The Effectiveness of Alternative Programs of Management by Objectives on Firm Performance: An Experimental Study *

Alessandro Rossi[†] and Massimo Warglien[‡]

First version: March 1, 1999
This version: October 19, 1999

Abstract

The research focuses on the use of laboratory experimentation in order to design an effective MBO program for the executives of the major Italian electric utility provider (Enel). A game theoretical formulation of the MBO program currently adopted by Enel is given (baseline model) and laboratory experiments are implemented to test (a) how experimental subjects behave within the stylized MBO program and (b) the relative effectiveness on subjects performance of

*Preliminary Draft, some references may be missing or uncorrect. Authors would like to thank Rachel Croson, Alessandro Narduzzo and Enrico Zaninotto for their helpful comments and suggestions during earlier version of this paper. Michele Lorenzini and Marco Tecilla provided unvaluable help during the development of the experimental software. Support from Enel is gratefully acknowledged.

[†]Dipartimento di Informatica e Studi Aziendali, Università degli Studi di Trento, arossi@cs.unitn.it, http://www.cs.unitn.it/rock

[‡]Dipartimento di Economia e Direzione Aziendale, Università Ca' Foscari di Venezia, warglien@unive.it

the introduction of two different institutions (liability and tournament rules) governing the assignment of incentives. Results highlight that: 1) the baseline model resembles what has been observed in the field study: targets negotiated between principals and agents are easy to fulfill and a large majority of executives reach their own prize. 2) Liability rules increase the bargaining position of principals and result overall in higher levels of target assigned to agents and corresponding higher levels of performance of them; conversely no savings are observed in terms of cost of the MBO program. 3) Tournament rules allow to save more in MBO program costs; on the other side performance are, on average, similar to the baseline and variance is higher since the population splits into two sub–groups where a majority of agents shows performance levels close to the case of the liability rule while a minority of them shirk and decrease their working effort until the minimal performance. Some indications on the use of laboratory experimentation as a tool of organizational design are finally suggested.

JEL Classification: xxx, xxx.

Keywords: Managerial compensation, Agency theory, Target based compensation, Tournaments, Experimental economics.

1 Introduction

The impact of MBO on organizational productivity and workers motivation have been largely investigated from the empirical standpoint in field studies involving various types of organizations, from banks (Level et al., 1990), to airlines (Ellis, 1982), to research and development workers (Mossholder and Dewhirst, 1980), to university faculty (Terpstra et al., 1982), to public administration employees (Busch, 1998). Most of the empirical research

claims that a positive relationship between the introduction of MBO and organizational productivity does exist. Rodgers and Hunter (1991) present a survey comprising 70 different studies on MBO in organizations both in the public and private sectors. The authors show that 68 out of 70 studies reported productivity gains as the joint result of goal setting, participation in decision making, and objective feedback.

On the other side many empirical studies on MBO show that various problems have been encountered with the effective implementation of the MBO programs. One evidence of the survey of Rodgers and Hunter (1991) is that an effective implementation of a MBO plan requires both the support and commitment from the top management. Some difficulties of implementing a MBO device have been addressed also from the theoretical viewpoint, for instance Halpern and Osofsky (1990) claim that the classical formulation of MBO suffer from many shortcomings such as that it does not give protection to subordinates in the goals negotiation process and against superior manipulation or arbitrariness. Thus one can easily derive that the pseudo–participative property of MBO may decline to conflict and the assignment of targets and goals may be a difficult process and may not always result in increasing firm performance.

The present study starts from the analysis of a case study about the introduction of a MBO program within the major Italian electric utility corporation (Enel). The MBO program, introduced during 1997, seemed to be quite ineffective with respect to the corporate aims (eliciting higher level of effort from executives involved). Three levels of executives were subject to the MBO: CEO, divisional directors and functional directors; evidences, gathered using interviews to executives and data available on the MBO program, show that objectives assigned to functional directors from their superior (the divisional director) were low. As a result, the productivity of functional directors was low. Thus the MBO program had little influence on job performance and as a matter of fact the prize connected with the fulfillment of objectives were assigned to a large majority of the executives

involved in the program.

This study tried to understand how different MBO programs affect job performance and tried to give some operative suggestions to Enel on the way to improve its existing MBO plan. The MBO plan of Enel was given a game theoretical formulation within the agency framework and some laboratory experiments were designed and were ran in order to assess to what extent the experimental outcomes were similar to the evidence gathered in the field study. Then, two alternative versions of the MBO game were introduced to test the relative effectiveness of different institutions (rules for assigning payoffs) on firm performance. Finally, the results of experimentation was used to suggest how to modify the MBO program currently adopted by Enel in order to make it more effective with respect to the corporate aims.

The rest of this paper is organized as follows: in Section 2 the issue of Management by Objectives is introduced and the case study of Enel is described; Section 3 we compare our experimental approach to previous empirical research. Then in Section 4 a game theoretical interpretation of the incentive issues underlying MBO is given. Section 5 summarize our experimental design and Section 6 the main results. Finally Section 7 gives some conclusions, and Appendix A presents the instructions for the baseline experiment.

2 Enel and the Management by Objective Program

2.1 The Management by Objectives system

The idea of Management by Objectives has been firstly devised by Drucker (1954) and gained the role of well–known managerial practice starting from the 70's. The managerial literature on Management by Objectives is large

and the reader interested in having a comprehensive introduction to this issue is referred to the many existing studies (Odiorne, 1979; Reddin and Ryan, 1988).

Here, for the limited purposes of our study we can define Management by Objectives as an Individual target–based system of compensation that assigns to each involved subject a set of targets to reach within a given working period (typically a year) and specifies some extra monetary rewards (prizes) contingent to the fulfillment of these targets.

Such a system of variable compensation aims principally to enhance productivity and working efforts of people subject to it, to shape converging expectations on future results between parties of the organization and to make compensation more flexible and variable (allowing partial risk shifting).

2.2 The Enel implementation of a MBO system

The introduction of MBO has been a major challenge for Enel in 1997, since in the same year the corporation experimented many crucial changes, ranging from the introduction of budgeting systems to the transition of the organization from a U–form to a M–form. 120 executives (within a population of 950 exec.) were involved in the program, aimed to increase the identification with corporate and divisional goals. The MBO system completed the whole range of evaluation systems introduced in the previous years in ENEL, since at lower levels in the organization executives, managers and workers were already subject to various individual and group incentive systems.

The executives involved in the MBO program belonged to three hierarchical levels: CEO, divisional directors and functional directors (inside a particular division). [1] Targets were mainly based on accounting–based

[1] Some corporate staff positions were also included in the MBO program.

measure of performance, although some qualitative measures were also introduced. Moreover, targets were multiple and nested, so that the CEO prize only depended on the fulfillment of corporate targets, while divisional directors prize depended both on corporate and divisional targets and functional directors prize on corporate, divisional and functional targets. Targets were assigned to individuals and their value was negotiated by the executive with his hierarchical supervisor. Prizes were nested as well, and ranged from a minimal to a maximum value depending on the degree of fulfillment of the various targets. The system of prizes and their magnitude (about 10% of the base compensation) was set up in advance and publicly revealed by the corporate human resource director.

In the corporate view, the introduction of the MBO plan within the higher levels of executives aimed to foster the radical cultural change needed by the organization to face the transition from the monopoly in the electric utility industry to the competitive market. Previous motivational systems had failed in this respect and resulted in giving additional bonus and perks to executive in general with negligible, if any, connection with their actual performance. The corporate H.R. direction thought that the introduction of the MBO program for executives could have been effective in eliciting the hoped changes only if the plan would have be able to remunerate only the higher performers. Accordingly, targets should have been set so that they would have been hard and really challenging to fulfill so that only about 50% of executive involved in the program would have earned the prize.

During the first two years of adoption of the MBO plan, ENEL experimented many difficulties both in the introduction of the new motivational scheme and in the implementation of the stage of targets negotiation and the one of performance evaluation. In particular:

- the introduction process was difficult since the corporation was undertaking many organizational changes at the same time (divisionalization, introduction of a new formal budgeting system,

information systems re–engineering) and there were cultural inertia and conflicts in the introduction of an evaluation systems for high level executives;

- the negotiation stage presented many shortcomings and problems, since many supervisors were not informed enough on the corporate aims of the MBO or familiar with the method of target negotiation and assignment: many of them reacted to the new method giving prudential evaluation in the assignment of targets to subordinates, many other interpreted the MBO plan as a consensus instrument and deliberately set low level of targets (or even delegate to the subordinate the whole procedure of fixing the targets) as a way to gather agreement and harmony within the subordinates. In some other cases the negotiation conflict between a supervisor and his subordinates arose, resulting in strong delays in the target setting process;

- The performance evaluation stage was also a source of problems since measurement difficulties arose and the process of information gathering and processing was not immune to defects.

As a result at the end of the 1998 a negative evaluation of the impact of the MBO plan was devised by the corporate H.R. director, since targets assigned to executives were too low and easy to fulfill, performance were not sensibly higher than in the period before the introduction of the scheme and a large share of the executives involved in the plan won the prize (on average over 75% of executives, with some organizational units scoring a 100%).

3 The Research Method

In this study we took a different approach with respect to the standard empirical studies on Management by Objectives. We gave a game–theoretical formulation of the incentive issues underlying the Management by Objectives program employed by Enel during 1997 and 1998. Then we employed laboratory experimentation in order to test in a controlled environment how real decision makers subject to a MBO game behave and to investigate the effect of the introduction of different institutions (rules in the assignment of prizes) inside the baseline MBO game. Results of experimentation were used to suggest to Enel how to change their MBO plan in order to make it more effective, both on the cost side and in eliciting higher level of performance from the executives participating in the MBO.

The choice of an experimental approach to analyze the MBO issue of Enel is justified if one thinks to the many difficulties and shortcomings of traditional field experimentation both in the empirical literature (such as *ex post* case studies) and in the specific case of Enel (implementation attempts during 1997 and 1998). As a matter of fact, field experimentation in these settings is difficult and expensive to implement (since its introduction in Enel the MBO program suffered from low performance of executives and high costs, given the huge share of prizes earned by executives); there are many problems of measurements and it is difficult to judge the results of the experimentation (it was unclear to Enel whether the bad results where to be attributed to bad implementation of the program or conversely they were affected by other organizational or external variables); many difficulties in the introduction, such as frictions and conflicts among people involved in the program are likely to arise (as shown above in the Enel case).

On the contrary the experimental approach has the virtue to make possible to test various hypotheses in laboratory controlled conditions and to evaluate their outcome before actual adoption. The laboratory environment

allows also to minimize control and measurement difficulties since unobservable or hard to measure variables (for instance, employee productivity, preferences and production functions) may be exogenously controlled by the experimenter and comparative and systematic analysis of the effects of institutional variables may be conducted *ceteris paribus*.

The laboratory experimental method has gathered in the past year a large use as an instrument for institutional design, that is the test and evaluation of laboratory trading institutions such as auctions, posted–offer markets and many more. This stream of literature has offered, as two scholars have clearly pointed out,

> "an inexpensive way to examine various economic policy proposals ... experimentation may allow identification of proposals that are unlikely to be effective, and this can shift he burden of proof for policy proposals that do exhibit predicted results in the laboratory." (Davis and Holt, 1993)

Inside this field of research, a negligible attention has been given, so far, to the issue of institutional design within organizations. Although some behavioral studies on social dilemmas, public goods and coordination games have focused on issues of organizational decision making (see for instance Camerer (1999)), the theme of institutional design within organizations has been explicitly addressed only by few experimental studies on agency issues and incentive design. For instance, Bull et al. (1987) and Schotter and Weigelt (1992*a*) focused on the effects in symmetric and asymmetric tournaments of various institutions such as equal opportunity law and affirmative actions. Nalbantian and Schotter (1997) compared the effects on workers productivity of various individual and group incentive schemes. Schotter and Weigelt (1992*b*) investigated how different long–term bonuses gave rise to different inter–temporal behavior. DeJong et al. (1985) tested in laboratory conditions how alternative institutions, such as liability rules and costly investigation by the principal, can mitigate the adverse effects of

moral hazard within the agency relationship. Lo et al. (1997) investigated the ratchet effect in a principal–agent signaling game in various conditions of incentives, context and subject sophistication. Finally, Fehr and other scholars studied the effectiveness of various contract enforcement devices such as reciprocal norms and explicit incentives in the agency relationship (Fehr et al., 1997, 1998).

Thus, the impression is that this is a field of research relatively new and still to be exploited and that the experimental method may be effectively used as a "wind tunnel" tool for doing organizational design (see also Rossi (forthcoming) for a survey of the existing experimental contributions in agency and incentive design).

In the design of the experiments we proceeded as follows: we framed the MBO problem within the agency framework and we modeled a simple two–level hierarchical organization with two types of players subject to the MBO plan: a "principal", corresponding to the divisional director (in the Enel case), and two "agents", corresponding to functional directors. No player corresponding to the upper hierarchical level (CEO) was introduced in order to keep the model simple. Conversely, the effect of the upper level was given introducing three alternative treatment of the game, reflecting different options of the upper hierarchical level in implementing the MBO plan.

At first a **baseline version** of the MBO problem was devised, where the target of the principal was fixed and its fulfillment depended on the performance of his agents, while each agent's target was negotiated with the principal and each agent was given the prize depending on his own performance. Some simplifying assumptions were introduced to model the MBO game, in particular targets were single targets rather than multiple, they were not modeled as nested, agents' task independence was assumed and some assumptions about information available to players were made (as will be clear in the following).

Then, two alternative institutions governing the distribution of prizes were introduced. In the **liability treatment** a liability rule for the principal was devised in order to give the superior partial responsibility of the cost of the MBO program given to his agents. When we were conducting the field study, this liability rule was an option that Enel was evaluating in order to improve the commitment and the bargaining power of divisional directors in selecting the target of their functional directors. Thus, we modeled the liability rule in order to make rational, in the game theoretical sense, for the principal to assign to agents high level of the targets so that they are "difficult" to fulfill and on average only one agent out of the two earn the prize (see Section 4). We found useful to assess in the laboratory how this rule performed with respect to the baseline version of the MBO problem.

Finally we devised an alternative institution that introduced competitive and relative evaluation, rather than absolute, in the attribution of prizes to the agents. The difference of the **tournament treatment** with respect to the previous one is evident: here higher levels of effort from the agents are elicited letting the two subordinates competing for one single prize. This rule has also the merit to be cost effective since it is designed so that only one agent earn the prize with certainty.

In the next Section we will comment more exactly on the game–theoretical specification of the three treatments.

4 A Game–Theoretic Model of MBO

4.1 The general framework

Imagine a corporate division having two functions: at the top of the division there is a supervisor (from now on, principal) and each function has a director (from now on, agent). These three individuals are all subjected to a MBO plan.

Each individual (the principal and the two agents) is paid a baseline compensation of 40 monetary units and may earn a prize of 40 additional units if he satisfies his production target. The principal's production target is unknown to the agents, fixed in advance and exogenously set to 10 production units by, say, the board of directors. The principal satisfies his target if the joint performance level of the two agents (expressed as the number of production units produced by the two) is equal or greater than his production target (agents' task independence is assumed, so that the joint production level of the agents is simply the sum of the individual performance level of the two). Each agent's production target is negotiated with the principal and may range from 1 to 8 production unit (integer values allowed only). One agent satisfies his target if his individual performance level is equal or greater than his production target.

The MBO game is modeled as a sequential two–stage game, as follows:

negotiation stage The principal negotiate with each agent i (individually) the value to assign to his target $t_i \in \{1, 2, \ldots, 8\}$. [2]

The negotiation stage is modeled in a similar way to a structured bargaining three–round game, although here the outcome of the game are not payoffs assigned to the players but only the value assigned to the agent's target (that influence the payoffs of the players in the second stage). The negotiation stage is represented in Figure 1: the principal in the first round makes a proposal on the value to assign to one agent's target. If this offer is accepted by the agent, his target is set equal to the principal's proposal and the negotiation stage ends. Conversely, if the proposal is rejected by the agent, he can make a counterproposal in round 2: this can be accepted by the principal, and then the agent's target is set equal to this counterproposal and

[2] In the following the negotiation process with one single agent is described , but please note that the principal has to play two different negotiation stages, one with agent 1 and one with agent 2.

the negotiation stage ends. On the contrary, if the principal rejects the counterproposal, in round three he can unilaterally fix the target of his agent (in a way similar to the dictator of bargaining games). The initial proposal (round 1), the agent counterproposal (round 2) and the final decision by the principal (round 3) may assume integer values within $\{1, 2, \ldots, 8\}$.

Figure 1: First phase

Negotiation is costly both to the principal and to the agents and negotiation costs are increasing over time (this it is a common feature of multi–stage bargaining games), as depicted in Table 1. Thus if the agent accepts the principal's proposal they do not incur in negotiation costs, while if the stage–game ends on round two (the principal accepts the agent's counteroffer) they both have negotiation costs of 5 monetary units; finally if stage–game ends on round three (the principal fixes the agent's target) negotiation costs amount to 10 monetary unit.

Table 1: Negotiation costs (n_i) for the principal and for agent i as a function of the last round of the negotiation stage

round	1	2	3
n_i	0	5	10

production stage in this second stage each agent i chooses his effort level $e_i \in \{0, 1, \ldots, 8\}$; then nature determines agent i performance level (that can be interpreted as the number units produced by the agent),

as specified in the following stochastic production function:
$y_i = e_i + \psi_i$, where

$$\psi_i = \begin{cases} 0 & \text{with prob. } 0.5 \\ -1 & \text{with prob. } 0.5 \end{cases}$$

is a random variable that is introduced to reflect the basic agency assumption that agent i has a relative control over his performance or, alternatively, that the principal has an imperfect technology to measure performance.

At the end of the production stage the payoff are distributed to the players. The payoff of the principal is as follows:

$$\pi_P = W_P - n_1 - n_2;$$

where W_P is the principal's compensation, n_1 are the negotiation costs with agent 1 and n_2 the negotiation costs with agent 2. Agent i, conversely, earns the following payoff:

$$\pi_{A_i} = W_{A_i} - n_i - c(e_i);$$

where W_{A_i} is the agent's compensation, n_i are the negotiation costs with the principal and $c(e_i)$ are agent i's cost of effort, that are increasing with effort, as shown in Table 2.

Table 2: cost of effort ($c(e_i)$) of agent i

e_i	0	1	2	3	4	5	6	7	8
$c(e_i)$	0	0.2	0.7	1.5	2.5	3.7	5.5	7.5	10

4.2 Compensation Formulas

The three treatment (baseline, liability rule, tournament rule) only differ in the way compensation are given to players:

Baseline Treatment (MBO_1)

In the baseline condition both the principal and the agents earn their individual prize if their individual target is satisfied: the principal earns the prize if the joint production of his agents is equal or higher than 10, otherwise he earns the base compensation of 40 points only, as in the following formula:

$$W_P = \begin{cases} 80 & \text{if} \quad y_1 + y_2 \geq 10 \\ 40 & \text{otherwise} \end{cases} . \tag{1}$$

Agent i earns his prize if his performance equals or exceeds his target, otherwise he only earn the base compensation of 40 points, as in the following formula:

$$W_{A_i} = \begin{cases} 80 & \text{if} \quad y_i \geq t_i \\ 40 & \text{otherwise} \end{cases} \tag{2}$$

Liability Treatment (MBO_2)

In the liability condition a liability rule for the principal is introduced, so that he is made partially responsible for the cost of the MBO program administered to the two agents. He still earns his MBO prize as in the case of the baseline condition, but here he is also endowed an additional bonus of 20 points if none of the two agents earns his prize or a penalty of 20 points if both of them reach their prize. If only one agent out of two earns the prize neither the additional bonus nor the penalty are given to the principal and his compensation is equal as in the baseline treatment.

Thus principal compensation are given in the following formula, while the agent compensation is equal to the baseline treatment (see Eq. 2).

$$W_P = \begin{cases} 80 & \text{if} \quad y_1 + y_2 \geq 10 \\ 40 & \text{otherwise} \end{cases} + \begin{cases} -20 & \text{if} \quad y_1 \geq t_1 \quad \text{and} \quad y_2 \geq t_2 \\ +20 & \text{if} \quad y_1 < t_1 \quad \text{and} \quad y_2 < t_2 \\ 0 & \text{otherwise} \end{cases}$$

Tournament Treatment (MBO_3)

Finally in this condition while the principal's compensation is kept equal to the baseline treatment (see Eq. 1) the production prize for the two agent are unique and a tournament rule is set up to assign the prize to one of the two agents. An index of satisfaction of the target by each agent is introduced as follows:

$$s_i = \frac{y_i - t_i}{t_i},$$

that measures how much the agent's performance outperforms his target. Then, if both the agents satisfies their own target, since the prize is unique, it is given to the agent presenting an higher value of the satisfaction index (note that stakes are broken at random), as in the following formula:

$$W_{A_i} = \begin{cases} 80 & \text{if} \quad y_i \geq t_i \quad \text{and} \quad s_i > s_{2-i} \\ 40 & \text{otherwise} \end{cases}$$

4.3 Theoretical Predictions

Let's start from the analysis of the production stage in the three treatment: in this stage parameters were chosen so to make always optimal for an agent to try to win the prize for every value assigned to his target (in particular, even when it was not possible to win the prize with certainty, such as when $t = 8$ or in the tournament condition).

More formally, in the baseline treatment and in the liability treatment, this means that agent i reaction function is the following one:

$$e_i = \begin{cases} t_i + 1 & \text{if} \quad t_i < 8 \\ t_i & \text{otherwise} \end{cases} .$$

Recalling this, the equilibrium predictions in the second and third treatment can be easily derived. Please note that for the sake of simplicity we will not indulge on formalism, restricting our analysis to symmetrical initial proposals by the principal, and we will use the following notation (x, x) to mean that the principal proposes x to both his agents.

In the liability treatment a perfect forward–looking principal will propose $(8, 8)$ since proposals such as $(4, 4)$ or lower will be accepted by agents and, given agent's reaction functions will not allow the principal to earn his prize. Again, proposals equal to $(5, 5)$, $(6, 6)$ or $(7, 7)$ will be avoided by the principal, since they will be accepted by the agents and will result in both the agents to fulfill their target with certainty, and then in a penalty of 20 points for the principal. Agents will accept the principal proposing $(8, 8)$ because any counterproposal will never be accommodated by the principal, since, at that point, it will be always optimal for him to fix independently both targets to 8 in the last round of the negotiation, earning on average the same payoff as he would have had if he proposed to agents lower proposals, such as $(7, 7)$. As a result average performance of the agents will be equal to 7.5.

In the tournament conditions things go differently: in the production stage the reaction functions for the agents are different than in the previous cases, since it will be always optimal for an agent to put up the higher available effort (8), no matter what the target is. Recalling this, in the first stage of the game the agent will decline any proposal by the principal different from 1, since it will be optimal for any agent to counterpropose 1 (and this counterproposal will be eventually accepted by the principal). A perfect forward looking principal, then, will offer $(1, 1)$, and this offer will be obviously accepted by the agents. Once again, average performance of

the agents will be equal to 7.5, and, as mentioned above, on average only one agent out of the two will earn the MBO prize.

Deriving the equilibrium conditions for the baseline treatment is less straightforward: since the value of X is unknown to the agents we have to solve a incomplete information game. Before to give a more precise idea of theoretical prescriptions in this case we will derive the equilibrium in the case of X known by the agents. Here, as in the liability treatment, the principal will avoid to propose to agents proposal such as $(4, 4)$ or lower, since he will not earn the prize. On the other side proposal such as $(8, 8)$ or $(7, 7)$ will result, to some extent, in some rejections and counterproposal by the agents.

Take for instance the $(7, 7)$ proposal: recalling that the negotiation stage is simultaneously played by the agents, for each agent will be optimal to counterpropose 3 if the other agent accepted the principal's proposal, since the principal will accept and the agent will put up an effort equal to 4 to win the prize, saving 7.5 points (in effort costs), while spending only 5 additional points (as the result of the negotiation). On the other side for each agent will be optimal to accept the principal proposal if the other agent counterproposed 3, since on the contrary his counteroffer will be rejected by the principal (which will fix the target again up to 7) with 50% probability. Thus, if the principal propose $(7, 7)$ a mixed–strategy equilibrium does exist so that with positive probability each agent will reject the principal proposal. As a result a perfect forward looking principal in this case will propose $(6, 6)$ or $(5, 5)$. Both these proposals will be accepted by agents and average performance values will be, respectively, equal to 6.5 and 5.5. Eventually this will result in all the agents winning the prize.

Since the value of X is unknown, rather than known, to the agents, formal analysis in this case does not allow to exclude a level of the targets equal to $(7, 7)$ or $(8, 8)$, since this strongly depends on the beliefs of the agent on the value of X. Thus in this case we believe that past experience and feedback

on the compensation earned by the principal should over time update the agents' beliefs on the value of X towards its real value. As a result, we predicts that outcomes in the last rounds of the experiment should be similar to the ones predicted in the case of perfect information of X.

5 The Experimental Design

In order to investigate the effect of different MBO plans on individual and group performance we ran a set of three different experiments involving 99 college undergraduates recruited at the University of Trento (Italy) during January 1999; 77 of them were undergraduates in Economics, the remaining ones came from other faculties. Subjects were recruited through announcements on bulletin boards in the Faculty of Economics and were asked to show up to the Computable and Experimental Economic Laboratory. The announcements claimed that subjects would have been engaged in an experiment lasting about 1 hour and would have be able to win up to 50000 italian liras (approximately equal to 28 US dollars). During the experiment subjects earned experimental points that were at the end converted in italian liras at the rate of 41 italian lira per experimental point. The exchange rate was known in advance by all subjects and was chosen so that 50000 italian liras corresponded to the maximum amount of money that subjects could earn. Their average final payoff was about 35000 italian liras (approximately equal to 19 US dollars), an amount which seemed more than sufficient to motivate them.

The subjects were randomly divided in groups of 3 subjects who remained anonymously grouped during the entire experiment; the role of principal or agent was also randomly assigned and subjects were asked not to reveal their role. Then subjects were seated in front of computer terminals. After reading the experiment's instructions[3] (and having them read aloud by an

[3] A translation from italian of instructions is in Appendix A.

experimental administrator) and answering aloud to any question [4], the experiment begun. Interaction between subjects were reduced to the minimum during the experiment: each subject could see some two other participants but not their terminal monitors and verbal communication was not allowed. Since one group could finish the experiment earlier than the others, participants were asked to remain seated at their desk and to fill an application form needed for the payment.

Any experiment consisted in the repetition of 15 identical rounds of one of the three MBO game discussed in Section 4. 15 rounds were considered a reasonable length of time for learning to occur while being not too challenging for subjects involved in the experiment. After each round, subjects were given feedback on the outcome of the game. In particular:

- the principal was given information on his payoff, on the targets and the performance of each agent, and on the negotiation costs he had with each agent;
- each agent was given information on his payoff, on his target, on his effort, on his performance and on the compensation (40 or 80 points) assigned to the principal (the reason this last information was given to agents is that the principal could easily infer, given his information, whether one agent had received his production prize or not).

No information on payoffs earned by the other two subjects in the group was given to participants; anyway, due to the information given, a principal may approximately compute the payoff of each agent and each agent could approximately compute the principal's payoff. Note also that each agent in general had no feedback at all on the payoff earned by the other agent. The only relevant exception is in the tournament treatment, since if one agent fulfilled his target but was not given the production prize, he could easily infer that the prize had been given to the other agent.

[4] Subjects were also told to ask questions without revealing their role.

The payoff of each subject at the end of the experiment were simply the sum of the payoffs earned by him during the 15 rounds.

The experimental design was the following: each subject was engaged in only one experiment; 10 groups, for a total of 30 subjects, were assigned both to the baseline and to the tournament treatment while the tournament treatment was dispensed to the remaining remaining 13 groups, for a total of 39 subjects.

6 Results

In order to present the results of the experiments we will proceed as follows: first we will compare how the three MBO program performed in terms of levels of target assigned to the agents and performance of the agents, then we will illustrate some more specific regularities arising during the experiments.

Table 3 collects descriptive statistics for the three experiments.[5] Figure 2 and 3 presents, respectively, mean and median target levels assigned to agents in the negotiation stage for each round of the experiments.

Let's start from the analysis of the baseline treatment. Mean target values fluctuate around 5 (with a slight upward tendency) confirming, on average, the theoretical predictions.

Agents' performance follows the same fluctuating trend around 5, although a slightly increasing trend can be observed (see Figures 4 and 5, that respectively collect mean and median agents performance levels). Mean values are lower than theoretical predictions. This can be explained considering that the mean value are diminished by the low performance of those subjects that decided not to fulfill their target. Moreover, the slightly upward trend is both due to a diminishing number of shirking agents over

[5] To economize in space this table and some of the figures collect data from the three treatments.

Table 3: Descriptive Statistics

	MBO1	MBO2	MBO3
Mean Target Levels			
All rounds	5.1	6.1	5.2
Last 5 rounds	5.2	6.3	5.1
First round	4.6	5.3	5.1
Last round	5.2	6.6	5.2
Mean Performance Levels			
All rounds	4.9	5.9	5.2
Last 5 rounds	5.2	6.2	5.2
First round	4.2	5.3	5.3
Last round	5.4	6.4	5
Agents Earning the Prize			
All rounds	69%	72%	46%
Last 5 rounds	79%	75%	48%

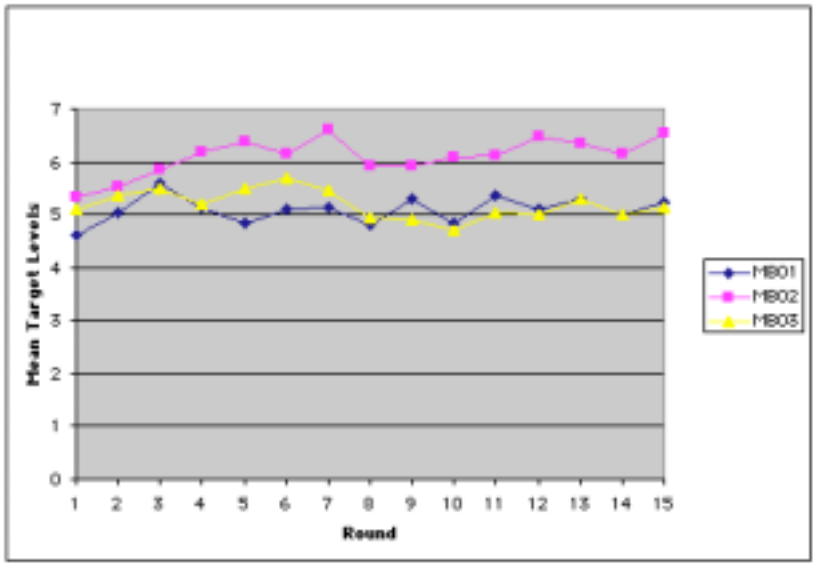

Figure 2: Mean Target Levels.

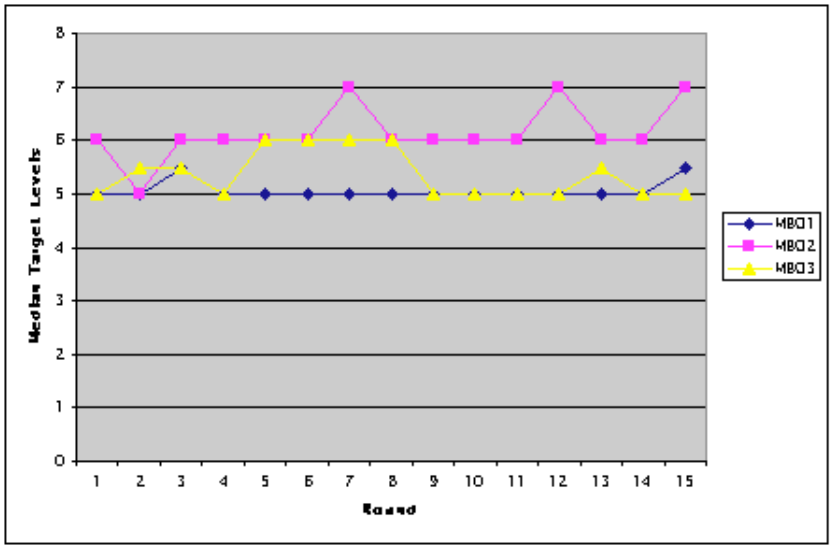

Figure 3: Median Target Levels.

time (from 27% of the observation in the first 5 periods to 15% in the 5 final periods) and to a diminishing frequency over time of a particular pattern of action. Actually, a closer look to data shows that some agents, aiming to fulfill their target, choose, especially during the early rounds of the experiment, an effort value equal to the target, apparently not caring to expose themselves to a lottery (recalling that the performance in the 50% of the cases is equal to the effort minus one, a subject choosing an effort equal to his target earns the prize, on average, only in the 50% of times). This pattern of action occurs in the 31% of the observations in the first 5 rounds and declines to the 14% in the last 5 rounds. A possible explanation may be that subjects are risk–seeking and prefer to save on cost of effort even if they expose themselves to the risk of not earning the prize. This may be the case but it seems poorly sustainable since one should assume an extreme degree of risk–seeking to justify that. A more plausible interpretation of this behavior may be that some subjects fails to understand, especially at the beginning of the game, that the optimal response in order to earn the prize with certainty is to choose an effort

equal to 1 unit higher than the target. This latter interpretation was confirmed, to some extent, also from some *ex–post* interviews made with a small sample of the subjects that supported also the evidence that subjects actually learned over time that the optimal response was to produce an effort one unit higher than their target.

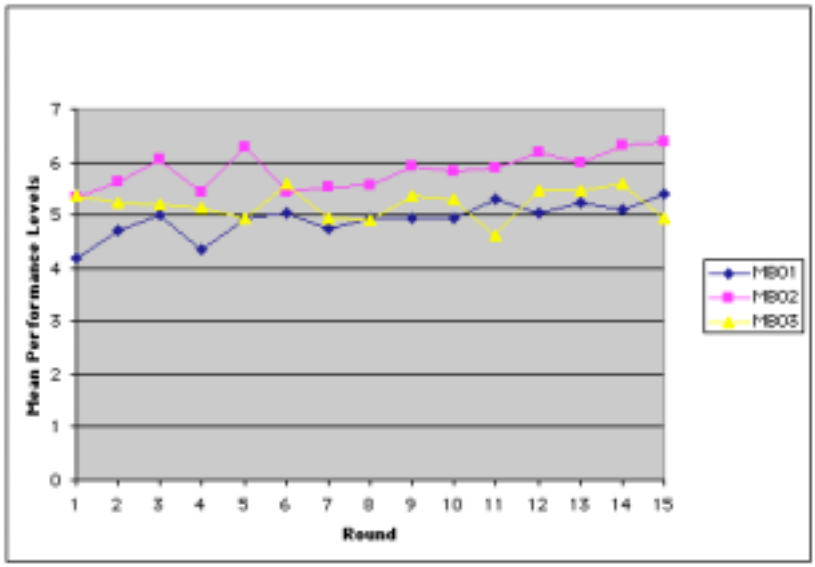

Figure 4: Mean Performance Levels.

Finally, the share of agents earning the prize was equal to 79% (value computed using the last 5 rounds data). The discrepancy with respect to the theoretical prediction of 100% did not depend on "difficult" targets set by principals (the target was set equal to 8 only on 4 out of 300 observation). This depended, on the contrary, on two alternative reasons: on the one side some agents intentionally failed to fulfill their target in order to reciprocate to a principal fixing targets interpreted by agents as "unfair". In some other cases (such as in the effort=target) the reciprocity hypothesis seemed less plausible and the hypothesis of bad comprehension of the rule of the game was assumed. In some sense the design of the experiment did not allow to perfectly discriminate between this two explaination of observed behavior; later in this section we will turn again to

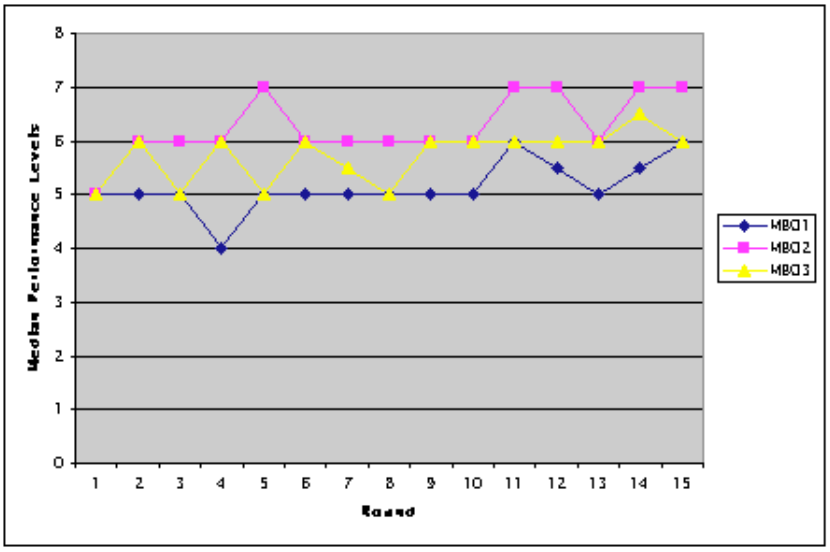

Figure 5: Median Performance Levels.

the theme of reciprocity in the three treatments.

The liability treatment presents a different picture: mean and median targets levels are higher than in the baseline treatment and both show a clear upward tendency over time. Nevertheless target levels are, on average, distant from the theoretical predictions (which state that the principal proposes intrinsically "difficult" levels of target, equal to 8, to both his agents), that are fulfilled only in the 16% of the observations. Anyway, there is clear evidence that principals present during the negotiation a behavior more firm and uncompromising than what they did in the baseline treatment: for instance the negotiation stage ends in the third round (corresponding to the principal unilaterally stating the value to be assigned to his agent) in the 11% of the observations (compared to 5% in the baseline treatment). At the same time also agents seems to be aware that the liability rule gives the principal a strong incentive to fix high level of targets, and this is reflected by the higher level of fulfillment (again compared to the baseline), in the production stage, of the targets by the agents, as shown by Figure 6, where the value of 41% of fulfillment when

targets are set to the maximum value (8) is close to the expected theoretical value (50%).

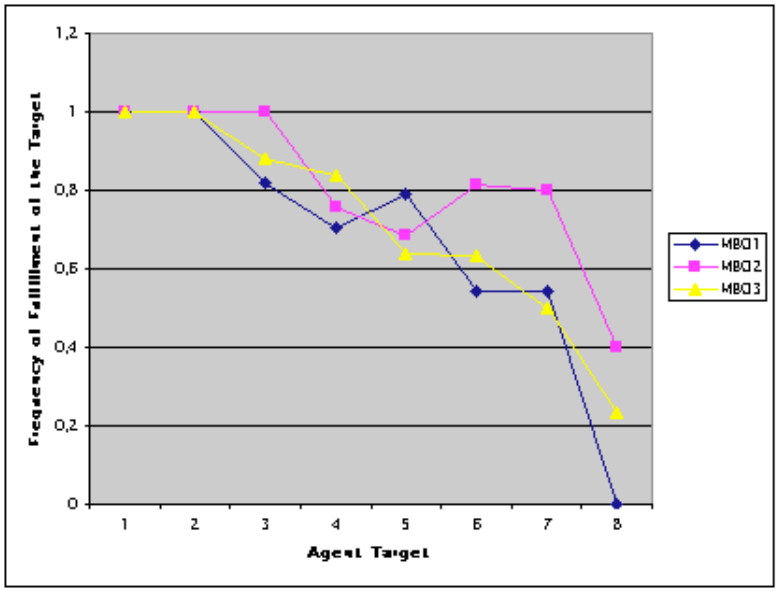

Figure 6: Frequency of Fulfillment of Agents' Target with Respect to the Value Assigned to the Target.

Thus, it seems that in the liability treatment the strategy of agents of intentionally shirk in order to reciprocate to high level of targets is here less used than in the baseline treatment. On the contrary, agents here seem to use more the reciprocal device of negotiation: in more than the 50% of the observations, when the principal proposed 8 as target, the agent did not agree and made a counterproposal, eventually forcing the principal to sustain additional negotiation costs. We suggest that this strong tendency of agents to reciprocate inflicting negotiation costs during the negotiation stage and the more limited tendency of the agents to reciprocate and shirk during the production stage jointly bring principals to give up their tendency towards setting "difficult" targets and to set them at levels lower than theoretical predictions.

We proved evidence that principals are not able to elicit the highest level of

performance by their agents. While mean target levels were higher than in the baseline treatment, it was still possible, for an agent willing to earn the prize, to fulfill his target with certainty (by choosing an effort level equal to the target plus one unit). As a result the shares of the agents earning the MBO prize were not significantly different from the baseline experiment (75% of the agents in the observations of the last 5 rounds). This resulted in the liability penalty to be assigned to the principal in almost 60% of the observations (Figure 7).

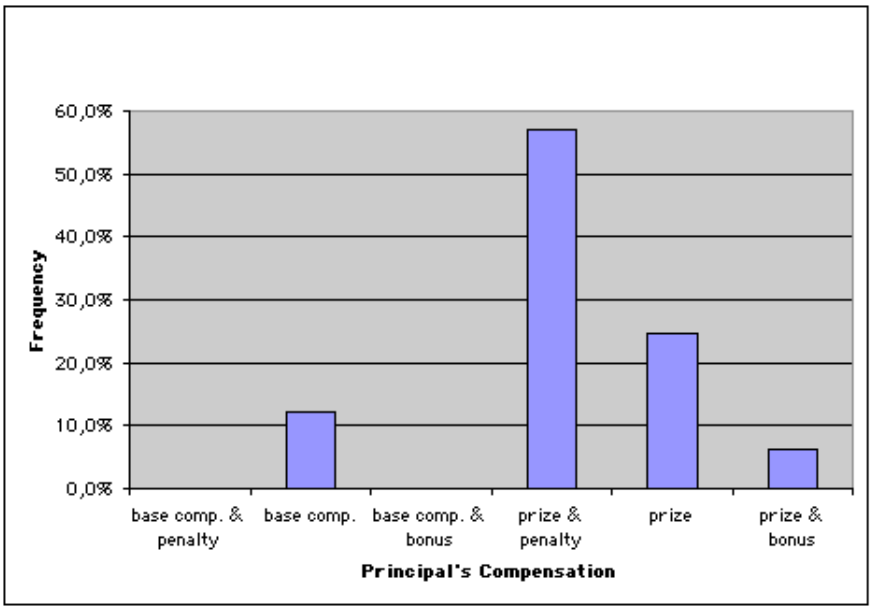

Figure 7: Frequency Histogram of Principal's Compensation in the Liability Treatment (MBO2).

Finally, in the tournament treatment both mean / median targets levels and mean performance levels were not significantly different than in the baseline treatment (in contrast with theoretical speculations). Anyway, at a closer look, the data reveal that variance of behavior in this treatment is much more higher. As a matter of fact, agents divide into two different subgroups: a large majority of them (approximatively 75%) presenting levels of performance similar to the liability treatment, and the rest of them

shirking and avoiding almost completely working effort. Figure 8, which shows the frequency histogram of performance observed in the three treatments, confirms this evidence: in the tournament condition the performance frequency distribution is bimodal, with a low modal value at 0 and a high modal value at 7 (as in the liability condition).

This result is similar to what has been observed in experiments on asymmetrical and unfair tournaments (Bull et al., 1987; Schotter and Weigelt, 1992*a*), where it is shown that disadvantaged agents participating in a two–person rank order tournament may present effort levels higher than the optimal value or may alternatively shrink and disengage from the tournament. In this setting over–performance of disadvantaged agents is interpreted assuming that agents maximize an utility function that takes into account not only earnings but, to some extent, also the fact to gain the prize in itself (even if costs connected with the effort levels needed to reach the prize with the same probability of the advantaged participant are not optimal for the disadvantaged participant). On the other side, under–performance and disengagement from working effort by some other disadvantaged agents is interpreted assuming that disadvantaged agents learned to shirk as the joint result, in the early stages of the game, of bad luck (in stochastic realizations and in splitting stakes) and aggressive play of opponents.

We believe that a similar explanation may apply in the case of our tournament experiment: even if some differences do exist (there are not disadvantaged agents and high performers presents effort levels below rather than over the theoretical predictions), shrinking arises as the result of repeated bad luck experienced during the early rounds of the game agents that fulfill their production target but which, due to the tournament rule, are not assigned the MBO prize, tend to lower their working efforts in the next round in order to save on effort costs and tend to shirk over time, relying on the sure compensation of 40 points and without incurring in

effort costs. [6]

This is, in some sense, surprising, as well as surprising is that, despite the mean target levels proposed by principals not being different to the baseline case, negotiation activity from the agents is not as high as one could expect. This two evidences, as well as many other details in the negotiation stage of the three treatment, still need to be investigated more systematically.

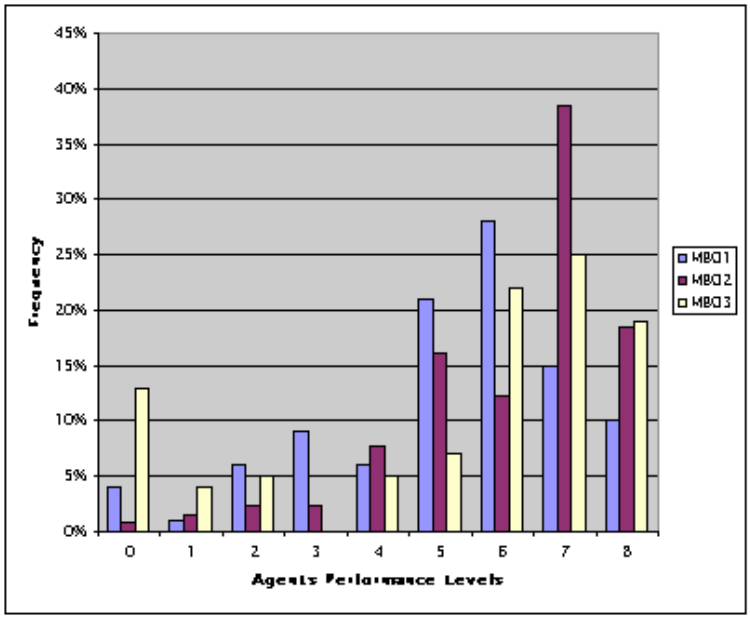

Figure 8: Frequency Histogram of Performance Levels (last 5 round).

In brief, we can summarize our main experimental findings looking at Figure 9, that plots the relationship between mean performance levels of agents and expected additional costs of the MBO program with respect to the case where only one agent out of the two earns the prize. As noted above, both the liability and the tournament rule dominates the baseline version, and suggest the clearly highlight the existence of a trade–off between performance and cost–effectiveness.

[6] It should be recalled that in the tournament treatment it is always optimal, in the game–theoretical sense, to put up the maximum effort in order to maximize the chances of winning the MBO prize.

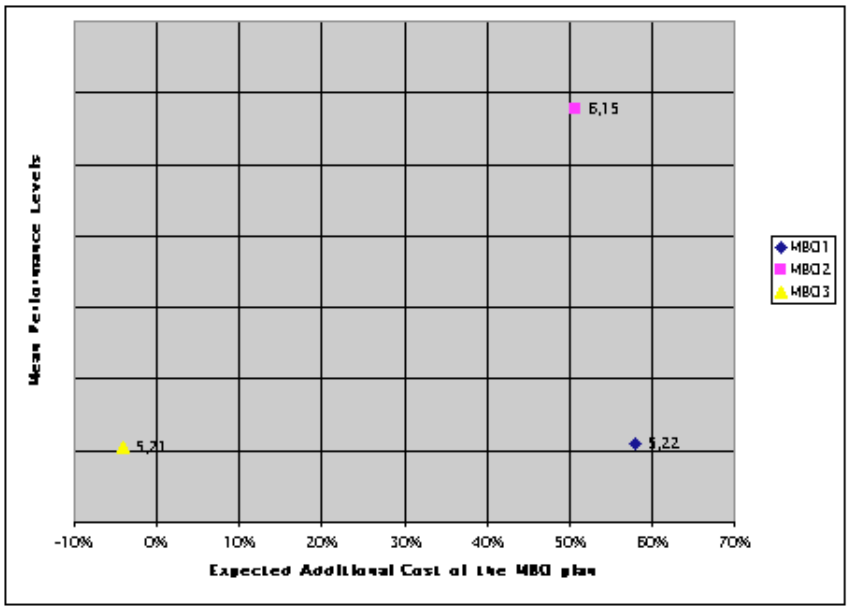

Figure 9: Mean Performance Levels and Expected Additional Cost of the Plan in the Three Treatments (0% corresponds to no additional costs when only one agent out of the two earns the prize).

7 Discussion

This paper suggests a first attempt to make use of laboratory experimentation for organizational design purposes: we presented a game–theoretical model of Management by Objectives and introduced three alternative institutional rules affecting how prizes are distributed to subjects. Then we conducted laboratory experimentation of the three models and we focused on their effects on firm's productivity. Main results of our study are the following ones: we found that the introduction of a liability rule for superiors increases their bargaining position and, as a result, targets of subordinates are set higher and consequently performance of them are higher. Anyway targets and performance are far from the theoretical predictions since subordinates reciprocate when superiors propose high levels of the target; as a consequence the liability rule is then ineffective in controlling the cost of the MBO program (in terms of amount of prizes given to subjects) since, even if targets are set higher than the baseline, it is still possible for the agents to earn the prize with certainty. On the other hand, the tournament treatment proves to be a cost effective mechanism while, on average, performance are not higher than in the baseline. A closer look to data shows that the introduction of a competitive rule in the assignment of the agents' prize results in eliciting in a large majority of the agents (75%) levels of effort similar to the ones observed in the liability treatment, while a minority of agents (25%) disengages from work and presents low levels of performance.

We are aware of the many risks of trying to generalize these laboratory findings to real workplaces and, in particular, to the Enel case. Our experimental design focused on the economic incentive properties of alternative Management by Objectives plan, ruling out intentionally many elements, such as communication, peer pressure, reputation, and many other extra–economic elements that characterizes the interactions among workers and are at the core of MBO.

Nevertheless we also believe that the analysis of the results of experimentation in the MBO settings may be useful not only to test how much the theoretical predictions of the economic model explain the behavior observed in laboratory conditions; but also to give, even using data from a simple and controlled environment, a rough idea on what behavioral response should be expected in a real setting as the result of the introduction of a different reward formula within an existing Management by Objectives program.

It is clear then that the adoption of a particular rule should be evaluated carefully, keeping in mind both the limits of experimental results and the corporate aims that drive the introduction of a Management by Objectives program within the organization. With respect to the former aspect, one should consider that the introduction of competitive rules such as in the tournament treatment may result as effective in eliciting high levels of performance as the liability rule if shirking could be detected and successfully avoided by the organization (for instance through monitoring by superiors or even by co–workers). With respect to the latter argument (corporate aims), it should be noted that the tournament version of the MBO may be an optimal selection device for an organization aiming to foster high levels of turnover and to discriminate among workers high from low performers.

A Experiment Instructions

This appendix presents the instructions (translated from italian) given to subjects engaged in the baseline treatment of the experiment. Instruction for the other two treatment are identical with the exception of specific instructions on the additional bonus / penalty in the liability treatment and on the tournament rule in the tournament treatment.

A.1 Introduction

You are participating to an economic experiment. You are kindly asked to carefully read the instructions. Then you will be able to ask questions that will be openly answered. This experiment will last about one hour. If you follow the instructions closely and make decisions carefully, during the experiment you can earn experimental points that at the end of the experiment will be converted into italian liras (1 experimental point = 41 italian liras).

A.2 Instructions

During the whole experiment you are anonymously matched with other two players in this room. One of the players is called *Principal* (from now on, P) and the other two players are called *agent* 1 and *agent* 2 (A_1 e A_2). Matching will be performed at random by the computer program at the beginning of the experiment and will not revealed. During the experiment your role will be the one of (principal / agent 1 / agent 2).

In the experiment P, A_1 e A_2 are paid a fixed compensation of 40 points and a production prize of 40 additional points (that depends on the fulfillment of production targets). For A_1 (e similarly for A_2) the fulfillment of his target depends on his output, that depends on his level of work effort. This is costly to A_1 (as it is for A_2): higher levels of work effort mean higher costs. The fulfillment of P's target, conversely, depends on the sum of the outputs of the two agents. P's target is fixed in advance, while the target of each agent is decided through negotiation between the principal and the agent. This negotiation is costly, both to the principal and to the agents.

The experiment involves the repetition for 15 times (rounds) of the following two phases:

First phase

(Please note that in the following the instructions will refer only to A_1 but the same apply also to A_2). In this phase P have to state with A_1 the value to assign to A_1's production target (and with A_2 the value to assign to A_2's production target). If during the second phase A_1 fulfills his target (regardless of what A_2 or P does) he wins 80 points (40 p. as the fixed compensation + 40 p. as the production prize for the fulfillment of his target), conversely if the target is not fulfilled he will win the fixed compensation of 40 points only.

A_1's target may range within the following values: 1, 2, 3, 4, 5, 6, 7, 8. The higher a target is fixed, the costly is for him to fulfill it, since the work effort is costly.

Figure 1: First phase

In order to set the target of A_1 at the beginning of this phase P have to propose to A_1 a value. He may accept this value as his target or counterpropose another value. Then P may accept A_1's counterproposal or reject it; in the latter case P will set A_1's target as he wish (see Figure 1).

If A_1 does not accept P's initial offer the negotiation is costly both to P and to A_1: if P accepts A_1's counteroffer they both have negotiation costs equal to 5 points; on the contrary if P reject A_1's counteroffer and fix his target as he wish, the negotiation costs are equal to 10 points for both.

Negotiation costs at the end of the round will be subtracted to the amount P will win (40 or 80 points) in order to compute his real payoff of the round. A_1's payoff will be his win (40 or 80 points) minus his negotiation costs and minus his effort costs.

The first phase ends when both the production target of A_1 and the one of A_2 are set.

Second Phase

In the second phase A_1 (the same holds for A_2) decides his level of working effort, within the following values: 0, 1, 2, 3, 4, 5, 6, 7, 8.

Working effort is costly to A_1, as shown in the following table:

effort level	0	1	2	3	4	5	6	7	8
costs	0	0.2	0.7	1.5	2.5	3.7	5.5	7.5	10

The output produced by A_1 depends jointly on his effort and on chance with probability 50% his output will be equal to his level of effort, otherwise will be equal his level of effort minus one unit. Thus his output will be as follows:

$$output = \begin{cases} effort & \text{with prob. } 50\% \\ effort - 1 & \text{with prob. } 50\% \end{cases}$$

Thus A_1 payoff will be equal to his compensation (80 points if his output will be equal or greater than his target, 40 points otherwise), minus his negotiation costs, minus his effort costs.

P target is fixed and is equal to X; if the joint output of the two agents is equal or greater than X, P win 80 points (40 p. as the fixed compensation + 40 p. as the production prize for the fulfillment of his target), conversely if P's target is not fulfilled P will win the fixed compensation of 40 points only. The real value of X will be communicated only to P, before the experiment start.

P payoff will then be equal to P's win minus his negotiation costs.

End of the round

At the end of the round the computer program will display to P this information: A_1's target, his negotiation costs with A_1, A_1's output, A_2's target, his negotiation costs with A_2, A_2's output, and his payoff.

The computer program will display to each agents this information: his target, his negotiation costs, his output, his effort, his payoff and the amount of points won by P (80 or 40 points).

References

Bull, C., A. Schotter and K. Weigelt (1987), 'Tournaments and piece rates: An experimental study', *Journal of Political Economy* **95**(1), 1–33.

Busch, T. (1998), 'Attitudes towards management by objectives: An empirical investigation of self-efficacy and goal commitment', *Scandinavian Journal of Management* **14**(3), 289–99.

Camerer, C. (1999), Coordination in organizations: a game-theoretic perspective, *in* Z.Shapira, ed., 'Organizational Decision Making', Cambridge University Press.

Davis, D. D. and C. A. Holt (1993), *Experimental Economics*, Princeton University Press, Princeton, NJ.

DeJong, D. V., R. Forsythe, R. J. Lundholm and W. C. Uecker (1985), 'A laboratory investigation of the moral hazard problem in an agency relationship', *Journal of Accounting Research* **23**(Supplement), 81–120.

Drucker, P. F. (1954), *The Practice of Management*, Harper & Row, New York, NJ.

Ellis, W. (1982), 'Use of a management team system to implement mbo in an airline', *Journal of Organizational Behavior Management* **4**(3 sup 4), 65–80.

Fehr, E., E. Kirchler, A. Weichbold and S. Gächter (1998), 'When social norms overpower competition: Gift exchange in experimental labor markets', *Journal of Labor Economics* **16**(2), 324–51.

Fehr, E., S. Gächter and G. Kirchsteiger (1997), 'Reciprocity as a contract enforcement device', *Econometrica* **65**(4), 833–60.

Halpern, D. and S. Osofsky (1990), 'A dissenting view of mbo', *Public Personnel Management* **19**(3), 321–30.

Level, D. A., J. G. Ormsby, L. R. Watts and D. B. Tinsley (1990), 'Management by objectives: Implications for managerial communication', *Journal of Managerial Issues* **2**(3), 325–36.

Lo, W., D. Cooper, J. H. Kagel and Q. Gu (1997), 'An experimental study of the ratchet effect: The impact of incentives, context and subject sophistication on behavior', mimeo, Dept. of Economics, University of Pittsburgh.

Mossholder, K. W. and H. D. Dewhirst (1980), 'The appropriateness of management-by-objectives for development and research personnel', *Journal of Management* **6**(2), 145–56.

Nalbantian, H. R. and A. Schotter (1997), 'Productivity under group incentives: An experimental study', *American Economic Review* **87**(3), 314–41.

Odiorne, G. S. (1979), *MBO: A System of Managerial Leadership for the 80s*, Fearon Pitman Publishers.

Reddin, B. and D. Ryan (1988), *Management by Objectives*, Tata Mcgraw-Hill Publishing, New Delhi, India.

Rodgers, R. and J. E. Hunter (1991), 'Impact of management by objectives on organizational productivity', *Journal of Applied Psychology* **76**(2), 322–336.

Rossi, A. (forthcoming), Incentives in managerial compensation: A survey of experimental research, Technical report, DISA, University of Trento.

Schotter, A. and K. Weigelt (1992*a*), 'Asymmetric tournaments, equal opportunity laws, and affirmative action: Some experimental results', *Quarterly Journal of Economics* **107**(2), 511–39.

Schotter, A. and K. Weigelt (1992*b*), 'Behavioral consequences of corporate incentives and long-term bonuses: An experimental study', *Management Science* **38**(9), 1280–98.

Terpstra, D. E., P. D. Olson and B. Lockeman (1982), 'The effects of mbo on levels of performance and satisfaction among university faculty', *Group and Organization Studies* **7**(3), 353–66.