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Overcoming Coordination Failure in Firms and Organizations: Experimental Evidence

Jordi Brandts

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1. Introduction

Bad performance of companies and other organizations can be due to what economists call coordination failure. In such situations improving performance requires that the different components of the company or the organization change their behaviour jointly. In contrast, isolated efforts to improve things will be futile and may even be very costly for those who are trying to lead the escape from the trap that the company or organization is in. In such cases the efforts of the different units are characterized by what economists call *complementarities*.

As an archetypical example, imagine a firm producing via an assembly line where the slowest worker determines the speed of the entire line. All the workers are exerting minimal effort, but could be better off if all tried harder and the line became more productive. However, any one worker who unilaterally begins to work harder wastes his effort if slow work persists elsewhere. Only

if our hypothetical worker is reasonably certain that others will also be working harder should he be willing to increase his effort. Thus, overcoming coordination failure is a question of coordinated change, and it is the task of managers to find ways to achieve it. Coordinated change may be particularly difficult if communication among individuals is difficult or ineffective and the inefficient situation has persisted for some time. Thinking again of our hypothetical worker, imagine how much more difficult it may be to convince him that others will be working harder if he has no means of formally talking with the other workers about the problem, and has observed a long history of laggardly behaviour.

The central issue here is how to implement change. Organizational change has been a topic of interest for scholars in economics and management for a long time.[1] One of the insights emerging from this literature is that the presence of complementarities may be at the root of many organizational problems. Several studies using data from actual companies analyze the effects of such complementarities. For example, Knez and Simester (2002) study the successful turnaround of Continental Airlines in the mid 1990s. The critical element in Continental's success was the introduction of an incentive program designed to improve on-time arrival, a key determinant of airline profitability. Knez and Simester stress the importance of complementarities among autonomous groups of employees in determining on-time arrival: "When a flight departs late, gates, employees and equipment are unavailable to service other flights arriving and departing from the same airport. The problem is further compounded when flights carry connecting passengers since departing flights may have to be delayed to allow passengers to make their connections". They posit that the global nature of Continental's incentive plan played a central role in its success, assuring employees that

their increased effort would be matched by colleagues in other units. In other words, coordinated change was necessary to improve Continental's situation. As another example, Ichniowski, Shaw, and Prennushi (1997) find similar results in a study of productivity in steel plants. The type of steel production they study takes place in an assembly line setting with productivity largely determined by unscheduled downtime. This implies that one employee who is doing a poor job (leading to breakdowns on his part of the assembly line) can largely destroy the efficiency of the entire line. Improving performance at one point in this production process will do little good if performance lags elsewhere.

Similar issues play an important role in other areas of economics, especially so in development economics. An idea going back to Rosenstein-Rodan (1943) and Hirschman (1958) is that underdevelopment can be seen as a large-scale coordination problem. Countries may fail to develop when the simultaneous modernization of many industries of an economy can be profitable for each of them but no industry can break even modernizing alone.[2] The question in this context is what the government can do to produce a "big push" which leads to the coordinated change that takes an economy from an underdeveloped state to one of greater prosperity.

The central goal of economic research on these problems is to understand how to overcome coordination failure in field settings like the ones described above. In this *opuscle* we present research on laboratory experiments which we think can — together with other types of research — play an important role in understanding how to achieve improved coordination.[3] The conducting of laboratory experiments is the centre of scientific activity in the natural sciences, such as biology, chemistry or physics. In contrast, in economics

laboratory experiments have only more recently started gaining acceptance. An economic laboratory experiment is something very simple and it takes place in the following way. A group of persons that have voluntarily signed up for participation in the experiment receive instructions about a simplified economic situation in which they play a certain role: for example, firms, consumers or workers. A typical example is a market situation in which some people act as buyers and others as sellers. Each participant can choose between different options and each of these options implies different monetary gains, depending on the decision of the participant in question and, possibly, also on the decisions of the other participants. The organizers of the experiments observe and register the decisions made by the participants as a source of information for the problem they want to study.[4]

The great virtue of experiments in all areas of research is that they make it possible to obtain evidence about behaviour under the conditions of *control* and *replicability*. The term control refers to the fact that the circumstances under which certain evidence is obtained are well known and can be varied systematically. The term replicability refers to the possibility of repeating an experiment under exactly the same circumstances. These two elements allow for a very orderly and systematic advance of research on a topic. Taking advantage of the controlled nature of laboratory experiments, we can introduce exogenous variation in the relevant factors without altering any other features of the decision-making environment. Laboratory experiments also make it possible to generate numerous observations at a rather low cost, allowing us to separate systematic effects from peculiarities of time or place.

How can laboratory experiments be used to study the issues of producing change for the better and overcoming coordination failure introduced above? The starting point is an experimental environment which we label the "corporate turnaround game". This game is meant to simulate a corporate environment in which coordination failure has occurred so that performance is very unsatisfactory. At that point management steps in and uses different instruments in order to redress the situation.

We will discuss the role of financial incentives, of communication between managers and employees and that of internal leadership of some of the employees. In the next section we focus only on the effects of financial incentives.

2. Financial incentives and overcoming coordination failure[5]

In our corporate turnaround game a firm consists of a manager and a number of employees, the latter choosing among different effort levels. The firm's overall productivity (as well as profitability) is determined by the effort of its employees.

There are three basic features to the stylized representation of the firm that we use. First, the firm's technology has an organizational structure such that productivity depends on the minimum effort chosen by an employee. Second, the firm manager only observes the minimum effort selected, since it determines the output, but employees can observe all effort levels selected. Third, the firm manager rewards employees with bonuses based on the minimum effort observed and is able to change the bonus rate but cannot otherwise influence the employees' choices.

An organizational structure in which the individual (or unit) doing the worst job determines the overall productivity of an organization has been

given the name of a "weak-link" structure. This is a very strong form of the complementarity we have introduced above. Kremer (1993, p. 551) describes this kind of interdependence nicely: "Many production processes consist of a series of tasks, mistakes in any of which can dramatically reduce the product's value. The space shuttle *Challenger* had thousands of components: it exploded because it was launched at a temperature that caused one of these components, the O-rings, to malfunction. "Irregular" garments with slight imperfections sell at half price. Companies can fail due to bad marketing, even if the product design, manufacturing, and accounting are excellent".

This is the kind of situation we shall study. By studying a production technology with a weak-link structure, we focus on a worst-case scenario. Presumably many organizations face coordination problems in more forgiving settings where a change for the better is more easily achieved. However, if we can understand how to overcome coordination failure in organizations with a weak-link structure, a tough environment, it should be even easier to accomplish in less difficult circumstances.

In the specific weak-link game that we use in our experiments, each player simultaneously chooses an effort level. Each player's payoff is a decreasing function of his own effort and an increasing function of the minimum effort chosen by the players in the group. Payoffs are set up so that it is worthwhile for a player to raise his effort level if *and only if* it will increase the minimum effort for the group.

What is very important about our weak-link game is the following. Coordinating on any of the available effort levels is a stable situation, in the sense that none of the employees wants to change his effort level, including situations in which all employees exert the lowest possible effort and the firm as a whole performs very poorly.[6] This implies that organizations can get trapped in situations that are unsatisfactory for all involved even though preferable outcomes are possible and would be stable if ever reached. Once a firm gets caught up in a low performance trap, any process designed to bring about a change for the better faces substantial obstacles — even if the benefits of improved coordination are clear — precisely because the low performance situation is an equilibrium. This is why we have above referred to a trap: once you are in it, it is difficult to escape from it.

What is also important here is that results from earlier experiments suggest that people can effectively quite easily get caught up in the equilibrium where all players choose the lowest possible effort level, and where all earn less than in any other equilibrium.[7] In a weak-link game it is not only theoretically possible to get stuck in a low performance trap; it has been observed to occur.

The second critical feature of our experimental environment is that while employees can observe the effort levels of all other employees, the firm manager can only observe the output, which is determined by the minimum effort chosen. Our goal is to study a setting where overcoming coordination failure is difficult. By limiting the instruments available to change employees' behaviour, we make it tougher to turn around a failing firm. Presumably the lessons learned from such a harsh environment will also be valuable in more forgiving settings. Although environments where the manager can observe all employees' choices raise interesting issues we feel that understanding the simpler environment studied here is a necessary first step in understanding more complicated settings.

The third crucial feature of what we discuss in this section is that the *only* instrument of change controlled by managers is the ability to change a bonus rate based on the minimum effort of employees. In reality, financial incentives are just one of many tools available to overcome coordination failure; other possible tools are better communication, building trust, etc. The first experiments we shall present look exclusively at financial incentives. Only after understanding how financial incentives in isolation can lead to turnarounds can we begin to study the interactions between changes in financial incentives and other possible interventions.

Turning to the specifics of the turnaround game, the players in our turnaround game are the manager and four employees of a firm. For all the experiments reported in this section, the decision of the firm manager will be made by the organizers of the experiment, in a way that will be explained shortly, while participants fill the roles of the four employees.[8]

Even though the manager's choices are exogenous, for expositional purposes it is useful to treat the manager as a player in the game. The game starts with the firm manager setting a flat wage (W) that each employee receives regardless of the outcome and a bonus rate (B) that determines how much additional pay each employee receives for each additional unit increase in the minimum effort. All four employees observe W and B and then simultaneously choose effort levels, where E_i is the effort level chosen by the i^{th} employee.

In the experiment employees' effort levels had to be in ten-hour increments. This means that they had to be one of the following integers: 0, 10, 20, 30 or 40. Intuitively, employees spend 40 hours per week on the job, and effort measures the number of these hours that they actually spend working hard rather than loafing. All payoffs are denominated in "experimental pesetas" which were converted to monetary payoffs at a rate of 1 dollar or 1 euro equal to 500 experimental pesetas:

Equation 1

Firm: $\pi_f = 100 + [(60 - 4B) \times \min_{i \in \{1,2,3,4\}} (E_i)]$

Equation 2

Employee i: $\pi^i_e = 200 - 5E_i + [B \times \min_{j \in \{1,2,3,4\}} (E_j)]$

The firm's profits depend on the minimum effort contributed by its employees, consistent with our assumption that the firm's production technology has the weak-link property. The firm manager sets the bonus which is tied to the minimum effort, as implied by the assumption that the manager cannot observe individual efforts. As can be seen in Equation 1, the bonus transfers a portion of the firm's profits to its employees.

For all values of the bonus rate, B, used in our experiments the resulting game is a weak-link game, and coordinating on any of the five available effort levels is a stable situation. To understand why overcoming coordination failure is so difficult in this environment, consider the game induced by a bonus value of $B = 6$, shown in Table 1.[9]

Table 1
Employee *i*'s payoff table, $B = 6$

		Minimum effort by other employees				
		0	**10**	**20**	**30**	**40**
Effort by employee *i*	**0**	200	200	200	200	200
	10	150	210	210	210	210
	20	100	160	220	220	220
	30	50	110	170	230	230
	40	0	60	120	180	240

Suppose that the employees have previously all chosen effort level 0. This is a stable situation. Consider the thought process of an employee who is entertaining the possibility of raising his effort from 0 to 10. He knows that his payoff will certainly be reduced by 50 pesetas due to increased effort. His gains are subject to what is called *strategic* uncertainty, that is, they depend on what others will do. If all the other participants follow his lead, his total gain is only 10 pesetas beyond the 200 pesetas he gets without risk by choosing 0. For the proposed increase to have a positive expected profit, the employee must believe the probability of all three other employees raising their efforts from 0 to 10 equals 5/6. Treating the other three employees as statistically independent, this translates into requiring a 94% chance of increased effort for each of the other three employees.[10] In other words, our fictitious employee must be almost certain that the other employees will increase their efforts for such an increase to be worthwhile for him. Now imagine that a new manager takes over the firm. Determined to shake the firm out of its underperforming ways, he decides to raise the bonus rate to $B = 14$. (Looking at Equation 1, this is the highest bonus rate at which the firm earns a profit.) This yields the payoff table shown below in Table 2.

Table 2
Employee *i*'s payoff table, $B = 14$

		Minimum effort by other employees				
		0	**10**	**20**	**30**	**40**
Effort by employee *i*	**0**	200	200	200	200	200
	10	150	290	290	290	290
	20	100	240	380	380	380
	30	50	190	330	470	470
	40	0	140	280	420	560

It is important to see that all four employees choosing an effort level of 0 is still a stable situation. However, the incentives to increase effort are now much stronger for the employees. Once again, suppose we start with all four employees choosing effort level 0. Consider again an employee who is thinking of increasing his effort from 0 to 10. While the certain losses remain 50 pesetas, the potential gain is now 90 pesetas. The probability that all three other employees will increase their efforts required to make this change break even is now only 5/11. Assuming the other three employees are independent, this translates into requiring a 76% chance that each employee increases his effort. While still daunting, these are better odds than we saw with $B = 6$. One can imagine employees at least attempting to overcome coordination.

We can now explain how the experiments developed. The participants played in fixed groups ("firms") of four participants ("employees"). They made decisions in thirty consecutive rounds. The term "round" refers here to one decision of each of the employees. Between these rounds the bonus rate changed in a predetermined way. Other than the bonus rate, no detail of the experimental environment was varied between rounds. The bonus rate was announced at the beginning of each of three ten-round blocks and was fixed during that time frame. While playing in a block with a particular bonus rate, participants did not know what the bonus rate would be in subsequent ten-round blocks. The bonus rate was always fixed at $B = 6$ for the first ten-round block. The goal was to get a high percentage of firms coordinated on the inefficient outcome with minimum effort equal to zero.

We studied behaviour under what experimentalists call different "treatments", i.e. slightly different, but easily comparable conditions under which an experiment is conducted. The treatments vary

the bonus rates for the second and third blocks of ten rounds. The experimental design, as summarized in Table 3, is motivated by the three following questions. First, will firms that with $B = 6$ have been caught up in the worst possible equilibrium, improve their performance if the bonus is raised to a higher level? Note that our focus is not on what economists call comparative static results. It is quite possible that participants with no previous experience will generally converge to a more efficient equilibrium in the turnaround game with $B = 14$ than in the game with $B = 6$. This, however, is not our point. Instead, we want to know what happens for players who have already experienced a history of coordination failure. Second, will the reaction to a bonus increase depend on the magnitude of the increase? Third, can the bonus be reduced once coordination improvement has been achieved? The reason why we are interested in the ability of only temporary increases in the bonus rate to permanently increase employees' efforts is that high bonuses may be effective at increasing the firm's revenues, but this move will be self-defeating if these increased revenues accrue largely to the employees as increased bonuses.

Table 3
List of treatments

	Tr.1	Tr.2	Tr.3	Tr.4	Tr.5
Bonus rate Rounds 1–10	6	6	6	6	6
Bonus rate Rounds 11–20	14	10	8	14	14
Bonus rate Rounds 21–30	14	10	8	10	6

3. Experimental results for financial incentives

All five treatments relate to whether firms can be extricated from the initial bad outcome by increasing the bonus. The comparison of behaviour in rounds 11–20 of treatments 1, 4 and 5 (taken together, since they all have $B = 14$) with treatment 2 and with treatment 3 will inform us about the importance of the magnitude of the bonus change. The comparison of behaviour in rounds 21–30 between treatments 1, 4 and 5 will inform us about what happens if the bonus is lowered from $B = 14$ to different lower levels in rounds 21–30.

The experiments were run both at Universitat Pompeu Fabra in Barcelona and at Case Western Reserve University in Cleveland. Participants for the experiments were recruited from the undergraduate populations using newspaper ads, posters, and classroom announcements. In both cases, a computerized lab was used to run the experiments. For each treatment we have data for five firms at each of the two locations, so that the sample is balanced between countries.

In each round the four employees of a firm simultaneously chose their effort levels for the round. At the end of each round, each employee was told their effort level, the minimum effort for their firm, their payoff for the round, and their running total payoff for the experiment. Separate windows on the computer screen showed them a summary of results from earlier rounds and the effort levels selected for all four employees in their firm. These effort levels were sorted from highest to lowest and did not include any identifying information about which employee was responsible for which effort level. In a related paper, we show that only giving participants information about the minimum effort has little impact on the likeli-

hood of coordination failure emerging initially but substantially reduces the likelihood that a successful turnaround occurs when the bonus rate is increased (Brandts and Cooper, 2006b).

The groups of four employees remained constant during the course of the experiment, a fact that was stressed in the instructions. This kind of repeated interaction of a fixed group of people corresponds to what happens in the field environments we want to represent. In such settings it is natural for individuals to makes decisions trying to influence others over time and these dynamic processes are one of the issues we are most interested in.

We can now look at the results starting with what happens in rounds 1–10. Recall that the goal for these ten rounds, played with $B = 6$, was to get firms stuck in a bad outcome — only then can we meaningfully examine overcoming coordination failure. We therefore start by confirming that play moves towards the least efficient outcome over the first ten rounds. The minimum effort is low throughout. It is zero for 71% of the observations in the first ten rounds, with this being the modal outcome in all ten rounds.[11] Average minimum effort changes little over the first ten rounds. It is 6.72 in round 1, compared with an average of 5.86 in round 10. However, these averages hide a great deal of underlying movement.

Figure 1 compares minimum effort distributions in rounds 1 and 10. There is what economists call a clear bifurcation in the data. Most firms move downward to the minimum of zero, but a small minority moves up to a minimum effort of 40. The frequencies of all the intermediate effort levels diminish. Since the increase is larger per firm going to 40 than the decrease per firm going to zero, the overall effect on the average minimum effort is the small decrease noted above.

Having trapped many of the experimental firms in the worst possible outcome, we now turn to the task of overcoming this coordination failure. Figure 2 shows average minimum effort levels in rounds 11–20 as a function of the bonus rate in these rounds.

Focusing on the cases where the bonus rate has increased, two central features of the data can be observed. First, an increase in the bonus rate leads to an increase in the minimum effort.[12] This effect is visible for all three bonus rates used in rounds 11–20. Second, there does not appear to be a positive relationship between the magnitude of the bonus increase and its long-run impact on minimum efforts. The highest bonus, $B = 14$, actually generates the lowest minimum efforts in rounds 16–20! Effort levels are roughly the same for $B = 8$ and $B = 10$ in rounds 16–20. If anything, performance appears to be the best with $B = 10$ given that this cell had the lowest average minimum effort prior to the bonus increase.[13] The occurrence of an increase to the bonus rate seems to matter far more in overcoming coordination failure than the magnitude of the increase.

We now want to look more closely at how the process of change for the better exactly takes place. For that we have to look at what individuals do. It turns out that the immediate response to an increase in the bonus rate is relatively modest. While virtually all employees move away from effort level 0, they do not necessarily move far. For round 11, effort level 40 is the modal outcome, but almost as many employees choose effort levels 10 and 20.

A bifurcation then emerges over time. In some groups, the employees who have moved to higher effort levels draw their more cautious partners after them. In other groups, the employees who do not raise their effort level following the bonus increase drive the process, pulling other employ-

Figure 1
Distribution of minimum effort, round 1 vs. round 10

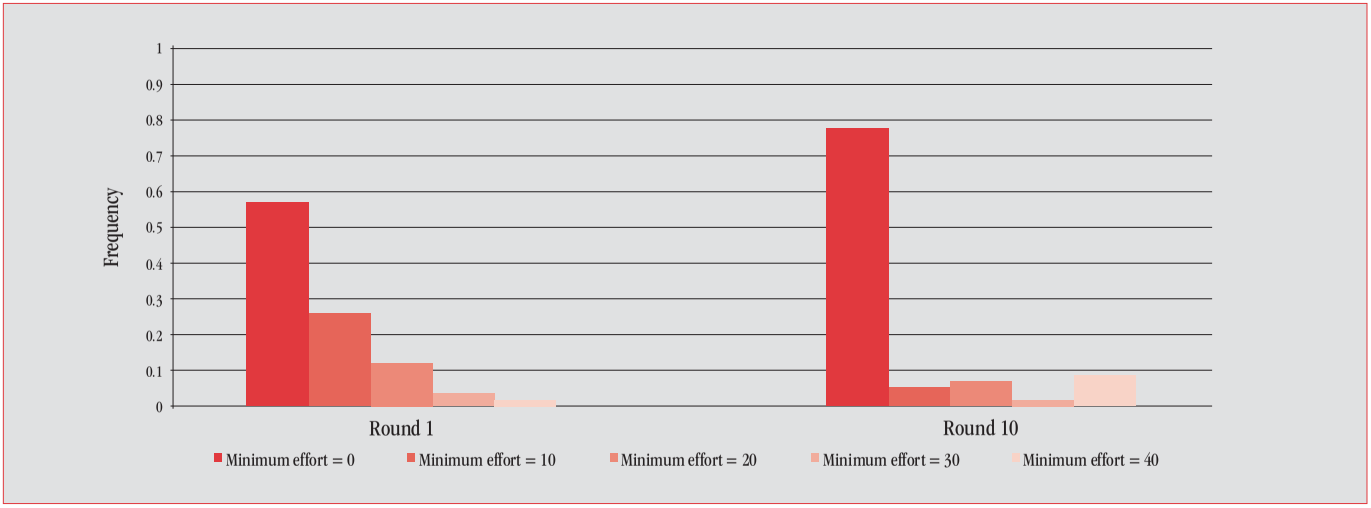
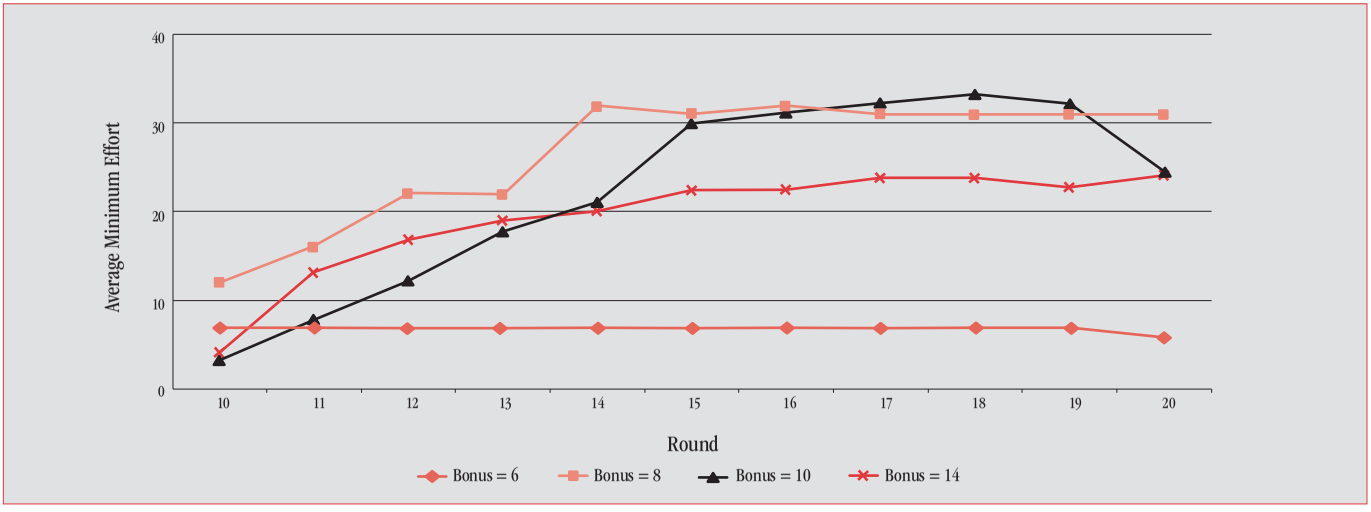


Figure 2
Comparison of treatments, rounds 11–20



ees back to themselves as can be seen from the increasing weight on effort level 0.

Which side of this bifurcation a firm finds itself on depends on how many of its employees initially respond strongly to the bonus hike. This means that whether a firm escapes from the coordination trap depends on particularities of the behaviour of its employees. We now study this process in more depth. We label employees as "strong responders" if they raise their effort by *at least two levels* between rounds 10 and 11 following the bonus increase. All 38 groups that had a minimum effort of zero in round 10 followed by a bonus increase for round 11 included at least one employee who was a strong responder. Table 4 shows the relationship between the number of strong responders in these firms and their long run response to the bonus increase. There is a clear relationship between the number of strong responders and average effort levels — the more employees who respond strongly to the bonus rate increase in round 11, the higher the firm's minimum effort (on average) in round 20. This result seems unsurprising until one realizes that no similar relationship exists between the minimum effort in round 11 and the minimum effort in round 20 or between the number of employees who increase their effort, by just one or more levels, from rounds 10 to 11 and the minimum effort in round 20 (see table 4)

Overcoming coordination failure requires a *strong* positive response to the bonus increase from multiple employees — this requires leadership. Brandts, Cooper and Fatás (2007) go deeper into issues of leadership.

We now get to responding to the third question formulated above. From a manager's standpoint the performance gains come at the cost of higher bonus payments. We would therefore like to know whether the bonus can be reduced without causing a collapse back to the original minimum effort level. To answer this question, Figure 3 shows average minimum effort in rounds 21–30 for treatments 1, 4, and 5, with a bonus rate of $B = 14$ for rounds 11–20. The figure also shows, as a point of comparison, the average minimum effort for rounds 1–10 of these three cells.

Table 4
Effect of immediate reaction to bonus increase

Number of strong responders in round 11	Number of observations	Average minimum effort in round 20
1	9	15.56
2	15	20.67
3	9	28.89
4	5	30.00

One can see that a cut in the bonus rate does not lead to a collapse back to the initial effort level. A cut to $B = 10$ actually yields an increase in average minimum efforts! Cutting the bonus rate to $B = 6$ causes the average effort to fall sharply, but not back to its original levels. Responses to the bonus rate reduction are typically extreme — firms tend to either not change at all or change a lot. Suppose we compare minimum efforts in round 20 with those in round 30. Of the 19 firms that see a decrease in the bonus rate for rounds 21–30, 10 have the same effort level in round 30 as in round 20. Among the nine firms that see changes, six see changes of at least two effort levels. The relatively good performance of firms that have their bonus reduced to $B = 6$ is almost entirely due to firms that didn't respond to the change — there were four firms in treatment 5 that increased their minimum effort between rounds 10 and 20 but did not change their minimum effort in response to the bonus cut for rounds 21–30. Generally, ef-

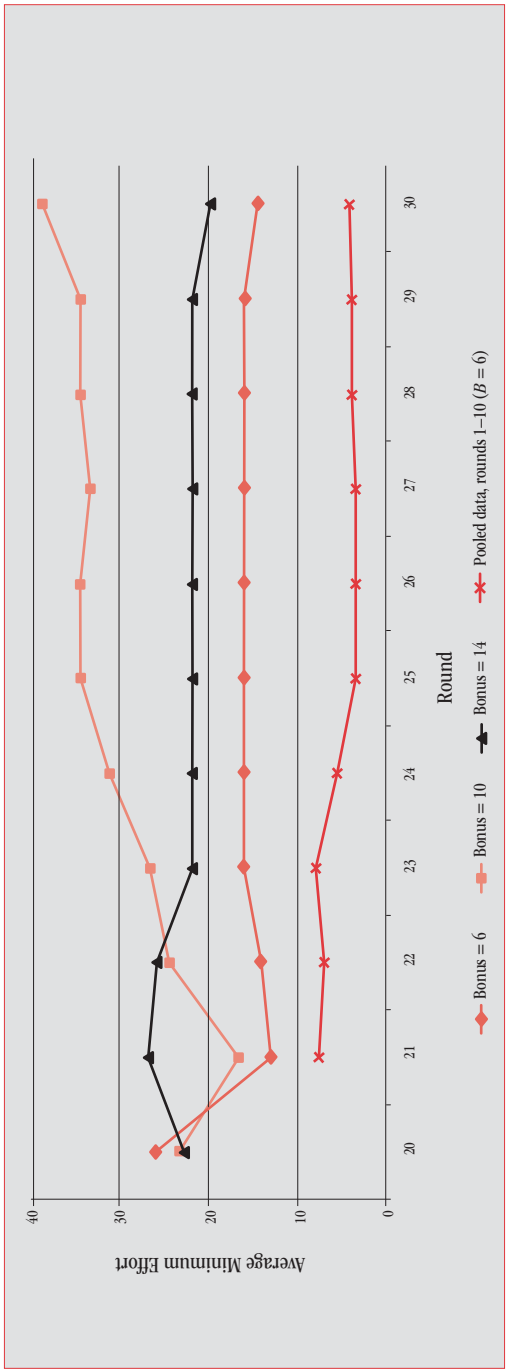


Figure 3
Comparison of treatments. Rounds 21–30 and control

fort levels show history dependence in only one direction — it is easy to move firms to higher effort levels, harder to move them back to lower effort levels.

We can gain some insight into why some firms stay at high effort levels following a bonus rate cut while others do not by looking at the employee-level data. Consider the 10 firms in treatment 5, the most extreme treatment where the bonus rate drops back to $B = 6$. Eight of these 10 firms have minimum effort levels greater than zero in round 20. For two of these firms, no employee changes their effort level in round 21. Both remain coordinated at the payoff dominant equilibrium (all employees choose effort level 40) throughout rounds 21–30. In the remaining six firms at least one employee reduces their effort level in round 21 below the firm's minimum effort in round 20. Four of the six firms converge to lower minimum effort levels while the other two eventually return to minimum effort level they achieved in round 20.

The primary difference between the firms that recover from an initial drop in the minimum effort and those that do not is how the other employees respond to having someone cut the minimum effort. In the four firms that do not recover, at least one employee (and usually more) who did not reduce their effort level in round 21 responds to the reduction in minimum effort in round 21 by cutting their own effort in round 22. In the two firms that recover, the employees who do not cut their effort in round 21 maintain their high effort in subsequent rounds. Thus, a negative response to the bonus cut involves a chain reaction — one or more employees initially cutting their efforts triggers effort reductions among the other employees. If there is a cohort of employees who hold steady, the employees who originally react negatively to the bonus cut eventually recover to their original effort levels.

One puzzling feature of the data that deserves a note is the weak performance with $B = 14$. A possible explanation is that people have reached their *aspiration levels*, a notion proposed by the Nobel laureate Herbert Simon (1955, 1959). This means that they are guided by an idea of reaching a certain preconceived earnings level and if they reach it, they do not feel they need to go beyond this. Applied to our case, subjects with $B = 14$ generally are making high payoffs and might be disinclined to spend much effort figuring out how to obtain even higher payoffs.

4. The interaction between incentives and communication[14]

We now move to a more complex environment. The two main changes with respect to what we studied in the previous section is that now the bonus will be set by a person in the role of the manager and that the manager and the employees will be able to communicate with one another. Studies in organizational behaviour suggest that communication is one of the crucial variables that influence change.[15] Indeed, there is good reason to believe that communication will be particularly effective in organizations afflicted by coordination failure, as this is primarily a problem of influencing employees' beliefs in a positive way. The ability to do this can be seen as an essential feature of leadership, one of the components of managerial vision.

We study different treatments in which we vary the avenues of communication available to managers and employees. In our baseline treatment, managers only control financial incentives and no communication is possible. We then allow for one-way communication — managers can send messages to employees — and two-way communication — managers can send messages to employees and vice versa. The content of communication between our managers and employees was completely unstructured and free, as participants could send any messages they desired subject only to minor restrictions.

A main feature of our work lies in a systematic analysis of the impact of the content of different types of messages. This is unusual in economics and connects our work to organizational studies and to psychology. We recorded all of the messages and quantified the content using a systematic coding scheme, a common methodology in psychology studies that involve verbal protocols as well as in preceding studies from economic experiments that involve communication. Our goal is not to just establish that communication is a valuable tool for managers but to explain *how* communication improves managerial payoffs, that is, profits.

The questions that we ask are the following. Will more avenues of communication lead to higher minimum effort holding financial incentives fixed? Which communication strategies will be most effective in increasing the minimum effort? Will firm managers' choices of financial incentives be more important in determining their profits than their choice of communication strategies?

The experiments developed in a very similar way to those described in the previous section. Participants interacted during 30 rounds of the turnaround game in fixed groups ("firms") of now five persons: one manager and four employees. For the first 10 rounds of the experiment the manager was strictly an observer. Managers could see the same round by round information feedback that they normally received, but could neither control the bonus rate nor communicate with employees. Managers were not paid for these rounds, although employees and managers were both shown the profits that the manager would have earned. The

bonus rate was fixed at $B = 6$ for the first 10 rounds. As before, the goal was to get a high percentage of firms coordinated on the inefficient outcome with minimum effort equal to zero.

For the remaining 20 rounds the manager actively managed his firm. The employees were informed when the manager took over control of the firm. In all treatments the manager was then responsible for choosing a bonus rate in each round and received payoffs as shown in Equation 1.

Specifically, we assume that the firm manager observes the minimum effort selected (which is revealed by the firm's productivity), but cannot observe any individual employee's effort level. Likewise, employees observe their own effort and the minimum effort for the firm, but not the individual efforts of the other three employees. For the managers this implies that they lack the necessary information to tailor bonuses to the effort put forth by individuals and can only offer bonuses based on the minimum effort over all employees. In other words, limiting the information available to the firm manager restricts the tools available for overcoming coordination failure. Limiting employees' information gives managers a significantly more difficult task.

Limiting the manager's information about employees' choices implies that he, consistent with the spirit of most principal-agent models, has difficulty monitoring them. Limiting the employees' information accentuates the importance of leadership by the manager. When employees can see the choices of other employees, leading by example often takes place. One or more employees make a large increase in their effort levels presumably in the hope of leading laggards to match this effort, thereby overturning a history of coordination failure. This sort of internal leadership works reasonably well with full feedback, but does not work with limited feedback as laggards cannot see the effort choices of putative leaders. Limited feedback therefore leaves managers as the primary source of potential leadership within the firm.

Table 5
Features of treatments

	Treatment Name			
Characteristics of the treatment	**Computer manager**	**No communication**	**One-way communication**	**Two-way communication**
Manager type Rounds 1–10	Computer	Computer	Computer	Computer
Manager type Rounds 11–30	Computer	Human	Human	Human
Communication	None	None	Managers to employees	Managers to employees and vice versa
Bonus rate Rounds 1–10	6	6	6	6
Bonus rate Rounds 11–30	10	Set by manager in each round	Set by manager in each round	Set by manager in each round

Table 5 summarizes the treatments in our experimental design. The primary treatment variable in our experiments is what type of communication was possible between a firm's manager and employees.

As an additional standard of comparison, we also included a treatment where the firm manager was played by the computer with bonus levels determined exogenously for all rounds. This treatment is a control for whether using a participant as the manager as opposed to the computer affects employees' choices independent of financial incentives, to be able to compare with the work presented in the previous section. Employees in these experiments knew that the manager was always

the computer rather than another participant. For these experiments the bonus rate was equal to 6 for the first 10 rounds and 10 for the remaining 20 rounds, similar to the average bonus level chosen in the experiments with human managers.

Our participants were undergraduate students from Case Western Reserve University in Cleveland and from either Universitat Pompeu Fabra or the Universitat Autònoma in Barcelona.[16] As before, all experiments were run on a computerized network.

In the one and two-way communication treatments managers could type — at the same time that they were asked to choose a bonus level — messages into a text box. Participants were given no instructions about the content of the messages except that they could not identify themselves or use offensive language. They were given no time or length limit on entering messages. Indeed, some of the messages were quite long and took some time to type. Once the manager was finished, whatever message he wrote was sent to all the employees in the firm, and at the same time they saw his choice for the bonus rate. The messages were cheap talk in the sense that any promises made were non-binding.

In the two-way communication treatment employee communication came into play. At the same time that employees were asked to choose an effort level, they were given a text box in which they could type a message. Their instructions about messages were identical to those given to managers. Employees' messages were sent to their manager, and at the same time the manager saw the minimum effort chosen by their employees in the previous round. Employees could *not* send messages among themselves. The manager could not identify which employee was specifically responsible for a particular message as messages were randomly ordered and displayed without any identifying information.

5. Results on how incentives and communication interact

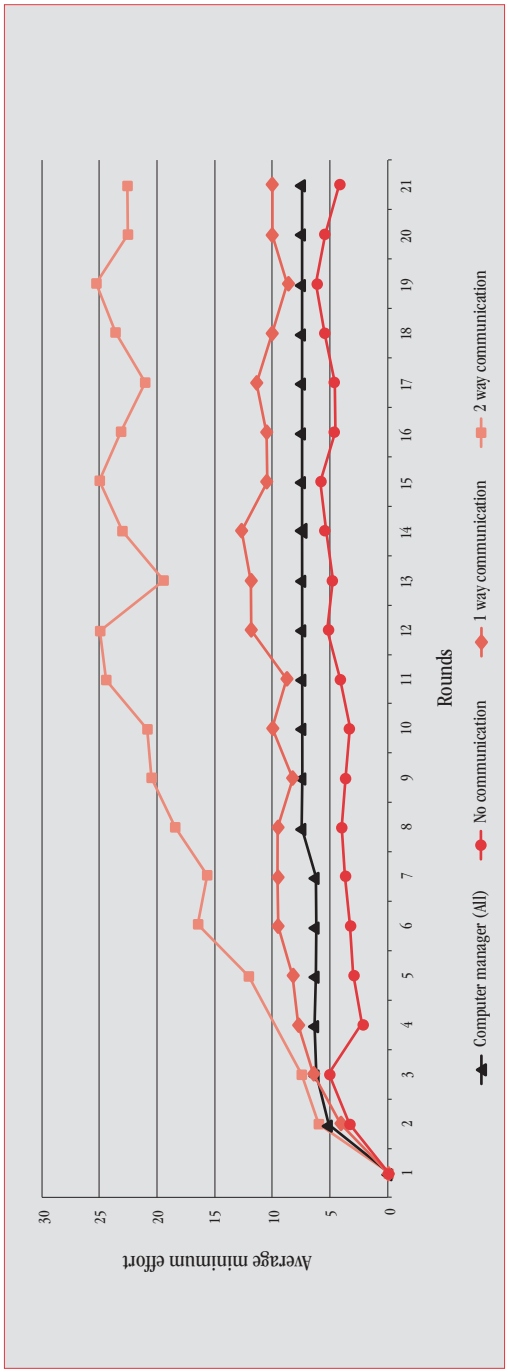
Moving to the results we again were able to create a history of coordination failure in the first 10 rounds. The average minimum effort falls from 7.09 in round 1 to a paltry 2.37 in round 10. Given that minimum effort is drawn from the set {0, 10, 20, 30, 40}, these averages are quite low. The minimum effort is zero in round 10 for 77 out of a total of 86 firms. When human managers took over in round 11, the need for a turnaround is almost always present.

Figure 4 shows the evolution of average minimum effort for the four main treatments, including only those experimental firms for which coordination failure occurred in round 10 (i. e., minimum effort equals 0 in round 10). The latter are the most pertinent data, since those few groups that do not fall into coordination failure fail to satisfy the precondition for our study of turnaround.

At this point we can respond to our first question above: globally, more communication possibilities and successful coordination go together. This brings us to the other two questions that go to the heart of the matter: what kinds of statements are linked to high effort levels and how does the impact of these statements compare with that of financial incentives?

To answer these questions, some way of quantifying the content of message is necessary. We therefore developed and implemented a systematic scheme for coding the content of messages. The goal was to systematically quantify any communi-

Figure 4
Comparison of minimum effort across treatments



cation that might be relevant to play of the game. We tried as much as possible to avoid pre-judging which sorts of messages would be important and which would not. Our methods are largely identical to those employed by Cooper and Kagel (2003).

Table 6 summarizes the coding of managers' messages.[17] This table only shows the most often chosen codes. We cannot eliminate the possibility that some of the rarer categories, *if used*, would have an impact on employees' choices, but the data provide insufficient observations of these categories to accurately measure their effect. In other words, our experimental design is not intended to determine the best (or worst) possible messages a manager *could* use, but instead examines what messages work well (or poorly) among those that managers *do* use.

For a number of the common categories, the brief descriptions in Table 6 do not adequately characterize the nature of the messages. We therefore begin by better describing some key categories along with examples. Starting with the managers, category 1 codes any request that employees choose a higher effort level. For example, "Please spend more hours on Activity A [effort]. Please". The frequent requests for a specific effort level were also coded under sub-category 1C.

Category 4 codes messages that point out the benefits of choosing higher effort levels for the employees — frequently this involved explicit discussion of the possibility for mutual gains by managers and employees (sub-category 4C). The following quote is a typical example: "We would all make more money if you, as employees, devoted your time to activity A [effort]".

Categories 5 and 6 are similar but not identical. Messages coded under category 5 involved the manager offering an implicit short-term con-

Tabla 6
Sumary of manager codings

		Frequency of coding		
Category	**Description**	**One way communication**	**Two way communication**	**All communication**
1	Ask for effort	0.271	0.443	0.352
1A	Polite	0.067	0.044	0.056
1B	Rude	0.014	0.006	0.010
1C	Specific effort level	0.141	0.357	0.243
2	Negative response	0.080	0.115	0.097
2A	Encouraging	0.014	0.023	0.018
2B	Hostile	0.022	0.018	0.020
2C	"Singling" out an employee	0.010	0.046	0.027
3	Positive response (praise, thanks, etc.)	0.124	0.134	0.129
4	Discuss monetary benefits of high effort	0.113	0.111	0.112
4A	Benefits for manager	0.018	0.001	0.010
4B	Benefits for employees	0.040	0.023	0.032
4C	Mutual benefits	0.059	0.086	0.072
5	Implicit contracts	0.058	0.110	0.082
5A	More effort now, higher bonus tomorow	0.038	0.076	0.056
5B	Lower effort now, lower bonus tomorrow	0.005	0.008	0.007
5C	High bonus now, request higher effort in response	0.017	0.022	0.019
6	Laying out a plan	0.033	0.172	0.099
6A	Alternating plan	0.011	0.084	0.045
6B	Ratcheting up effort	0.003	0.033	0.017
10	Emphasizing the bonus (includes explicitly stating what the bonus will be)	0.075	0.269	0.013
18	Soliciting feedback from employees (2-way)	0.007	0.077	0.010
19	Giving feedback to employees (2-way, involves responding to messages from employees)	0.000	0.094	0.001

tract. A common form of these implicit contracts was the promise of an increased bonus rate in the next round if the employees delivered the some requested minimum effort in the current round (coded as sub-category 5A). As an example, "I'll set the bonus high next time if we all do 40 this time". Category 6 was reserved for longer term plans, often lacking the explicit *quid pro quo* of the implicit contracts coded under category 5. Many times these plans involved employees choosing a high effort in all rounds while the manager alternated between setting a high bonus rate and a low bonus rate. The following is a simple example of this sort of plan: "I think the best way for everyone to get a lot of money is to all go 40 hours every time and alternate between a 7 and a 14 bonus every other time". As in the preceding quote, alternating plans were often presented, either explicitly or implicitly, as a way to even out payoffs between the employees and manager. While this could have been accomplished just as well by picking an intermediate bonus rate, there seems to be a preference for alternating, perhaps because it makes the gift exchange clearer.

Category 10 was coded when the manager emphasized the bonus, usually by explicitly stating what the bonus rate was. It is difficult to understand the importance of this category without seeing the messages in context. When a manager specifically refers to the bonus rate it is almost always to make some point other than what the bonus is. For example, consider the following message which was coded under category 10: "Thanks. I appreciate it. Now I'll raise it to 11". The employees have just raised their minimum effort from 20 to 30. The manager is responding by raising the bonus rate from 10 to 11. The implication is clear — the manager is rewarding the employees for their increased effort. As is almost always the case for messages coded under category 10, it is implied that a bonus rate of 11 is good pay. Looking

at the broader sweep of this particular manager's messages, it is also clear that he is signalling that an increase to a minimum effort of 40 will bring a further increase in the bonus rate. Indeed, he eventually succeeded in getting his employees to coordinate at effort level 40 in exchange for a bonus rate of 12. This is a good example of the implicit references to reciprocity that appears in many messages coded under category 10.

Just because a category of message is used frequently does not necessarily mean that it accomplishes much. Table 7 begins our examination of what types of messages are most effective for raising managers' profits. Data are drawn from the 39 firms in the communication treatments with minimum effort of 0 in round 10. Limiting the sample reduces the impact of differing initial conditions as well as focusing attention on the firms of primary interest, those in greatest need of a turnaround. The data are broken down by whether firms achieved earnings above our below the median for this group. We report statistics for all 20 rounds with human managers as well as for just the first five rounds (rounds 11–15) when most of the change in employees' choices occurs. For the four resulting cells we report the average bonus rate and the frequency of the most common message categories. We also calculate "all categories" which is the sum of the average frequencies for all of the categories. Sub-categories are not included in this statistic to avoid double counting. "All coded comments" provides a measure for how much a manager is communicating.

To begin our examination of Table 7, note that for rounds 11–15 the average bonus rates are almost equal for firms above and below the median earnings. Whatever leads some firms to eventually be more profitable than others, it does not appear to be differences in incentives. In contrast, there are fairly obvious differences in what messages are be-

Table 7
Determinants of managerial success
Minim effort in round 10 = 0

Variable	At or below median earnings		Above median earnings	
	Rounds 11–15	Rounds 11–30	Rounds 11–15	Rounds 11–30
Bonus	8.72	9.24	8.92	10.16
All Categories	0.940	0.911	1.879	1.836
Category 1	0.305	0.280	0.532	0.465
Category 1C	0.085	0.124	0.342	0.385
Category 2	0.055	0.126	0.100	0.076
Category 3	0.085	0.095	0.121	0.166
Category 4	0.125	0.089	0.226	0.138
Category 5	0.070	0.060	0.216	0.106
Category 6	0.035	0.034	0.079	0.171
Category 10	0.010	0.048	0.263	0.289
Category 18	0.050	0.029	0.078	0.095
Category 19	0.167	0.104	0.057	0.088

ing sent. Ignoring the content of messages, managers who earn more than the median earnings send twice as many coded messages as their less successful peers. Greater than median earners are 53% more likely to be coded for category 1, 81% more likely to be coded for category 4, more than three times as likely to be coded for category 5, more than twice as likely to be coded for category 6, and more than 26 times more likely to be coded for category 10![18] Most of these differences persist if we consider the longer sweep of rounds 11–30.

In summary, the effectiveness of messages depends both on what is said and when it is said. Manager messages that request greater effort (category 1) and emphasize the bonus rate (category 10) consistently have a positive persistent impact on minimum effort. Emphasizing the benefits of increased effort (category 4), proposing a long-term plan (category 6), and employee messages that offer advice to the manager (category 4) also lead to increased minimum effort under certain circumstances.

Table 8 presents the answer to our third and final question: will firm managers' choices of financial incentives be more important in determining their profits than their choice of communication strategies? It shows so-called marginal effects of changing the bonus and of using certain types of communication; these effects are based on ordered probit regressions.[19] Specifically, for the case of the bonus, the marginal effect captures the effect on profits of increasing the bonus level by one unit, starting at its average value. For the different communication categories it captures the impact of using that category as opposed to not using it.

In both panels of Table 8, increasing the bonus rate has a minimal effect on profits. Indeed, the marginal effect across all observations is negative! The increase in minimum effort caused by a bonus rate hike does not cover the additional bonuses that the manager must pay to employees. Even when the firm faces an immediate past of coordination failure, the best-case scenario for changes in the bonus rate being helpful (as the marginal effect cannot be negative), the impact on profits is quite small, amounting to 5.6% of average profits. In contrast, many of the message categories have large positive impacts. Across all observations, categories 1 (asking for effort), 4 (discussing benefits of higher effort), and 10 (emphasizing bonus rate) increase profits by 33.0%, 18.9%, and 33.5% respectively. Restricting attention to observations following a minimum effort of 0, categories 1 (asking for effort), 6 (laying out a plan), and 10 (emphasizing bonus rate) increase profits by 28.0%, 36.3%, and 24.9% respectively. Even in the best case for incentive payments, the marginal

Table 8
Marginal impact on manager profits

All Data:1684 observations, average current profit = 314.63

Category	Description	Significant effect on min. effort	Marginal effect on profit
N/A	Bonus	***	-21.53
1	Ask for effort	***	103.68
2	Negative response		-18.69
3	Positive response (praise, thanks, appreciation, etc)		27.36
4	Discuss monetary benefits of high effort	**	59.44
5	Implicit contracts		23.34
6	Laying out a plan	*	-49.45
10	Emphasizing the bonus (includes explicitly stating the bonus)	***	105.50
18	Soliciting feedback from employees (2-way only)	*	-146.70
19	Giving feedback to employees (2-way only)		-106.13

Lagged Minimum Effort = 0: 854 observations, average current profit = 140.14

Category	Description	Significant effect on min. effort	Marginal effect on profit
N/A	Bonus	***	7.87
1	Ask for effort	**	39.22
2	Negative response	***	-25.07
3	Positive response (praise, thanks, appreciation, etc)		-18.25
4	Discuss monetary benefits of high effort		5.48
5	Implicit contracts		4.06
6	Laying out a plan	*	50.88
10	Emphasizing the bonus (includes explicitly stating the bonus)	**	34.92
18	Soliciting feedback from employees (2-way only)		-14.85
19	Giving feedback to employees (2-way only)		-18.21

***, **, *: Significant effect on minimum effort at 1 %, 5% and 10%, respectively.

impact of the most effective comments is roughly 5–7 times greater than the marginal impact of a bonus rate increase. The bottom line is quite clear, the manager's communication strategy has a larger impact on his profits than his choice of a bonus rate — it's what you say, not what you pay!

6. Conclusions

We have presented the results of two studies and our results are quite encouraging. While one must always exercise caution in translating experimental results to field settings, the results from our first study suggest that firms and organizations can use financial incentives to overcome a history of coordination failure. Given that small increases in incentives are just as effective as large increases and given that incentives only need to be increased on a temporary basis, it seems that successful coordination can be accomplished rather cheaply.

In understanding why an incentive increase is effective, we believe that understanding the nature of the coordination problem is essential. We do not think that employees in firms experiencing coordination failure are unable to read the payoff table or fail to realize that everyone could be better off if all choose effort level 40. The trick, giving the riskiness of unilateral increases in effort, is figuring out how and when to get everyone to change their behaviour together. The bonus rate increases then serve as a way of explicitly calling everyone's attention to the need for improvement.

Focusing on the use of financial incentives as a coordination device for change allows us to better understand how an effective incentive scheme ought to be devised. First, a global scheme is effective. In contrast, if the goal is to get all agents (or at least many of them) to change behaviour simultaneously, a piecemeal approach may encounter more difficulties in generating the needed fraction of strong responses. This matches well with the conclusions of the empirical literature on organizational change. Second, the launch of an effective scheme needs to be highly public. Schelling's classic example on Grand Central Station being a focal point for a place to meet in New York City works because everyone (at the time) would have known where Grand Central Station was. Without common knowledge of its existence, an incentive scheme is unlikely to generate the coordinated change needed to overcome coordination failure.

In our second study we introduced the possibility of communication between management and employees. The overarching conclusion from our analysis is that communication between managers and employees can play a critical role in escaping coordination failure. More specifically, the effective use of communication helps our experimental firms to increase minimum effort, with two-way communication between human managers and employees being superior to one-way communication from managers to employees. Effective communication is more valuable for increasing managerial profits than manipulating the employees' bonus rate. There was no obvious reason to anticipate the latter result. Facing coordination failure, it is in everybody's interest for the firm to improve coordination. We would therefore expect that any coordination device would serve this purpose. In addition, simple economic intuition suggests that financial incentives should have strong drawing power.

Not all messages between management and employees have the same beneficial effect. The most effective managerial strategy seems to be rather simple and, *ex post*, natural. Managers should request a specific effort level and emphasize the mutual benefits of high effort. The goal is to act

as a good coordination device. It is useful to point out how well employees are being paid, although it is not important to actually pay employees especially well. For employees the most effective messages give advice to the manager, providing the firm with benefits of more than one person thinking about his problems.

It may come as a surprise to many economists that effective communication is much more important than the choice of bonus rates. Our interpretation of this result centres on how cognition enters into the achievement of coordination. Some means of achieving coordination may be naturally more salient than others. This kind of interplay is currently *terra incognito*, but may be of considerable importance for understanding social and economic life. In our context, the attribution of an intention to coordinate through a change of the bonus rate is based on a rather indirect channel. In addition, changes in the bonus rate raise issues of distribution which bring a separate question into the picture and, hence, may increase the complexity of the situation. Through the use of communication managers can directly point to the need for coordination. The exercise of cognitive leadership works better when leaders use cues which followers can grasp more easily.

Although superficially the results of our experiments indicate that incentives do not matter much, there actually exists a subtle interaction between incentives and communication. While changing the bonus rate accomplishes little for a manager, many of the most effective messages appeal to the financial interests of employees. For example, pointing out the mutual benefits of coordination is effective because employees care about coordinating and thereby earning higher payoffs. The key to success for a manager is not making it more lucrative for employees to coordinate; rather it lies in convincing employees that it is in their financial interest to attempt to coordinate by raising their effort levels. Incentives do matter even in this setting, just not in the way that economists are used to thinking about.

Our results have general implications for those interested in overcoming coordination failure. The specific managerial strategy that works best here will not necessarily work in all environments, but it seems clear that one role of a good manager is to act as a good coordinating device. By indicating clearly what is expected of employees and pointing out the benefits of coordinating, a good manager makes it easier for employees to overcome their strategic uncertainty and successfully coordinate. More generally, a successful manager cannot afford to rely on increased financial incentives to generate improvement. Good communication also has an important role to play.

As a final comment, we must note that our results are generated from a specific environment where coordination plays a central role. We do not argue that changing financial incentives will never be an effective managerial tool or that incentive design is always less important than communication. There exist ample examples of environments in which incentives play a central role. An important topic for future research is determining which settings, such as those that involve coordination, are particularly amenable to the use of communication and which are more sensitive to the choice of incentives.

Notes

(1) Foster and Ketchen (1998), Weick and Quinn (1999), and Pettigrew, Woodman and Cameron (2001) present surveys on work in the organizational behaviour and strategy literatures on change.

(2) Murphy, Shleifer and Vishny (1989) and Ciccone and Matsuyama (1996) present specific models of economies with these features.

(3) The content of this opuscle *is based on joint work with David Cooper and Enrique Fatás.*

(4) For an introduction to experimental economics see Davis and Holt (1993) and Holt (2007).

(5) This section is based on Brandts and Cooper (2006a).

(6) We use the term "stable situation" in relation to what economists call a Nash equilibrium. A bit more technically, in a Nash equilibrium every person involved in the situation takes a certain action and nobody would profit from deviating unilaterally. This concept of equilibrium was developed by Nobel laureate John Nash, whose life is narrated in the book by Sylvia Nasar (1994), "A Beautiful Mind".

(7) SeeVan Huyck et al *(1990).*

(8) Making the manager exogenous at this point has some advantages, which will become clear below. In the next section we will study the case where all managerial decisions are made by human participants.

(9) The reader may wonder whether the precise numbers — including the constants — which we chose for the payoff functions are crucial for obtaining our results. We can say that we have replicated the results discussed below for some variations of these numbers, so that our results have some robustness. However, we can not rule out different results for the variations that we have not studied.

(10) To derive this probability, solve for p such that 200 = 150(1-p3) + 210*p3. Given the linear payoff structure the same trade-off arises for one-step increases of effort starting at a level higher than 0, as well as for two or more step increases when feasible.*

(11) In weak-link games, coordination failure is not always so frequent. It all depends on the number of employees, the exact payoffs, etc.

(12) For all our results it is true that higher minimum effort led to higher worker income and higher firm profit.

(13) The downward spike for the final round of B = 10 is driven by a small number of individuals who, for inexplicable reasons, drop from choosing 40 to choosing 0 in the final round.

(14) This section is based on Brandts and Cooper (2007).

(15) For example, see Ford and Ford (1995) and Kotter (1996).

(16) Barcelona experiments with computer managers were run at UPF and all other Barcelona experiments were run at UAB. There is little difference between the student bodies at the two universities.

(17) Brandts and Cooper (2007) also discusses messages sent by employees.

(18) T-tests indicate varying degrees of statistical significance for these differences. Successful managers are significantly more likely to be coded in Rounds 11–15 for category 1 ($t = 3.26$, $p < .01$), category 5 ($t = 3.02$, $p < .01$), and category 10 ($t = 4.16$, $p < .01$). No significant differences exist for category 4 ($t = 1.58$, $p > .10$) or category 6 ($t = 1.21$, $p > .10$).

(19) This is a regression technique for the case where the dependent variable can take only a finite number of values, which have an inherent order.

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Jordi Brandts

Jordi Brandts graduated in economics from the Universitat Autònoma de Barcelona (UAB) and obtained his PhD in Economics from the University of Pennsylvania (1986).

At present he holds the Research Chair Antoni Serra Ramoneda UAB/Caixa Catalunya at the Department of Business of the UAB and is Research Professor at the Institute for Economic Analysis (CSIC) in Barcelona. He has been on the faculty of the Department of Economics and Economic History at the UAB and visiting professor at the University of California, Berkeley. He uses experiments to study interdependent preferences, inter-group conflict, organizational behavior and market behavior. Insights from other social sciences often influence his research.

He has published in a variety of journals among them the *American Economic Review, Management Science, Economic Journal, Games and Economic Behavior, Journal of the European Economic Association, Journal of Economic Behavior and Organization, Journal of Public Economics, Journal of Industrial Economics, International Journal of Game Theory, Labour Economics, Journal of Regulatory Economics* and *Public Choice.*

Since the beginning of 2007, he is co-editor of the journal *Experimental Economics.*

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Ramon Trias Fargas, 25-27 - 08005 Barcelona
Tel: 93 542 13 88 - Fax: 93 542 28 26
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