Information, Incentives, and the Design of Efficient Institutions

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"And Only the Master shall praise us, and only
the Master shall blame,
And no one shall work for money, and no one
shall work for fame,
But each for the joy of the working, and each,
in his separate star,
Shall draw the Thing as he sees It for the God
of Things as They are!"

R. Kipling. *When Earth's Last Picture*

1. Introduction

Taking the problem of work-incentives more seriously than Kipling, the relatively young literature on workers' enterprises (or "labor-managed firms"), while indicating the general viability and from certain viewpoints superiority of this form of economic organization, has also witnessed criticism, and this on two main accounts. One vein of theoretical discontentment with workers' enterprises as an institution derives from a pathology perceived to reside in the "short-run" behavior of the type of firm in question, namely from its alleged tendency to reduce employment and production in reaction to an increase in its relative price of output. Elsewhere we have shown how this illusory pathology can be dismissed, either by paying proper attention to members' attitudes toward the prospects of being laid-off [Steinherr and Thisse, 1978], or simply by recognizing the rights-and-responsibilities package of worker-partnership as a good and allowing a market for it to function [Sertel, 1978]. The second main source of theoretical dissatisfaction regarding workers' enterprises relates to the question of how these firms are to be financed, which of course is precisely our concern here. In this domain a problem popularized by the work of Furubotn and Pejovic (1970), and in fact already suggested in the pioneering study of Ward (1958), arises when the firm is forced to be self-financed and worker-partners are denied the means of recuperating their investment at retirement. The problem here is manifested in the form of a syndrome of chronic underinvestment. The inevitable inefficiency of the mentioned restrictions is clearly displayed by Drèze (1976). We will return to some finer points raised by Drèze, but only after we agree with the reader on some preliminary definitions and notions.

For the moment, however, let us simply note that it is not just workers' enterprises which are susceptible to the malady of underinvestment, but any firm tied and bound in the described manner - it suffices to imagine the shutting-down of the stock market. Clearly, the Furubotn-Pejovic problem vanishes when worker-partnership rights can be traded as in [Sertel, 1978].

We may now give a brief preview of the rest of this paper. The essence of what we are about to do is to search for efficient solutions to production and finance problems of an enterprise under uncertainty. As in [Kleindorfer and Sertel, 1979], the exact specification of information availability to the participants in their decision-making is critical in delineating which economic institutions, and most notably which incentive designs, are realizable. Most pertinent is the question of how costly it is for the contributors of one factor of production, say of capital goods, to accurately observe the inputs of other factors, say labor. For example, if labor inputs are effectively unobservable to the capital contributor, the latter will be unable to enforce wage incentives, and realizability will demand arrangements such as output-sharing. 1/ Another distinguishing characteristic in the specification of information availability is whether the parties to a potential contract can effectively observe the magnitude actually attained by the random variable $\tilde{\theta}$ affecting the value of output in our model. To illustrate the significance of this observability one need only point to the possibility of default by a workers' enterprise hiring capital, for it is only if the random variable in question is independently observable that it is possible to detect that a default on rental payments is a result of the debtors' genuine bad luck rather than due to their "shirking."

For each of a number of specifications of information availability we obtain the efficient solution to the finance-production problem of an abstract competitive firm and then compare against this the solution reached by the firm according to whether it is organized on the principles of capitalism or as workers' enterprise. Specifically, when neither type of factor-contributor can observe the input of the other factors and $\tilde{\theta}$ is not independently observable but only the value of output is seen, then neither the output-sharing enterprise designed as a workers' enterprise nor the output-sharing firm organized along capitalistic principles is efficient. Only through a system of lump-sum transfers can both organizations be made efficient. In contrast, when all factor inputs and $\tilde{\theta}$ are observable to all parties the workers' enterprise achieves the efficient solution but the capitalistic enterprise fails.

2. Basic Notions and the Setting

Any economic analysis of institutions has to take certain things as given. In the fashion of traditional economic theory, our data here will include a specification of the available production technology and the agents, notably their preferences. Furthermore, the manner in which uncertainty prevails and information avails will be described from the outset. All this will form the common setting in which we analyze and compare the two economic institutions of present interest, namely the capitalistic firm and the workers' firm.

The defining characteristic of a *workers' firm* is that its partners coincide with its workers. Thus, the income provided by such a firm to its worker-partners is the value of their output remaining after inputs other than labor have been paid, i.e., the value-added by labor. In contrast, a *capitalistic firm* is distinguished by the disjunction of its partners from its workers (i.e., by the fact that none of its workers are its partners and none of its partners are its workers). What comprises the income of the partners in a capitalistic firm is the value of output after *all* factors of production have been paid, i.e., profit. It is our understanding that workers' firms and capitalistic firms alike are run, directly or indirectly, by their partners, or at least in the interests of their partners. Whichever type of firm we study, we consider it to be competitive in the sense of being a price-taker in all the markets where it deals. In particular, capital goods can always be rented at a rate $\rho>0$ from the external world so long as absolutely no uncertainty is liable to affect rental payments.

In any case the available technology is described by

$$(1)\qquad Y = K^{\alpha} L^{\beta}, \qquad 0 < \alpha, \beta < 1,$$

where Y stands for the quantity of output, K for that of the capital goods utilized, and

$$(2)\qquad L = \sum_{i=1}^{n} x_i$$

stands for the aggregate labor input of the n workers of the firm, x_i denoting the i-th worker's labor input.

Every agent likes income in risk-neutral fashion and dislikes work. Expressing a typical agent's income in units of Y and denoting this quantity by y, his preferences between income (y) received and labor (x) contributed are represented by a common utility function

$$(3)\qquad u = y - x^{\gamma}, \qquad 1 < \gamma.$$

Uncertainty enters through a positive random variable $\tilde{\theta}$ with mean $E[\tilde{\theta}]=1$, whose moment $M=E\left[\tilde{\theta}^{\frac{\gamma}{\gamma-\beta}}\right]$ we assume to exist, and whose distribution is known to all agents. This random variable affects the value of output (1) corresponding to any combination of inputs K and L; in particular, the value of output is given by

$$(4)\qquad \tilde{Y} = \tilde{\theta}\, Y.$$

For the type of analysis we are entering, it is essential to clearly understand the crucial informational aspects of the setting. For our purposes, a complete description of these aspects specifies *which agents* get to observe *which of the variables* K, x_i, $\tilde{\theta}$, and $\tilde{Y}$, and *when*. We will consider two specifications of the informational setting. (Similar distinctions were made by Spence and Zeckhauser (1971), and Stiglitz (1975).) In either case we take it for granted that each factor contributor sees his *own* input, in fact the workers all see each other's labor contributions. Again in both cases the sequence of events is such that first capital inputs are chosen, then the value attained by $\tilde{\theta}$ is revealed to the workers, next the labor inputs are determined and $\tilde{Y}$ revealed to all. 2/ For the remaining information we distinguish two cases.

The information - rich setting

This case is completely described by its characteristic that each agent's factor contribution, as well as the value of $\tilde{\theta}$, is observed by all the agents (with $\tilde{\theta}$ seen only after the capital input, but before the labor inputs are determined). In this case one may imagine $\tilde{\theta}$ to be the price of output, although other interpretations are just as plausible.

The information - poor setting

The present setting is distinguished by the inability of the agent contributing the services of capital goods to observe labor inputs or the value attained by $\tilde{\theta}$. As a consequence, this agent is unable to hire labor by offering wages. 3/

3. Economic Design in the Information - Rich Setting

3.1. The Capitalistic Solution

Here we envisage a capitalistic firm whose partners hire capital godds as well as labor. Capital goods are hired at the rental ρ. Labor is engaged by signing on n workers with the provision that the wage will be determined in the firm's "internal labor market" by equating the workers' supply of labor with the employers' (partners') demand for it, but *after* $\tilde{\theta}$ reveals its value (otherwise there would be no risk-sharing with workers and partners would end up investing in less capital).

At any wage $w > 0$, a utility-maximizing worker whose income is set as $y = wx$ will supply

(5) $$x = \left(\frac{w}{\gamma}\right)^{\frac{1}{\gamma-1}}$$

of his labor, so that the total supply of labor of the n workers will be

(6) $$L = n\left(\frac{w}{\gamma}\right)^{\frac{1}{\gamma-1}} .$$

For the partners who have rented a quantity K of capital goods and observed $\tilde{\theta}$, utility maximization involves nothing but the maximization of the profit

$$(7)\qquad \tilde{\Pi} = \tilde{V} - wL,$$

where

$$(8)\qquad \tilde{V} = \tilde{Y} - \rho K$$

is labor's value-added. In maximizing (7), partners will exhibit the following demand for labor:

$$(9)\qquad \underline{\tilde{L}} = \left(\frac{\tilde{\theta}\beta K^{\alpha}}{w}\right)^{\frac{1}{1-\beta}}.$$

Equating (6) and (9) will yield the wage

$$(10)\qquad \underline{\tilde{w}} = \left[\left(\frac{\tilde{\theta}\beta K^{\alpha}}{n^{1-\beta}}\right)^{\gamma-1} \gamma^{1-\beta}\right]^{\frac{1}{\gamma-\beta}}$$

and the typical worker's labor input

$$(11)\qquad \underline{\tilde{x}} = \left[\frac{\tilde{\theta}\beta K^{\alpha}}{\gamma n^{1-\beta}}\right]^{\frac{1}{\gamma-\beta}}.$$

Using (10) and (11), the partners' expected profit, from (7), (8) and (4) becomes

$$(12)\qquad E(\underline{\tilde{\Pi}}) = (1-\beta)M\left[\left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta} K^{\alpha\gamma}\right]^{\frac{1}{\gamma-\beta}} - \rho K,$$

where $M = E\left[\tilde{\theta}^{\frac{\gamma}{\gamma-\beta}}\right]$. Maximizing (12) as a function of K, the partners thus choose

$$(13)\qquad \underline{K} = \left[\left(\frac{\alpha\gamma(1-\beta)M}{\rho(\gamma-\beta)}\right)^{\gamma-\beta} \left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta}\right]^{\frac{1}{\delta}},$$

where it is assumed that $\delta = \gamma(1-\alpha) - \beta > 0$, e.g., $\alpha + \beta < 1$.

From the above, using (13) it would now be mechanical to compute the expected values of the wage; typical worker's labor input, income and utility; output, labor's value added, and profit. For such computations see [İnselbağ and Sertel, 1979].

3.2 The Efficienct Solution

Once K is set and $\tilde{\theta}$ observed, the efficient labor inputs would be those which maximize the *communal surplus*

$$(14) \qquad \tilde{S} = \tilde{V} - nx^{\gamma},$$

i.e., precisely the typical worker's labor input $\underline{\tilde{x}}$ as given by (11). This being clear, the efficient solution requires choosing K, before $\tilde{\theta}$ is revealed, so as to maximize the expected communal surplus

$$(15) \qquad E(\tilde{S}) = E\left[\tilde{\theta}K^{\alpha}(n\underline{\tilde{x}})^{\beta} - n\underline{\tilde{x}}^{\gamma} - \rho K\right] = (1 - \frac{\beta}{\gamma})M\left[(\frac{\beta n^{\gamma-1}}{\gamma})^{\beta} K^{\alpha\gamma}\right]^{\frac{1}{\gamma-\beta}} - \rho K,$$

and this means renting capital goods by the amount

$$(16) \qquad \underline{K}^{*} = (\frac{\gamma-\beta}{\gamma(1-\beta)})^{\frac{\gamma-\beta}{\delta}}\ \underline{K},$$

which evidently exceeds the capital input $\underline{K}$ (see (13)) chosen in the capitalistic solution.

Thus, we see that the *capitalistic* solution to the economic design problem, presented in the last subsection, is *inefficient*. The way it determines labor inputs, once K is set, is faultless, but it *chronically underinvests* in capital goods.

The main question at this point is whether there is an economic system realizable in the present setting which actually achieves the efficient solution. The next subsection identifies just such a system.

3.3 The Workers' Solution

Here we consider the same n workers as before, now forming their own workers' enterprise. If anything, their problem is a financial one of procuring K. As Drèze (1976) observes, they cannot allow partners who are not workers and remain a workers' enterprise, but if they should attempt to set up their future uncertain output as collateral in a "futures market" they would fully rob themselves of any motivation to work, a transparently unappealing "moral hazard" to prospective financiers (capital rental agencies). There is, however, a sensible remedy to their finance problem in the present setting, and one which does not constrain the firm to self-finance.

The remedy is found in the notion of the workers' farming out all capital risk, as Drèze (1976) has tried to recommend, but through something other than the "futures market" he considers (and has to reject). What the worker-partners do is to contract at a rental

(17) $\tilde{r} = \tilde{\theta}\rho$

on capital goods, i.e., a rental which guarantees *certain* relative prices of output and of the services of capital goods. 4/ (Imagine $\tilde{\theta}$ as the price of output.) Their uncertain income now becomes $\tilde{\theta}V$ (rather than $\tilde{V} = \tilde{Y} - rK$). The competitive capital markets accepts this, as $E(\tilde{\theta}) = 1$ and, so, a rental agent's or financier's expected profit is zero.

Now once K is set and $\tilde{\theta}$ observed, the workers maximize

(18) $\tilde{S} = \tilde{\theta}V - nx^{\gamma}$

and thus choose the typical worker's labor input precisely in the efficient fashion of (11). This being so, their choice of K, before $\tilde{\theta}$ is seen, will seek to maximize the expected value of $\tilde{S}$ subject to (11), and this is nothing but (15), yielding the efficient level of capital goods utilization as given by (16).

4. Economic Design in the Information - Poor Setting

In the information - poor setting, since the workers' labor inputs are unobservable to others, there is no way of outsiders hiring their labor through wage contracts. Instead, however, they can be incentivized by giving them a *share* in an observable output-type of quantity, such as $\tilde{Y}$ or $\tilde{V}$. The case of value-added sharing, i.e., sharing $\tilde{V}$, is studied in [Kleindorfer and Sertel, 1976], so here we concentrate on sharing $\tilde{Y}$.

This, of course, is *sharecropping*, and so we will be able to use the optimal design results of Kleindorfer and Sertel (1979).

When the workers form their own enterprise in the present setting they are no longer able to incentivize the contributor of K by contracting to pay this agent $\tilde{r}K$ as in the information - rich setting, for $\tilde{\theta}$ is no longer observable by the agent. On the other hand, if the workers were to promise a certain rental r', for sufficiently low values of $\tilde{\theta}$ the workers would prefer not to produce at all and to default on their debts (so r' would naturally have to include a surcharge to compensate for the possibility to default), which reflects a clear inefficiency. Thus, for the reasons mentioned in the last paragraph, here again we will look at the *sharecropping* institution.

4.1. The Capitalistic Solution

The partners of the capitalistic firm hire the services of capital goods at the familiar rental ρ, but contract with the workers - the same n workers as before - so as to share $\tilde{Y}$ with them: the contract prespecifies a share $\mu\varepsilon[0,1]$ according to which the workers' income will be $\mu\tilde{Y}$. The capitalistic solution to this sharecropping design problem is that corresponding to the case where the partners of the capitalistic firm choose μ.

Once μ and K have been set and the workers see $\tilde{\theta}$, maximizing

$$(19) \qquad \sum_{i=1}^{n} u_i = \mu\tilde{Y} - nx^{\gamma},$$

they settle on the typical worker's labor input

$$(20) \qquad \tilde{x} = \left[\frac{\tilde{\theta}\mu\beta K^{\alpha}}{\gamma n^{1-\beta}}\right]^{\frac{1}{\gamma-\beta}},$$

as a result of which the partners' profit $\tilde{\Pi} = (1-\mu)\tilde{Y} - \rho K$ becomes

$$(21) \qquad \tilde{\Pi} = \tilde{\theta}^{\frac{\gamma}{\gamma-\beta}} (1-\mu)\mu^{\frac{\beta}{\gamma-\beta}} \left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\frac{\beta}{\gamma-\beta}} K^{\frac{\alpha\gamma}{\alpha-\beta}} - \rho K.$$

At any given μ, maximizing the expected value of (21) as a function of K, the partners will thus set

$$\bar{K} = [A\ f(\mu)]^{\frac{1}{\delta}}, \tag{22}$$

where

$$A = \left(\frac{\alpha\gamma M}{\rho(\gamma-\beta)}\right)^{\gamma-\beta} \left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta} \tag{23}$$

and

$$f(\mu) = \mu^{\beta}(1-\mu)^{\gamma-\beta}. \tag{24}$$

Now, the expected value of $\tilde{\Pi}$ (21) subject to (22) is

$$\bar{\Pi} = M\left[\left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta} f(\mu)\right]^{\frac{1}{\gamma-\beta}} \bar{K}^{\frac{\alpha\gamma}{\gamma-\beta}} - \rho\bar{K}, \tag{25}$$

which is what the partners maximize in choosing μ. Rewriting (25) as

$$\bar{\Pi} = \frac{\delta}{\gamma-\beta} M\left[\left(\frac{\alpha\gamma}{\rho(\gamma-\beta)}\right)^{\alpha\gamma} \left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta}\right]^{\frac{1}{\delta}} f(\mu)^{\frac{1}{\delta}} \tag{25'}$$

we see that the partners choose μ simply by maximizing $f(\mu)$. Thus, the partners set the workers' share as

$$\bar{\mu} = \frac{\beta}{\gamma}, \tag{26}$$

just as we expect from Kleindorfer and Sertel (1979). Note that $\bar{\mu}$ maximizes also the partners' contribution (22) of K to the venture.

4.2 The Workers' Solution

When our n workers set up their own firm as a workers' enterprise, sharecropping with the providers of capital goods, they get to set μ themselves. They will choose their share as $\underline{\mu} = 1-\alpha$ (see Kleindorfer and Sertel, 1979), and in very little space we can see why and how.

First notice that the supply of K to the firm by the "financiers" will be just as given by $\bar{K}$ in (22), and at any given K and μ, having observed $\tilde{\theta}$, the workers will input their labor just as in (20). The typical workers' expected utility subject to (20) and (22) is thus

$$(27) \qquad \bar{u} = (1 - \frac{\beta}{\gamma})\, M\left[(\frac{\beta}{\gamma})^{\beta}\,(\frac{A^{\frac{\alpha}{\delta}}}{n^{1-\beta}})^{\gamma}\right]^{\frac{1}{\gamma-\beta}} g(\mu)^{\frac{\gamma}{\delta}},$$

where

$$(28) \qquad g(\mu) = \mu^{1-\alpha}(1-\mu)^{\alpha}.$$

Of course, (27) is maximized, as a function of μ, just where (28) is maximized, at

$$(29) \qquad \underline{\mu} = 1 - \alpha,$$

and $1 - \underline{\mu} = \alpha$ is the share in $\tilde{Y}$ which the workers institute for their capital providers. Note that, since $\delta > 0$, we have $\underline{\mu} > \bar{\mu}$. Hence the workers' solution ends up utilizing less capital than the capitalistic (see (22)), but can be checked (using (20)) to incite the workers to be more industrious. The workers gain greater affluence in their own solution and to such an extent that they will prefer it to the capitalistic. Similarly, the contributors of capital goods end up richer under the capitalistic solution.

4.3 The Efficient Solution

Since the preferences of the "financiers" over the interval [0,1] of shares μ are represented by the concave function f (see (24)) and the preferences of the workers over the same interval are represented by the concave function g (see (28)), it is clear that the set of Pareto-optimal shares μ coincides with the non-degenerate interval $\left[\bar{\mu},\underline{\mu}\right]=\left[\frac{\beta}{\gamma},\ 1-\alpha\right]$. The greater the μ chosen in this interval, the happier the workers, but the sorrier the financiers.

The notion of efficiency we have been using, however, is sharper than this. Namely, as our criterion we take expected communal surplus

$$(30) \qquad E(\tilde{S}) = E[\tilde{V} - nx^{\gamma}]$$

subject to $x = \tilde{x}$ as in (20) and $K = \bar{K}$ as in (22). For this represents the expected communal surplus accruing to the community of financiers and workers constrained to the institution of sharecropping. The expected value (30) subject to (20) and (22) may be rewritten as

$$(30') \qquad \bar{S} = M\left[A^{\frac{\alpha\gamma}{\delta}}\left(\frac{\beta n^{\gamma-1}}{\gamma}\right)^{\beta}\right]^{\frac{1}{\gamma-\beta}} h(\mu)^{\frac{1}{\delta}}\, t(\mu)$$

where

$$(31) \qquad h(\mu) = \mu^{\beta}(1-\mu)^{\alpha\gamma}$$

and

$$(32) \qquad t(\mu) = \frac{\delta}{\gamma-\beta} + \left(\frac{\alpha\gamma}{\gamma-\beta} - \frac{\beta}{\gamma}\right)\mu.$$

Now the efficient shares, i.e., the values of $\mu\epsilon[0,1]$ maximizing (30'), are evidently nothing but those maximizing $h(\mu)^{1/\delta}t(\mu)$. We collect some useful information about these shares in the following

<u>Proposition</u>: Consider the "parameter space"

$$P = \{(\alpha,\beta,\gamma)\epsilon R^3 \,|\, 0 < \alpha,\ \beta < 1 < \gamma, \text{ and } 0 < \gamma(1-\alpha) - \beta\}.$$

For each $p\epsilon P$ there is a unique (efficient) $\mu^*(p)$ maximizing $h^{\frac{1}{\delta}}t$ as a function of μ subject to $\mu\epsilon[0,1]$, and $\frac{\beta}{\gamma} < \mu^*(p) < 1 - \alpha$.

<u>Proof</u>: Take any $p\epsilon P$. As $h^{\frac{1}{\delta}}t$ is continuous, on the compact [0,1] it attains a maximum at some $\mu^*(p)$. Despite some tedium, it is easily checked that $\mu^*(p)$ is unique. In fact, if p is such that the slope $\frac{\alpha\gamma}{\gamma-\beta} - \frac{\beta}{\gamma}$ of t vanishes, then t is a constant and $h^{\frac{1}{\delta}}t$ is maximized where h is maximized, i.e., at $\mu^* = \frac{\beta}{\alpha\gamma+\beta}$. As $p\epsilon P$ is changed so as to increase (resp., decrease) the slope of t, $\mu^*(p)$ also increases (resp., decreases). Now, for any $p\epsilon P$, we have $-1 < \frac{\alpha\gamma}{\gamma-\beta} - \frac{\beta}{\gamma} < 1$, and it is only on the boundary of P that (i) $\frac{\alpha\gamma}{\gamma-\beta} - \frac{\beta}{\gamma} = -1$, or (ii) $\frac{\alpha\gamma}{\gamma-\beta} - \frac{\beta}{\gamma} = 1$. In case (i) we have $t(\mu) = 1-\mu$; and

as p tends to a point satisfying (i), $\mu^*(p)$ tends to $\frac{\beta}{\gamma}$. In case (ii), $t(\mu) = \mu$; and as p comes arbitrarily close to a point satisfying (ii), so does $\mu^*(p)$ tend to $1-\alpha$. Thus, for $p\varepsilon P$, $\frac{\beta}{\gamma} < \mu^*(p) < 1-\alpha$, completing the proof.

From the above proposition it is clear that *neither the capitalistic nor the workers' sharecropping solution is ever efficient.*

The sense in which μ^* is efficient is, of course, that if somehow another share $\mu \neq \mu^*$ where operative, those gaining by a movement from μ to μ^* could always compensate the losers (if any) for the change and themselves strictly improve their own lot. 5/ In the light of this, if we had sufficient faith in efficiency somehow imposing itself on mankind, as through the survival of the most efficient, we should hardly expect to encounter the capitalistic or the worker's solution very often in the real world. (C.f. the emphasis on the capitalistic solution by Hurwicz and Shapiro (1978)). What we would expect to see in the information - poor setting then are sharecropping contracts employing efficient shares as coupled, possibly, with lump-sum transfers of income among parties to the contract. 6/

5. Conclusions

In this paper we have shown that efficient financial institutions exist for a workers' enterprise consistent with the definition of such a firm. Depending on the informational setting, the workers' solution is either more efficient than the capitalist (the information - rich setting) or can be made efficient through lump-sum transfers, in exactly the same way that capitalistic sharecropping can be made efficient (the information - poor setting). In each case income distribution is more favorable to labor in workers' enterprises than in capitalistic ones, while the reverse is true for financiers. It may therefore be possible to view the observable predominance of capitalistic institutions over workers' firms not as the survival of the superior, i.e., more efficient, species, as suggested, for example, by Alchian and Demsetz (1972) and Jensen and Meckling (1977), but as the best solution for the class of financiers. Marglin (1974) gives some empirical support to this interpretation.

Our entire study has been conducted with the assumption that financiers and workers are risk-neutral with respect to income ($\gamma > 1$ may be considered to imply both increasing marginal disutility of work *and* risk-aversion with respect to work). Our analysis underlines the existence of an incentive problem even if there are no dissimilarities in the attitudes of the contracting parties toward risk, the focus of the incentive analyses by Wilson (1969) and Ross (1973). The incentive problem in this paper arises because workers dislike work whereas, *cet. par.*, the capital provider is better off the higher are the workers' efforts. How restrictive is our assumption of risk-neutrality? Drèze (1976) considers stronger risk-aversion of workers compared to capital-owners as an essential problem of a workers' enterprise. We tend to disagree: employment typically cannot be diversified so that it is necessary to consider, as we have done, risk-aversion with respect to work; but income derived from work is not normally the sole source of income, and its associated risk can be diversified through savings. But even if one accepts the assumption of workers' greater risk-aversion, note that our *efficiency* analysis would be unchanged for the utility functions $u = y^{\eta} - x^{\gamma}$ as long as $0 < \eta < \gamma$. The precise outcomes would, of course, depend on η. (A similar result is obtained by Harris and Raviv (1978)).

Footnotes:

1/ Harris and Raviv (1978), p. 23, also observe that "*ex post* uncertainty as to the relationship between the effort and the product is essential if contracts based on worker performance are to be observed."

2/ Of course, if $\tilde{\theta}$ is seen before both capital and labor inputs are chosen, there is no speaking of uncertainty at any moment of decision-making. On the other hand, economists have typically considered uncertainty in terms of a random variable whose value becomes visible after all decisions have been taken [see, for example, Drèze (1976), McCain (1977), and Vanek (1977)]. We find that the most interesting case to analyze lies in the "medium-term" where the future is neither a complete certainty nor a simple gamble, but relevant information arrives after capital is fixed and still before labor inputs are. Harris and Raviv (1978) make a similar distinction and analyze two cases: one where workers take their actions before the value of $\tilde{\theta}$ is known and another where they first observe $\tilde{\theta}$.

3/ This crucial constraint on information is frequently overlooked in comparative analyses. For example, Cheung (1969) tries to explain the coexistence of fixed-rent contracts and of sharing agreements purely in terms of transaction costs and risk-aversion. Sharecropping is actually efficient, contrary to the assertion of various authors, within its relevant (restricted) informational setting, as we know from Kleindorfer and Sertel (1979).

4/ A rudimentary empirical example of the present institution is given by Cheung (1969). In Chinese agriculture fixed-rent contracts were adjusted downward in "famine" years. However, since no upward adjustment was made in "glut" years, the fixed rental contained a risk-premium.

Vanek (1977 has also proposed a variable rate of interest on capital, adjusted for deviations of realized value-added per worker from expected values. This proposal looks similar to the one institution analyzed here but, in fact, is closer to the one analyzed in section 4 since Vanek makes no distinction between variations in value-added caused by the random variable $\tilde{\theta}$ and those due to labor-input decisions. A refinement of Vanek's proposal is delivered by McCain (1977). Neither author stresses the informational exigencies of their proposed institutions or provides a comparative efficiency analysis.

5/ See Kleindorfer and Sertel (1976) for a more detailed discussion.

6/ A fixed transfer such as, for example, free housing can regularly be observed in common sharecropping. See, e.g., Cheung (1969).

References

Alchian, A.A. and H. Demsetz, "Production, Information Costs, and Economic Organization," *The American Economic Review* 62 (December 1972), pp. 777-795.

Cheung, S.N.S., "Transaction Costs, Risk Aversion and the Choice of Contractual Arrangements," *The Journal of Law and Economics* 12 (April 1969), pp. 23-42.

Dirickx, Y.M.I. and M.R. Sertel, " Comparative Political Economy of Capitalism, Communism, Slavery and Colonialism in a Nutshell," *Recherches Economiques de Louvain* 44, 3 (September 1978).

Drèze, J.H., "Some Theory of Labour-Management and Participation," *Econometrica* 44 (November 1976), pp. 1125-1139.

Furubotn, E. and S. Pejovich, "Property Rights and the Behavior of the Firm in a Socialist State: The Example of Yugoslavia," *Zeitschrift für Nationalökonomie* 30 (December 1970), pp. 306-322.

Harris, M. and A. Raviv, "Some Results on Incentive Contracts," *The American Economic Review* 68 (March 1978), pp. 20-30.

Hurwicz, L. and L. Shapiro, "Incentive Structures Maximizing Residual Gain under Incomplete Information," *The Bell Journal of Economics* 9 (Spring 1978), 180-191.

İnselbağ, I. and M.R. Sertel, "The Workers' Cooperative under Uncertainty in a Mixed Economy," *Economic Analysis and Workers' Management* (1979, forthcoming).

Kleindorfer, P.R. and M.R. Sertel, "Equilibrium Analysis of Sharecropping," Preprint series I/76-63, International Institute of Management, West Berlin, 1976.

Kleindorfer, P.R. and M.R. Sertel, "Profit-Maximizing Design of Enterprises Through Incentives," *The Journal of Economic Theory* (1979, forthcoming).

Marglin, S.A., "What Do Bosses Do? The Origins and Functions of Hierarchy in Capitalist Production," *The Review of Radical Political Economy* 6 (Summer 1974).

McCain, R.A., "On the Optimum Financial Environment for Worker Cooperatives," *Zeitschrift für Nationalökonomie* 37 (1977), n° 3-4, pp. 335-384.

Ross, S.A., "The Economic Theory of Agency: the Principal's Problem," *The American Economic Review*, Proceedings, 63 (May 1973), pp. 134-139.

Sertel, M.R., "Relative Size and Share Price of a Workers' Enterprise Facing Competitive Capitalism," paper presented at the Second Bosphorus Workshop on Industrial Democracy, Istanbul (July 1978).

Sertel, M.R., T. Başar, and H. Selbuz, "Workers' Enterprises Facing Competitive Capitalism," Technical Report No. 44, Applied Mathematics Division, Marmara Scientific and Technical Research Institute, Gebze, Turkey (September 1978).

Spence, A.M. and R. Zeckhauser, "Insurance, Information, and Individual Action," *The American Economic Review*, Proceedings, 61 (May 1971), pp. 380-387.

Steinherr, A. and J.F. Thisse, "Is There a Negatively Sloped Supply Curve of the Labor-Managed Firm?" *Economic Analysis and Workers' Management* (1979, forthcoming).

Stiglitz, J.E., "Incentives, Risk and Information: Notes Toward a Theory of Hierarchy," *The Bell Journal of Economics* 6 (Autumn 1975), pp. 552-579.

Vanek, J., "Uncertainty and the Investment Decision under Labor-Management and Their Social Efficiency Implications," in: J. Vanek, *The Labor-Managed Economy: Essays*. Ithaca: Cornell University Press, pp. 213-221.

Ward, B., "The Firm in Illyria: Market Syndicalism," *The American Economic Review* 48 (September 1958), pp. 566-589.

Wilson, R.B., "The Structure of Incentives for Decentralization under Uncertainty," in *La Décision*, Paris 1969.