Social interaction in the workplace: Several extensions to a co-worker altruism model.

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ABSTRACT

In this thesis I look at the effect of changing some of the assumptions in a principal agent model on social interaction in the workplace. Workers can engage in productive and socialization activities and develop feelings of altruism towards each other after socializing. I study how changing certain assumptions affects the effort and attention choices of the agents and how this affects the employer. The extensions I look at include the effect of interdependencies between cost of effort and attention and different preferences of the workers with respect to socialization.

During the seminar 'Games, Strategy and Markets' we discussed many articles, amongst which (Dur and Sol 2010). While discussing I became interested in the way a complicated concept as social interaction was being incorporated in an economic model. The discussions led to several questions concerning the robustness and the practical applicability of the article. This eventually brought me to the topic for this thesis. When looking at theoretical models on concepts like social interaction it is relevant to know the robustness and domain of the results. The effect of changing certain assumptions of the model is sometimes small and in other cases detrimental to the results. For instance I find that the change from individual output to team output complicates the model substantially for the employer.

I would like to thank my supervisor Robert Dur for his comments, suggestions and help while writing this thesis. Furthermore I would like to thank the participants from the seminar for their part in the discussions that eventually led to the topic of this thesis.

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1.1 INTRODUCTION

The employment relationship is one of the cornerstones in modern economics. It is not surprising that there is a substantial amount of research on incentive schemes and principal agent models. Often there is a large gap between what is discussed in economic literature and how the man in the street perceives his workplace. One of the reasons for this gap is the complicated nature of human beings. We do not simple exert effort, but also engage in social activities and have emotions.

In the workplace the role of social relations can become quite complicated, for instance some people try to play strategic games to get higher up the ladder. The popularity of books like 'How do I become a rat'[1] on manipulating people in the workplace shows the importance of these types of games. But even in less complicated structures, without manipulating, a lot of interaction is going on. Workers interact socially with their coworkers, they build relationships and have fights.

For many workers this aspect of the job is obvious and crucial to their participation: workers value a positive work atmosphere and friendships and dislike hostile relationships.

These friendships can lead to feelings of liking towards each other, which alters the behavior of the workers compared to the principal agent models. Performing a task with a group of friends might therefore lead to different results than performing the same task in a group of strangers. (Brandts and Solà 2010) show in a gift exchange experiment how the behavior of friends and strangers is different. Social relations can thus lead to seemingly irrational behavior from the point of view of the homo economicus.

As (Granovetter 1985) shows, economic literature on the workplace tends to under-emphasize the role of social relations. This is surprising considering the importance of the workplace relationship and how normal people perceive social relations. In this thesis I will attempt to expand some of the theoretical literature that incorporates these social relations in the workplace.

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[1] (Schrijvers 2002).

1.2 PROBLEM AND METHODS

After having established social interaction in the workplace as a topic, it has to be narrowed down to a workable level. Looking at the existing literature brought up several questions.

If social interaction between workers causes them to become altruistic and overcome some agency problems, would an employer be willing to stimulate social interaction, and to what extent?

If feelings of friendship enhance the atmosphere in the workplace and make it more pleasant to work, how does this affect the productivity and what should the employer think about this?

For the employer there might be a negative effect of all this socialization, in fact, people might spend too much time socializing in the workplace (which is not productive). In other words, while at work there is a time constraint on the workers. They can either work or socialize with their co-workers, this could mean that there is a negative relationship between working and social activities. How does this affect the productivity and profits of the employer and what happens to the level of socialization?

People might attach different values to friendships or the atmosphere in the workplace. Some people might not care at all about a good atmosphere and just want to work, while others are more social and attempt to engage in this social relations. How do these situations affect the productivity of workers and the equilibrium. Is this good for the employer? Will he be able to screen workers this way?

I will attempt to answer these questions by extending the model in (Dur and Sol 2010) in several ways. In Chapter 3 I will look at the basic properties of the model and the effect of loosening some assumptions. For instance what happens if the employer is unable to observe individual output and has to reward workers on their joint production?

In Chapter 4 I will allow for interdependence between the cost of effort and the cost of attention. This allows workers to either enjoy working in a more pleasurable environment or to face higher costs if they socialize too much on the job.

In Chapter 5 I will look at the effect of information asymmetry between the players of the game. Suppose that the agents value socialization differently, how will uncertainty about the players' type affect the results of the model and will the principal be able to screen workers?

2. Related Literature

2.1 General

The idea that workers care about other things than their material payoffs is not new, (Mayo 1933) was one of the first to suggest these types of effects.

Subsequently the Hawthorne experiments were conducted to investigate human relations in the workplace. (Dickson and Roethlisberger 1939) report that in these experiments the importance of human relations in the workplace is shown. A lot of experiments then tried to describe the relationship between productivity and human relations in small groups. (Goodman et al. 1987) look at what they call group cohesiveness, which is best described as the extent of feelings toward each other within the group. Unfortunately the results of the studies that tried to describe the relationship between productivity and group cohesiveness are rather mixed. These authors are often referred to as the Human Relations School, because they were amongst the first to incorporate the human relations in economic models. Within the empirical literature there is some evidence that confirms the important role of social relations. For instance (Van Echtelt and Hoff 2008) report that social interaction with coworkers is one of the main factors that cause unemployed workers to find jobs in Holland. Although there is evidence in the empirical literature that underlines the importance of social interaction, there is relatively little knowledge on how social interaction between coworkers affects productivity.

(Granovetter 1985) reviews economic literature from a sociologic point of view. He concludes that there is an under-emphasis on social relations within economic literature. Economic literature tends to focus on rational behavior, which is often assumed in principal agent models, while in reality social relations play a large role in decisions. Obviously this review was done quite some time ago, hence I will overview some of the more recent literature to develop some insight into the current state of economics.

I will start by looking at the empirical evidence on human relations in the workplace. This shows the relevance and was the reason more theoretical research was done later on. Afterwards I shall look at some of the theoretical papers and conclude with the point of view I take in this thesis compared to the existing literature.

2.2 EMPIRICAL EVIDENCE

There has been a lot of empirical research on human relations in the workplace not only in economic but also in sociologic and psychological literature. The empirical research in economic literature started with the Hawthorne experiments[2]. Scientists began to investigate the role of human factors and interaction instead of simply the material payoffs and strategies. Often empirical research shows that the social relations play a large role in decision making and contribute to the well-being of individuals. Whether these social relations also cause workers to become more productive is not always clear, however some results suggest that having a positive work atmosphere allows the employer to pay lower wages. This is due to the fact that the worker derives utility from social interactions, thus his participation constraint is met easier.

(Mueller and Price 1981) investigate the main causes of turnover according to nurses. They find that the intent to stay, opportunity, general training, and job satisfaction were the main factors that affected turnover. These results were somewhat in contrast to much of the theoretical literature, as social relations were often not incorporated in the models. Outside job opportunities and wage were generally considered to be factors that determine whether workers would stay or leave. Job satisfaction is shown to have an indirect effect by mediating the other factors. What exactly determines job satisfaction remains unclear, however the main contribution of the research is that it shows how the turnover of employees depends on both economic and social factors. This shows how economics should not overlook social relations, but instead incorporate them.

In a related paper (Mossholder et al. 2005) show that network centrality and interpersonal citizenship behavior are the two main predictors of employee turnover. Their data concerns five years of health care employees in the public medical centre. The key determinants of employee turnover in their research show not only the role of job satisfaction but also the importance of friendship relations for employee retainment. Informal friendship networks increase the likelihood of survival in an organizational setting. The cause for this is not completely clear but could be explained from an economic point of view by looking at the participation constraints of workers. Workers with more social relations can derive utility from friendships which makes it easier for the employer to meet the participation constraint by paying a wage. Workers in isolated situations, or with less communication skills, are less able to gain from the friendships and may be more inclined to leave the organization. Note that this is only one explanation for such a phenomenon and the hypothesis still requires empirical testing.

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2 See (Dickson and Roethlisberger 1939)

Similarly (Morrison 2004) develops a theoretical model on friendship in the workplace and its relationship with organizational commitment and turnover. Subsequently he tests the model in three empirical studies and finds a significant relationship. The effect of friendship tends to be stronger for individuals in interdependent roles than isolated individuals. This suggests that workers that are dependent on others for their productive activities enjoy social relations more than workers that produce individually. Note that self-selection could affect the empirical results, workers that value friendship more could self-select into jobs that involve more interaction with colleagues.

(Griffeth and Riordan 1995) hypothesize a theoretical model on the relationship between friendship in the workplace and productivity related factors[3]. They then empirically test the hypothesis and find that perceived friendship opportunities by employees have direct effects on factors like job satisfaction and indirect effects on organizational commitment and a negative effect on the intention to turnover. This sheds light on what contributes to job satisfaction and how social interaction can cause workers to be more likely to stay with a firm.
They also emphasize that friendship may be an underrated and underutilized tool within organizations, as the role of friendship could be larger than expected. Many activities within an organization are accomplished through an informal network of friends[4].

When looking at friendship relations in the workplace critics could point out that it could be hard to measure this accurately. (Jex et al. 2000) provide a study that shows the validity of friendship measurement on a linear scale. They suggest that the lack of empirical research on workplace friendships could come from the difficulty to measure it. After empirically testing the friendship measurement scale they conclude that it is a sound way to measure friendship in the workplace. They support the techniques used in several of the other contributions in this field.

Besides social relations as friendship there are also other human factors that contribute to job satisfaction. (Ducharme and Martin 2000) show how negative experiences at work, such as stress or conflict, can have a large impact on utility. They find a relationship between these negative experiences and psychological problems like depression and a burnout. These negative effects might even spillover to the personal sphere of the worker, it could affect friends and family. This shows how a worker is more than merely an agent that exerts effort and produces, he values support from

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3 (Winstead et al. 1995) *come to similar conclusions, but instead investigate already existing friendships.*
4 See (Krackhardt and Stern 1988) *as well on the importance of informal networks.*

coworkers and cares about the work atmosphere. The paper finds a clear relation between job satisfaction and two types of social interaction in the workplace: affective and instrumental support. A worker not only benefits from a coworker that helps him, but also from a coworker that engages in social interaction with him.

The industrial policy recommendations that follow suggest stimulation of social interaction, by increasing social connections between workers the employer could ultimately boost productivity.

One of the questions that remains is how employers view this social interaction. (Berman et al. 2002) attempt to answer this by analyzing a survey amongst managers in the US. The survey not only attempts to get a view of the perception of managers but also attempts to shed light on the measures they take to stimulate social interaction. Theoretically stimulating social interaction might not be obvious, as this comes at a cost to the managers. To complicate the setup even more one has to realize that simply stimulating social interaction could also have a negative effect, people could also start to act hostile towards each other. This possibility of hostile relationships between workers creates a risk for the employer.

The results show that despite the risks many employers perceive workplace friendships as a positive thing and try to stimulate them. Stimulating friendship should be limited to encouraging a climate where friendships can develop and not try to force friendships. This is due to the human nature and the different communication skills. For managers with poor communication skills they do recommend training in the importance of friendship making.

In (Hodson 1997) several of the previous results are confirmed in a team production setting. The paper not only focuses on friendly coworker relationships but also allows for hostility. He finds a significant relationship between the coworker relations and job satisfaction, often equaling or exceeding that of job characteristics. A good relationship with coworkers increases job satisfaction and conflict or hostile relations have a negative impact. Strangely enough they also find that solidarity between coworkers is often associated with a good relationship between workers and management. This suggests that our knowledge of how solidarity workers in horizontal and vertical settings is still limited and more research is needed. The paper also shows the importance of group cohesion and warns for managers that try to influence social interaction by introducing team or relative incentives. Without a sound scientific basis such measures could have an unanticipated effect.

I can conclude that empirical research in several disciplines has shown the importance of social relations in the workplace, however the full implications remain unclear. There are many indications that workers attach a positive value to friendships and the work atmosphere. In practice employers often try to encourage such a positive work atmosphere, however the complete effect of these social interactions on productivity is not sufficiently investigated. Some authors even warn employers that try to influence the socialization too much through relative or team incentives as this could have an adverse effect.

In the theoretical section I will look at economic models that attempt to describe this social interaction. I will show that the focus in those models is more on the incentives of the agents and the implications on total welfare.

2.3 ALTRUISM LITERATURE

The incorporation of social relations in the theoretical literature was somewhat later than most of the empirical studies. (Rotemberg 1994) is one of the first papers that attempts to explain friendship relations in a model. He does this by modeling the social relations and feelings of caring about each other in the form of altruism. Although these concepts need to be the same, it is often in practice useful to model these types of feelings as altruism. To clarify this further one has to realize that the word altruism within this type of literature refers to situations where an individual is willing to sacrifice a part of his own material payoff in order to increase someone else's payoff. The altruism thus refers to the sacrifice of material payoff, not to the total utility. (Rotemberg 1994) uses a model where agents can costly choose to become altruistic towards each other. This means that they will care about the utility of the other agent[5]. When they become altruistic they cannot revert this process[6]. In the last stage of the game the agents exert effort, in classical free riding setting. The altruism here serves as a commitment device and allows the workers to overcome some of the agency problems. Although the altruism is endogenously determined, it is still costly and can be chosen freely.

The choice to model social relations through altruism is not the only option. Several other authors did related research and used other types of methods to look at coworker relations. One of the interesting branches is the literature that looks at inequality between coworkers. It is often argued that people are inequity averse, this leads to wage compression to reduce disharmony between workers.

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5 *The utility of the agents will become complementary in the sense of* (Klemperer et al. 1985)*.*
6 *This is a necessary assumption to make altruism serve as a commitment device.*

(Lazear 1989) investigates such a model of pay equality between coworkers. He looks at a competitive situation between workers and the effect of wage compression. He finds that pay equality is not always a good thing, it may reduce disharmony between workers, but it also reduces the motivation of the good workers. One of the positive aspects is that when relative incentive schemes are used wage compression reduces the uncooperative behavior of workers. The main contribution is that, under some assumptions, some level of wage compression is efficient to the firm. The paper gives a nuanced view on inequity aversion, it shows both sides and concludes that some level of compression can be efficient. This shows how the incorporation of human relations changes standard incentive models.

Another point of view is that of fairness, people often accept negative things that happen to them as long as they happen according to their perception of fair[7].
(Cox et al. 2007) introduce a tractable model of fairness and reciprocity. They focus on the marginal rate of substitution between players' own payoff and another player's payoff. In their model this depends on the emotional state of the player, thus whether he feels he has been treated fairly. This corresponds to a notion of kindness. Whether someone is altruistic, and to what extent, in their model depends on perceptions of kindness and fairness. Similarly if a hateful relationship exists between the agents there is a negative marginal rate of substitution between their payoffs. More recently (Cox et al. 2008) made a more general version of the model and test it empirically again. Similarly to the earlier results it shows that people become more altruistic after being treated kindly.

(Van Dijk and Van Winden 1997) study a model of public good provision in small communities. They add interdependency of utility functions to the existing literature. In their model the altruism depends on the history: what happened in the previous stages of the game determines how much players care about each other. The results are very different from some of the other models, adding the interdependency of utility functions often leads to higher private and lower public contributions. This has clear policy implications, namely that it is easier to start public programmes than to end them. This is due to the fact that it takes time to develop social relations, if a public programme ends it will take time before the private provision takes over. Of course the assumption that altruism depends on history is crucial to this result.

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7 For this also see (Brandts and Solà 2010), in their experiment people accept being treated less favorable if they know about the friendship between the principal and the other agent.

(Bolle and Kritikos 2006) model reciprocity and altruism in a dynamic setting. The main insight they develop is that multiple steady states will exist. Which steady state the players end up in depends on their initial preferences. This means that whether two players that play the game end up in a situation of cooperation or war will depend on preferences, which brings uncertainty to real world scenarios. One of the main aspects is the dynamic setting of the model, it opens new possibilities of research. For example how does a group that is in a steady state react to newcomers in the workplace. With heterogeneous preferences it is not obvious that the newcomer will be absorbed into the old steady state or will subgroups emerge when the group becomes too large? This brings new questions with respect to social relations in the workplace.

2.4 ATTENTION AND ALTRUISM

(Dur and Sol 2010) develop a related model to (Rotemberg 1994). The main differences concern the cause and role of altruism in the model. In their model agents can give costly attention to each other. This costly attention is not only consumed, but also causes the receiving agent to develop altruism towards the other agent. In the final stage the agents exert effort, which creates output for the principal. The way altruism is modeled here allows for strategic interaction, for instance agents can alter the amount of attention they give in order to make the other agent exert more effort in the next stage. It also allows the principal to design the wage contract in such a way that it is beneficial to him. Within this framework (Dur and Sol 2010) look at how the principal can design his optimal wage contract when attention is non contractible. They find that even without contractible attention the principal is able to reach first best profits by giving the right mix of individual and team or relative incentives.

Socialization does not necessarily lead to altruism. In a closely related paper (Itoh 1991) develops a model that allows the agents to socialize and are assigned to two tasks. In his model socialization leads to lower costs for the agents, which corresponds to a notion of complementarity between effort and attention. Workers enjoy the positive atmosphere and find it less costly to work in such an environment. (Itoh 1991) also looks at the effect of different types of workers and possible collusion between the workers. He finds that workers tend to under-socialize if they have to privately optimize their welfare and that collusion can lead to over-socialization. Due to the different approach and specification of the model the results differ from (Dur and Sol 2010), however some common ground can be found. Under-socialization would also happen in (Dur and Sol 2010) if the principal is not able to provide a contract with the right team or relative incentives. Whether or not the principal and the agents reach a desirable equilibrium is heavily influenced by the assumptions of the model.

Observable effort, relative incentives and heterogeneous preferences of workers are all factors that could potentially affect the results.

2.5 DIFFERENT TYPES OF PEOPLE AND ATTENTION/ALTRUISM

(Arjan Non 2010) models a situation where altruism occurs not between the workers but between the principal and the worker. Not all workers respond to altruism in the same way, which is modeled by types of workers in the final stage of his model. This leads to several mimicking strategies and signaling and screening games. Chapter 6 will be similar to this model, with the main difference being that the altruism occurs between the workers and not the principal here.

Other contributions on the effect of heterogeneous preferences of workers include (Kosfeld and von Siemens 2009), (Bolle and Kritikos 2006) and (Itoh 1991).

2.6 POINT OF VIEW IN THIS THESIS COMPARED TO THE LITERATURE

In this thesis I will take the point of view from (Dur and Sol 2010). I will assume that workers are able to give attention to each other, which causes them to care about each other. This caring will be modeled as altruism. The main contribution lies in expanding the existing model by loosening some of the assumptions. This means that my point of view is also closely related to (Itoh 1991), especially with respect to complementarity between effort and attention and the heterogeneous preferences of workers.

In this situation social interaction does not just lead to altruism, but can also lead to lower costs of effort. Furthermore in the case of heterogeneous preferences of workers, there are different types of workers that do not value social interaction in the same way.

I will also look at the effect of the team production, when the principal is unable to observe individual effort he has to reward the agents for their joint output. Some of the things that I will leave out of the analysis are the effect of risk aversion and the use of a noisy signal to measure output. In that sense I will follow the analysis of (Dur and Sol 2010) and expand it by adding interdependence between effort and attention, and introduce heterogeneity of worker's preferences.

3. THE BASIC MODEL

3.1 OBSERVABLE AND CONTRACTIBLE EFFORT AND ATTENTION (FIRST-BEST)

The basic model I use is very similar to the one in (Dur and Sol 2010). In this section I will overview some basic properties of the model and look at the effects of loosening some assumptions. Some of the results are therefore an echo of results in (Dur and Sol 2010) and (Rotemberg 1994).

A principal offers a contract two identical agents that exert effort and give attention to each other. The attention the agents give to each other has two effects. Attention received by an agent is consumed and benefits him through the function $G(a_j)$. It also causes the receiving agent to become altruistic towards the other agent, this altruism is given by the function $F = \gamma a U_j$[8].

The total output depends on the effort of both agents and is given by the function $Q(e_i, e_j)$[9].

I assume that the principal offers the same contract to both agents[10]. He offers a wage contract to the agents that can consist of a base salary, individual incentives and team or relative incentives. The total wage contract is described by the function w.

Timing is as follows: The principal first offers a wage contract to the agents, which they can accept or reject. After accepting the wage contract the agents simultaneously give attention to each other. This causes them to be altruistic, they learn the level of attention the other agent has given before the final stage. In the last stage the agents simultaneously exert effort.

Profits for the principal are given by:

$$\pi = Q(e_i, e_j) - w_i - w_j$$

The utility of agent i is given by:

$$U_i = w_i + G(a_j) + F(a_j, U_j) - C(e_i, a_i)$$

The agents have an outside option which leads to the following constraint:

$$U_i = w_i + G(a_j) + F(a_j, U_j) - C(e_i, a_i) \geq \overline{U}$$

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8 As in the original model I will abstract from cases where F>1.
9 I will make the same assumptions as in (Dur and Sol 2010) considering the production function, namely that it satisfies the Inada conditions.
10 This seems reasonable as the agents are identical, there would be no reason to offer different contracts. Later on with different types of agents this might not be the case.

Because it is a dynamic game with one period, the game is solved by backward induction. For that reason the analysis will start with the stage where the agents choose their effort level.

First it is interesting to note what the players would do in case complete contracts are possible. This means that the principal gives the agents a wage that consists of only a base salary and contracts on the effort and attention levels the agents have to exert. As in (Rotemberg 1994) and (Dur and Sol 2010) he will set optimal effort and attention as follows:

Effort levels will be determined by setting the marginal benefit of effort to the principal equal to the marginal cost of the agent:

$$Q_e(\cdot) = C_e^i(\cdot)$$

Attention levels will be determined by setting the marginal benefit of the agent receiving attention equal to the marginal cost of the agent giving attention:

$$G_a^j(\cdot) + F_a^j(\cdot) = C_a^i(\cdot)$$

The wage contract is set by the principal in such a way that the participation constraints of the agents are just met:

$$w = C(\cdot) - G(\cdot) - F(\cdot) + \bar{U}$$

3.2 Non-contractible attention

When attention becomes non-contractible to the principal the situation becomes more complicated[11].

The agents' effort choice will depend on the marginal benefit and the marginal cost of effort. In equilibrium he will equate those[12].

The first derivate of the agent's utility with respect to effort is given by:

$$\frac{dU_i}{de_i} = w_{ei}^i(\cdot) + w_{ei}^j(\cdot) * F_{uj}(\cdot) - C_{ei} = 0$$

In the next previous stage the agents choose their attention level:

$$\frac{dU_i}{da_i} = -C_{ai}(\cdot) + F_{uj}(\cdot)[G_{ai}(\cdot) + F_{ai}(\cdot)] + \frac{F_{ui}(\cdot)w_{ej}^i(\cdot)}{C_{ejej(\cdot)}} w_{ej}^i(\cdot) = 0$$

According to (Dur and Sol 2010) the principal is able to set the right mix of individual and team or relative incentives to attain first-best profits. He can do this by using the individual incentives to set the first-best level of effort. Hence:

$$w_{ei}^i(\cdot) + w_{ei}^j(\cdot) * F_{uj}(\cdot) = Q_e(\cdot)$$

Rewriting this gives:

$$w_{ei}^i(\cdot) = Q_e(\cdot) - w_{ei}^j(\cdot) * F_{uj}(\cdot)$$

Similarly he sets the first-best level of attention by equaling the agents derivative to the optimal condition:

$$F_{uj}(\cdot)[G_{uj}(\cdot) + F_{aj}(\cdot)] + \frac{F_{uiaij}(\cdot)w_{ei}^j}{C_{ej}(\cdot)} w_{ei}^j = G_a(\cdot) + F_a(\cdot)$$

Rewriting this with respect to w_{ei}^j gives:

$$w_j^i = \mp \sqrt{\frac{\left(1 - F_{uj}(\cdot)\right)[G_{ai}(\cdot) + F_{ai}(\cdot)]C_{ee}(\cdot)}{F_{aiuaj}(\cdot)}}$$

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11 *This is the main situation researched by* (Dur and Sol 2010)
12 *As stated in* (Dur and Sol 2010) *the first-best level of effort from a social perspective would be where* $Q_e(\cdot) = C_e(\cdot)$.

3.3 Non-observable individual effort and non-contractible attention: team output

In some situations the employer might not be able to see the individual performance of his employees, for instance if they work together in teams. This leads to a situation where the employer does not reward his employees for their individual effort, but their performance as a team. In this section I will apply this to the model and look at how this affects the results.

Not being able to observe the individual effort of the agents reduces the set of instruments that the principal has to influence the behavior of the agents. Previously he had the base salary, individual incentives and team or relative incentives at his disposal to induce the desired behavior. Unobservable individual effort means that the principal will give team incentives, this leads to the situation where both employees receive the same amount of bonus regardless of who exerted the unit of effort. In other words the individual incentives and the team incentives are equally strong.

The principals profits are given by:

$$\pi = Q\big(e_i, e_j\big) - (w_e^i + w_e^j)e - s_i - s_j$$

The agents' utility is given by:

$$U_i = (e_i + e_j)w_e^i + s_i + G\big(a_j\big) + F\big(a_j, U_j\big) - C(e_i, a_i)$$

If we follow the line of solving the problem in (Dur and Sol 2010), two conditions arise. They describe the optimal level of effort and attention respectively.

$$w_e(\cdot) + w_e(\cdot) * F_{uj}(\cdot) = Q_e(\cdot)$$

$$F_{uj}(\cdot)\big[G_{uj}(\cdot) + F_{aj}(\cdot)\big] + \frac{F_{uiaij}(\cdot)w(\cdot)}{C_{ee}(\cdot)}w(\cdot) = G_a(\cdot) + F_a(\cdot)$$

In the original model he was able to use individual incentives to satisfy the first condition and team or relative incentives to satisfy the second. However, now that individual effort is no longer observable the toolset of the principal has been reduced. He has to use the team incentives to satisfy both conditions at the same time. Depending on the exact specification and shape of the functions it is unlikely that he can do this[13], which means that in general he will face a trade-off between inducing the first-best level of effort and the first-best level of attention.

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[13] *In the unlikely scenario that the principal is able to satisfy both conditions the solution is equivalent to* (Dur and Sol 2010).

The most likely scenario is that when the principal tries to induce the agents to exert the first-best level of effort that the attention level will be higher than first-best. This is due to the strong incentives required to reach first-best effort ($2Q_e(\cdot)$). It then becomes profitable to lower the team incentives, in order to reduce the high level of attention. In equilibrium there will be a situation where there is an under-provision of effort and an over-provision of attention.

In the other possible scenario the principal tries to induce first-best levels of effort, which leads to too little attention. This depends on the benefit of attention to the agents and requires that they benefit a lot.

In this situation the principal would find it profitable to increase the team incentives, which then leads to an equilibrium with an over-provision of effort and an under-provision of attention.

The previous part has shown that when the employer is unable to observe individual effort, but has to reward his employees on team productivity, there can be an under- or over-provision of effort and attention. To solve this problem the principal can look for other ways to influence the agents' attention choice. One of the ways would be to either facilitate or discourage social interaction by affecting the agent's cost of attention. Obviously there are many ways to do so, however structural changes in the cost of attention will not only affect the agents' choice of attention but also the level of attention desires from the principal's point of view. The most effective way to influence the attention levels would be in the form of a subsidy or tax on attention, without affecting the cost function in the long term. This means that organizing social activities for employees could be an effective instrument to make them reach the desired level of socialization, while investing in a coffee corner that makes it easier for employees to socialize is not an effective instrument.

3.4 Conclusions

Within the basic framework several conclusions can be drawn. When effort and attention are contractible the principal is able to induce the first-best solution. If attention is non-contractible but effort is, he can reach the first-best profits by giving the proper mix of individual and team or relative incentives. When individual effort is non-observable, and the principal has to reward the agents based on team output, the principal is no longer able to reach the first-best level of effort in general. He cannot satisfy both the condition for optimal attention and the condition for optimal effort. Depending on the exact specification of the functions there can be an over or under-provision of attention. The principal will take this into account and will abandon the first-best level of effort in order to increase his private profits.

In order to solve this problem in practical situations the principal could try to influence the cost of giving attention in other ways, for example by stimulating or trying to prevent social interaction in the workplace.

4. Effort and attention as substitutes or complements

4.1 Introduction

When looking at the models that passed so far some questions can be raised. For instance a worker has limited time that he spends on his job, if he is socializing most of the day he cannot at the same time exert effort. This means that he faces some time constraint, one of the ways to look at this is by allowing effort and attention to be substitutes within his cost function. As he spends more time socializing it will become more costly to exert effort, hence he will choose to exert less effort. Although this is not exactly the same as introducing a budget constraint it does provide an analysis that describes the intuitive phenomena that occur.

One of the conclusions that can be drawn from the empirical literature is that workers tend to value a good work atmosphere and find it enjoyable to work in a pleasant work environment.

In the model this can be described by allowing attention to lower the cost of effort for the receiving agent. After having received attention, and having socialized, the agent is more satisfied in the environment and finds it less costly to exert effort in the next stage. This is related to (Itoh 1991), with the main difference that altruism is incorporated in this model.

4.2 Complete contracts, substitutes

To model the situation where there is a relation between the cost of effort and attention I will assume that the agents' cost functions are no longer additively separable between the cost of effort and the cost of attention. This means that there will be some cross term that can be either positive or negative, where the negative term refers to the situation of a time constraint. This complicated the choice of effort and attention for the agents and in turn can also affect the principals maximization problem. The principal's profit function and the agents' utility functions will not change by this extension. I will start the analysis by looking at a situation where perfect contracts are possible to determine to first-best levels of effort and attention.

Similarly as in the original model the first-best profits are described by:

1. The optimal level of effort.

$$Q_e(\cdot) = C_e^i(\cdot)$$

2. The optimal level of attention

$$G_a^j(\cdot) + F_a^j(\cdot) = C_a^i(\cdot)$$

3. Optimal wage contract

$$w = C(\cdot) - G(\cdot) - F(\cdot) + \bar{U}$$

The principal will only be able to reach these levels if complete contracts are possible. Similarly as in the original model I will analyze the effect of loosening certain assumptions.

4.3 Incomplete contracts: non-contractible attention, substitutes

Now what happens if attention becomes non-contractible and the principal uses the a wage contract with a base salary, individual incentives and team or relative incentives as before?

In this situation the agents are free to choose their attention levels and the principal designs a wage contract with individual incentives and possibly team or relative incentives. The game is still solved by backwards induction, thus I move to the stage where the agents exert effort. The choice of effort for the agent is determined by:

$$\frac{dU_i}{de_i} = w_{ei}^i(\cdot) + w_{ei}^j(\cdot) * F_{uj}(\cdot) - C_{ei}(\cdot) = 0$$

Although the equation does not show it clearly, something has changed compared to Chapter 3. The derivative with respect to the cost function now also depends on attention. As a result the level of effort will depend on the amount of attention given to one's colleague.

In the previous stage the agents will realize that if they give attention to each other this has an effect on the other agents choice of effort in the next stage. However giving attention also becomes less attractive due to the increased cost of effort in the next stage. Lemma 1 in (Dur and Sol 2010) then changes to:

1. The effect of received attention on the choice of effort remains the same:

$$\frac{de_i}{da_j} = \frac{F_{ujaj}(\cdot) * w_{ei}^j(\cdot)}{C_{eiei}(\cdot)}$$

2. The effect of attention given now changes and influences his choice of effort in the next stage:

$$\frac{de_i}{da_i} = \frac{-C_{eiai}(\cdot)}{C_{eiei}(\cdot)}$$

The choice of attention will then determined by the following derivative:

$$\frac{dU_i}{da_i} = -C_{ai}(\cdot) + F_{uj}(\cdot)[G_{ai}(\cdot) + F_{ai}(\cdot)] + \frac{de_i}{da_i}\frac{dU_i}{de_i} + \frac{F_{ui}(\cdot)w_{ej}^i(\cdot)}{C_{ejej(\cdot)}}w_{ej}^i(\cdot) = 0$$

Although the first part of the third term is no longer equal to zero, the term will still drop out due to the envelope theorem. This means that the relationship between the cost of effort and the cost of attention does not qualitatively change the choice of attention for the agents. The main change that remains is the link between the choice of effort and the choice of attention through the derivative of the cost function. The derivative of the cost function with respect to effort will depend on the level of attention and, similarly the derivative of the cost function with respect to attention will depend on the level of effort in the next stage. The agents will solve their maximization problem by substitution of the effort levels into the choice of attention.

In the event where the cross-term in the cost function is positive, thus a situation of substitutes as discussed before, this will lead to both a lower choice of attention and a lower choice of effort.

The question that remains is how this affects the principal and whether he will still be able to reach first-best profits. It is interesting to realize how he sets the level of the individual and team or relative incentives. He equates the agent's derivative to the optimal level, where the cost term drops out. This means that the principal need not be concerned about a possible relationship between the cost of effort and the cost of attention within the agents' cost functions. He can simply set the wage according to the original model and achieve optimal profits.

The agents, however, will take the relationship into account and set their effort and attention levels accordingly.

4.4 COMPLETE CONTRACTS, ATTENTION LEADING TO LOWER COST OF EFFORT.

When, as discussed before, agent's value a positive work atmosphere, it can become less costly for them to exert effort after receiving attention. This means that an agent's cost of effort is negatively related to the attention given by the colleague. This will create a link between attention given and the agent's utility. When an agent gives attention to the other agent, he will lower the other agent's effort cost for the next stage. If the attention giving agent is altruistic he will benefit from the increased effort by the other agent.

Again I will start by looking at the situation of perfect contracts in order to determine the first-best levels of effort and attention.

1. In the final stage the optimal level of effort is still given by the following equation. Similarly as in 4.2 the derivative of the cost function with respect to effort looks the same as in the original model, but now also depends on the attention received.

$$Q_e(\cdot) = C_e^i(\cdot)$$

2. Giving attention now not only benefits the receiving agent by allowing for the consumption of attention and altruism, but also reduces the cost of exerting effort in the next stage. As a result the marginal benefit of attention received becomes higher than in the original model, this leads to a first-best level of attention which is higher[14].

$$G_a^j(\cdot) + F_a^j(\cdot) - C_{ai}^j(\cdot) = C_a^i(\cdot)$$

3. Optimal wage contract remains the same as in the original model, the principal simply makes sure that the participation constraints are just met.

$$w = C(\cdot) - G(\cdot) - F(\cdot) + \overline{U}$$

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[14] *Note that the derivative of the cross-term $C_{ai}^j(\cdot)$ has, by assumption a negative sign as it reduces the total cost.*

4.5 INCOMPLETE CONTRACTS, ATTENTION LEADING TO LOWER COST OF EFFORT.

Now consider the incomplete contracts case as before, the principal sets the wage function and the agents are free to choose their effort and attention levels. Again I start in the last stage where the agents set their effort levels.

As before the agent's choice of effort looks the same, however the derivative of the cost function with respect to effort also includes attention received. At this point the agent views this as constant and optimizes in the normal way.

$$\frac{dU_i}{de_i} = w_{ei}^i(\cdot) + w_{ei}^j(\cdot) * F_{uj}(\cdot) - C_{ei}(\cdot) = 0$$

Choice of attention:

The previous stage, where attention is given, has changed somewhat compared to before. Lemma 1 from (Dur and Sol 2010) now becomes:

$$\frac{de_i}{da_j} = \frac{F_{uiaj}(\cdot)w_{ej}^i(\cdot) - C_{eiaj}(\cdot)}{C_{ejej}(\cdot)}$$

$$\frac{de_i}{da_i} = 0$$

Attention received now has a larger impact on the choice of effort in the next stage compared to the original model. An agent giving attention will take into account that he will lower the cost of effort for the other agent in the next stage. As before, attention given has no effect on the agent's choice of effort.

$$\frac{dU_i}{da_i} = -C_{ai}(\cdot) + \frac{dU_i}{da_j}F_{uj}(\cdot) + \frac{de_j}{da_i}\frac{dU_i}{de_j} = 0$$

Where the second term refers to the benefit of giving attention to the other agent because he cares about his utility and the third term refers to the benefit by affecting the other agent's choice of effort in the next stage. Plugging the effects in leads to:

$$\frac{dU_i}{da_i} = -C_{ai}(\cdot) + F_{uj}(\cdot)[G_{ai}(\cdot) + F_{ai}^j(\cdot) - C_{ai}^j(\cdot)] + \frac{F_{uiaj}(\cdot)w_{ej}^i(\cdot) - C_{eiaj}(\cdot)}{C_{ejej}(\cdot)}w_{ej}^i(\cdot) = 0$$

Hence an agent giving attention will incorporate the effect he has on his colleague's choice of effort. The principal will then have to design his wage contract in such a way that he maximizes his profits, hence he will try to induce first-best levels of effort and attention as we have seen before. For the individual incentives he equates the agents' effort choice and the first-best level as usual:

$$w_{ei}^i(\cdot) = Q_e(\cdot) - w_{ei}^j(\cdot) * F_{uj}(\cdot)$$

For the team or relative incentives he also equates the agents' derivative to the first-best level, however this situation has changed considerably compared to the original model.

$$F_{uj}(\cdot)\big[G_{aj}(\cdot) + F_{aj}(\cdot) - C_{ai}^j(\cdot)\big] + \frac{F_{uiaij}(\cdot)w_{ei}^j - C_{eiaj}(\cdot)}{C_{ejej}(\cdot)} w_{ei}^j(\cdot) = G_a(\cdot) + F_a(\cdot) - C_{ai}^j(\cdot)$$

Rewriting this with respect to w_{ei}^j for the team or relative incentives gives:

$$(1 - F_{uj}(\cdot))\big[G_{aj}(\cdot) + F_{aj}(\cdot) - C_{ai}^j(\cdot)\big] = \frac{F_{uiaij}(\cdot)w_{ei}^j - C_{eiaj}(\cdot)}{C_{ejej}(\cdot)} w_{ei}^j$$

Solving for w_{ei}^j:

$$w_{ei}^j = \frac{C_{eiai}(\cdot) \mp \sqrt{C_{eiai}(\cdot)^2 + 4F_{uiaj}(\cdot)\big[C_{ejej}(\cdot)\big[1 - F_{uj}(\cdot)\big]\big[G_{ai}^j(\cdot) + F_{ai}^j(\cdot) - C_{ai}^j(\cdot)\big]\big]}}{2F_{uiai}(\cdot)}$$

The principal is then able to achieve first-best profits by setting the incentives as described above. The individual incentives remained relatively the same as in the original model, the team or relative incentives have become more complicated. Note that they are now biased towards team incentives rather than relative incentives, due to the cross term being outside the root.
Intuitively this bias can be explained by the positive effect from lowering a colleague's effort cost. Previously both team and relative incentives were equally viable to make the agents exert the right amount of attention. However now that attention lowers the effort cost for the receiving agent, it becomes less attractive to invest in attention for an agent to tame a colleague's willingness to outperform. As giving attention will both make him altruistic (and less willing to outperform), but also lowers his cost of effort, the total effect becomes ambiguous. In this situation it is then more likely that the principal influences the attention levels through team incentives than relative incentives.

4.6 Conclusions

In this chapter I looked at several situations that could potentially alter the behavior of the agents in the model. The time constraint pressing on the employees turns out to be not much of a concern for the principal. If effort and attention are substitutes through the cost function, the agents will set their effort and attention levels in a very similar way as before. There is no qualitative change in the sense that other factors play a role or that their decision is based in a different way. The only change for the agents is that, depending on marginal rate of substitution, they will choose lower levels of effort and attention due to the higher costs. The principal is able to achieve first-best profits by offering the same incentives as before. The main reason for this is that as the cross term increases, both his choice of effort and the optimal level of effort are affected in the same way. This holds in a similar way for the choice of attention and the optimal level of attention. For the principal this means that he need not worry about a possible relationship between the cost of effort and the cost of attention.

When attention has an effect not only through consumption and altruism, but also lowers the cost of effort for the receiving agent, the results change in a more significant way. The effort choice for the agents remains similar, however their attention levels will now also include the effect they have on the colleague's cost of effort.

For the principal this means that he can set the individual incentives in the usual way, but that the team or relative incentives change. The term does not just become more complicated, but also shows a bias towards team incentives as the effect of attention on the other agent's effort cost becomes larger.

5. DIFFERENT TYPES OF AGENTS

5.1 INTRODUCTION

One of the questions that may arise when looking at the standard model is how different people may react. People tend to have different preferences, where one person enjoys socialization to a large degree another person might not like it at all.

In this section I will introduce a type of worker that does not attach any value to social interaction. Having different types of workers interact with each other and allowing for uncertainty about the workers' types creates new possibilities for strategic behavior. For instance an agent that does not value socialization may be willing to give attention to his colleague because this alters the colleague's effort choice.

This introduction of a non-social agent can reduce the social welfare, which will effectively harm the principal. This is due to the fact that in general he will try to make the participation constraints bind exactly. A relevant question from his point of view is whether he can solve this problem by screening his employees.

5.2 OBSERVABLE TYPES

Suppose that in the standard worker there is one normal agent, which i shall refer to as the social agent, and one agent that does not value social interaction at all. I shall refer to the former agent as the non-social agent[15]. The profit and utility functions are then given by the following equations.

Principal's profit:

$$\pi = Q(e_i, e_j) - w_i - w_j$$

Agents utility:

Social type: $U_i = w_i + G(a_j) + F(a_j, U_j) - C(e_i, a_i) \geq \bar{U}$

Non-social type: $U_j = w_j - C(e_j, a_j) \geq \bar{U}$

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[15] *This type of agent is like the standard agent in principal agent models, he only cares about his wage and his costs.*

First-best levels of effort and attention:

Effort:

$$Q_e(\cdot) = C_e(\cdot)$$

Attention:

As attention given to the non-social agent does not benefit him, the best thing the social agent can do is not to give any attention at all. Attention given to the social agent does benefit him in the normal way, hence the optimal level of attention given by the non-social agent is given by:

$$G_{aj}(\cdot) + F_{ujaj}(\cdot) = C_{aj}(\cdot)$$

Lets now move on to the case of incomplete contracts, where the principal designs the wage contract with the usual components. Note that in this situation it will be desirable to create two different wage contracts. Looking at the choice of effort for both types of agents below shows that there is a difference, this makes it profitable for the principal two give different individual incentives to each type.

Effort:

$$\frac{dU_i^s}{de_i} = w_{ei}^i + w_{ei}^j * F_{uj}(\cdot) - C_{ei}(\cdot) = 0$$

$$\frac{dU_j^{ns}}{de_j} = w_{ej}^j - C_{ej}(\cdot) = 0$$

Attention

As stated in the complete contracts case attention given to the non-social agent will not benefit him at all. The social agent will also realize this when deciding on his attention level. This means that giving effort only imposes a cost on the social agent, thus the best thing he can do is not to give any attention. For the non-social agent there is some benefit in giving attention, although he does not become altruistic and will not benefit through the increase in his colleague's utility, he will benefit from giving attention by affecting his colleague's choice of effort in the next stage. The non-social agent's choice of attention depends on:

$$\frac{dU_j}{da_j} = -C_{ai}(\cdot) + \frac{F_{ujaj}(\cdot)w_{ei}^j(\cdot)}{C_{eiei(\cdot)}}w_{ei}^j(\cdot) = 0$$

This leads to the counterintuitive situation where a non-social agent engages in social interaction and the social agent refrains from doing so. The reason for this lies in the way that attention works, it only directly benefits the receiving agent.

The question that remains is how the principal solves his maximization problem. I will start by looking at the individual incentives. Both types of agents choose their effort levels in a different way, the social agent benefits from both the increase in his own utility and the effect he has on his colleague, while the non-social agent only benefits from his own individual incentives.

As usual the optimal individual incentives for a social agent will be giving by:

$$w_{ei}^i(\cdot) = Q_e(\cdot) - w_{ei}^j(\cdot) * F_{uj}(\cdot)$$

For a non-social agent the marginal benefit of exerting effort is lower, due to the fact that he does not benefit through altruism. Optimal individual incentives for him are given by:

$$w_{ej}^j(\cdot) = Q_e(\cdot)$$

Knowing that the social agent will not give any attention, the best thing the principal can do is to set his team or relative incentives equal to zero. Increasing them will not change anything in the agents' behavior and does impose a cost on the principal.

The team or relative incentives for the non-social agent do affect his attention choice and the level of effort the social agent will exert. As before the principal equates the desired attention level from the non-social agent to the optimal level:

$$\frac{F_{ujaj}(\cdot)w_{ei}^j(\cdot)}{C_{eiei}(\cdot)}w_{ei}^j(\cdot) = G_{aj}(\cdot) + F_{aj}(\cdot)$$

Solving for w_{ei}^j leads to:

$$w_{ei}^j = \mp\sqrt{\frac{[G_{aj}(\cdot) + F_{aj}(\cdot)]C_{eiei}(\cdot)}{F_{ujaj}(\cdot)}}$$

5.3 UNCERTAINTY ABOUT THE TYPES

In reality it might be hard to figure out the type of a worker. The employer could try to do so during the job interviews, however this is a costly signal for the worker and thus not reliable. In this section I will look at the effect of making the types unobservable for the other players. Note that this could also affect whether or not the participation constraints is satisfied, however for now I will assume that the agents accept the wage contract.

Nature will randomly choose the type of both players with equal probability and the players will receive a private signal about their type that is perfectly accurate. The agents can then base their choices on what they know about themselves, which brings uncertainty about the other player's behavior. Similarly the principal will be uncertain of the types of both players, which makes it even harder for him to design a wage contract.

In the effort stage the agents know their own type, hence their choice of attention is relatively straightforward. The social agent knows that he benefits from giving attention through both his individual incentives and his altruism, while the non-social agent knows that he only benefits from giving attention by his individual incentives. This leads to the two effort choices:

$$\frac{dU_{ei}^s}{de_i} = w_{ei}^i + w_{ei}^j * F_{uj}(\cdot) - C_{ei}(\cdot) = 0$$

$$\frac{dU_{ei}^{ns}}{de_j} = w_{ej}^j - C_{ej}(\cdot) = 0$$

In the attention stage the uncertainty for the agents starts to play a role. Whether or not giving attention to the other agent will benefit them depends on whether the other agent is of the social type, and whether the agent himself is social or non-social. A social agent will benefit from giving attention through his own altruism and the change in the choice of effort of his colleague. A non social agent will only benefit from giving attention if his colleague is social and changes his effort level in the next stage. The agents will take into account that there is a probability of ½ that they face a social or a non-social colleague. This leads to the following choice of attention for the social agent:

$$\frac{dU_i^s}{da_i} = \frac{1}{2}\left[-C_{ai}(\cdot) + F_{uj}(\cdot)[G_{ai}(\cdot) + F_{ai}(\cdot)] + \frac{F_{ui}(\cdot)w_{ej}^i(\cdot)}{C_{ejej}(\cdot)}w_{ej}^i(\cdot)\right] + \frac{1}{2}[-C_{ai}(\cdot)] = 0$$

$$\frac{dU_i^s}{da_i} = -2C_{ai}(\cdot) + F_{uj}(\cdot)[G_{ai}(\cdot) + F_{ai}(\cdot)] + \frac{F_{ui}(\cdot)w_{ej}^i(\cdot)}{C_{ejej}(\cdot)}w_{ej}^i(\cdot) = 0$$

Which describes a similar situation as in the original model, except for the fact that the relative cost of attention becomes higher. This is due to the fact that in ½ of the cases the agent will give attention, while the other agent is non-social. He will then just face the costs, without benefiting from giving attention at all. In a similar way the choice of attention for the non-social agent is:

$$\frac{dU_j^{ns}}{da_j} = \frac{1}{2}\left[-C_{ai}(\cdot) + \frac{F_{ujaj}(\cdot)w_{ei}^j(\cdot)}{C_{eiei}(\cdot)}w_{ei}^j(\cdot)\right] + \frac{1}{2}[-C_{ai}(\cdot)] = 0$$

$$\frac{dU_j^{ns}}{da_j} = -2C_{ai}(\cdot) + \frac{F_{ujaj}(\cdot)w_{ei}^j(\cdot)}{C_{eiei}(\cdot)}w_{ei}^j(\cdot) = 0$$

The non-social agent also has a chance of ½ that he faces a social agent, in that case he will benefit from giving attention through the change in effort of his colleague. If he meets a non-social colleague, giving attention does not benefit him either. This leads to the more intuitive situation where a non-social agent will be willing to give less attention than a social agent.

The question that remains is how the principal is affected by the uncertainty about the agents' types. When designing the wage contract he has to realize that he will no longer be able to reach first-best profits. The uncertainty makes it impossible for the principal to induce the agents to exert the right level of effort and attention in all states of the world. This means that he will choose effort and attention levels that are between the level of a social agent and a non-social agent. More precisely: as the chance of an agent being social goes from zero to one, the wage scheme the principal sets approaches the optimal scheme for a social agent. For the situation where the chance of an agent being social or non-social is equal, the principal finds it profitable to find a solution between the optimum for both types. This means that in any state of the world he does not induce the agent to set the right levels of effort and attention, but the level that maximizes his overall expected profit. The principal is then no longer able to reach the optimal profit level and may search for ways to solve this problem.

5.6 SCREENING BY THE EMPLOYER

In the previous section I assumed that the agents accept the wage contract, which means that the participation constraints have been satisfied. This leads to a situation where the principal is no longer able to obtain first-best profits, uncertainty about the agents' types reduced his profits. From the point of view from the principal this is harmful and he would obviously like to solve this problem. This leads to the question whether he will be able to screen the workers and return to the more desirable state. Noting that the social worker is able to generate more surplus compared to the non-social worker, it is evident that it is in the principal's interest to attract only the social workers[16]. To do so he must make sure that a non-social worker is no longer willing to accept the wage contract. When designing the wage contracts the principal knows the different participation constraints of the two types:

$$U_i^s = w_i + G(a_j) + F(a_j, U_j) - C(e_i, a_i) \geq \overline{U}$$
$$U_j^{ns} = w_j - C(e_j, a_j) \geq \overline{U}$$

Although the attention choice of the agents will be affected by uncertainty, they will always choose some level of positive attention[17]. This benefits the social agent more than the non-social agent, which allows the principal to violate the non-social agent's participation constraint[18]. By setting incentives the way he did in the basic model the principal can make sure that the social agents are just willing to accept the wage contract. He does this by setting the base salary in such a way that the social agent's participation constraint is just satisfied. In this situation the non-social agent will no longer be willing to accept the wage contract, because his benefit from social interaction is lower. For the social agent this alters his belief about his colleagues, he now knows that his colleagues are also of the social type and will be willing to return to his basic strategies.

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[16] *A requirement for this is that the outside option for both types of agent is the same.*
[17] *Unless the principal does not give any team or relative incentives, but in the attempt to screen he will do so.*
[18] *Note that there has to be a sufficient supply of workers, so that there is another (social) agent that does take the job.*

5.7 CONCLUSIONS

In this chapter I looked at the effect of different preferences of the workers. Because not every worker might value socialization in the same way, I allowed for a non-social agent in the model. The introduction of a non-social agent has altered the behavior of the players and allowed for more strategic interaction.

As long as types are observable, the counterintuitive situation occurs where the social agent no longer engages in social activities and the non-social agent does. In that situation the principal finds it profitable to design two different wage contracts with different incentives for each type.

When types are no longer observable there is uncertainty about what the other players will do, which has complicated the strategies. The effort stage is relatively similar to before, however in the attention stage the agents take into account that their colleague could be of the non-social type. This means that they could give attention, while this was not beneficial and did incur a cost. This leads to reluctance in the provision of attention and lower equilibrium levels of attention compared to chapter 3. Generally the loss in surplus will come at the expense of the principal, since he is able to make sure that the participation constraints are just satisfied using the base salary. To overcome this problem he will want to screen his workers, he prefers to have workers of the social type as they will require a lower base salary and are thus more profitable. The principal is able to screen his workers by violating the participation constraint of the non-social type. By doing so he makes sure he only attracts social workers and also removes the uncertainty for the workers.

6. Conclusion and discussion

In this thesis I attempted to answer several questions concerning social interaction in the workplace. I did this by making several extensions to the model in (Dur and Sol 2010), which consists of a principal an two agents that engage in both productive and social activities. After socializing the agents become altruistic and alter their behavior in the effort stage.

Before proceeding to the results and discussion I would like to emphasize that social interaction is a highly complex phenomenon and that the results from the models rely heavily on the assumptions, for that reason it can be hard to apply them to practical situations.

Changing the original model from individual observable performance to team performance made it unlikely that the principal is able to achieve first-best profits. When he has to use team incentives to promote both effort and attention it is likely that there will be an under-provision of effort and an over-provision of attention. In order to solve this problem the principal could look for other ways to influence his workers. One way could be to attempt to alter the cost of attention for the agent, in the event of over-socialization he could try to discourage the agents from socializing by increasing their cost of attention. However if he changes their cost function in a structural way, for instance by making long term investments, this also affects the optimal level of attention desired by the principal.

In Chapter 4 I allowed for cross-terms in the agents' cost functions. In the first place this means that effort and attention became substitutes for the agents, referring to a situation where the face some constraint that prevents them from increasing both levels. This turned out to not qualitatively affect the agents' effort and attention choices, but only lowered the equilibrium levels through the negative cross term. It is interesting to note that the principal does not need to be concerned about the relationship between the cost of effort and the cost of attention for the agent, he can still design his wage contract in the standard way.

The other cross term relationship I investigated was the effect where attention received also lowers the agent's cost of effort. Hence there is a relationship between attention given by one agent and the cost of effort of the other agent. In this situation the agents realize that giving attention affects their colleague's choice of effort in a greater way than before. They take this into account and achieve higher equilibrium levels of attention.

Finally I looked at the effect of different preferences, not every worker values social activities to the same extent and some might not value it at all. This, and especially uncertainty with regard to players' type, turned out to change the results significantly and allowed for more strategic behavior. In the case of uncertainty about players' type the principal finds it profitable to screen his workers. This way he can not only ensure that he is able to induce the right levels of attention, but also removes the uncertainty for his workers. He can screen his workers by violating the participation constraint for the non-social worker. Practically this means that an employer has to be aware of the type of wage contract that he is offering, especially as paying too much might attract a type of worker that is not desirable.

Both theoretically and empirically there is still much to be investigated on the topic of social interaction in the workplace. Although describing social behavior in models might seem unrealistic, it can sometimes lead to interesting results. It would be interesting to see an empirical verification of some of the theoretical results, not just in this thesis but also in other contributions such as (Dur and Sol 2010),(Rotemberg 1994) (Itoh 1991) and (Arjan Non 2010).

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