2003). Careful observation of other's approaches reduces the risk of getting stuck on a trajectory that ends up not being selected as the dominant design. As a consequence to be

efficient in knowledge generation *participants of a knowledge-creating team have to be specialized to a high degree*. In contrast, during the *exploitation* phase *a certain overlap of knowledge is crucial* (McEvily, Eisenhardt, & Prescott, 2004). It increases efficiency of cooperation, because a greater alignment of mental categories facilitates communication and understanding. The whole knowledge production process of a firm is composed of both types of knowledge work – exploration and exploitation – and in each type there exists an optimal trade-off between specialisation and overlap of knowledge (Postrel, 2002). However specialisation and differentiation of knowledge is more efficient for exploration and a high degree of knowledge overlap facilitates exploitation (Postrel, 2002).

What is lacking so far, however, is an elaboration on how the *motivational underpinnings* of both types of knowledge production differ and what the consequences of these different underpinnings are for knowledge management. Vining (2003) characterizes knowledge production – exploration or exploitation - as an internal public good: Employees have strong incentives to withhold their knowledge or to underinvest in collective knowledge sharing. Similarly according to Cabrera and Cabrera (2002) knowledge production can be conceptualized as a particular case of a social dilemma in which individual rationality - trying to maximize individual pay-off - leads to collective irrationality. However, as we will argue in this paper, the solutions offered by Vining (2003) and by Cabrera et al. (2002) are better suited to handle social dilemmas in the exploitation phase. During exploitation, *transactional solutions*, that is, solutions which change the rules of the game to make cooperation more attractive even for selfish actors, are sufficient. During exploration transactional solutions will not suffice. Exploration is better handled through *transformational solutions*, which focus on the change of preferences of economic actors. More precisely we will argue that organizational measures to foster intrinsic motivation are best equipped to overcome social dilemmas in explorative knowledge work. Thus we review evidence from psychological

economics and organizational behavior to redress this apparent imbalance in the knowledge management literature and discuss the transformational solutions for social dilemmas in the exploration phase.

Cooperation as a Social dilemma

Cooperation in organization is often characterized by social dilemmas (Miller, 1992). Cooperation takes place when the economic actors together can produce a higher output than the sum of the separate outputs of each economic actor working independently. Cooperation thus creates what is commonly known as synergy (Foss & Iversen, 1997). The more effort exerted by one economic actor, the more productive other the other economic actors become. As a result, activities are characterized in firms and networks by a high degree of complex interdependencies. Simon (1991:33) makes this point clear in his important paper on organizations and markets:

“In general, the greater the interdependence among various members of the organization, the more difficult it is to measure their separate contributions to the achievement of organizational goals. But of course, intense interdependence is precisely what makes it advantageous to organize people instead of depending wholly on market transactions.”

However, interdependencies also make team members more vulnerable to each other. By exploiting interdependencies a collective good is generated. A collective good (in contrast to a private good) is a good that can be used by people who have not contributed their share to its production. This is the case in interdependent cooperation. It is hard to determine exactly what input each of the economic actors has contributed to the joint output. Some actors could freeride at the cost of others. This was found to be true in a great number of situations: when people realize that their contribution cannot be measured, individual effort declines (Messick

& Brewer, 1983). More generally, this situation is referred to as a “social dilemma”. It characterizes situations in which the actions of self-interested and rational individuals lead to situations of collective irrationality in which everyone is worse off (Dawes, 1980). A “tragedy of the commons” (Hardin, 1968) may arise, which exemplifies the true meaning of a tragedy: Each team member is fully aware of the situation and realizes that their action leads to a negative outcome and “every team member would prefer a team in which no one, not even himself, shirked” (Alchian & Demsetz, 1972:790). However, rational selfish single actors are unable to solve such dilemmas on their own. If all or most of the team members’ free ride, the collective good will not be achieved, or will at least be undersupplied.

As a consequence, all cooperation is undertaken to raise productivity by leading to a joint output that exceeds the sum of the individual outputs. At the same time, all cooperation is faced with the problem of social dilemmas.

The traditional solution to social dilemmas is giving a central agency (principal) the right to supervise the other actors (agents) and to reward effort or punish shirking (Alchian et al., 1972). The principal is assigned the role of supervisor. Her main job is to monitor the agents and to make sure that nobody shirks. This task includes selection, instruction, observation of individual effort, sanctioning and rewarding, as well as (re-) negotiation of the contracts. As an incentive to doing her job well, the principal gets the net earnings of the joint production. Such supervision, or the “visible hand” of the owner, is characteristic of firms, in contrast to the “invisible hand” of markets (Chandler, 1977). With rational selfish actors, markets will not provide collective goods. This is the reason why social dilemmas are at the heart of management in firms and other forms of cooperation (Miller, 1992; Vining, 2003).

Cooperation in knowledge teams as a special kind of social dilemmas

The convincing explanation by Alchian and Demsetz (1972) of how cooperation can be managed is flawed if we take into account knowledge work. This solution does not work if there are information asymmetries between the principal and the agents. While this is a problem in all knowledge work (Cabrera et al., 2002), in the *exploitation* phase to overcome this problem is mainly a question of transaction costs, concerning the costs of collecting, evaluating and applying existent knowledge. Social dilemmas during this phase can be solved – as we will show – mainly with transactional solutions based on monetary incentives. This is not the case in the *exploration* phase, because the arising problems of free riding, spillover and holdup (Nooteboom, 2000b) have different origins and cannot be solved in the same way.

The problem of freeriding in (explorative and exploitative) knowledge work arises, because knowledge work in contrast to manual teamwork enhances productivity of joint production only if different knowledge is dispersed among different people (Foss & Foss, 2000; Grant, 1996). If all knowledge workers in a group have the same knowledge, one person could do the whole job almost entirely alone. If the principal knows what the agents know, then she also could do the knowledge work for herself. However, if she does not know what the agents know, then she can neither monitor whether the agents have chosen the most productive activities nor whether they shirk. The only thing she can do is a) to evaluate whether certain professional standards are met and b) to benchmark the output without understanding exactly how the output was obtained, just as you can benchmark certain machines or software programs without knowing exactly how they work. But this does not help to prevent shirking by *individual agents* producing a team output. As a result, self interested knowledge workers

in teams are in a good position to hide their expertise vis-à-vis their superiors (Davenport & Prusak, 1998).

The problem of spillover consists in the danger that sharing of knowledge can lead to a competitive disadvantage (Bogenrieder & Nooteboom, 2004). Sharing or publishing new individual knowledge means changing a private good into a public good. Once published, nobody can be excluded from this good. The access to this knowledge – for example knowledge that is collected in an electronic database – is unrestricted to members of the firm or a network which have access to this database. Why should an agent do that? By sharing his knowledge, he enables the principal to monitor him. He may gain some reputation, but at the same time lose his competitive edge. Sharing knowledge with others may negatively affect an economic actor's ability to outperform them. As a result, self interested knowledge workers in teams are not only in a better position, but they also have an incentive to hide their expertise vis-à-vis their principals as well as vis-à-vis their co-workers.

The problem of holdup consists in the necessity to make firm or network specific investments in order to raise the joint productivity. Such investments may not be recoverable for the individual economic actor, except by successfully carrying out the project and sharing the joint output. Thus the members of a knowledge team make themselves vulnerable to the principal and to each other. In such cases, the danger of under-investment in such resources arises among self interested team members without the principal being able to control this under-investment efficiently. As a consequence, the competitive advantage of the firm or the network will suffer. Again, a social dilemma arises.

Can Social Dilemmas in Explorative Knowledge Work be solved by Transactional or Transformational solutions?

The suggestions discussed for solving social dilemmas can be divided into transactional and transformational solutions (Kollock, 1998)¹. Transactional solutions change the rules of the game to make cooperation more attractive for selfish employees. Transformational solutions focus mainly on the change of preferences of the economic actors.

Transactional Solutions

Activating the "shadow of the future"

The most influential proposal for solving social dilemmas is to extend the shadow of the future by long-term, reciprocal relationships (Axelrod, 1984). There are *two* conditions for a shadow of the future to promote cooperation: The relationship must have a long term outlook and the partners employ a "tit for tat" strategy. Organizational career with a high longevity which cover a wide range of employees may create such a *long term outlook* (Whitley, 2003). Under such circumstances employees are more willing to share their knowledge and exploit their collective knowledge bases. However, at the same time this kind of career creates lock-in effects and reduces the cognitive distance between the employees: Knowledge-sharing is bound to departments or firms and exploration is much less likely to take place. A "*tit for tat*" strategy is easier adopted in the exploitation phase. It is often disregarded that, among self-

¹ Kollock (1998) differentiates between strategic (in our terminology transactional) solutions and motivational (in our terminology transformational) solutions. We have chosen a different terminology because strategic solutions include (extrinsic) motivation.

interested economic actors, this strategy only works on condition that individuals have perfect information as to how the other persons behaved in the past (Kollock, 1998). In the exploitation phase this condition is better fulfilled than in the exploration phase. Though also in the exploitation case there is room for misperceptions and mistakes, due to the greater knowledge overlap between partners it is easier to evaluate past cooperative behavior. In contrast, in the exploration case one can simple not evaluate how much cooperative behavior in sharing knowledge was exerted in the past, irrespective of transaction costs.

Selective incentives

A selective incentive is a private good (e.g. a bonus) given to individuals as an inducement to contribute to a public or common good (Olson, 1965). All firm or network members may have access to the electronic database, but only contributors receive a reward. If selective incentives exist, a social dilemma can be transformed into a coordination game where several equilibria exist (Sen, 1974). However, selective incentives raise two problems. Firstly, they increase costs, and secondly, some kind of performance-contingent measure must be applied, which raises the multi-task problem (Holmström & Milgrom, 1991). Take the case of a reward for contributions made to an electronic database. As a result, you might get a high number of contributions with little value. If you do not count the contributions as such, but the actual downloads, the incentive to enhance the value of the contribution might work. However, it might also happen that the contributors induce their colleagues to download their contributions. As a result, you have become the victim of “the folly of rewarding A while hoping for B” (Kerr, 1975). This so called multi task problem is the consequence of a pay for performance system that calls for a clear link between actions and results that can be easily measured. Thus, high-powered selective incentives in firms undermine the provision of firm specific common goods (Vining, 2003). This is the reason why even orthodox economists reach the conclusion: “The use of low-powered incentives within the firm, although

sometimes lamented as one of the major disadvantages of internal organization, is also an important vehicle for inspiring cooperation and coordination” (Frey & Osterloh, 2005; Holmström & Milgrom, 1994:989). This is true in particular for knowledge work. This work contains some easy to measure components (e.g. pages of written text) and some hard to measure components (e.g. the importance of a text). Selective incentives have to concentrate on few criteria that are clear cut. As a consequence, rational economic actors will focus on the easily measurable components and leave aside the components that are not so easy to measure. While this problem in the exploitation phase can be mitigated by evaluation by expert peer groups, this solution often fails in the exploration phase (Frey and Osterloh 2007). Even peers mostly do not know what might be the characteristics of a future dominant trajectory design or dominant design (Nelson, 2006). Peers often disregard that path-breaking explorative innovations demand for new criteria to be evaluated. There exists for example empirical evidence that in academic research expert peer groups often reject creative and unorthodox contributions and reward the mainstream (Frey, 2003). Many rejections in highly ranked journals are documented regarding papers that later were awarded high prizes, even the Nobel Prize (Campanario, 1996; Gans & Shepherd, 1994; Weingart, 2005). Many path breaking radical innovations could only be appreciated after decades (Gillies, 2006). As a consequence explorative knowledge work often cannot be evaluated adequately even by expert peers.

Profit Centers and Modularization

One frequently discussed suggestion is to decentralize decision authority into profit centers or modules or outsource activities so that market forces can do their work via (transfer-)prices. This suggestion refers to the traditional solutions of common good problems by internalization of external effects through privatization of gains and losses. The leader of the profit centers or modularized groups could be remunerated according to measurable criteria.

However, there are some problems with knowledge work organized as profit centers. *Firstly*, the leader of the profit centers has no incentive to share knowledge voluntarily with other profit centers, because then she would be giving away transactional opportunities for free. This is especially true for tacit knowledge. The transfer of tacit knowledge cannot be monitored or contracted as long as it is not embodied in a tradable product (Osterloh & Frey, 2000). *Secondly*, the sources of hard to imitate competitive advantages will be undermined. In order to be able to bargain over (transfer-)prices and service level agreements across the boundaries of profit centers, some tacit knowledge must be made explicit. As a consequence, the knowledge incorporated in the profit centers may become more tradable and imitable (Chesbrough & Teece, 1996). As a consequence, there are no incentives to produce synergies or common knowledge goods across the boundaries of profit centers. During the exploitation phase this problem is less relevant than during the exploration phase. In the exploitation phase when a dominant design or a dominant trajectory exists, most relevant knowledge is made explicit, while in the exploration case this is not the case.

During exploration, another problem arises. A precondition for profit centers is modularization. However, little attention has been paid to the problem of identifying what constitutes an appropriate modularization and what risks are involved with incorrect partitioning. Inappropriate modularization can take three forms: (1) undermodularization, (2) overmodularization, (3) modularization cutting through strong interdependencies. An example is Intel's Itanium chip design process (Hamilton, 2001). In a well-designed chip, signals flit from module to module, with the speed of the chip determined by the slowest signals. The engineers found ways to speed up the slowpokes via slight changes within single modules. However, it became clear that many of these changes disrupted the whole choreography, forcing engineers of other modules to rework their designs. As a result, several hundred engineers found themselves in a nightmare situation, because a change in one module ripples

through the whole design process. As a consequence, inappropriate modularization carries the risk of destroying possible synergies. Whenever knowledge integration with complex tasks is crucial, it is better to “undermodularize” than to “overmodularize” (Ethiraj & Levinthal, 2004). A low degree of modularizing increases the amount of information exchanged between all relevant actors, which is important in situations of high uncertainty as it is the case during the exploration phase.

To *summarize*, transactional solutions might mitigate the social dilemma, but have serious flaws in the case of explorative knowledge work. *Firstly*, the transactional solutions do not work if there are few overlaps of knowledge between the knowledge workers. *Secondly*, splitting knowledge work into modules to make it easier for supervisors to monitor the quality often carries with it the risk of inappropriate modularization. *Thirdly*, transactional solutions only work if the criteria for monetary incentives are clear cut. With complex tasks, as it is the case with explorative knowledge work, the risk of multi-tasking and of rewarding according to conventional criteria arises. As a consequence, social dilemmas in explorative knowledge teamwork cannot sufficiently be solved by transactional solutions.

Transformational solutions

As Simon (1991: 31-32) stated, “in most organizations, employees contribute much more to goal achievement than the minimum that could be extracted from them by supervisory enforcement...”. The incomplete contract literature emphasizes that in complex environments like knowledge work complete contracts cannot be written or enforced. Therefore honesty and intrinsic job satisfaction lead to better results for contracting parties than reliance on monetary incentives (Gintis & Khurana, 2006; Jensen, 2006). This makes clear that motivation is a main factor in cooperation’s, in firms and networks. As far as explorative knowledge work is concerned, “management by motivation” (Frey & Osterloh, 2002; Osterloh, Frost, & Weibel,

2002) might even become the most important factor in sustaining a competitive advantage. As the capability to produce new knowledge is the main source of inimitability, and its creation and transfer cannot be monitored and remunerated accordingly, motivation and, in particular, intrinsic motivation are the keys to dynamic capabilities as a foundation of long-term strategy. Introducing transformational solutions to social dilemmas we contradict traditional economics which assume that motivations or preferences should be treated as given. In contrast, we consider preferences as plastic and changeable by institutional measures such as job design, feedback mechanisms, procedural fairness and communication opportunities.

Extrinsic and Intrinsic Motivation

Two kinds of motivation can be distinguished: Extrinsic and intrinsic motivation. In reality, pure extrinsic motivation and pure intrinsic motivation are extremes on a continuum (Deci & Ryan, 2000).

Extrinsic motivation serves to satisfy indirect or instrumental needs, for example money or reputation. As such, money is almost always the means to an end – for example, paying for a vacation or buying a car – and not an end in itself. Extrinsic motivation stems from the desire to satisfy one's non-work-related needs. In this instance, a job is simply a tool with which to satisfy one's needs by means of the salary it pays. Transactional solutions focus mainly on extrinsic motivation.

Intrinsic motivation works through immediate need satisfaction. An activity is valued for its own sake and is undertaken without any reward except the activity itself (Deci, 1985). Intrinsic motivation is fostered by commitment to the work, which is satisfactory in an immediate way for the individuals. If one is motivated intrinsically, then shirking is not a preferable action, because the activity causes a benefit instead of a cost. The social dilemma

disappears and cooperation becomes a possible solution. There are two kinds of intrinsic motivation: enjoyment based motivation and obligation based or pro-social motivation (Lindenberg, 2001).

Enjoyment-based intrinsic motivation refers to a satisfying flow of activity without an external reward. Examples are skiing, reading a good novel, or solving an interesting puzzle. In each case, pleasure is derived from the activity itself and not just by arriving at the destination, i.e. with reading, reaching the last page of the novel would be the goal. During whatever activity, people often report a “flow experience” (Csikzentmihalyi, 1975) that makes them lose track of time. During explorative work it is often reported that people feel this kind of motivation, e.g. in research (Amabile, 1996) or during innovative software programming (Torvalds & Diamond, 2001).

Pro-social motivation takes the wellbeing of others into account without expecting a reward. The good of the community enters into the preferences of the individuals. These may be ethical standards, professional codes of practice, norms of fairness or reciprocity, group identity, or team spirit. A wealth of empirical evidence demonstrates that many people are indeed prepared to contribute to the common good of their company or community (Frey, 1997). Empirical work shows that substantial differences exist in shirking between branches of a company, despite identical monetary incentives due to different group norms (Ichino & Maggi, 2000). Two major instances have been discussed, which both include sacrificing individual interests for the sake of the community.

- *Voluntary rule following.* People are prepared to follow rules and regulations that limit their self-interests without sanctions, as long as they accept their legitimacy (Tyler & Blader, 2000).

- *Extra-role behavior.* Individuals do not only observe rules voluntarily, but also exert “organizational citizenship behavior” (Organ & Ryan, 1995). They provide voluntary inputs, going far beyond the duties stipulated in their contracts. “Extra-role behavior” is thought of as a “willingness to cooperate”.

Laboratory experiments also reveal that a large number of people voluntarily contribute to common goods (see the survey by Rabin, 1998). The most extensively discussed experiments are the public good game and the ultimatum game:

- *Public good game.* According to standard economics, people do not contribute to public goods; rational actors free ride on the contributions of others. However, when people trust others to contribute to a common good, they are also prepared to do the same. Suppose that subjects A and B are endowed with a certain amount of money, e.g. 10 dollars. They have to decide how much they want to donate to a common pool. They are also told that any money donated will be doubled and then redistributed equally among the subjects. If both keep what they got, each earns 10 dollars. If both transfer their whole endowment, each earns 20 dollars. This setting resembles team production, where cooperation leads to a surplus. If both actors are selfish, they donate nothing, regardless of how much they expect the other subject to give. Despite the incentive to cheat in experiments, people typically contribute about 50 percent of their initial stake (Sally, 1995).
- *Ultimatum game.* This game reveals that a sizeable number of people are willing to punish unfair behavior at a cost to them (Güth, Schmittberger, & Schwarze, 1982). Two persons have to agree on the division of a fixed sum of money. The proposer can make a proposal how to divide the money. If the responder rejects, both receive nothing. In the case of the responder accepting, the proposal is implemented.

Rejection can be viewed as punishment for the violation of a social norm of fairness, which comes at a price for the responder. In experiments, responders typically reject amounts below 40 percent.

With both games, considerable variation across different cultures has been found (Henrich et al., 2001). This indicates that prosocial preferences are not “hardwired”. They can be changed by institutional measures. As argued, transactional solutions which concentrate on extrinsic motivation fail in the case of explorative knowledge work; however, social psychology and psychological economics indicate that intrinsic motivation can be fostered by adequate institutional arrangements.

How to Foster Intrinsic Motivation

It is more difficult to guide intrinsically motivated persons to work according to the particular goals than to guide persons who work mainly for monetary compensation. Firstly, intrinsic motivation cannot be enforced. It can only be enabled. Secondly, it is difficult to govern intrinsic motivation precisely. Firms are not interested to enhance intrinsic motivation per se, for example to further employee’s pleasure of reading a novel during business hours. Rather firms aim to influence intrinsic motivation for work and contextual performance. As transactional measures fail to work with explorative knowledge work the question arises how the kind of intrinsic motivation can be induced that is required for this kind of activity.

Crowding theory (Frey, 1997) and self-determination theory (Deci, 1980; Deci et al., 2000) demonstrate how specific intrinsic motivation can be enabled. More precisely both theories analyze the effect of external interventions – such as rewards, organizational processes and communication – on intrinsic motivation. The so called *crowding-out effect* states that

external interventions which are primarily perceived as controlling undermine intrinsic motivation for an activity. External interventions which are perceived as supportive and competence-enhancing enhance intrinsic motivation, and lead to the *crowding-in effect*.

Crowding-Out of Intrinsic Motivation

Under certain conditions external interventions can reduce intrinsic motivation for an activity. A first condition for crowding-out to occur is that the individuals concerned have intrinsic motivation in the first place, which can then be undermined. In contrast, in situations where no intrinsic motivation exists, monetary rewards can increase performance, like simple manual work on an assembly line. Lazear (1999) provides an empirical example. He found that, in a large auto glass company, productivity increased from between 20 percent to 36 percent when the firm switched from paying hourly wages to piece rates. Second the crowding-out of intrinsic motivation occurs if people perceive an external intervention as reducing their self-determination, when doing an intrinsically interesting activity. In this case people feel that they are not the origins of their behavior. Their attention shifts from the activity itself to the external circumstances. The content of the activity loses its importance.

The crowding-out effect has been observed for two types of external interventions: incentives and managerial controls. It has shown to be relevant for both types of intrinsic motivation, that is, for enjoyment-based intrinsic motivation as well as for pro-social motivation.

Crowding-out by Incentives. Several meta-analyses of (field) experiments in both psychology and economics have shown that task-contingent rewards undermine intrinsic motivation. Examples are paying someone for volunteering, or paying performance-contingent rewards for innovative ideas (for an overview compare Deci, Koestner, & Ryan, 1999; Frey & Jegen, 2001). In a recent meta-study of experiments Weibel, Rost and Osterloh

(2007) have shown that performance-contingent rewards also hurt work performance in the case of complex and/or interesting tasks.

These effects of performance-contingent rewards can best be illustrated by an field experiment of Gneezy and Rustichini (2000a). It analyzes the behavior of school children collecting money voluntarily, i.e. without monetary compensation (e.g. for cancer research or disabled children). The children reduced their efforts by about 36 percent when they were promised a bonus of one percent of the money collected. Their effort to collect for a good cause could be raised when the bonus was increased from one to 10 percent of the money collected. But they did not reach the initial collection level again. This field experiment shows clearly that there are two countervailing forces affecting behavior: a crowding-out effect of rewards and an effect of motivating the children extrinsically after the intrinsic motivation has been decreased. It also shows that a “hidden cost of rewards” (Lepper & Greene, 1978) exists: The money collected after having been given a bonus comes at a high price compared to strengthening intrinsic motivation. On average, monetary incentives explain only 10 percent of the variance in performance, compared to 30 percent, which are explained by obligation based intrinsic norms (Tyler et al., 2000).

Burks and co-authors (Burks, Carpenter, & Goette, 2006) demonstrate another aspect of the crowding-out effect caused by performance-contingent rewards: among bicycle messengers, they find that employees at firms that pay for performance are significantly less cooperative than those who are paid hourly or are members of cooperatives. Performance pay appears to make messengers between 12 and 15% more likely to behave egoistically towards their co-workers (Burks et al., 2006: 9). These bicycle messengers when asked to play a sequential prisoners dilemma were more likely to defect than those bicycle messengers paid by the hour or working in a cooperative. The authors suggest that in practice this could mean that performance-contingently rewarded messengers are more likely to “cherry pick” the best

appointments, regardless of whether or not they are the best suited from the firm's perspective to make the delivery.

Crowding-out by Managerial Control. Managerial control too can undermine intrinsic motivation and performance. Managerial control, that is, the process of standard setting, monitoring, evaluation and providing feedback undermines intrinsic motivation if employees perceive control predominantly as a signal of distrust and autonomy thwarting (Weibel, 2007). Intrinsic motivation is strengthened, however, if the informative content of managerial control such as the feedback component and/or the supportive content of managerial control such as employee development perspective prevail (see next section).

Falk and Kosfeld (2006) test the negative effect of managerial control in a two-stage principal agent game. The principal can choose whether he wants to control the effort of his agent lightly, moderately, severely or not at all. Those principals who choose to trust, that is not to monitor their agents at all, fare best. For example agents who are trusted show twice the effort of agents who are lightly controlled. In an effort to understand the underlying reason for the performance reduction the authors design two games with different types of control: in the first case control is chosen by the principal, in the second case control is exogenously given. As a result agents reduce their efforts only in the first case, that is, they react negatively to the controlling intention of the principal and not to control per se.

The downside of the emphasis of a distrust-signalling managerial control system is also vividly illustrated by Gittell's research on American Airlines (Gittell, 2000a; Gittell, 2000b). American Airlines' then-CEO Robert Crandall insisted that delays come to his attention and get assigned to individuals and departments, so they would be accountable for their results and, moreover, would compete with each other to avoid creating problems. One field manager told Gittell that when a plane making a connection was late, "Crandall wants to see the

corpse”. Thus the characteristics of American Airlines control system were extensive monitoring, brief feedback and a focus on the “bad apples”. The post-monitoring phase consisted almost exclusively of sanctioning “the culprit”. The result of this approach was to create a culture of fear and infighting as people and units tried to pin the blame for problems on others. As a consequence performance faltered and pro-social motivation was greatly reduced.

Crowding-In of Intrinsic Motivation

Under certain conditions external interventions can enlarge intrinsic motivation for an activity. External interventions have a positive impact on intrinsic motivation if they are a) targeted to create an intrinsically rewarding job environment and/or b) support employees’ feelings of competence and relatedness.

Crowding-In by Job Design. Research in job characteristics theory shows that intrinsic motivation can be enhanced through altering job characteristics along five dimensions (Hackman & Oldham, 1974; Hackman & Oldham, 1980). These are

- variety (the degree to which a job requires the use of a number of different skills and talents);
- -identity (the degree to which the job requires completion of a “whole” piece of work, or doing a task from beginning to end with a visible outcome);
- significance (the degree to which the job has a substantial impact on the lives of other people);
- autonomy (the degree to which the job provides substantial freedom), and

- feedback (the degree to which the job provides clear information about performance levels).

Such an intrinsically involving job is shown to augment intrinsic motivation (Gagne, Senecal, & Koestner, 1997), contextual performance (Podsakoff, MacKenzie, Paine, & Bachrach, 2000) and cooperative learning (Janz & Prasarnphanich, 2003).

Finally Brickner and co-authors (1986) show that an intrinsically motivating job reduces free-riding and thus is instrumental in helping to overcome the social dilemma of knowledge management.

Crowding-In by Incentives. Frey and Osterloh (1998) propose that incentives can crowd-in intrinsic motivation either a) in a situation where incentives induce individuals to try new tasks whereby they might develop a taste for these tasks and/or b) if these incentives signal support, generosity and high esteem for the individual. Evidence for both types of crowding-in situation is rare.

Charness and Gneezy (2007) conducted a field experiment on the effect of incentives on physical exercise and thereby provide evidence on how incentives can help do develop a new taste. One group of participants is offered 125\$ under the condition that they would visit the gym once a week for five weeks. This intervention leads to an attendance level that is twice as high as the level when people have not been paid. In addition attendance level remains high even after the end of the intervention. However, the effect only holds for those participants who had not been regular attendees to the gym. These are presumably those individuals that did not enjoy exercising before the intervention but developed a taste for it while being paid to do it for some time.

Two studies show that non-controlling trust-signalling incentives can foster intrinsic motivation. Experiments show that if labor contracts are regarded primarily as a “gift

exchange” (Akerlof, 1982) rather than as a disciplining tool, then employees exert more effort. In a telling experiment, two different settings were compared (Irlenbusch & Sliwka, 2003). In the first setting, the “principals” offered a fixed amount of money and the “agents” chose an effort level. In the second setting, the principals had to make a choice between a fixed wage and an incentive scheme and then the agents chose their effort level. Efforts were higher in the first setting than in the case when piece rates were paid. Also, in the first setting, agents mentioned the well being of the principal significantly more often than in the second setting. Autonomy, which was higher in the first setting, was reduced in the second setting (Irlenbusch et al., 2003). This provides a strong argument for fixed wages whenever intrinsic motivation is crucial. Bard Kuvaas (2006) demonstrates in a field setting, a knowledge-intensive industry, the positive effect of a generous fixed wage. He shows a strong and positive effect of a generous fixed wage on work performance. Furthermore this effect can be partially explained by the fact that a generous fixed wage has a positive effect on intrinsic motivation and on affective commitment. Interestingly bonus schemes (a mixture of group and individual performance contingent pay) had no effects on the work performance of the knowledge workers studied.

Crowding-In by Control. Managerial control supports intrinsic motivation if the informational and supportive component of control is strengthened. In particular feedback as part of the control system can play an important part in initializing competence enhancing feelings. Empirical support to this proposition is, however, mixed.

In a meta-analysis, Kluger and deNisi (1996) conclude that feedback has on average a moderately positive effect on job outcomes. However, more than 38% of the effects found in the literature were negative. The authors conclude that only constructive feedback can have positive effects. Baron (1993) characterizes constructive feedback as feedback that is specific in content, timely, delivered in an appropriate setting and not containing threats and

attributions concerning causes of poor performance. Oldham and Cummings (1996) find constructive feedback particularly relevant for creativity: manufacturing employees produced the most creative outcomes when they worked on complex, challenging jobs and were provided positive and mainly informational feedback.

Crowding-In by Fair Processes. Fair processes are proposed to raise perceived social relatedness and thereby to strengthen prosocial motivation (Tyler & Blader, 2001; Tyler et al., 2000). Empirical evidence shows that procedural fairness impacts the willingness to contribute to common goods and to follow rules. This is true even in situations that are not favorable to one's own self-interest (Tyler & Blader, 2003). The characteristics that lead to perceived procedural fairness can be summarized as participation, neutrality, and being treated with dignity and respect.

Participation gives individuals a process control or the use of voice. It has been found that the use of voice is not just dependent on controlling outcomes; people value the opportunity of expressing their views (Folger, 1977). A precondition of *neutrality* is the belief of individuals that set the rules do not allow personal advantages to enter their decision-making. In laboratory experiments, it was shown that sanctions that served the punisher's self-interests crowded out cooperative behavior, whereas sanctions perceived as prosocially motivated enhanced self-interests (Fehr & Rokenbach, 2003). It follows that persons, who lay down the rules and regulations, should not be given an incentive to manipulate the corresponding criteria in their own favor. *Being treated with dignity and respect* has proved to be of high importance for organizational citizenship behavior, including helping behavior, altruism and extra role behavior (Niehoff & Moorman, 1993). Note that all three characteristics of procedural fairness (participation, neutrality and being treated with dignity and respect) are essentially unrelated to outcomes. Therefore, procedural fairness is crucial in situations which

might lead to unfortunate results for the employees, e.g. in conflict resolution or making decisions concerning promotions.

Crowding-In by Communication. Communication, or other conditions reducing social distance between persons, increases contribution in public good games (Dawes, van de Kragt, & Orbell, 1988). Communication has two important effects.

Firstly, experiments show that most people, after some minutes of talking to each other, have higher expectations of others' cooperative behavior. If they believe that others do not free ride, their willingness to contribute increases (Fischbacher, Fehr, & Gächter, 2001). This effect is much stronger when communicating face-to-face than when communicating via the computer. Secondly, communication provides an opportunity to invite other individuals to cooperate. It has been shown that being personally asked enhances contributions to collective goods greatly (Meier 2007: 65)

The growing role that “communities of practice” and “epistemic communities” play in knowledge-based industries underpins the significance of personal contacts and communication (Lave & Wenger, 1991). These communities that are based on communication and personal contacts foster not only creativity but also social relatedness and identification within the group. Also the literature on psychological contracts emphasizes that relational contracts (including the necessity for interaction), long time frames and many socio-emotional elements elicit greater commitment to the firm than transactional contracts short time frames and no socio-emotional elements (Rousseau, 1995).

Crowding-In by Instructions. People seem to be inclined to do what they are asked to do, especially when the request comes from someone who is perceived as a legitimate authority. Instructions to cooperate in public good games raise the cooperation rate as much as 40 percent (Sally, 1995). In real life settings, it is shown that people adhere to rules and accept

the decisions of authorities they believe to be legitimate, even if it is not in their own self-interest to do so (Tyler, 1990; Tyler & Huo, 2002).

Unfortunately in the last decade, standard economics instructs people to act otherwise (Osterloh and Frost 2007). As standard economics had become dominant in social science, people overestimate the power of self-interest to affect the behavior of others, even when their own behavior was not primarily self-interested (Miller & Ratner, 1998). As a result, more people behave in a selfish way: economics have to some extent become a self-fulfilling prophecy (Ferraro, Pfeffer, & Sutton, in press). Management can stop this self-fulfilling prophecy by providing employees with information about existing social norms and social behavior in their company and in their community.

Crowding by Framing. People are highly sensitive to signals about socially appropriate behavior. This became evident in a public good game. Players were divided into two groups. Each group played exactly the same game. The first group was told they were going to play “the Wall Street Game”. One third of the group cooperated. The second group was told that they were playing “the Community Game”. More than two thirds cooperated (Lieberman, Samuels, & Ross, 2003).

A strong framing effect was also shown in a field study, with parents being fined for picking up their children late from a childcare center. The fine had an adverse effect: it led to a significantly lower level of punctuality. When the fine was discontinued, punctuality remained at the lower level (Gneezy & Rustichini, 2000b). Fining switched the frame from a “normative frame” to a “gain frame” (Lindenberg, 2003). The fine indicated that in the gain frame, it was socially acceptable that parents arrive too late. A similar affect can be assumed with pay for performance. It signals that doing one’s duty without extra pay is not socially

appropriate. This signal could become a self-fulfilling prophecy. Fixed pay, based on fair overall procedural evaluations, avoids framing the teamwork into the “Wall Street Game”.

These results might be *summarized* in such a way that the less the situation approximates to a competitive market or to an iron cage bureaucracy, the more enjoyment based and pro-social intrinsic motivated behavior is likely to be observed. Anthropological field studies also provide examples for such changing behavior (Bowles, 1998:899). Though the empirical evidence cited mostly shows this effect with physical work (because it is easier to measure), there is no reason to suspect that with knowledge work there would be different evidence. As a consequence, the conditions for solving social dilemmas in explorative knowledge work are the better the less transactional solutions to solve it are applied.

Conclusions

The ideas presented in this paper are based in four ideas. *Firstly* cooperation in firms or in networks is undertaken to create synergies. All such cooperation causes interdependencies between the contributing economic actors. We *secondly* analyzed these interdependencies with the theoretical framework provided by the social dilemma literature. We compared the solutions to social dilemmas for exploitative and for explorative knowledge work. *Thirdly* we introduced the idea that explorative knowledge work differs from exploitative knowledge work mainly with respect to cognitive distance or cognitive overlap. This difference is crucial for the solutions that can be applied to overcome social dilemmas. We showed that transactional solutions, based on extrinsic incentives cannot solve the social dilemma arising in explorative knowledge work entirely. *Fourthly* we applied empirical evidence of social psychology and psychological economics to show how this special kind of social dilemma is to be solved by raising intrinsic motivation. *Fifthly* we showed that there exist convincing proposals for organizational design to strengthen intrinsic motivation. These proposals clash

with conventional wisdom of standard economics while they confer with the insights of psychological economics.

As a next step the proposals to strengthen intrinsic motivation should be tested empirically. The effect of intrinsic motivation and intrinsic incentives could be tested in the fields of the academic commons (Hellstrom, 2003), epistemic communities (Cowan, David, & Foray, 2000), knowledge alliances (Weibel, 2002) or the open source software community (Osterloh & Rota, forthcoming)2007. Because of the inherent measurement difficulties pertaining to explorative knowledge production a new research agenda is needed. We propose a triangulation of different methods, for example a combination of qualitative studies and quantitative vignette surveys or field experiments combined with longitudinal survey data.

To enhance productivity of knowledge work, in particular productivity of explorative knowledge, is the biggest challenge of the 21st century. Peter Drucker (1999: 83) states that less than one fifth of the workforce nowadays are blue-collar workers doing manual work, while white-collar workers doing knowledge work make up two fifths of the workforce. Yet, when it comes to our understanding of a knowledge worker's productivity, we are in the year 2000 roughly where we were in the year 1900 in terms of productivity of the manual worker. If companies could enhance productivity of knowledge workers in the 21st century as much as they did of manual workers in the 20th century, the payoffs would be astronomical.

References

- Akerlof, G. A. 1982. Labor contracts as partial gift exchange. Quarterly Journal of Economics, 97(4): 543-569.
- Alchian, A. A. & Demsetz, H. 1972. Production, Information Costs and Economic Organization. American Economic Review, 62: 777-795.
- Amabile, T. 1996. Creativity in context. Boulder: Westview Press.
- Axelrod, R. 1984. The Evolution of Cooperation. New York: Basic Books.
- Baron, J. N. 1993. Criticism (Informal Negative Feedback) as a Source of Perceived Unfairness in Organizations: Effects, Mechanisms, and Countermeasures. In R. Cropanzano

- (Ed.), Justice in the workplace, Vol. Series in applied psychology. Hillsdale, N.J.: L. Erlbaum Associates.
- Bogenrieder, I. & Nooteboom, B. 2004. Learning groups: What types are there? A theoretical analysis and an empirical study in a consultancy firm. Organization Studies, 25(2): 287-313.
- Bowles, S. 1998. Endogenous preferences: The cultural consequences of markets and other economic institutions. Journal of Economic Literature, 36(1): 75-111.
- Brickner, M. A., Harkins, S. G., & Ostrom, T. M. 1986. Effects of Personal Involvement - Thought-Provoking Implications for Social Loafing. Journal of Personality and Social Psychology, 51(4): 763-769.
- Burks, S., Carpenter, J., & Goette, L. 2006. Performance Pay and the Erosion of Worker Cooperation Field Experimental Evidence. Bonn: IZA.
- Cabrera, A. & Cabrera, E. F. 2002. Knowledge-sharing dilemmas. Organization Studies, 23(5): 687-710.
- Campanario, J. M. 1996. Using Citation Classics to study the incidence of serendipity in scientific discovery. Scientometrics, 37(1): 3-24.
- Chandler, A. D. J. 1977. The Visible Hand. The Managerial Revolution in American Business. Cambridge, Mass.
- Charness, G. & Gneezy, U. 2007. Incentives to Exercise.
- Chesbrough, H. W. & Teece, D. J. 1996. When is Virtual Virtuous?: Organizing for Innovation. Harvard Business Review, 74: 65-73.
- Cowan, R., David, P. A., & Foray, D. 2000. The Explicit Economics of Knowledge Codification and Tacitness. Industrial and Corporate Change, 9(2): 211-253.
- Csikzentmihalyi, M. 1975. Beyond Boredom and Anxiety: The Experience of Play in Work and Games. San Francisco: Jossey Bass.
- Davenport, T. & Prusak, L. 1998. Working Knowledge. Cambridge Mass.: Harvard Business School Press.
- Dawes, R. M. 1980. Social Dilemmas. Annual Review of Psychology, 31: 169-193.
- Dawes, R. M., van de Kragt, A. J. C., & Orbell, J. M. 1988. Not Me or Thee but We: The Importance of Group Identity in Eliciting Cooperating in Dilemma Situations - Experimental Manipulation. Acta Psychologica, 68: 83-97.
- Deci, E. L. 1980. The psychology of self-determination. Lexington, Mass: D.C. Heath Lexington Books.
- Deci, E. L. 1985. Intrinsic Motivation and Self-Determination in Human Behavior. New York: Plenum Press.
- Deci, E. L., Koestner, R., & Ryan, R. M. 1999. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychological Bulletin, 125: 627-668.
- Deci, E. L. & Ryan, R. M. 2000. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11: 227-268.
- Ethiraj, S. K. & Levinthal, D. 2004. Modularity and Innovation in Complex Systems., Management Science, Vol. 50: 159-173: INFORMS: Institute for Operations Research.
- Falk, A. & Kosfeld, M. 2006. The hidden costs of control. American Economic Review, 96(5): 1611-1630.
- Fehr, E. & Rockenbach, B. 2003. Detrimental effects of sanctions on human altruism. Nature, 422(6928): 137-140.
- Ferraro, F., Pfeffer, J., & Sutton, R. in press. Economics language and assumptions: How theories can become self-fulfilling. Academy of Management Review.
- Fischbacher, U., Fehr, E., & Gächter, S. 2001. Are People Conditionally Cooperative? Evidence from Public Good Experiments. Economic Letters, 71(3): 397-404.

- Folger, R. 1977. Distributive and Procedural Justice - Combined Impact of Voice and Improvement on Experienced Inequity. Journal of Personality and Social Psychology, 35(2): 108-119.
- Foss, N. J. & Iversen, M. 1997. Promoting Synergies in Multiproduct firms: Toward a Resource-Based View, Department of Industrial Economics and Strategy. Copenhagen Business School.
- Foss, N. J. & Foss, K. 2000. The Knowledge-based Approach and Organizational Economics: How much Do They really Differ? And does it Matter? In N. J. Foss & V. Mahnke (Eds.), Competence, Governance and Entrepreneurship: 55-79. Oxford: Oxford University Press.
- Frey, B. S. 1997. Not Just for the Money: An Economic Theory of Personal Motivation. Cheltenham, UK/Brookfield, USA: Edward Elgar.
- Frey, B. S. & Jegen, R. 2001. Motivation crowding theory: A survey of empirical evidence. Journal of Economic Surveys, 15(5): 589-611.
- Frey, B. S. & Osterloh, M. 2002. Successful Management by Motivation. Balancing Intrinsic and Extrinsic Incentives. Berlin/Heidelberg/New York: Springer.
- Frey, B. S. 2003. Publishing as prostitution? - Choosing between one's own ideas and academic success. Public Choice, 116(1-2): 205-223.
- Frey, B. S. & Osterloh, M. 2005. Yes, managers should be paid like bureaucrats. Journal of Management Inquiry, 14(1): 96-111.
- Gagne, M., Senecal, C. B., & Koestner, R. 1997. Proximal job characteristics, feelings of empowerment, and intrinsic motivation: A multidimensional model. Journal of Applied Social Psychology, 27(14): 1222-1240.
- Gans, J. S. & Shepherd, G. B. 1994. How Are the Mighty Fallen - Rejected Classic Articles by Leading Economists. Journal of Economic Perspectives, 8(1): 165-179.
- Gillies, D. 2006. Why Research Assessment Exercises Are a Bad Thing. Post-Autistic Economics Review, 37: 2-9.
- Gintis, H. & Khurana, R. 2006. Corporate Honesty and Business Education: A Behavioral Model, Free Enterprise: Values in Action Conference Series: 1-30.
- Gittell, J. H. 2000a. Organizing work to support relational co-ordination. International Journal of Human Resource Management, 11(3): 517-539.
- Gittell, J. H. 2000b. Paradox of Coordination and Control. California Management Review, 42(3): 101-117.
- Gneezy, U. & Rustichini, A. 2000a. Pay enough or don't pay at all. Quarterly Journal of Economics, 115(3): 791-810.
- Gneezy, U. & Rustichini, A. 2000b. A fine is a price. Journal of Legal Studies, 29(1): 1-17.
- Grant, R. 1996. Prospering in Dynamically Competitive Environments: Organizational Capability as Knowledge Integration. Organization Science, 7: 375-387.
- Grant, R. M. & Baden-Fuller, C. 2004. A knowledge accessing theory of strategic alliances. Journal of Management Studies, 41(1): 61-84.
- Güth, W., Schmittberger, R., & Schwarze, B. 1982. An Experimental-Analysis of Ultimatum Bargaining. Journal of Economic Behavior & Organization, 3(4): 367-388.
- Hackman, J. R. & Oldham, G. R. 1974. The job diagnostic survey: An instrument for the diagnosis of jobs and the evaluation of job redesign projects. New Haven, Conn.: Yale University.
- Hackman, R. J. & Oldham, G. R. 1980. Work Redesign. Reading, Mass.: Addison-Wesley.
- Hamilton, D. P. 2001. Intel gambles it can move beyond the PC with new microprocessors. The Wall Street Journal, 29 May: 1.
- Hardin, G. 1968. The Tragedy of the Commons. Science(162): 1243-1248.
- Hellstrom, T. 2003. Governing the virtual academic commons. Research Policy, 32(3): 391-401.

- Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., & McElreath, R. 2001. In search of Homo economicus: Behavioral experiments in 15 small-scale societies. American Economic Review, 91(2): 73-78.
- Holmqvist, M. 2004. Experiential Learning Processes of Exploitation and Exploration Within and Between Organizations: An Empirical Study of Product Development 10.1287/orsc.1030.0056. ORGANIZATION SCIENCE, 15(1): 70-81.
- Holmström, B. & Milgrom, P. 1991. Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design. Journal of Law, Economics and Organization, 7: 24-52.
- Holmström, B. R. & Milgrom, P. 1994. The Firm as an Incentive System. American Economic Review, 84: 972-991.
- Ichino, A. & Maggi, G. 2000. Work environment and individual background: Explaining regional shirking differentials in a large Italian firm. Quarterly Journal of Economics, 115(3): 1057-1090.
- Irlenbusch, B. & Sliwka, D. 2003. Incentives, decision frames and motivation crowding out - an experimental investigation. IZA Bonn.
- Janz, B. D. & Prasarnphanich, P. 2003. Understanding the antecedents of effective knowledge management: The importance of a knowledge-centered culture. Decision Sciences, 34(2): 351-384.
- Jensen, M. C. 2006. Putting Integrity into Finance Theory and Practice: A Positive Approach, Harvard Business School.
- Kerr, S. 1975. On the Folly of Rewarding A, while Hoping for B. Academy of Management Journal, 18: 769-783.
- Kluger, A. N. & DeNisi, A. 1996. The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. Psychological Bulletin, 119(2): 254-284.
- Kogut, B. & Zander, U. 1996. What Firms Do? Coordination, Identity and Learning. Organization Science, 7: 502-518.
- Kollock, P. 1998. Social Dilemmas: The Anatomy of Cooperation. Annual Review of Sociology, 22: 183-205.
- Kuvaas, B. 2006. Work performance, affective commitment, and work motivation: the roles of pay administration and pay level. Journal of Organizational Behavior, 27(3): 365-385.
- Lave, J. & Wenger, E. 1991. Situated learning: legitimate peripheral participation. Cambridge [England] ; New York: Cambridge University Press.
- Lazear, E. P. 1999. Personnel economics. Past lessons and future directions. Journal of Labor Economics, 17: 199-236.
- Lepper, M. R. & Greene, D. 1978. The hidden costs of reward: new perspectives on the psychology of human motivation.
- Liberman, V., Samuels, S., & Ross, L. 2003. The name of the game: Predictive power or reputation vs. situational labels in determining prisoners' dilemma game moves, Working Paper Department of Psychology Stanford University. Stanford, CA.
- Lindenberg, S. 2001. Intrinsic Motivation in a New Light. Kyklos, 54: 317-343.
- Lindenberg, S. 2003. The cognitive side of governance. In V. Buskens & W. Raub & C. Snijders (Eds.), The governance of relations in markets and organizations. Research in the sociology of organizations, Vol. 20: 47-76. Oxford: JAI Press.
- March, J. G. 1991. Exploration and Exploitation in Organizational Learning. Organization Science, 2: 71-87.
- McEvily, S. K., Eisenhardt, K. M., & Prescott, J. E. 2004. The global acquisition, leverage, and protection of technological competencies. Strategic Management Journal, 25(8-9): 713-722.

- Messick, D. M. & Brewer, M. B. 1983. Solving Social Dilemmas: A Review. In L. Wheeler (Ed.), Review of Personality and Social Psychology, Vol. 4: 11-44. Beverly Hills: Sage.
- Miller, D. T. & Ratner, R. K. 1998. The disparity between the actual and assumed power of self-interest. Journal of Personality and Social Psychology, 74(1): 53-62.
- Miller, G. 1992. Managerial Dilemmas. The Political Economy of Hierarchy. Cambridge UK: Cambridge University Press.
- Nahapiet, J. & Ghoshal, S. 1998. Social Capital, Intellectual Capital and the Organizational Advantage. Academy of Management Review, 23: 242-266.
- Nelson, R. R. 2006. Reflections on "The Simple Economics of Basic Scientific Research": looking back and looking forward. Industrial and Corporate Change, 15: 903-917.
- Niehoff, B. P. & Moorman, R. H. 1993. Justice as a mediator of the relationship between methods of monitoring and organizational citizenship behavior. Academy of Management Journal, 36(3): 527-556.
- Nooteboom, B. 2000a. Learning by interaction: Absorptive capacity , cognitive distance and governance. Journal of Management and Governance, 4: 69-92.
- Nooteboom, B. 2000b. Learning and Innovation in Organizations and Economies. Oxford: Oxford University Press.
- Oldham, G. R. & Cummings, A. 1996. Employee creativity: Personal and contextual factors at work. Academy of Management Journal, 39(3): 607-634.
- Olson, M. 1965. The Logic of Collective Action. Cambridge, MA: Harvard University Press.
- Organ, D. W. & Ryan, K. 1995. A Meta-Analytic Review of Attitudinal and Dispositional Predictors of Organizational Citizenship Behavior. Personnel Psychology, 48: 775-782.
- Osterloh, M. & Frey, B. S. 2000. Motivation, Knowledge Transfer, and Organizational Forms. Organization Science, 11(5): 538-550.
- Osterloh, M., Frost, J., & Weibel, A. 2002. Solving Social Dilemmas: The Dynamics of Motivation in the Theory of the Firm. University of Zürich: Arbeitspapier Institut für betriebswirtschaftliche Forschung.
- Osterloh, M. & Rota, S. forthcoming. Trust and community in open source software production. In U. Matzat & B. Lahno & M. Baumann (Eds.), Trust and community on the internet.
- Podsakoff, P. M., MacKenzie, S. B., Paine, J. B., & Bachrach, D. G. 2000. Organizational Citizenship Behaviors: A Critical Review of the Theoretical and Empirical Literature and Suggestions for Future Research. Journal of Management, 26(1): 513-563.
- Postrel, S. 2002. Islands of shared knowledge: Specialization and mutual understanding in problem-solving teams. Organization Science, 13(3): 303-320.
- Rabin, M. 1998. Psychology and economics. Journal of Economic Literature, 36(1): 11-46.
- Rousseau, D. M. 1995. Psychological Contracts in Organizations: Understanding Written and Unwritten Agreements. Thousand Oaks, CA: Sage Publications.
- Sally, D. 1995. Conversation and Cooperation in Social Dilemmas - a Metaanalysis of Experiments from 1958 to 1992. Rationality and Society, 7(1): 58-92.
- Sen, A. K. 1974. Choice, orderings and morality. In S. Körner (Ed.), Practical reasons: Paper and discussions. Oxford: Blackwell.
- Simon, H. A. 1991. Organization and Markets. Journal of Economic Perspectives, 5(2): 25-44.
- Spencer, J. W. 2003. Firms' knowledge-sharing strategies in the global innovation system: Empirical evidence from the flat panel display industry. Strategic Management Journal, 24(3): 217-233.
- Spender, J. C. 1992. Strategy Theorizing: Expanding the Agenda. In P. Shrivastava & A. Huff & J. Dutton (Eds.), Advances in Strategic Management, Vol. 8: 3-32. Greenwich.

- Torvalds, L. & Diamond, D. 2001. Just for fun : the story of an accidental revolutionary (1st ed.). New York, NY: HarperBusiness.
- Tyler, T. & Blader, S. 2001. Identity and cooperative behavior in groups. Group Processes and Intergroup Relations, 4(3): 207-226.
- Tyler, T. R. 1990. Why people obey the law. New Haven: Yale University Press.
- Tyler, T. R. & Blader, S. L. 2000. Cooperation in Groups: Procedural Justice, Social Identity, and Behavioral Engagement. Philadelphia: Psychology Press.
- Tyler, T. R. & Huo, Y. J. 2002. Trust in the law: encouraging public cooperation with the police and courts. New York: Russell Sage Foundation.
- Tyler, T. R. & Blader, S. L. 2003. The group engagement model: Procedural justice, social identity, and cooperative behavior. Personality and Social Psychology Review, 7(4): 349-361.
- Vining, A. R. 2003. Internal market failure: A framework for diagnosing firm inefficiency. Journal of Management Studies, 40(2): 431-457.
- Weibel, A. 2002. Kooperation in strategischen Wissensnetzwerken : Vertrauen und Kontrolle zur Lösung des sozialen Dilemmas. Zürich: Dissertation Universität Zürich.
- Weibel, A. 2007. Formal control and trustworthiness - never the twain shall meet? Group & Organization Management, 32(4): 500-517.
- Weibel, A., Rost, K., & Osterloh, M. 2007. Crowding-Out of Intrinsic Motivation—Opening the Black Box.
- Weingart, P. 2005. Impact of bibliometrics upon the science system: Inadvertent consequences? Scientometrics, 62(1): 117-131.
- Whitley, R. 2003. The institutional structuring of organizational capabilities: The role of authority sharing and organizational careers. Organization Studies, 24(5): 667-695.