IS THERE A NEGATIVELY SLOPED SUPPLY CURVE IN THE LABOR-MANAGED FIRM ?

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1. Introduction

Existing theoretical results concerning labor-managed economies point to their general viability ; see, e.g. Vanek (1970), Meade (1972) and Drèze (1974). However, a number of odd, if not problematic, features have emerged from the analysis. Among the most ardent difficulties is the one of adjusting labor when market price increases. Ward (1958) was the first to notice that, in this case, the labor-managed firm (LMF) tends to reduce employment and output in the short-run.

This troublesome result and its perverse implications have suscitated two kinds of reaction. One consists in investigating whether this result can be maintained under more general conditions. Domar (1966) and Vanek (1970) have been able to show that certain generalizations (including joint products, complementary inputs and an upward-sloping labor-supply curve to the firm) tend to diminish the severity of the problem. It may even, in these circumstances, be possible to obtain a positively sloped supply curve for the LMF ; nevertheless, the elasticity of supply remains below that of the profit-maximizing firm.

A more fundamental criticism was made by J. Robinson (1967). For this author, the above result brings into light the inappropriateness of the objective function by which LMFs are characterized, namely the maximization of labor's value-added per capita. Rather, would not a LMF pursue other objectives such as creating jobs ? And if an optimal policy indicates a reduction in employment, how can this reduction be implemented in practice ?

In this paper, we intend to approach this problem from the perspective of the internal organisation of the LMF. The analyses by Ward and Vanek assume implicitly, on the one hand, the existence of an exogenous classification of workers according to which workers are selected for dismissal and, on the other hand, indifference of remaining workers with respect to the fate of those who are dismissed.

Establishing an exogenous classification, i.e. independent of the workers' productive activities, poses several difficulties. Some of them are related to the choice and the aggregation of the criteria to be used (seniority, merit,...). The rules employed to determine the classification may also become to complex for being well understood by the workers. In practice, it is therefore likely that an exogenous classification has little chance of being acceptable to workers. An endogenous classification, i.e. dependent on the workers' performance, presents similar difficulties although it may be less arbitrary (for instance, if based on individual productivity). For these reasons, we prefer a random process. Random selection is, in a certain sense, neutral and less susceptible to manipulation. Each worker has a chance to remain employed - which is not the case with non-random selection. It seems therefore that workers will more easily accept random selection than other methods.

In this case, the objective function of the LMF must be modified to integrate the risk for workers to be selected for departure. Indeed, with the Ward-Vanek objective, workers maximize income of those remaining in the firm without taking into account that risk. Clearly, it is not easy to understand why workers would behave like that.

In the spirit of labor management the second implicit hypothesis in the Ward-Vanek analysis invites an even more fundamental critique of their objective function. Indeed, reducing employment in the firm and neglecting the possible welfare loss of departed members implies selfish behavior that seems incompatible with the philosophical foundations of labor-management. It appears more acceptable to require a certain degree of solidarity of workers, namely that they take the welfare losses of departed fellows into account.

Two particular but rather important mechanisms of solidarity are suggested by welfare theory. The first arises when the welfare of all workers, defined as the sum of the utilities of remaining and leaving workers, is considered as the objective. In the second the compensation principle is applied : dismissed workers must be compensated by those remaining in the LMF for their income losses. In either case, the objective function of the LMF needs revision.

2. Risk and the objective of the labor-managed firm

The objective function used by Ward (1958), Vanek (1970) and Drèze (1974), among others, can be written[(1)]

$$y = \frac{pF(L,K) - rK}{L} \tag{1}$$

where

y = labor's value-added (or income) per capita
p = market price for one unit of output
F = production function
K = stock of capital
L = employment
r = rental price of one unit of capital.

For our analysis, we assume an initial equilibrium where average incomes of workers are equal across all firms. Denoting the market price and the variables in this initial state with subscript zero, we have :

$$\frac{p_o F(K_o,L_o) - rK_o}{L_o} = w. \tag{2}$$

We now consider the case where market conditions improve, which can be expressed as follows :

$$p_1 > p_o. \tag{3}$$

Given this change, we know that the optimal employment for maximization of

$$\frac{p_1 F(K_o,L) - rK_o}{L} , \tag{4}$$

denoted by L_1, is smaller than the initial employment L_o. Furthermore, we also have $\bar{L}(K_o) < L_1$, where $\bar{L}(K_o)$ is such that $F'_L(L,K_o)$ increases on $[0,\bar{L}(K_o)[$ and decreases on $]\bar{L}(K_o), \infty[$. This follows directly from the fact that L_1 maximizes (4).

As discussed in the introduction, we assume that the selection of members to leave is made with some random process. One could imagine that specific probabilities are attached to each worker, determined on the basis of some pre-determined criteria. However, here also the choice of such criteria and the determination of these probabilities may be very difficult in practice. For simplicity we assume therefore that each worker has the same probability of being dismissed. Besides simplicity, this system has the further advantage of corresponding to a well-established, albeit particular, notion of justice. Acceptance of this rule is therefore likely. Dismissed workers are chosen simultaneously from a lottery (in practice, a computer program might select randomly a given number of names from the list of workers). Consequently, if L denotes the number of workers remaining in the firm, the probability for a worker to leave the LMF is given by

$$\Pi = \frac{L_o - L}{L_o} \tag{5}$$

while the probability to remain is

$$1 - \Pi = \frac{L}{L_o}. \tag{6}$$

In contrast to the capitalist firm, where labor is an input among others, it is expected that the objective of workers incorporates the risk of losing one's job. Indeed, among the workers who decide to reduce the employment level are those who will have to leave. It is therefore natural that the alternative revenue of dismissed workers is taken into account. This alternative revenue is equal to income from employment in another firm or unemployment benefits. The short-run horizon of our analysis precludes creation of employment through setting-up of new firms. Since we started out from an initial equilibrium situation and then assumed a market improvement, it is most likely that alternative revenues are inferior to the one a worker would have obtained if he had remained within the LMF. In fact we may make a stronger assumption : alternative incomes are no greater than the initial income w. This can be justified on the following grounds. As market changes affect the entire industry dismissed workers may find a job in other industries remunerated at w, but not in the one under consideration since all firms adjust their optimal size downwards. If a dismissed worker cannot find a job, he gets unemployment benefits that cannot exceed w. In the following analysis we assume that alternative income is equal to w. This is not restrictive, however, since the conclusions we are going to derive remain unaltered if alternative revenues are below w.

We are now in a position to rewrite the objective function of the LMF as follows :

$$\max V(L) \qquad \text{w.r.t. } L \in \left[0,\infty\right[,$$

where

$$V(L) = \begin{cases} w & \text{for } L = 0 \\ U\left[y(L)\right] \;.\; (1-\Pi) + U(w).\Pi & \text{for } 0 < L < L_o \\ y(L) & \text{for } L_o < L \;; \end{cases} \tag{7}$$

and where U denotes the utility function assumed identical for all workers[2]. Given the standard assumption of continuity of y(L) and given that y(L) tends to zero when L becomes arbitrarily large, it is easily seen that at least one value of L maximizing the expected utility of income per capita exists ; it is denoted by L^*. To characterize L^*, we subdivise the domain of L in disjoint intervals and we show that assuming L^* in each of these intervals leads to a contradiction, except in one case.

(i) Assume $L^* \in \left[0,\bar{L}(K_o)\right]$. Clearly, L^* differs from zero since workers can always obtain a higher income per capita than w by choosing L_o. Then consider $L^* \in \left]0,\bar{L}(K_o)\right]$. In this case, workers can guarantee to themselves a higher value of the objective by taking L_1. Indeed,

$$V(L^*) = U\left[y(L^*)\right] \cdot \frac{L^*}{L_o} + \frac{L_o - L^*}{L_o} U(w)$$

$$< U\left[y(L_1)\right] \cdot \frac{L_1}{L_o} + \frac{L_o - L_1}{L_o} U(w) + \frac{L^* - L_1}{L_o}\left[U(L^*) - U(w)\right]$$

since $\quad y(L_1) > y(L^*)$

$$< U\left[y(L_1)\right] \cdot \frac{L_1}{L_o} + U(w) \cdot \frac{L_o - L_1}{L_o}$$

as $\quad L^* < L_1$

$$= V(L_1)$$

We thus arrive at a contradiction.

(ii) Assume $L^* \in \left]\bar{L}(K_o), L_o\right[$. Then L^* must satisfy the first-order condition

$$\frac{dV}{dL} = U'\left[y(L^*)\right] \cdot \left[p_1 F'_L(K_o, L^*) - y(L^*)\right] + U\left[y(L^*)\right] - U(w) = 0. \tag{8}$$

As $L^* < L_o$ and as the marginal productivity of labor is decreasing, we have

$$p_1 F'_L(K_o, L^*) > p_o F'_L(K_o, L_o).$$

We also have

$$p_o F'_L(K_o, L_o) = w$$

so that

$$p_1 F'_L(K_o, L^*) > w. \tag{9}$$

Given (8) and (9), we obtain

$$U'\left[y(L^*)\right] \cdot \left[w - y(L^*)\right] + U\left[y(L^*)\right] - U(w) < 0. \tag{10}$$

Moreover,

$$y(L^*) > w \tag{11}$$

without which L_o would be preferred to L^*, which is impossible. We now show that (10) and (11) are incompatible when the utility function is concave. For that, put $a = w$ and $b = y(L^*)$ and re-write (10) as

$$U'(b) \,.\, (a - b) + U(b) - U(a) < 0. \tag{12}$$

Let $c = \theta a + (1 - \theta) b$ with $\theta \in]0,1[$. As U is concave, we have

$$U(c) \geq \theta U(a) + (1 - \theta) \; U(b)$$

which amounts to

$$\theta \left[U(b) - U(a) \right] \geq U(b) - U(c).$$

Given that

$$\theta = \frac{b - c}{b - a}$$

we obtain

$$U(b) - U(a) \geq (b - a) \,.\, \frac{U(b) - U(c)}{b - c} \,.$$

Taking the limit for $c \to b$, i.e. $\theta \to 0$, yields

$$U(b) - U(a) \geq (b-a) \,.\, U'(b)$$

that is

$$U'(b) \,.\, (a-b) + U(b) - U(a) \geq 0 \tag{13}$$

which contradicts (12).

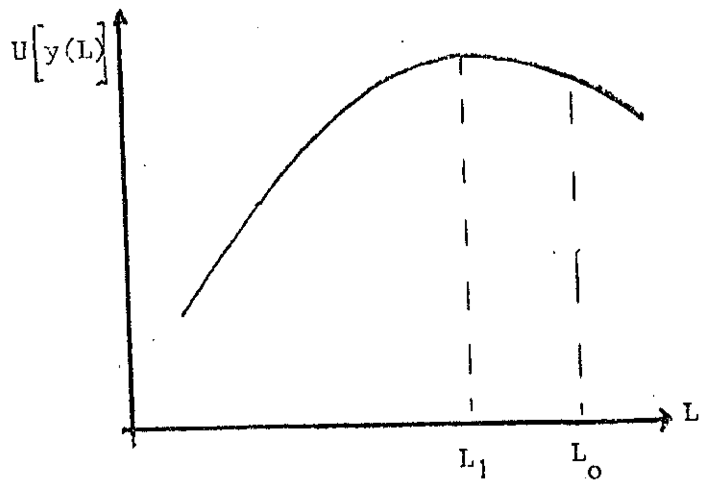
(iii) Assume $L^* \in]L_o, \infty[$. This means that $V(L^*) = y(L^*)$. As the marginal productivity of labor is decreasing on $]\bar{L}(K_o), \infty[$ and as $\bar{L}(K_o) < L_1$, the income per capita $y(L)$ is also decreasing on $]L_o, \infty[$. Accordingly, as $L_1 < L_o$, we have $y(L_o) = V(L_o) > V(L^*) = y(L^*)$ which is impossible.

The analysis of these three cases reveals that the optimal solution is unique and given by L_o. In other words, taking into account the risk for workers to lose their jobs and assuming that workers are risk-adverse implies that the level of employment remains unchanged when market conditions improve. Interestingly, this property remains valid when expected income, rather than expected utility of income, is maximized. Indeed, no use of the strict concavity of U is made in the above proof.(3)

How can this surprising result be understood ? Two comments are in order. First, although objective function (7) implies that each worker is only concerned with his own interest, the firm actually takes into consideration the income of all initial members ; this is easily revealed by an examination of (7). Thus, a reduction in dismissals appears as a natural result, as shown by (8). Second, that there is in fact no reduction at all in employment is the consequence of assuming that workers are not risk-lovers. This can be seen from the comparison of (12) and (13).

An illustration of this result is contained in figure 1. Selecting U(w) as the origin of the utility function, we consider a reduction of employment by one unit starting from L_o. As $U[y(L)]$ is concave on $]\bar{L}(K_o, \infty[$, the utility of income increases less than proportionately. The product, which is equal to the expected utility of income, is therefore decreased.

Figure 1



3. Group optimality

In this section, we assume again that a parametric change occurs as in (3) and ask the question : what would be the optimal solution when welfare of the group is the prime concern of workers ? Asking this question obviously implies a certain abandon of individual interests and a certain solidarity among workers.

Again, there is a large variety of schemes through which solidatiry can be introduced. Three typical forms can be distilled from various strands of the literature.

The first one, and perhaps the most popular, is the rule never to reduce the number of workers. This suggestion was made by J. Robinson (1967) and can also be encountered regularly in the sociological literature on participation. In this case, adjustment is realized through the number of hours worked by the members. As noticed by Berman (1977), this can give rise to tensions within the firm. They result from the divergence which may appear between the marginal revenue of a worker and his corresponding contribution to the income of the group. Only a strong cooperation between workers can guarantee an efficient allocation of labor inside the firm ; see Berman (1977). Less rigid mechanisms of solidarity should therefore be sought.

The second archetype consists in maximisation of the sum of the utilities of all initial workers, allowing employment to adjust optimally. This amounts to maximizing the following particular group utility function :

$$V(L) = \begin{cases} W(w).L_o & \text{for } L = 0 \\ W[y(L)].L + W(w).(L_o - L) & \text{for } 0 < L < L_o \\ W[y(L)].L & \text{for } L_o \leqslant L \end{cases} \qquad (14)$$

where W denotes the utility function of income, assumed concave and identical for all workers. Clearly, objective function (14) is formally equivalent to (7) on the domain $]0,L_o[$, so that the optimal employment corresponds, as in the above section, to the initial level of employment L_o. It must be emphasized, however, that the two objective functions are based on completely different behavioral and organizational assumptions.

The third form is suggested by the compensation principle : remaining workers have to compensate dismissed workers for their income losses. An obvious benchmark for the determination of a transfer would be the difference between the average income in the new state if all workers had remained in the firm and the alternative income w. Lower transfers would not compensate workers entirely and higher transfers would never be made as will become obvious from the analysis below.

The objective function can now be written :

$$\max V(L) \quad \text{w.r.t.}\ L \in [0,\infty[$$

where

$$V(L) = \begin{cases} w & L = 0 \\ y(L) - \dfrac{L_o - L}{L}\,[y(L) - w] & 0 < L < L_o \\ y(L) & L_o \leqslant L \end{cases} \tag{15}$$

and where the amount $y(L) - w$ represents the transfer payable to each dismissed worker.

Denote by L^{**} a maximizer of $V(L)$. From the properties of $V(L)$ it is immediately seen that L^{**} exists.

We distinguish three cases : (i) $L^{**} \in [0,\bar{L}(K_o)]$, (ii) $L^{**} \in]\bar{L}(K_o), L_o[$, and (iii) $L^{**} \in]L_o,\infty[$. Cases (i) and (iii) can be dealt with as in section 2. We still have to consider case (ii). Then L^{**} must verify the first-order condition given by

$$\frac{dV}{dL} = L^{**} p_1 F'_L(K_o, L^{**}) - L^{**} y(L^{**}) + L_o[y(L_o) - w] = 0. \tag{16}$$

As with (9), we obtain

$$p_1 F'_L(K_o, L^{**}) > w, \tag{17}$$

so that

$$L^{**} w - L^{**} y(L^{**}) + L_o[y(L_o) - w] < 0. \tag{18}$$

Denoting by Y(L) the revenue generated by the firm when L workers remain in the LMF, we may rewrite (18) as

$$Y(L_o) - Y(L^{**}) < 0. \tag{19}$$

Consider now the maximizer of Y(L) on $[0,\infty[$, i.e. $\hat{L}$. As $\hat{L} > 0$, we must have

$$p_1 F'_L(K,\hat{L}) = w.$$

Moreover, as $p_1 F'_L(K_o,L) > p_o F'_L(K_o,L)$ for any L, we obtain

$$\hat{L} \geq L_o. \tag{20}$$

Knowing that Y(L) is strictly concave on $]\bar{L}(K), \infty[$, it then follows from (20)

$$Y(L^{**}) < Y(L_o) \leq Y(\hat{L}) \tag{21}$$

which contradicts (19).

Thus, we have demonstrated that <u>when complete compensation has to be paid for income losses the LMF never reduces employment</u>. There is a direct economic interpretation of this result as shown with figure 2 where marginal revenue (for simplicity assumed constant) and average revenue in the initial state (AR_o) and in the new state (AR_1) are depicted.

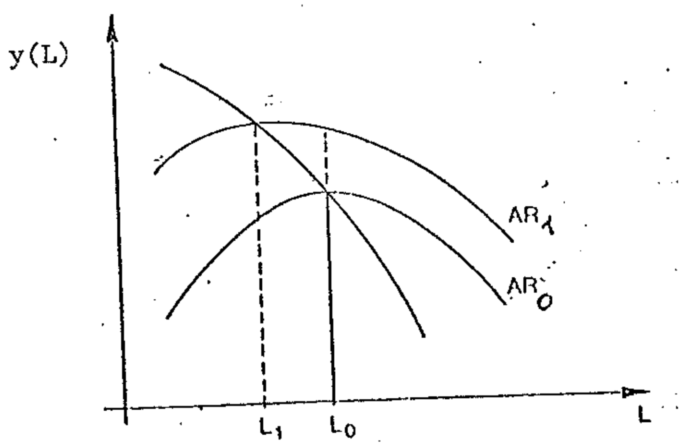


Figure 2

The Ward-Vanek firm reduces employment as long as average revenue exceeds marginal revenue : it moves threfore from L_o to L_1. If the firm has to pay a compensation equal to the difference between AR_o and AR_1 at L_o then it never pays to reduce employment. For the marginal worker the firm is indifferent, cet. par.For the second worker the transfer would already exceed the gain eschewing to remaining workers.

Note that objective functions (14) and (15) are written without specification of any particular selection process which is left exogenous. In particular, the obtained results apply to a system of seniority (last-in-first-out). On the other hand, the objective functions would have to be modified for endogenous and random selection processes.

5. Concluding remarks

One seemingly major problem of labor-managed organizations has disappeared : the labor-managed firm does not reduce employment and output when the price of output increases provided the objective function integrates relevant internal decision-making processes.[4] Obviously, this result can also be obtained for a reduction of the rental price of capital, or for Hicks-neutral technological progress. However, in those cases where Ward and Vanek obtain "perverse" results the LMF still does not increase employment and output as does the profit-maximizing firm. In the short-run, the supply curve is therefore perfectly inelastic with respect to increases in price. Since the marginal productivity of capital exceeds now the rental cost of capital investment will occur over time to adjust their capital-labor ratio to its optimal level, with employment remaining constant. Clearly, the speed of adjustment, i.e. investment per period of time, will inversely depend on adjustment costs. Thus, the incentives in our models lead to a long-run increase of the stock of capital and of output, whereas adjustment in the Ward-Vanek firm relies on a reduction of employment and output.

While other objective functions can be imagined, based on different mechanisms dealing with risk, or on other forms of solidarity, our results seem to be fairly general. Only minimal restrictions have been imposed on technology and preferences and the objective functions are quite generally formulated. We also have not neglected in this partial equilibrium analysis constraints arising in the remaining economy as in the Ward-Vanek analysis, by introducing the notion of an alternative income.

Footnotes

(1) It is assumed here that all capital can be borrowed in a perfect capital market or from a central agency without losing exclusivity of workers'control. Although a standard assumption in the LMF literature it is not an unproblematic one ; see Jensen and Meckling (1977).

(2) Note that an alternative interpretation of (7) would be as follows : exogenous rules of selection might be so complicated that all workers consider their partnership in the LMF as uncertain. It can then be supposed that workers behave approximately as maximizers of (7).

(3) The assumption that workers can always obtain w outside of the firm is obviously crucial for the result. The latter is not necessarily true for alternative incomes higher than w ; there exists a value $\bar{w}$ between w and $y(L_o)$ which corresponds to the highest alternative income for which all workers optimally remain in the firm. A simple expression is obtained for this income when the expected income is maximized in the LMF : $\bar{w} = p_1 F'_L(K_o, L_o)$.

(4) This result is consonant with the one obtained by Sertel (1978), who makes use of the idea that rights to participate as worker-partners in a workers'-firm are open to negotiation, in a worker-partnership market, between present members of such a firm and potential entrants of extants.

References

BERMAN, M.D., (1977), "Short-Run Efficiency in the Labor-Managed Firm", *Journal of Comparative Economics*, 1, 309-314.

DOMAR, E., (1966), "The Soviet Collective Farm", *American Economic Review*, 56, 734-757.

DREZE, J.H.,(1974), "The Pure Theory of Labour-Managed and Participatory Economies. Part I : Certainty", *Working Paper n° 7422*, CORE, Louvain.

JENSEN, M.C. and W.H. MECKLING, (1977), "On The Labor-Managed Firm and the Codetermination Movement", *Working Paper*, University Rochester, Feb. 1977.

MEADE, J.E., (1972), "The Theory of Labor-Managed Firms and Profit Sharing", *The Economic Journal*, 82, 402-428.

ROBINSON, J., (1967), "The Soviet Collective Farm as a Producer Cooperative : Comment", *American Economic Review*, 57, 222-223.

SERTEL, M., (1978), "Relative Size and Share Price of a Workers' Enterprise Facing Competitive Capitalism", paper presented at the *First International Conference on Economics of Workers' Management, Dubrovnik, 1978*.

VANEK, J., (1970), *The General Theory of Labor-Managed Market Economies*, Ithaca : Cornell University Press.

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