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Decision Support

Incentives and individual motivation in supervised work groups

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ABSTRACT

This paper introduces and analyzes a model of supervised work group where subordinates decide how to exert their effort in complementary tasks while the supervisors decide incentives. Incentives may be a combination of individual and group-based ones. The optimality of incentives is analyzed when considering two different cost functions for subordinates. The two cost functions describe different individual motivations; comparing the resulting effort allocations and production optimality, we can relate them to different organizational theories. Our results provide a measure of how motivation among subordinates may affect production and incentives. Furthermore, the optimal incentives schemes are examined in terms of Adams' equity theory.

1. Introduction

According to Boudreau et al. (2003), the fields of operations management and human resources management are intimately related, yet they maintain distinct perspectives.

Among the examples which try to merge these perspectives, Bordoloi and Matsuo (2001) applied control theory to deal with workforce planning taking into account also worker learning and controls for the risk. Another example is Gendron (2005), where a store scheduling problem with constraints deriving from union representatives' and human resources personnel's was approached and solved.

Recently, Boudreau et al. (2003) examine how human considerations affect classical operation management. In their conclusion, they highlight the research challenges and opportunities of bringing the human resources and operation management together.

In this paper, we explore this line of research and try to integrate human considerations in optimal incentive problems. The Moral Hazard literature approaches multi-agent relationships in different ways. For example, the joint production models provide interesting insights in terms of income distribution among the agents, see for instance Alchian and Demsetz (1972) and Holmström (1982). Another relevant aspect is the comparison between centralized and decentralized structures as far as contracting goes. For example, the literature provides conditions under which the delegation of the supervisory task, i.e. decentralizing, is beneficial; to obtain a first analysis of the advantages and disadvantages of delegation the reader may refer to Macho-Stadler and Pérez-Castrillo (1997).

One aspect usually neglected in the economic literature is the role of individual motivation; while, in psychology, motivation is a concept that has been discussed extensively. According to Spector (2003) work motivation theories are most typically concerned with the reasons, rather than ability, that some people perform their jobs better than others. Steers and Black list the stages the evolution of management thought concerning employee motivation has passed through. They are the traditional model, the human relations approach and, more recently, the human resources model. In particular, "this newer approach also assumes that different employees want different rewards from their jobs, that many employees sincerely want to contribute, and that employees by and large have the capacity to exercise a great deal of self-direction and self-control at work" (Steers and Black, 1994, p. 139).

To this extent the case of Kyocera Corporation is striking. As it concerns the reward system, Kyocera's founder Kazuo Inamori, in a booklet describing his philosophy, writes "We don't think in terms of individual rewards. We don't buy individuals' loyalty with monetary incentives or titles. Rather, we believe that individuals who are endowed with superior capabilities should contribute their capabilities for the good of the entire group." (for a discussion of Kyocera's organizational culture the reader may refer to Bylinsky (1990)). This example is contrasted by pay incentives used at Lincoln Electric, where most employees are paid on a piece-rate system (the Lincoln Electric Company has been described in several case studies by business schools, see for instance Fast and Berg (1975)). Several comparisons between incentive programs have

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been presented in the literature. Among others, Weiss (1987) provides an empirical comparison between individual wage incentives and group incentives examining the effects in terms of motivation and quit rates.

Following the joint production approach, we consider a modular model of hierarchical organization. Specifically, we concentrate mainly on pyramidal structures. This particular structure is widespread and, consequently, both the economic (see Beckmann, 1988, for a formal analysis) and simulative literature (for instance, see Glance and Huberman, 1994) find interest (for an analysis of the different approaches to pyramidal structures see Merlone, submitted for publication). In our model, the organization consists of two heterogeneous agents interacting in a supervised work group with a Cobb–Douglas production function. In the literature, the distinction between team and work group is hazy, nevertheless we will follow Spector (2003). As a consequence, we will refer to a supervised work group as, in our case, we consider interchangeable subordinates.

In this paper, we assume that individuals with different motivation may have different cost functions and analyze the incentive problem the supervisor faces, in order to maximize her own profit. In particular, we analyze how the optimal solution for the supervisor varies when considering two different cost functions for subordinates. Cost function plays an important role for the agent. While in Dal Forno and Merlone (2007) only piecewise constant cost function was considered, in this paper we also consider strictly convex costs. Usually economics assumes that costs are increasing and marginally increasing; the other kind of cost function in some cases may model more realistically some situations. We refer in particular to situations like those described in Smith (1977) where employees expend their discretionary effort (for a discussion about antecedents of discretionary effort and its consequences on performance the reader may refer to Bailey et al. (2001) and Sutton (2007)). In this sense, the two different cost functions can be interpreted in terms of motivation; while the piecewise constant cost function may be appropriate when subordinates have high self-efficacy and are highly motivated, the other cost function seems to be more appropriate for individuals who are mainly interested in monetary incentives. It is well known (Zhou, 2002) that, with regard to the principal-agent theory, in general it is difficult to derive analytical solutions; therefore, even in scholarly contributions, strong assumptions are usually required. This tradeoff between analytical tractability and extensive simplification is acknowledged by other authors approaching organization complexity (see Ethiraj and Levinthal, 2009). Nevertheless, the two different cost functions we analyze can be related to different cultures in the organizational structure we consider. As a consequence, by comparing the production outputs under the two different cost function assumptions, our analysis allows us to compare productivity under different organizational cultures and to measure what the cost of the culture in terms of production is. The two different cost functions, and the related organizational cultures, are particularly interesting when considering changes in competition induced by emergent countries such as China (for a discussion on the role of culture in the economic style of China, the reader may refer to Herrmann-Pillath (2005) and to Lum (2003), for an analysis of labor conditions in the same country).

The structure of the paper is the following. In Section 2, we present the theoretical model. Sections 3 and 4 summarize and analyze the optimal incentive problem with the two different cost functions in question, describing how these are related to the subordinates' motivation. In Section 5, optimal incentive schemes and outputs are compared and the results are interpreted in terms of organizational culture consequences on productivity. Finally, Section 6 is devoted to conclusions and further research.

2. The model

As in Dal Forno and Merlone (2007) and Dal Forno and Merlone (2009), we consider a model of supervised work group in which a supervisor (acting as principal) and two subordinates (acting as agents) cooperate. Agent i allocates his effort l_i with the partner, and the effort u_i with the supervisor. The joint production function for agents 1 and 2 is $\Gamma(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta}$, where $\Gamma \in \mathbb{R}_{++}$ is a constant factor,[1] and $\alpha, \beta \in (0,1)$ are, respectively, the output elasticity with respect to the joint effort with the supervisor and with the partner. As a consequence, the agents have to decide both how much effort to exert, and how to partition it in the two complementary tasks.[2] Agents bear a cost for effort: agent i's cost function $c_i : \mathbb{R}_+^2 \to \mathbb{R}_+$ will be denoted with $c_i(u_i, l_i)$; cost functions are private information. Furthermore, each agent can observe the level effort his partner provides with him, but not the one which is provided with the supervisor. Conversely, the supervisor can only observe the joint output and the effort each agent provides with her. The supervisor's profit is a share $\gamma \in (0,1)$ of the supervised work group production minus the incentives she pays to her subordinates. In the following, we assume that the output is sold on market at unitary price and the production and sharing constants Γ and γ are such that $\Gamma\gamma = 1$; this is not restrictive, it simplifies the notation, and allows us to simply consider monetary payoffs. Finally, agents' retribution consists of a fixed wage $w > 0$ plus a performance-contingent reward; we assume that the fixed wage is sufficient to meet basic needs, in terms of the hierarchy of needs theory (Maslow, 1970), physiological needs and needs of safety; in economic terms we say that the participation constraint is met.

Proposition 1. *The gross production $(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta}$ is maximized if and only if the aggregate efforts are allocated proportionally to the output elasticities.*

Proof. The result follows from combining and rearranging the first order conditions of the problem

$$\max_{u_1,u_2,l_1,l_2} (u_1+u_2)^{\alpha}(l_1+l_2)^{\beta}. \tag{1}$$

In fact, from

$$\begin{cases} \alpha(u_1+u_2)^{\alpha-1}(l_1+l_2)^{\beta} = 0, \\ \beta(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta-1} = 0, \end{cases} \tag{2}$$

it follows

$$\frac{u_1+u_2}{l_1+l_2} = \frac{\alpha}{\beta}. \qquad \square \tag{3}$$

Condition (3) is necessary in order to maximize the production of the supervised group. When either as the result of misaligned incentives or as lack of coordination between subordinates this condition is not met, then the effort allocation is not efficient. The performance-contingent reward is a linear incentive b_t on the joint output of the team and a linear incentive b_i on the effort each agent exerts with the supervisor. Therefore, the problem can be formalized as a bilevel programming problem:

$$\max_{b_t,b_1,b_2} (1-2b_t)(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta} - b_1u_1 - b_2u_2, \tag{4}$$

such that, given the incentives b_t, b_1, b_2, subordinates solve

$$\begin{aligned} &\max_{u_1,l_1} \quad w + b_t(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta} + b_1u_1 - c_1(u_1,l_1), \\ &\max_{u_2,l_2} \quad w + b_t(u_1+u_2)^{\alpha}(l_1+l_2)^{\beta} + b_2u_2 - c_2(u_2,l_2), \end{aligned} \tag{5}$$

[1] We recall that $\mathbb{R}_{++}$ is the set of positive real numbers; the case $\Gamma = 0$ is trivial.

[2] From the functional form of the production function it is immediate to observe that the two tasks are not additive; for a discussion the reader may refer to Spector (2003).