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On discrimination in the optimal management of teams[☆]

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HIGHLIGHTS

- Optimal wage schemes in a team production setting are largely discriminatory.
- The extent of the discrimination crucially depends on the existence of moral hazard.
- The effect of moral hazard changes from simultaneous to sequential production processes.

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ABSTRACT

We study the optimal management of teams in which agents' effort decisions are mapped (via a production technology) into the probability of the team's success. Optimal wage schemes in such context are largely discriminatory, but we show that the extent of the discrimination crucially depends on the existence of moral hazard. More precisely, for teams with a flat structure, the domain of production technologies giving rise to discrimination is broader when agents' actions are observable and contractible. For teams with a sequential structure, the result reverses and the domain of production technologies giving rise to discrimination is broader when there exists moral hazard. Finally, in more cooperative environments in which agents are allowed to collude, optimality does not entail discrimination, with or without moral hazard.

1. Introduction

In recent years, teams have become increasingly important in work settings. The design of wage schemes for team members is central to almost any debate on the optimal functioning of teams. It seems unquestionable that optimal wage schemes should entail *unequal treatment of unequals*, aiming to account for skill and performance heterogeneity within the team.[1] A more interesting, and somewhat surprising, feature of optimal wage schemes is to entail *unequal treatment of equals*, i.e., to discriminate among equally skilled team members who perform equally. Arbitrary discrimination carries adverse implications from a behavioral point of view.[2] Our aim in this paper is to explore this feature, with a special emphasis on scrutinizing the role of moral hazard on it.

In order to frame our discussion, let us consider first a stylized version of our model. Imagine a project that has to be managed by a team of (risk-neutral) equally skilled agents. Each agent decides simultaneously (i.e., without observing other agents' decisions) whether to exert effort or not in order to perform their tasks. The overall project succeeds with a probability which is a non-decreasing function (known as a *technology*) of the number of agents exerting effort. The success of the project yields proceeds for the (risk-neutral) principal, who aims to maximize expected benefits. The principal, who observes each agent's effort, is subject to limited liability of the agents and to a budget constraint (total

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1 The accountability principle according to which a person's entitlement varies in direct proportion to the value of her relevant discretionary variables, relative to others, is grounded in the theory of justice, as well as backed up by experimental evidence (e.g., Konow, 2000; Cappelen et al., 2007).

2 See, for instance, the experimental evidence recently reported by Goerg et al. (2010). Somewhat related, Abeler et al. (2010) show that when harder working agents are paid the same as those who exert less effort, the hard working agents start to withdraw effort even though it is in their interest to continue to work hard in the absence of social preferences.

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payment cannot exceed the proceeds from the project) while designing wage schemes.

We show that, for any (non-decreasing) technology, if the principal bases individual payments on own effort choice and the success of the project, the optimal wage scheme involves an endogenous hierarchy within the team. More precisely, one agent is induced to exert effort assuming no other peer is doing so. Another agent is paid enough to make her exert effort when one other agent does so as well, etc. A consequent feature of this scheme is that equal agents are treated unequally. That is, equally deserving agents will end up receiving different wages (depending on the position they occupy in the endogenous hierarchy).

Such a form of discrimination is reminiscent of some common strategies in trade contracts (e.g., Cabral et al., 1999; Segal, 2003). Nevertheless, the discriminatory nature of optimal schemes for teams was first highlighted by Winter (2004).[3] He analyzes a very similar model of team production in which agents' (simultaneous) effort decisions are also mapped into the probability of the team's success. Two crucial differences, however, exist with respect to our model. First, effort choices are not observable, which makes the moral-hazard problem the priority of the analysis. Second, it is simply assumed that the principal's aim is to make all agents exert effort, whereas our focus is to determine the optimal subset of agents (within the team) exerting effort. Winter's main result provides a necessary and sufficient condition for the optimality of fully discriminatory mechanisms. More precisely, he shows that the optimal way of making all agents exert effort involves full discrimination among identical agents if and only if technology functions exhibit *increasing returns to scale*. As mentioned above, we get a similar, albeit stronger, result. More precisely, we show that, without moral hazard, the optimal scheme (i.e., the one maximizing the principal's expected utility) also amounts to fully discriminate among identical agents, but this feature occurs without imposing additional conditions whatsoever on the technology functions. Therefore, an implication of our analysis says that an environment of (simultaneous) team production in which actions are observable and contractible gives rise to discrimination in a broader domain of production technologies than in an environment with moral hazard in teams.

The previous result can also be extended to more asymmetric environments. In particular, we deal with two types of non-symmetric extensions. One involves skill heterogeneity, modeled as differential effort costs, and the other involves productivity heterogeneity, modeled as differential probabilities. As we shall see, the structure of the optimal mechanism in these cases is similar to that of the symmetric case. However, in contrast with the symmetric case, the assignment of incentives to agents is not arbitrary anymore.

The implication of our analysis, regarding the role of moral hazard in the discriminatory nature of optimal contracts, crucially relies on two assumptions; namely, simultaneous actions, and equilibrium uniqueness. The former amounts to assume that members of the team take their effort decisions simultaneously (i.e., the team has a flat structure).[4] The latter amounts to consider only wage schemes whose resulting games have a unique pure strategy Nash equilibrium.[5] It turns out that dispensing with any of the two assumptions would substantially alter the previous insights.

In particular, if we consider a sequential structure for the team, in which effort decisions are taken sequentially, then our previous implication reverses and the domain of production technologies giving rise to discrimination becomes broader when there exists moral hazard. As a matter of fact, if agents' actions are observable and contractible in this new context, the optimal scheme is impartial, whereas discrimination still occurs, for certain technologies, in the case in which moral hazard exists, as shown by Winter (2006).

On the other hand, if we depart from the Nash equilibrium uniqueness assumption and allow, instead, for wage schemes whose resulting games have at least one pure strategy Nash equilibrium, the result vanishes.[6] More precisely, there would exist a scheme paying (equally deserving) agents a uniform reward, both in the moral hazard case as well as in the observable actions case. A caveat is in order. Such schemes would not only admit one Nash equilibrium in which all agents exert effort, but also another equilibrium in which no one exerts effort, which happens to be risk dominant and, thus, a more likely candidate to describe the potential coordination of the agents (e.g., Cabrales et al., 2010). Thus, if the principal has no way to coordinate agents to play the former equilibrium, she has to incur the extra cost of paying some agents more. Nevertheless, in more cooperative environments, where agents can coordinate their effort strategies, such "bad" equilibrium could be filtered out. We analyze this framework by adopting the very same model but assuming different solution concepts: strong equilibria and coalition-proof equilibria (e.g., Bernheim et al., 1987). As we shall see, both concepts lead to the same (symmetric) optimal mechanism. Winter (2004) shows that the counterpart optimal mechanism in the moral hazard case (for both solution concepts) is also symmetric. Thus, we conclude that, in more cooperative environments, the difference in the discriminatory nature of optimal contracts, between the moral hazard case and the observable actions case, vanishes. With or without moral hazard, optimality does not entail discrimination in such context.

The rest of the paper is organized as follows. Section 2 introduces the benchmark model. Section 3 contains the two non-symmetric extensions of the benchmark model. Section 4 deals with the case of more cooperative environments and Section 5 with that of sequential structures. We devote Section 6 to provide further insights of our analysis upon exploring situations in which the principal has more freedom to design wage schemes. Finally, Section 7 concludes.

2. The benchmark case

2.1. The preliminaries

We start analyzing a fully symmetric version of our model. There is a project involving n activities performed by n agents of a team, which we denote as $N = \{1, \dots, n\}$. Each agent $i \in N$ decides simultaneously whether to exert effort (invest) or not towards the performance of her activity. We denote by $\delta_i \in \{0, 1\}$ the effort decision of agent i, where $\delta_i = 1$ (0) if agent i does (not) exert effort. The cost of exerting effort is $c \geq 0$ and is constant across agents. An agent will invest if and only if her

[3] Alternative explanations as to why organizations might treat equal agents unequally have also been recently considered (e.g., Yildirim, 2007; Dhillon and Herzog-Stein, 2009).

[4] This seems to be a realistic assumption nowadays in industrial organization, where hierarchies are transforming themselves from top-down structures into more horizontal and collaborative ones (e.g., Friedman, 2007).

[5] Regarded as a standard requirement in the implementation literature, uniqueness of equilibrium has obtained surprisingly little attention in the literature on partnerships.

[6] Possible rationales for this weaker assumption would be to assume that the principal is able to pick her preferred equilibrium by acting as a mediator who coordinates the agents' expectations, or that one equilibrium out of multiple can be naturally focal (e.g., taking into consideration potential pre-play communication).