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THE VALUE OF MONITORING RISK AVERSE AGENTS IN TEAMS

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The Value of Monitoring Risk Averse Agents in Teams[†]

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Abstract

Vander Veen (1995) has argued that a principal has an incentive to monitor risk averse agents engaging in team production. We show that this result rests on specific informational assumptions that are not essential to team production. Moreover, under typical team environments and contract conditions there is no benefit from monitoring of individual agents, leaving only costs for the principal. We identify an additional mechanism design problem that arises in certain team settings—the principal must determine when to make information about each agent's reported ability public to the other team members.

Keywords: teams, monitoring, principal, agent, risk averse.

JEL Classification Numbers: D82

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1. Introduction

Teams are clearly an economically important organizational form. In fact, Alchian and Demsetz (1972) identify 'team use of inputs' to production as a defining property of firms. The typical motivation for team formation is the existence of complementarities or synergies in production between team members. Although other authors have been less precise, Alchian and Demsetz (1972) define team production as involving at least two inputs, where the production function is not separable in the individual inputs.[1] In a similar vein, McAfee and McMillan (1991) assume complementarities between individual agents' contributions.

Identification of the conditions under which a principal needs to monitor individual agents in a team is one of the major themes of this literature.[2] Vander Veen (1995) has argued that agent risk aversion provides an explanation for such monitoring. The objective of this article is to show that this result does not derive principally from core properties of team production (as defined above). Rather, it depends upon the requirement of an interim, rather than ex post, individual rationality. The remainder of the Introduction is dedicated to a brief survey of the relevant literature in order to place the issue in context.

Alchian and Demsetz (1972) conjectured that if team members have objectives that are not coincident with those of the principal, then a loss of team control will result if the team leader (employer) is unable to observe each team member's (employee's) actions (or private information). The intuition is that team members will be tempted to free-ride if the principal is unable to observe their individual effort. The idea that it is more difficult to make observations on the effort of individual agents is intuitive. Citing Alchian and Demsetz (1972):

> "For ... team production, measuring marginal productivity and making payments in accord therewith is more expensive by an order of magnitude than for separable production functions.

[1] In other words, the production function $f(x_1, x_2)$ satisfies that the cross-partial derivative $f_{12} \neq 0$.
[2] An alternative perspective on teams is offered by Marschak and Radner (1972).

Alchian and Demsetz (1972) suggest that this problem explains why capitalist firms have an advantage over partnerships and other cooperative organizational forms. The owner, or principal, is able to act as an external monitor, providing agents with incentives to behave efficiently. Since the principal is a residual claimant, moral hazard relating to monitoring does not arise.

However, several important papers have shown that a lack of observability of agent effort does not exacerbate free-riding problems. This is because team members' effort incentives can be perfectly and costlessly controlled using only incentives based on team output—no individual monitoring is required. The first such result is due to Groves (1973), although it is shown in a public goods setting—there is no individual rationality constraint—and there are no complementarities between team members.

Holmstrom (1982) showed that efficient team production can be achieved by relying solely on incentives (based only on team output) to eliminate free-riding by agents. Thus, the principal's essential role is not one of monitoring, but rather to allow breaking of the budget-balance condition, since obtaining efficiency requires penalizing all agents in the event that the efficient team output level is not produced. An important implication of this result is that it breaks the intuition that team production necessarily implies a loss of control. Regardless of the team size and the nature of team production, agent effort can be perfectly controlled through appropriate design of the compensation rule.[3] In the case of stochastic team production, a number of additional assumptions on the likelihood ratio and agent endowments are required to get this same result.

McAfee and McMillan (1991) further strengthen this finding by showing that Holmstrom's result also holds when team production is characterized by both moral hazard and adverse selection problems. Specifically, they show that the ability to monitor individual contributions does not affect the principal's welfare. The introduction of adverse selection results

[3]Eswaran and Kotwal (1984) note that the compensation rule used by Holmstrom suffers from the problem that a moral hazard now arises in relation to the principal, who has an incentive to bribe agents to ensure that the efficient output level is not produced.

in the principal having to pay agents an information rent, but the moral hazard aspect of the problem is essentially unchanged. The optimal compensation rule is of the form of a two-part tariff. Agents make a lump sum payment to the principal prior to production and the principal makes a variable payment (based on team output) to agents after production occurs. Each agent's lump sum payment equals their expected variable payment less their information rent and effort cost, thus ensuring their participation and incentive compatibility constraints are satisfied. In order to ensure efficient production, in the absence of adverse selection each agent is paid 100 percent of the value of any increase in team marginal output. Since in an n member team this results in aggregate marginal rewards equal to n times the value of team marginal output, the above offsetting lump sum payments are required. Introducing adverse selection causes the principal to distort effort incentives downward for all but the most efficient type, in order to economize on information rents payable. Thus, these agents are paid less than 100 percent of the value of team marginal output. Once again we see that the role of the principal is essentially to allow breaking of the budget. No monitoring role is implied.

More recently, Vander Veen (1995) has used the model of McAfee and McMillan (1991) (hereafter MM) to argue that agent risk aversion can explain why principals monitor individuals in teams.[4] In order to understand this result, recall that in MM the solution is independent of whether compensation is conditioned on individual or team output. It follows that if each agent perceives their individual contribution to output to be deterministic while viewing team output as stochastic, then conditioning agent compensation on team output rather than individual output makes risk averse agents strictly worse off. Alternatively, ignoring monitoring costs, it is cheaper for the principal to offer the required incentives to agents when compensation is conditioned on individual rather than team output, so the principal strictly prefers the former. Thus, provided monitoring is not too costly, the principal prefers to monitor agents and compensate them according to their individual contribution.

[4]Another example of such a result, based on constraints on feasible transfers rather than risk aversion, is contained in Hyde, Rausser and Simon (2000).

In the next section we discuss Vander Veen (1995), bringing into sharp focus the assumptions underlying his result. In doing so, we show the result depends on aspects of the informational structure of the problem that are not intrinsic to team production.

2. A Critique of Vander Veen (1995)

Several issues coincide to make the contribution of Vander Veen (1995) (hereafter VV) at first unclear. The statement of the principal's problem is confusing to the extent that expectations over agents' types are not taken in either the objective function or the individual rationality constraint. The former is of little consequence since the solution maximizes the principal's objective function pointwise. However, as we show below, the use of an ex post, rather than interim, individual rationality constraint is precisely what is required to invalidate the main result. Together with the fact that Equation (7) in MM, which is the reference model for VV, clearly implies an interim individual rationality constraint, it appears that the use of an ex post constraint in VV is a typographical mistake.

Following from above, there is potential for confusion in identifying the source of the result. It is useful to begin by noting that agents in MM face *two* types of uncertainty. First, they do not know the ability of the other agents—this is private information.[5] Second, they do not know what team output will be realized ex post, even if they know all agents' types, since team output is a stochastic function of team inputs.

In principle, removal of either type of uncertainty could underpin VV's result. However, removal of the second type of uncertainty would be of limited interest since this uncertainty is not an essential element of team production. To cite Holmstrom (1982):

> "In contrast to the single-agent case, moral hazard problems may occur even when there is no uncertainty in output. The reason is that agents who cheat cannot be identified if joint output is the only observable indicator of inputs."

[5]Although agents also cannot observe each others' effort, this does *not* constitute a second, distinct source of uncertainty. The reason is that agents can infer the principal's desired team output level for any given profile of team member abilities.

Moreover, to assume team output is stochastic but that individual contributions can be measured perfectly seems somewhat arbitrary. Intuition suggests that individual contributions are difficult to observe and thus likely to be measured imprecisely. This will detract from the principal's preference for monitoring. In any case, the following quote from VV suggests that the result rests on the removal of the uncertainty stemming from private information:

> "Since effort and ability are unobservable, each individual agent cannot be certain what each of the agents will contribute, and thus, there is an inherent uncertainty for each of the agents. Removing this uncertainty would increase the utility of risk averse agents. If the principal can (perfectly) monitor individual contributions of both effort and ability, then this uncertainty can be eliminated."

For the reason discussed above and in order to avoid confusion, henceforth we ignore the uncertainty due to the stochastic nature of team production.

In order to explain the mechanism underlying the result, it is necessary to clarify how this uncertainty enters agents' decision problem. Each agent is assumed to know their own ability, but not the ability of the other agents, at the time of their participation decision—that is, an *interim* participation constraint is imposed. Each agent's uncertainty about the abilities of the other agents causes them to also be uncertain about the individual contributions of other agents, since it is not known what compensation rule they will be offered. Thus, each agent is uncertain about the team output that will be realized, implying uncertainty about their own compensation (since it is a function of team output). Monitoring individual contributions allows agent compensation to be metered on a non-stochastic variable since agents fully control their individual contribution. Ceteris paribus, this elimination of uncertainty is welfare improving for risk averse agents. This allows the principal to offer a given set of incentives at lower cost, thus providing the motivation for monitoring.

The central observation then is that the reduction in uncertainty due to monitoring stems directly from the assumption that each agent does not know the ability of other agents at the time of their participation decision. But is this assumption an intrinsic property of teams? In

the sense that it is not part of the usual definition of team production, the answer is no. Yet, there are certainly plausible team situations wherein this assumption will hold. Specifically, it will hold if agents have no prior knowledge of each other and labor contracts cannot be broken (or can only be broken at high cost). In such cases, the participation decision must be made before there is any opportunity for information revelation. Another setting in which this assumption would be appropriate is if, despite labor contracts not being enforceable, agents do not learn about the abilities of other team members before team output is finalized. However, such a scenario is suggestive of weak interactions between team members, in which case the pure team aspect of production may be of second-order importance to the firm. Thus, this scenario may not be very instructive to our understanding of why firms monitor agents in teams. This leaves situations involving enforceable employment contracts as the primary basis upon which to argue for use of an interim individual rationality constraint.

We contend, however, that labor contracts can typically be broken (at low cost). Indeed, casual observation suggests that most employees can resign with very little cost by simply allowing their employer the customary notice period (often one month). Assuming that either agents' reports to the principal are publicly observable or that agents are able to make direct observations on each others' abilities before engaging in substantial effort, it follows that agents will be informed about other agents' abilities when making their participation decision. In these situations, the result of VV does not hold—there is no benefit from monitoring because there is no uncertainty to be removed from agents' compensation. Monitoring only introduces additional costs for the principal.

To summarize, the main technical point we make here is as follows.

Proposition 1. *If the principal is required to satisfy ex post individual rationality constraints for team members, then costly monitoring of individual contributions makes the principal strictly worse off.*

We feel this point is worth making because ex post individual rationality constraints seem more relevant to understanding real-world teams than the interim counterpart. The reason is captured in the following conjecture.

Conjecture 1. *Agents can typically break employment contracts at little or no cost. Also, team interactions will typically result in an agent's ability being quickly revealed to other team members.*

This leads us to draw the following conclusion.

Corollary 1. *For the class of teams characterized by the properties in Conjecture 1, monitoring agents' individual contributions will typically decrease the welfare of the principal.*

3. Conclusion

A natural conclusion to draw from the discussion above is that any role risk aversion has in explaining why principals monitor agents is more likely to work through agents' perception that measures of team output involve greater uncertainty than measures of individual output. However, for reasons already mentioned, in some sense this is an unsatisfactory basis upon which to argue for the importance of risk aversion as an explanation for monitoring individuals in teams. While uncertainty over measures of individual contributions may plausibly be viewed as an inherent property of team production, the assumption of stochastic team output given deterministic inputs does not appear to be essential to the concept of team production. Note that we are not saying that the latter is always an unrealistic assumption, simply that it does not appear to be a *necessary* property of teams. For these reasons, we believe that in many (if not most) team situations that risk aversion will tend to provide a *disincentive* for principals to monitor.

We finish by noting that the discussion here raises an interesting design issue. Suppose that the principal is able to determine whether agents' reports of their ability will be publicly observable. We know that if agents would not otherwise observe each others' ability, then, using the logic of VV, there is a benefit to the principal from making these reports public—it eliminates a source of uncertainty for risk averse agents. Moreover, it seems likely that such public revelation will be a much less expensive way for the principal to eliminate this uncertainty than engaging in individual monitoring. However, under some circumstances (i.e., draws of agent types), the principal will have a strict incentive not to reveal agents'

ability reports because doing so will result in violation of the ex post individual rationality constraint for some team members (whose interim individual rationality constraint was satisfied).

Under what conditions will a principal choose to publicly reveal agents' abilities? Presumably it is least likely to be optimal when the draw of types is highly skewed in the sense of having many low ability agents and relatively few high ability agents. In this case, it may be profitable for the latter to default on their employment contract following revelation of others' types. However, if the principal is unable to credibly commit to a revelation strategy before types are reported, what then can agents infer about other team members' abilities when the principal does not reveal their reports? It may be optimal for high ability agents to quit the team anyway, since the absence of information may lead them to conclude that the remaining agents are of low ability. Are there conditions under which it is optimal for the principal to commit ex ante to a report revelation strategy? What incentives are in place to ensure that the principal's public retransmission of the reports back to the agents is truthful? In particular, it would seem that both the principal and low ability agents could benefit from some exaggeration of the ability of the latter—both benefit from persuading high ability agents to remain on the team.

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