**January 4, 2003 10:15 a.m. AEA Session: Lessons from Enron**

# Accounting in Partnerships[†]

by

Steven Huddart
*Smeal College of Business Administration*
*Pennsylvania State University*
*University Park PA 16803-1912, USA*

and

Pierre Jinghong Liang
*Graduate School of Industrial Administration*
*Carnegie-Mellon University*
*Pittsburgh PA 15213-3890 USA*

this draft: January 9, 2003

[†] Send correspondence to:

Steven Huddart
216 Beam Smeal College of Business Administration
Pennsylvania State University
Box 1912
University Park, PA 16802-1912

telephone: 814 865–3271
facsimile: 814 863–8393

e-mail: huddart@psu.edu
web: www.smeal.psu.edu/faculty/huddart

Pierre Jinghong Liang
Room 362, Graduate School of Industrial Administration
Carnegie-Mellon University
Pittsburgh PA 15213-3890 USA

telephone: 412 268–3315
facsimile: 412 268–6837

e-mail: liangj@andrew.cmu.edu

# Accounting in Partnerships

*By* Steven Huddart and Pierre Jinghong Liang*

In 1914, an accounting professor named Arthur Andersen founded a public accounting practice that became the world's largest professional-services firm. For years preceding the Enron debacle and Andersen's collapse, the firm had struggled to create incentives within the organization for partners to provide high-quality service, develop and sell new services, and meet the compensation expectations of various factions of partners. A years-long dispute over the division of profits between the firm's consulting and accounting arms led to the 1998 separation of the consulting practice from the audit and tax practices. The rise, break-up and fall of Andersen underlines the importance of questions concerning incentive structures within public accounting firms in particular, and partnerships of professionals in general. This paper offers a perspective on partner compensation schemes and the accounting information systems that support them.

In partnerships, ownership and control lie with the partners. Furthermore, each member of a partnership is endowed with human capital that may be employed either within the firm or without. Every partner is simultaneously a principal (who shares in the net output of the partnership) and an agent (who produces output). Ownership and control are diffused among many persons, and partners are subject to moral hazard: Each

* Huddart: Smeal College of Business Administration, Pennsylvania State University, Box 1912, University Park, PA 16802-1912 (e-mail: huddart@psu.edu); Liang: Graduate School of Industrial Administration, Carnegie-Mellon University, Pittsburgh, PA 15213-3890 (e-mail: liangj@andrew.cmu.edu).
We thank Thomas Hemmer for helpful discussions.

must be motivated by his peers.

It is intuitive that the structure of professional partnerships is a function of the production and monitoring technologies available to the partners. As Oliver Williamson (1975, 43) points out: "Group affiliation ... can provide income guarantees to buffer the effects of unanticipated contingencies on terms superior to that which market insurance can provide ... A group will have an advantage over the market to the extent it is better able to ... check malingering and other ex post manifestations of moral hazard. [This advantage requires] ... that performance be accurately assessed."

Within Andersen Worldwide, for example, the profit sharing formula was designed to level partner compensation across units of the firm. When moral hazard is suspect, sharing invites undersupply of effort. Two avenues are open to reduce shirking. First, the size of the partnership can be reduced: the opportunity to free ride decreases in the number of partners in the firm, but opportunities to exploit synergies are forgone. Monitoring and associated incentive contracts are another way to combat shirking.

What factors determine the size and composition of partnerships? Our analysis focuses on one particular omnipresent size synergy, namely improved risk sharing. We consider sharing rules that are linear in the observable contracting variables under three information regimes. In the first-best case, perfect information about each partner's effort is contractible. Next, we consider the case where only firm output is contractible. In the final case, we assume that an accounting system provides noisy signals of partners' efforts.

In each case, the tension between the risk-sharing synergy and moral hazard determines firm size.

## I. The Model

Let $N = \{t_1, t_2, \ldots, t_n\}$ denote the set of individuals in a partnership. Each of the $n$ partners exerts effort to produce output. The partners then divide the output among themselves. Each individual $i$ is endowed with human capital and preferences parameterized by his type, $t_i = (k_i, \sigma_i, r_i)$. When partner $i$ exerts effort $p_i$, he incurs cost $k_i p_i^2/2$ and firm output is $x = \sum_{i \in N} p_i + \sigma_i \epsilon_i$. In this formulation, a partner's contribution to firm output does not depend on the effort choices of other partners, which considerably simplifies the analysis by making each partner's effort choice separable from the effort choices of the other partners. The $\epsilon_i$ are mutually independent and normally distributed random variables with mean zero and unit variance realized after contracting and effort choices have been made. Partner $i$'s preferences over end-of-period wealth are described by a von Neumann-Morgenstern utility function with constant absolute risk aversion, $u_i(Z) = -\exp(-r_i Z)$. In addition to firm output $x$, partners' compensations may also be based on a set of $n$ signals that are informative of individual effort. Each signal is $s_i = p_i + \phi_i \xi_i$. Like the $\epsilon_i$ variables, the $\xi_i$ variables are normally distributed random variables with mean zero and unit variance and are mutually independent of each other and the $\epsilon_i$ variables.

Define a partnership sharing rule for a set of individuals, $N$, as $(\alpha, \beta, \gamma, p)$ where $\alpha$ is an $n \times n$ matrix whose $ij$th element is the piece rate applicable to signal $s_i$ in determining partner $j$'s draw, $\beta$ is an $n$-vector whose $i$th element is partner $i$'s share of the output of the firm, $p$ is an $n$-vector whose $i$th element is the productive effort exerted by partner $i$, and, $\gamma$ is an $n$-vector whose $i$th element is a side payment to partner $i$.

The rule specifies how the members of $N$ divide the output. The parties to the contract are the partners. Because individuals have constant absolute risk aversion and all random variables are normally distributed, it is convenient to express payoffs in terms of certainty equivalents. In certainty equivalent terms, partner $i$ receives

$$Z_i(\alpha, \beta, \gamma, p) = \sum_{j \in N} \left( (\alpha_{ji} + \beta_i) p_j - \frac{r_i}{2} \left( \alpha_{ji}^2 \phi_j^2 + \beta_i^2 \sigma_j^2 \right) \right) + \gamma_i - \frac{k_i p_i^2}{2}. \tag{1}$$

At the start of the game, the members of $N$ commit to a contract $(\alpha, \beta, \gamma)$. Signals and outcomes are observed after effort has been chosen. Partners can commit to make payments according to the agreement, but moral hazard exists for production effort, $p_i$. Once a particular sharing rule is adopted, each partner acts selfishly to maximize his utility given the stated sharing rule. Pareto optimal sharing rules maximize the sum of the certainty equivalents of the partners, or the joint surplus. Because the consumption good is transferable, the problem of maximizing output separates from the problem of distributing the surplus among the partners. That is, the transfers $\gamma$ distribute the joint surplus among the partners, but do not affect the amount of surplus.

The partnership agreement must satisfy four constraints:

(a) Incentive Compatibility: Given the sharing rule, each partner weakly prefers to obey his production instructions to any other course of action.

(b) Budget Balancing: The sum of the side payments is zero, and partners bear all the risks and benefits of the technology they control.

(c) Indefectibility: No partner or group of partners has an incentive to defect from the partnership.

(d) Participation: Each partner expects to earn at least his reservation utility from participation in the partnership.

An individual's reservation utility in (d) must be at least the utility he would derive from working independently in a sole proprietorship. If the individual could work as an employee of a corporation for a wage in excess of his risk-adjusted sole proprietorship income, then (d) and (c) do not coincide. When the reservation utility is exactly the utility from a sole proprietorship, then (c) subsumes (d). Henceforward, assume that (c) is sufficient for (d).

Holding aside constraint (c), the problem is to maximize the joint surplus among individuals in $N$.

$$\max_{\alpha,\beta,\gamma,p} \sum_{i\in N} Z_i(\alpha,\beta,\gamma,p) \quad \text{subject to}$$

$$p_i \in \arg\max_{\hat{p}_i} Z_i(\alpha,\beta,\gamma,p_{-i},\hat{p}_i) \qquad \forall \quad i \in N,$$

$$0 = \sum_{j\in N} \alpha_{ij} \quad \forall \quad i \in N, \quad 1 = \sum_{i\in N} \beta_i, \quad \text{and} \quad 0 = \sum_{i\in N} \gamma_i,$$

where where $p_{-i}$ denotes all the elements of $p$ except the $i$th. A partnership $N$ is indefectible if no proper subset of $N$ strictly prefers to leave the partnership to divide their surplus among themselves rather than share it with members of the larger set.

## II. First-best

In the first-best case, perfect signals $s_i = p_i$ of every individual's effort are available. The joint surplus is maximized by setting partner $i$'s draw at

$$s_i + \frac{R(N)}{r_i}\left(x - \sum_{j \in N} s_j\right) + \gamma_i,$$

where $R(N) = (\sum_{i \in N} 1/r_i)^{-1}$ is familiar from Robert Wilson's (1968) analysis of syndicates. This implies $\beta_i = R(N)/r_i$. Every partner's stake in the output of the firm is proportional to his risk tolerance, so the allocation of risk across the partners is efficient. The scheme also provides each partner with compensation, at the margin, equal to his marginal product. As in Richard Arnott and Joseph Stiglitz's (1991) analysis of moral hazard in nonmarket institutions, the first best effort level, $p_i^{FB} = 1/k_i$, is exerted by each partner. Thus, perfect accounting facilitates production efficiency and optimal risk sharing. In this setting, adding any individual, regardless of type, to an existing partnership improves risk sharing without imposing agency costs and thereby increases the joint surplus. Since the joint surplus increases, there exist transfers between the individual and the partnership that constitute a Pareto improvement. The same logic applies in merging

two formerly separate partnerships. It is also possible to show that if individual output, $p_i + \sigma\epsilon_i$ were observable, then it would always be attractive to increase the size of the firm.

## III. Only Aggregate Output Is Observable

Consider now the case in which no signals of individual effort are available. If the only observable is aggregate output, $x$, then the costs imposed by free riding grow as the number of partners increases. Without an accounting system, risk sharing cannot be separated from the provision of incentives, which leads to inefficiency.

Ronald Gilson and Robert Mnookin (1985) analyze law partnerships as mechanisms that facilitate risk sharing among human capitalists. They identify shirking and "grabbing and leaving" as dysfunctional behaviors that sharing rules must overcome. Grabbing and leaving (i.e., the demand made by a partner for a larger share of profits accompanied by a threat to leave the firm) is quite similar to the indefectibilty constraint. In our setting, no general comment seems possible on the indefectibility or optimal size of an arbitrary partnership. When aggregate output is the only observable, all players are identical (i.e., $t_i = (k, \sigma^2, r)$), and the technology is low risk (i.e., $kr\sigma^2 < 2$), then: (i) the joint surplus of a firm is $1/k - r\sigma^2/2 - 1/(2kn)$; (ii) there is an upper bound on the number of partners in an indefectible firm, $3/(2 - kr\sigma^2)$, and (iii) there is an optimal number of partners in a firm, one of the two whole numbers closest to $2/(2 - kr\sigma^2)$. The largest indefectible partnership is not necessarily the optimal partnership size. For instance, in the case $(k, \sigma^2, r) = (1, 3/2, 1)$,

the joint surpluses for partnerships of size 1 through 7 are, respectively, $-0.2500$, 0.0000, 0.0833, 0.1250, 0.1500, 0.1667, and 0.1786. Partnerships of size six and less are indefectible. When the number of potential partners is large in relation to the optimal firm size, the joint surplus over $n$ people is greatest when (almost) all individuals are members of partnerships of size four. In an industry like auditing of publicly-listed companies where the firms are very large in relation to the number of potential partners, partnership size may be driven more by indefectibility considerations than by considerations of optimal firm size.

Even with no hidden action, hidden information or risk aversion, splitting profit equally can limit the optimal size of partnerships. Joseph Farrell and Suzanne Scotchmer (1988) analyze a coalition-formation game in which potential partners with diverse abilities choose to form partnerships to exploit a size synergy. As partnership size increases, the basic tradeoff is between gains from the size synergy and reductions in the income of the most productive partners (given equal sharing) as less productive partners are added to the partnership. In our analysis, the most able individuals have a low-risk technology ($\sigma_i^2$ is small), a high risk tolerance, ($r$ is small), and high level of talent ($k_i$ is small). Less able partners have riskier technologies, higher risk-aversion, and lower talent levels. There are greater returns to the firm to motivating (with a higher ownership stake) a talented partner than an untalented one. Also, it is less costly to motivate a partner who is risk tolerant or who operates a low-risk technology. On the other hand, the surplus that must be allocated to such a partner to keep him from defecting must be higher.

One might suppose a partnership between able individuals would be indefectible while less able individuals would enjoy higher surplus from forming separate sole proprietorships than from forming a partnership, but this is not true in general. For instance, suppose $t_1 = (k_1, \sigma_1, r)$ and $t_2 = (k_2, \sigma_2, r)$. Then comparison on the surpluses from a partnership and two sole proprietorships imply that a two-person partnership is indefectible if and only if $k_1 k_2 r^2 (\sigma_1^2 + \sigma_2^2)^2 > 1$. That is, the more able the individuals, the less attractive partnership becomes.

## IV. Accounting Information

Assume now that an exogenously-specified accounting information system provides a vector of signals $s$ where $s_i$ is informative only of effort by partner $i$. One feature of the accounting information in partnerships deserves special mention. In the usual agency setting with a risk-neutral principal, the principal serves as the "sink" who costlessly bears the risk associated with any risky signal-contingent compensation. In partnerships, in contrast, imposing a risky incentive contract on one partner entails distributing the risk associated with that payment schedule across the other risk-averse partners of the firm. The risk imposed by signal-contingent contracts can be reduced either by making the signal more precise or by reducing the change in the payment associated with a change in the signal. Because $s_i$ says nothing about the effort of partner $j$ for $j \neq i$, risk sharing alone dictates the choice of $\alpha_{ji}$ for $j \neq i$. Therefore, $\alpha_{ji} = -\alpha_{jj} R(N_{-j})/r_i$.

Since the partners can always choose $\alpha = 0$, the accounting system can only help the partners to capture size synergies, so the size of indefectible partnerships is larger here than in the case where only aggregate output is observable. The first order conditions on the incentive compatibility constraints imply that $p_i^* = (\alpha_{ii} + \beta_i)/k_i$. Making this substitution and taking the first-order condition on the joint surplus with respect to the weight attached to a signal in the corresponding partner $i$'s compensation yields $\alpha_{ii}^* = (1 - \beta_i)\left(1 + k_i\phi_i^2\left(r_i + R(N_{-i})\right)\right)^{-1}$. It remains to maximize the joint surplus over $\beta$ given $p^*$ and $\alpha^*$, and subject to $\sum_{j \in N} \beta_j = 1$.

It follows that the characteristics of the accounting system determine the marginal share of each partner in the firm's output since the accounting information complements partners' stakes in firm output in inducing effort. The optimal choice of contract parameters $\alpha$ and $\beta$ requires four factors to be balanced: (i) the output attributable to the signal-contingent compensation, (ii) the risk imposed on the partner who is monitored, (iii) the risk imposed on the partners who serve as the sink, and (iv) each partner's cost of production. As $\phi_i^2$ becomes small, the signal $s_i$ is more precise. In the limit as $\phi_i^2$ tends to zero for all $i$, $\beta_i = R(N)/r_i$ and $\alpha_{ii} = 1 - R(N)/r_i$ exactly as was determined under the first best sharing rule. In the limit as $\phi_i^2$ tends to infinity, signal $s_i$ is uninformative and $\alpha_{ii} = 0$. If this is true of all signals, then the contract approaches the inefficient case without an accounting system.

# V. Conclusions

This paper considers the tradeoffs involved in combining units of "human capital" into partnerships. The need to share risk and create incentives to produce output governs the optimal size of partnerships. When perfect signals of effort are available, every partner's share of the firm's output is proportional to his risk tolerance irrespective of firm size and first-best effort is motivated by the signals. Since output is not incrementally useful in reducing moral hazard, optimal risk sharing dictates the allocation of output among the partners. When no information on effort is available, the assignment of profit shares must trade off risk sharing and motivational objectives. Accounting information systems that provide noisy signals of partner effort are an intermediate case. Noisy signals lead to contracts that mitigate moral hazard and share output risk more efficiently at the cost of introducing signal risk to be shared among the partners. Such contracts facilitate the construction of larger partnerships so that risks can be shared and other synergies exploited.

Measuring professional effort is difficult because judgements about quality are necessary and because effort is multi-faceted, including such elements as staff development, rain-making, and civic involvement. Producing and interpreting soft information about such effort so that it is made hard and contractible is critical to the formation of large partnerships. Likely, this measurement process is best accomplished by experts in the same professional field. In turn, this suggests that the accounting information system be

designed and operated by the partners themselves.

While the analysis in the preceding sections presumes the accounting information system is exogenous, the considerations in this section suggest that its design is an endogenous choice of the partners. Eugene Kandel and Edward Lazear's (1992) conclusion that mutual monitoring and peer pressure can affect effort but are likely to be effective only when profits are shared by a very small group. To the extent the benefits of operating the accounting system are a public good whose cost is privately incurred, there can be shirking in the supply of this monitoring effort in partnerships of size three or more. This constitutes a serious organizational constraint in larger partnerships. If shirking of the monitoring task implies noisy signals, then it is interesting to consider what partners have the most incentive to monitor and what contract parameters induce partners to monitor more. From inspection of partner $i$'s certainty equivalent in (1), partner $i$ bears at least as much risk from signal $s_i$ as any other partner, and so may be expected to desire precise signals of his productive effort; accordingly, a regime of self-reporting may be effective in measuring and rewarding productive effort. If self-reports are not feasible, concentrating the role of monitor (or sink) in subset of the partners would motivate those partners to monitor more intensely (and may produce more surplus) than when the role of sink is distributed across partners in proportion to their risk tolerances. These issues are explored in Huddart and Liang (2002).

# References

**Arnott, Richard and Stiglitz, Joseph.** "Moral Hazard and Nonmarket Institutions: Dysfunctional Crowding Out or Peer Monitoring?" *American Economic Review,* March 1991, 81(1), pp. 179–190.

**Farrell, Joseph and Scotchmer, Suzanne.** "Partnerships." *Quarterly Journal of Economics,* May 1988, 103(2), pp. 279–297.

**Gilson, Ronald J. and Robert H. Mnookin.** "Sharing Among the Human Capitalists: An Economic Inquiry into the Corporate Law Firm and How Partners Split Profits." *Stanford Law Review,* January 1985, 37, pp. 313–392.

**Huddart, Steven and Liang, Pierre Jinghong.** "Profit Sharing and Monitoring in Partnerships." Mimeo, Pennsylvania State University, 2002.

**Kandel, Eugene and Lazear, Edward.** "Peer Pressure in Partnerships." *Journal of Political Economy* August 1992, 100 (4), 801–817.

**Williamson, Oliver E.** *Markets and Hierarchies: Analysis and Antitrust Implications.* New York: The Free Press, 1975.

**Wilson, Robert.** "The Theory of Syndicates." *Econometrica,* January 1968, 36(1), pp. 119–132.