December, 2006

Anti-Sharing as a Theory of Partnerships and Firms

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December 24, 2006

Abstract

Anti-Sharing may improve the efficiency of teams. The Anti-Sharer collects a fixed payment from all team members; he receives the actual output and pays out its value to them. However, if a team members assumes the role of an "internal" Anti-Sharer, he will be unproductive in equilibrium. Hence, internal Anti-Sharing fails to yield the first-best outcome. External Anti-Sharing may induce the team members to choose efficient effort. The paper presents possible applications of Anti-Sharing: while internal Anti-Sharing may provide an explanation for the existence of senior (or managing) partners, external Anti-Sharing leads to a new theory of the incorporated firm.

JEL-Code: *D 23, L 23, C 72*

Keywords: Budget-breaker, corporate law, constrained efficiency.

1 Introduction

The members of a partnership or firm form a team and contribute to a joint product. A theory of partnerships or firms must explain how the organization motivates its members to contribute non-verifiable inputs. An obvious solution gives each member a share of the joint product. A sharing contract is called "budget-balanced" when the sum of the payments to members equals the joint product. It is, however, well established that budget-balanced sharing contracts do not motivate risk-neutral team members to choose efficient effort.[1] An actor has incentives to supply an efficient level of non-verifiable inputs when he

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[1] See the general proof in Holmstrom (1982). The inefficiency of relative performance evaluation in teams was demonstrated by Choi (1993). For risk-averse teams, Rasmusen (1987) has shown that sharing contracts may implement first-best effort. Strausz (1999) has proposed an efficient sharing rule for sequential teams. However, an optimal contract for teams of risk-neutral agents who choose their non-verifiable effort simultaneously has not yet been derived.

internalizes all of the joint output. Internalizing the joint output requires him to receive 100 % (and not just a fraction) of it. If the parties agree upon a budget-balanced sharing contract, however, each one receives only a fraction of the output, so each one has imperfect incentives.

"Anti-Sharing" is an attempt to solve this sharing problem. Under an Anti-Sharing contract, the team members have to make a fixed payment to the Anti-Sharer who, in turn, is obligated to pay the full team output to each member who, thereby, internalize the joint product. All team members except for the Anti-Sharer are, thus, residual claimants and have stronger incentives to spend effort than under a sharing contract. Corporate executive, partners, fiduciaries, lawyers, employees, and suppliers often contract for a combination of fixed and variable payments in which the sum of the marginal payments to actors exceed their joint marginal product. Bonuses, commissions, prizes, and collateralized finance may produce such results.

We investigate a fundamental problem of Anti-Sharing contracts that concerns the difference between active and passive members of an organization, because the role of the Anti-Sharer may be played by an outsider or by one of the team-members. In some circumstances, an outsider who does not contribute to the teams joint product can play the role of the Anti-Sharer. In these circumstances, the Anti-Sharers only task is to organize a contract among the actors who contribute to the joint product. Since the Anti-Sharer does not supply inputs to the joint product, the Anti-Insurer needs no incentives to produce. An external Anti-Sharer is usually a financier, principal, managing partner, administrator, or factor who does not participate in production. External Anti-Sharing can induce first-best efforts. This type of contract is closely related to "bonding"[2] and to"Anti-Insurance for gains" in Cooter/Porat (2002).[3] However, the Cooter/Porat model deals with risk, while Anti-Sharing does not exclude deterministic choice situations.

Sometimes, only an active member of the production team can organize an Anti-Sharing contract. This situation may occur when outsiders cannot observe the teams total payoff. However, a problem arises with regard to the Anti-Sharer's input to the joint product: the Anti-Sharer contracts to pay the full output to all the other team members. Hence, after the contract is signed, the Anti-Sharer has no incentive to increase production. To the contrary, he may even have every incentive to undermine it.

In a heterogeneous team, it makes sense to assign the role of an internal Anti-Sharer to the team member with the lowest productivity, or with the highest opportunity costs of providing productive effort. Therefore, internal Anti-Sharing may explain the division of labor in partnerships. Partnerships often consist of productive partners (who generate the output) and non-productive (senior, or managing) partners, who do not actively contribute to the output

[2]See Holmstrom (1982, 328). It differs, however, from outside enforcement of non-balanced sharing.

[3]See their examples 7 and 8 on the collaboration of several attorneys or the attorney-client relationship.

of the team. In some industries, the senior partners specialize in organizing the business and their ability diminishes to work on its projects. In others, the senior partner is concerned with so many different cases simultaneously that his opportunity costs of contributing productive effort to one single case would be too high, compared to the associate who is dealing with just one case. A partner who specializing in organizing others faces high opportunity costs when participating in their projects.

Internal Anti-Sharing, therefore, is a theory of the firm in the spirit of Alchian/Demsetz (1972). In their theory, one team member becomes residual claimant and (perfectly) monitors the others to solve the sharing problem. Under an Anti-Sharing contract, a team member assumes a special role, but fulfilling it does not require monitoring abilities. Moreover, the resulting hierarchy is not based on formal authority or command rights.

External Anti-Sharing avoids the inefficiency caused by internal Anti-Sharing. For the team output, it is irrelevant that an outsider who is unproductive anyway does not have an incentive to contribute effort after he is appointed Anti-Sharer. On the other hand, it is important for the Anti-Sharer to have enforceable rights against the team members. This is a prerequisite for avoiding renegotiation.

When serving as external Anti-Sharer, the outsider may face other opportunity cost. Hence, the cheapest way for a team of n members to appoint an additional player is to create a legal entity. A corporation faces no opportunity costs, and no productivity is lost when it serves as Anti-Sharer, but it is endowed with enforceable rights against its owners (which distinguishes it from non-incorporated firms). To view the corporation as an external Anti-Sharer which is created by the team members themselves may provide a micro-economic foundation for the "team production theory of corporate law" as it was outlined in Blair/Stout (1999) and Blair (2001).

We set up a simple model with homogeneous agents in section 2 and briefly review Holmstrom's inefficiency result on Sharing. Then we introduce internal Anti-Sharing and demonstrate, as the internal Anti-Sharer remains unproductive in equilibrium, first-best efforts will not be reached. However, the team profit can be higher than under a sharing contract. Section 3 derives the efficient result under external Anti-Sharing, while section 4 presents conclusions.

2 The model

2.1 Inefficiency of the Sharing Contract

Consider n risk-neutral agents who spend effort $e_i \geq 0, i = 1..n$ to produce an output $Y(e)$, where $e = (e_1..e_n)$ represents the effort vector of all n players.[4] The

[4] Let $e_{(-i)}$ denote the effort vector of all n players except player i, i.e., $(e_1..e_{i-1}, e_{i+1}..e_n)$. Consequently, $e_{(-i,-j)}$ is the effort vector without the contributions of players i and j. For convenience, we write $e = (e_{(-i)}, e_i) = (e_{(-i,-j)}, e_i, e_j)$.

production function $Y(e)$ is twice differentiable, continuous, with positive but diminishing marginal returns, and with non-negative cross-partials. Individual efforts are assumed to be non-verifiable. We denote the effort disutility of agent i as $C(e_i)$ and assume $C_1 > 0 < C_{11}$ as well as $C(0) = 0$ and $C_1(0) = 0$.[5] Players' utility functions are separable in wealth and effort cost. To keep the model simple, we assume the agents to be homogeneous, i.e., they are identical with regard to effort costs, utility functions, and marginal productivity. Moreover, for all agents the second derivatives and the cross-partials of the production function are assumed to be identical.

The socially optimal effort vector e^* maximizes the team profit $T(e) = Y(e) - \sum_{i=1}^{n} C(e_i)$ and, thus, satisfies the first order conditions[6]

$$Y_i(e^*_{(-i)}, e_i) - C_1(e_i) = 0, i = 1..n. \tag{1}$$

As Holmstrom (1982) has demonstrated, a budget-balanced "Sharing" contract does not induce the players to choose e_i^*. Sharing is budget balanced if the players' shares $s_i \geq 0$ add up to 1. Under such a contract, at least one player receives a share smaller than one. The incentives are, thus, insufficient at least for some players even if all other players choose efficiently. Let e_i^S denote player i's equilibrium effort under the symmetric sharing contract with equal shares, i.e., $s_i = 1/n$. Each player $i = 1..n$ maximizes his individual payoff $Y(e^S_{(-i)}, e_i)/n - C(e_i)$, and the first-order condition for an internal solution is $Y_i(e^S_{(-i)}, e_i) = nC_1(e_i), i = 1..n$.

The individual payoff in equilibrium amounts to $Y(e^S)/n - C(e_i^S)$. Hence, for $n > 1$ the equilibrium efforts are suboptimal. Sharing not only induces each of the agents to choose lower than efficient effort, this also reduces the marginal productivity of each agent if cross-partials of the production function are positive, which further reduces the agents' motivation.

2.2 Internal Anti-Sharing

Without loss of generality, we assign the role of the internal Anti-Sharer to the 1st team member. Each of the other agents $i = 2..n$ promises to pay an amount $p_i \geq 0$ to him. All players choose their effort, denoted as e_i^{AS}. The actual output is produced $Y(e^{AS})$ and transferred to the Anti-Sharer. He pays out its value to each of the other team members, net of p_i. The Nash equilibrium analysis starts with player 1.

Proposition 1: *In equilibrium the internal Anti-Sharer chooses zero effort.*

[5] With regard to functions (in capital letters), the index i denotes the first derivative with respect to the ith argument, while an index ij denotes a second derivative with respect to the ith and j^{th} argument. With regard to variables (lower case letters), an index i denotes the ith player. Subsequently, we use the superscript S to indicate the sharing contract, while AS refers to internal Anti-Sharing.

[6] We assume the second-order conditions for a finite maximum to be satisfied, hence the Hessian to be negative definite, which requires the cross partials to be not too great. This implies the second-order conditions for the individual players' maximization problems under Sharing and Anti-Sharing to hold as well.

Proof: The Anti-Sharer receives the lump sum payments p_i from the other players as well as the actual output; he has to pay out $(n-1)$ times the value of the actual output; and he bears his own effort costs. Thus, he chooses

$e_1^{AS} = \arg\max \left[\sum_{i=2}^{n} p_i + Y(e_1, e_{(-1)}^{AS}) - (n-1)Y(e_1, e_{(-1)}^{AS}) - C(e_1)\right]$.

The first derivative with respect to e_1 is $(2-n) \cdot Y_1(e_1, e_{(-1)}^{AS}) - C_1(e_1)$.

As $n \geq 2$, this expression is negative, hence $e_1^{AS} = 0$. □

The intuition behind this result is the distortion of the Anti-Sharer's incentives to spend effort. He receives the actual output once, but has to pay its value $(n-1)$ times to the other team members. For $n \geq 2$, his individual marginal profit from spending effort is negative.

We denote as $\hat{e}_{(-1)}$ the *"constrained efficient"* efforts of players $i = 2..n$ which maximize the team profit under the constraint $e_1 = 0$, i.e., $\hat{e}_{-1} = \arg\max \left[Y(0, e_{(-1)}) - \sum_{i=2}^{n} C(e_i)\right]$, and derive our second result.

Proposition 2: *Under an internal Anti-Sharing contract, a Nash equilibrium exists in which players $i = 2..n$ choose constrained efficient efforts $\hat{e}_i$.*

Proof: Under the condition $e_1 = 0$, the first-order conditions for constrained efficient efforts are $Y_i(e_{0,(-1,-i)}, e_i) = C_1(e_i), i = 2..n$. Anticipating $e_1 = 0$, each of the team members $i = 2..n$ chooses $e_i^{AS} = \arg\max \left[Y(0, e_{(-1,-i)}^{AS}, e_i) - C(e_i) - p_i\right]$. As p_i is independent of e_i, the first-order conditions are identical to those for constrained efficient effort. □

An arbitrage argument allows us to derive the side payments p_i endogenously. If the Anti-Sharer's payoff is greater, each team member wants to become Anti-Sharer, if is is lower, then no one assumes this role. Hence $(2-n)Y^{AS} + (n-1)p_i = Y^{AS} - p_i - C(e_i^{AS})$, where $Y^{AS} = Y(0, e_{(-1)}^{AS}) = Y(\hat{e})$. This implies $p_i = (n-1)[Y(\hat{e}) - C(\hat{e}_i)]/n$. In this arbitrage-free equilibrium, each team member $i = 1..n$ earns $[Y(\hat{e}) - (n-1)c(\hat{e}_n)]/n$.

In an asymmetric case, the least productive partner should become internal Anti-Sharer. The productivity of team member i, however, is not only to be measured by his own marginal productivity, but also by his impact on the other players via the cross-partials.

2.3 Comparison of Sharing and internal Anti-Sharing

Anti-Sharing Pareto-dominates Sharing if it yields a greater team profit $T(e) = Y(e) - \sum c(e_i)$, because side-payments are allowed. In Kirstein/Cooter (2006) we explore this comparison formally. Here, we just present the main result:

Proposition 3: *Anti-Sharing is more likely to be the superior contract, the greater n, Y_{ii}, or C_1, and the smaller Y_1, Y_{ij}, or C_{11}.*

The intuition behind the results regarding n and T_{ij} can easily be understood

by comparing the conditions for individual rationality:

- the inefficiency of the Sharing contract is caused by the fact that all members of the team face an incentive to spend inefficient low effort. The Sharing problem increases with a greater n.
- The inefficiency of Anti-Sharing is due to the lack of player 1's contribution, but this problem becomes less relevant the greater the team. On the other hand, a higher cross-partial of the production function may increase the inefficiency of Anti-Sharing.

Look at the extreme case of a Cobb-Douglas or Leontief production function: the best reply of all players i to $e_1 = 0$ would be $e_i^{AS}(0) = 0$. Hence, complete substitution of the inputs is a necessary condition (albeit not sufficient) for Anti-Sharing to yield a higher team profit than Sharing.

3 First-best: external Anti-Sharing

The derived inefficiency of internal Anti-Sharing can be avoided if an external person assumes this role. The external Anti-Sharer is, thus, introduced as a player $(n+1)$. We assume the market for external Anti-Sharers to be competitive, thus they work without profit. However, this assumption has no influence on the efficiency result of this contract. We demonstrate that a Nash equilibrium exists in which the players choose first-best effort.

The contract between the team members and the external zero-profit Anti-Sharer each of the n team members to make a fixed payment $\frac{n-1}{n}Y(E^*)$ to the Anti-Sharer. The team members choose their effort, actual output is produced and transferred to the Anti-Sharer. The latter is obliged to pay the value of the actual output to each of the team members.

Let us denote the actual effort of player i as e_i^X, where X indicates external Anti-Sharing. Hence, $e_i^X = e_i^*$ is to be proven.[7]

Proposition 4: *If an external, zero-profit Anti-Sharer offers the above contract to the n team-members, then it is a Nash equilibrium when all players $i = 1..n$ choose the efficient effort e_i^*. If the team members choose efficient effort, then the external Anti-Sharer yields zero-profit.*

Proof: Each team member chooses his actual effort $e_i^X = \arg\max Y(e_{(-i)}^X, e_i) - C(e_i) - \frac{n-1}{n}Y^*$. The first-order condition for e_i^X thus is

$$\frac{\partial Y(e_{(-i)}^X, e_i)}{\partial e_i} = \frac{dc_i(e_i)}{de_i} \ \forall\ i = 1..n \tag{2}$$

which is identical to equation (1), the condition for first-best effort. Thus, we have established that it is a Nash-equilibrium for all team members to choose

[7] A parallel result has been demonstrated in Cooter/Porat (2002), see section V, "Anti-Insurance for Gains".

first best effort under this mechanism. It is individually rational to choose the efficient effort if all other team-members do the same. To prove part b) of proposition 1, we calculate the Anti-Sharer's equilibrium payoff. He collects $(n-1)Y^* + Y(e^X)$ and pays out $nY(e^X)$. His payoff amounts to $(n-1)[Y^* - Y(e^X)]$, which is zero if $e^X = e^*$. $\square$

The mechanism is not budget-balanced should the team members fail choose first-best efforts. Holmstrom (1982) points out that an unbalanced Sharing contract imposes a credibility problem: the parties would be motivated to spend efficient effort if they were credibly committed to throw away some part of the output in case of inefficient output, but they anticipate that they would not do so. The existence of an Anti-Sharer avoids this credibility problem, as he may claim the agents' payments and only has to pay out their actual achievement. If the parties choose less than the efficient effort, then the Anti-Sharer's collects a positive payoff.

It is the introduction of an outside enforcer which protects external Anti-Sharing from renegotiation among the n team members. However, it may still be vulnerable to renegotiation between the Anti-Sharer and just one team member. This criticism has been brought forward by Eswaran/Kotwal (1984) with regard to the outside enforcement of an all-or-nothing contract as proposed in Holmstrom (1982). In that model, the outside enforcer has a very strong incentive to close a tacit agreement with one of the team members. If this team member chooses less than efficient effort, the external enforcer receives the whole profit.

In our model, the incentive for the external Anti-Sharer is much smaller. If he tacitly induces, e.g., team member n to choose $e'_n < e^*_n$, then the Anti-Sharer captures $(n-1)[Y(e^*) - Y(e^*_{(-n)}, e'_n)]$ (if the other team members anticipate this, they would be induced to choose less than e^*_i which further decreases the Anti-Sharer's extra payoff). From this small cheating rent, he still had to deduct the side-payment to player n. This player needs at least $Y(e^*) - Y(e^*_{(-n)}, e'_n) + c(e'_n) - c(e^*_n)$ to be fully compensated. Hence, the profit margin of the external Anti-Sharer is very small, and may not justify the risk of detection.[8]

In the external Anti-Sharing equilibrium, individual rationality keeps the team-members form investing more than the efficient effort, since they had to bear the additional effort costs. Thus, the Anti-Sharer would never face the problem of having to pay out more than he collects. The only weakness of this mechanism is that the efficient equilibrium is not necessarily unique. If some team players expect their colleagues to spend less than efficient effort, it is individually rational to spend lower effort as well (due to the positive cross-partial), which would make the expectation self-confirming.

The mechanism implements first-best efforts since each team member calculates with the total actual output $Y(e^X)$ - and not with just a share of it - in his individual yield function. Therefore, the total marginal return of his effort is

[8] If the Anti-Sharer is burdened with a small penalty , should the team output be smaller than expected, then this problem may already be solved.

internalized. Of course, the actual effort can be distributed only once, but the difference between $nY(e^X)$ (what the n team members receive) and Y^X (what is actually distributed among them) is covered by their fixed payments. These payments are fixed, since they are independent of their actually chosen effort.

However, from the viewpoint of institutional economics this approach is not satisfying. It leaves the question unanswered where the player $(n+1)$ comes from. If he does not appear out of the blue, but has already been present in society before the team chooses to employ the mechanism under scrutiny, then the question arises what this agent has been doing before. If this was a productive activity, then being employed by the team may keep him from pursuing this alternative activity. Hence, even an external Anti-Sharer might not be able to operate without opportunity cost.

4 Conclusion

We have demonstrated that internal Anti-Sharing can make a team better off, compared to the symmetric sharing contract. However, as the internal Anti-Sharer has no incentive to contribute positive effort, this contract also fails to achieve the first-best solution; it might even be worse than Sharing. The convexity of iso-team-profit curves as well as the team size are the decisive factors for the question which contract makes the team better off.

We have argued in the introduction that internal Anti-Sharing may serve as a theory of a partnership in which active and non-active partners are present. The model demonstrates that it can bell we justified for efficiency reasons if a partner receives a share of the output even though he does not contribute to the team output (directly). His contribution to the team's success is to fulfill the role of the internal Anti-Sharer, which motivates the other partners to spend (constrained) efficient effort.

External Anti-Sharing avoids the inefficiency that comes with internal Anti-Sharing. Hence, a first-best equilibrium exists. This is the basis for a new theory of the incorporated firm, in which a legal entity is established by n team members to play the role of an external Anti-Sharer for them. To do so, a corporation needs to have the ability to enforce claims against its members. Hence, its assets need to be shielded against its founders. After the corporation is established, its fiduciary has to be an agent of the firm, not of the individual shareholders.

A concise theory of the team is yet to be written. Our analysis is limited to external Anti-Sharing on the one hand, and the comparison of Sharing with internal Anti-Sharing on the other. This allows already to derive inspiring conclusions for corporate law.

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