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PRINCIPALS AND PARTNERS: THE STRUCTURE OF SYNDICATES

by

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Abstract

This paper analyzes conditions which help to determine the optimal organization of a syndicate when the input of members of the syndicate is not observable. If the cost of monitoring agents' actions is free or if a principal will agree to operate an optimal incentive scheme at no cost, then well-known results tell us that a principal-based hierarchy is optimal. However, when all members of a syndicate share equally in the surplus generated by the syndicate including the principal, this cost must be borne in mind in forming the optimal organization. Sometimes it is preferable to bear the costs of shirking rather than to share the gains of the enterprise with another agent. This paper shows that the bias towards such partnerships varies in a predictable manner determined by the parameters of the environment. In particular, it shows that while growth of an enterprise might provide an incentive to form a hierarchy, increased efficiency of the agents through learning for instance provide countering biases favouring the formation of a partnership.

Principals and Partners: The structure of syndicates.

A problem endemic to the working of teams is that of moral hazard. The input of a team member may be by its nature difficult to monitor or evaluate. From the perspective of economic theory, though, the problem of moral hazard in teams appears to be solved. When the actions of team members cannot be observed, all that is required is a principal who is willing to operate an incentive scheme which induces the optimal effort level from each agent even without monitoring. The separation of ownership from management which is present in many capitalist firms reflects the general principle that an unengaged principal can be used to achieve an efficient outcome.

How can we explain, then, the persistence of partnerships even in mature firms? Consider these examples: in the fall of 1988, a large portion of the consulting section of Arthur Anderson left the firm to form a small partnership of their own; recently, a number of small franchise operations have changed their organizational structure -- a franchisee group of Arthur Treacher's restaurants bought out the parent company in 1982 to operate the franchise as a partnership, and similar reorganizations have occurred with other companies; joint venture operations abound in which two or more firms form partnerships in order to produce a given product, usually in the realm of research and development. One of the constant phenomena in the flux of firms is not just the change in the ownership of enterprises but often radical changes in the way the firm is organized. The prevalence of partnership schemes suggests that the partnership organization of a syndicate may often be an attractive arrangement even when shirking is a pervasive problem. This paper argues that while a principal provides a

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valuable service as a source of discipline to prevent shirking on the part of the partners, he also serves as a drag on the syndicate in that he represents another member with a claim on the surplus of the enterprise -- a member who does not serve a directly productive role. A model is developed in which syndicates are formed subject to the constraint that all members earn an equal share in the firm's net profits. Their objective is the maximization of per member profit. This framework helps to explain the incentives that may lead to the formation of partnerships and it provides simple conditions on the production environment which can determine whether a principal-based hierarchy or a partnership based on sharing total output is optimal.

The paper takes as its starting point, an insightful article by Holmstrom (1982) which argued (among other things) that the use of a principal can help a team achieve the efficient outcome. When actions are unobservable, a simple proportional sharing rule gives agents the incentive to shirk. Holmstrom shows that by introducing a principal to operate a scheme which punishes each agent severely whenever the total output falls below the optimal amount (and who collects this penalty for himself) agents can be induced to provide a desired effort level.

Suppose that the syndicate generated an economic surplus which was distributed to each member of the organization equally (including the principal if there is one). An alternative to using the principal to discipline other members would be to draft him directly into the production process instead. In many instances where shirking does not impose too great an efficiency cost, for example, if the number of agents in the syndicate was not large, total utility could be raised by exploiting this alternative.

Of course, output still must be shared among n+1 agents; an optimal decision should involve the best choice of n as well. The paper examines the question of forming the optimal syndicate by choosing both the optimal size and the optimal organizational structure.

In this light, the paper attempts to address the following question. A project is available which requires the input of more than one agent but no more than some finite number. For a given organizational structure and assuming that each agent maximizes individual utility, what is the optimal achievable effort level and organization size which will maximize per member utility. By comparing the answers in the separate cases of partnerships and hierarchies, we can discover if and when partnerships may be preferable to a hierarchy.

Section I: The Model

The opportunity arises to form an enterprise which has the following structure. Agent i belonging to the enterprise expends effort level $a_i \in [0,\infty)$ at a monetary cost given by

A1) $V(a_i) = v + v(a_i)$, $v \geq 0$, $v(0) = 0$, $v' > 0$, $v'' > 0$.

Total output for the enterprise is a function of total input.

A2) $x = f(y)$, $y = \Sigma a_i$, $f(0) = 0$, $f(.)$ is twice continuously differentiable for $f(y) > 0$.

In what follows, attention is restricted to situations where, in equilibrium if all agents expend positive effort, they expend equal effort in which case

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f can be written as $x = f(na)$ when there are n active agents.

Consider, first, the case in which each agent's action can be observed. Abstracting from integer problems, the optimal solution to the problem of maximizing _total_ net surplus of the firm is given by action levels a_e which minimize average cost (or, more precisely, average cost per unit effort) and a syndicate size n_e which satisfies the equation

$$f'(n_e a_e) = v'(a_e). \tag{1}$$

Such an objective is an unlikely one from the point of view of the syndicate members who are concerned with maximizing personal utility. The question of how total output is to be divided is a thorny one and one which this paper will not shed light on. It is assumed that, ex ante, the value of the enterprise is shared equally among all participants. Syndicate members wish to determine how many members to invite to join them in order to maximize per member utility. Implicit in this formulation is the assumption that if a smaller or larger subset of members can do better than in any given syndicate, they can always leave the current organization and form the more advantageous one.[1] The departure of the Arthur Anderson consulting partners to form their own firm and the decision of a group of Convenient Food Mart franchisees in New York to form a separate chain of stores may both be seen in this light.[2] The objective function is similar to that used

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[1] A formal description of a similar coalition formation game can be found in Farrell and Scotchmer (1988). Important in both their model and the model used here is the assumption that the production of a given group is unaffected by the coalition structure of other groups. It would be desirable to relax this assumption since we could then analyze behaviour of coalition formation within a market context.

[2] For a contemporary account of the Arthur Anderson incident see the _Wall Street Journal_, Oct. 10, Nov. 1, 1988 and Oct. 17, 1989. For the Convenient Food Mart see the _Wall Street Journal_, May 18, 1989.

in Ward's (1958) model of market syndicalism [3].

Now the objective function becomes

$$\max_{n,a,\ n \geq 1} (f(na))/n \ - \ v \ - \ v(a). \tag{2}$$

Notice that if $f(.)$ is always concave, given A1) and A2), the optimal syndicate size is always $n = 1$ (or zero). To ensure that there is an incentive to invite at least one more member in the syndicate, then, it is assumed that $f(.)$ is not strictly concave. Specifically, we assume

A3) There is a region $[0,k]$ over which f is convex and that f is strictly concave over (k, ∞).

A4) $f'(y) \geq 0$ for all y and $f'(y)$ approaches zero as y approaches infinity.

An implication of A4) is that the average product function of f, $f(y)/y$ has a unique maximum, y^*.

One useful formulation which will be used later is to let $h(.)$ be a strictly concave, increasing function such that $h(0) = 0$ and limit $h'(y) = 0$ as y goes to infinity.

A4') Choose $d \geq 0$. Let $f(y) = h(y-d)$ for all $y \geq d$, $f(y) = 0$, $y \in [0,d]$ -- f is just the rightward translation of h.

Finally, to ensure that some level of activity is desirable it is

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[3] The team structure is what Wilson (1968) terms a syndicate. Similar objective functions are also used in the theory of worker-managed firms. See Svejnar (1982), Dreze (1976) or Steinherr (1977).

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assumed that the maximum average product exceeds the minimum average cost.

A5) The line $z(f'(y^*))$ intersects the function $V(z)$ at at least one point $z \leq y^*$.

The convexity of the production function, of course, is important to introduce the potential gains from forming a syndicate. Many joint venture schemes exhibit this flavour in a special way. Japanese steel and auto firms have formed joint ventures with American firms in order to take advantage of the domestic firms' familiarity with the home market. In the case of franchise companies, among the advantages that franchises offer their clients is a homogeneity of product. Clients appreciate Macdonalds because they can count on going anywhere in the world and getting essentially the same hamburger. Individual restaurants may not be counted on to maintain similar standards of cleanliness or quality on their own and part of the function of the parent company is to ensure that these standards are met.

Abstracting again from integer problems, the solution to (2) is given by the level of total output $y = n^*a^*$ which maximizes average product, ie y^* $= n^*a^*$. The first order conditions characterizing the solution to (5) are given by

$$f'(n^*a^*) = v'(a^*) \tag{3}$$

$$f(n^*a^*) \geq n^*a^*f'(n^*a^*) \tag{4}$$

where equality holds in (4) if $n > 1$. Under our assumptions on f there is a unique solution n^*a^* to (4) when $n > 1$ and thus a unique solution a^* to (3), yielding n^* as well. (See Figure One). Since we are concerned with behaviour when there are returns to forming a syndicate, attention is restricted to

situations in which under perfect observability, the optimal syndicate size exceeds one. This is implied by assumption A7).

A7) Let $y*$ be the level of output which maximizes $f(y)/y$. Then $f(y*) < V(y*)$.

Proposition One: A syndicate wishing to maximize per member output when actions are observable will choose fewer members than the number which maximizes total surplus and will choose an optimal action level which is higher than the level which minimizes average cost.

Proof: (See Figure One) Consider the line $zf'(y*)$. Clearly it must lie above the line $zv'(a_e)$ or else no action would be taken in the second enterprise since per member utility is given by

$$[f(n*a*)]/n* - v - v(a*) = a*f'(n*a*) - V(a*). \qquad (5)$$

Therefore, $v'(a*) \geq v'(a_e)$ so $a* > a_e$ by the convexity of $v(a)$. Suppose that $n_e a_e < n*a*$. Since $f'(n*a*) > f'(n_e a_e)$, this would require $n_e a_e$ to be at the convex portion of f. This would mean that higher output could be achieved by keeping actions fixed and adding one more member so an optimal number n_e could not have been chosen. Therefore $n_e a_e > n*a*$ and combining with the result for $a*$ gives $n_e > n*$. $||$

Proposition One simply formalizes the intuition that maximizing per member profit requires limiting membership. Figure One characterizes graphically the solutions to the two problems: maximizing total surplus and maximizing per member profit under perfect information.

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Section II: Optimal Syndicate Size With Moral Hazard

When actions are observable, the determination of the optimal size of a syndicate is fairly straightforward. If, however, agents are able to hide their actions, the choice of the optimal size must be made with an eye to determining how optimal actions can be induced. In this section, two alternatives are considered. In the first one, a simple partnership in which each of the n agents receive 1/n of the total output and take their actions with this payoff in mind is formed. In the second, one of the n agents is chosen at random to operate as the principal who then either institutes an optimal incentive scheme or else in some other manner costlessly ensures that the members provide the desired effort level.[4]

Partnerships:

In a partnership scheme with n agents, for any output x, each agent receives x/n. Given the actions a of each of the n - 1 other agents, then agent i will attempt to maximize

$$f((n-1)a+a_i)/n \cdot v - v(a_i). \qquad (6)$$

The necessary condition is, of course,

$$f'(na)/n - v'(a) \qquad (7)$$

(Recall that we are restricting attention to symmetric solutions.) The optimization problem for a partnership, then, can be formulated as in (2) subject to the additional constraint that each agent's action, a_i, be individually utility maximizing. That is, maximize (2) subject to the constraint (7).

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[4] Observe that what matters here is that the actions of the monitor are both costless and enforceable. Notice that the Holmstrom scheme satisfies this requirement and can always be constructed so that when agents do provide the agreed on effort level, 1/n of the net surplus is allotted to the principal.

For simplicity and tractability, restrict the cost function to be of the form $V(a) = v + ba^2$. Notice that the individual incentive condition becomes $2bna = f'(na)$. Observe as well that for any total output level na, if a line of slope K is drawn from the origin to $f(na)$ satisfying $Kna = f(na)$, per member payoff is given by $Ka - V(a)$. Recall that a_e is the action which minimizes total cost per unit action, $V(a)/a$. Therefore, for $K'' < v'(a_e)$, the output levels y such that $K''y = f(y)$ are infeasible. Let $y\#$ satisfy $v'(a_e)y\# = f(y\#)$. Only total output levels above $y\#$ will be feasible in any partnership. We now show that if the number of partners is greater than one, then $f(na)$ is less than $f(y^*)$, the level which maximizes total average product.

Lemma Two: Suppose $n > 1$. Then any feasible choice of (n,a) for a partnership has $f(na) < f(y^*)$. Furthermore, any optimal choice, if it exists, must be the largest na between $[y\#, y^*]$.

Proof: Assumption A5) implies that at y^*, $f'(y^*) \leq v'(y^*) = 2by^*$. The left side is decreasing in y and the right side is increasing in y so the inequality persists for all $y > y^*$. The only possible solution to (2) that also satisfies (7) then, is with $na = y < y^*$. Thus the total output level under a partnership lies below y^*.

The optimal y, y_p, is the largest total output level which satisfies $f'(y)/y = 2b$. To see this, note that as long as $f'(na) = 2bna$, any action is inducible as long as n is changed accordingly. Since for $y < y^*$, at a fixed action level, $f(na)/n$ is increasing in n, an action level that is chosen for a low value of y is also available for the higher value of y by increasing n. Furthermore, the per member gross surplus increases. If that y is such

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that y < y#, then total output from a feasible partnership scheme is unprofitable. We concentrate attention on the case where a partnership can make money -- that is, the solution y_p such that $f'(y_p)/y_p - 2b$ lies in $[y\#, y*]$.

We can now examine the solution to the optimization problem with a partnership. (See Figure Two.) Draw a line from the ray to the point $f(y_p)$ and let the slope of the line be K_p. For any action a, if a is the action taken by all members of the syndicate, per member profit is given by $K_p a - V(a)$. Furthermore, given n, all a's such that $na - y_p$ are inducible since $nv'(a) - na2b - f'(na)$. Since v(a) is convex, this difference is maximized at the a such that $v'(a_p) - K_p$. Typically, of course a_p will not yield $n_p - y_p/a_p$ as an integer. The maximization problem for the partnership though now simply involves searching over the whole numbers n so that the solution to $na - y_p$ lies as close as possible to a_p. Figure Two shows the possible choices for n - 2,3 and 4. Such a process will yield a generically unique n and a. For ease of exposition, however, it is assumed that $n_p - y_p/a_p$ is an integer and therefore solves the optimal partnership problem yielding the two conditions

$$2bn_p a_p - f'(n_p a_p) \qquad (8)$$

$$v'(a_p) - 2ba_p - f(n_p a_p)/n_p a_p . \qquad (9)$$

It is interesting to observe that, in Lemma Two, there is no certainty that at the optimal total output level the production function be concave. To ensure that each agent's maximization problem yield a maximum, it is necessary that f(.) not be too convex, that is that $f''(n_p a_p) - nv''(a_p) < 0$, however the costs of shirking may be such as to keep the team from exploiting some further gains from scale. Notice that if $f''(n_p a_p) - 2b > 0$,

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then $d[f'(y)]/dy = [f''(n_p a_p) - f'(n_p a_p)/n_p a_p]/n_p a_p = [f''(n_p a_p) - 2b]/n_p a_p > 0$

and since $f'(y)/y$ is eventually decreasing it could not have been the case

that the highest output level satisfying $f'(n_p a_p)/n_p a_p = 2b$ was chosen.

Therefore, $f''(n_p a_p) - 2b \leq 0$ and the agent's second order condition is

automatically satisfied. In what follows, it is assumed that the inequality

is strict.

The advantage of the quadratic formulation of $V(a)$ lies in the fact

that the incentive constraints on the member agents collapse to the choice

of the appropriate total output level. An implication of equations (8) and

(9) is that per member payoff can be expressed wholly in terms of induced

action levels:

$$f(na)/n - V(a) = av'(a) - V(a) \qquad (10)$$

If $f(na)$ can be written as $f(na) = h(na - d)$ as in A4'), then the result in

(10) can be generalized to

$$f(na)/n - V(a) \geq av'(a) - V(a) \qquad (10')$$

if $v'(a)$ is convex. The inequality is reversed if $v'(a)$ is concave. In what

follows, use is made of the relation between per member payoff and $av'(a)$ -

$V(a)$ and the result for quadratic cost of effort is exploited though many of

the results of the paper can be generalized using (10') in obvious ways.

Hierarchies:

In the hierarchical syndicate, one agent serves only to operate the

incentive scheme, $n - 1$ agents provide effort. The objective function then

becomes

$$\max_{n,a} U(n,a) = \{f((n-1)a) - (n-1)V(a)\}/n \qquad (11)$$

which can be written as

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$$\max_{n,a} \quad (1-1/n)\{f((n-1)a)/(n-1) - V(a)\}. \tag{12}$$

Given any n-1 working agents, of course, the optimal level of activity should satisfy

$$v'(a) = f'((n-1)a) \tag{13}$$

The next Lemma shows that aside from problems of integers, the total output in an optimal hierarchy, (n-1)a will exceed that of the optimal partnership with observable output, y^*, and therefore the total output of an optimal partnership without observable actions, y_p.

Lemma Three: Let $y_h = (n-1)a$ be the total output for an optimal hierarchy. Then $y_h \geq y^*$.

Proof: Suppose $(n-1)a < y^*$. Draw a ray from the origin to $f((n-1)a)$ with slope M. $Ma = f((n-1)a)/(n-1)$ and in the optimal hierarchy, per member profit is given by $(1-1/n)(Ma - V(a))$. By our assumption that $f'(y)$ goes to zero as y goes to infinity, there exists another z such that $Mz = f(z)$. Fix a and choose n' so that $(n'-1)a = z$. With a hierarchy, the principal could choose an incentive scheme with the $n'-1$ agents to induce the same action a if it was desired. Since $n' > n$, even at action a, $(1-1/n')(Ma - V(a))$ exceeds $(1-1/n)(Ma - V(a))$ and in general a better action than a will be chosen. Therefore, there always exists an output which dominates $(n-1)a < y^*$. ||

Refer to Figure Three. In light of Lemma Three, we can restrict attention to output levels above y^*. Once any n is chosen for the syndicate, the syndicate will wish the principal to enforce the most efficient action

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level, that is where $f'((n-1)a) = v'(a)$. Consider the problem of choosing n

to maximize (11) allowing a to be chosen optimally. Let (13) define a as an

implicit function of n and let $U(n) = U(n,a(n))$.

Lemma Four: $U(n)$ is a concave function of n.

Proof: Differentiate U to yield after some manipulation exploiting (13)

$$dU(n)/dn = \{((av'(a)-V(a)) - (f((n-1)a) - (n-1)af'((n-1)a))\}/n^2. \qquad (14)$$

From (13) a is a decreasing function of n so $av'(a) - V(a)$ is a decreasing

function of n. As n increases, $v'(a)$ decreases so $f'((n-1)a)$ decreases which

requires $(n-1)a$ to increase for $(n-1)a > y^*$. Furthermore, for $(n-1)a > y^*$,

$f((n-1)a) - (n-1)af'((n-1)a)$ increases so the numerator in (14) is a

decreasing function of n and so dU/dn is decreasing in n. $U(n)$ is concave in

n. ‖

Given Lemma Four, the integer programming problem approximates the

solution when n is a real number. This solution is characterized by an

output level $y_h = (n_h-1)a_h$ such that $v'(a_h) = f'(y_h)$ and

$$a_h v'(a_h)-V(a_h) = f(y_h) - y_h f'(y_h) \qquad (15)$$

Proposition Five: At the approximate solution to the optimal hierarchy

problem, per member utility is given by

$$U_h = a_h v'(a_h)-V(a_h). \qquad (16)$$

Proof: (Subscript h is dropped for simplicity) Add $(n-1)af'(y) = (n-1)av'(a)$

to each side of (14) yielding

$$nav'(a) - V(a) = f(y). \qquad (17)$$

Subtract $(n-1)V(a)$ from each side and divide by n to get

$$a_h v'(a_h) \cdot V(a_h) = \{f(y) - (n-1)V(a)\}/n. \qquad (18)$$

The results from Three through Five give particularly simple ways of characterizing the solutions to the partnership and principal problems of syndicate formation. For a given technology, the optimal partnership syndicate has a lower number of agents and lower total output than does the optimal principal-syndicate. In both cases the optimal action lies between a_e, the minimum average cost action and a^*, the optimal action in a partnership when effort can be monitored. Furthermore, the optimality of a partnership versus a hierarchy can be expressed directly in terms of the optimal action level. The optimal structure is the one in which the members work harder.

Proposition Six: Suppose $V(a) = v + ba^2$. The partnership dominates the hierarchy if and only if the optimal action in the partnership a_p is higher than the optimal action in the hierarchy, a_h.

Proof: This simply follows from the fact that in both structures the per member payoff is given by $U = av'(a) - V(a)$ which is increasing in a under our assumption on V.

Notice that since $V(.)$ is increasing in a, then Proposition Six also tells us something about observable characteristics of the model. That is, if a given organization is better than the other then per member net payoff is higher, so too, is the action level and therefore the gross cost of effort. As a result, then, the gross wage will also be higher in the preferred syndicate structure.

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The results for the hierarchy can be generalized to slightly different sharing rules for the principal. Suppose that the principal receives α/n of pthe output. If the syndicate is organized to maximize the per member surplus of the workers, then expressions for the optimal return to the agents can be found by a process similar to equations (11) through (18) to yield the per member payoff to be

$$(n-\alpha)/(n(n-1))(f((n-1)a)-(n-1)V(a))-(n-\alpha)^2/((n-\alpha)n-\alpha(n-1))(v'(av'(a)-V(a))$$
$$- g(n,\alpha)(v'(a)a - V(a))$$

The function g is less than one for $\alpha \le 1$ and greater than one for $1 \le \alpha \le n^2/(2n-1)$. Thus if $\alpha \le 1$, and the induced action level of a partnership exceeds that of a hierarchy, then the partnership is optimal. If $\alpha > 1$, and the induced action level of a hierarchy exceeds that of the partnership, the hierarchy yields a higher per member surplus.

Section III: Comparing Structures

In general, whether or not a partnership dominates a hierarchy will depend on the shapes of the various curves defining the technology. With the specifications from the above sections, it is possible to determine the bias in one direction or the other in terms of some simple parameters of the model.

The next result shows that for a given f(na) and v(a), as the fixed cost of effort, v, falls, partnerships become more desirable.

Proposition Seven: Fix f(na) and the variable cost function v(a). As long as an optimal partnership exists for some fixed cost v, the difference $U_h - U_p$ declines as v falls.

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Proof: Refer to Figure Three. Notice that the conditions characterizing the solution to the partnership problem n_p, a_p are independent of v. As v falls, per member profit rises but the optimal action stays the same. As v falls, however, the optimal action for a hierarchy also falls although total output rises. From Proposition Six, then, per member partnership payoff rises relative to the hierarchy. ||

A vertical shift in the cost function has no effect on incentive conditions in a partnership since these conditions are determined solely by the marginal conditions. Thus a fall in the fixed cost of providing effort provides a direct gain to the partners. On the other hand, in the hierarchy, while the incentive effects are accounted for by the principal, any gain in costs must be shared with the principal, the gains are diluted.

Characterizing precise sufficient conditions under which a partnership dominates the hierarchy requires putting yet more structure on the model. However, it is clear from the diagrams that general technology structures exist in which the partnership arrangement dominates. This domination is more likely the lower is the fixed cost of providing the effort required for the enterprise.

The next result analyzes the effects of changes in the marginal cost on the choice of organizational structure.

Proposition Eight: Let the cost function be $V(a) = v + ba^2$ and suppose that at the current parameters, the optimal hierarchy generates the same per member profits as the optimal partnership. A rise in b leads to lower per member profits in the partnership relative to the hierarchy.

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Proof: The proof is a simple application of comparative statics analysis on the systems (8), (9) and (12), (14) and is provided in the appendix. ||

Proposition Eight is readily understandable. The steeper the marginal cost curve the greater the incentive at any given action level for an agent to cheat in a partnership and therefore, the lower the sustainable effort level. Combined with Proposition Six, it is clear that the bias shifts in favour of a hierarchy when marginal costs are high.

Propositions Seven and Eight suggest that learning might have an effect on the optimality of a given organizational structure. If either the fixed or the marginal cost of providing effort falls with practice, then the advantages offered by a monitor are reduced and the members of the organization might be better served in a partnership.

We can also use this analysis to examine the effects of changes in production conditions. Suppose that $f(.)$ satisfies A4'). Increases in the efficiency of production can be parametrized by changes in d. This might be interpreted as decreasing the non-concavity of f. Alternatively, a rise in d represents a rise in the minimum scale of production required to generate output. As d becomes smaller, the tendency is to move toward fewer agents in either type of syndicate. One would expect that the smaller the optimal syndicate, the more attractive the partnership. Proposition Nine confirms this intuition.

Proposition Nine: Let the cost function be $V(a) = v + ba^2$ and the production function be $f(y) = h(y-d)$ for all $y \geq d > 0$ and suppose that at the current parameters, the optimal hierarchy generates the same per member profits as

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the optimal partnership. A fall in d leads to higher per member profits in the partnership relative to the hierarchy.

Proof: This is shown again simply by differentiating the conditions characterizing the optimal solutions under the two regimes and seeing that $da_p/dd = -((2b-h''/n_p)/(2b-h'')) < -1/n_h = da_h/dd$. The inequality can be shown using the fact that $n_p < n_h$. The algebra is provided in the Appendix.||

The move of the Arthur Anderson consultants to form a new partnership may be explained in this context. The company had used consultants initially as an adjunct to its main accounting service. Recently, though, the demand for consulting services has risen dramatically. The company expected the consulting part of the firm to make up more than fifty percent of the firm's revenues by 1993. The increased productivity of consulting meant that the service no longer needed to be offered as part of an overall package including accounting services. The production function shifted leftward providing an inducement for the consulting partners to break away and form their own, smaller firm.

Section IV: Conclusion

There are, of course, other explanations for the persistence of partnerships -- favourable tax laws, agency problems concerning the principal, or uncertainty in the production function all might explain the choice of a partnership. The intuition that this paper draws on instead is that even if the actual process of monitoring is costless in that it does not use up real resources, a partnership may still be optimal if, by introducing a principal, an additional claim on the net surplus of the

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enterprise is created. The principal's claim on a share of the surplus may induce the agents to accept the costs of shirking. As learning reduces either the fixed costs or the marginal costs of the unobservable activity, this preference can be reinforced and might lead other hierarchical organizations to break up and reform as partnerships.

There are three directions in which this research might be extended. The paper can be interpreted as an attempt to understand the value of information in a non-competitive environment. When is it worthwhile for agents to invest some of their resources in an additional activity -- that of monitoring. As such, it would be fruitful to consider models in which monitoring uses up real resources as well -- a plausible assumption would be that the more agents, the higher the cost of monitoring.[5] Balancing off the advantages of more productive members of a syndicate would be the additional costs of policing them. Second, it would be interesting to see what insights this framework provides for the recent phenomena of management-based leveraged buy-outs. The management sponsored LBOs can be seen as a change in organizational structure away from a hierarchy towards a partnership. In such environments, however, there exists well defined property rights over the production process in the form of share ownership. Any reforming of the organization of such syndicates would typically have to involve compensating members who may no longer be needed. Such a model would have to be much more sophisticated, strategically, than the structure in this paper where agents can drop out of one syndicate and re-form in another costlessly. A third and connected direction would be to imbed this model in a market structure. It

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[5] In Benopoulos (1991) the principal pays a fixed cost, γ, for a monitoring technology which allows the monitor to observe perfectly the performance of any agent with probability $1/n$.

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is really of more interest to see how this behaviour will be modified if the output of the enterprise is sold on a market. The production function, $f(.)$, will in general depend on the conditions of the market. Whether or not a group of agents decide to break away and form a new organization will typically depend on their perception of the effects this action will have on the market. Before these more sophisticated extensions can be examined, however, an understanding of the underlying incentives in organizational structure is needed. It is this gap which the paper has attempted to fill.

Appendix One

Proof of Proposition Eight: Start from a position in which the optimal hierarchy and the optimal partnership generate the same per member profit. From Proposition Six, this means that the action levels are the same, $a_h = a_p$. We now see how these levels change in response to a change in b by totally differentiating the systems (8),(9) and (11),(13) which characterize the optimal solutions.

Partnership: (8) and (9) yield

$$2ba\ dn + 2na\ db + 2nb\ da - f''(na)\ (nda+adn) = 0$$

or $2na + (2nb-f''n)\ a' = (f''a-2ba)\ n'$ (8')

$$2ba^2\ dn + 2na^2\ db + 4nba\ da - f'(na)(nda + a\ dn\ ) = 0$$

Using $f'(na) = 2ba$ yields after manipulation

$$na + nb(2-n)\ a' = ab(n-1)\ n'$$ (9')

Combining to eliminate n' yields

$$da/db = -a/b + (2a(n-1)/(f''-2b)) < -a/b.$$ (A1)

Hierarchy: (13) and (15) yield

$$ba^2(2n-1) - v - f((n-1)a) = 0$$

or $a^2(2n-1)\ db + 2ba^2\ dn + 2ba(2n-1)\ da - f'\ ((n-1)da + adn) = 0$ and using (17) gives

$$a^2(2n-1) + 2ba((2n-1) - (n-1))\ a' = 0$$

$$a^2(2n-1) = -2bna\ a'\ \text{or}\ a' = -a(2-1/n)/2b > -a/b.$$ (A2)

(A1) and (A2) show that as b rises the optimal action level in both the partnership and the hierarchy falls. However, a_p falls faster than a_h. Again using Proposition Six, this implies that the bias works in favour of the hierarchy.

Proof of Proposition Nine: Rewriting (9) yields

$2bna^2 - h(na - d).$

Differentiating and using (8) gives

$2b(a^2dn + 2nada) - 2bna(adn + nda - dd)$

$(2na - n^2a)da - (n-1)a^2dn - nadd$

$$n(2 - n)da + ndd - (n-1)adn \tag{A3}$$

Differentiating (8) gives

$$dn - -n/a \ da - h'' \ dd \ /(2b - h'') \tag{A4}$$

Combining (A3) and (A4) results in

$$da/dd - -\{(2b-h''/n)/(2b-h'')\} < 0 \tag{A5}$$

A fall in d leads to a rise in a_p and a fall in n_p as we would expect.

Now, operating on (15) gives

$b(2a(2n-1)da + 2a^2dn) - h' ((n-1)da + adn - dd).$

Using (13) and eliminating b, $2ba^2dn$ and a gives

$2(2n-1)da - 2(n-1) \ da - -2dd$

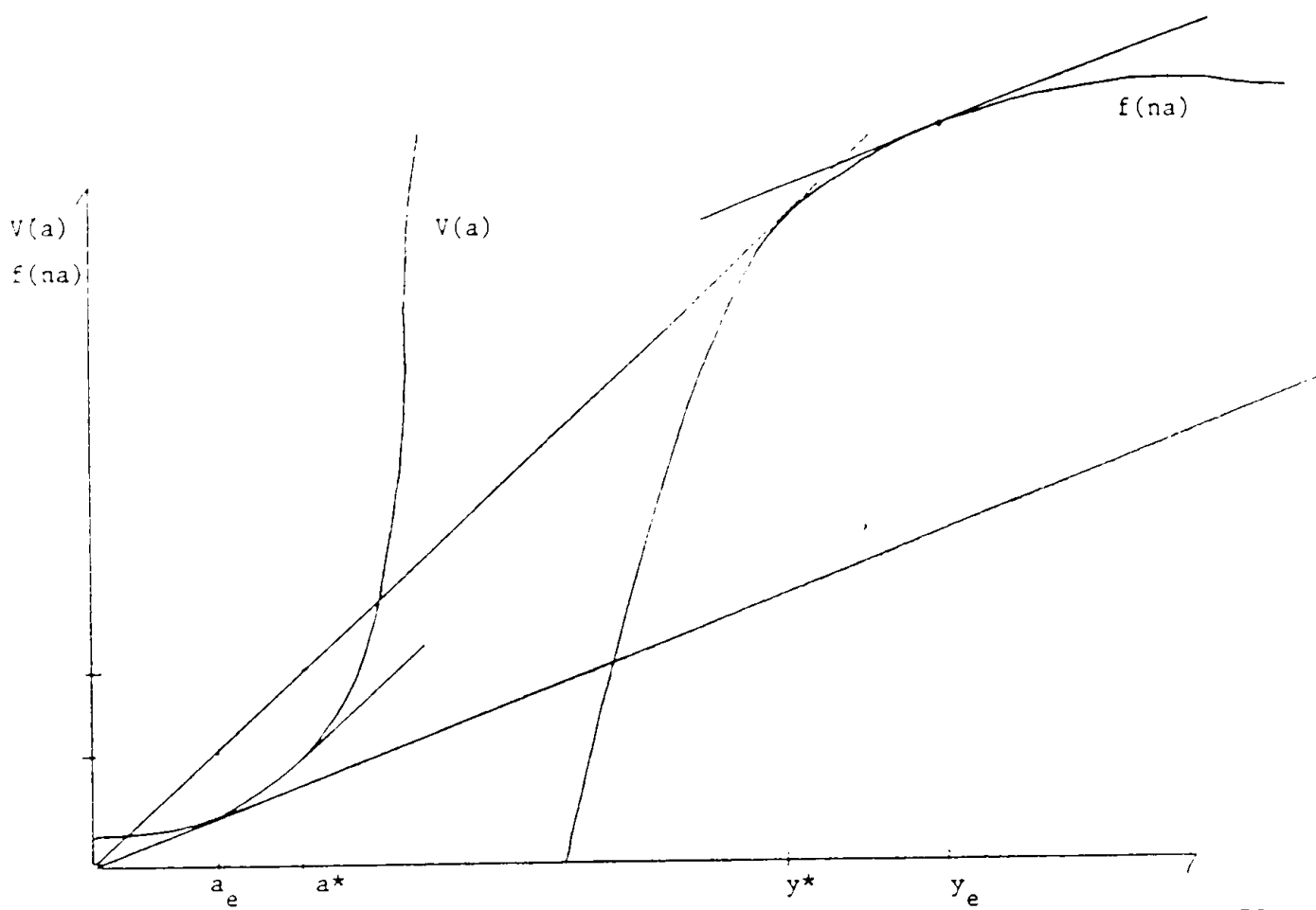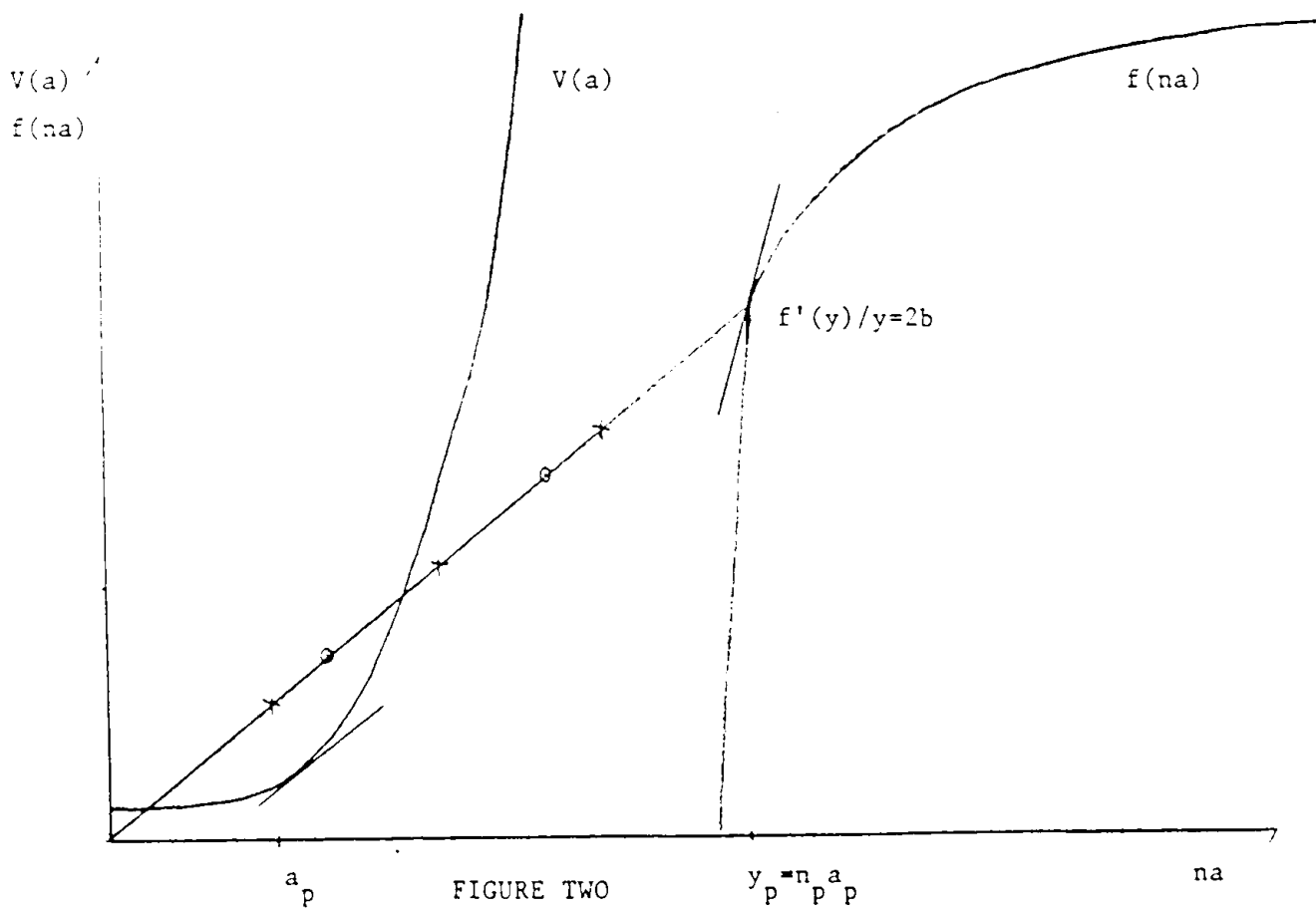or $nda - -dd, \quad da_h/dd - - 1/n_h.$ $\tag{A6}$

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FIGURE ONE

FIGURE TWO
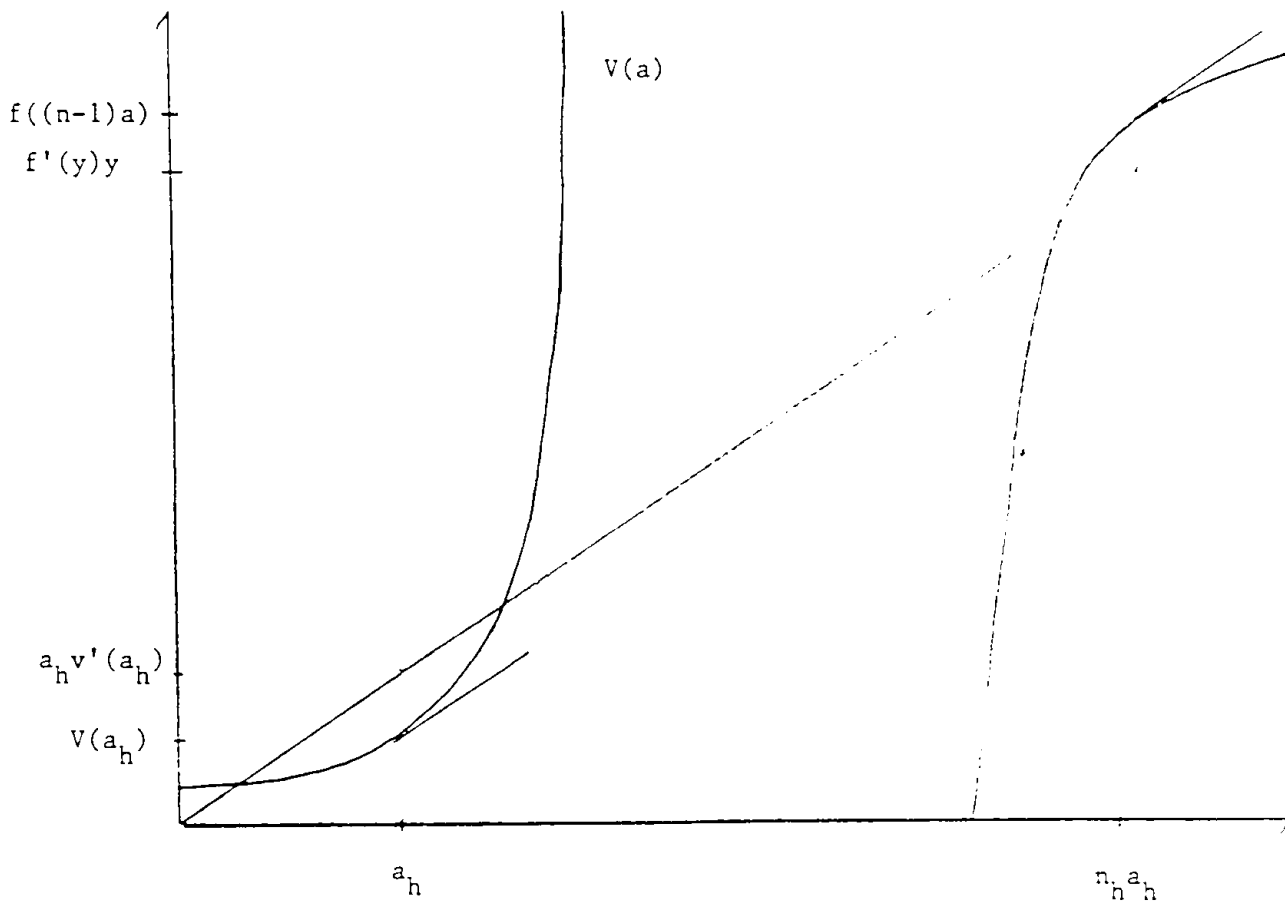
FIGURE THREE

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