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INSIDER AND CAPITALIST CONTROLLED FIRMS: EQUIVALENCE AND DIFFERENCES

by

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ABSTRACT

Two ownership types are considered: the insider-controlled or co-operative firm which maximizes average net returns to labor, and the capitalist managed firm which maximizes average net returns to capital. The set of efficient production techniques and income distribution achieved by either type of firms is found to be the same as the standard profit maximizing firm. At the point where labor productivity is maximized, interest rate is equal to the growth rate of output and real wage equals labor productivity for both types of firms. The differences due to ownership type emerge, however, when the firms are subjected to comparative static exercises in the form of output and input subsidies.

JEL Classification Numbers: D21, J54, L21

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1. INTRODUCTION

In recent years, many countries have opted for transition to a market economy to increase efficiency in production and promote economic growth. The crucial element in this transition is transfer of ownership rights. A somewhat natural interim phase in this process, common to most transtition economies, has been transfer of ownership/management rights to insiders (workers), with the objective of ultimately turning the enterprise into a capitalistic one. An important question in this context is: How does ownership affect enterprise behavior? The purpose of this paper is to study the effects of ownership on variables such as productivity and factor shares particularly when all factors are variable.

We consider two types of ownership: (i) insider-controlled (IC firm), and (ii) capitalist-managed (CM firm). In the IC firm, workers cooperatively run the firm, buy capital equipment or its services from the market and maximize average returns net of costs. This is, thus, the typical labor-managed firm discussed in the literature, where the problem of the firm is, to use standard notation, maximize $(pQ-rK)/L$, with p and r taken as given.[1] In the capitalist-managed firm (CM firm), on the other hand, "owners of machines (K) get together, put their machines into a common enterprise, hire labour (L) and sell output ...on the best terms which they can obtain on the market, and run the concern so as to maximize the return per machine" (Meade 1972 p 416). In other words, we specify that the problem of the CM firm is to maximize $(pQ-wL)/K$ with given p and w. This is different from the standard profit maximizing firm where the problem is to maximize $(pQ-rK-wL)$. There are two reasons why we choose a different objective function for the CM firm:[2] First, by analogy with the IC firm, it makes more sense to specify that the capitalists maximize *average* returns to their assets rather than total returns. If there is only one capitalist investing his limited assets in one firm, he may want to maximize profits. If, on the other hand, the firm is a joint-stock company owned by many shareholders, investment expenditures are not limited by their assets. It is perhaps more appropriate in this case to maximize earnings per each share. Secondly, the standard profit maximizing firm has been widely studied, and there is already a substantial literature comparing such firms with the IC firm. It is, therefore, of some theoretical interest to understand the similarities and differences between the IC firm and the CM firm that maximizes average returns to capital.

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1 Also called 'worker-managed' or 'Illyrian' firm. See for example, Ward (1958), Domar (1966), Vanek (1970), Meade (1972), Horvat (1982), and Prasnikar et al. (1993). Equivalently, the workers could take average salary w as given and maximize $(pQ-rK - wL)/L$.

2 Dubravcic (1970), Meade (1972) and Horvat (1982) also use a similar objective function for the CM firm. Meade refers to the CM firm as a 'Joint-Stock firm' and the typical neoclassical profit-maximizing firm as the 'Enterpreneurial firm'.

We also assume that capital is producible using labor input. Thus, each firm is assumed to be integrated, producing both output and capital input. This gives us an explicit relation between cost of capital, interest rate and wage rate and helps us avoid unit problems associated with measurement of total factor productivity, which is essential for analysing efficiency aspects.

The plan of the paper is as follows: The next section contains results showing equivalence of the solutions of the two types of production organizations. It shows that irrespective of whether the production organization is cooperative or capitalistic, the set of efficient production techniques and income distributions are the same. Section 3 contains comparative static results relating to changes in prices of output and inputs. We conclude in section 4 with a few brief remarks.

2. Equivalence Between Insider-Controlled and Capitalist-Managed Firms

We will assume that both types of firms have identical technological conditions. Thus they differ only in their objective functions. Output Q is produced according to the production function $Q = Q(K, L), Q_K > 0, Q_L > 0, Q_{KK} < 0, Q_{LL} < 0$ where K is capital and L labor. Capital K in turn is produced using labor L_k according to a fixed input-output coefficient (γ) technology.[3] Each firm thus produces Q as well as K. Let δ the depreciation rate for capital. If producers of capital good use i as the discount rate, the user cost (or rental) of capital is given by[4]

(1) $$r = \gamma(i + \delta)w$$

The Insider-Controlled Firm (IC Firm)

The IC firm is assumed to maximize the average returns to insiders (workers and managers) net of capital costs. Thus, we specify that the objective of the IC firm is to maximize the average wage rate. Competition among the IC firms will ensure that revenue equals expenditure, so we have, using (1), the identity

(2) $$pQ = Kr + Lw = \gamma K(i + \delta)w + Lw$$

$$\Rightarrow \quad w = \frac{pQ}{\gamma K(i + \delta) + L}$$

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3 Note that L is labor input for producing Q, whereas L_k is labor input for producing K. The total employment is $L+L_k$.

4 Cost of producing 1 unit of K at the margin is $\gamma w(1+i)$. The present value of returns to this unit of capital is $r[1 + (1-\delta)/(1+i) + ((1-\delta)/(1+i))^2 + ...] = r(1+i)/(i+\delta)$. Equating cost to present value yields $r=\gamma(i+\delta)w$.

Therefore we assume that the IC firm's problem is

$$\underset{K,L}{Max}\ w \equiv \frac{pQ}{\gamma K(i+\delta)+L}$$

given interest rate i and output price p. The first order conditions, assuming an interior solution and after simplification using (1) and (2), are

(3) $pQ_K = [pQ.\gamma(i+\delta)]/[\gamma K(i+\delta)+L] = \gamma(i+\delta)w = r$

(4) $pQ_L = pQ/[\gamma K(i+\delta)+L] = w$

It is interesting to note that the first order conditions are exactly the same as in the case of a typical profit-maximizing firm which takes both i and w as given.

The Capitalist-Managed Firm (CM Firm)

In the CM firm, the capitalist(s) own the capital and hire laboreres at the market wage rate. We assume that the problem of the CM firm is to maximize the gross rate of return to investment $(i+\delta)$ which is equivalent to maximizing $r=\gamma(i+\delta)w$ when w is given. That is,

$$\underset{K,L}{Max}\ (i+\delta) \equiv \frac{pQ-wL}{\gamma Kw}$$

given p and wage rate w. Again, the first order necessary conditions, assuming an interior solution and after simplification using (1) and (2), are

(5) $pQ_K = (pQ-wL)/K = \gamma(i+\delta)w = r$

(6) $pQ_L = w$

Note again the similarity between these first order conditions with those of the IC firm and the typical neoclassical profit-maximizing firm. This suggests that the two may indeed lead to the same optimal choice, if input prices are right. This is what we obtain.

Equivalence: *The production organizations represented by the IC firm and the CM firm are equivalent if factor rewards are appropriately chosen. In other words, the set of efficient production techniques achieved by the CM firm (IC firm) can be achieved by an IC firm (CM firm), if the rental on capital (wage rate) is appropriately fixed.*

The proof is simple.[5] Interestingly, a similar equivalence between the IC and the CM firms was first noted by Wicksell (1893), although his technology involving Austrian production schemes is different from the neo-classical technology (see Horvat 1982 p 301).

The two production organizations are similar in at least two other aspects:

(i) Constant returns to scale: An interesting implication of the first order conditions in either type of firm is that the point of the maximum lies in the region where the production function exhibits constant returns to scale (CRS).[6] One implication of this result is that *maximizing the rate of return is not meaningful if there is no CRS.*

(ii) Productivity: Total factor productivity (TFP) is output per unit of an aggregate (composite) measure of inputs. In our case, we define productivity as output per unit of the labor equivalent of all inputs, i.e.,

$$q \equiv Q/[L+\gamma(g+\delta)K]$$

where g is the growth rate of the output of the firm.[7] It is easy to see that for both production organizations, at the point of maximum of productivity q, the interest rate equals growth rate of output and the productivity equals real wage rate, i.e., $i=g$ and $q=w/p$. This result also implies that a positive relationship between q and w/p is an indicator of inefficiency.[8]

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5 Let (K^*,L^*) be the CM firm's optimal choice when wage rate is w^*. Then $i^* = [pQ(K^*,L^*) - L^*w^*]/\gamma K^*w - \delta > i = [pQ(K,L) - Lw]/\gamma Kw - \delta$ for any $(K,L) \neq (K^*,L^*)$. We claim that if $i=i^*$, the IC firm will choose the same (K^*,L^*) to maximize w. Suppose not. Then there is another (K',L') such that $w' = pQ(K',L')/[\gamma K'(i^*+\delta)+L'] > w^*$. Define $i = [pQ(K,L) - Lw]/\gamma Kw - \delta$. Clearly, $i = [pQ(K,L) - Lw]/\gamma Kw - \delta$. A contradiction, since i^* is the maximum by assumption. Similarly, let (K'',L'') be optimal choice of the IC firm when $i=i''$. Let $w'' = pQ(K'',L'')/[\gamma K''(i^*+\delta)+L'']$. It is easily seen, using similiar argument, that (K'',L'') also maximizes profit rate for the CM firm when wage rate is w''.

6 This is seen, for the IC firm, as follows. Multiply (3) by K and (4) by L and add the resultant equations to obtain $p(KQ_K+LQ_L)=rK+wL$. The r.h.s. is equal to pQ by product exhaustion (2) so we get $KQ_K+LQ_L=Q$. In other words, the Euler theorem for (linear) homogeneous functions must hold at the equilibrium of the IC firm. This is a well-known result for labor-managed firm noted, e.g., in Vanek (1970), Smith and Ye (1988) and Haruna (1986). The same holds also for the CM firm as can be seen by applying the same operations on (5) and (6).

7 This also gives a measure of labor productivity which takes into account both direct and indirect labor inputs, i.e., TFP $= Q/(L+L_k)$. When the output of the firm grows at a rate g, we have $K_{t+1} = (1+g)K_t = (1-\delta)K_t + L_{kt}/\gamma$, i.e., $L_k = \gamma(g+\delta)K$. Therefore, TFP $\equiv q = Q/[L+\gamma(g+\delta)K]$.

8 Setting $\partial q/\partial L = 0 \Leftrightarrow [L+\gamma(g+\delta)K]\partial Q/\partial L - Q = 0$. Using (4) or (6) and the definition of q yields $w/p=q$. Now $\partial q/\partial K = 0 \Leftrightarrow [L+\gamma(g+\delta)K]\partial Q/\partial K - Q\gamma(g+\delta) = 0$. Using (3) or (5) and the definition of q again, we have $\gamma(i+\delta)w/p = q\gamma(g+\delta)$. Since $w/p=q$, $i=g$ using (2). Note the similarity of this result to the golden rule in the growth literature. one way to test for long run efficiency is to test whether $w/p=q$. Since $w/p \leq q$ (i.e., wages not higher than labor productivity) by feasibility, an equivalent test of inefficiency is whether $w/p<q$. It is easy to show that $\partial q/\partial w > 0 \Leftrightarrow w/p<q$ (see Appendix B).

Note that the objective function of either of the firms is not always concave in *(K,L)*. That would imply that the first order conditions are only necessary (but not sufficient) conditions for a maximum. If workers or capitalists rely only on the marginal conditions or local information based on price signals, they may reach a local (and not the global) maximum, and the solution may not be efficient.[9]

3. COMPARATIVE STATICS

In most economies in transition from socialism to market, controls on output and input prices of many commodities are being relaxed gradually. In this section we explore the comparative static response of both firms to changes in output and input prices.

In this context, the four important equations for both types of firms are the two first order conditions [(3) and (4) for the IC firm, (5) and (6) for the CM firm] and the product exhaustion equation (2). As we noted before, the CRS property of the optimal solution of either type of firms creates certain difficulties in comparative static exercises (see Appendix). As a result, K and L and, hence Q, cannot be determined from the first order conditions. However, it is also well-known that we could still elicit important information about capital intensity ($k \equiv K/L$) and productivity.

Table 1 summarizes the response of both firms to output and input price increases. We discuss them below. The proofs are given in the Appendix.

Output Price Increase

What happens to factor prices, choice of technique (capital intensity) and productivity when output price p goes up, say, due to price liberalization? It is easily seen that

Differences: *In the IC firm, an increase in the output price* p *results in an increase in wage rate* w, *capital intensity* k *and total factor productivity* q. *In the CM firm, on the other hand, the effects are exactly the opposite, i.e., an increase in the rental rate (hence a decrease in wage rate) and a decrease in capital intensity and productivity.*

When output price goes up, the real wage (w/p) would decline, provided w is exogenously given. This is what happens in case of the CM firm, and the relative price of capital increases. In case of the IC firm, however, w is residually determined and thus is an increasing function of the output price. An increase in output price is then accompanied by two opposing effects on the wage rate. The positive effect is found (using the Envelope theorem) to dominate the opposite effect, resulting in an increase in real wage rate.

It seems rather perverse that as output price goes up, the workers cooperative ends up using relatively more capital and hence less labor! A corollary of this result is that if the level of capital is given, say, in the

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9 It can be shown that if the objective function of the IC firm is concave in *(K,L)*, the objective function of the CM firm is also concave. The converse is not true. The efficiency aspects of the solutions for the two types of firms are subject of a forthcoming paper.

short run, an increase in the output price would lead to a decline in the level of employment in a labor-managed firm. Also the output level would decline implying a backward-bending supply curve in the short run. This perverse aspect of a labor-managed firm has been widely noted in the literature,[10] although such behavior is easily explained after noting that an increase in output price is actually translated into an increase in the wage rate leading to factor substitution away form labor. In the long run, however, the shape of the supply curve is not determinate, but output *per worker* increases in response to an increase in the price of output.

The behavior of the capitalist firm may also seem perverse in that the capitalists choose to employ relatively less capital when they get higher prices for the output. Again, this behavior is easily explained by noting that the output price increase is in effect an increase in the relative price of capital. As a result, relatively more labor is used. Also productivity, which as defined here is actually a measure of labor productivity, decreases.

Input Price Increase

For both firms under consideration, only one input price is given exogenously, the other being the maximand itself. As noted earlier, the output price increase is directly translated into an increase in the wage rate in case of the IC firm and an increase in the rental rate for the CM firm. In other words, an output price increase is in effect the same as an increase in interest subsidy to the IC firm and an increase in wage subsidy to the CM firm. Thus, the response of the IC firm to an increase in the rental rate is exactly the opposite of its response to an increase in its output price. Similarly, the response of the CM firm to an increase in the wage rate is the opposite of its response to an increase in output price.

4. CONCLUSION

We started by specifying that the objective function of the IC firm is to maximize average net returns to labor and that of the CM firm, to maximize average net returns to capital. It turns out that the solutions for both firms are not only identical, they are also the same as the solution of standard profit maximizing firm. It is thus seen that irrespective of whether the production organization is cooperative or capitalistic, the set of efficient production techniques are the same.

The first order conditions from both firms' optimization problems imply that the point of the maximum lies in the region where the production function exhibits constant returns to scale. An implication of this result is that *maximizing the rate of return is not meaningful if there is no CRS.*

An interesting result for both types of firms is that at the point where long run labor productivity is maximized, interest rate is equal to the growth rate of output and real wage equals labor productivity. This implies that labor productivity is not at its maximum when labor productivity is not equal to real wage. When labor productivity is greater than real wage, they are positively related. *A simple test of inefficiency, therefore, is to check if labor productivity and real wage rate are positively related.*

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10 See, among others, Domar (1966), Vanek (1970), Meade (1972), Bonin and Fukuda (1986), Breyer (1987), Kahana (1987), Rosefielde and Pfouts (1987), and Prasnikar et al. (1993).

When output prices change, say due to a change in government tax-subsidy policy or relaxation of price controls, the two types of firms show very different responses (Table 1). It is seen that when output price increases, each type of firm ends up using relatively less of the factor that the owners own. A direct corollary of this result is that in the short run where the capital stock is given, the IC firm will have a backward-bending output supply curve—a perverse behavior which has been noted widely in the literature on labor-managed firms. The long run output supply curve, however, is indeterminate for either type of firms. The seemingly divergent behavior of the two ownership types, however, is easily explained when we realize that an output price increase is directly translated into an increase in the real wage rate for the IC firm and an increase in the rental rate for the CM firm.

It may be noted that the equivalence results for the two types of firms crucially depend on the set of (rather universal) assumptions about their behavior. The equivalence will break down if, for example, we introduced labor-leisure choice on the part of the insiders, because clearly the capitalists do not face this choice in the use of their assets.

TABLE 1
Response to Policy Changes:
Differences Between the IC Firm and the CM Firm

	IC Firm	CM firm
When output price *p* increases		
Wage rate	increases	exogenous
Rental rate	exogenous	increases
Capital intensity *(k)*	increases	decreases
Productivity *(q)*	increases	decreases
When input price (*i* for IC firm, and *w* for CM firm) increases		
Wage rate	decreases	--
Rental rate	--	decreases
Capital intensity *(k)*	decreases	increases
Productivity *(q)*	decreases	increases

APPENDIX

Comparative Static Results

Indeterminacy of K, L and Q due to CRS

For the IC firm, total differentiation of the two first order conditions (3) and (4) yields

(A1) $$pQ_{KK}dK + pQ_{KL}dL = \frac{\gamma(i+\delta)Q}{\gamma(i+\delta)K+L}dp + \left(\frac{pQ\gamma}{\gamma(i+\delta)K+L} - \frac{pQK\gamma^2(i+\delta)}{(\gamma(i+\delta)K+L)^2}\right)di$$

(A2) $$pQ_{LK}dK + pQ_{LL}dL = \frac{Q}{\gamma(i+\delta)K+L}dp - \frac{pQK\gamma}{(\gamma(i+\delta)K+L)^2}di$$

To solve for dK and dL in terms of dp and dw, the Hessian $\begin{pmatrix} Q_{KK} & Q_{KL} \\ Q_{LK} & Q_{LL} \end{pmatrix}$ has to be non-singular, i.e., $Q_{KK}Q_{LL}$-$Q_{KL}Q_{LK}\neq 0$. Now, first differentiate the CRS equation (13) w.r.t. K and again, w.r.t. L to obtain

(A3) $$Q_{KK}/Q_{LK} = -L/K,$$

(A4) $$Q_{KL}/Q_{LL} = -L/K$$

Combining the two, it follows that $Q_{KK}Q_{LL}$-$Q_{KL}Q_{LK}=0$. In other words, equations (A1) and (A2) are not linearly independent.

Similarly for the CM firm, total differentiation of the first order conditions (5) and (6) yields

(A5) $$pQ_{KK}dK + pQ_{KL}dL = (Q/K - Q_K)dp - (L/K)dw$$

(A6) $$pQ_{LK}dK + pQ_{LL}dL = -Q_L dp + dw$$

The Hessian determinant is again zero showing that these two equations are not linearly independent.

Comparative Static Results

Let $k \equiv K/L$, the capital-labor ratio in the production of Q. Then,

(A7) $$dk = (LdK - KdL)/L^2$$

Now, define elasticity of susbstitution as $\sigma=dln(K/L)/dln(dK/dL)$ which simplifies to $\sigma=Q_KQ_L/Q_{KL}Q$ using the Euler theorem for CRS production function. Using the first order conditions (3) and (4) [or (5) and (6)], it follows that

(A8) $\sigma = Q_KQ_L/Q_{KL}Q = (r/p)(w/p)(1/Q)(1/Q_{KL})$

Output Price Increase

(I) For the IC firm, (i) $\partial w/\partial p>0$, (ii) $\partial k/\partial p>0$, and (iii) $\partial q/\partial p\geq 0$.

Proof: (i) By the envelope theorem, $\frac{\partial w}{\partial p}=\frac{Q}{\gamma K(i+\delta)+L}>0$.

(ii) Set $di=0$ in (A2) and divide both sides by dp. Since $Q_{LK}=Q_{KL}$, substituting for Q_{LL} from (A4) yields

$$\partial k/\partial p = Q/[\gamma(i+\delta)K+L]pQ_{KL}L = Q\sigma/Lr > 0.$$

(iii) Note that g is exogenous. We have

$$\frac{\partial q}{\partial p}=\frac{w\gamma(i-g)}{p[1+\gamma(g+\delta)k]^2}\frac{\partial k}{\partial p}$$

Since ($q\geq w$ and hence) $g\leq i$ by feasibility, $\partial q/\partial p\geq 0$.

(II) For the CM firm, (i) $\partial i/\partial p>0$, (ii) $\partial k/\partial p<0$, and (iii) $\partial q/\partial p\leq 0$.

Proof: (i) Using the envelope theorem, we have $\frac{\partial i}{\partial p}=\frac{Q}{\gamma Kw}>0$.

(ii) Set $dw=0$ in (A5) and divide both sides by dp. It follows, using (A3), that

$$\partial k/\partial p=-\lambda\sigma/r < 0.$$

(iii) Again, the expression for $\partial q/\partial p$ is the same as in case of IC firm. The result follows from (ii).

Input Price Increase

(III) *For the IC firm, (i) $\partial w/\partial i<0$, (ii) $\partial k/\partial i<0$, and (iii) $\partial q/\partial i\leq 0$.*

Proof: (i) By the Envelope theorem, $\frac{\partial w}{\partial i} = -\frac{pQ.\gamma K}{(\gamma K(i+\delta)+L)^2} < 0$.

(ii) The proof is very similar to (I). The response to change in i is easily computed by setting $dp=0$ in (A2) and dividing both sides by di. It follows, using (16), that $\partial k/\partial i = -k\sigma/(i+\delta) < 0$.

(iii) $\frac{\partial q}{\partial i} = \frac{w\gamma(i-g)}{p[1+\gamma(g+\delta)k]^2}\frac{\partial k}{\partial i}$. The result follows because $\partial k/\partial i<0$ and $i \geq g$ by feasibility.

(IV) *For the CM firm, (i)* $\partial i/\partial w<0$, *(ii)* $\partial k/\partial w>0$, *and (iii)* $\partial q/\partial w \geq 0$.

Proof: (i) By the Envelope theorem, $\frac{\partial i}{\partial w} = -\frac{pQ}{\gamma K w^2} < 0$.

(ii) Setting $dp=0$ in (A5) and dividing both sides by dw, $\partial k/\partial w = 1/(LpQ_{KL})$. Since $Q_{KK}<0$ and $Q_{LL}<0$, from (A3) and (A4), $Q_{KL}>0$. Thus, $\partial k/\partial w>0$.

(iii) We have $\frac{\partial q}{\partial w} = \frac{w\gamma(i-g)}{p[1+\gamma(g+\delta)k]^2}\frac{\partial k}{\partial w}$. So $\partial q/\partial w \geq 0$ because $g \leq i$ and by (ii) above.

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