Effective Communication or High Effort Levels: The Trade-Off Examined in The Context of a Two-Divisional Firm

MSc Thesis (Economics & Business)

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1 Introduction

Within various kinds of organisations, (middle) managers have the potential to learn from each other which intuitively should improve the performance of the organisation as a whole. However, in order to learn within an organisation, willingness to share private information is indispensable. In this paper, I introduce three different systems of payment- and cooperation structures in the context of a multidivisional firm (or any other organisation) in order to investigate the behaviour of the middle management of that firm. Particularly, I am interested in the question whether different payment- and cooperation structures have an effect on the effectiveness of communication and thus on the aforementioned learning process of the management within the firm. Next to this, I will verify whether the different systems might result in free rider issues and ultimately whether a trade-off exists between effective communication and adequate learning processes on the one hand, and the rise of free rider issues on the other hand.

I obtain the following main results. In the first setting, which is a completely decentralised setting in which the payment of the middle management is based on own performance only, there are no free-rider issues, but managers do not utilise their learning potential at all. In the second setting in which the firm is decentralised in the first period, but centralised in the second period and payment is based on a split of total profits over the two periods between the two managers, free rider issues are huge, but managers have an incentive to effectively communicate and learn from each other. In the third setting in which the firm is decentralised in the first period, but centralised in the second period and payment is based on output managers communicate themselves, managers will only communicate effectively under a certain condition. Next to this, managers still encounter free rider problems but those are less severe than in the second setting, if managers are in an equilibrium where they are honest to one and other. A trade-off between effective communication, learning and effort levels within an organisation therefore indeed exists.

My work is closely related to Swank and Visser (2015), who consider learning processes within an organisation (or other collaboration structure) by investigating how the determination of decision rights and information on which perceptions of competence are based, jointly affect the establishment of effective communication within an organisation. Next to this, Swank and Visser (2015) also explore the effect of this on the quality of decisions (if there is effective communication) and on the overall welfare of the organisation. They make a distinction between organisations operating in local markets and firms operating in global markets. Through analysing the model, Swank and Visser (2015) find that with decentralised decision making, there is effective communication within

the framework of a local markets, but there is no exchange of information whatsoever in the framework of global markets. Because of this, the authors conclude that performance is basically higher within the framework of local markets. Nevertheless, reputational concerns, if severe enough, can reverse this outcome. Moreover, the authors find that under centralised decision making, exchange of information does not work as well, because agents are inclined to supply distorted information. The authors conclude that the quality of communication is intermediate as compared to exchange of information under local and global markets with decentralised decision making.
Moreover, my work is comparable to the paper of Alonso, Dessein and Matouscheck (2008) who have investigated centralised- and decentralised cooperation structures in order to identify which system benefits the performance of a firm mostly. In their framework, the performance of each division increases in taking into account own and privately observed market circumstances in their decision making. Next to this, the performance of each division also increases in sharing and aligning decision making with other divisions. They show that a decentralised system can be dominant in terms of performance relative to a centralised system, even if alignment of decision making between divisions is essential. Where Alonso, Dessein and Matouscheck (2008) study adaptation and coordination of decision making, I establish the effects of payment- and centralised or decentralised structures on the quality of communication/learning processes within a firm on the one hand and free rider issues on the other hand.
Furthermore, my work is related to Li, Rantakari and Yang (2016), who investigate two managers, each manager being responsible for a certain project. Both managers have to report the performance of their project to the principal, who determines which project is implemented. Managers care about the value of the project, but are also biased towards their own project. After analysing the model, they find that if the interest of the managers are partially aligned with the interest of the principal, there is some information transmission. Furthermore, a key result of this study is that reducing the bias towards managers' own project will improve the quality of communication of both managers. Correspondingly, authors conclude that the manager that is least biased towards his own project should have veto power to determine the final choice of the project. Where Li, Rantakari and Yang (2016) investigate communication towards a centre (the principal), I investigate mutual communication between managers without intervention of a (higher) manager or principal who pursues his own interest.

Lastly, the work of Crawford and Sobel (1982) is worth mentioning. They have established that cheap talk between a better-informed sender and an uninformed receiver can be informative. The quality of communication depends on the extent to which sender and receiver share the same concerns.

The remainder of this paper is structured as follows. First, I introduce the three relevant models. Thereafter, in the subsequent chapters a game theoretical analysis of the three models follows. Lastly, I will elaborate on the main results and limitations of this study.

2 The Models

In this section, I introduce three two-period models in order to investigate the effects of different payment- and cooperation structures within a decentralised firm (or any other organisation) on the behaviour of the middle management of that firm (or organisation).

First, I introduce a model in which the firm is purely decentralised in the sense that the managers do not work together whatsoever in both periods and that payment of the managers is solely based on own performance. Thereafter, I introduce a model in which the firm is decentralised in the first period, but centralised in the second period and payment is based on a split of total profits over the two periods between the two managers. Lastly, I consider a model with the same cooperation structure as the second model, but payment is based on performance that managers communicate themselves.

All models contain two time periods. The relative importance (or length) of the first period is denoted by σ and the relative importance of the second period is denoted by $1 - \sigma$ with $0 \leq \sigma \leq 1$. Put differently, $1 - \sigma$ measures the relative importance of learning within the organisation.

2.1 Model 1: No Cooperation; Payment Based On Own Performance Only (Pure Decentralisation)

Consider a decentralised firm consisting of two divisions $I \in \{\text{A,B}\}$. Manager I runs division I of the firm. The performance of division I in the first period is denoted by v_I that takes value h if the performance is high and value l if the performance is low, where $0 < l < h$. The probability of high performance is denoted by $\text{P}(v_i = h) = i$, where $0 \leq i \leq 1$ denotes the effort manager I chooses (i.e. $i = a$ is the effort of manager A and $i = b$ is the effort of manager B). It follows that the probability of high performance of division I increases in the effort of manager I. It should be noted that it must hold by definition that P(v_i = l)= 1 − P(v_i = h) = 1 − i. Since the managers do not work together, the performance of division I in the second period is exactly the same as in the first period.

Moreover, $\frac{i^2}{2\lambda}$ denotes the cost of effort function, which shows that each manager is effort averse. λ can be considered a parameter that measures the manager's intrinsic motivation.

In this model, managers receive a wage that equals their performance in both periods, resulting in the following wage function:

$$w_I = \sigma v_i + (1 - \sigma)v_i = v_i \tag{1}$$

which gives the following pay-off function of an individual manager:

$$v_i - \frac{i^2}{2\lambda} \tag{2}$$

2.2 Model 2: Cooperation in The Second Period; Payment Based On Split of Total Profits

Consider a decentralised firm consisting of two divisions $I \in$ {A,B}. Manager I runs division I of the firm. In the first period, the firm is decentralised and the performance of the managers is defined in the same way as in model 1.

After the first period, the managers update each other regarding the performance of their respective divisions in the past period. Then in the second period, the managers join forces by shifting resources (e.g. labour, capital) from the division that has performed worst in the first period to the best performing division in the first period, which results in output $v_X = 2\max\{v_A, v_B\}$ in the second period, which means that in this second period, the firm as a whole specialises in the (actually) best performing division completely.

The total profits made by the two division over the two periods can be denoted by:

$$\Pi = \sigma(v_A + v_B) + (1 - \sigma)v_X \tag{3}$$

Managers receive a wage that equals a split of total profits over the two periods between the two managers:

$$w_I = \frac{1}{2}\Pi = \frac{1}{2}(\sigma(v_A + v_B) + (1 - \sigma)v_X) \tag{4}$$

which gives – since the cost of effort function is defined in the same way as in the previous model – the following pay-off function of an individual manager:

$$\frac{1}{2}(\sigma(v_A + v_B) + (1 - \sigma)v_X) - \frac{i^2}{2\lambda} \tag{5}$$

2.3 Model 3: Cooperation in The Second Period; Payment Based On Communicated Performance

Consider a decentralised firm consisting of two divisions $I \in \{\text{A,B}\}$. Manager I runs division I of the firm. In the first period, the firm is decentralised and the performance of the managers in the first period is defined in the same way as the previous models.

After the first period, the managers update each other regarding the performance of their respective divisions in the past period, yielding the following value of v_X in the second period:

$$v_X = \begin{cases} v_A, & \text{if } \bar{v_A} > \bar{v_B} \\ v_B, & \text{if } \bar{v_A} < \bar{v_B} \\ \frac{1}{2}v_A + \frac{1}{2}v_B, & \text{if } \bar{v_A} = \bar{v_B} \end{cases} \tag{6}$$

In the above functions, $\bar{v_I}$ and v_I denotes the respective communicated and actual output in the first period of manager I.

The distinction between actual- and communicated performance is necessary, because in this framework, managers get paid based on the output they communicate, which might give them an incentive to overdraw their performance. However, managers have to pay jointly for potential overstatements in the second period. The wage function looks like this:

$$w_I = \sigma\bar{v_I} + \frac{1}{2}(1 - \sigma)(v_X - (\bar{v_I} - v_I) - (\bar{v_J} - v_J)) \tag{7}$$

which gives the following pay-off function of an individual manager:

$$\sigma\bar{v_I} + \frac{1}{2}(1 - \sigma)(v_X - (\bar{v_I} - v_I) - (\bar{v_J} - v_J)) - \frac{i^2}{2\lambda} \tag{8}$$

3 Analysis of Model 1

In model 1, the managers do not work together whatsoever and the payment of the managers is solely based on own performance. The pay-off function of manager B looks like this:

$$v_B - \frac{b^2}{2\lambda} \tag{9}$$

Formally, this can be considered a game with only one player in which manager B chooses b^* as to maximise his expected pay-off.

Plugging in for $v_B = bh + (1 - b)l$ and maximising the pay-off function with respect to b gives the following first order condition:

$$h - l - \frac{b^*}{\lambda} = 0 \tag{10}$$

Solving for b yields:

$$b^* = \lambda(h - l)^1 \tag{11}$$

One can see immediately that the optimal effort level of manager B increases in λ. This in an intuitive result, because if the manager's intrinsic motivation increases, the manager's cost of effort function decreases, which results in the manager choosing a higher effort level. Moreover the optimal effort level of manager B increases in (h - l) as well. This too is an intuitive result, because if difference between the value of high performance and low performance is getting larger, manager B is more motivated to get high performance, resulting in choosing a higher effort level. Moreover, there are no freeride issues here, because if manager B would have maximised the sum of pay-offs of manager A and manager B, the effort level remains the same. On the contrary, it should be noted that within this framework, managers do not learn from each other at all, since there operations are completely separated from each other and there is no communication whatsoever.

4 Analysis of Model 2

In this case, it is in the interest of the managers to honestly reveal to each other the performance of their division, because a more efficient resource reallocation in the second period benefits them

[1] Note that the model is solved the same way for the optimal effort of manager A, which yields the same results.

directly through their wage, since their wage equals half of the profits. Manager B's pay-off equals:

$$w_B - \frac{b^2}{2\lambda} \tag{12}$$

$$\frac{1}{2}(\sigma(v_A + v_B) + (1 - \sigma)v_X) - \frac{b^2}{2\lambda} \tag{13}$$

I calculate the Nash equilibrium of this game using backward induction. Strategies of the managers are optimal responses to each other. First, I derive the best-response functions of the managers.

Because the manager's honestly reveals the performance of their division, it must hold true that:

$$\begin{aligned} v_X = \Pr(v_A = h|v_B = h)2h + \Pr(v_A = h|v_B = l)2h + \\ \Pr(v_A = l|v_B = h)2h + \Pr(v_A = l|v_B = l)2l \end{aligned} \tag{14}$$

This results into:

$$v_X = (1 - (1 - a)(1 - b))2h + (1 - a)(1 - b)2l \tag{15}$$

Plugging in $v_A = ah + (1 - a)l$, $v_B = bh + (1 - b)l$ and the expression for v_X into manager's B pay-off function and maximising this pay-off function with respect to b gives the following first-order condition:

$$\frac{1}{2}\sigma(h - l) - \frac{b}{\lambda} + (h - l)(1 - a)(1 - \sigma) = 0 \tag{16}$$

Solving for b yields the following best-response function:

$$b^* = \lambda(h - l)(\frac{1}{2}\sigma + (1 - a)(1 - \sigma)) \tag{17}$$

Because of symmetry, it must hold that:

$$a^* = \lambda(h - l)(\frac{1}{2}\sigma + (1 - b)(1 - \sigma)) \tag{18}$$

It should be noted that manager B does not take into account the positive effects his effort has on the pay-off of manager A; managers choose their effort levels as to maximise their own pay-off instead of total pay-offs. This results in managers choosing a lower effort level, which means that they have an incentive to free ride on the effort of their colleague. See appendix 1 for the proof of the aforementioned.

When a^* and b^* are best responses, given these values of a^* and b^*, there is a Nash equilibrium. Therefore, substituting the optimal expression for a into the optimal expression for b and subsequently solving for b yields the Nash equilibrium:

$$b^* = \frac{\lambda(1 - \frac{1}{2}\sigma)(h - l)}{\lambda(1 - \sigma)(h - l) + 1} \tag{19}$$

This clear expression for the optimal effort level enables us to analyse the impact of the different parameters in the model on the manager's (optimal) effort level.

Differentiating optimal effort with respect to the value difference between h and l yields:

$$\frac{\partial\left(\frac{\lambda(1 - \frac{1}{2}\sigma)(h - l)}{\lambda(1 - \sigma)(h - l) + 1}\right)}{\partial(h - l)} = \frac{\lambda(1 - \frac{1}{2}\sigma)}{(\lambda(1 - \sigma)(h - l) + 1)^2} > 0 \tag{20}$$

This means that the optimal effort level increases in $h-l$. This is an intuitive result, because if this difference gets larger, the manager is relatively more rewarded for high performance and relatively more punished for low performance through their profit-based wage remittances, which results in the manager choosing a higher effort level.

Differentiating optimal effort level with respect to λ yields:

$$\frac{\partial\left(\frac{\lambda(1 - \frac{1}{2}\sigma)(h - l)}{\lambda(1 - \sigma)(h - l) + 1}\right)}{\partial\lambda} = \frac{(1 - \frac{1}{2}\sigma)(h - l)}{(\lambda(1 - \sigma)(h - l) + 1)^2} > 0 \tag{21}$$

This means that the optimal effort level increases in λ. This in an intuitive result, because if the manager's intrinsic motivation increases, the manager's cost of effort function decreases, which results in the manager choosing a higher effort level.

Differentiating optimal effort level with respect to σ yields:

$$\frac{\partial\left(\frac{\lambda(1 - \frac{1}{2}\sigma)(h - l)}{\lambda(1 - \sigma)(h - l) + 1}\right)}{\partial\sigma} = \frac{\frac{1}{2}(h - l)(\lambda(h - l) - 1)}{(\lambda(1 - \sigma)(h - l) + 1)^2} \tag{22}$$

The optimal effort level is increasing in σ if and only if $\lambda(h - l) > 1$. This means that if the first period becomes longer (more important), the effort of the manager increases if his intrinsic- (λ) and/or extrinsic ($h-l$) motivation is large enough. This is an intuitive results, since a longer (more important) first period means that the first period is more essential for the eventual pay-off of the managers. Motivated managers therefore choose a higher effort level, striving to increase the pay-off in period 1 directly. On the contrary, unmotivated managers choose a lower effort level, because they have an incentive to free ride on the effort of their colleague in the first period.

Within this framework, managers will effectively communicate and therefore fully utilise their learning potential, which benefits the performance of the firm as a whole. On the other hand, it follows that managers have an incentive to free ride on one another's effort.

5 Analysis of Model 3

Manager B's pay-off equals:

$$\sigma \bar{v_B} + \frac{1}{2}(1 - \sigma)(v_X - (\bar{v_B} - v_B) - (\bar{v_A} - v_A)) - \frac{b^2}{2\lambda} \tag{23}$$

In the following, I derive two equilibrium conditions for this Bayesian game with incomplete information. In the first equilibrium, managers choose $\bar{v_A} = \bar{v_B} = h$. In the second equilibrium, managers honestly reveal to each other their actual performance. As a conjecture, I expect the equilibrium to depend on the value of the parameter σ. If $\sigma > \bar{\sigma}$, managers always choose $\bar{v_A} = \bar{v_B} = h$. If $\sigma < \underline{\sigma}$, managers honestly reveal their actual performance.

5.1 Deriving Effort Levels in (Potential) Nash Equilibrium Where Both Managers Report High Performance

Using the same equilibrium concept as in model 2, plugging in $v_X = \frac{1}{2}(ah + (1 - a)l) + \frac{1}{2}(bh + (1 - b)l)$, $v_A = ah + (1 - a)l$, $v_B = bh + (1 - b)l$ and $\bar{v_A} = \bar{v_B} = h$ into the pay-off function of manager B and maximising the pay-off function with respect to b gives the following first order condition:

$$-\frac{(4b - 3h\lambda + 3l\lambda + 3h\sigma\lambda - 3l\sigma\lambda)}{4\lambda} = 0 \tag{24}$$

Solving for b yields:

$$b^* = \frac{3}{4}\lambda(1 - \sigma)(h - l) \tag{25}$$

Because of symmetry, it must hold that:

$$a^* = \frac{3}{4}\lambda(1 - \sigma)(h - l) \tag{26}$$

Similar to model 2, managers maximise their private pay-off instead of the total pay-off of the organisation, resulting in a free rider problem. See appendix 2 for the proof of the aforementioned.

5.2 Deriving Condition for The Nash Equilibrium in Which Both Managers Report High Performance

Note that the effort levels are equilibrium sunk. After choosing his effort level, manager B sees his actual performance and after that he sends a message to the other manager. He can choose between $\bar{v_B} = l$ and $\bar{v_B} = h$. If manager B has output $v_B = h$, there is never an incentive to deviate from this equilibrium; he always reports $\bar{v_B} = h$.

More interesting is the question whether there is an incentive to deviate from equilibrium and report $\bar{v_B} = l$, if manager B has output $v_B = l$. I derive the equilibrium condition in the following. In equilibrium, where $\bar{v_B} = h$ (given $v_B = l$), manager B's pay-off equals:

$$\sigma h + \frac{1}{2}(1 - \sigma)(\frac{1}{2}l + \frac{1}{2}(a^* h + (1 - a^*)l) - (h - l) - (h - a^* h - (1 - a^*)l)) - \frac{b^{*2}}{2\lambda} \quad (27)$$

In the situation of deviation from equilibrium, where $\bar{v_B} = l$ (given $v_B = l$, manager B's pay-off equals:

$$\sigma l + \frac{1}{2}(1 - \sigma)(a^* h + (1 - a^*)l - (h - a^* h - (1 - a^*)l)) - \frac{b^{*2}}{2\lambda} \quad (28)$$

There is a Nash equilibrium in which both managers report high performance, if and only if:

$$\sigma h + \frac{1}{2}(1-\sigma)(\frac{1}{2}l + \frac{1}{2}(a^* h + (1-a^*)l) - (h-l) - (h - a^* h - (1-a^*)l)) - \frac{b^{*2}}{2\lambda} > \sigma l + \frac{1}{2}(1-\sigma)(a^* h + (1-a^*)l - (h - a^* h - (1-a^*)l)) - \frac{b^{*2}}{2\lambda} \quad (29)$$

Note that the advantage of staying in equilibrium is getting h in the first period. The disadvantage of staying in equilibrium is a higher change of getting $v_X = l$ and having the term $-(h-l)$ in the second period. The advantage of deviating from equilibrium is a lower change of getting $v_X = l$ and not having the term $-(h-l)$ in the second period. The disadvantage of deviating from equilibrium is getting l in the first period. The equilibrium condition therefore depends on the level of σ.

Solving for yields:

$$\sigma > \frac{a^* + 2}{a^* + 6} \quad (30)$$

It is evident that the threshold value of σ is a positive function of a^*. Manager B knows that $a^* = \frac{3}{4}\lambda(1-\sigma)(h-l)$, so it is possible to conduct comparative statics to analyse the impact of λ and $(h-l)$ on the threshold value of σ.

Since the effect of λ on a^* is positive, and the effect of a^* on the threshold value of σ is positive as well, an increase in λ increases the threshold value of σ, which means that managers are less inclined to report high performance given that they have low performance. Note that this effect is somewhat mitigated by the fact that a^* negatively depends on σ. The same reasoning holds for the parameter $h-l$.

5.3 Deriving Effort Levels in (Potential) Nash Equilibrium Where Both Managers Honestly Reveal Their Actual Performance

Recall the pay-off function of manager B:

$$\sigma \bar{v_B} + \frac{1}{2}(1-\sigma)(v_X - (\bar{v_B} - v_B) - (\bar{v_A} - v_A)) - \frac{b^2}{2\lambda} \tag{31}$$

Using the same equilibrium concept as in model 2, plugging in $v_X = (1-(1-a)(1-b))h + (1-a)(1-b)l$, $v_A = \bar{v_A} = ah + (1-a)l$ and $v_B = \bar{v_B} = bh + (1-b)l$ into the pay-off function of manager B and maximising the pay-off function with respect to b gives the following first order condition:

$$\sigma(h - l) + (\frac{1}{2}\sigma - \frac{1}{2})(h - l)(a - 1) - \frac{b}{\lambda} = 0 \tag{32}$$

Solving for b yields:

$$b^* = \frac{1}{2}\lambda(h - l)(\sigma - a + \sigma a + 1) \tag{33}$$

Because of symmetry, it must hold that:

$$a^* = \frac{1}{2}\lambda(h - l)(\sigma - b + \sigma b + 1) \tag{34}$$

Just like in model 2, managers maximise their private pay-off function instead of the total pay-off of the organisation, resulting in a free rider problem. See appendix 3 for the proof of the aforementioned.

Substituting the optimal expression for a into the optimal expression for b and subsequently solving for b yields:

$$b^* = \frac{\lambda(h - l)(\sigma + 1)}{(h - l)(1 - \sigma) + 2} \tag{35}$$

5.4 Deriving the Nash Equilibrium in Which Both Managers Honestly Report Their Actual Performance

Note that the effort levels are equilibrium sunk. After choosing his effort level, manager B sees his actual performance and after that he sends a message to the other manager. He can choose between $\bar{v_B} = l$ and $\bar{v_B} = h$.

If manager B has output $v_B = h$, there is never an incentive to deviate from this equilibrium; he always honestly reports $\bar{v_B} = h$.

More interesting is the question whether there is an incentive to deviate from equilibrium and report $\bar{v_B} = h$, if manager B's actual output is $v_B = l$. I derive the equilibrium condition in the following.

In equilibrium, where $\bar{v_B} = l$ (given $v_B = l$), manager B's pay-off equals:

$$\sigma l + \frac{1}{2}(1 - \sigma)(a^* h + (1 - a^*)l) - \frac{b^{*2}}{2\lambda} \tag{36}$$

In the situation of deviation from equilibrium, where $\bar{v_B} = h$ (given $v_B = l$), manager B's pay-off equals:

$$\sigma h + \frac{1}{2}(1 - \sigma)(a^*(\frac{1}{2}h + \frac{1}{2}l) + (1 - a^*)l - (h - l)) - \frac{b^{*2}}{2\lambda} \tag{37}$$

There is a Nash equilibrium in which both Manger honestly reveal their actual performance if and only if:

$$\sigma l + \frac{1}{2}(1-\sigma)(a^*h + (1-a^*)l) - \frac{b^{*2}}{2\lambda} > \sigma h + \frac{1}{2}(1-\sigma)(a^*(\frac{1}{2}h + \frac{1}{2}l) + (1-a^*)l - (h-l)) - \frac{b^{*2}}{2\lambda} \tag{38}$$

Note that the advantage of staying in equilibrium is a lower change of getting $v_X = l$ and not having the term $-(h-l)$ in the second period. The disadvantage of staying in equilibrium is getting l in the first period. The advantage of deviating from equilibrium is getting h in the first period. The disadvantage of deviating from equilibrium is a higher change of getting $v_X = l$ and having the term $-(h-l)$ in the second period. The equilibrium condition therefore depends on the level of σ.

Solving for σ yields:

$$\sigma < \frac{a^* + 2}{a^* + 6} \tag{39}$$

Just like in paragraph 5.2, the threshold value of σ is a positive function of a^* here as well. Manager B knows that $a^* = \frac{\lambda(h - l)(\sigma + 1)}{(h - l)(1 - \sigma) + 2}$, so one can conduct comparative statics to analyse the impact of λ and $(h-l)$ on the threshold value of σ again.

Since the effect of λ on a^* is positive, and the effect of a^* on the threshold value of σ is positive as well, an increase in λ increases the threshold value of σ, which means that managers are more inclined to honestly reveal their actual performance. Note that this effect is reinforced by the fact that a^* positively depends on σ as well. The same reasoning applies to $h-l$.

Therefore, within this framework, managers will communicate and learn from each other effectively if the second period is long enough (i.e. $1-\sigma$ is large enough). As the first period gets larger, managers will be more inclined to disregard each other's messages, which means that an adequate learning process will not occur. Next to this, there are still free rider issues here, although less severe than in the second model (given effective communication).

6 Discussion

Having analysed the three different payment- and cooperation structures, I now compare them. Particularly, I will focus on the question whether the systems facilitate effective communication and learning and next to that, I will elaborate on the potential rise of free rider issues.

The first model, in which the organisation is decentralised completely and payment is based on own performance of the managers, there are no free rider issues, which can be considered an advantage. This is quite straight forward, since there are no possibilities to free ride, because each manager works for himself. However, this setting excludes every possibility for the managers to learn from each other; every managers works for himself and there is no effective communication at all. All information remains private, which does not benefit the organisation as a whole.

In the second model, where the organisation is decentralised in the first period and centralised in the second period and payment of the managers is based on the total profit of the organisation, there is a large free rider problem. On the one hand, profit is equally split between the managers, regardless of their performance, which gives an incentive to not exert too much effort. On the other hand, in the second period the firm as a whole will specialise in the (actual) best-performing division, which also means that managers will be conservative in choosing high effort levels, as they expect that they will be able to free ride on the effort of their peer. Nevertheless, this system has the enormous advantage of creating an atmosphere of effective communication and an adequate learning process. Namely, it is in the interest of both managers to honestly reveal their actual performance after the first period, because a more efficient resource reallocation in the second period benefits them directly through their wage. This effective communication enables the managers to learn, which benefits the organisation as a whole. Learning within the organisation is particularly important if the second period (the period in which the organisation is centralised) is rather large.

In the third model, that has the same cooperation structure as the second model, but differs from the second model in the sense that payment is based on performance that managers communicate themselves, communication problems can arise, which undermines the learning potential of the organisation. If the second period is longer (more important), there are no communication problems and managers are inclined to honestly reveal their actual performance to each other. The losses in the second that are involved with overdrawing their performance do not outweigh the gains in the first period. However, if the first period is rather long (more important), managers have an incentive to not reveal their actual performance, but to overdraw their performance, which does not benefit the organisation as a whole. Within this situation, managers will disregard the message of their peer, which means they do not learn. Next to this, there are free rider issues here, since managers do not maximise the performance of the firm as a whole, but solely consider their own pay-out. In case managers are in an equilibrium in which they are honest to one and other, it should be noticed that this free rider problems are less severe in this model than in the second model.

It can be concluded that a certain trade-off exists between effective communication and managers' incentives to learn from each other on the one hand, and chosen effort levels on the other hand. Firms should take this into account when choosing the appropriate cooperation- and payment structure. Future research could take this trade-off in consideration and for example combine the second and the third model in order to find the optimal balance of communication, learning and effort of the management within an organisation.

7 References

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A Appendix 1

It follows from section 4 that the optimal effort level of private pay-off maximization reads:

$$a^* = b^* = \lambda(h - l)(\frac{1}{2}\sigma + (1 - a)(1 - \sigma)) \tag{40}$$

In the following, I derive optimal effort of manager B in case he would have optimised total pay-offs of the organisation (i.e. the sum of the pay-off of manager A and manager B). In that case, his pay-off function would have looked like this:

$$(\sigma(v_A + v_B) + (1 - \sigma)v_X) - \frac{a^2}{2\lambda} - \frac{b^2}{2\lambda} \tag{41}$$

Plugging in $v_A = ah + (1-a)l$, $v_B = bh + (1-b)l$ and the expression for v_X (see section 4) into the total pay-off function and maximising this pay-off function with respect to b gives the following first-order condition:

$$\sigma(h - l) - \frac{b}{\lambda} + 2(h - l)(1 - a)(1 - \sigma) = 0 \tag{42}$$

Solving for b yields the following best-response function:

$$b^* = 2\lambda(h - l)(\frac{1}{2}\sigma + (1 - a)(1 - \sigma)) \tag{43}$$

It follows that the effort in case of optimisation of private pay-offs is twice as low as in case of optimisation of total pay-offs, which leads to the conclusion that a free rider problem is present here.

B Appendix 2

It follows from section 5.1 that the optimal effort level of private pay-off maximization reads:

$$a^* = b^* = \frac{3}{4}\lambda(1 - \sigma)(h - l) \tag{44}$$

In the following, I derive optimal effort of manager B in case he would have optimised total pay-offs of the organisation (i.e. the sum of the pay-off of manager A and manager B). In that case, his pay-off function would have looked like this:

$$\sigma(\bar{v_A} + \bar{v_B}) + (1 - \sigma)(v_X - (\bar{v_B} - v_B) - (\bar{v_A} - v_A)) - \frac{a^2}{2\lambda} - \frac{b^2}{2\lambda} \tag{45}$$

Plugging in $v_X = \frac{1}{2}(ah + (1-a)l) + \frac{1}{2}(bh + (1-b)l)$, $v_A = ah + (1-a)l$, $v_B = bh + (1-b)l$ and $\bar{v_A} = \bar{v_B} = h$ into the total pay-off function and maximising the pay-off function with respect to b gives the following first order condition:

$$-\frac{(2b - 3h\lambda + 3l\lambda + h\sigma\lambda - l\sigma\lambda)}{2\lambda} = 0 \tag{46}$$

Solving for b yields the following best-response function:

$$b^* = \frac{3}{2}\lambda(1 - \sigma)(h - l) \tag{47}$$

It follows that the effort in case of optimisation of private pay-offs is twice as low as in case of optimisation of total pay-offs, which leads to the conclusion that a free rider problem is present here.

C Appendix 3

It follows from section 5.3 that the optimal effort level of private pay-off maximization reads:

$$b^* = \frac{1}{2}\lambda(h - l)(\sigma - a + \sigma a + 1) \tag{48}$$

In the following, I derive optimal effort of manager B in case he would have optimised total pay-offs of the organisation (i.e. the sum of the pay-off of manager A and manager B). In that case, his pay-off function would have looked like this:

$$\sigma(\bar{v_A} + \bar{v_B}) + (1 - \sigma)(v_X - (\bar{v_B} - v_B) - (\bar{v_A} - v_A)) - \frac{a^2}{2\lambda} - \frac{b^2}{2\lambda} \tag{49}$$

Plugging in $v_X = (1-(1-a)(1-b))h + (1-a)(1-b)l$, $v_A = \bar{v_A} = ah + (1-a)l$ and $v_B = \bar{v_B} = bh + (1-b)l$ into the total pay-off function and maximising the pay-off function with respect to b gives the following first order condition:

$$-\frac{(b - h\lambda + l\lambda + ah\lambda - al\lambda - ah\sigma\lambda + al\sigma\lambda)}{\lambda} = 0 \tag{50}$$

Solving for b yields the following best-response function:

$$b^* = \lambda(h - l)(a\sigma - a + 1) \tag{51}$$

It follows that the effort in case of optimisation of private pay-offs is lower than in case of optimisation of total pay-offs for $\sigma < 1$, which leads to the conclusion that a free rider problem is present here.