Communication versus (restricted) delegation: An experimental comparison*

Silvia Dominguez-Martinez[a] and Randolph Sloof[a,b]

[a] University of Amsterdam and the Tinbergen Institute

[b] Copenhagen Business School

May 2017

Abstract

This paper reports the results from a laboratory experiment investigating a manager's decision whether or not to delegate authority to a better informed worker whose interests are often, but not always, congruent. Keeping authority implies a loss of information, as the worker communicates his information strategically. Delegating authority leads to a loss of control. A key aspect of our design is that the manager can restrict the worker's choice set when delegating authority. We find that, in case of delegation, managers (as predicted) put tighter restrictions when interests are less aligned. Workers send more informative messages under communication than predicted by the pure strategy equilibria. This finding neither appears to be driven by lying aversion of workers nor by credulity of managers. Qualitatively, our results are in line with a mixed strategy equilibrium under communication, which strictly outperforms optimal restricted delegation and is relatively close to the optimal stochastic mechanism in our setting.

JEL: C90, D80, M20.

Keywords: Delegation, Communication, Laboratory Experiment, Organizational Economics.

*The paper benefitted greatly from the insightful comments received from Suzanne Bijkerk, Wooyoung Lim, Joel Sobel and Junze Sun. An earlier version has been presented at conferences and workshops in Bergen, Geneva, and Maastricht; we gratefully acknowledge the remarks from the respective audiences. We thank the priority research area Behavioral Economics of the University of Amsterdam for financial support. Corresponding author: S.DominguezMartinez@uva.nl.

1 Introduction

Apart from the performance evaluation and reward system, a key feature of organizational architecture is the assignment of decision rights. In deciding whether to delegate decision authority to lower level employees (and to what extent), managers face a basic trade-off between a loss of control and a loss of information (cf. Jensen and Meckling, 1992). Lower level employees are typically better informed and therefore able to take more informed decisions. At the same time, they may have different interests. Providing them with decision making power thus potentially leads to different decisions than the manager would have taken if she would have the same information. This loss of control under delegation has to be compared with the loss of information under centralized decision making. Even though manager and agent can communicate under centralization, the divergent interests imply that agents do so strategically. This typically precludes full information disclosure, such that the manager's decision will be based on coarse information.

The loss of control versus loss of information trade-off has received widespread theoretical attention. Dessein (2002) for instance shows that, in the cheap talk setting of Crawford and Sobel (1982), full delegation outperforms direct communication (as long as the incentive conflict is not too large relative to the manager's uncertainty about the environment). The intuition here is that the bias in information transmission that results under centralization is an order of magnitude larger than the bias in decision making after delegation. Managers are therefore predicted to delegate authority, even though this leads to a loss of control. In fact, theoretically managers are even better off when they impose an upper limit on the level of the agent's discretion, i.e. opt for 'restricted delegation' (see also Holmstrom, 1984; Ottaviani, 2000; Alonso and Matouschek, 2008). Moreover, restricted delegation implements the second best outcome, i.e. corresponds to the optimal general mechanism (Goltsman et al, 2009; Kováč and Mylovanov, 2009).[1]

The frequent observation of highly centralized organizations suggests that delegation does not always dominate communication. Indeed, Dessein's main result does not generalize to some other, arguably relevant situations. A key assumption in the setup of Dessein is that the agent's bias is common knowledge. If the bias is a priori uncertain, the effectiveness of communication is improved and the trade-off can go either way. Centralization then may outperform (full) delegation (cf. Dessein, 2002, Section 8.2; Ottaviani, 2000; Rush et al., 2010).[2] Also on behavioral grounds

[1] Mylovanov (2008) shows that, if managers can choose a default option, the optimal second best outcome can also be implemented by veto-based delegation: the agent can choose freely, but the manager retains the right to block the decision (in which case the default applies).

[2] Other key assumptions are that the sender is fully informed on the state and that the receiver has no private

one may expect that communication performs better than the analysis in Dessein (2002) suggests. Experimental studies of signaling games, for example, typically find that cheap talk is far more informative than standard theory predicts; see e.g. Cai and Wang (2006) and de Haan et al (2015). One plausible explanation put forward is that most people are somewhat lying averse. If agents are sufficiently lying averse, the bias in information transmission under centralization is much lower and communication may become superior to delegation (cf. Kartik, 2009; Proposition 4). Moreover, a behavioral force that may limit the attractiveness of restricted delegation is that most people dislike being restricted and are willing to costly punish the manager when they are (Falk and Kosfeld, 2006). This may lower the actual attractiveness of restricted delegation as compared to standard theoretical predictions.

In this paper we explore the driving forces that govern a manager's delegation choice by means of a laboratory experiment. We focus on a very simple setting, in which the worker's bias varies with the state of the world and thus is uncertain for the manager (cf. Blume et al., 1998, 2001). In three equally likely states preferences are perfectly aligned, in the fourth state preferences are opposed. Depending on the probability $1-q$ that the latter 'conflict' state occurs, full delegation may either be better or worse than communication. Our highly stylized setup thus captures situations where the trade-off can go either way. A key characteristic of our design is that the manager may restrict the agent's choice set when delegating authority. Focussing on pure strategy equilibria, optimal (restricted) delegation then theoretically outperforms optimal communication. Behaviorally, however, we expect that the manager may prefer communication. On the one hand, communication is likely to perform better when agents are lying averse. On the other hand, restricted delegation may perform worse because workers may dislike being restricted.

Our main experimental findings are as follows. If managers delegate, they (as predicted) put tighter restrictions in case interests are less aligned. Workers send more informative messages under communication than predicted by the pure strategy equilibria. This finding neither appears to be driven by lying aversion of workers nor by credulity of managers. Qualitatively, our results are in line with a mixed strategy equilibrium under communication, which strictly outperforms optimal restricted delegation and is relatively close to the optimal stochastic mechanism in our setting. Our results thus tentatively suggest that centralization may be an enforceable and realistic way to reap part of the benefits of stochastic allocation mechanisms, and provide an (standard instrumental)

information of his own. Otherwise cheap talk may dominate delegation in some cases; see e.g. Agastya et al (2014) for a setting where the sender only observes one dimension of the (essentially two dimensional) state of the world and Garfagnini et al (2014) for a setup where the receiver has additional (private) information.

explanation why managers are less inclined to delegate than to keep decision authority.

A large number of experimental studies on delegation already exist. One strand of the literature focuses on strategic delegation as commitment device or as a way to shift responsibility.[3] Closer to our study are experiments that study the informational role of delegation.[4] Fehr et al (2013), Dominguez-Martinez et al (2014) and Sloof and von Siemens (2015) focus on the motivational consequences of (effective) delegation and examine a setup based on Aghion and Tirole (1997) in which the worker has to exert costly effort to become informed. If the manager keeps authority or closely monitors the worker, the worker has weakened incentives to gather information, leading to a loss of initiative. This has to be traded off against the loss of control in case authority is delegated or the manager does not monitor. Like us, Lai and Lim (2012) also consider a communication-delegation setting in which the worker is informed from the outset and loss of information under centralization is due to strategic communication.[5] The worker can be of two types and two different strategic situations are studied. In game C the most preferred action in both states for the worker is the least preferred action of the manager (action a_4 in their Figure 1). Preferences over the other three actions in this game are perfectly aligned. Communication thus allows full revelation of information while at the same time making sure that a_4 is not chosen. This makes communication far more attractive for the manager than full delegation. Game D drops action a_4 and changes the preferences of the worker over the remaining three actions in such a way that in one state preferences are aligned while in the other state they are not. This gives the worker an incentive to always claim that the congruent state applies and strategic communication is predicted to be uninformative. The manager is thus better off delegating. The experimental findings largely confirm these predictions, although in game D there is still a substantial fraction of managers that does not delegate. Lai and Lim (2012) show that this can be explained within a level-k framework, in which under-delegation results due to a belief that a less-than-fully strategic worker will provide some information.

Our experiment differs in a number of respects from Lai and Lim (2012). First and foremost, we allow for restricted delegation as well. This is important from both a theoretical and a practical

[3] See e.g. Fershtman and Gneezy (2001), Hamman et al (2010), Coffman (2011) and Bartling and Fischbacher (2012). Another strand of the literature focuses on carefully inferring individual's intrinsic valuation of decision authority and control (beyond the instrumental benefits), see e.g. Bartling et al (2014) and Owens et al (2014), thereby providing a rationale why in general people are reluctant to delegate.

[4] Other recent experiments consider settings with one head office and two divisions and focus on the tradeoff between improving coordination between the divisions through centralization versus facilitating adaptation to local circumstances via delegation; see e.g. Brandts and Cooper (2015), Evdokimov and Garfagnini (2015) and Hamman and Martinez-Carrasco (2015).

[5] In a recent contribution Battaglini et al (2016) experimentally test the informational theory of legislative committees by comparing the "closed rule" with the "open rule". Effectively, the former essentially corresponds to delegation while the latter equals cheap talk communication.

perspective. Note, for instance, that in game C of Lai and Lim restricted delegation – with action a_4 excluded from the worker's choice set – would be fully equivalent to communication. It may thus very well be the case that delegation would have been predominantly chosen if managers could optimally limit the worker's discretion. Second, we employ a richer message space, allowing the worker to either make a factual statement about the state, or a recommendation about which project to choose. This provides additional insights in how strategic communication actually takes place. Third, instead of a level-k analysis as possible driver of over-communication, we experimentally explore lying aversion by including individual incentivized measures of lying aversion and credulity. Fourth, we provide a comparison with the optimal stochastic mechanism.[6]

The remainder of this paper is organized as follows. Section 2 presents the theoretical predictions. In Section 3 we describe the experimental design. In Section 4 results are presented. Section 5 discusses potential explanations for the findings presented in Section 4. Section 6 concludes.

2 The model and its predictions

2.1 Strategic situation

We consider a game between a manager and a worker. The manager has the initial decision authority which project $a \in \{A, B, C\}$ to implement. The optimal project choice depends on the state of the world $t \in \{1, 2, 3, 4\}$. Ex ante states 1, 2, and 3 each occur with a probability of $\frac{1}{3}q$ while state 4 occurs with probability $1 - q$ (for $0 < q < 1$). The worker knows the actual state of the world, the manager only its prior distribution. In the 'congruent' states 1, 2, and 3 preferences of manager and worker are perfectly aligned; in these states both prefer project A, B, and C, respectively. In the 'conflict' state 4 preferences are completely opposed. The manager then prefers project A while the worker prefers C, and the in between project B can be seen as a compromise solution. Parameter q can thus be interpreted as an ex ante measure of interest alignment (cf. Pitchik and Schotter, 1987). The larger q is, the higher the interest alignment between manager and worker is.[7]

[6] Another difference is that our two treatments can be unambiguously ordered in terms of interest alignment. When moving from game C to game D in Lai and Lim (2012), two things change at the same time: (i) action a_4 is dropped, leading to better aligned incentives, and (ii) changes in the worker's payoffs belonging to action a_2 are made leading to less aligned incentives. The games are thus not straightforwardly ordered (see also the discussion on p. 544 in Lai and Lim (2012)). Yet in terms of predictions their game C resembles our weak alignment case (communication outperforms full delegation but is equivalent to restricted delegation), while game D resembles our strong alignment treatment (full delegation outperforms communication).

[7] Pitchik and Schotter (1987) study a discrete model of strategic information transmission with two states and two actions. The preferred action of the receiver varies with the state, the preferred action of the sender does

In our experimental implementation of the above strategic situation, payoffs over state-action pairs are given by Table 1 below:[8]

Table 1: Payoffs over state-project pairs

$Pr(t)$	t	A	B	C
$q/3$	1	$80, 80$	$0, 0$	$0, 0$
$q/3$	2	$0, 0$	$100, 100$	$0, 0$
$q/3$	3	$0, 0$	$10, 10$	$100, 100$
$1-q$	4	$120, 10$	$80, 80$	$10, 120$

Note: The first payoff belongs to the manager, the second payoff belongs to the worker.

In the absence of any information, the manager would either choose project A or B, depending on the value of q; project C is then always dominated by project B in expected payoff terms. Because the manager's preferred project depends on the state, he would like to take a more informed decision. One possibility to do so is full or partial delegation of the decision right to the worker. Another possibility is that the worker sends a cheap talk message about the state before the manager takes a decision ('centralization/communication'). Of these two options, the manager prefers the one that yields him the most in expected payoff terms.

2.2 Equilibrium predictions

First consider the delegation case. Let $\Delta \subseteq \{A, B, C\}$ denote the set of projects the manager allows the worker to choose from. A selfish worker then chooses the project from Δ that yields him the most. Anticipating this, the manager's optimal level of delegation follows from a straightforward comparison of expected payoffs (proofs are relegated to Appendix A):

Proposition 1. The optimal level of delegation for the manager equals:

(a) If $q \geq \frac{7}{10}$, then *Full Delegation* (referred to as *Del-(3)*): $\Delta = \{A, B, C\}$;

not (although the intensity of his preferences do). The state where preferences over actions coincide occurs with probability r. Pitchik and Schotter compare their setup with the framework of Crawford and Sobel and argue that r can be interpreted as a measure of (ex ante) interest alignment.

[8] The general structure of payoffs has been chosen such that: (i) under delegation the manager may either consider to exclude no project, to exclude project C, or to exclude both B and C, whereas (ii) under centralization a worker knowing that $t = 4$ always has an incentive to pretend being $t = 3$. The exact payoff levels are subsequently chosen to draw the predictions in the next subsection sufficiently far apart.

(b) If $\frac{12}{23} \leq q < \frac{7}{10}$, then *Restricted Delegation (Del-(2))*: $\Delta = \{A, B\}$;

(c) If $q < \frac{12}{23}$, then *No Delegation (Del-(1))*: $\Delta = \{A\}$.

Proposition 1 is intuitive. If preferences are well aligned (q high), the manager is best off by delegating full decision power. In case preferences are badly aligned (q low), the manager should effectively not delegate at all and fully restrict the worker's "choice". When interest alignment is in between (q intermediate), restricting the worker to choosing either A or B is optimal.

Next consider the centralization/communication case. Here the manager always takes the project decision, after having received a cheap talk message from the worker about the state of the world. Without loss of generality we assume there are four possible messages $m \in \{m_1, m_2, m_3, m_4\}$. For ease of reference, these messages can be interpreted as literal statements about the state. Alternatively, messages m_1, m_2, and m_3 could be interpreted as saying that the best project for both is A, B, or C respectively, and m_4 that there is a conflict of interests. As is standard in cheap talk games, messages only get their meaning in equilibrium though.

As is well-known, cheap talk games allow for a multiplicity of equilibria; see Sobel (2013) for an informative discussion. In deriving our theoretical predictions we therefore focus on the arguably more plausible equilibria, by employing the *neologism proofness* refinement of Farrell (1993).[9] This essentially deletes only those equilibria in which type $t = 1$ cannot secure that project A is chosen. Moreover, if multiple pure strategy equilibria exist side by side (with happens for higher values of q), the refinement deletes the less informative among these. As ex ante both worker and manager alike prefer the equilibrium in which the larger amount of (influential) information is transmitted, the equilibrium selection here can thus also be justified by assuming that, among the pure strategy equilibria, parties always coordinate on the most informative one.

Proposition 2 below characterizes all neologism proof equilibrium outcomes in our game (where for ease of reference we use the above labelling of messages; obviously these equilibrium outcomes could also be sustained by permuting the messages).

Proposition 2. The set of neologism proof equilibrium outcomes in the communication game corresponds to::

[9] In the present context neologisms are (out-of-equilibrium) messages that are assumed to have a literal meaning of the form: "choose project a, because my type belongs to set S". A neologism is credible if: (i) all types in S prefer a over the project they receive in equilibrium, (ii) all types outside S prefer their equilibrium project over a and (iii) choosing a is a best response for the manager when restricting the support of his prior beliefs to S. An equilibrium is neologism proof if no credible neologisms exist.

(a) For $q \geq \frac{33}{43}$, *Communication (Com-(3)):* The worker sends message m_1 when $t = 1$, m_2 when $t = 2$, and m_3 if $t = 3$ or $t = 4$. In response the manager chooses A, B, and C respectively;

(b) For $\frac{12}{23} \leq q < \frac{33}{43}$, *Limited Communication (Com-(2)):* The worker sends message m_1 when $t = 1$, and m_2 if $t = 2$, $t = 3$ or $t = 4$. In response the manager chooses A and B, respectively;

(c) For $q < \frac{12}{23}$, *No Communication (Com-(1))*: The worker always sends message m_1 irrespective of its type and the manager chooses A in response;

(d) For $\frac{66}{141} \leq q \leq \frac{33}{43}$, *Communication using mixed strategies (Com-(3-mixed)):* The worker sends message m_1 when $t = 1$, m_2 when $t = 2$, m_3 if $t = 3$, and employs a mixed strategy when $t = 4$, sending m_2 with probability $\tau_2 = \frac{33-43q}{33(1-q)}$ and m_3 with probability $\tau_3 = \frac{10q}{33(1-q)}$. The manager chooses A after m_1, B after m_2, and after m_3 she chooses A with probability $\alpha_{3A} = \frac{4}{11}$ and C with probability $\alpha_{3C} = \frac{7}{11}$.

Proposition 2 reveals that there are essentially three pure strategy equilibrium outcomes and one mixed one. The latter is the most informative equilibrium on the domain where it exists and yields both the manager and the worker the most in expected payoff terms. The comparison between delegation and communication thus crucially depends on whether parties are able to coordinate on the mixed communication equilibrium. If they are, communication (weakly) outperforms delegation whereas if they are not, this is the other way around. Proposition 3 summarizes this immediate observation.

Proposition 3. Comparing delegation with communication in terms of expected payoffs for the manager, it holds that:

(a) If $q \geq \frac{33}{43}$: Del-(3) $\sim$ Com-(3);

(b) If $\frac{7}{10} \leq q < \frac{33}{43}$: Com-(3-mixed) $\succ$ Del-(3) $\succ$ Com-(2);

(c) If $\frac{12}{23} \leq q < \frac{7}{10}$: Com-(3-mixed) $\succ$ Del-(2) $\sim$ Com-(2);

(d) If $\frac{66}{141} \leq q < \frac{12}{23}$: Com-(3-mixed) $\succ$ Del-(1) $\sim$ Com-(1);

(e) If $q < \frac{66}{141}$: Del-(1) $\sim$ Com-(1).

As Sobel (2013, fn. 7) notes, most applications of sender-receiver games assume that the receiver has a unique best response to each distribution over types, ruling out mixed equilibrium strategies for the receiver by design. This also holds for the analysis in Dessein (2002) that builds on the standard Crawford-Sobel framework. Focusing first on pure strategy communication equilibria only, Proposition 3 is reminiscent of Dessein's finding that delegation outperforms communication if interests are sufficiently aligned such that communication can be influential. Delegation then has the advantage that (for intermediate values of q) decision making is more sensitive to the information available than strategic communication is. It is important to note, however, that Proposition 3 compares *optimal* delegation with communication. The result does not imply that full delegation is always better than communication, even not when the level of interest alignment is relatively large and communication can be influential. To illustrate, suppose that $\frac{12}{23} \leq q < \frac{7}{10}$. From Proposition 1 it then follows that the manager prefers the restricted delegation outcome to the full delegation outcome, while Proposition 2(c) indicates that the former can be reached under communication (i.e. equilibrium Com-(2)). As noted in the Introduction, the improved effectiveness of communication in our setup is partly due to the alignment of interests not being constant across states. Ottaviani (2000), for instance, obtains a similar result when extending the standard Crawford-Sobel framework by assuming that the receiver's bias is a priori uncertain (equal to either $-b$ or b with equal probabilities).

In contrast to most applications, in our game the receiver does not have a unique best response to every possible type distribution. Hence in case of centralization, for intermediate values of q a mixed communication equilibrium exists. This Com-(3-mixed) equilibrium yields the manager more than any form of delegation does. A key feature of the mixed communication equilibrium driving this result is that the decision maker - in that case the manager - may optimally use a mixed strategy, such that the overall equilibrium relation between state and project choice can be stochastic. In contrast, after delegation the decision maker - in that case the worker - will always employ a pure strategy, because he knows the state and in each state the different projects are strictly ordered for him. The equilibrium relation between state and project choice is then necessarily deterministic. This may be particularly restrictive when the optimal general mechanism is stochastic. In the next subsection we therefore explore whether that is the case in our setting.

In our experiment we are especially interested in testing whether managers use the option to restrict the worker's choice set in case of delegation, how this varies with the alignment of interests as represented by parameter q, and how delegation compares to communication. To that purpose we consider two different levels of interest alignment: $q = \frac{3}{4}$ and $q = \frac{3}{5}$, belonging to parts (b) and (c) of Proposition 3, respectively. Regarding delegation, standard theory then predicts that managers restrict more when interests become less aligned. How variations in q affect communication (and, in turn, the relative comparison with delegation) crucially depends on whether parties are able to coordinate on the mixed strategy communication equilibrium.

2.3 Comparison to the optimal (stochastic) mechanism

In a general mechanism the manager can commit to a probabilistic decision rule to choose project a in state t with probability p_{ta}. Using the revelation principle only direct mechanisms that induce truthtelling need to be considered to derive the optimal mechanism. It appears that in our setting the optimal mechanism is indeed stochastic for a large range of q values.

Proposition 4. (i) The optimal deterministic mechanism corresponds to optimal delegation as in Proposition 1. (ii) The optimal general (stochastic) mechanism equals:

(ii.a) If $q \geq \frac{231}{271}$: Del-(3)=Com-(3);

(ii.b) If $\frac{11}{26} \leq q < \frac{231}{271}$: The manager implements A if $t = 1$, B if $t = 2$, A with probability $\frac{4}{11}$ and C with probability $\frac{7}{11}$ if $t = 3$, and B if $t = 4$;

(ii.c) If $q < \frac{11}{26}$: Del-(1)=Com-(1).

Note that the optimal mechanism in case (ii.b) corresponds to the strategies in Proposition 2(d) for $\tau_2 = 1$. (Obviously, for $\tau_2 = 1$ the manager's strategy is no longer a best response to the worker's strategy.) The worker therefore earns the same under the optimal mechanism as under Com-(3-mixed). The manager earns strictly more though.

The focus in the literature on communication and optimal delegation is predominantly on deterministic mechanisms. Kováč and Mylovanov (2009) theoretically explore a Crawford and Sobel type of framework in which sender (agent) and receiver (principal) both have quadratic preferences. They show that in this setting the optimal mechanism is necessarily deterministic if a certain regularity condition on the distribution of states and the conflict of interests holds.[10] Alonso and Matouschek (2008) provide a specific example where this condition is violated and the optimal mechanism is stochastic. Departing from quadratic preferences, Kováč and Mylovanov (2009) provide another example in which the optimal mechanism is stochastic, the driving force

[10] For the more specific case of a uniform prior and a constant conflict of interests across states, Goltsman et al (2009) provide an alternative proof that the optimal mechanism is deterministic.

being there that the principal's payoffs (an absolute value loss function) have less curvature than the agent's payoffs (a quadratic loss function). This enables the principal to use variance as an incentive device and thereby implement decisions that are closer to his ideal point than under a deterministic mechanism, without additional costs. Note that in our theoretical setup manager and worker are both assumed to be risk neutral with essentially symmetric payoffs.[11]

Our setup provides yet another specific example (but in an arguably natural setting) in which the optimal mechanism can be stochastic. Observations like these have typically been interpreted as having little practical relevance because, as noted by e.g. Alonso and Matouschek (2008) and Laffont and Martimort (2002, p. 67), the enforcement of random allocation rules may in practice be too problematic. Yet an interesting feature of our setting is that part of the gains of random allocation mechanisms are also captured by the Com-(3-mixed) equilibrium under centralization. This organizational structure may thus be an enforceable way to reap at least part of the benefits of stochastic mechanisms if parties are able to coordinate on the favorable mixed communication equilibrium. Indeed, our experimental results reveal that this is not just a remote theoretical possibility, as subjects are by and large indeed able to do so.[12]

2.4 Predictions under alternative behavioral forces

Even if parties are unable to coordinate on the mixed communication equilibrium, behavioral forces may provide an alternative reason why one may expect communication to outperform delegation. First consider the delegation case in isolation. Restricted delegation may perform less well than predicted, because the worker may purposely make a suboptimal project decision if the manager intentionally decided to restrict his choice set to $\Delta = \{A, B\}$. Such hidden costs of control have been observed in related principal-agent settings with no private information (cf. Falk and Kosfeld, 2006). Punishment may in principle occur in states 1 through 3 (in state 4 a deviation from B, i.e. the worker's best project in $\Delta = \{A, B\}$, to A would be rewarding the manager). Arguably

[11] That is, only in the conflict state payoffs of projects A and C differ between manager and worker, but these are just the flip side of each other ((120,10) versus (10,120)).

[12] It is straightforward to show that the optimal mechanism in game D of Lai and Lim (2012) is also stochastic, with action a_1 chosen for sure in the congruent state t_1 and actions a_2 and a_3 chosen with equal probabilities in conflict state t_2. Under this optimal mechanism both manager and worker earn more than under the unique babbling equilibrium under communication ($(725, 550) \succ (500, 500)$). Qualitatively the data are in the direction of this outcome, see Figure 4 in Lai and Lim (2012). An alternative interpretation of their findings, therefore, is that managers (erronously) perceive the game as a repeated one, trying to build a reputation for committing to the optimal mechanism. In doing so, both players gain as compared to the uninformative babbling outcome. Alonso and Matouschek (2007) formally model such implicit commitment in an infinitely repeated cheap talk game and label it 'relational' delegation.

the most salient state for the worker to do so is $t = 3$; in this state the principal's restriction to $\Delta = \{A, B\}$ really hurts both. If the worker only punishes in this state by suboptimally choosing A instead of B, the principal prefers full delegation whenever $q > \frac{21}{31} \approx 0.68$. Given our parameter choices, this drop (from $\frac{7}{10}$ to $\frac{21}{31}$) in the cutoff between full delegation and restricted delegation is likely to have little effect.[13]

The other side of the same coin is that the worker may reward the principal for not restricting the choice set to $\Delta = \{A, B\}$ when it is theoretically optimal to do so. Full delegation signals trust and can be considered a kind act, to which a reciprocal agent might react with using her authority more "responsibly". In particular, the worker may choose project B as a compromise in state 4 if authority is fully delegated, to reward the manager for her trust. If the worker indeed does so, the principal never prefers $\Delta = \{A, B\}$. If only a fraction $r \in [0, 1]$ of workers behaves reciprocal in this way, the cutoff between full and restricted delegation becomes $\frac{7-7r}{10-7r}$. For $r \geq \frac{5}{14} \simeq 0.36$ we would then also expect to observe full delegation in the low interest alignment case $q = \frac{3}{5}$.[14] Given that this requires a sizable fraction of sufficiently reciprocal types, we a priori do not expect that in our setting hidden costs of control (or the flip side, hidden benefits of autonomy) overturn the earlier comparative statics predictions.

A behavioral force that may affect the communication equilibria is lying aversion. When sending their message workers may be averse to lying, especially when the costs to the manager are substantial relative to the benefits of the worker if the lie is believed (cf. Gneezy, 2005). Lying aversion in particular has a bite when $t = 4$ and a worker acting strategically has an incentive to let the manager believe that $t = 3$. Suppose a fraction λ of workers is sufficiently lying averse and always speaks the truth, thus also when $t = 4$. This increases the range of q values for which Com-(3) exists from $q > \frac{33}{43}$ to $q > \frac{33(1-\lambda)}{10+33(1-\lambda)}$ and at the same time reduces the existence of Com-

[13] A behavioral force that may make restricted delegation relatively more attractive as compared to full delegation is anticipated regret. Regret may operate in two ways. The manager may regret having restricted the worker (by excluding project C) when it turns out ex post that the state equals $t = 3$. Likewise, the manager may regret having given full discretion to the worker when it turns out ex post that $t = 4$. The tradeoff between these two types of anticipated regret depends on the relative weight attached to them, the monetary payoffs in the various states and the likelihood of each state occuring. The auction experiment of Filiz-Ozbay and Ozbay (2007) suggests that regretting too much discretion gets a relative larger weight; they find that subjects feel regret from not being aggressive enough ('loser regret' of bidding too low) but not from being too aggressive ('winner regret' of bidding too high). Our parameter choices make regretting full delegation also more salient. Fehr et al. (2013) indeed find that regret aversion, exhibited through a distaste for being overruled, provides a behavioral explanation for under-delegation in their setup (in our setup this would correspond to either restricted delegation or communication).

[14] In Oosterbeek et al (2011) a related argument is formally developed using intention based reciprocity in a multitasking context. Translated to the current setup, the argument is that the smaller q, the stronger full delegation is a signal of trust, thus warranting a stronger reciprocal response. Therefore, behaviorally one may expect that full delegation does not increase with q.

(3-mixed) by the same shift in the upper bound on q. For $q = \frac{3}{4}$ then at least a fraction of $\lambda = \frac{1}{11}$ lying averse people are required to make a difference, for $q = \frac{3}{5}$ this becomes $\lambda = \frac{6}{11}$. Given earlier lying experiments, the former requirement is rather likely to be satisfied, the latter is not. Note that in that case for $q = \frac{3}{4}$ delegation and communication coincide.[15]

Similarly, when there is a sufficient fraction of managers that is credulous and always believes the message received and acts accordingly, the Com-(3) message strategy of the worker can be sustained for values of q below $\frac{33}{43}$. In that case a rational, non-credulous manager always chooses A after m_3. For the worker to still send this message when $t = 4$, it is then required that the fraction of credulous managers exceeds $\frac{7}{11}$. (In fact, in that case Com-(3) is the only outcome for all values of q.) This a priori seems too stringent for credulity to have an impact.[16]

Overall, lying aversion seems to be the most relevant alternative behavioral force that may affect comparative statics. A priori one would then expect that especially the outcome under communication changes when interest alignment increases from weak ($q = \frac{3}{5}$) to strong ($q = \frac{3}{4}$). Moreover, with lying aversion the potential comparative advantage of (full) delegation over communication vanishes under strong interest alignment.

3 Experimental design

The purpose of our experiment is to test the comparative statics of centralization and delegation with the level of interest alignment. We therefore considered two different values of q: under weak interest alignment $q = \frac{3}{5} = 0.6$, while under strong interest alignment $q = \frac{3}{4} = 0.75$. Moreover, before subjects actually had to choose between centralization and delegation, we wanted them to have some experience already with these two institutions in isolation. To account for potential order effects, we used the order of these 'exogenous institution' games as second treatment dimension. Table 2 provides an overview of our 2 by 2 treatments design.

The experiment was conducted at the University of Amsterdam and was programmed using the z-tree programming package by Fischbacher (2007). In total 230 subjects participated. For each treatment we ran 2 or 3 sessions, where the number of participants per session ranged from 20 to 30. As the sessions differed in the number of participants, in each session we had either two or three matching groups of either 8, 10, or 12 subjects. Subjects were only matched within their

[15] Like lying aversion, level-k analysis may also rationalize over-communication and, thereby, under-delegation; see Lai and Lim (2012) for an elaborate discussion of level-k in the context of their model.

[16] For the standard Crawford and Sobel framework, Ottaviani (2000) shows that there is a fully revealing equilibrium as soon as there is a positive fraction of credulous (or 'naive' in his wording) managers.

matching groups, so matching group averages can be taken as strictly independent observations. Table 2 also lists the number of matching groups per treatment.

Each session consisted of four incentivized parts and an ex post questionnaire. After reading the instructions for part 1 and completing some control questions, each subject learned her/his role: either Manager or Worker. Subjects kept the same role throughout the experiment. The experiment was framed in an organizational setting (see Appendix B for sample instructions). Overall earnings equalled the sum of earnings in parts I through IV. The conversion rate was 250 points for 1 euro.

Table 2: Treatment variations

q	Treatment	# subj.	# groups	Part I	Part II	Part III	Part IV
0.6	CD60	60	6	C	D	C vs. D	lying aversion
0.6	DC60	50	6	D	C	C vs. D	lying aversion
0.75	CD75	66	7	C	D	C vs. D	lying aversion
0.75	DC75	54	6	D	C	C vs. D	lying aversion

Parts I and II of the experiment gave subjects the opportunity to gain experience with Centralization and Delegation in isolation. In the Centralization game the subject in the role of manager took the project decision, but before doing so the subject in the role of worker sent a message about the actual state of the world (of which only the worker was informed). We restricted the worker to use exactly one of the following eight messages: "The state is t" for $t = 1, 2, 3, 4$, "I recommend project P" for $P = A, B, C$ and "I make no recommendation". Subjects were explicitly informed in the instructions that: "The set of available messages does not depend on the actual state; so irrespective of the actual state, the worker can always choose one of the above eight messages." Our choice for this particular set of messages was partly inspired by Sobel (2013). He notes that linguists typically make a distinction between the *referential* function of communication ('reporting the facts') and the *conative* function of communication ('giving advice'). Another reason was to explore whether subjects shy away from explicitly telling a lie in the conflict state $t = 4$, e.g. by then using "I recommend project C".[17]

[17] Serra-Garcia, Van Damme, and Potters (2011) compare a setting with precise communication about the state of the world to a setting with vague communication using a public good game with three values: low, intermediate or high. Under precise communication subjects can send "The value is v" for v=low, intermediate, high. Under vague communication subjects are also allowed to send for example the message "The value is intermediate or high". In the vague treatment subjects can refrain from lying by sending a vague message. They find that when vague communication is allowed subjects turn to vague messages in the conflict state.

In the Delegation game the worker took the project decision, but before doing so the manager could restrict the worker's choice options. In part III of each session the manager first had to choose between Centralization and Delegation and then the corresponding subgame was played.

Each of the parts I, II and III consisted of 20 periods. In each period the manager and the worker were anonymously and randomly rematched within their matching group. At the end of each period, a summary of the manager's and worker's decisions and the resulting payoffs in that period was shown to them. These payoffs equalled the number of points of the implemented project given the true state of the world as reflected in Table 1. Subjects did not receive information on the behavior of other managers and workers. Furthermore, before making any decision in part III, subjects received an overview of the decisions made in the first two parts of the experiment. The overall payoffs of each subject in each part was equal to the sum of points earned in all 20 periods.

We included a part IV in the experiment with the aim of measuring lying aversion of workers as well as credulity of managers in an incentivized way. We used an adjusted version of the experiment by Gneezy et al (2013). The exact setup is discussed in Section 5 where we discuss our findings. We ended the experiment with an ex post questionnaire. Besides background characteristics, we included Likert type statements to measure preferences for control, power, authority and reciprocity. Most importantly, to complement the incentivized measure of part IV we also included the 10 items from Lundquist et al (2009) to measure attitudes towards lying.

Sessions lasted around two hours. Average earnings equalled 20 euros, with a minimum of 13.8 euros and a maximum of 28.3 euros.

4 Results

This section presents an overview of the experimental results. First we look at the choices made in parts I and II where delegation and centralization are studied in isolation. Subsequently we will consider subjects' behavior when the manager has the opportunity to choose the organizational structure (part III data). Unless indicated otherwise, all tables and test statistics are based on matching group averages. Moreover, we always pool the data of the two different orders given that the two orders are balanced over the two different values of q.

4.1 Delegation

In this subsection we consider the results under delegation when exogenously imposed. The manager and the worker interact for 20 periods. To account for learning effects we focus on the decisions taken in the last 10 periods. Following the theoretical predictions, we distinguish three types of outcomes based on the number of projects that are allowed: Del-(3), Del-(2) and Del-(1). Table 3 summarizes the results. Managers restrict the choice set of workers more frequently under weak alignment than under strong alignment. In the latter case managers choose to delegate full decision power to workers in 66% of the cases, while under weak alignment this only happens in 13% of the cases.[18] The difference is highly significant according to a ranksum test ($p < 0.001$). Another way to illustrate the exact same finding is to look at the average number of allowed projects. This equals 2.6 under strong interest alignment, significantly higher than the 1.9 observed under weak alignment ($p < 0.001$). These comparative statics findings are in line with theoretical predictions.

Table 3: Delegation decision manager

	$q = 0.75$	$q = 0.6$	p-value
Del-(3)	66%	13%	< 0.001
Del-(2)	29%	68%	< 0.001
Del-(1)	5%	19%	0.03
# of allowed projects	2.6	1.9	< 0.001

Note: The p-values in the last column are from ranksum tests performed at matching group averages. For the top part the three tests are not independent.

As to the worker's project choice (unreported), in the far majority of cases the worker chooses the project that maximizes his payoffs given the state and his allowed choice set. In the conflict state $t = 4$, the worker chooses project C under full delegation in about 75-85% of the cases, even though this project really hurts the manager in this situation. In the remaining 15-25% of the cases the worker chooses the compromise project B. The worker is more likely to do so under weak interest alignment. As discussed in Section 2, a potential reason might be that full delegation is a stronger signal of trust the lower q is, leading to a stronger reciprocal reaction. If restricted to either project A or B in state 3, the worker chooses A in only 5-7% of the cases. We thus do not

[18] In almost all of the Del-(2) cases managers restrict the choice set to projects A and B. In almost all of the Del-(1) cases this is either project A or project B.

find large hidden costs of control in our setting. By and large, under delegation managers and workers behave reasonably well in line with standard theoretical predictions.

We next compare actual payoffs with predicted payoffs. Under strong alignment theory predicts full delegation and expected payoffs for the manager of $10+\frac{250}{3}q = 72.5$ per period. For the worker this is $120-\frac{80}{3}q = 100$. Under weak interest alignment Del-(2) is predicted with expected payoffs of $80-\frac{50}{3}q = 70$ per period for both the manager and the worker. Table 4 depicts the actual and predicted average payoffs over the final ten periods; here the predicted values differ slightly from the ones just discussed as these are calculated based on the actual realized draws of states (rather than their theoretical distribution as reflected by q). The table reveals that actual payoffs fall short of predicted payoffs. Except for managers under strong interest alignment, these differences are significant. Under delegation subjects thus earn less than theory predicts.

Table 4: Actual and predicted payoffs under delegation

	$q = 0.75$	$q = 0.6$	p-value
Manager's payoffs			
Actual	71.3	64.0	0.001
Predicted	72.3	68.1	<0.001
Act. vs Pred. (p-value)	0.80	0.00	
Worker's payoffs			
Actual	86.9	62.4	< 0.001
Predicted	100.1	68.1	<0.001
Act. vs Pred. (p-value)	0.00	0.03	

Note: The p-values in the last column are from ranksum tests using matching group averages. The other p-values are from signed rank tests.

4.2 Centralization

We next turn to the results under centralization, again focusing on the decisions taken in the last 10 periods (out of 20). We first discuss workers' messages and managers' responses in isolation, and then verify whether workers and managers best respond to each other. We end the subsection by comparing actual payoffs to the predicted payoffs.

4.2.1 Workers' messages

Table 5 provides an overview of the messages sent by workers. (The table also reports best responses in the columns labelled BR; these are discussed later. The corresponding rows ‘ "1" equivalent to "A" ’ et cetera, are then explained as well.)

Table 5: Worker's actual messages and best responses by treatment and state

		State 1		State 2		State 3		State 4	
Strong alignment (q = 0.75)		Actual	BR	Actual	BR	Actual	BR	Actual	BR
M1	The state is 1	84	38 [38]	0	0 [0]	0	0 [0]	0	0 [0]
	I recommend project A	14	8 [2]	0	0 [0]	1	0 [0]	1	0 [0]
	"1" equivalent to "A"		54 [52]		0 [0]		0 [0]		0 [0]
M2	The state is 2	0	0 [0]	84	54 [47]	2	0 [0]	30	31 [13]
	I recommend project B	2	0 [0]	16	0 [0]	0	0 [0]	13	0 [0]
	"2" equivalent to "B"		0 [0]		46 [46]		0 [0]		23 [12]
M3	The state is 3	0	0 [0]	0	0 [0]	74	92 [69]	45	38 [17]
	I recommend project C	0	0 [0]	0	0 [0]	19	8 [2]	9	8 [0]
M4	The state is 4	0	n.a.	1	n.a.	1	n.a.	1	n.a.
	I make no recommendation	0	n.a.	0	n.a.	3	n.a.	2	n.a.
Weak alignment (q = 0.6)									
M1	The state is 1	77	42 [35]	0	0 [0]	0	0 [0]	0 [0]	0 [0]
	I recommend project A	18	0 [0]	0	0 [0]	0	0 [0]	1 [0]	0 [0]
	"1" equivalent to "A"		58 [55]		0 [0]		0 [0]		0 [0]
M2	The state is 2	0	0 [0]	82	67 [58]	5	0 [0]	50	33 [14]
	I recommend project B	0	0 [0]	17	8 [2]	1	0 [0]	16	8 [0]
	"2" equivalent to "B"		0 [0]		17 [16]		0 [0]		8 [6]
M3	The state is 3	0	0 [0]	0	0 [0]	76	75 [58]	21	33 [5]
	I recommend project C	2	0 [0]	0	8	16	25 [3]	7	17 [1]
M4	The state is 4	0	n.a.	0	n.a.	1	n.a.	2	n.a.
	I make no recommendation	3	n.a.	1	n.a.	2	n.a.	2	n.a.

Note: Percentages in table are based on matching group averages. n.a. means that best responses are not available because of insufficient actual occurrences of messages M4. Numbers within brackets reflect the best responses that correspond to the actual message sent.

Workers can either send a message about the state or recommend a project. Workers can also choose not to make a recommendation. Overall in 81% of the cases under strong interest alignment workers send a message about the state. For weak interest alignment this is 76%. There are little differences between the congruent states 1, 2 and 3 and the conflict state 4 in this regard. For state 4 the percentage of messages that reports about the state equals 76% (73%) under strong (weak) alignment, while in the three congruent states this is 81% (80%). Hence, in the conflict state subjects are only slightly less inclined to make a factual statement about the state. But according to signrank tests differences are marginally significant only under weak interest alignment (p-value of 0.51 (0.09) under strong (weak) alignment). [19]

In the three congruent states 1, 2 and 3, workers predominantly announce the true state or otherwise recommend the project that is best for both. However, in state 4 where interests conflict, workers tell an explicitly lie in the majority of cases (75% resp. 71% under strong resp. weak alignment), by stating that the state equals either 2 or 3. Otherwise they typically recommend project B or C. One interpretation of the latter recommendations is that in these cases subjects shy away from explicitly telling a lie. Yet the fact that the fraction of messages about the state relative to making a recommendation is essentially the same for all four states,suggests that subjects do not adapt the type of language they use in the conflict state. Lying aversion therefore does not seem to play a major role. Moreover, only in 3% of the $q = 0.75$ cases (4% for $q = 0.6$) the worker can be considered truly open about being in the conflict state, by sending either "the state is 4" or "I make no recommendation". Lying aversion therefore does not seem to play a major role. (We return to this in the next section.)

Given the pattern in Table 5, for ease of reference we sometimes bundle the different types of messages in the four classes M1 through M4. M1 then corresponds to "The state is 1" and "I recommend project A", et cetera (see the first column in Table 5). With this labelling, workers' behavior can be summarized as follows. Workers truthfully report their type in the congruent states 1, 2 and 3, by using different messages M1, M2 and M3, respectively. In conflict state 4 the worker essentially mixes between M2 and M3, thus neither sending M1 nor M4. Comparing this with the set of neologism proof equilibria listed in Proposition 2, actual worker behavior appears well in line with the Com-(3-mixed) equilibrium. For $q = 0.75$ the mixed strategy of the worker in the conflict state reduces to $\tau_2 = \frac{1}{11}$ and $\tau_3 = \frac{10}{11}$, while for $q = 0.6$ this becomes $\tau_2 = \frac{5}{11}$ and $\tau_3 = \frac{6}{11}$. Actual behavior is such that under strong alignment workers choose M2 in about 43% of the cases where the state equals 4 and M3 in about 54% of these cases (cf. Table 5). Compared to the mixed

[19] Similar results are obtained when we consider the congruent states separately. In state 4 subjects are less inclined to make a factual statement about the state than in state 1, state 2, or state 3. However, the differences are only significant when comparing state 2 and state 4 under weak alignment (p-value of 0.04).

equilibrium, they thus send message M3 substantially less often than predicted (91%). In case of weak interest alignment they choose M3 in about 28% of the cases, again substantially below the 55% predicted. Comparative statics, however, are well in line with theoretical predictions: workers send M3 substantially more often in the conflict state 4 when interests are strongly aligned than when they are weakly aligned.[20]

4.2.2 Managers' responses

Next we look at how the manager reacts to the worker's information. Table 6 shows for each treatment separately, the manager's project choice (in the columns) given the worker's message (in rows). Again the columns with best responses BR are discussed later. Messages that the state equals 1 or that project A is recommended, almost always lead to a choice for A. An announcement that the state equals 2 leads to project B being implemented almost for sure. Yet a recommendation for this project is treated slightly more skeptical, leading to a choice for project A now and then. Likewise, a recommendation for project C is treated more skeptical than a message that the state equals 3 is. After both messages project A is chosen frequently (besides project C), but this happens much more often after the recommendation than after the factual statement.

[20] We also observe mixed strategies at the individual level. Under strong (weak) interest alignment, about 35% (60%) of the workers who observe state 4 more than once choose different messages in these instances, thus providing direct evidence for mixed strategy play. However, managers may effectively be exposed and thus perceive a mixed strategy more often, as they are each period randomly matched with a worker in the matching group. Around 60% (80%) of the managers are exposed to a mixed strategy under strong (weak) alignment.

Table 6: Manager's response to received messages under centralization by treatment

		Project A		Project B		Project C	
Strong alignment (q = 0.75)		Actual	BR	Actual	BR	Actual	BR
M1	The state is 1	99	100 [99]	0	0 [0]	1	0 [0]
	I recommend project A	100	100 [100]	0	0 [0]	0	0 [0]
M2	The state is 2	0	0 [0]	100	100 [100]	0	0 [0]
	I recommend project B	9	30 [3]	91	70 [64]	0	0 [0]
M3	The state is 3	39	0 [0]	7	0 [0]	54	100 [54]
	I recommend project C	63	17 [13]	15	0 [0]	22	83 [20]
M4	The state is 4	100	n.a.	0	n.a.	0	n.a.
	I make no recommendation	10	n.a.	83	n.a.	7	n.a.
Weak alignment (q = 0.6)							
M1	The state is 1	100	100 [100]	0	0	0	0 [0]
	I recommend project A	98	100 [98]	2	0 [0]	0	0 [0]
M2	The state is 2	5	0 [0]	95	100 [95]	0	0 [0]
	I recommend project B	22	45 [13]	78	55 [46]	0	0 [0]
M3	The state is 3	44	25 [13]	10	0 [0]	45	75 [36]
	I recommend project C	62	73 [43]	16	0 [0]	22	27 [0]
M4	The state is 4	88	n.a.	13	n.a.	0	n.a.
	I make no recommendation	39	n.a.	48	n.a.	13	n.a.

Note: Percentages in table are based on matching group averages. n.a. means that best responses are not vailable because of insufficient actual occurrences of messages M4. Numbers within brackets reflect the best responses that correspond to the actual project implemented.

Previously we have seen that (under weak alignment) in the conflict state workers tend to send less often a message about the state than in the congruent states. In line with this, the above observations suggest that managers respond somewhat differently to a message about the state than to a message containing a recommendation. To test this more carefully, we define "following the worker's message" as taking the message to be truthful or as sincere advice, and determine the ratio of "following the worker's message about state t" and "following the worker's message recommending project P". We do so for the three relevant cases M1 ($t = 1$, $P = A$), M2 ($t = 2$, $P = B$), and M3 ($t = 3$, $P = C$). The ratio under strong (weak) alignment equals 0.99 (1.02) for M1, 1.13 (1.28) for M2, and 1.71 (1.54) for M3. According to a Cuzick test for trends the positive trend in the ratio is only significant for the strong alignment treatment (p-value 0.004 under strong alignment and 0.614 under weak alignment). We thus find some weak evidence that factual statements are treated less skeptical than recommendations.

Taken together, and ignoring the differences between factual statements and recommendations, the manager's behavior can be roughly summarized as follows. After M1 the manager always follows and implements project A. After M2 the manager is very likely to follow by choosing project B; only now and then she opts for project A. But if M3 is received, the manager's behavior is more mixed. In that case she is about equally likely to follow by choosing C, as not to follow and opting for project A (in only 9% of the cases the manager chooses B).[21] Comparing this with the equilibria of Proposition 2, also for managers Com-(3-mixed) comes closest. In that equilibrium the manager chooses project A after message m_3 with a probability of 36% and project C with a probability of 64%, irrespective of the level of interest alignment. Actual behavior is such that in the strong alignment treatment managers choose project A in about 42% of the cases and project C in about 50%. Under weak interest alignment, managers choose A in about 47% of the cases and C in about 42%. The manager's actual strategy is thus indeed fairly insensitive to variations in q, just as the mixed strategy equilibrium predicts.[22]

4.2.3 Best response analysis

By and large the data shows that the worker truthfully reports his type when the state is either 1, 2, or 3, and pretends that his type is either 2 or 3 when the state equals 4. The manager typically chooses A after message M1, project B if the message is M2, and switches between project A and C after M3. This combination of strategies is qualitatively in line with the Com-(3-mixed) equilibrium, suggesting that manager and worker are close to best responding to each other. In this subsection we investigate this more carefully.

[21] Messages in the M4 category are hardly ever received (see Table 5), making reliable inferences about the manager's reaction difficult. Moreover, it is a priori not clear what following the worker's message "I make no recommendation" would entail. If anything, note that the manager almost always follows the factual statement that "the state is 4" by choosing project A.

[22] Under strong (weak) interest alignment, around 55% (38%) of the managers respond differently to M3 on the multiple occasions they observe this message, thus pointing at individual level mixed play. Around 67% (80%) of the workers are exposed to a mixed strategy under strong (weak) alignment, i.e. perceive mixed play by the manager.

To determine the worker's best response, we take managers' average behavior in a matching group as the manager's strategy (as before we focus on the final 10 periods). For each state of the world we subsequently determine which message would maximize the worker's payoffs and label this as the best response message. In a number of instances (i.e. matching groups) two different messages induce the manager to make the same choice. For instance, after both "The state is 1" and "I recommend project A" the manager chooses project A. In that case there is no unique best response and we label that as: "1" is equivalent to "A".[23] Both messages in category M1 are then in line with best response. The columns labelled BR in the earlier Table 5 report the average (of the matching group averages) percentage of cases in which the message in question would be the worker's best response. The fraction of actual messages that is in line with the best response is reflected in brackets in the columns labelled BR. We leave the messages from the M4 category out of the analysis, as these are hardly ever sent so no reliable estimates of the manager's response to these messages can be inferred.

In state 1 the worker is almost always best responding. The worker then should either send "the state is 1" or "I recommend project A", and often both are equally good (in overall 54% of the cases that state 1 occurs). Indeed, the worker hardly ever sends a message outside M1. Similar observations can be made regarding states 2 and 3, where workers should and indeed do pick a message from M2 and M3, respectively. However, while under strong alignment in state 3 workers rightfully choose a message from M3, they tend to send more often a recommendation and less often a message about the state than would be optimal given the manager's behavior. Workers deviate from best response when the state is 4. Then, under strong interest alignment, workers actually send M3 somewhat more often and M2 somewhat less often than would be optimal given managers' behavior. In the weak alignment treatment we see the opposite. There M2 is sent more often and M3 less often as compared to best response. In both treatments workers send a message recommending project B more often than would be optimal.

In a similar way we determine the manager's best response. Now we take workers' average behavior in a matching group as the worker's strategy. We use this to determine for each message

[23] In some cases "I recommend project C" also leads to the manager choosing project A. Again there is no unique best response in these cases. For ease of presentation we do not label these cases separately, but include them either in category "The state is 1" or in category "1" is equivalent to "A". More precisely, under strong (weak) alignment in category "The state is 1" the fraction 38% (42%) is a combined fraction; 8%(25%) have "The state is 1" as unique best response, while 31% (17%) "The state is 1" and "I recommend project C" are best responses. Furthermore, under weak alignment in category "1" is equivalent to "A" 42% have "The state is 1" and "I recommend project A" as best response, while for 17% "The state is 1", "I recommend project A", and "I recommend project C" are best responses.

received which project maximizes the manager's payoff. From Table 6 it can be observed that the manager best responds to messages in M1. This is also the case when message "the state is 2" is received. However, after "I recommend project B" the manager is too credulous. Under both strong and weak interest alignment project B is chosen too often; the manager would benefit from choosing project A more frequently. In contrast, the factual statement that the state equals 3 is on average treated too skeptical. Managers then frequently opt for project A while project C is either always (under strong alignment) or very often (under weak alignment) the best response. A similar observation holds when the worker "recommends project C" under strong interest alignment; this advice is treated too skeptical. Under weak alignment such an advice is by and large interpreted appropriately.

In sum, the best response analysis reveals that workers rightfully use different messages in the three congruent states 1, 2 and 3, respectively. Nevertheless, (only) in state 3 they tend to send a recommendation (for project C) too frequently; workers would have done better if they would have made the factual statement 'the state is 3' instead. In state 4 the worker chooses between M2 and M3, and given the manager's response this is indeed the right thing to do. The exact frequencies with which M2 and M3 are chosen do not match the best responses, but deviations are in opposite directions for the two interest alignment treatments. In that sense workers do not seem to make systematic mistakes, but rather miscalibrate in the exact mixing probabilities. A similar conclusion applies for managers; we do not find systematic evidence that they are too credulous (or too skeptical).

4.2.4 Actual versus predicted payoffs

In both treatments there are two neologism proof communication equilibria: Com-(2) and Com-(3-mixed). The former yields expected payoffs of $80 - \frac{50}{3}q$ per period for the manager and the worker alike, i.e. 67.5 on average when $q = \frac{3}{4}$ and 70 in case $q = \frac{3}{5}$. The expected payoffs in Com-(3-mixed) equal $80 - \frac{260}{33}q$ for the manager and $80 + \frac{40}{33}q$ for the worker. This corresponds to 73.95 and 80.91 respectively under strong interest alignment, and to 75.16 and 80.73 under weak alignment.

Table 7 depicts the actual and predicted payoffs; again the predicted values differ slightly from the ones above due to the actual realized draws of states. Except for workers under weak interest alignment, both the manager and the worker obtain significantly larger payoffs than the Com-(2) equilibrium predicts. In fact, for managers the actual payoffs are not significantly different from the predicted payoffs under Com-(3-mixed). Yet workers earn significantly less than predicted in the mixed strategy equilibrium.

Table 7: Actual and predicted payoffs under centralization

	$q = 0.75$	$q = 0.6$	p-value
Manager's payoffs			
Actual	72.0	74.4	0.34
Predicted: Com-(2)	67.3	69.0	<0.001
Predicted: Com-(3-mixed)	74.3	74.8	<0.001
Actual vs Predicted: Com-(2) (p-value)	0.03	0.02	
Actual vs Predicted: Com-(3-mixed) (p-value)	0.17	0.81	
Worker's payoffs			
Actual	74.7	68.4	0.09
Predicted: Com-(2)	67.3	69.0	<0.001
Predicted: Com-(3-mixed)	81.0	80.3	<0.001
Actual vs Predicted: Com-(2) (p-value)	0.01	0.81	
Actual vs Predicted: Com-(3-mixed) (p-value)	0.02	0.00	

Note: The p-values in the last column are from ranksum tests using matching group averages. The other p-values are from signed rank tests.

4.3 Choice between centralization and delegation

In the third part of the experiment, the manager chooses whether to delegate the project choice to the worker or to make the choice himself. Theoretically, this choice can go either way, depending on whether or not parties are able to coordinate on the mixed equilibrium under communication. The data reveal that over all 20 periods, the manager delegates in 40% of the cases under strong interest alignment and in 36% under weak interest alignment. The difference between treatments is insignificant according to a ranksum test ($p = 0.48$). Moreover, the delegation fraction is significantly lower than 50% (under weak [strong] alignment $p = 0.01$ [$p = 0.06$] according to a signrank test), implying that the manager chooses less often to delegate than to communicate. In the previous subsections we have seen that actual payoffs under Delegation are typically smaller than predicted, while under Centralization payoffs for the manager are well in line with the most profitable Com-(3-mixed) equilibrium. This may explain the low proportion of delegation. Indeed, if we look at the correlation between delegation fractions and the relative profits of delegation vs. communication in the first two parts, we find that managers who in previous parts received a higher profit under delegation than under centralization are more likely to delegate in part III. Under strong interest alignment the (Spearman) correlation equals 0.60 whereas under weak interest alignment it equals 0.64. In both cases it is highly significant ($p < 0.001$).[24]

Part III behavior under each of the two organizational designs is closely in line with subjects' behavior when the design at hand is exogenously given (as in parts I and II). The endogenous choice between delegation and centralization thus appears to have little impact on behavior per se. In case delegation is chosen, the manager puts restrictions on the worker similar as in Table 2. The average number of allowed projects equals 2.8 under strong alignment, significantly higher than the 2.0 under weak alignment ($p < 0.001$).[25] The worker again typically chooses the project that maximizes his payoffs given his allowed choice set and the state.

Under communication the worker almost always sends message Mt in the congruent states $t \in \{1, 2, 3\}$. In the conflict state 4, the worker mixes between M2 and M3. Under strong alignment each of these two messages is then chosen about equally often, under weak alignment M2 is chosen substantially more often than M3 is. The manager almost always follows M1 by implementing project A, and in the far majority of cases implements project B after M2. Finally, if M3 is received, then the manager implements Project C in about 50% of the cases independent of the level of interest alignment. Overall the worker is thus equally willing to share information as in the exogenous communication part, even though now delegation was an explicit option but forfeited by the manager.

Average payoffs also follow a similar pattern as observed in the exogenous parts. As Table 8 reveals, the manager earns about the same under centralization as under delegation in the strong alignment treatment. In the case of weak alignment the manager earns significantly more under centralization. The worker receives a significantly larger average payoff under delegation than under centralization in the strong alignment treatment. In case of weak alignment differences are not significant.

[24]No significant correlations are found with items in the ex post questionnaire that relate to control, power and authority.

[25]The distributions over Del-(3), Del-(2) and Del-(1) are now somewhat more pronounced: 82%, 16% and 2% for $q = \frac{3}{4}$ and 8%, 83% and 9% for $q = \frac{3}{5}$.

Table 8: Actual payoffs by organizational design

	$q = 0.75$	$q = 0.6$	p-value
Manager's payoffs			
Delegation	76.2	68.7	0.00
Centralization	76.0	75.9	0.97
Del. vs Cen. (p-value)	0.91	0.00	
Worker's payoffs			
Delegation	91.4	69.2	0.00
Centralization	75.4	67.6	0.06
Del. vs Cen. (p-value)	0.00	0.69	

Note: The p-values in the last column are from ranksum tests using matching group averages. The other p-values are from signed rank tests.

5 Discussion

The overall pattern of behavior that we observe in the experiment appears well in line with standard strategic motives; by and large subjects play according to Com-(3-mixed). This raises at least two issues. First, given existing empirical evidence, the apparent limited role of lying aversion and credulity under communication is rather surprising, thus begging the question what makes our experiment different. Second, what makes that subjects are able to quickly coordinate on Com-(3-mixed)? In this section we address these two questions in turn.

5.1 Lying aversion and credulity

5.1.1 Lying aversion

As discussed in Subsection 4.2.1, lying aversion does not seem to be a strong driver behind worker's actual messages. In the conflict state 4 workers tell an outright lie (by sending either 'the state is 2' or the 'state is 3') in about 71-75% of the cases. Otherwise they typically recommend either project B or C. Although not an explicit lie, the latter recommendations have the flavor of trying to fool the manager about the actual state (for otherwise the worker could have said "The state is 4" or "I make no recommendation"). The overall pattern of communication is thus very much in line with standard strategic motives. This is somewhat surprising. As Sobel (forthcoming) notes, the existing experimental evidence namely suggests that agents are more honest and more credulous than equilibrium theory suggests, with lying aversion being one of the main explanations. It thus begs the question whether either our subject pool is somewhat special, or rather the strategic situation that we consider. The latter may be due to the fact that in our setting sender and receiver often have common interests (i.e. in the congruent states), and the sender is best off telling the truth. This may make lying in the conflict state less problematic, as this state only occurs now and then. This is different in experimental tests of the standard Crawford-Sobel framework like Cai and Wang (2006), where the alignment of interests is state independent and the sender effectively always has an incentive to portray the state differently than it actually is. Another factor here might be that our design is based on messages of a fixed format. Typically this leads to more lying than a free format chat does (cf. Charness and Dufwenberg, 2010).

Part IV of our experiment sheds some light on whether our subject pool is special. Here we measure lying aversion of workers (and credulity of managers, see the next subsection) using an adjusted version of the experiment by Gneezy et al (2013). In particular, workers in the earlier parts are assigned role A, while former managers are assigned role B. Each randomly matched pair of A and B is assigned an integer out of 1 to 6, of which only subject A is informed. Subject A sends a message m about the assigned number to subject B. The higher the message she sends, the more A earns, irrespective of the actual number assigned to the pair. In particular, A earns $500 + 100m$. Subject B can either follow ('believe') A's message, then earning 500 only if the message equals the number actually assigned, or not follow and getting 150 points for sure. The strategy method is employed, asking A for her message for any number that might be assigned and asking B for his decision for any message that he might receive. After A and B make their decisions, the choices that result from the random number actually assigned to the pair are carried out. Note that this is a sender-receiver game with a high conflict of interests; the single equilibrium outcome is $m = 6$ and 'not follow'.

In total 115 workers made decisions in part IV. Of these, 25% always reported truthfully while 50% always reported 6. The reports of the remaining 25% were more mixed. These findings suggest that the fraction of lying averse subjects lies somewhere in between 0.25 and 0.5, which seems to accord reasonably well with the findings in earlier (either constant or high conflict) experiments. Yet these numbers do not match with our finding in the centralization game that true honesty occurs in less than 5% of the conflict cases (state 4). Apparently those who are averse to lying in the high conflict game of part IV have less of a problem with it in the centralization game where interests are often (but not always) aligned.

A similar conclusion follows from correlating individual lying behavior in the two different parts. Let $m(i;j)$ denote the message worker j sends in part IV if the assigned number to the pair equals i. Then $L_j = \sum_{i=1}^{6} |m(i;j) - i|$ measures the extent to which j is prone to lying. If a worker always tells the truth $L_j = 0$, whereas if a worker always reports 6 it holds that $L_j = 15$. To arrive at an individual measure of lying behavior in the centralization game, we calculate the proportion of cases in which the worker lies out of all cases where conflict state 4 occurs.[26] We consider two different versions. In the first we employ a literal (or strict) definition of lying: lying in state 4 corresponds to sending a message that the state is 1, 2, or 3. So recommending a project is not seen as lying. The Spearman correlation between this individual measure of lying behavior and L_j appears to be small (0.03) and insignificant (p-value of 0.81).[27] In the second version lying in state 4 equals sending a message different than 'The state is 4', 'I recommend Project A', or 'I make no recommendation '. So here recommending either project B or C is considered lying. Also for this less strict (and arguably inferior) measure of lying, the Spearman correlation with L_j is small (0.08) and insignificant (p-value of 0.47).[28] Overall we therefore conclude that our strategic situation makes that even in principle lying averse subjects, have no problem telling a lie only now and then.

5.1.2 Credulity

To assess the role of credulity we use the manager's following behavior in part IV to construct an individual measure of credulity. Let $r(i;j) \in \{0,1\}$ denote whether (1) or not (0) manager j follows message i. Then $C_j = \sum_{i=1}^{6} r(i;j) * (i-1)$ measure the extent to which j is credulous. The idea behind this measure is that following after message 1 is not credulous. Besides in the true state 1 for truth-telling reasons, there are no other states in which subject A has an incentive to lie and

[26] Here we focus on parts I and II. For part III we get simliar results. Note, however, that in part III the group of workers playing the centralization game is not random. Only workers who are coupled with a manager who chose centralization are considered and the manager's decision is likely to be influenced by worker behavior in previous parts.

[27] An alternative measure of lying proneness follows from the 10 items taken from Lundquist et al (2009) included in the ex post questionnaire. Participants answered these items on a 1 (fully disagree) to 7 (fully agree) scale. Let $\widetilde{L}_j = \sum_{i=1}^{10} s(i)$, with $s(i)$ the score on item i. The Spearman rank correlation between $\widetilde{L}_j$ and L_j is small (0.11) and insignificant (p-value of 0.23). This also holds for the correlation between $\widetilde{L}_j$ and the proportion of lying in the centralization game (0.14 with a p-value of 0.17).

[28] The Spearman rank correlation between $\widetilde{L}_j$ (measure based on questionnaire data) and the second measure of proportion of lying in the centralization game is small and not significant (0.13 with a p-value of 0.22).

report 1. This is different for message 6. Apart from when the state is indeed 6 (truth-telling), there are five other states where A has an incentive to lie and report 6. Following after message 6 is thus particularly credulous. The overall measure C_j weighs all the messages accordingly. It ranges from 0 (not credulous at all and only follow when message is one) to 15 (always follow, irrespective of A's message).

Of the 115 managers, almost 45% always decided to follow (so has $C_j = 15$). 7% is not credulous at all and only follows after message 1 (i.e. $C_j = 0$). To investigate to what extent credulity can explain manager behavior under centralization, we determine the proportion of cases in which the manager chooses to follow the worker's message.[29] As previously discussed messages in M1 are sent only in state 1 and the manager best responds to these. Credulity is therefore best measured when the manager receives M2 or M3. We calculate the proportion of cases in which the manager chooses to implement project B after receiving M2 or project C after receiving M3. The Spearman correlation between this proportion and C_j equals 0.15 and is marginally significant (p-value equals 0.10).[30] A similar conclusion follows if we look at factual statements and recommendations in isolation. The Spearman correlation between C_j and the proportion of cases in which the manager chooses to follow the worker's message 'the state is 2' or 'the state is 3' is 0.07 and insignificant (p-value 0.46). For messages recommending B or C the correlation with C_j equals 0.19 (p-value 0.08).

A potential drawback of our individual measure of credulity is that in many cases implementing project B after M2 or project C after M3 is the best response. To account for this we construct an alternative measure where we eliminate the cases where the manager is best responding. Hence, we calculate the proportion of cases in which the manager chooses to implement project B (C) when the manager receives M2 (M3) and implementing project B (C) is not a best response. The Spearman correlation between this proportion and C_j is small (0.14) and insignificant (p-value equals 0.13). Taken together, also credulity does not appear a strong driver of behavior under centralization.

[29] The manager follows the worker's message if he considers statements about the state as true, follows the worker's recommendation, and decides on the basis of the prior belief if the worker makes no recommendation.

[30] Again we focus on the data from Part I and II. The results for Part III data are similar, yet have to be interpreted with caution as only managers who at least once decided to keep the decision rights are included.

5.2 Equilibrium coordination

In our two treatments two (neologism proof) equilibria exist side by side: Com-(2) and Com-(3-mixed). In the experiment subjects are by and large able to coordinate on the latter. One potential explanation might be that the Com-(3-mixed) equilibrium Pareto dominates the Com-(2) equilibrium; both worker and manager are better off in the former. Yet it is unrealistic to assume that inexperienced subjects will play according to the 'best' equilibrium from scratch, if alone because it is not straightforward for them how to derive the Com-(3-mixed) equilibrium. In this subsection we therefore provide a (highly simplified) and more exploratory analysis of what may move subjects towards the Com-(3-mixed).outcome.

The three communication equilibria in which some information is revealed (Com-(2), Com-(3) and Com-(3-mixed)) can all be captured by the same general structure: worker type $t = 1$ sends m_1, $t = 2$ sends m_2, and types $t = 3$ and $t = 4$ send either m_2 or m_3. After m_1 the manager chooses A for sure, after m_2 she chooses B for sure, and after m_3 she chooses either A, B or C. As before, let $\tau_2 = \Pr(m_2|t = 4)$ and $\tau_3 = \Pr(m_3|t = 4) = 1 - \tau_2$, and define $\sigma_2 = \Pr(m_2|t = 3)$ and $\sigma_3 = \Pr(m_3|t = 3) = 1 - \sigma_2$ similarly. Moreover, again let α_{3a} be the probability that the manager chooses project $a \in \{A, B, C\}$ after message m_3. The three equilibria then follow from inserting the appropriate values for σ_2, σ_3, τ_2, τ_3 and α_{3A}, α_{3B} and α_{3C}. Note that this is a simplified representation of the communication game, as it fixes the behavior of the $t = 1$ and $t = 2$ worker types from the outset, as well as the manager's reaction to messages m_1 and m_2. These simplifying assumptions are well in line with our experimental data though.

Although not a dynamic concept, some intuition for why subjects are able to coordinate over time can be obtained from looking at the quantal response equilibrium (QRE) in the above simplified setup (McKelvey and Palfrey, 1995, 1998). QRE assumes that people are not perfectly maximizing, yet choose better responses with higher probability. Decision making is thus noisy, but there is "common knowledge of noise": players are aware of the noise in others's choices, and beliefs about others's behavior are correct on average (cf. Goeree et al, forthcoming). QRE includes a rationality parameter $\lambda \geq 0$, reflecting the extent to which choices are responsive to expected payoff differences between choice options. For $\lambda = 0$ they are not and players choose randomly from the available options, while for $\lambda \to \infty$ they choose a best response with probability one.

Figure 1 plots the values of the relevant choice probabilities in the QRE of the above simplified game as a function of λ.[31] It reveals that the probabilities converge to the Com-(3-mixed) equilib-

[31] The QRE follows from the solution to the following five equations, where we have written β_3 as shorthand for

rium if the rationality parameter goes to infinity. Intuitively, this can be understood as follows. For the manager, expected payoffs are always second best when choosing B after m_3; for any belief about the worker's type he might have, there is a better choice (viz. either A or C). When the rationality parameter increases, B is thus chosen less and less often after m_3 and the manager essentially chooses between A and C. For the worker it holds that the $t = 3$ type has a stronger incentive to choose m_3 than type $t = 4$ has. Hence: $\sigma_3 \geq \tau_3$ necessarily. Starting from $\beta_3 = \frac{q}{3-2q}$ for $\lambda = 0$, posterior belief β_3 thus tends to increase with λ towards $\beta_3 = \frac{11}{21} \approx 0,52$, i.e. the value at which the manager is indifferent between A and C. This makes that the QRE converges to Com-(3-mixed) as λ increases.

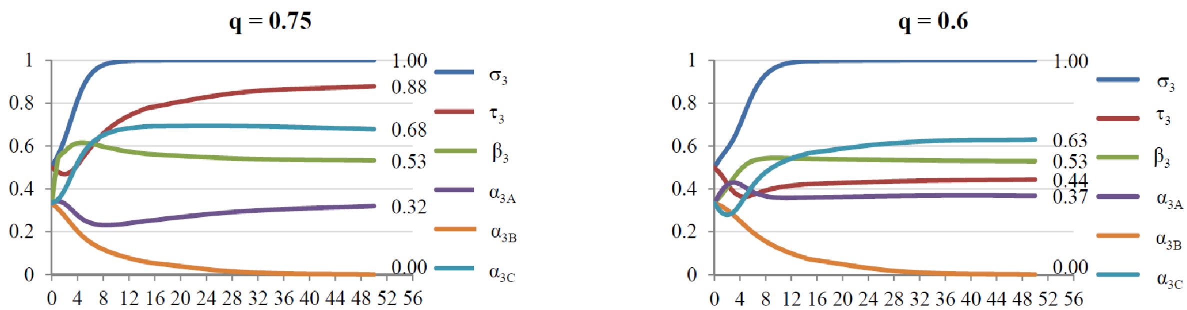

Figure 1: QRE probabilities as function of λ

Similar forces operate in a level-k analysis of the above simplified setup. Level-k models allow for heterogeneity between subjects and assume that level-k players L_k best respond against L_{k-1}. Beliefs about others' choices / cognitive level need not be correct though, hence it reflects a non-equilibrium approach. Key and degree of freedom in any level-k model is the assumption about

$\beta_3 (m_3)$, i.e. the manager's posterior belief that $t = 3$ after having received message m_3:

$$\sigma_3 = \frac{\exp \lambda (10 - 10\alpha_{3A} + 90\alpha_{3C})}{\exp \lambda (10 - 10\alpha_{3A} + 90\alpha_{3C}) + \exp \lambda (10)}$$

$$\tau_3 = \frac{\exp \lambda (80 - 70\alpha_{3A} + 40\alpha_{3C})}{\exp \lambda (80 - 70\alpha_{3A} + 40\alpha_{3C}) + \exp \lambda (80)}$$

$$\beta_3 = \frac{\sigma_3 \cdot q}{\sigma_3 \cdot q + \tau_3 \cdot 3 (1-q)}$$

$$\alpha_{3A} = \frac{\exp \lambda (120 - 120\beta_3)}{\exp \lambda (120 - 120\beta_3) + \exp \lambda (80 - 70\beta_3) + \exp \lambda (10 + 90\beta_3)}$$

$$\alpha_{3C} = \frac{\exp \lambda (10 + 90\beta_3)}{\exp \lambda (120 - 120\beta_3) + \exp \lambda (80 - 70\beta_3) + \exp \lambda (10 + 90\beta_3)}$$

Note that: $\tau_2 = 1 - \tau_3$, $\sigma_3 = 1 - \sigma_2$ and $\alpha_{3B} = 1 - \alpha_{3A} - \alpha_{3C}$. As σ_2 and τ_2 are simply the complements of σ_3 and τ_3, they have been left out from Figure 1. Moreover, Figure 1 is in fact based on the normalized version of the game where all payoffs in Table 1 (and thus in the formulas above) are divided by the maximum payoff possible, viz. 120.

how the nonstrategic level-0 players behave. Assuming that level-0 workers choose m_2 or m_3 with equal probabilities after both $t = 3$ and $t = 4$, and level-0 managers choose A, B or C with equal probabilities after message m_3, the following choices for the different levels emerge:

Table 9: Exploratory level-k analysis of simplified setup

Worker	$t = 1$	$t = 2$	$t = 3$	$t = 4$	Manager	m_1	m_2	m_3
L_0	m_1	m_2	m_2 or m_3	m_2 or m_3	L_0	A	B	A, B or C
L_1	m_1	m_2	m_3	m_2	L_1	A	B	A
L_2	m_1	m_2	m_2	m_2	L_2	A	B	C
L_3	m_1	m_2	m_3	m_3	L_3	A	B	A or C

Note: for higher order levels we have $L_4 = L_1$, $L_5 = L_2$ et cetera.

The behavior of level-1 workers reflects that a best responding worker has a stronger incentive to choose m_3 when $t = 3$ than when $t = 4$. Similarly so, a best responding manager would never choose B after having received m_3. Qualitatively our aggregate experimental data are in line with the above behavior if the distribution of subjects over level types put little mass on L_0 (as in the experiment managers do not choose B after m_3), and a higher mass on L_1 than on L_2 (to accommodate that the $t = 3$ worker does not often send m_2). This seems well in line with the empirical distributions over level types typically observed (cf. Lai and Lim, 2012). Moreover, it may also explain why managers more often opt for project A (instead of C) after message m_3 than Com-(3-mixed) and our best response analysis predicts. Obviously the above level-k analysis is highly simplified and for illustrative purposes only. However, it does suggest that our experimental data could also be explained by some (more elaborate) level-k models as in e.g. Lai and Lim (2012).

6 Conclusion

In this paper we report the results from a laboratory experiment investigating a manager's decision whether to delegate decision authority to a better informed worker. The manager can keep authority and communicate with the worker, but divergent interests imply that workers communicate their information strategically. Alternatively, the manager can delegate the decision to the worker. A key characteristic of our setup is that the manager can restrict the agent's choice set when delegating authority ('restricted delegation'). Another key feature of our experimental design is that the worker's message should either be a factual statement about the state, or a recommendation about which project choice to make (or no recommendation at all). We find that, as expected, delegating managers put tighter restrictions if interests are less aligned. Workers send more informative messages under communication than predicted by the pure strategy equilibria. This finding neither appears to be driven by lying aversion of workers nor by credulity of managers. Qualitatively, our results are in line with a mixed strategy equilibrium under communication, which strictly outperforms optimal restricted delegation and is relatively close to the optimal stochastic mechanism in our setting.

A priori we expected 'over'-communication as compared to standard theory due to some subjects being lying averse. Although we do not find a big impact of lying aversion in our setting where interests are more often than not congruent, other cheap talk experiments like Cai and Wang (2006) do find over-communication if interests are always partly opposed. This seems to make communication rather than (restricted) delegation particularly attractive in these cases. At the same time it also suggests a potential way for managers to improve outcomes under delegation. If, after delegation, the worker is still required to send a message about the state – for instance as to justify or explain his choice of project – some workers may feel reluctant to lie and in turn also hesitant to choose the project that hurts the manager the most. Instead of restricting the worker's choice set to curb opportunistic behavior, it may in practice thus pay for the manager to let the worker feel accountable for his choices via a cheap talk justification. Investigating whether this would make unrestricted delegation more attractive for behavioral reasons seems an interesting avenue for future research.[32]

In our experiment workers can make factual statements as well as recommendations. Another issue worthwhile to explore further is to compare situations where subjects are restricted to factual statements only with situations in which they can only give advice. A priori one would expect that more information is communicated if messages have a literal meaning and it is thus rather clear to everyone what would be considered a lie. In contrast, when only recommendations are allowed, one would expect the worker to be less informative in the conflict state, essentially reverting to more vague communication as in Serra-Garcia et al (2011).

[32] See Xiao (2015) for a recent experiment investigating justification effects in a revised sender receiver game.

References

[1] Agastya, M., Bag, P.K. and I. Chakraborty, 2014, Communication and authority with a partially informed expert, *Rand Journal of Economics* 45, 176-197.

[2] Alonso, R. and N. Matouschek, 2007, Relational delegation, *Rand Journal of Economics* 38, 1070-1089.

[3] Alonso, R. and N. Matouschek, 2008, Optimal delegation, *Review of Economic Studies* 75, 259-293.

[4] Bartling, B., Fehr, E. and H. Herz, 2014. The intrinsic value of decision rights. *Econometrica* 82, 2005-2039.

[5] Bartling, B. and U. Fischbacher, 2012. Shifting the blame: On delegation and responsibility, *Review of Economic Studies* 79(1), 67-87.

[6] Battaglini, M., Lai, E.K., Lim, W. and J.T. Wang, 2016. The informational theory of legislative committees: An experimental analysis, working paper.

[7] Blume, A., D.V. DeJong, Y.G. Kim, and G.B. Sprinkle, 1998. Experimental Evidence on the Evolution of Meaning of Messages in Sender-Receiver Games. *American Economic Review,* 88, 1323–1340

[8] Blume, A., D.V. DeJong, Y.G. Kim, and G.B. Sprinkle, 2001. Evolution of Communication with Partial Common Interest. *Games and Economic Behavior,* 37, 79–120.

[9] Brandts, J. and D. Cooper, 2015. Centralized vs. decentralized management: An experimental study, working paper.

[10] Cai, H. and J.T-Y. Wang, 2006. Overcommunication in strategic information transmission games, *Games and Economic Behavior* 56, 7-36.

[11] Charness, G. and M. Dufwenberg, 2010. Bare Promises: An Experiment, *Economics Letters* 107, 281-283.

[12] Coffman, L.C., 2011. Intermediation reduces punishment (and reward), *American Economic Journal: Microeconomics* 3(4): 77-106.

[13] Crawford,V, and J. Sobel, 1982. Strategic Information Transmission. *Econometrica*, 50, 1431–1451.

[14] Dessein, W., 2002. Authority and communication in organizations. *Review of Economic Studies* 69, 811-838.

[15] Dominguez-Martinez, S., Sloof, R. and F.A. von Siemens, 2014. Monitored by your friends, not your foes: Strategic ignorance and the delegation of real authority, *Games and Economic Behavior*, 85, 289–305.

[16] Evdokimov, P. and U. Gargagnini, 2015. Mend your speech a little: Authority, communication, and incentives to coordinate, working paper.

[17] Falk, A., and M. Kosfeld. 2006. The Hidden Costs of Control. *American Economic Review*, 96(5), 1611-1630.

[18] Farrell, J., 1993. Meaning and Credibility in Cheap-Talk Games. *Games and Economic. Behavior*, 5, 514–531.

[19] Fehr, E., Herz, H. and T. Wilkening, 2013. The Lure of Authority: Motivation and Incentive Effects of Power. *American Economic Review*, 103(4), 1325-1359.

[20] Fershtman, C. and U. Gneezy, 2001. Strategic delegation: An experiment. *Rand Journal of Economics*, 32(2), 352-358.

[21] Filiz-Ozbay, E., and E.Y. Ozbay, 2007. Auctions with Anticipated Regret: Theory and Experiment. *American Economic Review*, 97(4), 1407-1418.

[22] Fischbacher, U., 2007. z-Tree: Zurich Toolbox for Ready-made Economic Experiments. *Experimental Economics*, 10(2), 171-178.

[23] Garfagnini, U., Ottaviani, M. and P.Norman Sørensen, 2014. Accept or reject? An organizational perspective, *International Journal of Industrial Organization* 34, 66-74.

[24] Gneezy, U., 2005. Deception: The Role of Consequences. *American Economic Review*, 95(1), 384-394.

[25] Gneezy, U., B. Rockenbach, and M. Serra-Garcia, 2013. Measuring Lying Aversion. *Journal of Economic Behavior and Organization,* 93, 293-300.

[26] Goeree, J.K., Ph. Louis, and J. Zhang, forthcoming. Noisy introspection in the "11-20" game, *Economic Journal*.

[27] Goltsman, M., Hörner, J., Pavlov, G. and F. Squintani, 2009, Mediation, arbitration and negotiation, *Journal of Economic Theory* 144, 1397-1420.

[28] de Haan, Th., Offerman, Th. and R. Sloof, 2015. Money talks? An experimental investigation of cheap talk and burned money, *International Economic Review* 56, 1385-1426.

[29] Hamman, J.R., Loewenstein, G. and R.A. Weber, 2010. Self-interest through delegation: An additional rationale for the principal-agent relationship, *American Economic Review*, 100(4), 1826-1846.

[30] Hamman, J.R., and M.A. Martínez-Carrasco, 2015, Making the tough choices: Delegation and team selection in organizations, Working paper.

[31] Holmstrom, B., 1984. On the theory of delegation, in M. Boyer and R. Kihlstrom (eds.), *Bayesian Models in Economic Theory*, North-Holland, New York.

[32] Jensen, M.C. and W.H. Meckling, 1992. Specific and general knowledge and organizational structure, in L. Werin and H. Wijkander (eds.), *Contract Economics*, Blackwell, Oxford.

[33] Kartik, N., 2009. Strategic communication with lying costs. *Review of Economic Studies*, 76 (4), 1359–1395.

[34] Kováč, E. and T. Mylovanov, 2009, Stochastic mechanisms in settings without monetary transfers: The regular case, *Journal of Economic Theory* 144, 1373-1395.

[35] Laffont, J.-J. and D. Martimort, 2002. *The theory of incentives: The principal-agent model*, Princeton University Press.

[36] Lai, E.K. and W. Lim, 2012. Authority and communication in the laboratory. *Games and Economic Behavior*, 74, 541-560.

[37] Lundquist, T., T. Ellingsen, E. Gribbe, M. Johannesson, 2009. The aversion to lying. *Journal of Economic Behavior and Organization,* 70(1), 81-92.

[38] McKelvey, R.D. and T.R. Palfrey, 1995. Quantal response equilibria for normal form games, *Games and Economic Behavior*, 10, 6-38.

[39] McKelvey, R.D. and T.R. Palfrey, 1998. Quantal response equilibria for extensive form games, *Experimental Economics,* 10, 9-41.

[40] Mylovanov, T., 2008. Veto-based delegation, *Journal of Economic Theory* 138, 297-307.

[41] Ottaviani, M., 2000. The economics of advice. mimeo.

[42] Pitchik, C., and A. Schotter, 1987. Honesty in a model of strategic information transmission. *American Economic Review,* 77 (5), 1032-1036.

[43] Oosterbeek, H., R. Sloof, and J. Sonnemans, 2011. Rent-seeking versus productive activities in a multi-task experiment. *European Economic Review*, 55 (5), 630-643.

[44] Owens, D., Grossman, Z. and R. Fackler, 2014. The control premium: A preference for payoff autonomy, *American Economic Journal: Microeconomics* 6(4): 138-161.

[45] Rush, A, Smirnov, V. and A. Wait, 2010. Communication Breakdown: Consultation or Delegation from an Expert with Uncertain Bias, *The B.E. Journal of Theoretical Economics* 10(1), 1-27.

[46] Serra-Garcia, M., E. Van Damme, and J. Potters, 2011. Hiding an inconvenient truth: Lies and vagueness, *Games and Economic Behavior*, 73, 244-261.

[47] Sloof, R. and F. von Siemens, 2015. Decision initiation, decision implementation, and the allocation of decision rights, Tinbergen Institute Discussion Paper TI 2015-105/VII.

[48] Sobel, J., 2013. Giving and Receiving Advice, in: Advances in Economics and Econometrics, D. Acemoglu, M. Arellano and E. Dekel (eds.).

[49] Sobel, J., forthcoming. Ten possible experiments on communication and deception, *Journal of Economic Behavior and Organization.*

Appendix A: proofs

Proof of Proposition 1. We first show that Del-(3), Del-(2) and Del-(1) are the three relevant options to consider. Assuming that the worker always implements his most preferred project, it is never optimal for the manager to set $\Delta = \{B\}$, as this choice is dominated by $\Delta = \{A, B\}$. Clearly, $\Delta = \{C\}$ can never be optimal either, because project C is dominated by project B in expected payoff terms. Finally, $\Delta = \{A, C\}$ and $\Delta = \{B, C\}$ make no sense because full delegation would always yield the manager strictly more.

The optimal level of delegation thus follows from comparing the manager's expected payoffs in the three relevant cases. Under Del-(3) the manager earns $\frac{q}{3}(80 + 100 + 100) + (1 - q)\,10 = 10 + \frac{250}{3}q \equiv \Pi_{Del-(3)}$, under Del-(2) he gets $\frac{q}{3}(80 + 100 + 10) + (1 - q)\,80 = 80 - \frac{50}{3}q \equiv \Pi_{Del-(2)}$ and under Del-(1) he earns $\frac{q}{3}(80) + (1 - q)\,120 = 120 - \frac{280}{3}q \equiv \Pi_{Del-(1)}$. Comparing these payoffs, the thresholds for q are obtained. ■

Proof of Proposition 2. Throughout the proof we define as 'equilibrium message' a message that is sent with positive probability in equilibrium. Moreover, we consider two equilibrium messages as being 'different' iff they induce a different probability distribution over project choices. The general structure of the proof is to first show that there is always an equilibrium message m_1 inducing project A for sure. Subsequently it is shown that in equilibria with two different equilibrium messages, types $t = 1$ and $t = 2$ necessarily fully separate, and if three (or more) different equilibrium messages are sent, types $t = 1$, $t = 2$ and $t = 3$ always fully separate.

We first show that in a neologism proof equilibrium, there necessarily exists an equilibrium message m_1 that induces project A for sure. Suppose not. Then type $t = 1$ could profitably send the neologism "Choose A, because my type belongs to $\{1\}$". None of the other types would then have an incentive to mimic (as project A gives them their lowest possible payoff), while $t = 1$ strictly gains. Therefore, if only one message m_1 is sent in equilibrium (pooling), it must induce A. Types $t = 2$ through $t = 4$ then would strictly gain if they could induce the manager to choose B with positive probablity instead; the neologism "Choose B, because my type belongs to $\{2, 3, 4\}$" is credible iff $q \geq \frac{12}{23}$. In a similar vein, the neologism "Choose C, because my type belongs to $\{3, 4\}$" is credible iff $q \geq \frac{33}{43}$. Hence pooling on m_1 is neologism proof iff $q < \frac{12}{23}$. This gives part 2(c).

Next consider equilibria with two different equilibrium messages, m_1 and m_2. Let α_{ia} be the probability that the manager chooses project $a \in \{A, B, C\}$ after message m_i. From the above, $(\alpha_{1A}, \alpha_{1B}, \alpha_{1C}) = (1, 0, 0)$ necessarily. First, suppose $\alpha_{2B} > 0$. Then types $t = 2$ through $t = 4$ all strictly prefer, and thus choose, m_2 over m_1. After message m_2 the manager then prefers A if $q < \frac{12}{23}$ and B otherwise. The former case corresponds to the pooling outcome of part 2(c). The latter case corresponds to the Com-2 outcome of part 2(b). The upper bound $q < \frac{33}{43}$ there follows from the neologism "Choose C, because my type belongs to $\{3, 4\}$" being credible iff $q \geq \frac{33}{43}$. Second, suppose $\alpha_{2B} = 0$. For m_1 and m_2 to be different, then necessarily $\alpha_{2C} > 0$. This implies in turn that $t = 3$ and $t = 4$ choose m_2 for sure. If $\alpha_{2C} = 1$ type $t = 2$ could profitably send the neologism "Choose B, because my type belongs to $\{2\}$". Hence necessarily $\alpha_{2C} < 1$, i.e. the manager strictly mixes between A and C. With $\beta_3(m_2) = \Pr(t = 3|m_2)$ and $\beta_4(m_2) = \Pr(t = 4|m_2)$ denoting the posterior beliefs, this requires $120\beta_4(m_2) = 100\beta_3(m_2) + 10\beta_4(m_2)$, i.e. $\frac{\beta_4(m_2)}{\beta_3(m_2)} = \frac{10}{11}$. From Bayes' rule, together with $t = 3$ and $t = 4$ choosing m_2 for sure, this in turn requires $\frac{(1-q)}{\frac{1}{3}q} = \frac{10}{11}$, i.e. $q = \frac{33}{43}$. But for this value of q either the neologism "Choose B, because my type belongs to $\{2\}$" (if $\alpha_{2C} > \frac{7}{11}$), or the neologism "Choose B, because my type belongs to $\{2, 4\}$" (if $\frac{1}{10} \leq \alpha_{2C} \leq \frac{7}{11}$), or the neologism "Choose B, because my type belongs to $\{2, 3, 4\}$" (if $\alpha_{2C} < \frac{1}{10}$) is credible.

Next consider equilibria with three different equilibrium messages, m_1, m_2 and m_3, with $(\alpha_{1A}, \alpha_{1B}, \alpha_{1C}) = (1, 0, 0) \neq (\alpha_{2A}, \alpha_{2B}, \alpha_{2C}) \neq (\alpha_{3A}, \alpha_{3B}, \alpha_{3C})$. (Labelling of messages is such that $\alpha_{2B} \geq \alpha_{3B}$). This necessarily requires $\alpha_{2B} > \alpha_{3B}$ and $\alpha_{2C} < \alpha_{3C}$; if not, for all types $t = 2$ to $t = 4$ either m_2 or m_3 would be a dominated choice and not chosen in equilibrium. With $\alpha_{2B} > \alpha_{3B}$ type $t = 2$ will never choose message m_3. Let $\beta_j(m_3) = \Pr(t = j|m_3)$ again denote posterior beliefs. It then follows that $\beta_2(m_3) = 0$ and $\beta_3(m_3) + \beta_4(m_3) = 1$. Choosing project B after m_3 then gives the manager $80 - 70\beta_3(m_3)$ in expected payoffs, while project A yields him $120 - 120\beta_3(m_3)$. Project B yields more iff $\beta_3(m_3) > \frac{4}{5}$. But for these values of $\beta_3(m_3)$ project C is better for the manager (yielding $10 + 90\beta_3(m_3)$) than project B. Hence $\alpha_{3B} = 0$ necessarily. Now, if type $t = 3$ is indifferent between m_2 and m_3, $t = 4$ strictly prefers m_2. (Indifference of $t = 3$ implies $\alpha_{2B} = 10(\alpha_{3C} - \alpha_{2C})$. Choosing m_2 then yields type $t = 4$ an expected payoff of $10 + 70\ \alpha_{2B} + 110\ \alpha_{2C} = 10 + 700\ \alpha_{3C} - 590\ \alpha_{2C} > 10 + 110\ \alpha_{3C}$ for $\alpha_{3C} > \alpha_{2C}$.) But in that case $\beta_3(m_3) = 1$ and $\alpha_{3C} = 1$. The latter is inconsistent with $\alpha_{2B} > 0$ and type $t = 3$ indifferent between m_2 and m_3. If type $t = 3$ strictly prefers m_2 over m_3, $\beta_3(m_3) = 0$ and thus necessarily $\beta_4(m_3) = 1$; this implies $\alpha_{3C} = 0$, contradicting $\alpha_{2C} < \alpha_{3C}$. Hence type $t = 3$ necessarily strictly prefers m_3. This in turn implies $\alpha_{2C} = 0$.

From the above it follows that, if three different equilibrium messages are sent in (a neologism proof) equilibrium, types $t = 1$, $t = 2$ and $t = 3$ fully separate by choosing m_1, m_2 and m_3, respectively. Type $t = 4$ has no incentive to choose m_1 or yet another message m_4 that would separate him out, hence this type necessarily chooses between m_2 and m_3. If he does not choose m_3, $\beta_3(m_3) = 1$ and thus $\alpha_{3C} = 1$.But then $t = 4$ would prefer m_3 over m_2.Therefore, type $t = 4$ either sends m_3 for sure, or mixes between m_2 and m_3. In the former case $\alpha_{3C} > 0$ necessarily requires $\beta_3(m_3) = \frac{\frac{1}{3}q}{\frac{1}{3}q+(1-q)} \geq \frac{11}{21}$ (this follows from project C yielding $100\beta_3(m_3)+10(1-\beta_3(m_3))$ while project A earns $120(1-\beta_3(m_3))$; project B always gives less than the best of these two), and thus $q \geq \frac{33}{43}$. This gives part 2(a). In the latter case, mixing by $t = 4$ requires $\alpha_{3C} < 1$ and thus using Bayes' rule $\beta_3(m_3) = \frac{\frac{1}{3}q}{\frac{1}{3}q+\tau_3(1-q)} = \frac{11}{21}$. This reduces to $\tau_3 = \frac{10q}{33(1-q)}$, where τ_3 denotes the probability with which type $t = 4$ chooses m_3. This in turn requires $q \leq \frac{33}{43}$ to secure $\tau_3 \leq 1$. $\tau_3 = \frac{10q}{33(1-q)}$ implies $\tau_2 = \frac{33-43q}{33(1-q)}$ and thus $\beta_2(m_2) = \frac{\frac{1}{3}q}{\frac{1}{3}q+\tau_2(1-q)} = \frac{11q}{33-32q}$ by Bayes' rule. If $\beta_2(m_2) > \frac{2}{7}$ the manager strictly prefers B over A after m_2 (as $100\beta_2(m_2) + 80(1-\beta_2(m_2)) > 120(1-\beta_2(m_2))$) and thus $\alpha_{2B} = 1$. This translates to $q > \frac{66}{141}$. In that case, for $t = 4$ to be willing to mix it is necessarily required that $10 + \alpha_{3C} \cdot 110 = 80$, i.e. $\alpha_{3C} = \frac{7}{11}$. This yields part 2(c). (For the non-generic knife edge case $q = \frac{66}{141}$ the manager's strategy is not uniquely defined in the mixed equilibrium and any combination satisfying $\alpha_{3C} = \frac{7}{11}\alpha_{2B} > 0$ can be sustained; these equilibria are payoff equivalent to the manager and therefore for ease of exposition not listed separately in Proposition 2.)

The expected payoffs for the manager in the mixed equilibrium are $80 - \frac{260}{33}q \equiv \Pi_{Com-(3-mixed)}$. This exceeds $\Pi_{Del-(3)}$ whenever $q \leq \frac{33}{43}$, it always exceeds $\Pi_{Del-(2)}$, and it exceeds $\Pi_{Del-(1)}$ whenever $q \geq \frac{66}{141}$. ■

Proof of Proposition 4. Let p_{ta} be the probability that the manager implements project $a \in \{A, B, C\}$ in state $t \in \{1, 2, 3, 4\}$. The optimal general mechanism then follows from the following optimization program:

$$\begin{aligned}\max_{p_{t,a}} \Pi &= \frac{q}{3} \cdot (80p_{1A} + 100p_{2B} + (10p_{3B} + 100p_{3C})) \\ &\quad + (1-q) \cdot (120p_{4A} + 80p_{4B} + 10p_{4C})\end{aligned}$$

subject to the following constraints:$0 \leq p_{ta} \leq 1 \ \forall t, a$

$$0 \leq p_{ta} \leq 1 \ \forall t, a \qquad \text{(Prob\_1)}$$

$$p_{tA} + p_{tB} + p_{tC} = 1 \ \forall t \qquad \text{(Prob\_2)}$$

$$80p_{1A} \geq \max\{80p_{2A}, 80p_{3A}, 80p_{4A}\} \tag{IC\_1}$$

$$100p_{2B} \geq \max\{100p_{1B}, 100p_{3B}, 100p_{4B}\} \tag{IC\_2}$$

$$10p_{3B} + 100p_{3C} \geq \max\{10p_{1B} + 100p_{1C}, 10p_{2B} + 100p_{2C}, 10p_{4B} + 100p_{4C}\} \tag{IC\_3}$$

$$10p_{4A} + 80p_{4B} + 120p_{4C} \geq \max\left\{\begin{array}{c} 10p_{1A} + 80p_{1B} + 120p_{1C}, \\ 10p_{2A} + 80p_{2B} + 120p_{2C}, 10p_{3A} + 80p_{3B} + 120p_{3C} \end{array}\right\} \tag{IC\_4}$$

In case of a deterministic mechanism, condition $(Prob\_1)$ should be strengthened to $p_{ta} \in \{0, 1\}$ for all t, a. We proceed in various steps, first proving two general features that hold in both optimal deterministic and optimal stochastic mechanisms alike.

(step 1) $p^*_{1A} = 1$ *necessarily.* To show this, note that Π is increasing in p_{1A} and independent of p_{1B} and p_{1C}. The l.h.s. of (IC_1) is increasing in p_{1A}, so more easily satisfied the higher p_{1A} is. Similarly so, both (IC_2) and (IC_3) are more easily satisfied the lower p_{1B} and p_{1C} are, i.e. the higher p_{1A} is. Also (IC_4) is relaxed for higher p_{1A}, as the first element in the $\max\{\}$ term on the r.h.s. necessarily gets smaller. Therefore the entire set of incentive constraints is relaxed the higher p_{1A} is. Given $p^*_{1A} = 1$, condition (IC_1) is always satisfied and can be ignored from now on.

(step 2) $p^*_{2C} = 0$ *necessarily.* To see this, note that Π is independent of p_{2C} (and p_{2A}) and increasing in p_{2B}. Condition (IC_2) is more easily satisfied when p_{2C} decreases, as this implies that either p_{2A} or p_{2B} gets higher. Also (IC_3) and (IC_4) are relaxed for lower p_{2C}, as the second elements in the $\max\{\}$ terms on the r.h.s. necessarily get smaller. If $p_{2C} > 0$ the manager would thus strictly benefit from shifting this probability mass to p_{2B} without harming feasibility.

(i) Consider deterministic mechanisms only, i.e. replace condition $(Prob\_1)$ with $p_{ta} \in \{0, 1\}$ for all t, a. Given (step 1) and (step 2) above we consider the three relevant cases in turn.

(i.a) Suppose $p^*_{3C} = 1$. The r.h.s. of (IC_4) then equals 120 and to satisfy this condition $p^*_{4C} = 1$ necessarily. The latter implies $p^*_{4B} = 0$ and thus that (IC_2) is always satisfied. p_{2B} can then be chosen freely as to maximize Π, yielding $p^*_{2B} = 1$. The overall outcome $p^*_{1A} = p^*_{2B} = p^*_{3C} = p^*_{4C} = 1$ corresponds to Del-(3) and yields the manager $\Pi_{Del-(3)}$.

(i.b) Suppose $p^*_{3C} = 0$ and $p^*_{3B} = 1$. To satisfy (IC_2) then $p^*_{2B} = 1$ necessarily. Moreover, $p^*_{4A} = 1$ would then violate (IC_4), so either $p^*_{4B} = 1$ or $p^*_{4C} = 1$ necessarily. The latter would violate (IC_3), hence $p^*_{4B} = 1$. The overall outcome $p^*_{1A} = p^*_{2B} = p^*_{3B} = p^*_{4B} = 1$ corresponds to Del-(2) and yields the manager $\Pi_{Del-(2)}$.

(i.c) Suppose $p^*_{3C} = 0$ and $p^*_{3B} = 0$. In that case $p^*_{3A} = 1$. To satisfy(IC_3) then $p^*_{2A} = p^*_{4A} = 1$ necessarily. The overall outcome $p^*_{1A} = p^*_{2A} = p^*_{3A} = p^*_{4A} = 1$ corresponds to Del-(1) with the worker always choosing A, yielding the manager $\Pi_{Del-(1)}$.

Comparing the expected payoffs of the manager in the three cases (cf. proof of Proposition 1), yields part (i) of the proposition.

(ii) Next consider general stochastic mechanisms, i.e. condition $(Prob\_1)$ has to be satisfied. Note that (step 1) and (step 2) continue to hold. We first prove two additional features of the optimal stochastic mechanim.

(step 3) $p^*_{3B} = 0$ *necessarily.* Suppose to the contrary that $p^*_{3B} = p > 0$. Then consider the alternative mechanism with $p'_{3B} = 0$, $p'_{3A} = p^*_{3A} + \frac{4}{11}p$ and $p'_{3C} = p^*_{3C} + \frac{7}{11}p$. Given that $10p'_{3B} + 100p'_{3C} = 10p^*_{3B} + 100p^*_{3C} + p\left(\frac{7}{11} \cdot 100 - 10\right) > 10p^*_{3B} + 100p^*_{3C}$, this leads to a strict increase in Π. Moreover, this alternative mechanism is still feasible as (IC_2) is relaxed because the r.h.s. gets smaller, (IC_3) is relaxed because the l.h.s. gets larger, while the alternative mechanism is chosen such as to keep (IC_4) unaffected.

(step 4) $7p^*_{4B} + 11p^*_{4C} = 11p^*_{3C}$ necessarily. This corresponds to (IC_4) being necessarily binding for mimicking type $t = 3$. First suppose to the contrary that (IC_4) does not bind at all. This can only happen when $p_{4A} < 1$. But then it is possible to increase p_{4A} at the margin, and thus decrease either p_{4B} or p_{4C} slightly. This would lead to a strict increase in Π while still being feasible, because both (IC_2) and (IC_3) are relaxed. Thus (IC_4) must bind necessarily. Next suppose it does not bind for mimicking type $t = 3$. This can only happen when $p_{3C} < 1$. In that case p_{3C} can be increased at the margin to strictly improve Π, while relaxing (IC_3) and leaving (IC_2) unaffected. Hence (IC_4) binds for mimicking type $t = 3$. From this it also follows that (IC_3) is always satisfied and can be ignored from now on.

Given (step 1) through (step 4) we consider the three relevant cases in turn.

(ii.a) Suppose $p^*_{3C} = 1$. Then the exact same reasoning as under (i.a) above gives the overall outcome $p^*_{1A} = p^*_{2B} = p^*_{3C} = p^*_{4C} = 1$ (corresponding to Del-(3)), yielding the manager. $10 + \frac{250}{3}q$ in expected payoffs.

(ii.b) Suppose $0 < p^*_{3C} < 1$. Given that Π is strictly increasing in p_{2B}, either p^*_{2B} is such that (IC_4) binds for mimicking type $t = 2$ as well, or $p^*_{2B} = 1$. This implies $p^*_{2B} = \min\left\{p^*_{4B} + \frac{11}{7}p^*_{4C}, 1\right\}$. Together with $7p^*_{4B} + 11p^*_{4C} = 11p^*_{3C}$ from (step 4) and $p^*_{4A} = 1 - p^*_{4B} - p^*_{4C}$ from $(Prob\_2)$, we can write Π as a function of p_{4B} and p_{4C} only: $\Pi(p_{4B}, p_{4C}) = \frac{q}{3} \cdot \left(80 + 100 \cdot \min\left\{p_{4B} + \frac{11}{7}p_{4C}, 1\right\} + 100\left(\frac{7}{11}p_{4B} + p_{4C}\right)\right) + (1-q) \cdot (120 - 40p_{4B} - 110p_{4C})$. Note that $\Pi(p_{4B}, p_{4C})$ is piecew-wise linear in p_{4B} and p_{4C}. For $q < \frac{11}{26}$ it is strictly decreasing in both, implying $p^*_{4A} = 1$. But then by $7p^*_{4B} + 11p^*_{4C} = 11p^*_{3C}$ we must have $p^*_{3C} = 0$. Hence $0 < p^*_{3C} < 1$ necessarily requires $q \geq \frac{11}{26}$. So assume q to be such. Suppose the optimum is such that $p_{4B} + \frac{11}{7}p_{4C} \leq 1$. Then $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} = \frac{100q}{3} \cdot \frac{18}{11} - 40(1-q)$ and $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} = \frac{100q}{3} \cdot \frac{18}{7} - 110(1-q)$. For $q < \frac{1617}{2337} \simeq 0.69$, it holds that $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} > \frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} > 0$, which implies $p^*_{4B} = 1$. For $q > \frac{1617}{2337}$, it holds that $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} > \frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} > 0$, which would imply $p^*_{4C} = 1$ and $p_{4B} + \frac{11}{7}p_{4C} \leq 1$ does not hold. Next suppose the optimum is such that $p_{4B} + \frac{11}{7}p_{4C} \geq 1$. Then $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} = \frac{100q}{3} \cdot \frac{7}{11} - 40(1-q)$ and $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} = \frac{100q}{3} - 110(1-q)$. For $q < \frac{231}{271} \simeq 0.85$, it holds that $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} > \frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} > 0$, which implies $p^*_{4B} = 1$. For $q > \frac{231}{271}$, it holds that $\frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4C}} > \frac{\partial \Pi(p_{4B}, p_{4C})}{\partial p_{4B}} > 0$, which would imply $p^*_{4C} = 1$. But then by $7p^*_{4B} + 11p^*_{4C} = 11p^*_{3C}$ we must have $p^*_{3C} = 1$. Hence $0 < p^*_{3C} < 1$ necessarily requires $q \leq \frac{231}{273}$. Taken together, $0 < p^*_{3C} < 1$ implies that $p^*_{4B} = 1 = p^*_{2B}$ necessarily and thus $p^*_{3C} = \frac{7}{11}$ from (step 4). The overall outcome thus equals: $p^*_{1A} = p^*_{2B} = p^*_{4B} = 1$, $p^*_{3A} = \frac{4}{11}$ and $p^*_{3C} = \frac{7}{11}$. This yields the manager 80-$\frac{260}{33}q$.

(ii.c) Suppose $p^*_{3C} = 0$. From (step 3) we have $p^*_{3B} = 0$ and the exact same reasoning as under (i.c) applies; the overall outcome equals $p^*_{1A} = p^*_{2A} = p^*_{3A} = p^*_{4A} = 1$ (i.e. Del-(1)), yielding the manager $120 - \frac{280}{3}q$ in expected payoffs.

Comparing the expected payoffs of the manager in the three cases, yields part (ii) of the proposition. ■

Appendix B: sample instructions [treatment CD75]

Instructions Experiment

General Information

Thank you for participating in this experiment. The amount of money you earn depends upon the decisions you and the other participants make. Your earnings are given in points. The experiment consists of four parts. Your overall earnings equal the sum of your points in each part. The conversion rate is 2.5 points for 1 eurocent, so 250 points corresponds with 1 euro. We will pay out your overall earnings in cash after you have completed the entire experiment and filled out a final questionnaire. We ensure that your final earnings remain confidential: no other participant from the experiment will learn your final earnings.

This (two-sided) sheet contains the instructions for part one of the experiment. Instructions for the next part follow after this part has been completed (and so on). Please do not communicate with other participants during the experiment. If you have a question, please raise your hand. The experimenter will then come to your table to answer your question in private.

Instructions part I

There are two types of participants: managers and workers. One half of the participants will be managers, and the remaining half will be workers. You will be randomly assigned one of these roles. Which role you have, you will learn at the start of this part. You will keep the same role in parts II and III. In part one 20 project implementation decisions have to be made. In every project implementation decision (period), manager and worker face three projects **(A,B,C)** that can be implemented. These projects differ in the points that they yield manager and worker upon implementation. The points belonging to a given project depend on the state of the world. There are four possible states **(1,2,3,4)**. The following table presents the points the different projects yield manager and worker in the different states:

	Project **A**		Project **B**		Project **C**	
	Manager	Worker	Manager	Worker	Manager	Worker
State **1**	80	80	0	0	0	0
State **2**	0	0	100	100	0	0
State **3**	0	0	10	10	100	100
State **4**	120	10	80	80	10	120

At the beginning of each period the computer determines the state. The four states are equally likely. That is, with probability 25% the state is 1, with probability 25% the state is 2, with probability 25% the state is 3, and with probability 25% the state is 4.

As explained above, Part I consists of 20 periods. In each period, one manager and one worker are randomly paired. You are never paired with the same other participant twice in a row. You cannot predict when you will be paired with the same other participant again.

At the beginning of each period the worker learns the state. The manager decides which project (either A, B, or C) will be implemented. Before the manager does so, the worker sends a message to the manager. The manager only learns the actual state at the end of the period, after the project has been implemented.

Sequence of Actions

The precise timing within each period is as follows. There are two phases.

Phase 1

The worker learns the state and sends one of the following eight messages to the manager:

The state is 1

The state is 2

The state is 3

The state is 4

I recommend project A

I recommend project B

I recommend project C

I make no recommendation

The set of available messages does not depend on the actual state; so irrespective of the actual state, the worker can always choose one of the above eight messages.

Phase 2

The manager observes the worker's message (but not the actual state) and decides which project to implement: either A, B, or C.
Upon completion of phase 2 both manager and worker are informed about the outcome in that period.

Payoffs

The number of points earned by manager and worker respectively are their points from the implemented project; see the table on the other side of the sheet.
Your overall payoff from this part is the sum of points earned in the 20 periods.

Instructions Part II

This part of the experiment also consists of 20 periods. As compared to part I the main difference is that now the worker takes the implementation decision in each period. Before s/he does so, the manager may restrict the set of projects that the worker can choose from.
As before, in each period one manager and one worker are randomly paired. You are never paired with the same other participant twice in a row. You cannot predict when you will be paired with the same other participant again.
Like in part I the worker learns the state (the four different states occur with the same probabilities as in part I). Before the worker decides which project to implement, the manager decides which projects the worker is allowed to choose for implementation. The manager only learns the state at the end of the period, after the project has been implemented.

Sequence of Actions

The precise timing within each period is as follows. There are two phases.

Phase 1

The manager selects the projects that the worker is allowed to choose for implementation.

Phase 2

The worker learns the state and the set of projects from which s/he is allowed to choose, and decides which of these projects to implement. (If the manager only allows one project, this becomes a trivial choice.)

Upon completion of phase 2 both manager and worker are informed about the outcome in that period.

Payoffs

The number of points earned by manager and worker respectively are their points from the implemented project. The same table as in part I applies.

Your overall payoff from this part is the sum of points earned in the 20 periods.

Instructions Part III

This part of the experiment combines the previous two parts and consists of 20 project implementation decisions (periods). At the beginning of each period the manager first decides whether s/he will take the implementation decision her- or himself or whether s/he delegates the implementation decision to the worker. The former corresponds with the decision structure of part I, the latter with the decision structure of part II.

As in the previous parts, in each period one manager and one worker are randomly paired. You are never paired with the same other participant twice in a row. You cannot predict when you will be paired with the same other participant again.

Sequence of Actions

The precise timing within each period is as follows. There are three phases.

Phase 0

The manager chooses between taking the project implementation decision her- or himself, **Decision Manager**, and delegation of this decision to the worker, **Decision Worker**.

Phases 1 and 2

The structure of phases 1 and 2 depends on the manager's choice in phase 0:

	Decision Manager (phases 1 and 2 are as in part I)	**Decision Worker** (phases 1 and 2 are as in part II)
Phase 1	The worker learns the state and sends a message(out of the eight messages possible) to the manager;	The manager selects the projects that the worker is allowed to choose for implementation
Phase 2	The manager observes the worker's message (but not the actual state) and decides which project to implement	The worker learns the state and the set of projects from which s/he is allowed to choose, and decides which of these projects to implement

Payoffs

The number of points earned by manager and worker respectively are their points from the implemented project. The same payoff table as in parts I and II applies. Your overall payoff from this part is the sum of points earned in the 20 periods.

Overview parts I and II

Before the start of the first period in part III, you will get a history overview of your own outcomes in parts I and II.

Instructions Part IV

The final part has a structure that differs from the previous parts. It consists of only one period. You are randomly paired with one other participant, taking either the role of participant A or participant B.

The computer will randomly assigns one of the numbers 1, 2, 3, 4, 5, or 6 to each pair. Based on the assigned number, participant A sends a message about that number to Participant B. Participant B observes the message sent by Participant A, but not the number actually assigned by the computer, and decides whether or not to follow the message of Participant A.

Both participants A and B indicate their choices for each situation that may occur. In particular, for every possible number assigned to the pair, participant A has to formulate a message to participant B about the assigned number. The message does not have to contain the actual assigned number:

If the assigned number is	1	2	3	4	5	6
then your message to participant B is: The assigned number is	___	___	___	___	___	___

Before participant B receives the actual message of participant A, s/he has to decide for all possible messages whether or not s/he will follow the message:

If participant A sends the message	Then your decision is:
"The assigned number is 1"	to follow O O not to follow
"The assigned number is 2"	to follow O O not to follow
"The assigned number is 3"	to follow O O not to follow
"The assigned number is 4"	to follow O O not to follow
"The assigned number is 5"	to follow O O not to follow
"The assigned number is 6"	to follow O O not to follow

After A and B have made their decisions, the choices that result from the number actually assigned to the pair are carried out. That is, given the assigned number, the corresponding message of participant A is sent to participant B and the decision of participant B corresponding to this message is carried out.

Payoffs

Participant A receives 500 points plus 100 times the number sent in the message to Participant B. This means that if Participant A sends the message that the assigned number is 1, then her/his payoff equals 600 points; if Participant A sends the message that the number is 2, then her/his payoff equals 700 points; and so on.

The payoff of participant B depends on whether s/he decides to follow Participant A or not and on whether the message of Participant A contains the actual assigned number to the pair.

If Participant B decides to **follow**, then Participant B receives 500 points if the message of Participant A contains the actual assigned number to the pair. Otherwise Participant B receives zero. This means that if Participant B decides to follow and the actual assigned number to the group is 1 and the reported number in the message of Participant A is 1, then Participant B gets 500 points; however, if Participant B decides to follow and the actual assigned number to the group is 1 and the reported number in the message of Participant A is 2, then Participant B earns zero points; and so on.

If Participant B decides **not to follow**, then Participant B receives 150 points.