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MORAL HAZARD AND COOPERATION IN COMPETING TEAMS

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Abstract

We give the conditions for the attainment of self-enforcing Pareto efficiency under complete effort non-observability, strict agent rationality and global budget balance among teams involved in a winner-takes-all contest for a prize. Employing Nash conjectures and fixed fee financing of the prize, we characterize the competitive environment that allows teams to overcome the moral hazard problem and induce self-enforcing egalitarian outcomes. If the number of identical teams is finite, the production technology is restricted to factor symmetric ones. When the number of identical teams becomes unbounded, the restriction on the production technology vanishes and there always exists a fee level that supports a self-enforcing Pareto efficient solution as long as member utilities over own share are identical and obey the Inada conditions. Some form of membership symmetry cannot be ruled out for Pareto efficiency.

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I. INTRODUCTION

Pareto efficiency and strict individual rationality are uneasy partners in the best of circumstances. In organizations that do not have residual claimants (i.e., partnerships and teams) that have to contend to boot with moral hazard, the combination is destined to produce inferior outcomes. This was the message of Alchian and Demsetz (1972) and which Holmstrom (1982) demonstrated. Specifically, Holmstrom showed that where non-observability of effort is complete, agents have quasi-linear utilities, effort supply is voluntary and budget balance is the rule, teams cannot attain Pareto efficiency. Likewise, Hammond (1994) shows using the more general Mirlees model (1973) that where skill is a private information, effort is voluntary and budget balance is observed, an efficient allocation is impossible for large economies. Indeed, even when effort is perfectly observable whereas member capacity is not, if effort is voluntary, and budget balance is observed, proportional allocation (a member's share in output equals his/her share in total effort) is Pareto efficient if and only if production technology is constant returns to scale with symmetric marginal products (see Fabella, 1989, for the case without the symmetry assumption; Sen, 1966, for the case with symmetry; Roemer and Silvestre, 1993 for the case associated with the "tragedy of the commons"). Where production technology is non-constant returns, even perfect observability cannot deliver Pareto efficiency under budget balance. We will limit our scope to completely non-observable effort.

The interesting part, of course, is that the team and near team organizations have held their own in the market economies. One of the organizational exports of Japan which have become part of the competitive arsenal apart from "just-in-time" is the "team

concept". The success of Japan has forced a growing recognition of the advantage in certain circumstances of organizations where workers assume larger responsibility for framing the production process (see, e.g., *Made in America* by Dertouzos, Lester and Solow, 1989). There is an interesting universe outside the pure principal-agent relationship. Professional partnerships abound and persists. The question is how the moral hazard problem is overcome. Holmstrom, in the same paper, proposed a mechanism which punishes every agent if Pareto efficiency is not attained by giving each agent nothing and throwing away output. This collective punishment strategy is quite grim even as it clearly violates budget balance.

Other approaches have been put forward to attain the Pareto efficient outcome. One is to transform the team game into a supergame. Where the usual assumptions of the Folk Theorem are satisfied (viz., infinitely lived members, low discount rate, observable output which is separable from random effects), the Pareto efficient outcome as well as other outcomes are attainable though not uniquely (Macleod, 1984; Radner, 1986). A similar multi-stage "tit-for-tat" process was proposed by Guttman and Schnytzer (1990) which forces the Pareto efficient outcome under egalitarian (equal division) sharing but not under proportional sharing. Valsecchi (1996) resorts to job design to force the Pareto efficient outcome. Rasmusen (1987) adopts a different tack. If Holmstrom's risk-neutral agents are replaced by risk-averse agents, a budget balance lottery on who gets to be taxed in case of an output shortfall can be devised which forces agents to supply exactly the Pareto efficient effort (or whatever is the principal's tendency, which means that a multiplicity of solutions is possible) as long as agents are risk-averse enough and the punishment is stiff enough. There is here, however, an unacceptable unfairness

which it shares with the Holmstrom proposal because punishment is random and even the most cooperative could draw the short stick. Random punishment even by occupiers (Nazis or otherwise) is distasteful at best.

The Pareto efficiency in the Holmstrom team is naturally an economic design challenge (Guttman and Schnytzer's and Rasmusen's proposals are design approaches without being explicitly formulated in that language). An explicit implementation approach is provided by, e.g., Sjöström (1996) who assumes a risk neutral principal (thus departing somewhat from the original framework) hiring risk-averse agents working as a team. Each agent communicates his best forecast of output to the principal (random state of the world is assumed) and on the basis of the forecasts and actual output, wages are paid each agent. The implementability of the principal's "first best" outcome under the forecasting mechanism with agents knowing the state of the world is not feasible under two important circumstances: when effort is a private and when effort is a public information! It is feasible when a "supervisor" observes all actions and when there is "nearest neighbor" observability. When agents cannot observe the state of the world and effort is non-observable, the first best cannot be implemented (see also Ma, 1988). Another mechanism proposed by Gradstein (1995) in the context of oligopoly uses balanced transfers (positive or negative but summing to zero) to force deviants to cooperate towards the group optimum. But he assumes fully observable action. Thus, the design approaches so far appear to fall short of the full blown problem we confront in this paper: complete non-observability of effort and no principal or full budget balance.

The interesting feature about these results, however, is that, they, for the most part, concern organizations which are self-standing and isolated in the sense of non-

interacting with the outside environment. This is odd because almost everyone's notion of teams includes a competitive setting as in team sports. In an isolated self-sufficient team, Pareto efficiency may be only a peripheral concern for members. In a competitive environment where team survival is not guaranteed, the attitude of members toward team goals should alter.

There is some evidence that competition can foster cooperation and efficiency in teams as it should with normal firms. Attwood (1990) compares the performance of two groups of Indian sugar cooperatives and singled out market competition as the driving force in the difference in their efficiencies. The relative efficiency of the Israeli Kibbutz and the stark inefficiency of the Russian Kolkhoz can be traced partly to the fact that for the Kibbutz to survive Kibbutzim oranges have to compete favorably with oranges from Spain and Africa while Kolkhoz oranges need not (although Guttman and Schnytzer (1989) favor Kibbutzim egalitarianism as explanation). Thus, competition among teams appears to mitigate moral hazard. Where competition does not exist as in the Russian Kolkhoz, team structure and inefficiency are natural buddies in accordance with the Alchian-Demsetz-Holmstrom thesis. Odagiri (1992) champions the view that competition among domestic companies is the touchstone to superior performance of the tradeable sector in Japan where many large corporations exhibit both principal-agent and partnership features (Aoki, 1988; Dore, 1973; Nagatomi, 1997). Porter (1990) claims that Japan's prowess in the world market sprung from intense domestic inter-firm rivalry although Almsden and Singh (1994) claims the competition policy was geared towards dynamic efficiency.

This paper takes its cue from the current thinking on the emergence of cooperation literature (see, e.g., Boyd and Richerson, 2009; Rowthorn, et al., 2009) that group selection is the touchstone of cooperation in groups. This goes back all the way to Charles Darwin's (1871) famous observation:

“It must not be forgotten that although a high standard of morality gives but a slight or no advantage to each individual man and his children over the other men of the same tribe, yet that an increase in the number of well-endowed men and advancement in the standard of morality will certainly give an immense advantage to one tribe over another. A tribe including many members who from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy, were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection.” (Darwin 1871, p. 166)

Darwin and subsequent literature (Trivers, 1971; Heinrich and Boyd, 1998) was concerned with how morality becomes hardwired among members of a group. This paper differs from this literature in that it asks how cooperation itself rather than the trait is induced among purely self-interested agents. The strategy employed is common in the static cooperation literature (Holmstrom, 1982; Rasmussen, 1988): putting the team in a situation where every member becomes a *critical decision maker*. The paper constructs team environment characterized by strict agent rationality, budget balance and complete effort non-observability and an inter-team winner-takes-all contest. The model employs Nash conjectures among agents, inter-team symmetry, and a fixed fee financing of the contest prize. We will show that under certain

competitive conditions, teams in this environment can attain the cooperative solution (Pareto efficiency).

In Section II, we first define the contest environment and characterize Pareto efficient Nash solutions under quasi-linear utility. We do the same under risk aversion and finally when the number of teams becomes very large. In III, we set down our conclusion.

II. THE MODEL

A. General Structure

Consider a team of $n \geq 2$ members. Every i contributes effort level $L_i \in [0, \bar{L}_i]$, $\bar{L}_i < \infty$ to a production function F defined over $\mathbf{L} = \{L_i\}$. Thus, L_i is bounded from above by $\bar{L}_i$. F is twice differentiable, non-decreasing and quasi-concave on $\mathbf{L}$. Effort is completely voluntary. Every member i receives a share $s_i \geq 0$ of the team's total revenue R , and $\sum_{i=1}^n s_i = 1$. Thus, there is no residual after members receive their respective shares and, thus, no principal or residual claimant. The utility function of i is

$$u_i = U_i(s_i R) - V_i(L_i) \quad (1)$$

where R is a linear function of F . We assume $U_i(\cdot)$ to obey the VN-M axioms and to be concave, increasing and twice differentiable in own share $s_i R$ ($U'(\cdot) > 0$, $U''(\cdot) \leq 0$). Thus, every i is strictly rational. Finally, $V_i(L_i)$, the disutility of effort function is strictly increasing and convex.

Definition 1: A team with the above characteristics, namely, (i) budget balance ($\sum s_i = 1$), (ii) strict rationality, (iii) concave utility over own share but separable in strictly voluntary effort, we will call Team C.

Let $f^i = (\partial F / \partial L_i)$, the marginal product of member i and $V'_i = (\partial V_i / \partial L_i)$, the marginal disutility of effort of i .

Definition 2: Pareto efficiency is attained if $F^i = V'_i$, $\forall i = 1, 2, \dots, n$. These generate the Pareto efficient effort supply $\mathbf{L}^* = \{L_i^*\}$ and Pareto efficient output $F^*(\mathbf{L}^*)$.

Remark 1: The team Pareto efficient solution also attains the maximum of $\sum u_i$, the cooperative solution, if every U_i is an identity function (Campbell, 1995; Campbell and Truchon, 1988).

We now assume that Team C is just one of its kind in a competitive environment. The structure of the competition is given below.

Definition 3: The contest environment Farrel-Lander-Hirshleifer (FLH) if (a) there are $m + 1$ Type C type teams in a “winner-takes-all” contest; (b) the probability P of the “home team” (unlabelled) winning is Hirshleifer type, i.e.,

$$P = [e^\beta / (e^\beta + m e_0^\beta)], \quad \beta \geq 0. \quad (2)$$

(c) Following Farrel and Lander (1989), $e = \left(\sum_{i=1}^n L_i / n \right)$, the effort level average of the home team and e_0 is the same for the representative rival team,

Remark 2: (i) The parameter β is the contest mass effect parameter (Hirshleifer, 1989). When $\beta \leq 1$, P is a concave function of e . When $\beta > 1$, P has an inflection point and becomes convex in e and escalates rapidly beyond a certain e . We will call β the “Hirshleifer parameter”. If $\beta = 0$, $P = (1 + m)^{-1}$ and is invariant to individual effort.

Definition 4: The contest prize X is “fixed fee-financed” if $X = \delta + \sum_{j=1}^n \delta_j$, where δ_j is the j th team’s entry fee and δ is home team’s entry fee.

Remark 3: The net revenue of home team is $R = (F - \delta + X)$ if it wins and $(F - \delta)$ if it loses; for any rival team j , it is $R_j = (G_j - \delta_j + X)$ if it wins or $(G_j - \delta_j)$ if it loses. The expected winnings across all the teams is zero. With the environment taken as a whole, we say that there is “global budget balance”. We call “ m ” the width of the competition and, in case of budget balance, “ δ ” is the depth of competition.

The expected utility of individual i in the home team is, thus:

$$Eu_i = PU_i(W) + (1-P) U_i(L) - V_i(L_i) \quad (3)$$

where $W = s_i(F - \delta + X)$ is i th share if the team wins and $L = s_i(F - \delta)$ is i th share if the team loses.

Assumption 1: Every member has identical Cournot-Nash conjectures on the behavior of other members within his/her team and players in other teams.

The first order condition for a maximum of (3) with respect to own effort L_i is:

$$PU'_i(W)[s_i F^i] + PU'_i(W)[F - \delta + X]s_i^i + U_i(W)P^i + [1 - P]U'_i(L)[s_i F^i] + [1 - P]U'_i(L)[F - \delta]s_i^i - U_i(L)P^i - V'_i = 0,$$

where $U_i'(W) = (dU_i/dW)$, $F^i = (\partial F/\partial L_i)$, $s_i^i = (\partial s_i/\partial L_i)$, $P^i = (\partial P^i/\partial L_i)$, $U_i'(L) = (dU_i/\partial L_i)$.

Upon rearranging, we have:

$$s_i \{ P U_i'(W) + [1 - P] U_i'(L) \} F^i + \{ U_i(W) - U_i(L) \} P^i + \{ P U_i'(W) [F - \delta + X] + [1 - P] U_i'(L) [F - \delta] \} s_i^i - V_i' = 0. \quad (4)$$

Assumption 2: Effort is completely unobservable so that individual share s_i is not a function of L_i . Thus, $s_i^i = (\partial s_i/\partial L_i) = 0$. In view of this, we assume $s_i = n^{-1}$, i.e., “equal division” is used.

Remark 4: The allocation could be anything. It could be a lottery. We adopt “equal division” because it has its own attraction theoretically (Roemer, 1994; Guttman and Schnytzer, 1987) and in practice (viz., the Israeli Kibbutz). Equal division also figures in the concept of “partnership” (Radner, 1986)

Assumption 3: (Team Symmetry): All the $(m + 1)$ teams are identical in every respect: number of members n , member profile, production technology, entry fee, etc.

Remark 5: The members of the team are, however, not identical. Thus, no membership symmetry assumption is being made.

Employing Assumptions 2 and 3, condition (4) is now rewritten as:

$$\left\{ n^{-1} [P U_i'(W) + (1 - P) U_i'(L)] + [U_i(W) - U_i(L)] [F^i]^{-1} P^i \right\} F^i = V_i'. \quad (5)$$

Letting $A_i = \{.\}$, the bracketed expression in (5), we have:

$$A_i F^i = V_i', \quad \forall i = 1, 2, \dots, n. \quad (6)$$

B. Quasi-Linear Utility

We investigate the possibility of self-enforcing Pareto efficient equilibria when agents have quasi-linear utilities (risk neutrality), i.e., $U_i(s_i R) = s_i R$ in (1). We have:

Lemma 1: If u_i is quasi-linear, Team C attains a self-enforcing Pareto efficiency under FFF and Assumptions (1-3) iff. $A_i = 1, \forall i = 1, 2, \dots, n$.

In general, the condition $A_i = 1, \forall i$, is difficult to satisfy. It is important to demonstrate that the set satisfying it is non-empty. Before we explore cases where self-enforcing Pareto efficient solution is supported, we first present a case where it is not.

B.1. The Degenerate Contest Case

If $\beta = 0$, $P = (1 + m)^{-1}$ from the start and the contest is a pure lottery with even odds. Effort makes no difference to the win probability and $P^i = 0$. Thus, (5) simplifies into:

$$n^{-1} [P U_i'(W) + (1 - P) U_i'(L)] F^i = V_i',$$

which with quasi-linear utility simplifies into:

$$n^{-1} \left\{ [n(1 + m)]^{-1} x + n^{-1}(F - \delta) \right\} F^i = V_i'. \quad (7)$$

Thus:

$$A_i = n^{-1} [x(1 + m)^{-1} - \delta] + F n^{-1} = F n^{-2},$$

and $A_i = 1 = > F = n^2$ which can occur only from pure happenstance. In any case, (7) can be solved for Nash equilibrium effort levels $\{L_i^0\}$, $i = 1, 2, \dots, n$ where “0” refers to $\beta = 0$ and $L_i^0 \geq 0 \quad \forall i$ and $L_i^0 > 0$, some i .

B.2. Farrel-Lander-Hirshleifer (FLH)

We know that for risk-neutral members, the Alchian-Demsetz-Holmstrom result holds, that is, the self-enforcing equilibrium solution is inefficient when the team operates in isolation. Likewise, Rasmusen’s Pareto inducing punishment lottery proposal does not work in this case.

From (2), we have $P^i = (\partial P / \partial L_i) = \{ [e^\beta + m e_0^\beta] [(\beta/n) e^{\beta-1}] - [e^\beta (\beta/n) e^{\beta-1}] \} / [e^\beta + m e_0^\beta]^2$. Imposing team symmetry we have $P^i = \beta m / (1 + m)^2 \sum L_j = P'$ and $P = (1 + m)^{-1}$.

Substituting $P = (1 + m)^{-1}$ for P , $U_i(W) = (F - \delta + X) n^{-1}$ and $U_i(L) = (F - \delta) n^{-1}$ in $A_i = 1$, we have:

$$\{1 + X [F^i \sum L_j]^{-1} [\beta m (1 + m)^{-2}]\} = n.$$

Solving for β , we have:

$$\beta = n (F^i \sum L_j^*) (1 + m)^2 (mX)^{-1}, \quad i = 1, 2, \dots, n. \quad (8)$$

This is still problematic because while β , n , c , m and X are the same for every member i , F^i in the expression $F^i \sum L_j^*$ is generally different for every i . There is, however, a unique family of functions having this property (Fabella, 1997).

Assumption 4: F is “factor symmetric” if $F^i = F^j$, $\forall i, j = 1, 2, \dots, n$.

Note that if $\mathbf{L} = \sum_{i=1}^n L_i$, then $F(\mathbf{L})$ is always factor symmetric. Let $h_i = F^i \sum$

L_j^* . For this family, $h_i = h_k = h > 0$. From Lemma 1 and from (8), we

have:

Lemma 2: Suppose members have quasi-linear utility. Then, Team C under FLH, FFF and Assumptions (1-4) attains a self-enforcing Pareto efficiency if and only if

$$\beta h^{-1} = n\delta^{-1} (1 + m)m^{-1}. \quad (9)$$

We still do not know whether in fact (9) is attainable. Note that $h = F^i \sum L_i^*$ where L_i^* solves (6) under the assumptions. But every L_i^* is a continuous function of β . Thus, h is a continuous function of β . The left hand side of (9) can be written as $[\beta/h(\beta)]$. Note that for $\beta = 0$, $0/h(0) = 0/F'(\sum L_i^0) = 0$ since $L_i^0 > 0$ some i . As β rises from zero, effort begins to impact on the win-probability and effort should rise from $L_i^0, \forall i$. Let $\beta \rightarrow \infty$; then $L_i^* \rightarrow \bar{L}_i, \forall i$ and $(F^i \sum L_i^*)$ approaches a finite limit since F^i is finite. Therefore, $\lim_{\beta \rightarrow \infty} \beta/h(\beta) = \infty$. We now have:

Proposition 1: Assume the conditions in Lemma 2. If $(\partial L_i^*/\partial \beta) \geq 0, \forall i, L_i \leq \bar{L}_i < \infty, \forall i, n < \infty$ and $\delta > 0$, then there exists a $\beta^* > 0$ that forces a Pareto efficient Nash equilibrium in FLH.

Proof: By the mean-value theorem, as β rises from zero to ∞ , $[\beta/h(\beta)]$ attains any finite positive value since $[\beta/h(\beta)]$ is continuous in β . In particular, it attains $n(1 + m)(m\delta)^{-1}$ which is finite for $n < \infty$ and $\delta > 0$. Q.E.D.

Remark 6: Proposition 1 shows how there always exists a Hirshleifer competition parameters that supports a self-enforcing Pareto efficiency in FLH despite complete moral hazard and quasi-linear utility. At β^* , there is no incentive for any member to deviate since the equilibrium is Nash.

Note that to maintain Pareto efficiency, (9) says that for given n , h and m , a fall in the stakes δ requires an increase in the Hirshleifer parameter β . Also, a rise in team size n requires a rise in the competitiveness index β to maintain Pareto efficiency. This is as one expects because larger n exacerbates the moral hazard problem which requires more intense competition to overcome.

Remark 7: Note that if u_i is quasi-linear, it is impossible even with “factor symmetry” for a team *in isolation* ($m = 0$ or $\delta = \delta_j = 0 \Rightarrow X = 0$) (as in Holmstrom, 1982; Fabella, 1989) to attain Pareto efficiency. (7) reduces to $n = 1$, a contradiction if $n \geq 2$. Note further that “factor symmetry” does not result in membership symmetry since effort disutility is still vary.

C. Risk Aversion

In this section, we focus on the possibility of a Pareto efficient Nash equilibrium when agents are risk averse. To simplify the discussion, we assume that agents exhibit utility functions satisfying the Inada conditions. Not only is risk aversion present but also boundedness from above or satiation.

Assumption 5: $U_i(.)$ satisfies the Inada conditions, i.e., $U_i'(0) = \infty$ and

$$U_i'(\infty) = 0.$$

The 1^o conditions for a maximum of (3) under FFF and Assumptions (1-3) simplify into:

$$n^{-1} \left[T + XC P^i(F^i)^{-1} \right] F^i = V_i', \quad \forall i = 1, 2, \dots, n, \quad (12)$$

where $T = \left\{ (1+m)^{-1} U_i'(W) + m(1+m)^{-1} U_i'(L) \right\}$ is the tangent slope or average of the tangencies of U at W and L and $C = [U_i(W) - U_i(L)] [Xn^{-1}]^{-1}$ is the chord slope, i.e, the slope of the line joining $U_i(W)$ and $U_i(L)$. Thus, A_i in (6) is:

$$A_i = n^{-1} \left\{ T + XC P^i(F^i)^{-1} \right\} \quad (13)$$

Note that under quasi-linear utility $T = C = 1$ and $A_i = n^{-1}$, if $\delta = 0$. We need to spell out the values A_i takes as δ moves from 0 to F . We have,

Lemma 3: For $0 \leq \delta < F$, $A_i \in [n^{-1}, \infty)$.

Proof: Suppose $\delta = 0$. Then $X = (1+m)\delta = 0$ and $A_i = n^{-1} T$. But $W = (F - \delta +$

$X) n^{-1} = L = (F - \delta) n^{-1}$ if $\delta = 0$. Thus, $T = 1$ and $A_i = n^{-1}$. Suppose $\delta \rightarrow F$,

$W \rightarrow Xn^{-1}$ and $U'(W) \rightarrow U'_i(Xn^{-1}) > 0$. But $L \rightarrow 0$ and $U'(L) \rightarrow \infty$ by the Inada conditions. Thus, $T \rightarrow \infty$ as $\delta \rightarrow F$. On the other hand, $C \rightarrow U_i(Xn^{-1})(Xn^{-1}) > 0$. Now, $(P^i/F^i) > 0$ so $A_i \rightarrow \infty$ as $\delta \rightarrow F$. By continuity of U_i , F , X and P^i , A_i attains any value in $[n^{-1}, \infty)$ as δ moves from 0 to F . Q.E.D.

Since $n^{-1} < 1 < \infty$, $A_i = 1$ is attainable by some δ^* . If $F^i = F^j$, $\forall i, j$ and $U^i = U^j$, $\forall i, j$, then we have:

Proposition 2: Suppose all agents exhibit identical U_i satisfying the Inada conditions. Let Assumptions (1-4) all hold. Then, there always exist an entry fee δ^* that forces a self-enforcing Pareto efficient solution.

What differentiates this from previous possibility results, i.e., Proposition 1, is that it depends on the value of δ and it makes no use of the Hirshleifer win probability parameter β . Indeed, it is independent of the definition of e . The drawback is that “factor symmetry” (Assumption 4) still has to operate since F^i characterizes A_i .

D. The Walrasian Limit and Risk Aversion

At the traditional Walrasian limit the number of agents approaches infinity and agents become price takers. In this model, there are no prices and the Walrasian limit is predicated on the number of teams. What members take as given is the team’s probability of winning P and their capacity to alter it.

Definition 6: As $m \rightarrow \infty$, FLH approaches its Walrasian limit.

Note that as $m \rightarrow \infty$, $P \rightarrow 0$ and $P' = m\beta [(1 + m)^2 e^{\beta+1}]^{-1} \rightarrow 0$ for any $e > 0$ at the FLH environment.

Lemma 4: Suppose $U_i(\cdot)$, all i , satisfies the upper Inada condition. At the Walrasian limit of FLH, the first order condition (5) reduces to

$$n^{-1} U'_i(L) F^i = V'_i, \quad \forall i = 1, 2, \dots, n. \quad (14)$$

Proof: From (5) observe that as $m \rightarrow \infty$, the expression $s_i [PU'(W) + (1-P)U'(L)]$ reduces to $s_i U'(L)$ since $P \rightarrow 0$. Likewise, as $m \rightarrow \infty$, the expression $[\beta m / (1 + m)^2] \rightarrow [\beta m / m (2 + m)] = [\beta / (2 + m)] \rightarrow 0$. The prize $X = (1 + m) \delta \rightarrow \infty$ as $m \rightarrow \infty$. But $U[s_i (F - \delta + X)] [\beta / (2 + m)] \rightarrow 0$ since $(2 + m)^{-1}$ decreases proportionally with m while $U(\cdot)$ increases less than proportionately with m as $U'_i(X) \rightarrow 0$. Thus, the second expression vanishes at the limit. What is left is $s_i U'_i(L) F^i = V'_i$ with $s_i = n^{-1}$. Q.E.D.

Thus, at the Walrasian limit with the Inada risk aversion, the structure of F becomes unrestricted. Likewise, the Hirshleifer degree of competition parameter β ceases to be a factor as quantity overwhelms quality. Still, these are not enough to guarantee efficiency. For that, we have the following:

Proposition 3: If $U_i(\cdot)$, $i = 1, 2, \dots, n$ are identical and satisfy the upper Inada condition, and $0 < U'_i(n^{-1}F^*) \leq n$, then at the Walrasian limit of FLH, there always exists an entry fee $\delta^* > 0$ with FFF that supports a self-enforcing Pareto efficiency.

Proof: Since $U_i(\cdot)$ satisfies the Inada conditions and are continuous, (12) holds at the Walrasian limit. $U'_i(n^{-1}(F^* - \delta))$ ranges from $U'_i(n^{-1}F^*)$ to ∞ as δ goes from $\epsilon > 0$ to F^* . Thus, for any n , $2 \leq n < \infty$, there always exists a δ^* that guarantees that $n^{-1}U'_i(L) = 1$. Since $U_i(\cdot) = U_j(\cdot)$, $\forall i, j = 1, 2, \dots, n$, δ^* also guarantees that $F^i = V'_i$, $\forall i$. Q.E.D.

For a self-enforcing first best efficiency in teams at the Walrasian limit of FLH, only the structure of risk aversion, the size of the membership and the size of the entry fee matter.

Corollary 1: Suppose the conditions in Proposition 4 hold. As team size becomes very large, Pareto efficiency can be maintained only by “cut-throat competition” (i.e., $\delta \searrow F^*$).

Proof: Clearly by the lower Inada condition, $U'_i(L) \searrow \infty$ as $\delta \searrow F^*$. Q.E.D.

Remark 8: Corollary 1 shows that intense competition among teams with risk-averse members can allow teams to become large while at the same time remaining efficient.

There remains the persistent necessity of the identity of members in their evaluation of own share. Although this does not mean member symmetry because the disutility function $V_i(L_i)$ may be different, it still remains that a certain degree of homogeneity among the members cannot be ruled out. It always helps when the membership share certain strategic values. Hansmann (1996) confirms the strategic role of shared values and homogeneous interests in the efficiency of organizations.

Note that (14) is consistent with a self-enforcing “overexertion equilibrium” where effort is much greater than Pareto efficient, i.e., $F^i < V_i'$, $\forall i$, if δ is pushed closer and closer to F^* . This may explain the phenomenon of “Karosi” or “overwork death” in Japan.

III. SUMMARY

This paper investigates how competition between teams can overcome the moral hazard problem in teams. The teams display classical features: absence of a principal or residual claimant, strictly rational members with utilities separable in own share and effort. The team competes against other teams for a prize financed by fixed (entry) fees from the teams, thus, satisfying global budget balance. The win-probability is Hirshleifer

type and is based on average effort of the teams. We call this environment the Farrel-Lander-Hirshleifer environment.

Assuming Cournot-Nash conjectures all around, and inter-team symmetry, we show that if members have quasi-linear utility and production technology is factor symmetric, there always exists a Hirshleifer parameter value that supports a self-enforcing Pareto efficiency in the teams. The moral hazard problem in teams can thus be overcome by a proper level of competition. But the required conditions in most of the cases under limited number of teams are rather strong. The requirement of factor symmetry of the production function remains very restrictive. Under risk aversion of the Inada type, we show that there always exists an entry fee δ that forces Pareto efficiency if technology is factor symmetric. This particular problem can be overcome at the Walrasian limit of the game (i.e., as the number of contesting teams rises without limit). At the Walrasian limit, the structure of the production technology vanishes from the decision problem provided the utility functions over own share obey the Inada conditions and are identical. Only the risk aversion, the entry fee level and team size matter. That is, there always exists a fee level so that if the Pareto efficiency is attained, no incentive to deviate exists.

The results here have certain drawbacks: First, there is no way to rule out some degree of homogeneity among members. Pareto efficiency in this approach is always easier to attain when members either or both productively identical and share some strategic values in common, in this case, their valuation of own share. Hansmann (1996) confirms the role of homogeneous interests in his study of enterprise ownership. Second, in common with results in this area, the sustainable Pareto efficient solution is only one

among the many possible sustainable equilibrium. An “overexertion equilibrium” can also be sustained.

Finally, to go back to the issue of Japanese tradable goods sector, we observed that this displays many team or near-team features, relatively more equitable income distribution and very intense competition and competitiveness. Our view in common with Odagiri (1992) is that intense competition allows this sector to overcome the potential moral hazard problem associated with this organizational set-up. The moral hazard problem motivates a more equitable distribution of income which itself helps cement the homogeneity and “shared fate” character of the firm. The intense competition is what holds the Alchian-Demsetz-Holmstrom inefficiency effect at bay. It also helps that there is an appreciable degree of homogeneity among the “Kaishain”.

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