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COOPERATIVES WITH HETEROGENEOUS TRAINING METHODS

By JUN SUZUKI

The purpose of this paper is a consideration of the implication of cooperatives for investment in human capital. The model consists of an industry in which cooperatives are heterogeneous in the efficiency of the training method. We extend the model developed by Moene and Wallerstein (1993) with regard to investment in human capital. The analysis in this paper shows how the efficiency on training affects the behavior in training, production, price and the size of an industry with cooperatives, in comparison to those in an industry with profit-maximizing firms. In equilibrium, workers in cooperatives would be trained to a higher level of skills than workers in profit-maximizing firms. It is shown that a variant of the well-known perverse effects of cooperatives arises in the heterogeneous training model, without fixed costs and exogenous environmental differences between the two forms of organizations.

1. Introduction

Much attention has been given to workers' ownership or cooperatives, more generally expressed as workers' participation in the workplace, from various points of view. In recent years it has been observed that cooperative sectors have acquired increasing importance in economic systems. In economic theory there are a series of studies which examine the economic consequences of those firms where workers participate in decision-making and ownership, that is the theories of labor-managed firms. Among these studies it was demonstrated by Drèze (1976) that in long-run competitive equilibria firms behave in the same way whether they are cooperatives or profit-maximizing firms. Beyond this equivalence, some attempts have been made to show the difference between the implications of the two forms of organization. The best-known attempt was made by Fruboton and Pejovich (1970), as the "horizon problem". Their argument is based on the relatively limited property rights of cooperatives over physical capital, and they point out the inefficiency of investment in cooperatives. In contrast to the horizon problem, Askildsen and Ireland (1993) posed the problem of the investment in human capital. They discussed another deviation from the equivalence by using a model where differences in restrictions on wage-training contracts exist between the two organizational forms.

In fact, several studies point out that the existing pattern of workers' ownership shows the frequency of occurrence of workers' ownership relative to that of conventional investors' ownership in those industries which are characterized by the impor-

1) For detailed studies see, for example, Spear and Voets (1995).
2) See also Miyazaki and Neary (1983).
3) For a recent argument, see Pejovich (1992). A similar problem was raised as the "common property problem" in Jensen and Meckling (1979).
4) See also Ireland (1994) and Dow (1993).
tance of skills and knowledge, that is human assets, and by the low requirement for physical assets\textsuperscript{5).}

However, there has been a different attempt to explain the deviation from the equivalence of cooperatives with profit-maximizing firms. Moene and Wallerstein (1993) derives the differences between the equilibrium with cooperatives and that with profit-maximizing firms by using a model which consists of an industry where firms are heterogeneous in efficiency in productivity. As examples of the source of the differences in productivity they mention superior skills and special knowledge. In this case, we can consider how the differences among firms in terms of skills or knowledge, that is human capital, arise. If there are some differences in the methods of accumulating human capital between firms, then those differences should affect firms' behavior over investment in human capital. Moreover it is expected that, from the heterogeneity in the efficiencies of the methods of accumulating human capital, differences emerge between cooperatives' behavior in human capital investment and in that of profit-maximizing firms, and the equivalence of the two equilibria can not be held.

The author has examined the effects of specific skill and training efficiency on cooperatives, in a more general form or more descriptively, in Suzuki (1998). The purpose of this paper is a consideration of this scenario more formally and an examination of the implication of cooperatives for investment in human capital. We will extend the model developed by Moene and Wallerstein (1993) regarding investment in human capital. Our model consists of an industry in which firms are heterogeneous in the efficiency of training methods. The industry is assumed to be small relative to the aggregate economy so that prices and wages in other industries are constant. Also, free entry is assumed. The analysis in this paper shows how the efficiency of training affects the behavior in training, production, price and the size of an industry with cooperatives, in comparison to those in an industry with profit-maximizing firms. In the following sections, after characterizing the equilibrium with cooperatives and the equilibrium with profit-maximizing firms, we will compare them, and discuss the results of our analysis.

2. The Model

The model consists of an industry in which firms produce one homogeneous product but in which these firms differ in the efficiency of intra-firm training. Production requires only skilled labor. Firms employ unskilled workers (or in the case of cooperatives unskilled workers form cooperatives) and then train them. Here we will consider a firm-specific skill. Thus training can be accomplished within the firm, especially in the workplace, not outside the firm. The skill level, denoted by $s$, which workers in a firm obtain by training, is the firm's choice. We assume that the cost of training a worker is not affected by the number of workers who are trained in the firm.

All firms in the industry have the same production function. Output is given by $f = f(L)$, where $f(0) = 0$, and $f'(L) > 0$, $f''(L) < 0$. The variable $L$ is the number of skill units of labor, so that $L/s$ represents the number of $s$-level skilled workers.

We will represent the industry as a continuum of firms, arrayed from the firm with

\textsuperscript{5) See, for example, Hansmann (1990) and Russell (1985).}
most efficient training method to the least efficient, as in Moene and Wallerstein (1993). Particular firms are identified according to their distance from the origin. We will term the firm located at the distance $i$ from the origin as the firm of type $i$, and, if necessary, denote the variables which represent the variables in the firm of type $i$ simply by the subscript $i$, for example $L_i$. Differences in the efficiency of training appear as differences in the cost of training. The cost of training a worker up to skill level $s$ in the firm located at distance $i$ from the origin is denoted as $t_i(s)$. Imagine a function of $s$ which is identical for all firms, $T(s)$ with $T'(s) > 0$ and $T''(s) > 0$. Define

$$t_i(s) = \theta(i) T(s),$$

where $\theta(0) > 0$, $\theta'(i) > 0$. In this model differences in the efficiency of training are represented by the term $\theta(i)$. Free entry is assumed, and entry in the industry begins with the firm which has the most efficient training method and ends with the firm with a degree of efficiency of training that is less than that of the firm of type 0.

We assume that firms behave as price takers and that the price of output depends on the aggregate production in the industry. Let $k$ represent the distance from the origin to the firm with the least efficient training method. The firm of type $k$ is the marginal firm and it has the least efficient method of training in the industry. When we write $L$ in the firm of type $i$ as the function of $i$, the price of output $p$ is given by:

$$p = p \left( \int_0^k f(L(i)) dt \right),$$

with $p'(\cdot) < 0$. We denote the workers' outside option as $w$. $w$ is assumed to be exogenous. A competitive labor market is assumed. Under these settings we will characterize the equilibrium with cooperatives and that with profit-maximizing firms in the following sections.

3. Equilibrium with Workers' Cooperatives

Cooperatives are assumed to be democratic and to divide the revenue and costs of production equally among their members. We also assume that cooperatives maximize their members' income. It is unlikely that cooperatives adjust the number of their members in the short run. But in the long run, the number of members can be increased by accepting new members or reduced by retirement or resignation on each member's own initiative. Hence this income per member maximization holds in the long-run case.

Let the income received by members in the cooperative of type $i$ be denoted $\phi_i$. Then

$$\phi_i = \max_{s,L} \left[ pf(L_i) - \frac{L_i}{s_i} \theta(i) T(s_i) \right].$$

The first order conditions which determine the skill level $s$ and total labor factor $L$ in the cooperative of type $i$ are
\[ pf'(L_i) - \theta(i) T'(s_i) = 0, \tag{2} \]

and

\[ f(L_i) - f'(L_i)L_i = 0. \tag{3} \]

From equations (2) and (3), the optimal level of skills in the cooperative of type \( i \) satisfies

\[ s_i T'(s_i) - T(s_i) = \frac{\phi_i}{\theta(i)}. \tag{4} \]

And from equation (3), the optimal size of the labor factor in cooperatives is independent of \( \theta(i) \). Output levels in all cooperatives in the industry are the same. This feature of the equilibrium stems from the form of the cooperatives' object function, the kind of training supposed here and the assumption that production requires only a labor factor. But skill levels differ among cooperatives according to the efficiency of the training.

Workers will form cooperatives while their incomes are higher than the expected income which they can receive outside the industry. This is the participation condition for cooperatives, that is \( \phi_k \geq w \). Free entry of cooperatives implies that the members' income in the marginal cooperative equals the outside option 6):

\[ pf'(L_k) - \left( \frac{L_k}{s_k} \right) \theta(k) T(s_k) \frac{L_k}{s_k} = w. \tag{5} \]

From the first order conditions (2) and (3), and the participation condition in equilibrium, in the cooperative of type \( k \), the following conditions are satisfied:

\[ pf'(L_k) = \frac{1}{s_k} \left( w + \theta(k) T(s_k) \right), \tag{6} \]

and

\[ s_k T'(s_k) - T(s_k) = \frac{w}{\theta(k)}. \]

The last equation determines the skill level in the cooperative of type \( k \).

4. Equilibrium with Profit-Maximizing Firms

In this section, we consider the same industry with profit-maximizing firms. Since a competitive labor market is assumed, the wage received by all workers in the industry is no higher than the outside option, \( w \). The profit earned by the firm of type \( i \), denoted \( \pi_i \), is given by

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6) \( \theta(0) \) is assumed to satisfy the condition \( \phi_0 > w \).
The first order conditions for profit maximization are
\[ pf'(L_i) - \theta(i) T'(s_i) = 0, \]
and
\[ pf'(L_i) = \frac{1}{s_i} (w + \theta(i) T(s_i)). \]

The former condition (8) is the same as that for cooperatives' maximization with respect to skill level (2). And the latter condition (9) is the usual condition for profit maximizing, which implies that the marginal value product equals the cost per skill unit. As in the equilibrium with cooperatives, from equations (8) and (9), the optimal level of skills in the profit-maximizing firm of type \( i \) satisfies
\[ s_i T'(s_i) - T(s_i) = \frac{w}{\theta(i)}. \]

Since free entry is assumed, the profit earned by the marginal firm \( \pi_k \), is driven to zero\(^7\), or
\[ pf(L_k) - \frac{L_k}{s_k} (w + \theta(k) T(s_k)) = 0. \]

From the zero-profit condition and the first order condition (9), we obtain the following condition for the marginal firm,
\[ f'(L_k) L_k = 0. \]

Equations (7), (8), (9) and (11) describe the equilibrium in the industry with profit-maximizing firms. The equilibrium characterized by these equations will be a benchmark for analyzing the equilibrium with cooperatives in the next section.

5. Comparative Analysis

Now we compare the two equilibria characterized above. First, we will examine the skill levels chosen in the two forms of enterprise. With regard to the effect of the training efficiency on the skill level, cooperatives and profit-maximizing firms behave similarly. In the case with cooperatives, from equation (2),
\[ \frac{d s^c}{d \theta} = -\frac{T'(s^c)}{\theta(i) T''(s^c)} < 0, \]
where the superscript \( c \) represents the equilibrium value of variables with cooperatives. And in the case with profit-maximizing firms, from equation (10), we obtain
\[ \pi_0 > 0. \]

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\(^7\) As in the marginal cooperative, it is assumed that \( \pi_0 > 0 \).
where the superscript \( p \) represents the equilibrium value of variables with profit-maximizing firms. Since the right-hand side of equation (10) decreases with \( \theta \),

\[
\frac{d s^p}{d \theta} < 0.
\]

In both cases, the skill level decreases with \( \theta \). The more-efficient method of training the firm has, the higher the level of training that is achieved in the firm.

In addition, (13) applies to the case with cooperatives, that of equation (4). The income of workers in all but marginal cooperatives is higher than the outside option. Hence

\[
s^c > s^p,
\]

when \( \theta(i) < \theta(k^p) \). The skill level in a cooperative is higher than that of the potential profit-maximizing firm with the same efficiency of training.

From these results regarding skill levels and from the characteristics of the two equilibria shown before, the results of the comparison of cooperatives with profit-maximizing firms can be summarized as follows,

**Proposition**

If \( \theta(k^p) > \theta(0) \), then

(a) When \( \theta(i) < \theta(k^p) \), the skill level in a cooperative is higher than that of a profit-maximizing firm with the same efficiency of training.

(b) The skill level is lower in a marginal cooperative than in a marginal profit-maximizing firm.

(c) The number of cooperatives is larger than that of profit-maximizing firms.

(d) Price is higher in the industry with cooperatives than in that with profit-maximizing firms.

**Proof.** Part (a) of the proposition is shown above by (14).

To prove part (b), first we see the size of the skilled labor factor, or the scale of output in the marginal firm. From (3), the scale of output in the marginal cooperative is determined by

\[
f(L^c_k) - f'(L^c_k)L^c_k = 0
\]

Since this equation is equivalent to equation (12) which determines \( L^p_k \), then \( L^c_k = L^p_k \).

Define \( S_kp = \alpha \) and \( \theta(k) T(s_k) = \beta \). The participation condition (5) and the first order conditions for the marginal cooperative (6) are rewritten as,

\[
\alpha f(L_k) - \beta L_k = wL_k
\]

\[
\alpha f'(L_k) - \beta = w.
\]

These two equations determine a unique solution for \( \alpha \) and \( \beta \). In the case with profit-
maximizing firms, we obtain the same two equations from (11) and (9). Since
\[ L_k^c = L_k^p, \]
\[ s_k^c p^c = s_k^p p^p, \quad (15) \]
and
\[ \theta(k^c) T(s_k^c) = \theta(k^p) T(s_k^p) \quad (16) \]

Part (b) is simply proven by contradiction. Suppose \( s_k^c \geq s_k^p \). This implies \( p^c \leq p^p \)
from equation (15), and also implies \( \theta(k^c) \leq \theta(k^p) \), or \( k^c \leq k^p \) from equation (16).
But since \( L_k^c = L_k^p \) and \( L^p \) is a nonincreasing function of \( \theta \), \( k^c \leq k^p \) implies \( p^c > p^p \).
We have a contradiction and part (b) of the proposition is proven. From part (b) and
equations (15) and (16), we can immediately prove parts (c) and (d).
Q.E.D.

In both the cases with cooperatives and profit-maximizing firms, the zero-surplus con­
ditions are equivalent for the marginal firm. Also the conditions which determine the
scale of output for the marginal firm are equivalent in both cases. Hence, the scale of output
for the marginal cooperative is the same as that for the marginal profit-maximizing
firm. In addition, the cost of training a worker up to \( s_k \) for the marginal firm is the
same for both in the two equilibria.

In profit-maximizing firms the scale of output \( L_i \) is decreasing with the inefficiency
of training \( \theta(i) \), since a lower efficiency of training means a higher cost per worker.
However the scale of output is identical in all cooperatives in our model. The number
of skill units would not change with the efficiency of training. This result stems from
the object function of cooperatives and the assumption that the cost of training a
worker is not affected by the number of workers trained.

The efficiency of training in the marginal cooperative is lower than that in the mar­
ginal profit-maximizing firm. This implies that the number of enterprises is greater in
the equilibrium with cooperatives than in the equilibrium with profit-maximizing firms.
The scale of output is smaller in all but the marginal cooperatives. These results are, on
the whole, similar to past studies of cooperatives or worker-owned firms, which began
with Ward (1957) and included Moene and Wallerstein (1993). Our results can be said
to show a “perverse effect”. We show these results by using a model of the heterogene­
ous cost of training.

The skill level increases with the efficiency of training in cooperatives, while the scale
of output does not change with the efficiency of training. To maximize the income per
member, cooperatives adjust the number of their members in the long run. The increase
in skill levels with the efficiency of training applies to both in the two equilibria. But
the skill level is higher in cooperatives than in profit-maximizing firms with the same ef­
niciency of training. However, the skill level in some cooperatives with a lower effi­
ciency of training may be lower than in the marginal profit-maximizing firm, and the
skill level in the marginal cooperative is lower, since enterprises with lower efficiency
can enter the industry in the equilibrium with cooperatives than that with profit­
maximizing firms.
6. Concluding Remarks

We have seen how the efficiency of training affects the behavior in training and in production in cooperatives, in comparison to that in profit-maximizing firms. The main results of this paper were observed in the preceding section. These results depend on the specific assumption that we made about the efficiency of training and the industry. We assumed firms to be heterogeneous in the efficiency of training. If we assume that firms are homogeneous, free entry into the industry implies that all firms are marginal. And in this case cooperatives' behavior is the same as that of profit-maximizing firms' in training and in production.

Moene and Wallerstein (1993) has shown the differences between the equilibria with cooperatives and with profit-maximizing firms by using the model of firms that are heterogeneous in productivity. By using a model of firms that are heterogeneous in the efficiency of training, we were able to obtain similar results for output, price, and the number of enterprises, and in addition for the implication of workers' cooperatives for investment in human capital.

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