Part II.

Knowledge Sharing

Nothing is Quite so Practical as a Good Theory

Andrew Van de Ven [190]

3. Theory of Knowledge Sharing

In this chapter we present a theory of knowledge sharing in the context of an open knowledge repository. To develop the theory we describe knowledge sharing as a public-good game and as a prisoner's dilemma (see Figure 3.1). In Section 3.1, we extend the public-good game and the prisoner's dilemma to an economic model of knowledge sharing. In Section 3.2, we use the findings of experimental economics to infer knowledge-sharing motives. This foundation allows us to analyze the effect of different influential factors in Section 3.3. With this theoretical basis we are able to analyze the effect of incentives (Section 3.4) and culture (Section 3.5). The predictions of the influence of incentives and culture on knowledge sharing are then tested on field data in Chapter 4. The propositions of Section 3.1 and part of the propositions of Section 3.2 are experimentally tested in Chapter 6.

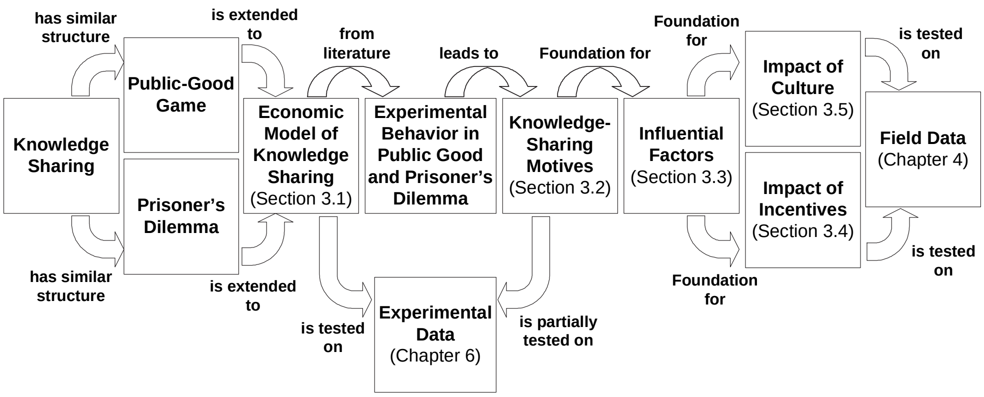

Figure 3.1.: Research Steps in Chapter 3

3.1. An Economic Model for Knowledge Sharing

In the following, we shall show that knowledge sharing in an open knowledge repository can be viewed as a social dilemma [39]. We shall present two models for this knowledge dilemma: first, a two-person/one-period knowledge-sharing situation, with only sharing or no sharing options; second, an n-person/one-period knowledge-sharing situation where each employee can decide how much time he wants to spend on knowledge sharing.

3.1.1. Two-Person Knowledge-Sharing Dilemma

Knowledge sharing between individuals can possibly result in a benefit for both, but game-theoretically it might not be the equilibrium strategy. First we analyze a situation with only two people and two possible actions. The action space ($\mathcal{A}$) per player consists of the two possibilities: knowledge sharing (s) and knowledge hoarding (h). The utility U of each player is a function of the actions of both players:

$$U : \mathcal{A} \times \mathcal{A} \rightarrow \mathbb{R}. \tag{3.1}$$

There are four possible outcomes with the respective payoffs (see Table 3.1):

U(h,s) = hs: Utility of hoarding while the partner shares his knowledge

U(s,s) = ss: Utility of mutual knowledge sharing

U(h,h) = hh: Utility of mutual knowledge hoarding

U(s,h) = sh: Utility of sharing while the partner is hoarding

The best situation for a player is to hoard the knowledge while the other player shares the knowledge (hs). Only the second best outcome is that both share their knowledge (ss). This difference between hs and ss comes from the cost of knowledge sharing and the benefit of being the only one who has this particular knowledge. The third best option is the mutual knowledge hoarding (hh). Therefore, both would be better off if they share mutually instead of mutual hoarding. The worst option is that the player spends the time and effort to share knowledge while the other player hoards his (sh). This leads to the following ranking of the payoffs:

$$hs > ss > hh > sh \quad . \tag{3.2}$$

We also assume a situation where the best *collective* strategy would be mutual knowledge sharing rather than a collusion of sharing and hoarding:

$$ss > \frac{sh + hs}{2} \quad . \tag{3.3}$$

The ranking of the payoffs corresponds to the *prisoner's dilemma game* [160, p.34]. In this situation, it is always *individually* best not to share the knowledge,

Player B / Player A	Knowledge Hoarding h	Knowledge Sharing s
Knowledge Hoarding h	hh / hh	sh / hs
Knowledge Sharing s	hs / sh	ss / ss

Table 3.1.: Payoff Matrix of a Two-Person Knowledge-Sharing Dilemma (Outcomes for both Players)

independent of the choice of the other person, i.e. knowledge hoarding is a strictly dominant strategy. Consequently mutual hoarding is the equilibrium.

Caused by the payoff structure, the players are trapped in a social dilemma. In a social dilemma, optimal individual behavior has the effect that everybody is worse off than they would be otherwise [110]. Individual rationality leads to collective irrationality. In a social dilemma there is at least one outcome in which every person would be better off than in the equilibrium [110].

Proposition 1. *A large proportion of the users will do free riding in an open repository situation.*

Discussion:

We assume that the knowledge-sharing situation can be described as a prisoner's dilemma with the payoff ranking described in Equation 3.2. In this situation, knowledge hoarding is a strictly dominant strategy [115, p. 631] and the Nash equilibrium [142] is mutual knowledge hoarding. Therefore, we would expect that a high fraction of participants would free ride in the open repository situation. ■

Proposition 1 will be tested experimentally with Hypothesis 8 on page 173 in Section 6.4.

3.1.2. Multiple-Person Knowledge-Sharing Dilemma

The two-person knowledge-sharing dilemma becomes a public-good problem if there are multiple persons who choose to share multiple knowledge assets. We focus on knowledge in the form of documents. In our model there is no person-to-person knowledge sharing but all knowledge assets are shared through a central open repository.

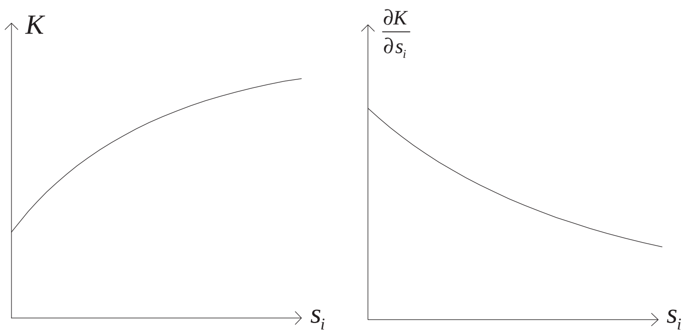

Figure 3.2.: Amount of useful Knowledge in Repository (K) and Marginal Knowledge Externalization Efficiency ($\partial K/\partial s_i$) dependent upon Time for Knowledge Sharing (s_i)

Such an asset has the characteristics of a public good. Firstly, it can be accessed by everyone authorized to query the repository and be delivered for marginal costs. Secondly, the consumption of an asset by one person does not affect further consumption by other persons. Hence, the contribution of knowledge assets into an open repository without incentives can be viewed as a private (i.e. voluntary) contribution to a public good. The public-good theory predicts insufficient knowledge sharing, because each player only considers the individual benefits of contributing, but not how others would benefit from sharing. In public-good games, it has been observed that private contribution often leads to free riding and to an undersupply of the good [171]. In the context of an open-knowledge repository, we can call this a knowledge-sharing dilemma [39]. We shall apply the public-good theory [171, 172, 25] to the field of knowledge sharing.

Assumptions

We make the following assumptions. There are n users of a shared knowledge repository. Each user i has a time budget of b_i hours. The user allocates the time to knowledge sharing activities s_i or other work x_i. In his time of knowledge sharing, the user enhances the knowledge base so that every user can benefit from it. There is no person-to-person knowledge sharing but all the knowledge transfers take place through a central knowledge repository (see Figure 2.5).

The amount of useful knowledge K in the knowledge repository is a function of the time of knowledge sharing of each worker, i.e. $K = K(s_1, \ldots, s_n)$. The

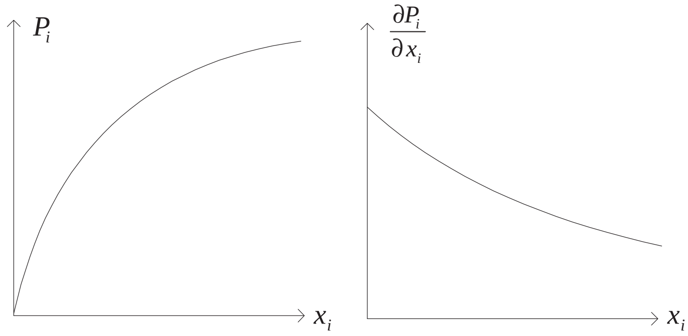

Figure 3.3.: Performance (P_i) and Marginal Work Productivity ($\partial P_i/\partial x_i$) of Employee i with changing Time for Working (x_i)

useful knowledge increases with more knowledge sharing ($\frac{\partial K}{\partial s_i} > 0$), but there are diminishing marginal returns on knowledge sharing ($\frac{\partial^2 K}{\partial s_i^2} < 0$). We call $\frac{\partial K}{\partial s_i}$ the *marginal knowledge externalization efficiency* of employee i. The function K and the first derivative is sketched in Figure 3.2.

We isolate two sources of the performance of the worker: the working time and the knowledge repository. The performance $P_i(x_i, K)$ of an employee i is therefore a function of the time the employee is working (x_i) and the shared knowledge in the knowledge repository (K). We assume normal properties of a production function that means: the more the employee works the better is the outcome ($\frac{\partial P}{\partial x_i} > 0$), but the marginal return is decreasing with higher work time ($\frac{\partial^2 P}{\partial x_i^2} < 0$). The function P and the first derivative is shown in Figure 3.3. Also, the performance is dependent on the useful knowledge in the repository. We call the first derivative of the performance with respect to the useful knowledge in the repository ($\frac{\partial P_i}{\partial K}$) the *knowledge productivity* of employee i. Again we assume properties of a production function: The higher the amount of useful knowledge in the repository, the higher the performance of the employee ($\frac{\partial P_i}{\partial K} > 0$), but the marginal return of further knowledge is decreasing ($\frac{\partial^2 P_i}{\partial K^2} < 0$).

We are assuming that nobody spends all the time on knowledge sharing without working and that the workers at least spend some time on knowledge sharing.

The utility function U_i of the worker i is equivalent to the income of the employee. The income of each worker is composed of two parts: A fixed base wage w_i and a variable component dependent on the individual performance. The performance P of each employee is fully visible to the management. The variable component is

Table 3.2.: Mathematical Notation

Symbol	Meaning
U_i	Utility of employee i
s_i	Time for knowledge sharing of employee i
x_i	Time for working of employee i
b_i	Fixed time budget of employee i
w_i	Fixed wage of employee i
K	Amount of useful knowledge in repository
$P_i(x_i, K)$	Production function of employee i
$\partial P_i/\partial x_i$	Marginal work productivity of employee i
$\partial P_i/\partial K$	Marginal knowledge productivity of employee i
$\partial K/\partial s_i$	Marginal knowledge externalization efficiency of employee i
$\frac{\partial K^2}{\partial s_i \partial s_j}$	Knowledge complementarity of knowledge explication of employees i and j
φ	Variable payment fraction of employee performance
π	Firm's profit

a φ fraction ($0 < \varphi < 1$) of his performance. φ and w_i are set by the company. We assume a one-period situation. The employees and the company are risk neutral. We therefore assume that the amount of salary is the only deciding factor for the employee:

$$U_i(x_i, K) = \varphi P_i(x_i, K) + w_i \; . \tag{3.4}$$

The company's objective function is the profit. It is calculated as the firm's fraction of the sum of all the output of each employee:

$$\pi(\varphi, w, x, s) = (1 - \varphi) \sum_{j=1}^{n} P_j(x_j, K) - w_j \quad . \tag{3.5}$$

3.1.3. Voluntary Knowledge Sharing

Proposition 2. *Voluntary knowledge sharing is lower than the organizational desired optimum and the collective employee optimum (Pareto optimum).*

Proof:

Voluntary Knowledge Sharing

Firstly, we analyze a distributed-decision–making situation in which the employees independently decide on their knowledge sharing level. The company offers the wages as described in Equation 3.4, i.e. the company decides on φ and w_i. In return the company gets the performance (output) P_i of each employee and the time for knowledge sharing. Every participant knows all parameters of the model and therefore can anticipate the behavior of others. The behavior is *ex post* visible.

Figure 3.4 shows the interrelations between the company and the employee level. The figure displays the flow of benefits, incentives and instruction as well as the anticipation of actions (see [176, p. 17] for distributed-decision–making diagrams). In our model the level of the wage (φ and w_i) has no effect on the knowledge sharing level (cf. Equation 3.15). Therefore, there is no anticipation arrow from the employees to the company. However, each employee anticipates the behavior of the other employees. The decision about the knowledge sharing level is done by the employees simultaneously.

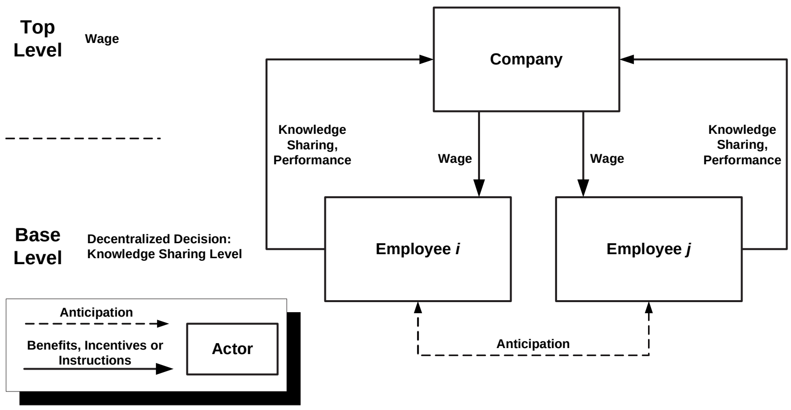

Figure 3.4.: Interrelations between Company and Employee Level in the Voluntary Knowledge Sharing Situation

Every employee tries to maximize his own performance by choosing how much he will work and how much knowledge he will share. So he will solve the maximization problem (Problem 1):

$$\max_{x_i, s_i} U_i = \max_{x_i, s_i} \varphi P_i(x_i, K) + w_i \tag{3.6}$$

$$\text{s.t. } x_i + s_i = b_i \tag{3.7}$$
$$K = K(s_1, \ldots, s_n) \tag{3.8}$$
$$x_i \geq 0 \tag{3.9}$$
$$s_i \geq 0 \tag{3.10}$$

We have assumed that at least some knowledge sharing and work is happening, that means we have an inner solution, and that the equations 3.9 and 3.10 are not binding. The Lagrangian of the worker's problem (Problem 1) is then

$$L = \varphi P_i(x_i, K) + w_i - \lambda(x_i + s_i - b_i) - \mu(K - K(s_1, \ldots, s_n)) \,. \tag{3.11}$$

Then the first order conditions with respect to x_i, s_i and K are

$$\frac{\partial L}{\partial x_i} = \varphi \frac{\partial P_i}{\partial x_i} - \lambda = 0 \tag{3.12}$$

$$\frac{\partial L}{\partial s_i} = -\lambda + \mu \frac{\partial K}{\partial s_i} = 0 \tag{3.13}$$

$$\frac{\partial L}{\partial K} = \varphi \frac{\partial P_i}{\partial K} - \mu = 0 \tag{3.14}$$

When we insert 3.13 and 3.14 in 3.12, we get the following optimality condition:

$$\underbrace{\frac{\partial P_i}{\partial K}\frac{\partial K}{\partial s_i}}_{\text{Marginal Individual Benefit of Sharing}} = \underbrace{\frac{\partial P_i}{\partial x_i}}_{\text{Marginal Benefit of Working}} \tag{3.15}$$

Let $s^* = (s_1^*, \ldots, s_n^*)$ be the individual-optimal knowledge sharing level, that means the s_i that satisfies Equation 3.15. Then the knowledge stock is $K^* = K(s^*)$ and the working time is $x^* = (x_1^*, \ldots, x_n^*) = (b_1 - s_1^*, \ldots, b_n - s_n^*)$. In the individual optimum, the marginal benefit of working is equal to the marginal benefit of knowledge sharing. Shifting time to either knowledge sharing or working would only lower the individual utility.

Company Optimal Situation

In the company optimal situation we assume that the company can order the proper knowledge sharing time of each employee. This is a rather strong assumption that we will relax in Section 3.4.1. However, as a model variation or thought experiment we

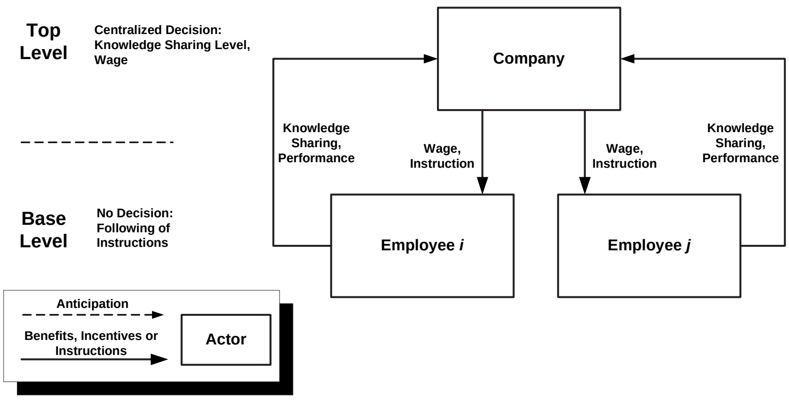

Figure 3.5.: Interrelations between Company and Employee Level in the Company Optimal Situation

can thereby ensure a company optimal solution. Figure 3.5 shows the interrelation between the company and the employee level in this central control situation.

The company wants to maximize the profit. This optima is defined by the solution of this maximization problem (Problem 2):

$$\max_{x_1,\ldots,x_n,s_1,\ldots,s_n} \pi = \max_{x_1,\ldots,x_n,s_1,\ldots,s_n} (1-\varphi)\sum_{j=1}^{n} P_j(x_j,K) - w_j \tag{3.16}$$

$$\text{s.t.} \quad x_j + s_j = b_j \quad \forall j \tag{3.17}$$

$$K = K(s_1,\ldots,s_n) \tag{3.18}$$

$$x_j \geq 0 \quad \forall j \tag{3.19}$$

$$s_j \geq 0 \quad \forall j \tag{3.20}$$

We again only consider an inner solution. The Lagrangian of the company's problem (Problem 2) is then

$$L = (1-\varphi)\sum_{j=1}^{n}(P_j(x_j,K)-w_j) - \sum_{j=1}^{n}\alpha_j(x_j+s_j-b_j) - \mu((K-K(s_1,\ldots,s_n))\ . \tag{3.21}$$

Then the first order conditions with respect to x_i, s_i and K are

$$\frac{\partial L}{\partial x_i} = (1-\varphi)\frac{\partial P_i}{\partial x_i} - \alpha_i = 0 \tag{3.22}$$

$$\frac{\partial L}{\partial s_i} = -\alpha_i + \mu \frac{\partial K}{\partial s_i} = 0 \tag{3.23}$$

$$\frac{\partial L}{\partial K} = (1-\varphi) \sum_j \frac{\partial P_j}{\partial K} - \mu = 0 \tag{3.24}$$

When we insert Equation 3.22 and 3.23 in 3.24, we get the (inner) optimality condition for the company's solution:

$$\underbrace{\sum_j \frac{\partial P_j}{\partial K} \frac{\partial K}{\partial s_j}}_{\text{Marginal Collective Benefit of Sharing}} = \underbrace{\frac{\partial P_i}{\partial x_i}}_{\text{Marginal Benefit of Working}} \quad \forall i \tag{3.25}$$

That means in the collective optimum the marginal benefit of working is equal to the marginal benefit of knowledge sharing for all workers. Let $s^\diamond = (s_1^\diamond, \ldots, s_n^\diamond)$ be the company-optimal knowledge sharing for the company, that means the s_i that satisfies Equation 3.25. Then the company-optimal knowledge stock is $K^\diamond = K(s^\diamond)$ and the company-optimal working time is $x^\diamond = (x_1^\diamond, \ldots, x_n^\diamond) = (b_1 - s_1^\diamond, \ldots, b_n - s_n^\diamond)$.

The increased productivity of the *other* workers is not considered in the individual optimization of the worker. The left hand side of Equation 3.15 is lower than the left hand side of 3.25, because we assumed $\frac{\partial P_i}{\partial x_i} > 0$ and $\frac{\partial^2 P_i}{\partial x_i^2} < 0$, x_i is higher in Equation 3.15 than in 3.25. Therefore, knowledge sharing in the individual optimum is too small from the company perspective. Also, all employees could improve their situation in the company optimal situation. Therefore, the switch from the individual to the company optimum would also be a Pareto improvement for the employees; however, it is not an equilibrium and can therefore not be reached individually. We conclude that knowledge sharing in an open-knowledge repository is insufficient.

■

Proposition 2—voluntary knowledge sharing is lower than the organizational desired optimum and the collective employee optimum—will be tested experimentally in Section 6.4 with Hypothesis 9 on page 173.

3.1.4. Numerical Example

In this example, there are only two workers. We assume a Cobb-Douglas production function [80, p. 185] for the individual work performance in the form of:

$$P_i(x_i, K) = x_i^\alpha K^\beta \tag{3.26}$$

with $0 \leq \alpha \leq 1$ and $0 \leq \beta \leq 1$.

Note that the production functions fulfill all assumptions of the former section. For the numerical example we use $\alpha = \beta = \frac{1}{2}$. The function is plotted in Figure 3.6 and 3.7.

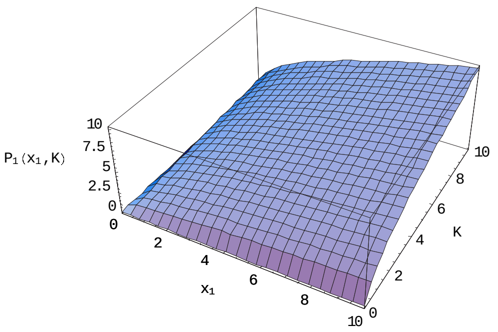

Figure 3.6.: 3D Plot of Production Function $P_1(x_1, K)$

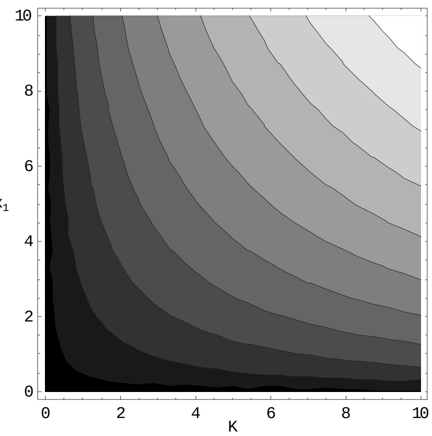

Figure 3.7.: Contour Plot of Production Function $P_1(x_1, K)$

We assume a variable payment component of $\varphi = \frac{1}{2}$ and no fixed base wage ($w_i = 0$). The maximal time budget in a week is 40 hours ($b_i = 40$). The useful knowledge in the repository (K) is defined as the sum of the time both players spent on knowledge sharing[1]:

$$K(s_1, s_2) = s_1 + s_2 \quad . \tag{3.27}$$

The utility of Employee 1 is

$$U_1(x_1, s_1) = \varphi P_1(x_1, K(s_1, s_2)) \tag{3.28}$$

and the utility of Employee 2 is

$$U_2(x_2, s_2) = \varphi P_2(x_2, K(s_1, s_2)) \quad . \tag{3.29}$$

The Lagrangian for the optimization problem of the first employee is

$$\mathcal{L} = \varphi \sqrt{s_1 + s_2} \sqrt{x_1} + \lambda (s_1 + x_1 - b_1) \tag{3.30}$$

[1] For simplicity reasons we calculate this example without units of measurement.

The first order conditions are:

$$\frac{\partial L}{\partial x_i} = \lambda + \frac{\varphi\sqrt{s_1 + s_2}}{2\sqrt{x_1}} = 0 \tag{3.31}$$

$$\frac{\partial L}{\partial s_i} = \lambda + \frac{\varphi\sqrt{x_1}}{2\sqrt{s_1 + s_2}} = 0 \tag{3.32}$$

$$\frac{\partial L}{\partial \lambda} = -b_1 + s_1 + x_1 = 0 \tag{3.33}$$

By solving the equations, we get a reaction function s_1^* for voluntary knowledge sharing. The function shows the optimal knowledge sharing level of Employee 1 dependent on the knowledge sharing level of Employee 2:

$$s_1^*(s_2) = \max\left(0, \frac{b_1 - s_2}{2}\right) \tag{3.34}$$

We get a corresponding reaction function for Employee 2 if we solve his decision problem:

$$s_2^*(s_1) = \max\left(0, \frac{b_2 - s_1}{2}\right) \tag{3.35}$$

Figure 3.8 shows both reaction functions. The intersection point is the Nash equilibrium. By solving the equations 3.34 and 3.35 we get the Nash equilibrium. In this Nash equilibrium Employee 1 spends

$$s_1^* = \frac{b_1}{3} = 13.3 \tag{3.36}$$

with knowledge sharing and Employee 2 spends

$$s_2^* = \frac{b_2}{3} = 13.3 \ . \tag{3.37}$$

The corresponding working hours are $x_1^* = x_2^* = 26.7$. The useful knowledge in the repository is $K^* = s_1^* + s_2^* = 26.7$. The utility of Employee 1 is $U_1^* = 1/2\sqrt{x_1^*}\sqrt{K^*} = 13.3$. and of Employee 2 is $U_2^* = 13.3$. The profit of the company is $\pi^* = (1-\varphi)\sum_{i=1}^{2} P_i(x_i^*, K^*) = 26.7$.

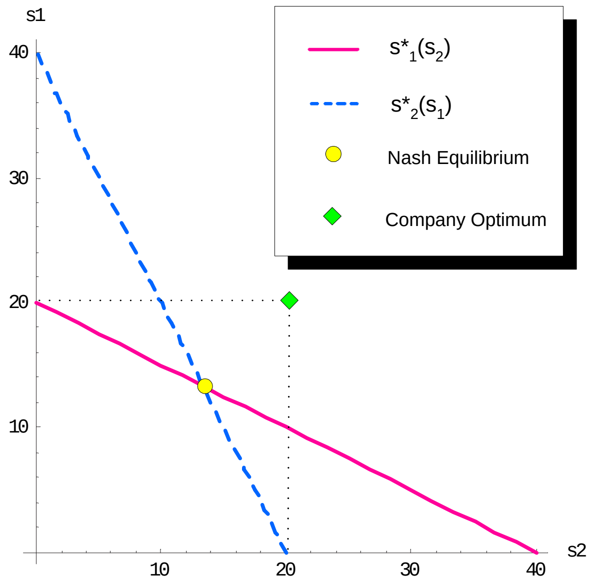

Figure 3.8.: Reaction Functions

Company Optimum

The company optimizes the sum of the output of both employees minus the variable and fixed costs:

$$\pi(s,x) = (1-\varphi)\sum_{i=1}^{2} P_i(x_i, K) \tag{3.38}$$

The company has also to consider the time constraint of both employees. By solving the related optimization problem we get as the company optimal solution for Employee 1

$$s_1^{\diamond} = \frac{b_1}{2} = 20 \tag{3.39}$$

and for Employee 2

$$s_2^{\diamond} = \frac{b_2}{2} = 20 \quad . \tag{3.40}$$

The company optimal point is also shown in Figure 3.8.

The corresponding working hours are $x_1^\diamond = x_2^\diamond = 20$. The useful knowledge in the repository is $K^\diamond = s_1^\diamond + s_2^\diamond = 40$. The utility of employees 1 and 2 are $U_1^\diamond = 1/2\sqrt{x_1^\diamond}\sqrt{K^\diamond} = 14.1$. and $U_2^\diamond = 14.1$. The profit of the company is $\pi^\diamond = (1-\varphi)\sum_{i=1}^{2} P_i(x_i^\diamond, K^\diamond) = 28.3$. The numerical example shows that the company optimal situation is a Pareto improvement to the voluntary knowledge sharing because the company as well as the employees are better off.

3.2. Sharing Motives in Knowledge-Sharing Dilemmas

Why do people share their knowledge in a knowledge management system? We showed in the previous section that knowledge sharing can be viewed as a public-good game or as a prisoner's dilemma. In the public good model we have proved that knowledge sharing is lower than the company optimum. In the prisoner's dilemma model the Nash equilibrium was mutual knowledge hoarding. But the experimental analysis of public-good games and prisoner's dilemmas provides us with some explanations as to why some people contribute to a public good [119]. In experimental economics, the actual behavior of people in an environment (i.e. game) is analyzed. The players get real money depending on their payoff in the game. The experiment is carried out under laboratory conditions where influential factors can be carefully controlled. Numerous experiments show that players contribute more than the Nash equilibrium might predict [119]. In the following, we shall analyze different factors derived from experimental economics that influence social dilemmas and motivate people to contribute, even though the game-theoretical equilibrium would be not to contribute at all. We shall check whether these factors and motives are applicable for knowledge sharing or not.

We distinguish between motives (Section 3.2) and factors (Section 3.3). We define motives as internal or external circumstances that directly influence knowledge sharing. Factors are circumstances that influence knowledge sharing indirectly through motives.

3.2.1. Relative Payoff

One way to overcome the knowledge-sharing dilemma is to *directly* change the payoff matrix. Public-good experiments have shown that higher marginal benefit of the public-good contribution has a positive effect on the public-good contribution [119, p. 149].

We can increase the benefits of knowledge sharing by changing the human resource and career policies in a way that values knowledge sharing, or by paying incentives for uploading knowledge assets. Also, the time and effort of knowledge sharing can be decreased by making it easier to share, and by making the employees more familiar with the technology [39, 82].

Proposition 3. *Increasing the relative benefit of knowledge sharing will increase knowledge sharing.*

Discussion:

We have assumed that knowledge sharing with an open repository has a similar structure as a public-good game. In public-good experiments the marginal return of contributing has a positive influence on voluntary contribution [119, p. 149]. Therefore, we also expect the relative payoff for sharing to have a positive influence on the knowledge sharing intensity.

■

The effect of changing the relative payoff by incentives is analyzed in Section 3.4. The effect of incentives is tested empirically on field data in Hypothesis 1 (p. 111) and experimentally in Hypothesis 5 (p. 169).

3.2.2. Altruism

Altruism can be defined as a “personally costly behavior that benefits others” [77]. In contrast to strategic reciprocity, altruism can be considered as a form of unconditional kindness without the expectation of a return [64]. The results of public-good experiments have shown that the actual behavior of the test person is not consistent with the traditional economic view of the “Homo Economicus” [119]. This means that the game’s standard theoretic assumption of “more money is preferred to less” [27, p.167] is relaxed. In one-round public-good experiments, a significantly higher cooperation rate has been observed than could be explained by self-interest. A meta study of public-good experiments showed that—consistently in early rounds—average and median contribution ranged from 40% to 60% of the budget; that is significantly higher than the Nash equilibrium of zero [65].

There are some theoretical approaches that try to incorporate these experimental findings in decision theory [14, 64]. Because only the monetary payoffs are visible in the games, but in decision theory utilities are relevant, the theoretical approaches try to add factors to the utility function that explain the altruistic behavior. A common factor in all these explanations is that the utility not only depends on one’s own payoff but also on the payoffs of other players.

Andreoni [14] distinguishes between “pure altruism” and “impure altruism.” In the public-good context, pure altruism means that the utility not only depends on the individual payoff but also on the collective payoffs of the others [14]. In an impure altruistic utility, the pure act of giving will enhance the utility of the giver [14].

In the public-good context pure altruistic utilities are functions where the utility not only depends on the individual payoff but also on the collective payoffs of the others [14]. That means for the utility U that the first partial derivation with respect to the payoff of each player j is strictly positive, so that the utility increases with the payoffs of the others [66, p. 12].

One possibility of a pure altruistic utility in our example could be

$$U_i = \varphi P_i(x_i, K) + w_i + A(\sum_{j \neq i} U_j) \tag{3.41}$$

where the altruism function A is strictly monotonically increasing with the utility of the others and represents the monetary equivalent of the altruistic pleasure.

Impure altruistic preferences means that the pure act of giving will enhance the utility of the giver [14]. The utility may be

$$U_i = \varphi P_i(x_i, K) + w_i + A(s_i) \tag{3.42}$$

where the altruism A is a strictly monotonically increasing function dependent on the amount of knowledge sharing of player i and represents the monetary equivalent of altruistic joy.

Proposition 4. *Altruism influences knowledge sharing positively.*

Discussion:

We have assumed that knowledge sharing in an open repository has the same decision structure as a public-good game. In public-good experiments altruism has a positive influence on voluntary contribution [14]. Therefore, we also expect altruism to have a positive influence in a knowledge-sharing situation.

■

Wasko and Faraj [196] found that the participants of communities of practices help each other because of pro-social behavior. Constant et al. [47] discovered that self interest—the contrary of pro-social behavior—has a negative influence on information sharing. Both findings support our Proposition 4.

3.2.3. Conditional Cooperation

Fehr and Gächter [64] have shown that many individuals in public-good experiments are conditionally cooperative, which means they are willing to cooperate if others cooperate as well, whereas they will stop the cooperation if others stop cooperating. This behavior can be observed, even if the participants know that they will not meet each other again. Therefore, *strategic reciprocity* (see Section 3.2.4) cannot be an explanation because it focuses on the self-interested benefits of cooperation in long-term interactions. The conditional cooperation motive in a way transforms the subjective game from a prisoner's dilemma into an assurance game. The *assurance game* [110] is similar to the prisoner's dilemma, but has two Nash-equilibrium strategies: both share their knowledge or both hoard their knowledge. The corresponding payoffs can be ordered in the following way: $ss > hs > hh > sh$. In Table 3.3 a numerical example is sketched. The corresponding utility values are $ss = 10, hs = 5, hh = 2$ and $sh = 0$.

The sufficient condition for a Nash equilibrium is that nobody can enhance his utility by deviating from their equilibrium action. This is the case with mutual hoarding (hh) as well as with mutual sharing (ss).

Player B / Player A	Knowledge Hoarding h	Knowledge Sharing s
Knowledge Hoarding h	2 / 2	0 / 5
Knowledge Sharing s	5 / 0	10 / 10

Table 3.3.: Utility Values for an Assurance Game

One thread of models explains conditional-cooperative behavior with *unfairness aversion* [66, 27]. A person is unfairness averse if he prefers an egalitarian payoff distribution or cares about the relative share of the payoff. He feels altruistic if another person's payoff is below an aspired equity level and he feels envy if it is above. Both situations will lower their utility. This theory is able to explain both positive and negative reactions to other people. They show that cooperative players "punish" (deduct payoff) uncooperative players even when it is costly for them to do so. Therefore, participants have a desire for equal contribution to a common knowledge pool and might react by withholding their own knowledge due to uncooperative behavior on the part of others.

Brandts and Schram [31] present a *cooperative gain seeking* model in which part of the players will contribute if they believe that the total contribution will be high enough so that the payoffs will be higher than in a free-riding situation. Therefore, the expected cooperation of the others is critical to the behavior of the player. These expectations are formed and updated through past observed behavior.

A way to incorporate such an unfairness aversion would be a utility function like

$$U_i = \varphi P_i(x_i, K) + w_i + \mathrm{UA}(s^e, s_i) \tag{3.43}$$

with UA as an unfairness aversion component which is a function that has its maximum if the individual sharing level s_i and the expected sharing level of the others s^e are equal and would be lower if the sharing levels of the others are lower or higher than the individual level (see Figure 3.9). s^e is the expectation of the average sharing level of the others ($E(avg_{j \neq i} \;\; s_j)$). The expectation can be formed through different methods, for example, by observing the past behavior.

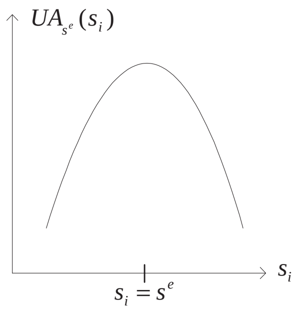

Figure 3.9.: Unfairness aversion dependent on sharing level s_i (with a fixed expected sharing level of the others s^e)

These models can explain not only cooperative behavior in public-good games but also a spiteful reaction to previous uncooperative behavior.

Proposition 5. *Conditional cooperation motives have a positive influence on knowledge sharing if there is a relatively high knowledge sharing level. If there are only a few employees who share their knowledge, it has a negative influence on knowledge sharing.*

Discussion:

We have assumed that knowledge sharing in an open repository has a similar structure as a public-good game. In public-good experiments it has been observed that the conditional cooperative motive is an important factor for contributors [64, 66, 27, 31]. The conditional cooperative motive makes itself visible through high contribution rates if the players expect high contribution by the other, and lower contribution rates if they expect low contribution by the other. Therefore, we also expect an influence of conditional cooperative motives on knowledge sharing and a corresponding behavior. ■

This knowledge-sharing motive would be consistent with the findings of Chua [43]: Chua elicited individual estimations of the payoff matrix in a knowledge-sharing situation. The resulting payoff matrix could be described as an assurance game.

Probst et al. [155] recognized that a lot of knowledge management solutions suffer from a downward spiral of activity. Conditional Cooperation can explain this downward spiral, because of expectation update and unfairness aversion.

This motive would result in a downward spiral in knowledge sharing if the knowledge sharing starts at a relatively low level. The downward spiral emerges from an update of the expectations of the other contribution rates. We shall test if the knowledge sharing level has indeed a negative trend in Hypothesis 10 on page 174.

3.2.4. Strategic Reciprocity

Davenport and Prusak [51] suggest that employees are motivated to contribute knowledge because they expect to receive useful knowledge in return in the future. How can this be explained from a game-theoretic view?

Repetition of a game can lead to strategic cooperation. In a repeated prisoner's dilemma game, cooperation (i.e. knowledge sharing) can be an equilibrium. In this case, the participants will play the prisoner's dilemma game against each other several times. Thus the players not only try to optimize the outcome of the current round but of all rounds. They will anticipate that the current uncooperative behavior will trigger uncooperative behavior of others in the next round. So it is possible that all players cooperate in expectation of future benefits and fear of a possible triggered strategic punishment. In contrast to conditional cooperative motives, all players are only self interested, only care for their own payoff, and do not care about their relative share or how equally the burden of knowledge sharing is divided.

The Folk Theorem makes some statements about equilibria in infinite repeated prisoner's dilemma games [74]. If the players are sufficiently patient—meaning they calculate with an internal interest rate that is sufficiently low—all *individual* rational solutions can be realized as a *collective* solution [74].

The power of reciprocal strategies was also shown by Axelrod [18]. He invited a large number of game theorists to a computer tournament of repeated two-person prisoner's dilemma games. A cooperative reciprocal strategy called "Tit-for-Tat" from the game theorist Rapoport was the most successful. Tit-for-Tat cooperates on the first move and then does whatever the other player did in the previous move. So if the opponent plays uncooperatively in the previous move, Tit-for-Tat "punishes" the other with reciprocal uncooperativeness. Axelrod identified three prerequisites for the appearance of cooperation: (1) there are frequent and durable encounters, (2) the actors are identifiable and (3) there is sufficient information about the past actions of the actors.

The Folk Theorem as well as Axelrod's experiments show that long-term orientation, or—as Axelrod says—the "unlimited shadow of the future," makes it more likely that cooperation might occur in the future. Also, a previous positive experience with a certain partner in the past will increase the probability of future cooperation.

In public-good experiments, it has been observed that the player contributes more the more others contribute [21, 198]. This can be explained by reciprocity [21]. Therefore, the generalization from two persons to many persons is legitimate.

It has also been discovered that the contributions in public-good experiments decline and reach their minimum in the final round [119, 198].

Proposition 6. *Strategic reciprocity motives have a positive influence on knowledge sharing if there is a relatively high knowledge sharing level. If there are only a few who share their knowledge, it has a negative influence on knowledge sharing.*

Discussion:

We have assumed that knowledge sharing in an open repository has a similar structure to a prisoner's dilemma. In repeated prisoner's dilemma experiments a tit-for-tat strategy can be strategically optimal. With a tit-for-tat strategy we would expect cooperation if all others also cooperate. However, if others do not cooperate, we would expect an ever increasing "punishment" of the defecters, ending in mutual hoarding. Therefore, we expect an influence of strategic reciprocity on knowledge sharing and a corresponding behavior.

Also in public-good situations, it has been observed that the player contributes more the more the others contribute [21, 198] and that average contribution spirals downwards [119, 198]. A similar behavior is expected in the knowledge sharing situation with an open repository.

■

Wasko and Faraj [196] found that the participants of communities of practices help each other because of reciprocity—they anticipate valuable knowledge in return—which would support our Proposition 6.

There are situations when only one motive—strategic reciprocity or conditional cooperation—can explain cooperation. For example, in infrequent interactions strategic reciprocity is impossible and only conditional cooperation can work.

Strategic reciprocity as well as conditional cooperation has the same consequences for knowledge sharing: sharing if the others share, hoarding if the others hoard. We would also expect a downward trend in knowledge sharing and we test this in Hypothesis 10 (p. 174). In the empirical test we have not distinguished between a strategic reciprocity and a conditional cooperation component of the downward trend.

3.2.5. Reputation

The sharing of knowledge can lead to a higher reputation [51, 82]. Inside a company, a higher reputation can be valuable as a means of achieving career advancement and, accordingly, better payment if the human resource policy supports the knowledge sharer. It can also be a goal in itself. Huberman et al. [95] showed in an experiment that people regard status as a valued resource itself and they are willing to pay money for it, even if they cannot transfer it later to other material gains.

Proposition 7. *Improving one's reputation by knowledge sharing influences knowledge sharing positively.*

Discussion:

A higher reputation raises the utility of a person directly [95] or indirectly through higher promotion possibilities [51]. *Ceteris paribus* a situation where participants gain a higher reputation for knowledge sharing should lead to a higher benefit from sharing and consequently more knowledge sharing than in a situation without a reputation gain for knowledge sharing. ■

3.2.6. Social Norms

Social norms are rules of behavior that are enforced by sanctions of the group [45]. These sanctions can take the form of approval or disapproval. As Becker [22, p.1083] phrased it: "apparent 'charitable' behavior can also be motivated by a desire to avoid the scorn of others or to receive social acclaim."

Social pressure will change the payoff structure of the knowledge-sharing game and even rational, self-interested people will contribute to a common knowledge pool if the drawback of the scorn of the others is greater than the benefits of hoarding the knowledge.

Social pressure can only work effectively if the knowledge-sharing behavior is visible and the knowledge sharer is identifiable. Social norms change the payoff structure of the game. So even when no knowledge sharing is anticipated in return, social pressure can motivate people to cooperate in a knowledge-sharing environment.

Proposition 8. *Social norms that are favorable towards knowledge sharing influence knowledge sharing positively.*

Discussion:

We have assumed that knowledge sharing in an open repository has a similar structure to a prisoner's dilemma. Social norms for knowledge sharing may change the payoff structure of the game because knowledge hoarding is "punished" by the scorn of others and this would lower the utility of knowledge hoarding. Therefore, we also expect a positive influence of social norms on knowledge sharing.

■

Constant et al. [47] found out that the belief in organizational ownership of information and knowledge sharing as the socially expected behavior has a positive influence on information sharing. This supports our Proposition 8.

3.2.7. Summary of Knowledge-Sharing Motives

We show the various knowledge-sharing motives in Figure 3.10.

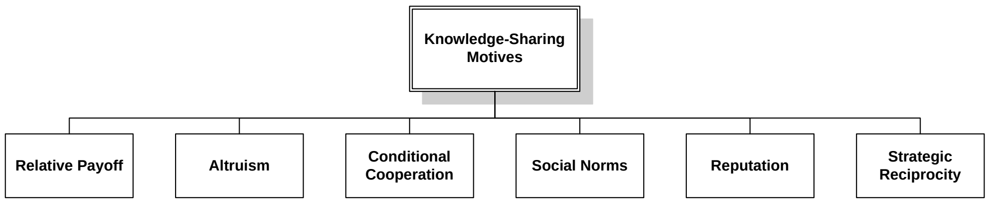

Figure 3.10.: Knowledge-Sharing Motives

3.3. Influential Factors

In the previous section we have derived major knowledge-sharing motives. On this basis we can analyze different influential factors. All propositions have a reasonable explanation and give testable predictions for the effects. Also, for some propositions, supporting empirical references can be given. However, we have not tested the propositions of the influential factors empirically in this thesis.

3.3.1. Identifiability

The identifiability is the degree to which the identity and the actions of a player are visible. Different levels of ever decreasing identifiability can be distinguished: (1) The identity and the behavior of every player is recorded and for everybody accessible. (2) The identity and the actual behavior of every player is visible without further effort. (3) The identity and the actual behavior of every player is only visible after additional actions. (4) The actual behavior is not visible. (5) The identity and the actual behavior is not visible.

As we already mentioned in Section 3.2.4, the identifiability of the participants and sufficient information about the past actions are necessary conditions for strategic reciprocity. In Section 3.2.6, we mentioned that social norms can only work effectively if the knowledge-sharing behavior is visible and the knowledge sharer is identifiable. Also, the reputation motive needs visible knowledge sharing. The impact of identifiability is sketched in Figure 3.11.

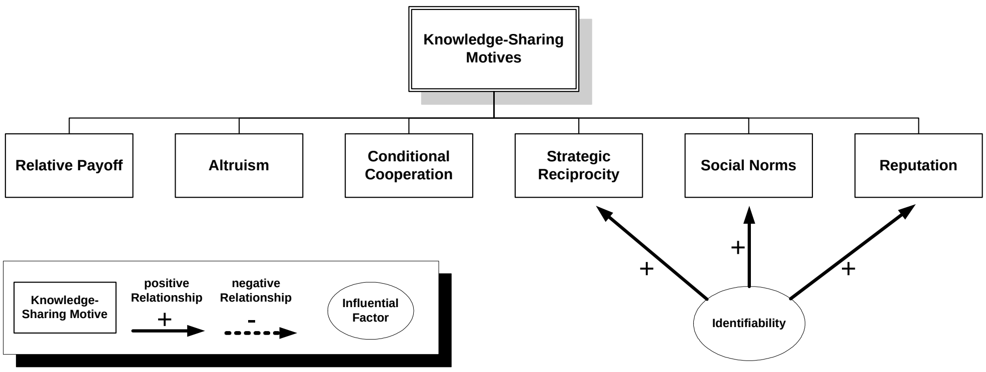

Figure 3.11.: Impact of Identifiability on Knowledge-Sharing Motives

Proposition 9. *Identifiability influences knowledge sharing positively.*

Discussion:

We have assumed that knowledge sharing in an open repository has a similar structure to a prisoner's dilemma. In prisoner's dilemma experiments a tit-for-tat reciprocity strategy is easier to maintain if the participants are identifiable. Also, social norms and reputation motives are stronger with better identifiability of the actors. Therefore, we expect a positive influence of identifiability of actors on knowledge sharing. ■

3.3.2. Long-Term Membership

Long-term membership is the expectation of the employees to be part of the company for a long time. This could be measured by a survey that asks the employee how long he expects to be employed by the company.

Proposition 10. *Long-term membership influences knowledge sharing positively.*

Discussion:

In Section 3.2.4, we discussed that a strategic tit-for-tat strategy is more successful if there are frequent and durable encounters [18]. A long-term membership will increase the chance of future cooperation. Also, social norms can only work if an employee sees himself for a long period of time as a member of the group. Otherwise social norms would not be internalized and the thread of scorn of others is not valid. Therefore, if an employee expects to be a company member for a long time in the future, higher strategic reciprocity and higher social norms motives should induce higher knowledge sharing (see Figure 3.12).

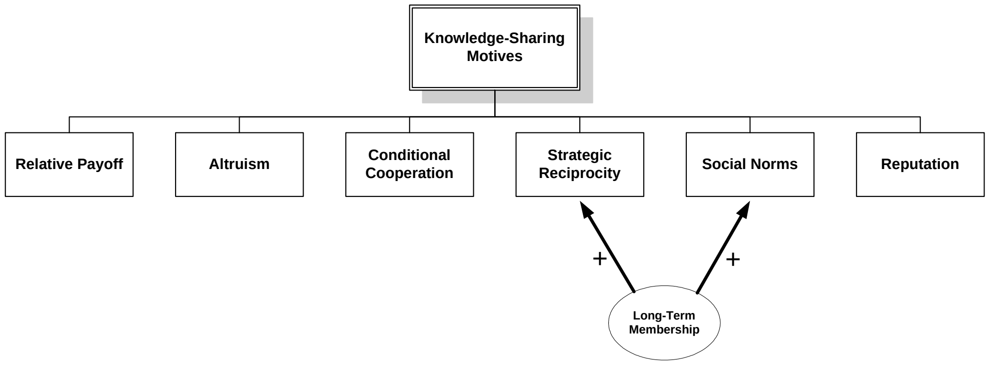

Figure 3.12.: Impact of Long-Term Membership on Knowledge-Sharing Motives

■

Constant et al. [47] found a positive influence of longer work experience on information sharing which would support Proposition 10.

3.3.3. Perceived Efficacy

One reason for not sharing his own knowledge could be that an individual employee in a company thinks holding back his knowledge would not make a great perceivable difference. Not to contribute one document to the central knowledge repository would normally not result in the bankruptcy of the company or the loss of one's job [39].

Olson [147, p. 55] describes the problem of efficacy is follows: "When a partnership has many members, the individual partner observes that his own effort or contribution will not greatly affect the performance of the enterprize, and expects that he will get his prearranged share of the earnings whether or not he contributes as much as he could have done."

Perceived efficacy is "the extent to which one believes that his or her own contribution helps to achieve the collective goal" [191, p. 18]. In public-good experiments it was found that perceived efficacy is critical to contribution [105, p. 62].

In experiments of all-or-nothing public-good games a higher estimation of the efficacy of their own contribution leads to higher contributions (cf. [159], [105, p. 62]). The direct increase in the efficacy of the individual contribution also has a positive effect on the cooperation rate [105].

The perceived efficacy in the knowledge management context consists of two factors: the belief that others will receive the knowledge and the belief that the knowledge would be helpful to others, when they receive it [39].

Translated into our model, perceived efficacy is (1) the expectation of the impact of the knowledge on the individual performance, i.e. the function $P_i(x_i, K)$ of all other employees as well as (2) the expectation of the impact of one's own knowledge sharing on the common knowledge stock, i.e. the function $K(\ldots)$ with resp. to s_i. If the employee underestimates one of these factors, this would lead to lower altruistic knowledge sharing. Therefore, higher perceived efficacy of knowledge sharing leads to higher altruistic benefit and finally to higher knowledge sharing (see Figure 3.13).

Kerr [105, p. 201] showed with the example of charity organizations, that the creation of perceived efficacy can be tricky. To better raise donations and to overcome the reservations that the individual contribution makes no difference, some organizations assign a specific child in a developing country for each donor. This creates a personal responsibility and increases the perceived efficacy of contributions and therefore enlarges the cooperation. In a way this framing strategy transforms the conception of the decision problem from a normal public-good game to a public-good game with a step-level production function.

A similar strategy is also possible in the knowledge management context. Success stories of knowledge sharing can be promoted and thereby increase the feeling that one's own knowledge sharing really makes a difference. Therefore, incorporating feedback that shows the efficacy of knowledge sharing in a knowledge management system is not only worthwhile from the quality assurance aspect but also from the motivational aspect (see also [39]).

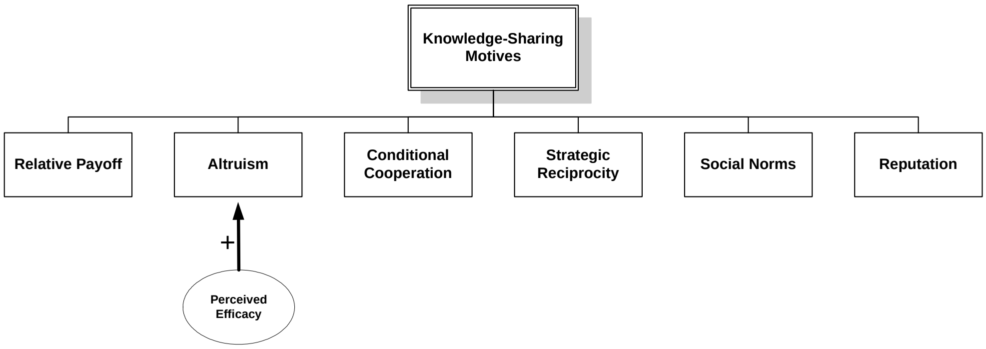

Figure 3.13.: Impact of Perceived Efficacy on Knowledge-Sharing Motives

Proposition 11. *Perceived efficacy influences knowledge sharing positively.*

Discussion:

We assumed that knowledge sharing can be viewed as a public-good game. In public-good games, there is a positive effect of altruism on the contribution to a public good. Higher perceived efficacy means that more people can gain from a contribution and therefore altruistic goals can be better achieved. Therefore, we would also assume perceived efficacy to have a positive effect on knowledge sharing. ■

There are also supporting empirical facts for the proposition. Ford and Staples [69] analyzed the effect of perceived value of knowledge on the intention to share the knowledge. They found a positive relationship between perceived value of the knowledge and the intention to share. The positive relationship can be explained by Proposition 11. Perceived value of knowledge is a prerequisite for perceived efficacy. Higher perceived value of the knowledge asset may lead to a higher perceived efficacy of the contribution and consequently to higher knowledge sharing.

3.3.4. Group Identity

Group identity is the awareness of the members of belonging to a group or team.

Proposition 12. *Group identity influences knowledge sharing positively.*

Discussion:

There are several experiments [119, 191, 113, 149] that foster the assumption that higher group identity leads to higher cooperation in a social dilemma. For example in

[149], participants were partnered in a social dilemma game either with members of their own group or with members from other groups. The cooperation rate was nearly twice as high when participants were identified as members of their own group.

There are at least three reasons why higher group identity could lead to higher cooperation in social dilemmas.

1. The self interest could be defined not in an individualistic but in a group perspective. So altruistic behavior could be increased.
2. Higher group identity could increase the expectations of cooperative behavior of the others [53]. Therefore, a reciprocal strategy would more likely start with cooperation. Also, the higher expectation of knowledge sharing from the others would lead to higher conditional cooperation.
3. Higher group identity may increase the awareness and effectiveness of social norms.

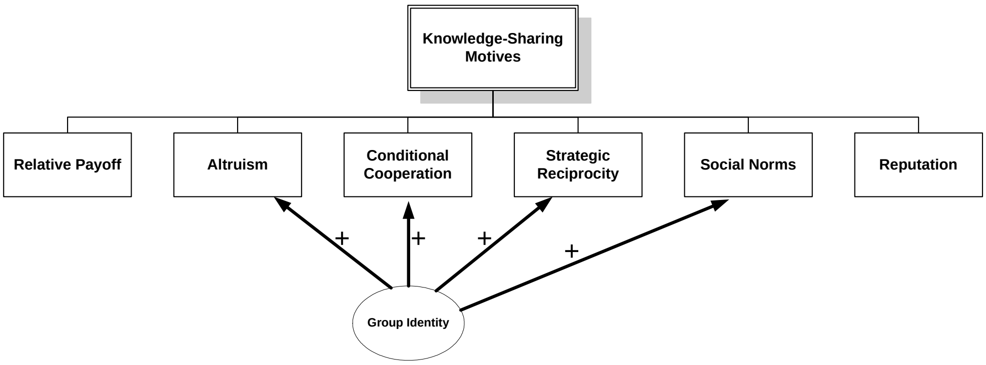

Figure 3.14.: Impact of Group Identity on Knowledge-Sharing Motives

Figure 3.14 shows the impact of the group identity on knowledge-sharing motives. ■

Wasko and Faraj [196] found that the participants of a community of practice help each other because of community interest and a moral belief in the value of the community, which would also support our Proposition 12.

3.3.5. Group Communication

Group communication describes the amount of possible interaction between the participants through text, voice, video, or face-to-face. Different levels of ever increasing communication possibilities between the group members can be distinguished: (1) Only text communication, (2) text with voice communication, (3) text with voice and video communication, (4) face-to-face interaction.

Proposition 13. *Group communication influences knowledge sharing positively.*

Discussion:

There are numerous experiments that consistently and reproducibly show a strong positive effect of group communication on the level of cooperation in public-good games (cf. [101, p. 67] [119, p. 156] [191, p. 15]).

This is even the case when the individual actions are not visible. From a game theoretical view the communication would be an incredible signal or "cheap talk". The positive effect could be explained by different reasons: Firstly, people feel committed to what they said and even more so if they promised to cooperate [149]. A commitment enhances the social norms motive because the public mutual commitment becomes a social norm and deviating from this commitment will be socially punished like any other norm.

Secondly, the group communication may also enhance the level of group identity [149, 191]. Thirdly, the communication will enhance the expectation of others' cooperation [191, p. 16] and therefore enhance conditional cooperation and strategic reciprocity. In this way communication can lead to changed beliefs of the future actions of others and therefore to higher contribution [106].

Brosig et al. [36] examined the effect of different communication media on the cooperation level in public-good games. They showed that unidirectional media are rather inefficient in coordinating joint cooperation and express little hope that a large group succeeds in cooperation only with unidirectional communication technology. They also find that face-to-face and video conferences are both equally effective and better than other communication media in coordinating the cooperation of the participants.

For knowledge sharing, Cabrera and Cabrera [39] mentioned the importance of encouraging communication in order to enhance group identity, commitment, and expectation of others' participation.

Therefore, increasing communication between the participants should increase the social norms motive through higher commitment, the group identity and the strategic reciprocity as well as the conditional cooperation through higher expectation of others' contribution. Due to this we would expect increasing knowledge sharing when communication possibilities between the participants are enhanced. Figure 3.15 visualizes the described influence. ■

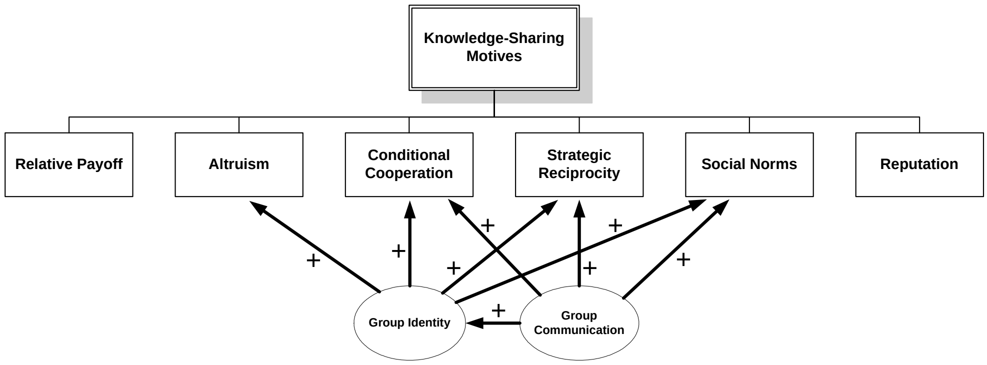

Figure 3.15.: Impact of Group Communication on Knowledge-Sharing Motives

3.3.6. Group Size

The group size has different, opposing effects on the knowledge-sharing motives.

Firstly, there are effects that decrease knowledge sharing. With increased group size it is more difficult to detect non-contributors. Therefore, the identifiability of actors and the information about past actions are more difficult to obtain and strategic reciprocal cooperation is less likely. If a group wants to coordinate their cooperative actions, the cost of coordination will rise by the group size [147]. The larger a group gets, the less effective it is to “punish” non-cooperators with non-cooperative actions in the next round. In a reciprocal strategy you can only punish the whole group, therefore it is harder to influence the behavior of other players through conditional-cooperative strategies.

Secondly, there are effects that increase knowledge sharing. Increased group size has the effect of greater perceived efficacy because, in a situation of an open knowledge repository, more people can gain from the shared knowledge. If we assume pure altruism (cf. Section 3.2.2, Equation 3.41), altruistic motives are getting stronger with larger group size. The effects of the group size are summarized in Figure 3.16.

There are numerous experiments that examine the influence of the group size on the contribution in a public-good experiment (see [119, p. 151 ff], [191, p. 18] and [110, p. 201] for surveys of group size experiments). In general the experimental results are mixed.

There are some supporting experiments for the hypothesis that increased group size will decrease the voluntary contribution to a public good. Hamburger et al. [83] found higher contributions in a three-person group than in a seven-person group. Bonacich et al. [28] observed a higher cooperation rate in groups with six participants than with

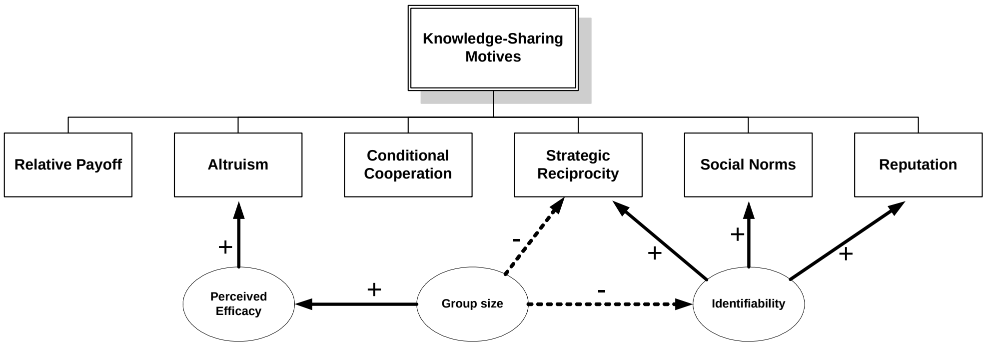

Figure 3.16.: Impact of Group Size on Knowledge-Sharing Motives

nine participants. Brewer [34] found in a social dilemma experiment that was framed as a public-good game that in a small group (8 persons) the contribution rate was greater than in a large group (32 persons). However, several studies [159, 128, 100] found no effect of the group size on the proportion of contributors.

Therefore, there is no clear prediction of the effect of the group size on knowledge sharing.

3.4. Effect of Incentives on Knowledge Sharing

The idea of an incentive system is to align the individual benefits of certain behavior with corporate goals. In this way, the threat of opportunistic behavior ought to be removed because individual and company payoffs correspond.

Proposition 14. *Incentives influence knowledge sharing positively.*

Discussion:

In the two-person knowledge-sharing dilemma (cf. Table 3.1) an incentive i that is high enough changes the payoff structure in such a way that mutual knowledge sharing emerges as the new equilibrium (cf. Table 3.4). The incentive has to compensate for the possible benefit of hoarding the knowledge—that means $i > hs - ss$ and $i > hh - sh$. Then mutual knowledge sharing is the Nash equilibrium.

■

Player B / Player A	Knowledge Hoarding h	Knowledge Sharing s
Knowledge Hoarding h	hh / hh	hs / sh+**i**
Knowledge Sharing s	sh+**i** / hs	ss+**i** / ss+**i**

Table 3.4.: Payoff Matrix for a Two-Person Knowledge-Sharing Game with Incentives

3.4.1. Optimal Incentive Schema

We use our multi-person knowledge sharing model of Section 3.1.2. One of the assumptions was the common knowledge of the model parameter (work and knowledge productivity). However, now it is not possible that the company can directly command the knowledge sharing time as in the optimal company situation of Section 3.1.3. The company can only influence the employees indirectly by constructing an incentive function I that is dependent on the knowledge sharing of the employee. Figure 3.17 shows the interrelations between the company and the employee level in the situation with incentive.

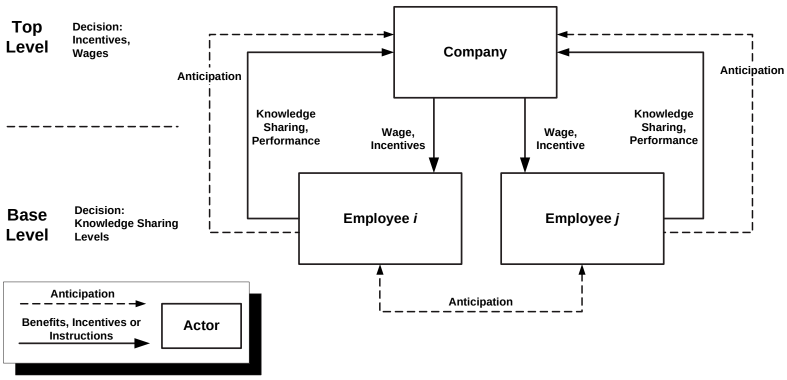

Figure 3.17.: Interrelations between Company and Employee Level in the Situation with Incentives

In this situation, we can prove the following proposition:

Proposition 15. *If the company has complete information about the work and knowledge productivity of its employees, it can achieve optimal knowledge sharing by setting a linear incentive function.*

Proof:

The incentive schema I should be incentive compatible [80, p. 350]. For an incentive compatible schema two additional constraints must be fulfilled:

1. Participation constraint: The employee must not be worse off in the optimum with incentives than in the situation without incentives. We assume that employers are competing for employees and that the wage schema of the company without incentives was competitive with other employers. Therefore, if the company pays less, then the employee will quit and go to another company (cf. Equation 3.46, where x_i^* is the equilibrium working time for worker i in the case without incentives and K^* the resulting knowledge in the repository). We still assume that the amount of salary is the only decision factor for the employee.

2. Optimality constraint: The company has to anticipate that the employee optimizes his utility.

Therefore, the company must anticipate the optimality problem of the employee:

$$\max_{x_i, s_i} U_i = \max_{x_i, s_i} \varphi P_i(x_i, K) + w_i + I(s_i) \tag{3.44}$$

$$\text{s.t. } x_i + s_i = b_i \tag{3.45}$$

$$\varphi P_i(x_i, K) + I(s_i) \geq \varphi P_i(x_i^*, K^*) \tag{3.46}$$

$$K = K(s_1, \ldots, s_n) \tag{3.47}$$

$$x_i \geq 0 \tag{3.48}$$

$$s_i \geq 0 \tag{3.49}$$

We limit ourselves to linear incentive functions. Let $s^\diamond = (s_1^\diamond, \ldots, s_n^\diamond)$ be the solution of the optimality problem of the firm (Problem 2) and the resulting knowledge stock in the repository $K^\diamond = K(s^\diamond)$. An incentive function

$$I(s_i) = a s_i - b \tag{3.50}$$

with

$$a = \varphi \sum_{j \neq i} \frac{\partial P_j(K^\diamond)}{\partial K} \frac{\partial K(s_j^\diamond)}{\partial s_j} \tag{3.51}$$

and

$$b = as_i^\diamond - \varphi P_i(x_i^*, K^*) - \varphi P_i(x_i^\diamond, K^\diamond) \tag{3.52}$$

induces the company's optimal knowledge sharing.

The Lagrangian of the worker's problem is

$$L = \varphi P_i(x_i, K) + w_i + I(s_i) - \alpha(x_i + s_i - b_i) - \mu(K - K(s_1, \ldots, s_n)) \ . \tag{3.53}$$

Then the first order conditions with respect to x_i, s_i and K are

$$\frac{\partial L}{\partial x_i} = \varphi \frac{\partial P_i}{\partial x_i} - \alpha = 0 \tag{3.54}$$

$$\frac{\partial L}{\partial s_i} = \varphi \sum_{j \neq i} \frac{\partial P_j}{\partial K} \frac{\partial K}{\partial s_j} - \alpha + \mu \frac{\partial K}{\partial s_i} = 0 \tag{3.55}$$

$$\frac{\partial L}{\partial K} = \varphi \frac{\partial P_i}{\partial K} - \mu = 0 \tag{3.56}$$

When we insert Equation 3.54 and 3.56 in 3.55, we get the optimality condition with incentives for employee i:

$$\underbrace{\sum_j \frac{\partial P_j}{\partial K} \frac{\partial K}{\partial s_j}}_{\text{Marginal Collective Benefit of Sharing}} = \underbrace{\frac{\partial P}{\partial x_i}}_{\text{Marginal Benefit of Working}} \tag{3.57}$$

It is the same as the optimality condition of the firm, therefore individual and company interests are aligned and the individual-optimal knowledge sharing leads to the company optimum. In the optimum the incentive-compatible constraint of Equation 3.46 is also satisfied. In the proposed incentive schema all the surplus of additional knowledge sharing is absorbed by the company.

■

3.4.2. Principal Agent Situation

In the former section, we have assumed that the model parameters are common knowledge. Now we want to extend the model with asymmetric information about specific model elements. We still assume opportunistic behavior, that means no altruism and risk-neutral agents.

We use the principal agent theory [176, pp. 125] to analyze this situation. In the principal agent theory (PAT) there exists a principal that delegates a task to an agent.

The PAT assumes that the agent has better information about some aspect of the world and that he will opportunistically use the information advantage to his benefit (see also Section 5.10). The principal agent theory also assumes only two players—principal and agent—and therefore also no team production of several agents. In this point we defer from the standard principal agent theory, because we assume several employees (agents) and a team production of the useful knowledge in the open knowledge repository.

Let t_0 be the time point the incentive contract is signed and t_1 the time of the decision or action of the agent.

We can distinguish between three types of information asymmetry [176, p. 126]:

Hidden Action. If the principal cannot observe some actions of the agent (employee), we call the situation hidden action. Therefore, even after the action of the agent ($t > t_1$) the principal does not have complete information. In our model the knowledge sharing time s_i may not be visible by the company.

Hidden Information. Hidden information is defined as a situation in which the agent gets new exclusive information after the contract is completed but before he has made his decision or action ($t_0 < t < t_1$). In our model this may be new knowledge assets that the employee gets with the result that his knowledge externalization efficiency is changed.

Hidden Characteristics. We define hidden characteristics as a situation in which the company (principal) does not have complete information about the characteristics of the employees (agents) before the incentive contract is completed ($t < t_0$). Therefore, the agent has an information advantage before the contract is signed. In our model the individual knowledge explication efficiency, the work and knowledge productivity may not be visible by the company. However, the action—the time spent on knowledge sharing—is observable.

There are three different possible strategies to reduce the risk of opportunistic behavior in a situation with hidden characteristics [176, p. 127]:

Simple Screening. The strategy consists of normal strategies to gain information about the characteristics and actions of the agent. Examples are job interviews or assessment center.

Signaling. Here the agent actively signals his agent type with the corresponding characteristics. However, only signals that cannot easily be imitated by other types of agents are credible. For example, the agent shows the principal university diplomas or other certificates.

Self selection. In this strategy the principal offers the agents a menu of contracts. By choosing a contract, the agent is disclosing his type. The agent, of course, only chooses the right contract if it is better than the other contracts in the menu. Therefore, the menu of contracts has to be carefully designed to be self separating.

We analyze, in the following, a hidden-characteristics situation with self-selecting incentives.

There are two types of employees: experts (E) and implementers (I). The model properties of both types are known to the company. However, the company does not know what type an employee is.

Experts are better in knowledge explication than implementers, that means $\frac{\partial K}{\partial s^E} > \frac{\partial K}{\partial s^I}$. However, implementers are better in producing output than the experts, that means $\frac{\partial P^I}{\partial x} > \frac{\partial P^E}{\partial x}$ and $\frac{\partial P^I}{\partial K} > \frac{\partial P^E}{\partial K}$.

The principal can now construct two contracts: one contract intended for the experts (C^E) and one intended for the implementer (C^I). The contracts specify the performance component φ, the incentive function dependent on knowledge sharing I and the base wage w.

$$C^E = \langle \varphi^E, I^E, w^E \rangle \tag{3.58}$$

$$C^I = \langle \varphi^I, I^I, w^I \rangle \tag{3.59}$$

Let $U^q(C^c)$ be the utility of an employee of type $q \in \{E, I\}$, given he chooses the contract C^c, $c \in \{E, I\}$:

$$U^q(C^c) := \varphi^c P^q(x_i, K) + w^c + I^c(s_i) \tag{3.60}$$

The principal (company) anticipates the behavior of the agent and calculates the maximal utility $\widehat{U}^q(C^c)$ of an employee of type $q \in \{E, I\}$ under the condition he chooses the contract C^c, $c \in \{E, I\}$.

The company tries to find the optimal contract menu under the restriction that (a) the experts and (b) the implementers will choose their respective contract and (c) that all employees will participate.

Let $M^\diamond$ be the optimal contract menu $M^\diamond = \langle C^{\diamond I}, C^{\diamond E} \rangle$ which is the result of the following optimization problem:

$$M^\diamond = \arg \max_{C^I, C^E} \pi(C^I, C^E) \tag{3.61}$$

$$s.t. \quad \widehat{U}^E(C^E) \geq \widehat{U}^E(C^I) \tag{3.62}$$

$$\widehat{U}^I(C^I) \geq \widehat{U}^I(C^E) \tag{3.63}$$

$$\widehat{U}^q(C^q) \geq \overline{U}^q, \quad q \in \{E, I\} \tag{3.64}$$

The optimal contract menu $M^\diamond$ consists of the contracts that optimize the profit of the company (Equation 3.61) under the condition that (a) the expert chooses the expert contract (Equation 3.62), (b) the implementer chooses the implementer contract (Equation 3.63) and (c) everybody will participate, that means signing the contract is better for the employees than leaving the company, i.e. better than the reservation utility $\overline{U}^q$ (Equation 3.64).

If the contract menu is self separating, that means that the Equations 3.62 and 3.63 are fulfilled, then the profit π is:

$$\pi(C^I, C^E) = \sum_j \Big((1 - \varphi_j^q)P_j^q(x_j, K) - I^q(s_j) - w_j^q\Big) \tag{3.65}$$

where $q \in \{E, I\}$ is the type of employee as well as the type of contract.

With this self selecting strategy the company can overcome the information asymmetry and give the appropriate incentives for knowledge sharing to each type of employee by considering of their knowledge sharing characteristics.

3.4.3. Motivational Crowding-Out Effect

The effect of incentives is seen critically by proponents of the motivational crowding-out theory [72, 71, 150]. The motivational crowding-out effect is perhaps intuitively best described by an old Jewish tale [54, p.26]:

> "It seems that bigots were eager to rid their town of a Jewish man who had opened a tailor shop on Main Street, so they sent a group of rowdies to harass the tailor. Each day, the ruffians would show up to jeer. The situation was grim, but the tailor was ingenious. One day when the hoodlums arrived, he gave each of them a dime for their efforts. Delighted, they shouted their insults and moved on. The next day they returned to shout, expecting their dime. But the tailor said he could afford only a nickel and proceeded to hand a nickel to each of them. Well, they were a bit disappointed, but a nickel is after all a nickel, so they took it, did their jeering, and left. The next day, they returned once again, and the tailor said he had only a penny for them and held out his hand. Indignant, the young toughs sneered and proclaimed that they would certainly not spend their time jeering at him for a measly penny. So they didn't. And all was well for the tailor."

The motivational crowding-out theory suggests that monetary incentives may undermine intrinsic motivation. This "hidden cost of reward" [121] is observable if a previously intrinsically-motivated task is rewarded by external incentives. The crowding-out effect is particularly visible if the incentive is perceived as being controlling and thereby reduces the level of self-determination [71].

The effect of incentives on the total knowledge sharing is therefore twofold: Firstly, the relative benefit compared to the costs of knowledge sharing is enhanced (relative price effect) and secondly, the intrinsic motivation of knowledge sharing is lowered (crowding-out effect). The total effect can be positive if the relative price effect is stronger than the crowding-out effect. But it is also possible that the total effect of incentives is negative. In Figure 3.18 these effects on knowledge-sharing motives are sketched.

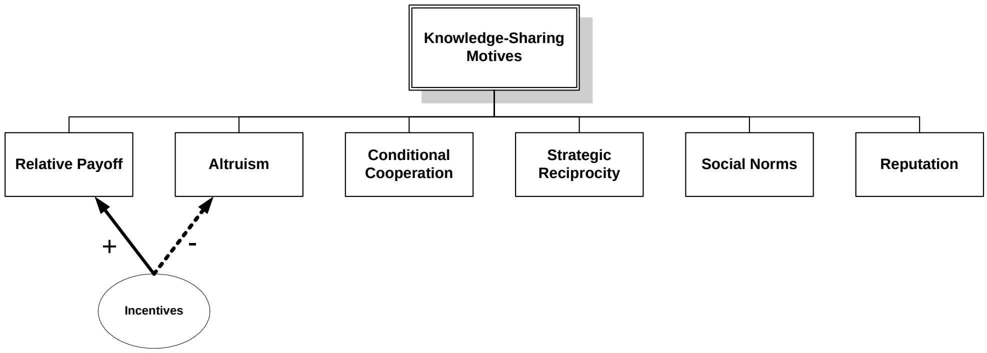

Figure 3.18.: Impact of Incentives on Knowledge-Sharing Motives

There are several examples of empirical evidence of the crowding-out theory (see [72, 71, 150] for an overview). For example, Lepper et al. [122] observed children who were given a choice between different activities. In the first phase, the authors monitored how much time children spent drawing. In the second phase they randomly assigned the children to three groups: (1) Expected Reward: the children were promised a reward, which they would get if they drew. After drawing, the children would get prizes. (2) Unexpected Reward (control group): children from this group were asked to draw without mentioning any reward. After they had drawn, they got an unexpected reward. (3) No Reward (control group): In this group no reward was mentioned nor any reward given. In the third phase, after two weeks the children were observed inconspicuously and the time they spent drawing was measured. The first group (expected reward group) spent less time drawing than the other two groups and less time than in phase one. Groups two and three showed no difference in drawing time.

Eisenberger and Cameron [60] claim in a meta study that the crowding-out effect is only a myth. Later meta studies [55, 72] maintain that the effect does indeed exist, but they also emphasize that crowding-out does not always outweigh the relative price effect.

It is important to emphasize that only for previously intrinsically motivated tasks crowding-out can happen. If there is no previously intrinsically-motivated knowledge sharing, then rewarding the sharing cannot be harmful for intrinsic motivation.

Crowding-out model

We can incorporate the crowding-out effect in our model (see [71] for a general mathematical model of the crowding-out effect).

Proposition 16. *The crowding-out effect of intrinsic motivation may lower the incentive effect.*

Proof:

For modelling the crowding-out effect we use an extension of the impure altruistic utility of Section 3.2.2. In the case of impure altruism there is an intrinsic motivation to knowledge sharing. However, we add a negative effect of incentives on the intrinsic motivation according to the empirical findings mentioned previously. Let U be the utility of an employee

$$U_i = \varphi P_i(x_i, K) + w_i + A(s_i, I) + I(s_i) \tag{3.66}$$

with A as the altruistic intrinsic motivation of sharing and I as the incentive. The altruistic part $A(s_i, I)$ is dependent on knowledge sharing s_i and the incentive I. To be comparable with the other monetary elements of the utility, A is measured in a monetary equivalent of the altruistic utility of sharing. However, all results remain valid after a positive monotonic transformation of the utility function [80, p. 75]. $\frac{\partial A}{\partial I}$ is the level of crowding out of intrinsic motivation by incentives.

Rational employees choose the amount of individual-optimal knowledge sharing (s^*) time so that U is maximized, i.e. that their optimization problem (Problem 4) is solved:

$$\max_{x_i,s_i} U_i = \max_{x_i,s_i} \varphi P_i(x_i, K) + w_i + A(s_i, I) + I(s_i) \tag{3.67}$$

$$\text{s.t. } x_i + s_i = b_i \tag{3.68}$$

$$K = K(s_1, \ldots, s_n) \tag{3.69}$$

$$I = I(s_i) \tag{3.70}$$

$$x_i \geq 0 \tag{3.71}$$

$$s_i \geq 0 \tag{3.72}$$

The Lagrangian of the worker's optimization problem (Problem 4) is

$$L = \varphi P_i(x_i, K) + w_i - \alpha(x_i + s_i - b_i) - \mu(K - K(s_1, \ldots, s_n)) - \beta(I - I(s_i)) \; . \tag{3.73}$$

Then the first order conditions with respect to x_i, s_i, K and I are

$$\frac{\partial L}{\partial x_i} = \varphi \frac{\partial P_i}{\partial x_i} - \alpha = 0 \tag{3.74}$$

$$\frac{\partial L}{\partial s_i} = \frac{\partial A}{\partial s_i} + \frac{\partial I}{\partial s_i} - \alpha + \mu \frac{\partial K}{\partial s_i} - \beta \frac{\partial I}{\partial s_i} = 0 \tag{3.75}$$

$$\frac{\partial L}{\partial K} = \varphi \frac{\partial P_i}{\partial K} - \mu = 0 \tag{3.76}$$

$$\frac{\partial L}{\partial I} = \frac{\partial A}{\partial I} - \beta = 0 \tag{3.77}$$

When we insert 3.74, 3.77 and 3.76 in 3.75, we get the optimality condition

$$\varphi \frac{\partial P_i}{\partial K} \frac{\partial K}{\partial s_i} + \frac{\partial A}{\partial I} \frac{\partial I}{\partial s_i} + \frac{\partial I}{\partial s_i} = \varphi \frac{\partial P}{\partial x_i} \; . \tag{3.78}$$

We can distinguish two opposite effects: the relative price effect ($\frac{\partial I}{\partial s_i}$) and the crowding-out effect ($\frac{\partial A}{\partial I} \frac{\partial I}{\partial s_i}$).

Relative Price Effect: An increase in the incentive I will decrease the opportunity cost of knowledge sharing, because the relative difference of monetary payment of knowledge sharing to knowledge hoarding will decrease. If there is no crowing-out effect ($\frac{\partial A}{\partial I} \frac{\partial I}{\partial s_i} = 0$) an incentive would increase knowledge sharing.

Crowding-out Effect: An increase of the incentive could also decrease the altruistic joy of knowledge sharing ($\frac{\partial A}{\partial I} < 0$). This can be explained as the intrinsic motivation is crowding-out the extrinsic motivation.

The sum of both effects could lead to either a positive or a negative effect on knowledge sharing.

■

3.4.4. Summary of the Influential Effects on Knowledge Sharing

Figure 3.19 shows a summary of the influential effects on knowledge sharing.

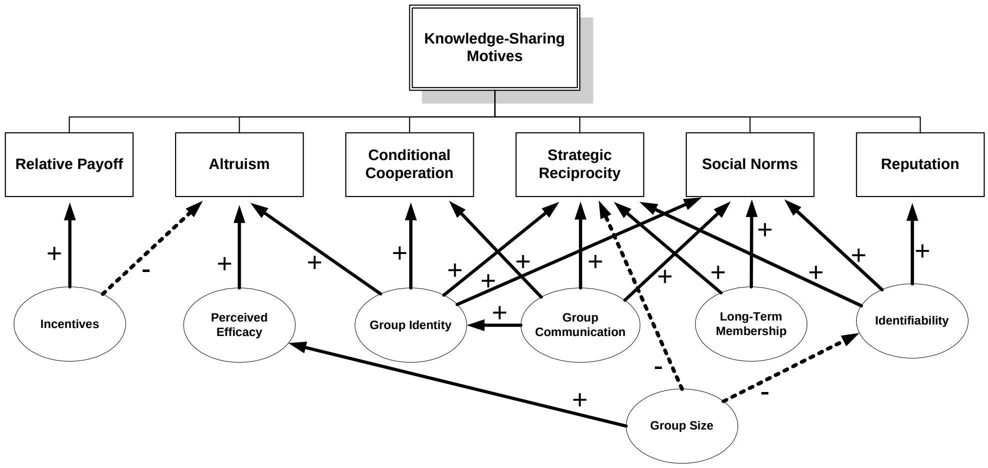

Figure 3.19.: Knowledge-Sharing Motives and the Influential Factors

3.5. Cultural Effects on Knowledge Sharing

The tendencies of human beings to react to an environment can be divided into universal, cultural and individual factors (see Figure 3.20). So it is also important to analyze the cultural dimensions of knowledge sharing.

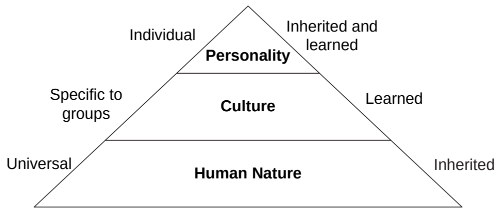

Figure 3.20.: Three Levels that determine Human Action [92, p. 6]

Culture is a broad term that covers professional culture, organizational culture and national culture [92]. We shall limit our following analysis to national culture, because our empirical data in Chapter 4 is from one multi-national company and so we cannot analyze different organizational or professional cultures. However, these results should also be transferable to professional and organizational culture.

Culture is the “collective programming of the mind which distinguishes the members of one human group from another” [91, p. 21]. It is based on values which have “a broad tendency to prefer certain states of affairs over others” [91, p. 18]. Culture describes the common values and attitudes of a group and influences the behavior of its members in an environment.

3.5.1. Hofstede’s Dimensions of Culture

Hofstede did a broad international analysis about work-related attitudes between 1967 and 1973 at IBM, where he analyzed about 117,000 survey questionnaires from 88,000 employees [91]. Four dimensions of national culture were found by clustering answers about value orientation, and index scores for forty countries were developed. Index scores for the dimensions were normalized to the interval (0 , 100). The four dimensions are individualism/collectivism, power distance, uncertainty avoidance and masculinity/femininity [91]. We shall discuss only the first three of them. In Table 3.5 the scores of the Hofstede’s dimensions are displayed. Note that there exist countries with scores that are higher than 100. This is because Hofstede analyzed these countries after he published the first scores and he didn’t re-normalize the scores.

Individualism Index (IDV)

The individualism-collectivism dimension measures the “relationship between the individual and the collectivity which prevails in a given society” [91, p. 148] and the degree to which individuals are integrated into groups.

Societies with a high Individualism Index (IDV) have loose ties between individuals: “everyone is expected to look after him/herself or his/her immediate family” [92, p. 51]. Freedom to adopt their own working style, a challenging work environment, and possibilities for individual achievements are important. Individuals act mainly according to their own goals and organizations must design the work environment and incentive systems in such a way that organizational and personal goals will be aligned.

Cultures with a low IDV “are societies in which people [...] are integrated into strong, cohesive groups, which continue protecting them in exchange for unquestioning loyalty” [92, p. 51]. Group goals and group harmony are more important than individual goals [92, p. 51].

Power Distance Index (PDI)

Power Distance means “the extent to which less powerful members of organizations and institutions expect and accept that power is distributed unequally” [92, p. 28]. In societies with a high Power Distance Index (PDI), social inequality is tolerated. The style of leadership is benevolent autocratic. Employees fear disagreeing with their managers. In societies with a low PDI, high social equality is expected. Employees prefer a more democratic style of leadership with more independence in decision making. The Power Distance Index is derived from questions which deal with perceptions of the superior’s decision-making style, fear of disagreement with managers, and the type of decision making which subordinates prefer in their boss [92, p. 25].

Uncertainty Avoidance Index (UAI)

Uncertainty Avoidance is the “extent to which the members of a culture feel threatened by uncertain or unknown situations” [92, p. 113].

Cultures with a high Uncertainty Avoidance Index try to manage uncertainty with a highly-structured environment. Employees comply with written and unwritten company rules even in situations where the company would benefit from breaking these rules. People expect to continue working for the company for a long time and appear busier and more restless.

In countries with low UAI, people tolerate ambiguous and unstructured circumstances. There is an antipathy against formal rules. People appear to be more “easy going" (cf. [92, p. 109] and [91, p. 110]).

3.5.2. Cultural Influence on Knowledge-Sharing Motives

Numerous experiments indicated the influence of culture on economic decision making [88, 89, 38, 40]. For example, Henrich et al. [89] played an ultimatum game in 15 small-scale societies. In an ultimatum game, you choose which fraction of an initial starting endowment to share with another player. Afterwards, the other player can decide if both players get anything from the donation or not. The Nash equilibrium is to offer the least possible amount of money, while the other player accepts all sharing fractions. Henrich et al. [89] observed that not only the behavior was fundamentally different to the Nash equilibrium, but that behavior also varied drastically between different cultures. Some societies were even "super fair", with average offer rates larger than 50%.

In public-good games, the appreciation of fairness and hence the culture should also make a difference. Because we see knowledge sharing as a public-good game, our hypothesis is that there is also cultural influence on knowledge sharing.

Individualism Index (IDV)

From the definition of the individualism dimension we expect that people from societies with a high IDV score will free-ride more than people from societies with low IDV.

There are some experimental indications for that hypothesis. Burlando and Hey [38] showed in a public-good experiment that participants of the UK free-ride more than participants from Italy. UK has a higher IDV score (89) than Italy (76). Cason et al. [40] examine in a public-good experiment the voluntary contribution in the United States (IDV score 91) and Japan (IDV score 46). Only individuals in the USA behave consistently with the Nash equilibrium prediction of the game and contribute only small amounts. Individuals in Japan contributed more to the public good. They also reacted more spitefully to non-cooperative behavior even though in this experiment subjects never interacted twice with the same opponent. That means that high IDV also influences the *conditional cooperation* motive negatively. Wagner [195] examined the effect of the individualism-collectivism dimension on cooperation behavior in an experimental setting. Differences in the individualism-collectivism attitude were measured by a questionnaire. Wagner found a positive impact of high individualism on free-riding. However, Brandts et al. [30] found only minor differences in voluntary contribution behavior between Japan, the Netherlands, Spain and the USA, although the IDVs of these countries differ greatly.

Country	PDI	IDV	UAI
Argentina	49	46	86
Australia	36	90	51
Belgium	65	75	94
Brazil	69	38	76
Canada	39	80	48
China	68	25	29
Colombia	67	13	80
Croatia	76	27	88
Denmark	18	74	23
Ecuador	78	6	67
Egypt	80	38	68
Germany	35	67	65
Finland	33	63	59
France	68	71	86
Greece	60	35	112
India	77	48	40
Indonesia	78	14	48
Iran	58	41	59
Ireland	28	70	35
Israel	13	54	81
Italy	50	76	75
Japan	54	46	92
Jordan	80	38	68
Malaysia	104	26	36
Mexico	81	30	82
Netherlands	38	80	53
Norway	31	69	50
Austria	11	55	70
Pakistan	55	14	70
Peru	64	16	87
Philippines	94	32	44
Portugal	63	27	104
Saudi Arabia	80	38	68
Sweden	31	71	29
Switzerland	34	68	58
Singapore	74	20	8
Slovenia	76	27	88
Spain	57	51	86
South Africa	49	65	49
Taiwan	58	17	69
Thailand	64	20	64
Tunisia	80	38	68
Turkey	66	37	85
UK	35	89	35
United Arab Emirates	80	38	68
USA	40	91	46
Venezuela	81	12	76

Table 3.5.: Cultural Dimensions in different Countries [91]

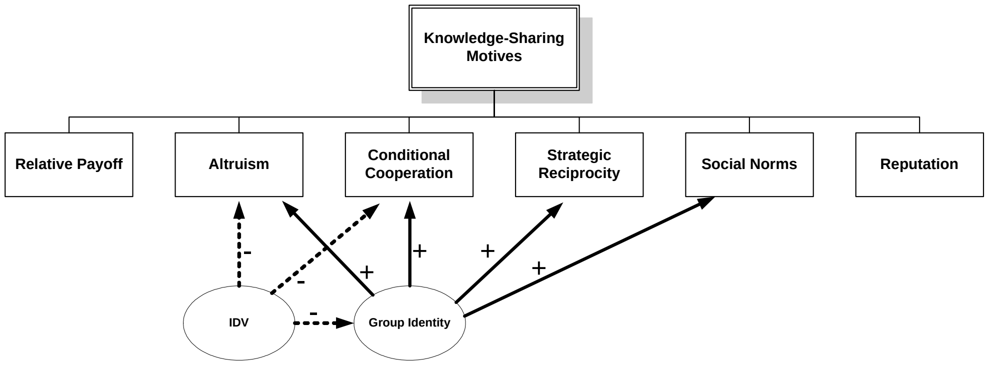

Figure 3.21.: Impact of Individualism Index (IDV) on Knowledge-Sharing Motives

Proposition 17. *Individualism influences knowledge sharing negatively.*

Discussion:

Because cultures with a low Individualism Index value group goals above individual interests, we would expect lower altruism, conditional cooperation and group identity in societies with a higher Individualism Index and accordingly lower knowledge sharing (see Figure 3.21). ■

Power Distance Index (PDI)

Proposition 18. *Power Distance influences knowledge sharing positively.*

Discussion:

In Section 3.2.5, we already mentioned reputation as a motive for contributing to the public good with respect to knowledge sharing. The intensity of striving for status, measured by the money participants are willing to sacrifice for that status, varies by culture as Huberman et al. [95] showed in an experiment. The valuation of status corresponded to the Power Distance of the respective culture of the participants.

It is also plausible that, in cultures with a high power distance, hoarding knowledge with the reason that "knowledge is power" is less attractive because power is more static than in cultures with a low power distance. Power distance does not necessarily have an effect on group identity because autocratic leadership does not directly contradict high group identification. So we predict that a higher Power Distance In-

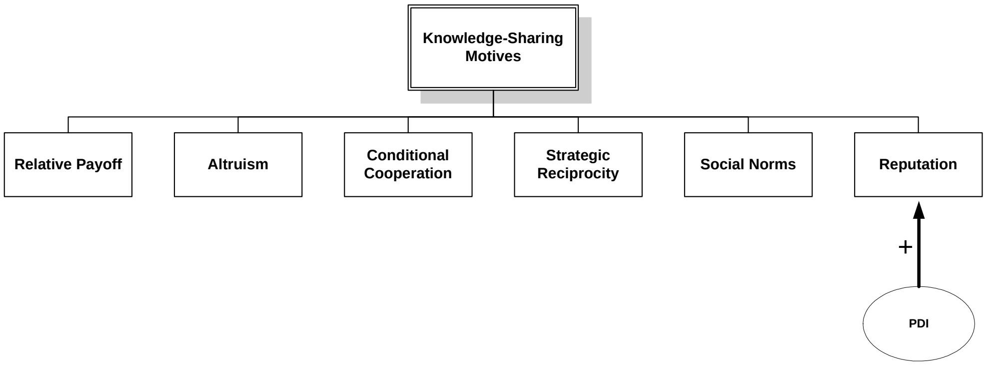

Figure 3.22.: Impact of Power Distance Index (PDI) on Knowledge-Sharing Motives

dex leads to more motivation for a good reputation and therefore to more knowledge sharing (see Figure 3.22). ■

Uncertainty Avoidance Index (UAI)

Proposition 19. *Uncertainty Avoidance influences knowledge sharing negatively.*

Discussion:

The benefit of a strategic reciprocal strategy is uncertain. This is due to the fact that there is a risk of getting no knowledge in return. If a participant is less willing to tolerate uncertainty, the strategic reciprocal motivation to share the knowledge may decrease. It is also possible that knowledge sharers will leave a company before they can profit from the impact of their knowledge sharing on corporate success. Moreover, there is also uncertainty as to the accuracy of measurement in the incentive system that leads to uncertainty of the reward of knowledge sharing. This would lead to the assumption that the UAI affects knowledge sharing negatively.

However, in cultures with a higher uncertainty avoidance, the expected employment duration in a company is longer [92]. The benefit of reciprocity behavior increases in long-term job relations. A high UAI also means greater compliance with written and unwritten rules. This results in the social norms motive becoming more important and therefore may counter the effect that we have predicted (see Figure 3.23).

■

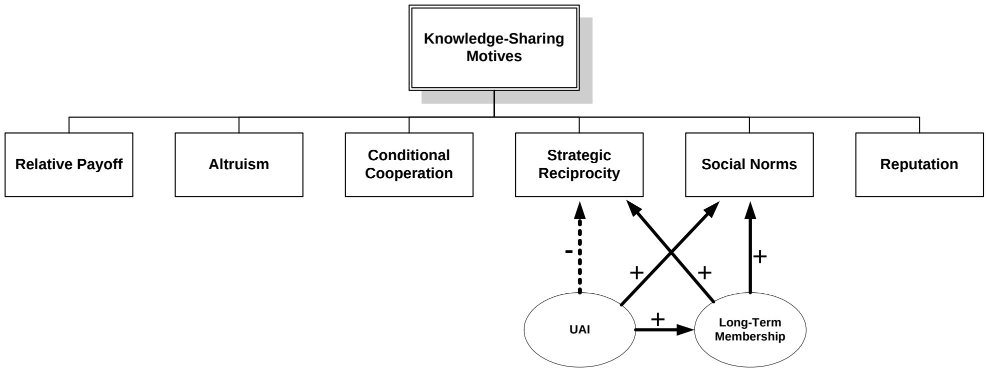

Figure 3.23.: Impact of Uncertainty Avoidance Index (UAI) on Knowledge-Sharing Motives

3.6. Related Work

There are some other works that try to explain information and knowledge sharing with the prisoner's dilemma [124] or with the social dilemma [46, 196, 39]. However, they lack a detailed theoretical model of different influential factors like we have presented here and none of them incorporate motivational crowding-out or cultural aspects.

There are some empirical findings that support some propositions of our theory.

Chua [43] elicited individual estimations of their own payoff matrix in a knowledge-sharing situation. The resulting payoff matrix could be described as an assurance game. This supports our Proposition 5 (Conditional Cooperation).

Constant et al. [47] analyzed the effect of self interest and the belief of organizational ownership on information sharing in a vignette-based experiment. Vignette-based experiments ask the participants to imagine a situation, and then ask them how they would behave. They discovered a negative influence of self interest on information sharing. This supports our Proposition 4 (Altruism). Also, they found out that the belief of organizational ownership of information has a positive influence on information sharing. This supports our Proposition 8 (Social Norms). They also found a positive influence of work experience on information sharing. This finding supports Proposition 10 (Long-Term Membership).

Wasko and Faraj [196] conducted a seven-week longitudinal study of three communities of practice. They found that the participants help each other because of generalized reciprocity, pro-social behavior, and community interest. This would support our Propositions 6 (Reciprocity), 4 (Altruism), and 12 (Group Identity).

Ford and Staples [69] analyzed the effect of perceived value of knowledge on the intention to share the knowledge. They found a positive relationship between perceived value of knowledge and the intention to share. However, this relationship also depends if the sharing is to distant colleagues or to close colleagues. The positive relationship may be explained by Proposition 11, which predicts a positive influence of perceived efficacy on knowledge sharing. Higher perceived value of knowledge may lead to a higher perceived efficacy of the contribution.

Cabrera and Cabrera [39] coined the term "knowledge-sharing dilemma". They predicted a positive influence of reward, communication, and efficacy on knowledge sharing. This is in line with our Propositions 3 (Relative Payoff), 13 (Communication), and 11 (Perceived Efficacy). However, they did not discuss motivational crowding-out problems and cultural determinants, nor did they test their predictions empirically.

Hall [82] considered strategies for making intranet portals more "input-friendly". She suggested explicit and soft rewards like economic rewards, career advancements, enhanced reputation, and personal satisfaction. This is in line with our Propositions 14 (Incentives), 3 (Relative Payoff), 7 (Reputation), and 4 (Altruism).

There are some papers that deal with the interlink of incentives and motivation in knowledge management systems. Osterloh and Frey [150] have mentioned the possibility of crowding out intrinsic motivation with incentive systems in knowledge intensive companies. Wilkesmann and Rascher [202] analyzed the reasons for knowledge sharing and did a survey about the possible crowding-out effect of intrinsic motivation in a knowledge management system. Krönig [117] used survey methods to elicit interlinks between incentive systems and other properties of the organization. None of them give an empirical evaluation of the actual behavior of knowledge sharers, though. Sundaresan and Zhang [185] presented an economic model for the impact of IT investments and incentives on knowledge transfer. The model differs from our mathematical model because their model does not represent a public-good situation. Therefore, in their case it is not possible to transfer the results of public-good experiments to knowledge sharing, as we did.

There are only a few sources that analyze the relationship between culture and knowledge management. Holden [93] emphasizes the importance of cross-cultural factors and knowledge management. He gives some case studies of successful international knowledge management projects but does not present an empirical analysis nor a systematic model of the relationship between cultural factors and knowledge sharing.

Heier and Borgman [86] analyze a knowledge management project at Deutsche

Bank. They discovered a negative correlation between the Power Distance Index and the knowledge searching queries. Because they have analyzed the knowledge seeking—not the knowledge sharing—behavior, the results are therefore not comparable.

Then there are some remotely related papers in the area of information system research that analyze the influence of culture on different IS aspects. These include the effect of culture on software piracy rates [134], on the transformation process by which people acquire information [189], on the search behavior on websites [112], and on group decision support systems [166, 50, 197].

3.7. Summary

In this chapter we have presented a novel theory of knowledge sharing. The theory models knowledge sharing as a public-good game. It is grounded on well-established game theory and experimental economics. The theory consists of 3-layers: (a) knowledge sharing motives, (b) influential factors and (c) the role of culture and incentives upon the influential factors. This gives us a framework for analyzing knowledge sharing in different environments.

The theory makes testable propositions for the impact of different influential factors on knowledge sharing. The propositions dealing with the effect of incentives and culture are tested in Chapter 4. Additionally, the propositions from Section 3.1 and part of the propositions from Section 3.2 are tested in Section 6.4.