UNCERTAINTY AND THE PRODUCTION DECISIONS OF OWNER-MANAGED AND LABOR-MANAGED FIRMS

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UNCERTAINTY AND THE PRODUCTION DECISIONS OF OWNER-MANAGED AND LABOR-MANAGED FIRMS

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UNCERTAINTY AND THE PRODUCTION DECISIONS OF OWNER-MANAGED AND LABOR-MANAGED FIRMS

Abstract

The purpose of this paper is to re-examine some of the standard results regarding the production decisions of owner-managed firms (Sandmo (1971)) and labor-managed firms (Muzondo (1979)) facing price uncertainty. The standard analytical framework assumes that firms make single-period, ex ante production decisions-they produce before the output price is revealed-and concludes that the risk averse owner-managed (labor-managed) firm produces a smaller (greater) output under price uncertainty than under price certainty. This paper suggests an alternative and more realistic analytical framework which allows firms to make multiple-period, ex post production decisions. This alternative framework leads to production decisions which differ from the standard results. For example, it is shown that the production decisions of risk-neutral firms are no longer similar to those reached under condition of certainty and that risk-averse owner-managed firms do not necessarily produce a smaller output under price uncertainty.

UNCERTAINTY AND THE PRODUCTION DECISIONS OF OWNER-MANAGED AND LABOR-MANAGED FIRMS

I. INTRODUCTION

Over the last decade several papers have examined the effects of output price uncertainty on the production decision of firms. One of the earliest contribution in this area was by Sandmo (1971). He and others have shown that the level of output of an owner-managed (O-M) firm producing under perfect competition and facing price uncertainty depends on the owner's attitude toward risk.[1] The risk-averse O-M firm produces less than the risk-neutral O-M firm which, in turn, produces less than the risk-seeking O-M firm. Sandmo and others define certainty to be a situation in which the firm faces the mean of the probability distribution of output prices with certainty. In other words, the certain price is defined as the mean price. In this context, the level of output under price certainty equals the level of output that would be produced under price uncertainty and risk neutrality. Consequently, Sandmo's conclusion can be restated as follows: the risk-averse O-M firm produces a smaller output under price uncertainty than under price certainty and the risk seeking O-M firm produces a larger output under price uncertainty than under price certainty.

In this paper I will argue that the definition of certainty adopted by Sandmo and other students of the theory of the firm under price uncertainty is arbitrary. An alternative and more realistic definition of certainty is suggested which modifies some of the standard conclusions regarding the production decision of firms under price uncertainty. Specifically, I show that:

(1) when the O-M firm is risk neutral, the certainty output is no longer equal to the output produced under price uncertainty. In this case the risk-neutral O-M firm will produce a larger output under price uncertainty than under price certainty;

(2) the behavior of the risk averse O-M firm facing uncertain demand is no longer unambiguous. I will show that the risk-averse O-M firm does not necessarily produce a smaller output under price uncertainty than under price certainty;

(3) the production decison of the risk-seeking O-M firm is not affected by the alternative definition of certainty presented in this paper. The risk-seeking O-M firm will still produce more under price uncertainty than under price certainty.

Following the work of Baron (1970), Sandmo (1971) and Batra and Ullah (1974) on the O-M firm, several authors have examined the effects of output price uncertainty on the production decision of labor-managed (L-M) firms. Early contributors in this area are Muzondo (1979) and Ramachandran, Russell and Seo (1979)[2]. The theory of the L-M firm under price certainty was first developed by Ward (1958) and later extended by Vanek (1970) and others. A labor-managed firm is an enterprise organized and managed by workers who are the firm's proprietor-members, in contrast to the owner-managed firm which hires labor. The objective of the L-M firm is to maximize the utility of the income-per-worker whereas the O-M firm seeks to maximize the owner's utility of total profits. Muzondo (1979) and Ramachandran et al. (1979) have shown that the level of output of a L-M firm producing under perfect competition and facing price uncertainty depends on the workers' attitude toward risk. The risk-averse L-M firm produces more under price uncertainty than under price certainty and the risk-seeking L-M firm produces less under price uncertainty than under price certainty. Again, certainty is defined as a state equivalent to risk-neutrality. Note that the production decisions of the L-M firm under price uncertainty are exactly the opposite of those of the O-M firm. For the L-M firm, risk aversion implies a larger output whereas for the O-M firm it implies a smaller output under price uncertainty than under certainty/risk neutrality.

As in the case of the O-M firm, I will show below that with the alternative definition of certainty presented in this paper some of the conclusions reached by Muzondo (1979) and Ramachandran et al. (1979) are modified. Specifically, I will show that:

(1) when the L-M firm is risk neutral, the certainty output is no longer equal to the output produced under price uncertainty. In this case the L-M firm produces more under risk neutrality and price uncertainty than under price certainty;

(2) the production decision of the risk averse L-M firm is not affected by the alternative definition of certainty introduced in this paper. It still produces more under price uncertainty than under price certainty;

(3) The behavior of the risk seeking L-M firm facing uncertain demand is no longer unambiguous. I will show that the risk-seeking L-M firm does not necessarily produce a smaller output under price uncertainty than under price certainty.

The rest of this paper is organized as follows. Section II develops an alternative framework within which firms' production decisions under uncertainty can be analyzed. Section III examines the behavior of owner-managed firms within the new framework. In Section IV, the behavior of labor-managed firms is investigated. Concluding remarks are contained in the last section.

II. PRODUCTION DECISIONS UNDER PRICE UNCERTAINTY: AN ALTERNATIVE FRAMEWORK.

Consider a perfectly competitive firm facing an uncertain output price $\tilde{p}$ where $\tilde{p}$ is a parametrically given random variable with a known density function. The firm is a price-taker in a probabilistic sense. It cannot affect the probability distribution of future output prices. Production is assumed to take place over the short run. The amount of capital stock is fixed and output can be varied only by changing labor units . In this case there is a one-to-one correspondence between optimal employment decisions and optimal production decisions[3]. The firm can produce the same good period after period but is not allowed to carry stocks over to the next period[4].

Single-period production decisions

Assume first that decisions are made over a single-period horizon. In this case, uncertainty means that the firm makes it employment and production decisions before the actual output price is revealed in the market at the end of the period[5]. Once the price is revealed, the firm sells all its output at the revealed price. In other words, we have a case of *ex ante* employment and production decisions since the firm makes these decisions at the beginning of the period without knowing the actual price at which it will sell its output at the end of the period.

As pointed out in the introduction, certainty in this framework is a situation in which the firm faces the mean price of the probability distribution with certainty. It is implicitly assumed that, say, some government agency has stabilized prices at their average level. Consequently, what authors like Sandmo (1971), Muzondo (1977) and others are doing is to compare the behavior of a risk averse firm under price uncertainty to its behavior under a policy of price stabilization.

An alternative and more realistic specification of certainty is suggested here. Certainty would be better qualified as a situation in which the firm waits until the end-of-period output price is revealed in the market and then makes its employment and production decisions. In this case the firm makes *ex post* decisions. In other words, the firm produces its output after it has observed the actual price at which this output can be sold[6]. This is clearly a situation where decisions are made under condition of certainty. By delaying production until the output price is revealed, the firm has in effect removed all the risk which accompanies *ex ante* employment and production decisions.

Multiple-period production decisions

The previous discussion can be easily extended to a multiple-period framework. Assume that the firm faces that same probability distribution of prices period after period and that these distributions are independent of one another. In the standard framework of Sandmo (1971), Muzondo (1977) and others this assumption implies that the firm's optimal level of *ex ante* employment and production is identical in each period. Consequently, the average level of employment/production over multiple periods will equal the single-period optimal level of employment and production.

Suppose now that the firm decides to make *ex post* employment and production decisions. As in the single-period framework, the firm will wait for the actual price to be revealed in the market period after period and then produce the corresponding profit-maximizing level of output. The price that the firm will observe at the end of each period will be drawn from the same probability distribution of prices but will generally not be the same price period after period. Consequently, the optimal level of employment (and output) will not be identical period after period. It is important to note that although the firm operates under price certainty (all periodic decisions are made on an *ex post* basis), it nevertheless faces price *instability* since prices vary period after period. To summarize, the standard analytical framework to deal with firms' behavior under price uncertainty assumes a single-period *ex ante* setting whereas here we suggest a multiple-period *ex post* setting.

III. COMPARATIVE EMPLOYMENT AND PRODUCTION DECISIONS OF OWNER-MANAGED FIRMS: UNCERTAINTY VS. CERTAINTY

Using the multiple-period framework presented in the previous section we can now compare the average level of employment and production of the O-M firm in the case of price uncertainty (ex ante decisions) to the case of price certainty (ex post decisions). To do this we must examine the equilibrium conditions of the O-M firm under price uncertainty and price certainty.

Equilibrium under price uncertainty

Consider first a single-period horizon. Under price uncertainty (p) the objective of the O-M firm is to hire the number of workers (L) and produce the corresponding level of optimal output (Q(L)) that maximizes the expected utility of the owner's total profit ($E[U(\pi)]$). We have:

$$\max_{L} E\left[U(\pi = p.Q(L) - wL - F)\right] \qquad (1)$$

where w is the competitive wage rate, F are the fixed costs incurred in the short run and $U(\pi)$ is a von Newmann-Morgenstern (1953) utility function for money which summarizes the owner's attitude toward risk. It has the following properties: $U'(\cdot) > 0$ with $U''(\cdot) < 0$ under risk aversion, $U''(\cdot)=0$ under risk neutrality and $U''(\cdot) > 0$ under risk seeking.

The first order condition for an extremum is:

$$E\left[U'(\pi)\cdot\frac{\partial\pi}{\partial L}\right] = 0 \qquad (2.a)$$

and the second order condition for a maximum is assumed to be satisfied for the problem at hand. Using the relationship $E(A\cdot B)= E(A).E(B)+ COV(A,B)$, condition (2.a) can be rewritten as:

$$E[U'(\pi)] \cdot E\left[\frac{\partial\pi}{\partial L}\right] + COV\left(U'(\pi), \frac{\partial\pi}{\partial L}\right) = 0$$

or

$$E\left[\frac{\partial\pi}{\partial L}\right] = - \frac{COV(U'(\pi), \partial\pi/\partial L)}{E[U'(\pi)]} \qquad (2.b)$$

On the RHS of (2.b) $E[U'(\pi)]$ is positive and the covariance term has the sign of $U''(\pi)$[7]. Since $\frac{\partial\pi}{\partial L} = pQ_L - w$ then (2.b) becomes:

$$E[pQ_L - w] \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \quad \text{if } U''(\pi) \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} 0 \tag{3.a}$$

where $Q_L = (\partial Q / \partial L)$ is the marginal product of labor (MPL) with $Q_{LL} < 0$. Condition (3.a) can be further rewritten as:

$$\bar{p}Q_L(L_u) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} w \quad \text{if } U''(\pi) \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} 0 \tag{3.b}$$

where $\bar{p}$ is the mean output price and L_u is the optimal level of employment under price uncertainty. Under risk aversion ($U'' < 0$) the MPL exceeds the wage rate w and therefore the optimal level of employment under price uncertainty (L_u^{RA}) is smaller than in the case of risk neutrality/certainty ($L_u^{RN} = L_c$) where $U''=0$ and MPL= w. Under risk seeking ($U'' > 0$) MPL < w and therefore the optimal level of employment under price uncertainty (L_u^{RS}) is larger than in the case of risk neutrality/certainty. This is the standard Sandmo (1971) result which is summarized as follows:

$$L_u^{RA} < L_u^{RN} = L_c < L_u^{RS} \tag{4}$$

where L_c is the level of employment under certainty.

Consider now a multiple-period framework. Recall that the firm employs the same number of workers in each period. Hence, the average level of employment over a multiple-period horizon is simply equal to the single-period level of employment and (3.b) can be rewritten as:

$$\bar{p}Q_L(\bar{L}_u) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} w \quad \text{if the owner is} \begin{Bmatrix} \text{risk averter} \\ \text{risk neutral} \\ \text{risk seeker} \end{Bmatrix} \tag{5.b}$$

The average level of employment under price uncertainty in a multiple-period framework must therefore satisfy:

$$\bar{L}_u^{RA} < \bar{L}_u^{RN} = \bar{L}_c < \bar{L}_u^{RS} \tag{5.b}$$

Equilibrium under certainty with price instability

Recall that in this case the firm makes ex post decisions. Suppose that p* is the output price revealed after the end of a single period horizon. This price is known with certainty to the firm. Optimal employment and output are found at the point where:

$$E[U'(\pi)\cdot(p^*Q_L - w] = U'(\pi)\cdot(p^*Q_L - w) = 0$$

and since $U'(\pi) \neq 0$, it follows that the optimal level of employment under certainty and a single-period horizon, L_c, must satisfy the equilibrium conditions:

$$p^* Q_L (L_c) = w \qquad (6)$$

Suppose now that the O-M firm produces over a multiple-period horizon. Recall that this means that the firm faces the same probability distribution of prices period after period. Over each period, the firm waits for the actual price to be revealed and then produces the corresponding optimal level of output according to condition (6). The average level of employment in this multiple-period context must satisfy the following condition:

$$E[pQ_L (L_c)] = w \qquad (7.a)$$

assuming the wage rate w does not vary period after period. Note that both p and L_c are now random variables. Their values are known with certainty at the end of each period but p as well as L_c have, in general, different values period after period.

The equilibrium condition (7.a) can be rewritten as:

$$E(pQ_L(L_c) \equiv \bar{p}\, E(Q_L(L_c)) + Cov\,(p, Q_L) = w \qquad (7.b)$$

with $Cov(p, Q_L) < 0$

Note that the covariance term in (7.b) is negative[8]. Applying Jensen inequalities[9] to $E(Q_L(L_c))$ in (7.b) we get:

$$E(Q_L(L_c)) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} Q_L(\bar{L}_c) \quad \text{if } Q_{LLL} \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \tag{8}$$

where $Q_{LLL} > 0$ implies a convex MPL curve, $Q_{LLL} = 0$ implies a linear MPL curve and $Q_{LLL} < 0$ implies a concave MPL curve.

Equation (7.b) together with (8) imply the following equilibrium conditions:

$$\left.\begin{array}{lll} \bar{p}Q_L(\bar{L}_c) \begin{matrix} > \\ = \\ < \end{matrix} w & \text{if MPL is convex } (Q_{LLL} > 0) \\ \bar{p}Q_L(\bar{L}_c) > w & \text{if MPL is linear } (Q_{LLL} = 0) \\ \bar{p}Q_L(\bar{L}_c) > w & \text{if MPL is concave } (Q_{LLL} < 0) \end{array}\right\} \tag{9}$$

<u>Comparative employment and production decisions: uncertainty vs. certainty</u>.

We can now compare the employment and production behavior of the O-M firm under price uncertainty to its behavior under certainty and price instability. Refer to the equilibrium conditions under price uncertainty summarized in (5.b) and compare them to the equilibrium conditions under certainty summarized in (9). From them we can easily infer the relationships between optimal employment and production under price uncertainty ($\bar{L}_u$) and optimal employment and production under price certainty ($\bar{L}_c$). These relationships are summarized in Table 1.

Consider first the case of risk aversion. Regardless of the curvature of the MPL curve we have:

$$\bar{L}_c \begin{matrix} > \\ = \\ < \end{matrix} \bar{L}_u$$

This implies that the risk averse O-M firm may produce under price uncertainty an output which is greater, equal or smaller than the certainty output. This conclusion weakens considerably the earlier result established by Sandmo (1971) and others according to which risk averse O-M firms produce a smaller output under price uncertainty compared to the case where price certainty prevails.

Under risk neutrality we have $\bar{L}_c \gtreqless \bar{L}_u$ when the MPL curve is convex and $\bar{L}_c < \bar{L}_u$ when the MPL curve is not convex. In the former case comparative employment is ambiguous. In the latter case the risk neutral O-M firm produces a greater output under price uncertainty than under price certainty. Again, these results differ from those drawn from the standard ex ante framework which does not distinguish between risk neutral behavior and behavior under certainty.

Finally, when the firm is risk seeker and the MPL curve is not convex, employment and production under uncertainty are greater than under certainty. This result is in agreement with that obtained in the standard ex ante, single period framework. Ambiguous comparative employment and production will occur only if the MPL curve is convex.

IV. COMPARATIVE EMPLOYMENT AND PRODUCTION DECISIONS OF LABOR-MANAGED FIRMS: UNCERTAINTY VS. CERTAINTY.

In this section the focus is on the L-M firm to which the analytical framework developed in the previous section is applied.

Equilibrium under price uncertainty

We begin with a single-period horizon. The L-M firm seeks to maximize the expected utility[10] of the income-per-worker (Y). We have:

$$\text{Max } E\left[U\left(Y = \frac{pQ(L) - F}{L}\right)\right]$$

The first order condition for an extremum is:

$$E\left[U'(Y)\cdot\frac{\partial Y}{\partial L}\right] = 0$$

and the second order condition for a maximum is assumed to be satisfied for the problem at hand. The production function is well behaved, that is, $Q_L > 0$, $Q_{LL} < 0$ and production takes place in the range within which the MPL (Q_L) is smaller than the average product of labor ($a = Q/L$). The first order condition can be rewritten as:

$$\frac{1}{L}\cdot E[U'(Y)\cdot(pQ_L - Y)] = 0 \qquad (10)$$

Using the relationship $E(AB) = E(A) \cdot E(B) + Cov(A.B)$ and noting that $p(Q_L - Y) = p(Q_L - a) - F/L$, condition (10) becomes:

$$E(pQ_L) = E(Y) - (Q_L - a)\left[\frac{Cov(U'(Y),p)}{E[U'(Y)]}\right]$$

Since the term $(Q_L - a)$ is negative by assumption and since the sign of the covariance is that of $U''(Y)$[11] it follows that the optimal level of employment under price uncertainty (L_u) must satisfy the conditions:

$$\bar{p}Q_L(L_u)\begin{Bmatrix}<\\=\\>\end{Bmatrix}E[Y(L_u)] \quad \text{if } U''(Y)\begin{Bmatrix}<\\=\\>\end{Bmatrix}0 \qquad (11)$$

The risk averse L-M firm $(U'' < 0)$ employs and produces more $(E(pQ_L) < E(Y))$ than the risk neutral L-M firm $(U'' = 0)$ which is also the "certainty" firm. The opposite holds for the risk-seeking firm. This is the standard result established by Muzondo (1977) and Ramachandran et al. (1977). It can be summarized as follows:

$$L_u^{RA} > L_u^{RN} = L_c > L_u^{RL}$$

Extending this result to a multiple-period framework as we did for the O-M firm we get:

$$pQ_L(\bar{L}_u)\begin{Bmatrix}<\\=\\>\end{Bmatrix}E[Y(\bar{L}_u)] \quad \text{if workers are} \begin{Bmatrix}\text{risk averter}\\\text{risk neutral}\\\text{risk seekers}\end{Bmatrix} \qquad (12)$$

where $\bar{L}_u$ designates average employment under price uncertainty.

<u>Equilibrium under certainty with price instability</u>

Following the same procedures as in the case of the O-M firm we have:

$$E(pQ_L(L_c) - Y) = 0$$

or

$$E(pQ_L(L_c)) = E(Y) \qquad (13.a)$$

under certainty with price instability in a multiple-period framework.

The expected value of the value of the marginal product of labor is equal, in equilibrium, to the expected value of the income-per-worker.

The equilibrium condition (13) can be rewritten as:

$$E(pQ_L(L_c)) \equiv \bar{p}E(Q_L(L_c)) + \text{Cov}\ (p,Q_L) = \bar{Y} \qquad (13.b)$$

with Cov $(p,Q_L) < 0$

Applying Jensen inequalities to $E(pQ_L(L_c))$ in (13.b) - these inequalities are shown in (8)- and referring to inequalities (12) we can easily deduce the following equilibrium conditions for the L-M firm:

$$\left.\begin{array}{ll} \bar{p}Q_L(\bar{L}_c) \gtreqless \bar{Y} & \text{if MPL is convex } (Q_{LLL} > 0) \\ \bar{p}Q_L(\bar{L}_c) > \bar{Y} & \text{if MPL is linear } (Q_{LLL} = 0) \\ \bar{p}Q_L(\bar{L}_c) > \bar{Y} & \text{if MPL is concave } (Q_{LLL} < 0) \end{array}\right\} \qquad (14)$$

Comparative employment and production decisions: uncertainty vs. certainty

We can now compare the employment and production behavior of the L-M firm under price uncertainty to its behavior under certainty and price instability. Refer to the equilibrium conditions under price uncertainty summarized in (12) and compare them to the equilibrium conditions under certainty summarized in (14). From them we can easily infer the relationships between optimal employment and production under price uncertainty $(\bar{L}_u)$ and optimal employment and production under price certainty $(\bar{L}_c)$. These relationships are summarized in Table 2.

Consider first the case of risk-averse behavior. When the MPL curve is not convex the average output under certainty is smaller than the output produced under price uncertainty. This result is in agreement with the conclusion reached by Muzondo (1977) and others. Differences emerge when we examine risk-neutral and risk-seeking behavior. Under risk neutrality, output under uncertainty exceeds average output under certainty whereas in the standard ex ante single period framework they are the same. Note that the behavior of the risk-neutral L-M firm is similar to that of the risk neutral O-M firm. When the MPL curve is not convex, both produce a greater output when facing price uncertainty. Finally, the behavior of the

risk seeking L-M firm is ambiguous. It produces under price uncertainty an output that may be greater, equal or smaller than the average output under certainty. This conclusion differs from the one reached under the standard ex ante single period framework where the L-M firm produces a smaller output under price uncertainty than under price certainty.

V CONCLUDING REMARKS

In this paper I reexamined the short run employment and production behavior of owner-managed and labor-managed firms within a multiple-period framework in which output prices are uncertain and firms are allowed to make ex post employment and production decisions. I have shown that some of the conclusions drawn from the standard single-period ex ante framework adopted by Sandmo (1971), Muzondo (1977) and others are modified when firms' behavior is examined in the more realistic multiple-period ex post framework.

TABLE 1

AVERAGE EMPLOYMENT OF THE OWNER-MANAGED FIRM UNDER PRICE CERTAINTY VS. PRICE UNCERTAINTY

PRICE CERTAINTY

PRICE UNCERTAINTY: OWNER'S ATTITUDE TOWARD RISK	THE MARGINAL PRODUCT OF LABOR CURVE IS: CONVEX $Q_{LLL} > 0$	LINEAR $Q_{LLL} = 0$	CONCAVE $Q_{LLL} < 0$
RISK AVERSE $U'' < 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c \gtreqless \bar{L}_u$
RISK NEUTRAL $U'' = 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c < \bar{L}_u$	$\bar{L}_c < \bar{L}_u$
RISK SEEKING $U'' > 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c < \bar{L}_u$	$\bar{L}_c < \bar{L}_u$

TABLE 2

AVERAGE EMPLOYMENT OF THE LABOR-MANAGED FIRM UNDER PRICE CERTAINTY VS. PRICE UNCERTAINTY

PRICE UNCERTAINTY: WORKERS' ATTITUDE TOWARD RISK	PRICE CERTAINTY: THE MARGINAL PRODUCT OF LABOR CURVE IS CONVEX $Q_{LLL} > 0$	LINEAR $Q_{LLL} = 0$	CONCAVE $Q_{LLL} < 0$
RISK AVERSE $U'' < 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c < \bar{L}_u$	$\bar{L}_c < \bar{L}_u$
RISK NEUTRAL $U'' = 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c < \bar{L}_u$	$\bar{L}_c < \bar{L}_u$
RISK SEEKING $U'' > 0$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c \gtreqless \bar{L}_u$	$\bar{L}_c \gtreqless \bar{L}_u$

FOOTNOTES

1. One of the earliest contributors to the theory of the firm under price uncertainty is Baron (1970). For a mean-variance exposition of the theory of the firm under price uncertainty see Hawawini (1978).

2. See also the work of Paroush and Kahana (1980).

3. The relaxation of the assumption of a fixed capital stock will not affect the qualitative conclusions reached in the case of the owner-managed firm. It will only complicate the exposition. See for example the work of Batra and Ullah (1974) in which both labor and capital enter into the production function. In the case of the labor-managed firm, explicit recognition of capital as a variable input not only complicates the exposition but renders mathematical manipulations practically intractable because labor and capital do not play an interchangeable role in the objective function of the O-M firm. In this respect see Hawawini (1980) and (1983).

4. The absence of stock-holding possibilities is not only introduced to simplify the exposition but also for the purpose of undertaking a comparative analysis with the work of Sandmo (1971) and Muzondo (179). Their framework rules out stock-holding possibilities.

5. The period, of course, is of arbitrary length.

6. This does not mean that the firm must produce its output instantaneously.

7. The sign of the covariance is the same as the sign of the derivative of its first argument with respect to the second. This derivative is equal to $\partial U'(\pi)/\partial p$ which, in turns, equals $U''(\pi)\cdot(\partial\pi/\partial p)$. Since $\partial\pi/\partial p$ is positive it follows that the sign of the covariance is that of $U''(\pi)$.

8. The sign of the covariance is the same as the sign of the derivative $\partial Q_L/\partial p$. This derivative is equal to $Q_{LL}(\partial L/\partial p)$ and is negative since $Q_{LL} < 0$ and $\partial L/\partial p > 0$.

9. According to Jensen's inequalities, the expected value of a convex (concave) function of a random variable is greater (smaller) than the value of that function evaluated at the expected value of the random value.

10. We implicitly assume that all workers have the same utility function. This is a standard assumption when dealing with price uncertainty and the labor-managed firm. See Muzondo (1979), Ramachandran et al. (1979) and Paroush and Kahana (1980).

11. See footnote 7. The sign of the covariance is that of $U''(Y)\cdot(\partial Y/\partial p)$ which has the sign of $U''(Y)$.

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