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Monitoring the Monitor: Does Ownership Matter?

Yijiang Wang*

University of Minnesota - Twin Cities
321-19th Ave. S., MPLS, MN 55455
E-mail: YWANG@CSOM.UMN.EDU

One of the most intriguing and influential questions in organizational theory is "who monitors the monitor?" A theory of ownership is proposed by Alchian and Demsetz in answer to this question. In this paper, a model of successive monitoring is constructed to show that, when it is feasible for a capitalist owner to overcome free riding in a team through monitoring, it is equally feasible for the workers as owners to do so with an outcome-based incentive for the monitor at the top. Thus the answer to the question "who monitors the monitor" has no specific implications for ownership, capitalist or labor. While ownership is neutral in affecting the feasibility of monitoring, it is generally not so in affecting income distribution and other design variables in the organization.

Key Words: Monitor; Ownership.
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1. INTRODUCTION

Does capitalist ownership enjoy an advantage in solving the free-riding problem in teams through monitoring than labor-managed firms (LMFs, also known as labor-owned firms or producers' cooperatives)? In an influential work Alchian and Demsetz (1972) gave an affirmative answer to the question. In the work, they raised the challenging question: When monitoring is used to prevent shirking in a team, who will monitor the monitor? They then argued that giving ownership to the monitor provides the ultimate solution to the monitor's own incentive problem of shirking.

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Their argument provides a theory of the classical capitalist firm in which the monitor as the owner is given the residual rights of benefit and control.[1]

In the literature on LMFs, free-riding in teams due to sharing is seen as a difficulty in the internal organization of LMFs. In a survey article, Bonin et al (1993) asked: "Does the internal organization of the [LMF], in particular, worker participation in decision making and the sharing of value-added, affect worker motivation and productivity?" (p.1291.) They noted that: "Organization theory suggests links between profit sharing and enhanced worker productivity while incentive theory focuses on the deleterious effects of free-riding in a sharing situation when individual effort is not observable." (p.1316.) Bonin and Putterman (1993) show that, in the classic N-person revenue sharing problem, effort can increase or decrease with monitoring depending on worker's utility and production and monitoring technologies. Their findings make clear that the relationship between monitoring and effort is far more complicated than one might think. However, these authors noted that "it must be admitted that the central question raised by [Alchian and Demsetz], namely, who monitors the monitor, has not been addressed by us." Consequently, who monitors the monitor "is a question that must be answered elsewhere." (p.681.)

However, an indisputable empirical fact is that in capitalist market economies, LMFs of different sizes exist alongside with conventional capitalist firms. Successive (hierarchical) supervision and monitoring are common in both types of firms. Furthermore, when some largest capitalist firms, e.g., the United Airlines, are transformed into LMFs, there is no evidence that monitoring suddenly becomes more difficult than before. Empirical evidence is thus quite inconsistent with the view of Alchian and Demsetz (1972) that ownership is necessary to solve the monitor's incentive problem. Given the theoretic significance of it and the fact that it remains not satisfactorily answered, there is a need to further discuss the question if ownership indeed affects monitoring in the setting of a team.

This paper constructs a formal model of successive monitoring to study this question. The model finds that ownership has no effect on the feasibility of using monitoring to overcome the problem of free-riding in teams. When a given level of effort can be obtained through monitoring when the (top) monitor owns the firm, the same effort level can also be obtained by the workers with ownership in their own hands, and vice versa. This means that, empirically, we should not find firms of a particular ownership (e.g.,

[1]By showing that, without the balanced-budget constraint and uncertainty, group incentives based on output can solve the problem of shirking without monitoring, Holmstrom (1982) argues outside (capitalist) ownership as an alternative to monitoring.

LMFs) to be at disadvantage to those of another (e.g., classic capitalist firms) in overcoming the problem of free-riding through monitoring.[2]

This finding is not really that surprising. Note that, when the workers have ownership, their problem with the monitor who is not further monitored is similar to that of a principal with an agent whose action is unobservable. It is well-known that the principal's failure to observe an agent's effort does not mean that shirking cannot be prevented. Instead, an outcome-based incentive can be used to motivate the agent to exert desired effort. This paper argues that, without yielding ownership, the worker owners in a team setting can do the same, i.e., use a properly designed outcome-based incentive to motivate the monitor. However, unlike in a dyadic principal-agent relationship, in the setting of a team the problem of shirking exists through all the tiers of successive monitoring. A challenge to the model is to show that an outcome-based incentive for the (top) monitor is consistent with incentive constraints for all other members in the organization.

While ownership is neutral in affecting monitoring, it is not so in affecting income distribution and welfare in the organization. The model shows that, in a monitoring hierarchy, the party (the workers or the monitor) who has ownership is generally strictly better off than the one without.[3] This is so because the party with ownership can use the control right associated with it to make decisions on the design variables, such as the span of control, wage, and effort of those in different tiers, to best advance its own interest. This result, together with the aforementioned one on the feasibility of monitoring, suggests that the need to monitor productive inputs does not have much predicting power about the allocation of ownership in a firm. One has to look somewhere else for an answer to the question as

[2]Bonin et al (1993, p.1316) note that "Empirical work using data sets having [LMFs] only found positive relationships between the degree of profit sharing in a [LMF] and productivity." While the finding is far from being conclusive about the relationship between ownership and effective monitoring in an organization, it is more consistent with the finding of this paper than the opposite view.

[3]This assumption is made under the assumption that all members in the firm have utility functions of the same form and also have the same reservation (market) wage. An alternative way of stating the idea, which does not depend on these assumptions on utility functions and reservation wage, is that a party is worse off if ownership is transferred to the other without a corresponding price compensation. So no party will expect the other party to make decisions leading to a Pareto improvement of welfare in the firm and, therefor, voluntarily give ownership to the other for free. Price mediated transfers of ownership need to deal with the problem of asymmetric information between workers and the monitor regarding the value of the firm. This problem is out of the scope of this paper and not modeled here. See Ben-Ner and Jun (1997) for a game of priced mediated transfer of ownership from capitalist owners to workers.

why or why not firms of a particular ownership exist or prevail in a market economy.[4]

The rest of the paper is organized as follows. Section 2 presents the model. Sections 3 and 4 use the model to show ownership does not affect the feasibility of constructing successive monitoring in an organization. Section 5 shows that ownership in general affects income distribution and other choice variables in hierarchy. Section 6 concludes the paper with a summary.

2. THE MODEL.

At the bottom of the hierarchy, labelled as Tier 0, there are n identical workers, $n > 1$, with a production function of the form

$$y = \begin{cases} f(a_{01} + \cdots + a_{0n}), & \text{if the number of workers is } n \text{ or larger} \\ 0, & \text{if the number of workers is smaller than } n \end{cases} \tag{1}$$

where $a_{0i} \geq 0, i = 1, \ldots, n$, is the effort of worker i. The specification of the production function assumes away n as a choice variable.[5] The function $f(\cdot)$ is continuous in aggregate effort of n workers a_0 and has the familiar properties that $f(0) = 0, f'(\cdot) > 0, f''(\cdot) \leq 0$.

The disutility function of effort is $g(a_{0i})$. $g(a_{0i})$ is continuous and has properties $g(0) = 0, g'(0) = 0, g'(a_{0i}) > 0, g'(\infty) = \infty$, and $g''(a_{0i}) > 0$.[6] The worker's net utility is the difference between wage $w_{0i} \geq 0$ and the disutility of effort,[7]

$$U_0 = w_0 - g(a_0) \tag{2}$$

The worker's utility increases (linearly) in wage but decreases in effort, providing an incentive for the worker to shirk. Suppose that monitoring is used to solve the problem. Ignore the integer problem and let $x_1 > 0$ be the number of monitors in Tier 1 to monitor the workers. The number of workers supervised by each monitor, i.e., the span of control of a Tier 1 monitor, is then $s_1 = (n/x_1)$. Following Calvo and Wellisz (1978), let

[4] Ben-Ner (1988), for example, discusses how existing members' unwillingness to share leads to declining membership over time in LMFs.

[5] This assumption will help us to focus on the question raised by Alchian and Demsetz (1972) on monitoring and ownership. Williamson (1967), Calvo and Wellisz (1978) assume n to be a choice variable to study limit to the size of hierarchy.

[6] Throughout this paper a subscripted number denotes the tier $t = 0, \ldots, T$. For example, a_0 and a_T denote, respectively, the effort level of the worker in Tier 0 and that of the monitor at the top of the hierarchy, while w_0 and w_T denote, respectively, the wages of the worker in Tier 0 and the monitor in Tier T.

[7] Hereon we omit subscript i in w_{0i} and a_{0i}. w_0 and a_{0i} denote wage and effort of the representative worker.

the probability that the worker will be caught if he shirks depend on the span of control of a monitor and the monitor's effort. The essence of this monitoring technology is that, given the effort of a monitor, the smaller the span of control, the more likely that the monitor will catch a shirking worker. Similarly, given the span of control, the greater the monitor's effort, the more likely he will catch a shirking worker. Without the loss of generality, we assume that the monitoring technology has the form that

$$p_0 = a_1/s_1 = a_1 x_1/n$$

where $0 \leq p_0 \leq 1$ is the probability that a worker is caught shirking. One may note that $a_1 x_1$ in the expression stands for the "total amount" of monitoring effort from all monitors in Tier 1. This number divided by the number of workers gives the amount of monitoring received by each worker.

Suppose that, due to limited liability, the maximum penalty to a worker who is caught shirking is to fire the worker and let the worker receive the wage $w_0 = 0$.[8] An effort is incentive compatible (IC) if

$$w_0 - g(a_0) \geq (1 - p_0)w_0 + p_0 0, \quad \text{or} \quad a_1 x_1 w_0/n - g(a_0) \geq 0. \tag{3}$$

The next question is how much effort will be extended by a monitor, that is, what the value of a_1 is? Suppose that the monitor has a utility function of the same form as that of the worker, i.e., the representative monitor's utility is given by

$$U_t = w_t - g(a_t), t = 1, \ldots, T.$$

Without monitoring, the monitor is better off by not making any effort. Suppose that $x_{t+1} > 0$ monitors are hired in Tier $t+1$ to monitor those in Tier t, and $x_{t+2} > 0$ are then hired to monitor those in Tier $t+1$, and so on, until the top of the hierarchy, Tier T, is reached. The top of the hierarchy is occupied by a single monitor. The span of control for a monitor in Tier $t+1$ is $s_{t+1} = (x_t/x_{t+1})$. Suppose that, like workers, monitors also have limited liability so that the maximum punishment is to fire a monitor who is caught shirking and in such an event the monitor's wage is $w_t = 0$. An effort is incentive compatible if

$$a_{t+1} x_{t+1} w_t/x_t - g(a_t) \geq 0, \quad t = 1, \ldots, T-1. \tag{4}$$

[8]Zero wage may be interpreted as the normalized best alternative for the worker in the market. The analysis is not effected if this best alternative is a different value. The assumption of limited liability is crucial here. Without it, a punishment arbitrarily large can prevent workers from shirking even if the probability of being caught shirking is very small. The need for monitoring essentially disappears.

Suppose that the budget is balanced, i.e., the hierarchy has the balanced budget (BB) constraint

$$f(\cdot) = \sum w_t x_t. \tag{5}$$

If the (top) monitor owns the hierarchy, the profit is

$$w_T = f(\cdot) - \sum w_t x_t.$$

The monitor owner's utility is

$$U_T = w_T - g(a_T). \tag{6}$$

Finally, assume that the individual rationality (IR) constraint for the worker or the monitor is,

$$U_t \geq 0, t = 0, \ldots, T. \tag{7}$$

Define ownership as the decision right in the organization, i.e., the right to choose the values of all the endogenous variables $a_t, w_t,\ x_t,\ t = 0, \ldots, T$, subject to IC, IR and BB. The monitor owner's problem is to

$$\max_{\{w_t\},\{a_t\},\{x_t\}^{-1,T}} U_m = w_T - g(a_T) \tag{8}$$
$$\text{subject to:}(3), (4), (5), (7), x_0 = n \text{ and } x_T = 1$$

If the workers own the hierarchy, BB implies $w_0 = [f(\cdot) - \sum w_t x_t]/n$. The worker can sign a contract with the monitor in which it is specified that the monitor will receive a high wage $w_T > 0$ if output is at or above a certain level, and a low wage $w_T = 0$ if it falls below the level. The contract is enforceable because output level is verifiable. An effort a_T is incentive compatible if making the effort leads to the specified output level so that the monitor receives the high wage w_T, and the wage and the effort satisfy the inequality

$$w_T - g(a_T) \geq 0. \tag{9}$$

The worker's problem is to

$$\max_{\{w_t\},\{a_t\},\{x_t\}^{-1,T}} U_0 = w_0 - g(a_0) \tag{10}$$
$$\text{subject to: } (3), (4), (5), (7), (9), x_0 = n, \text{ and } x_T = 1$$

The monitor's and the worker's optimization problems described by (8) and (10) respectively share many features with each other. Both problems have the same domain for the choice variables a_t, x_t, w_t and T (i.e., they must all be positive numbers), and the same initial and end point conditions ($x_0 = n$ and $x_T = 1$). In both problems the effort and wage for the worker and the monitor in $t < T$ must satisfy the ICs (3) and (4). Both must satisfy BB constraint (5) and IR (7). The differences between the two problems are that, first, the owner(s) will choose the endogenous variables to maximize her (their) own utility. Second, in (10) the worker faces the problem of how to motivate the top monitor, giving rise to IC (9) which is not in the monitor's optimization problem described by (8).

3. FEASIBILITY OF SUCCESSIVE MONITORING

If there is a combination of the $3T - 1$ endogenous variables, $a_t, w_t,\ t = 0, \ldots, T,\ x_t,\ t = 1, \ldots, T-1$, and T itself, at which all constraints in the monitor's optimization problem described by (8) and (10) are satisfied, then we say it is feasible for the monitor owner to construct a monitoring hierarchy to solve the incentive problem of shirking in the team. The feasibility for the worker owners to construct a monitoring hierarchy is defined in a similar manner with respect to the problem described by (10). If there are conditions under which there are values of a_t, w_t, x_t and T that satisfy all constraints in (8) but are no values of these choice variables that can satisfy all constraints in (10), then it can be said that under these conditions the need to monitor gives rise to the need to grant ownership to the monitor, for otherwise it is not feasible to construct a monitoring hierarchy.

Let $(a_t, w_t, x_t, T)_m$ be a combination of $a_t, w_t, x_t,\ t = 0, \ldots, T$, that satisfies all the constraints in the monitor owner's problem (8), and S_m the set of all possible such combinations.[9] Define $(a_t, w_t, x_t, T)_w$ and S_w in a similar way for the worker's problem (10). By neutrality of ownership, it is meant that if S_m is not null, S_w is not either, and vice versa, i.e., $S_m \neq \emptyset$ and $S_w \neq \emptyset$ imply each other.

PROPOSITION 1. *Let S_m and S_w be the sets of all possible combinations $a_t, w_t, x_t,\ t = 0, \ldots, T$, that can satisfy all constraints in the monitor's problem described by (8) and that of the worker's problem described by (10), respectively. $S_m \neq \emptyset$ and $S_w \neq \emptyset$ imply each other.*

Proof. Suppose that $S_m \neq \emptyset$ and $(a_t, w_t, x_t, T)_T \in S_m$ is a combination that satisfies all constraints in (8). Suppose for the moment that (3) and

[9] For notational economy, "$a_t, w_t, x_t,\ t = 0, \ldots, T$" is used in place of "$a_t, w_t,\ t = 0, \ldots, T,\ x_t,\ t = 1, \ldots, T-1$, and T itself," with the knowledge that $x_0 = n, x_T = 1$ and T is a choice variable.

(4) are binding at $(a_t, w_t, x_t, T)_m$. The worker can adopt the same x_t, w_t and $a_t,\ t = 0, \ldots, T-1$, so that IC (3) and (4) are still satisfied and binding, as long as a_T remains unchanged.

The incentive for the top monitor can be specified as follows. If the output $f(\cdot)$ reaches the same level as before under $(a_t, w_t, x_t, T)_m \in S_m$, the monitor will receive w_T that equals the monitor's previous income (in the form of profit), i.e., $w_T = f(\cdot) - \sum w_t x_t$ given by $(a_t, w_t, x_t, T)_T$. Otherwise $w_T = 0$. By definition $(a_t, w_t, x_t, T)_m$ satisfies IR (7). This implies that the incentive specified above satisfies IC (9) and the monitor will make a_T as before. Because (3) and (4) are binding, a lower a_T will lead to $a_t = 0,\ t = 0, \ldots, T-1$, which implies $f(\cdot) = 0$ and $w_T = 0$.

Since all ICs are satisfied as before and also the same amount of effort is made by everybody as before, including the worker, the same amount of output is produced. With no change in output $f(\cdot)$ and income $w_t,\ t = 0, \ldots, T$, the budget is again balanced (Constraint (5) is satisfied).

If (3) and (4) are not binding at $(a_t, w_t, x_t, T)_m$, the worker can still use the same incentive for the top monitor as described above. Under the incentive, there is no guarantee that the monitor will make the same effort as before. The monitor can lower effort a_T to a at which the IC for Tier $T-1$ becomes binding, i.e., $(aw_{T-1}/x_{T-1}) - g(a_{T-1}) = 0$. This change, however, does not lead to a violation of (3), (4) and (9). (9) is still satisfied because, with a smaller a_T but no change in w_T, U_T is actually increased so $w_T - g(a_T) \geq 0$ still holds. The monitor will not lower a_T to below a, for that leads to $a_{T-1} = 0, f(\cdot) = 0$ and $w_T = 0$. As long as $a_T \geq a$, the IC for monitors in Tier $T-1$ is satisfied and a_{T-1} will be made as before.

By the same logic, it is obvious that if there is a combination $(a_t, w_t, x_t, T)_w \in S_w$ that satisfies all constraints in the worker's problem (10), the same combination also satisfies all constraints in (8) so $S_m \neq \emptyset$. ▮

The strategy we used to prove Proposition 1 is to show that the worker and the monitor can always mimic each other in choosing all endogenous variables except for a_T. The fact that the worker cannot always mimic the monitor in choosing a_T, however, does not affect the feasibility of constructing a monitoring hierarchy. As long as the worker owners mimic the monitor in every other variable, an outcome-based incentive can induce at least a from the top monitor to satisfy the IC for the monitor in Tier $T-1$. The feasibility condition of satisfying the constraints in (8) and those in (10) are thus identical.

4. FEASIBILITY UNDER UNCERTAINTY

The result of Proposition 1 is not altered if output is jointly determined by workers' effort and a mean-preserving random variable ε with $E(\varepsilon) = 0$, e.g., $y = f(a_{01} + \cdots + a_{0n}) + \varepsilon$ if the number of workers is n or larger.[10]

Note that in our model both the worker and the monitor are risk-neutral with utility increasing linearly in wage. This means that with uncertainty in output, the monitor owner's profit can be simply rewritten as

$$w_T = f(\cdot) - \sum w_t x_t + \varepsilon,$$

and the monitor's IR in (7) redefined as $E(U_m) = E(w_T) - g(a_T) \geq 0$. The optimization problem that corresponds to that described by (8) is then to

$$\max_{\{w_t\},\{a_t\},\{x_t\}^{-1},T} E(U_m) = E(w_T) - g(a_T) \tag{8$'$}$$
$$\text{subject to: } (3), (4), (5), (7), x_0 = n, \text{ and } x_T = 1$$

The worker owner can specify $w_T = f(\cdot) - \sum w_t x_t + \varepsilon$ as the monitor owner. The monitor's IC to be satisfied becomes

$$E(w_T) - g(a_T) \geq 0. \tag{9$'$}$$

Accordingly, the worker's optimization problem is to

$$\max_{\{w_t\},\{a_t\},\{x_t\}^{-1},T} U_w = w_0 - g(a_0) \tag{10$'$}$$
$$\text{subject to: } (3), (4), (5), (7), (9)', x_0 = n, \text{ and } x_T = 1$$

Proposition 2. *Let S_m and S_w be the set of all possible combinations $a_t, w_t, x_t,\ t = 0, \ldots, T$, that can satisfy all constraints in the monitor's problem described by (8$'$) and that of the worker's problem described by (10$'$), $S_m \neq \emptyset$ and $S_w \neq \emptyset$ imply each other.*

Proof. Suppose that $S_m \neq \emptyset$ and $(a_t, w_t, x_t, T)_m \in S_m$ is a combination at which all constraints in the monitor's optimization problem (8$'$) are satisfied. The worker can mimic the monitor and adopt $(a_t, w_t, x_t, T)_m$.

[10] Alchian and Demsetz (1972) themselves downplay the importance of risk aversion and uncertainty to their theory: "Risk averseness and uncertainty with regard to the firm's fortunes have little, if anything, to do with our explanation although it helps to explain why all resources in a team are not owned by one person." Still, for those who are used to studying incentive problems under the assumption of uncertainty, it is worthwhile to see if the result of ownership neutrality holds when there is output uncertainty.

ICs (3) and (4) are satisfied if the monitor makes an adequate effort. But the monitor has a lower expected utility if $a_T < a$ is chosen, with a given by

$$aw_{T-1}/x_{T-1} - g(a_{T-1}) = 0,$$

for it leads to $a_t = 0, t = 0, \ldots, T-1, f(0) = 0$, and $E(w_T) = 0$ for the monitor. We thus know that the monitor will choose $a_T \geq a$ when $(9')$ is satisfied. It follows that $S_m \neq \emptyset$ implies $S_w \neq \emptyset$. Following the same logic, it is obvious that $S_w \neq \emptyset$ implies $S_m \neq \emptyset$. ▮

The assumption that the worker and the monitor are both risk-neutral is not essential for the result of Proposition 2. In fact, the result will continue to hold if the assumption is partially relaxed. Suppose that the monitor is risk-neutral and the worker risk-averse. The payoff for the risk-neutral monitor can always be specified as $w_T = f(\cdot) - \sum w_t x_t + \varepsilon$ regardless of ownership. The worker can then receive a fixed wage under either ownership and bear no risk. Thus the fact that the worker is risk-averse does not affect the result of Proposition 2.[11] Similarly, if the worker is risk-neutral but the monitor risk-averse, the worker's wage can be specified as $w_0 = f(\cdot) - \sum w_t x_t + \varepsilon$ under either ownership so that the worker bears all the risk. The IC for the worker is, accordingly, $a_1 x_1 E(w_0)/n - g(a_0) \geq 0$. Replacing this constraint for (3) in (8) or (10) does not affect the nature of nor the solution to the problem.[12]

5. OWNERSHIP AND WELFARE

The neutrality of ownership in determining the feasibility of constructing a monitoring hierarchy by no means implies that the workers' and the monitor's solutions to each's respective problem are identical. To the contrary, in general, they are different. This is so because, in general, there is more than one combinations of the $3T - 1$ endogenous variables, $a_t, w_t, t = 0, \ldots, T, x_t, t = 1, \ldots, T-1$, and T, that can satisfy all the constraints in (8) and (10). The owner can thus choose the values of these endogenous variables to maximize his own utility, leading to a higher utility for the owner. Ownership allocation in a monitoring hierarchy, therefore, is not neutral in affecting members' welfare.

[11] The worker's utility function can be assumed to have the separable form of $U_w = h(w_0) - g(a_0)$, with $h' > 0$ and $h'' < 0$ to capture the idea that the worker is risk-averse.

[12] When workers and the monitor are both risk-averse, we suspect that the result of Proposition 2 still holds. However, a rigorous discussion requires us to specify the utility discount for risk and the optimal risk sharing.

PROPOSITION 3. *If ownership in the hierarchy is transferred from one party to the other, the party who gains (loses) ownership is better (worse) off.*

Proof. Let $(a, w, x, T^*)_m \in S_m$ be the monitor owner's solution to (8) at which $U = w - g(a) > 0$. With the control right, the worker can keep all other variables unchanged, but increase w_0 at the cost of w_T up to the point that the IC for the monitor becomes binding, i.e., $w_T - g(a) = 0$. This transfers income from the monitor owner to the workers. Since the transfer does not violate the monitor's IC, the monitor can be asked and will make the same effort as before. The combination of a higher income w_0, the same effort and the same level of monitoring as before does not violate the worker's IC. So the workers can continue to make the previous effort. Since the workers are making the same effort as before, the same amount of output is produced and the budget is still balanced. So after the transfer of income from the monitor to the worker owners, the workers are strictly better off at the cost of the monitor.

By the same logic, the monitor can also make himself strictly better off at the cost of the workers. ∎

It should be noted that, in the optimum, all ICs must be binding. So that, after the worker increased w_0 at the cost of w_T, optimization requires changing all the endogenous variables to restore the equal signs in the ICs. As the values of a_t and x_t change, the ratio of the number of monitors to that of workers in the hierarchy and the final output level are both changed. This means that besides income and welfare, productivity and the structure of the hierarchy are, in general, also different under different ownership arrangements. One might suspect that, since under workers' ownership distribution is more favorable to the workers than under the monitor's ownership, by (3), either the monitor/worker ratio is lower or output level is higher under workers' ownership, or both.[13] The conjecture, however, is flawed because we do not know if the workers would choose a lower effort for themselves than that chosen for them by the monitor. Without an answer to the question regarding worker's effort, there is little we can say as how total output and the monitor/worker ratio under one ownership may compare with those under the other.

[13] Greenberg (1986) and Craig and Pencavel (1995) provide some empirical support to this conjecture.

6. SUMMARY.

It has been shown that ownership does not affect the feasibility of using monitoring to solve the problem of free-riding in teams due to sharing. But it does affect the welfare of different parties in the team. While recognizing that an outcome-based incentives can induce effort from the monitor, the model further verifies that such an incentive is consistent with those for all other members in the organization. These findings suggest the need to solve the free-riding problem through monitoring does not call for capitalist ownership nor workers' ownership. The result holds when there is uncertainty in output, but the worker and the monitor are not both risk-averse. The finding is consistent with the empirical observation that successive, hierarchical supervision and monitoring are common in firms of both capitalist firms and LMFs.

In the model, some specific assumptions are made about the production technology, the monitoring technology and the utility function. The force that drives the results of Propositions 1 through 3, however, is that the workers and the monitor can always mimic each other. Since these results do not depend on the specific characteristics of the technologies and the utility function, they can be expected to be robust of more general specifications of technologies and utility.

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