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Occasional Paper 154

**STOCHASTIC RATIONING OF CREDIT AND
ECONOMIC ACTIVITIES IN A MODEL OF
MONOPOLISTIC COMPETITION**

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APRIL 1996

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INTRODUCTION

The development* economics literature emphasizes the role of money and credit in a way significantly different from that of the developed countries. The most important difference, it is argued, arises due to the operation of the transmission mechanism between the real and financial sectors of these economies. The financial sector or to be more specific the organized part of the financial sector (which is the most important part of the financial sector in an LDC like that of India) is directly or indirectly controlled by the Government directly through the operation of the public sector banks and non-banking financial institutions and indirectly through Central Bank's different legislations. The most important policy of the Central Bank that affects the financial sector is that the deposit as well as the lending rates in these economies are completely administered. As a result, rate of interest can no more be considered as the adjustment variable to equilibrate demand for loans with the supply of loans. Then there is either excess demand for credit or excess supply [see for example, Blinder (1987), Blinder and Stiglitz (1983), Rakshit [(1982), (1987), (1989)], Taylor (1983)]. It is argued in these works that because of the very low level of the interest rate there is a generalized excess demand for credit. In this situation of excess demand for credit, it is the allocation of credit through which the transmission mechanism between the real and financial sectors operates. As far as the requirement of credit is concerned,

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there are two uses of credit—(i) credit requirement for working capital and (ii) credit requirement for investment in fixed capital. The former is often called the short term requirement of credit and the latter the long term requirement.

Usually in the LDC literature, availability of short term loans are treated as a constraint on the total production. On the other hand, availability of additional credit for investment purpose augments the demand side [see Rakshit (1987), (1989)]. But investment has also an effect on the supply side through its effect on productivity. This role of term loans are completely ignored in the literature because of the very short run nature of these models. Another inadequacy of these models is that in the face of constraints on either of the short term or long term loans the producer-investors do not take into account these factors in their pricing decisions. Prices are based on a uniform mark up over a (constant) unit prime cost which implies some kind of imperfection in the market and excess capacity in the industrial sector. But in an imperfectly competitive framework producers do not set their profit maximizing prices without taking into account what others (which can be captured by the average price level) set. On the other hand constraint on the availability of credit for investment purposes may be incompatible with excess capacity in the industrial sector. Another lacuna that needs to be dealt with is that how constraint on one type of credit affects decision making process of other endogenous variable (s). A concrete example is that if production is constrained by the availability of credit then it will in turn affect the demand for investment. Formally speaking, these models do not have the necessary micro foundations of incorporating imperfect competition in macro models without any reference to any kind of explicit or implicit interactions between agents as well as for a particular agent

interactions between different factors, specially in respect of expectation formation.

On the other hand in the main stream literature particularly in the new Keynesian approach one can find the necessary micro foundations of macro economics incorporating imperfect competition (specifically monopolistic competition), but these are grossly inadequate as model descript for the LDCs because the institutional set up of these models are quite different from the ones that prevails in an LDC. As far as credit markets are concerned, credit rationing arises because of asymmetry of information between the lenders and the borrowers and so the usual adverse selection and moral hazard problems [see for example, Bencivenga and Smith (1993), de Mezza and Webb (1992), Jaffee and Russell (1976), Stiglitz and Weiss (1981)]. In this type of setting financial intermediation is an efficient organization which reduces the risk of a lumpy investment project in the sense of an assured return and easy liquidity to the lenders and provides credit to the producers [see Bernanke and Gertler (1987), Gertler (1988), Williamson (1987)¹]. But in this literature no distinction is made between two different uses of credit mentioned earlier, viz. working capital loans and loans for investment [see McKinnon (1973) and Shaw (1973) for these issues]. But one should distinguish between the two types of loans from the standpoint of borrowers as also from the standpoint of lenders in terms of liquidity and risk. Working capital loans are more liquid and less risky. In the literature of monopolistic competition and macro economics more emphasis is put on the explanation of nominal or real rigidities [see for example, Blanchard and Kiyotaki (1987), Blanchard and Fischer (1989)]. Very little has been written about the determinants of investment in a setting of monopolistic competition². Perhaps the single most exception

is Nishimura (1992). Nishimura considers a two-period framework where investment takes place in the first period contingent on the optimal profit function of the second period. It is assumed (and this is a crucial assumption) that a typical firm does not have perfect information about its competitors' investments which affect its profit when the firm determines its own investment. The firm forms rational expectations about the other firms' investment (measured by the average investment) on the basis of all available information. From this Nishimura addresses two questions that whether imperfect information destabilizes investment and that increased competition is stabilizing under imperfect information. But the financial market is assumed to be perfect. This is the crucial departure of this paper from that of Nishimura. I consider a framework where either because of imperfect information about the borrowers or simply being administered by the authority the bank interest rate is not market clearing one. Thus there may arise credit rationing in either or both the periods. As a result it is possible that the optimal profit function of second period is a constrained one and this in turn affects determination of optimal level of new investment. In such a setting I will consider the problems of pricing and investment for a typical firm as also for the industry. However I will not address the corresponding problems in a macro set up.

The rest of the paper is divided into three sections—Section II will consider the basic model, Section III the effects of different types of shocks on the industry wide average price and quantity and Section IV gives a brief conclusion.

Section II

As I mentioned earlier the paper considers a two-period model where investment is undertaken in the first period and

production in the second period. At the end of the second period total capital stock is completely exhausted. Needless to mention this is a very simplistic approach to study investment. But this simplification makes the analysis simple and tractable. In this model all credit is financed through loans from financial institutions, banks for short. There is no equity capital or internal fund. In the first period each firm determines its own optimal capital stock subject to the availability of bank loans. The loans for fixed capital are repaid after selling the goods. In the second period the firms determine profit maximizing levels of production and prices given capital stock and the availability of bank loans for working capital. Working capital loans are also repaid after the goods are sold. But working capital loans are loans for one period while loans for fixed capital are loans for two periods. The interest rates for both types of loans are either administered by the financial authority as in the spirit of structural macro models of Rakshit and Taylor or the rates are fixed by the banks at some level well below the market clearing one because of the informational problems as in the neo-classical literature of Stiglitz and Weiss and others. It may be mentioned that the rates may be same or different. The availabilities of credit follow stochastic processes. The product market of second period is assumed to be monopolistically competitive with number of firms being exogenously given. The case for free entry implying determination of the number of firms can be easily extended. While setting optimal price in second period each firm takes into account what is the average price in the market. As it is not known with certainty one has to form an expectation about it and in this respect I assume that expectation about average price is formed on the basis of linear least squares projection in the spirit of rational expectations literature.

Now let us consider the information structure of the economy. In the first period each firm decides its level of investment subject to the availability of (stochastic amount of) credit for investment purpose. I assume that the information about the availability of credit for investment purpose is known to a typical firm but being stochastic this amount may vary from firm to firm. This may arise because the credit is provided by the bank which may have, and it is generally so, different perceptions of risk about different firms. A typical firm knows the constraint that may operate on the availability of credit for itself but it does not know how far it deviates from others in the industry. In other words the firm can't distinguish between firm specific and industry wide components of the availability of first period credit. In the second period a typical firm has the information about the maximum working capital credit that it can get which has also a firm specific and industry wide component. But the firm can't distinguish between the two parts.

Depending upon whether a typical firm's notional investment is constrained or whether its notional supply is constrained one can conceive of four cases given below.

- Case I : The firm is constrained in first period and not constrained in second period.
- Case II : The firm is not constrained in first period and constrained in second period.
- Case III : The firm is constrained in both the periods.
- Case IV : The firm is constrained in neither period.

I will consider first three cases only. Case IV is not interesting from the standpoint of interaction of credit with real factors. This case is same as that of Nishimura.

First, I will spell out a typical firm's decision problems in each period in general terms, then case by case analysis. It is helpful to consider the firm's decision backwards, from the second period to the first. Throughout this paper all variables are in logarithm, if not otherwise stated. Investment goods are taken as numeraire, so that all prices are relative ones.

Second Period

The demand for the firm's products in the second period is given by³

$$q^d = -m(p - \bar{p}) - b\bar{p} \quad (1)$$

where q^d = log of the demand faced by individual firm,
 p = log of the price set by individual firm,
 \bar{p} = log of the average price prevailing in the market,

b, m are parameters, industrywide and firm specific price elasticities of demand respectively.

The form of the individual demand curve shows that demand for the individual firm's product depends negatively upon own price and positively upon prices of other firms' products summarized by the average price. This is a characteristic feature of the firms operating in a monopolistically competitive industry. It is assumed $m > b \geq 1$; that is the slope of the individual demand curve is flatter than that of the market demand curve.

The firm produces according to the production function given by

$$q = \theta l + k \quad (2)$$

where

q = output,

l = labor employed,

k = capital employed, determined in first period and hence given in second period, and

θ = parameter of the production function.

I assume that the parameter θ satisfies $0 < \theta < m/(m-1)$ which is the second order condition for profit maximization.

The problem of typical firm in the second period is

$$\begin{aligned} \max_p E_{(\bar{p})} [\exp(p) \exp(q^d) - \exp(r) \exp(1)] & \quad (p2) \\ \text{s. t. } q^d &= -m(p - \bar{p}) - b\bar{p} \\ q &= \theta l + k \\ q^d &\leq q \\ l &\leq l_0 + \beta \end{aligned}$$

The first three constraints are preference and technological constraints. The fourth is the working capital loans constraint. For the sake of convenience I have written it as having a deterministic component, l_0 (which is same for each firm) that deviates by the shock factor β (actually logarithm of the shock factor). The shock to availability of working capital credit β has two components firm specific (w) and industry wide (s). The firms can't distinguish between firm specific and the industry wide shocks, they only observe their aggregate β . r is the log of interest rate factor ($1 + \text{interest rate}$). $E_{(\bar{p})}$ is the expectation operator with respect to average price, \bar{p} . The firm specific as well as the industry wide shocks are assumed to follow normal distributions with $E_s = E_w = E_{sw} = 0$, $E_s^2 = \sigma_s^2$ and $E_w^2 = \sigma_w^2$.

From the above maximization exercise one can find out the optimal price and output functions and thus the optimal profit function whether the working capital loans constraint is binding or not. Let the optimal profit function⁴ be denoted by $\Pi(\cdot)$. Now we consider the decision problem of a typical firm in the first period.

First Period

In the first period the firm knows the form of its profit function obtained from the second period. It also knows the cost of investment given by

$$C = 2R + k = C_0 + k$$

where C = cost of investment,

R = logarithm of interest rate factor $(1 + \text{interest rate})$ for term loans, exogenously given

$$C_0 = 2R.$$

The cost of investment function has been assumed to imply a constant average and marginal cost of investment. This is a simplifying assumption. With increasing marginal and average cost of investment all the results go through.

The firm's problem in first period is to determine optimal investment subject to the availability of credit for investment purposes. It may however be noted that while determining optimal investment the firm does not know other firms' investment (and hence average investment), due to imperfect information problem but average investment affects a typical firm's profit through average productivity. Thus as in the case of second period the firm forms rational expectation about the average investment.

Stated mathematically a typical firm's problem is

$$\max_k E_{\{k, \cdot\}} [R^{*-1} \exp(\Pi(\cdot)) - \exp(c)] \quad (P1)$$

s.t. $k < k_0 + \alpha$.

In this case also I have written the constraint on loans for investment in such a way that it has as if a deterministic component (k_0), same for all firms and the actual one deviates from it by a shock factor α ; α has two components—firm specific (u) and industry wide (d). The firm can not distinguish between d and u , it only observes their sum. d and u are

assumed to follow normal distributions with $E d = E u = E du = 0$.
 $\text{Var} (d) = \sigma_d^2$, $\text{Var} (u) = \sigma_u^2$. $E\{\bar{k}..$ is the expectation operator
with respect to average investment, \bar{k} and some other variables
to be made precise later on. R^* is the discount factor (actually
inverse of one plus discount rate) for discounting second period
profit function.

Now I will consider the problem set out in general terms for
each of the cases separately mentioned earlier.

Case I

Case I corresponds to the case when there is no constraint
on working capital loans but there is constraint on loans for
investment. In this case last constraint for the firm's problem
(p2) becomes one of strict inequality. The first order condition
for profit maximization gives⁵

$E\{\bar{p}\} [(m-1) \exp(p+q^d) - (m/\theta) \exp(r+(q^d-k)/\theta)] = 0$ which
after simplification becomes

$$\frac{m + \theta(1-m)}{\theta} p = -\ln \theta - \ln(1-1/m) + r - k/\theta - \ln E\{\bar{p}\} \quad (4)$$

As I mentioned earlier the firm is assumed to form
expectation about \bar{p} rationally, based on the information set Ω
which includes the parameters of the model and the stochastic
shocks α and β . Specifically, \bar{p} is assumed to be normally
distributed with mean $e(\bar{p}/\Omega)$ and variance $V(\bar{p}/\Omega)$ where
 $e(\bar{p}/\Omega)$ is the linear least squares projection of \bar{p} on Ω and
 $V(\bar{p}/\Omega)$ ⁶ is the error variance. Utilizing the properties of log
normal distribution [see Maddala (1977)] (4) can be written as

$$p = f^{-1} [Z - k/\theta - (1/\theta)(m-b)(\theta-1)e(\bar{p}/\Omega)] \quad (5)$$

where $f = (m + \theta(1-m))/\theta$

$$Z = -\ln \theta - \ln(1-1/m) + r - 1/2(m-b)^2(\theta-1)(1/\theta)V_{\bar{p}}$$

To determine $e(\bar{p}/\Omega)$ I employ the method of undetermined coefficients as in the rational expectations literature. Every firm assumes that other firms form expectations about the average price as a linear combination of the observed values of α and β . say

$$e(\bar{p}/\Omega) = G + H\alpha + J\beta \quad (6)$$

Here, G, H, and J are the undetermined coefficients to be determined as in below.

Inserting (6) in (5) and averaging over all firms, the firm gets \bar{p} as a linear function of s and d :

$$\bar{p} = f^{-1} [Z - \bar{k}/\theta - (m - b)(1/\theta)(\theta - 1)(G + Hd + Js)]$$

Consequently, the firm's projection of \bar{p} based on the information set Ω is given by

$$e(\bar{p}/\Omega) = f^{-1} [Z - \bar{k}/\theta - (m - b)(1/\theta)(\theta - 1)(G + He(d/\Omega) + Je(s/\Omega))]$$

Here, $e(d/\Omega)$ and $e(s/\Omega)$ are the firm's projections of d and s based on its information set Ω which are linear least squares regressions on $\Omega = \{ \alpha, \beta \}$. Using the method of linear least squares regression it can be shown that⁷

$$e(d/\Omega) = A_1\alpha + A_2\beta \text{ and } e(s/\Omega) = B_1\alpha + B_2\beta$$

$$\text{Where } A_1 = [(1 + r_\beta^2)(1 + r_\alpha^2) - \rho^2]^{-1} (1 + r_\beta^2 - \rho^2) ;$$

$$A_2 = [(1 + r_\alpha^2)(1 + r_\beta^2) - \rho^2]^{-1} (\rho/r_m) r_\alpha^2 ;$$

$$B_1 = [(1 + r_\alpha^2)(1 + r_\beta^2) - \rho^2]^{-1} \rho r_m r_\beta^2 ;$$

$$B_2 = [(1 + r_\alpha^2)(1 + r_\beta^2) - \rho^2]^{-1} (1 + r_\alpha^2 - \rho^2) .$$

Here the following definitions were used :

$r_m^2 = \sigma_s^2 / \sigma_d^2$, variance ratio of the industry-wide shock to the availability of working capital loans to that of fixed capital loans;

$r_\alpha^2 = \sigma_u^2 / \sigma_d^2$, variance ratio of the firm-specific shock to the availability of fixed capital loans to that of industry-wide shock;

$r_{\beta}^2 = \sigma_w^2 / \sigma_s^2$, variance ratio of the firm-specific shock to the availability of working capital loans to that of industry-wide shock;

$\rho = \sigma_{sd} / \sigma_s \sigma_d$, correlation of the industry-wide shock to the availability of working capital loans to that of fixed capital loans.

It is evident that the correlation between s and d is an important determinant of the expectations. Then the firm's expected average price is given by

$$e(\bar{p}/\Omega) = f^{-1} \{ Z - \bar{k}/\theta - (m - b)(1/\theta) (\theta - 1) \{ G + H(A_1\alpha + A_2\beta) + J(B_1\alpha + B_2\beta) \} \} \quad (7)$$

Because all firms are identical except for α and β , and other firms use the same expectation formation process, (6) and (7) must be the same. Thus collecting terms,

$$G = f^{-1} \{ Z - \bar{k}/\theta - (m - b)(1/\theta) (\theta - 1) \} G \quad (8)$$

$$H = f^{-1} \{ - (m - b)(1/\theta) (\theta - 1) (HA_1 + JB_1) \} \quad (9)$$

$$J = f^{-1} \{ - (m - b)(1/\theta) (\theta - 1) (HA_2 + JB_2) \} \quad (10)$$

Solving for G , H and J and simplifying,

$$G = (\theta / (b + \theta(1 - b))) (Z - \bar{k}/\theta)$$

$$H = 0 \text{ and } J = 0.$$

The rational expectations values for H and J turn out to be zero. This is not unexpected in view of the fact that projection of average price is the problem of second period and in this case production being not constrained by the availability of working capital loans, β (or α whatever may be the value of ρ , the correlation between d and s) has no effect on the expectation formation of average price. Thus in this case the conditional expectation of the average price turns out to be

$$e(\bar{p}/\Omega) = (\theta / (b + \theta(1 - b))) (Z - \bar{k}/\theta). \quad (11)$$

Accordingly, $V_{\bar{p}} = 0$.

Substituting for $e(\bar{p}/\Omega)$ in (5) the optimal price charged by the firm is found to be

$$p = f^{-1} [\theta + m(1-\theta)] (\theta + b(1-\theta))^{-1} Z - k / \theta + (m-b) \\ (\theta-1) \theta^{-1} (b + \theta(1-b))^{-1} \bar{k}$$

Taking expectation across firms the average price is

$$\bar{p} = \frac{\theta}{b + \theta(1-b)} Z - \frac{\bar{k}}{b + \theta(1-b)} \quad (12)$$

putting these in (1) the typical firm's optimal output in this case becomes

$$q^d = -b\theta (b + \theta(1-b))^{-1} Z + m(m + \theta(1-m))^{-1} (k - \bar{k}) + \\ b(b + \theta(1-b))^{-1} \bar{k} \quad (13)$$

Again taking expectation across firms the average output in the industry is given by

$$\bar{q}^d = -b\theta (b + \theta(1-b))^{-1} Z + b(b + \theta(1-b))^{-1} \bar{k} \quad (14)$$

Putting the optimal values for individual firm's price and output and for average price and output the second period optimal profit function can be found to be

$$\Pi(k, \bar{k}) = \psi + \frac{m-1}{m + \theta(1-m)} k - \\ \frac{m-b}{[m + \theta(1-m)][b + \theta(1-b)]} \bar{k} \quad (15)$$

$$\text{where } \psi = - \frac{b-1}{b + \theta(1-b)} r + \frac{\theta(b-1)}{b + \theta(1-b)} [\ln \theta - \ln(m-1)] \\ - \frac{b}{b + \theta(1-b)} \ln m + \ln [m + \theta(1-m)]$$

The second period optimal profit function has a number of properties. If, *ceteris paribus*, the firm's capital stock k increases, its profit increases; whereas if the other firms' capital stock (\bar{k}) increases, its profit decreases.⁸ If the firm's investment is not accompanied by other firms, it has a cost advantage relative to them in the second period. Then the firm can lower its price relative to others in the industry, attract more customers and earn more profit. By contrast, if the other firms' investment increases, the firm suffers from a cost disadvantage, so that its profit decreases. This is the way that competition among firms operates in the investment process.

As I mentioned earlier, in the first period the firms determine the optimal capital stock subject to the availability of loans for fixed capital from the banks. In this case however, the availability of loans for fixed capital being a binding constraint, the typical firm's capital stock is given by

$$k = k_0 + \alpha \quad (16)$$

Taking expectations across firms the average capital stock in the industry is given by

$$\bar{k} = k_0 + d \quad (17)$$

Putting for k and \bar{k} in (11) to (14) the individual and average prices and quantities are found to be

$$p = \frac{\theta Z - k_0}{b + \theta(1-b)} - \frac{\alpha}{m + \theta(1-m)} + \frac{(m-b)(\theta-1)}{[m + \theta(1-m)][b + \theta(1-b)]} d \quad (18)$$

$$q^d = - \frac{\theta Z - k_0}{b + \theta(1-b)} - \frac{m}{m + \theta(1-m)} \alpha - \frac{\theta(m-b)}{[m + \theta(1-m)][b + \theta(1-b)]} d \quad (19)$$

$$\bar{p} = \frac{\theta Z - k_0}{b + \theta(1-b)} - \frac{d}{b + \theta(1-b)} \quad (20)$$

$$\bar{q}^d = - \frac{\theta Z - k_0}{b + \theta(1-b)} + \frac{b}{b + \theta(1-b)} d \quad (21)$$

Now I will consider the complete information counterpart of Case I. Complete information about \bar{p} and \bar{k} means that $e(\bar{p}/\Omega) = \bar{p}$ and $e(\bar{k}/\Omega) = \bar{k}$ and the corresponding variances, $V(\bar{p}/\Omega) = 0$ and $V(\bar{k}/\Omega) = 0$. Then the price and output of a typical firm as well as that of the industry (i. e. average price and output) are found to be same as in the incomplete information case. Thus unconditional expectation of \bar{p} (as well

as that of \bar{q} (when $E_d = E_s = 0$) under complete information is same as that under incomplete information. This is because of the fact that though there is incomplete information about industry wide shock to working capital loans constraint in the second period and consequently average price, this does not affect the individual firm's price and output decisions as the working capital loans constraint is not binding for a typical firm. On the other hand, in the first period a typical firm can't invest in fixed capital as much as it intends to as the fixed capital loans constraint is binding. As a result, $e(\bar{k}/\Omega)$ has no role to play in the individual firm's decision making process. These are true under all assumptions about the properties of the stochastic disturbances. Hence in Case I incomplete information and complete information give same industry wide average price and output. A change in s has no effect on \bar{p} , \bar{q} and \bar{k} while change in d reduces \bar{p} and increases \bar{q} and \bar{k} .

Case II

Case II is the exact opposite of case I. In case II the constraint on the availability of loans for fixed capital in first period is non-binding while that for working capital in second period is binding. Now I consider period by period analysis starting with the second period.

In this case output is given by the availability of working capital loans. However, price charged by a typical firm in such a situation is not the price corresponding to the given level of output (given by the availability of working capital loans), because in deciding its price the typical firm takes into account the fact that availability of working capital credit for other firms in the industry may not be same as of itself. Thus in deciding its price the firm also takes into account the industry-wide shock to working capital credit vis-s-vis itself.

Availability of credit in second period is given by the last constraint of program (P2). Putting this in the second constraint of (P2) one gets the corner solution for output. Equating this with the left hand side of the first constraint of (P2) and taking expectations the firm arrives at its optimal price. Thus,

$$\exp(\theta(1_0 + \beta) + k) = E\{\bar{p}\} \exp[-m(p - \bar{p}) - b\bar{p}]$$

Utilizing the properties of the log normal distribution as in Case 1 the optimal price function, given k is:

$$p = m^{-1} \{ \bar{Z} - \theta\beta - k + (m - b) e(\bar{p}/\Omega) \} \quad (22)$$

where $\bar{Z} = (1/2)(m - b)^2 V_{\bar{p}} - \theta 1_0$.

To obtain $e(\bar{p}/\Omega)$, I set it to be equal to linear combination of α and β as in case I. Substituting this in (22) and averaging over all firms

$$\bar{p} = m^{-1} \{ \bar{Z} - \theta s - \bar{k} + (m - b)(G + Hd + Js) \}.$$

Taking expectations conditional on the information set Ω

$$e(\bar{p}/\Omega) = m^{-1} \{ \bar{Z} - \bar{k} + (m - b)G + (m - b)H e(d/\Omega) + \{ (m - b)J - \theta \} e(s/\Omega) \}$$

Substituting for $e(d/\Omega)$ and $e(s/\Omega)$ the above can be written as

$$e(\bar{p}/\Omega) = m^{-1} \{ \bar{Z} - \bar{k} + (m - b)G + (m - b)H [A_1\alpha + A_2\beta] + \{ (m - b)J - \theta \} [B_1\alpha + B_2\beta] \}$$

Collecting terms and solving I get

$$G = (\bar{Z} - \bar{k}) / b$$

$$H = - \frac{m\theta\rho r_m r_\beta^2}{\Phi}$$

$$J = - \frac{\theta \{ (m - b)(1 - \rho^2) + m(r_\alpha^2 + (1 - \rho^2)) \}}{\Phi}$$

where $\Phi = b^2(r_\alpha^2 + r_\beta^2) + m^2 r_\alpha^2 r_\beta^2 + b^2(1 - \rho^2)$.

The co-efficient of β (i.e. J) is negative because of the fact that the typical firm is constrained by the availability of working capital loans so that it can't produce at the profit maximizing level and is forced to charge a higher price.

Loosening the constraint will increase production. In this situation the typical firm expects other firms in the industry to face similar constraints. Hence estimate of \bar{p} depends negatively upon β . But though a typical firm is not constrained by the availability of loans for fixed capital the coefficient of α is not zero as one may expect. This is so because when a typical firm is constrained by the availability of working capital credit with incomplete information about the same constraint for other firms in the industry (i. e. incomplete information about s), it expects other firms to raise investment in fixed capital subject to the respective fixed capital loans constraint so as to set the prices at lower levels, attract more customers and earn higher profits. But the firm has also incomplete information about industry-wide constraint to the availability of fixed capital loans. Hence in order to estimate \bar{p} the firm takes into account α from which it can infer about industry wide shock to the availability of fixed capital loans. If however $\rho = 0$ — the correlation between two industry-wide shocks is zero α is not affected by β and then $H = 0$. On the other hand when ρ is positive (negative) β affects α directly (inversely) and then H is negative (positive). It may also be noted that ρ determines the value of J , though for J it can't determine the sign which is unequivocally negative.

Substituting for G , H and J the second period optimal price becomes

$$p = \bar{Z} / b - m^{-1} \{ k + (m - b) (i/b) \bar{k} \} + m^{-1} [(m - b) H \alpha + \{ (m - b) J - \theta \} \beta] \quad (23)$$

Taking expectation across firms average price becomes

$$\bar{p} = \bar{Z} / b - \bar{k} / b + m^{-1} [(m - b) H d + \{ (m - b) J - \theta \} s]. \quad (24)$$

In this case individual firm and average industry outputs (given k and \bar{k}) are respectively

$$q^d = \theta (1_0 + \beta) + k \text{ and} \quad (25)$$

$$\bar{q}^d = \theta (1_0 + s) + \bar{k}. \quad (26)$$

In this case also optimal profit function, $\Pi (k, \bar{k}, \alpha, \beta, d, s)$ shows same properties as in the earlier case, viz. $\delta \Pi (.) / \delta k > 0$ and $\delta \Pi (.) / \delta \bar{k} < 0$.

In the first period the firm decides about optimal choice of k by solving the program (P1). In this case k is not constrained by α . The firm has imperfect information about average capital stock \bar{k} as also about d and s . As in second period it is assumed that the firm forms expectations about \bar{k} , d , s rationally based on the information set Ω . Specifically, \bar{k} , d , s are assumed to be jointly normally distributed with mean vector $(e(\bar{k}/\Omega), e(d/\Omega), e(s/\Omega))$ and variance-covariance matrix $V(\bar{k}, d, s/\Omega)$ where $e(\bar{k}/\Omega)$, $e(d/\Omega)$ and $e(s/\Omega)$ are respectively, the linear least squares regressions of \bar{k} , d and s on Ω and $V(\bar{k}, d, s/\Omega)$ is their error variance-covariance matrix. Now I consider the program (P1) which in this case is

$$\text{Max}_k E(\bar{k}, d, s) \{ R^{*-1} \{ \exp(p + q^d) - \exp(r + 1_0 + \beta) \} - \exp(c) \}$$

From above the following optimal investment formula is derived from the first order condition of optimality⁹:

$$k = mZ^* - (m - b) (1/b) e(\bar{k}/\Omega) - (m - b) (m - 1) H\alpha + \\ (m - b)^2 e(d/\Omega) - \{ (m - b) J - \theta \} (m - 1) \beta + \\ \{ (m - b) J - \theta \} (m - b) e(s/\Omega) \quad (27)$$

where $Z^* = \log(1 - 1/m) - 2R - \bar{R} - \bar{Z}(b - 1)/b + F^t V(\bar{k}, d, s/\Omega) F$,

$\bar{R} = 1/n(R^*)$ and $F^t = (- (m - b)/mb, (m - b)^2 H/m,$

$\{ (m - b) J - \theta \} (m - b) / m$) and t denotes transpose.

All of $e(\bar{k}/\Omega)$, $e(d/\Omega)$ and $e(s/\Omega)$ are based on information α and β . Thus average investment \bar{k} is solely dependent on the averages of α and β , i.e. d and s . Hence I assume

$$k = \mu_0 + \mu_1 \bar{d} + \mu_2 s$$

Taking expectations conditional on Ω ,

$$e(\bar{k}/\Omega) = \mu_0 + \mu_1 e(d/\Omega) + \mu_2 e(s/\Omega)$$

$$\text{i. e. } e(\bar{k}/\Omega) = \mu_0 + (\mu_1 A_1 + \mu_2 B_1) \alpha + (\mu_1 A_2 + \mu_2 B_2) \beta. \quad (28)$$

Substituting for $e(\bar{k}/\Omega)$ from (28) in (27) and averaging over firms,

$$\begin{aligned} \bar{k} = mZ^* + (m-b)(1-m)Hd + \{(m-b)J-\theta\}(1-m)s - (m-b) \\ (1/b)\{\mu_0 + \mu_1 e(d/\Omega) + \mu_2 e(s/\Omega)\} + (m-b)^2 He(d/\Omega) + \\ \{(m-b)J-\theta\}(m-b)e(s/\Omega) \end{aligned}$$

Taking expectations with respect to information set and substituting for $e(d/\Omega)$ and $e(s/\Omega)$,

$$\begin{aligned} e(\bar{k}/\Omega) = mZ^* - (m-b)(1/b)\mu_0 + \{(m-b)(1-b)H - \\ (m-b)(1/b)\mu_1\}[A_1\alpha + A_2\beta] + \{[(m-b)J-\theta] \\ (1-b) - (m-b)(1/b)\}[B_1\alpha + B_2\beta]. \end{aligned}$$

Equating coefficients from (28),

$$\mu_0 = mZ^* - (m-b)(1/b)\mu_0,$$

$$\mu_1 A_1 + \mu_2 B_1 = \{(m-b)(1-b)H - (m-b)(1-b)\mu_1\}A_1 + \\ \{[(m-b)J-\theta](1-b) - (m-b)(1/b)\mu_2\}B_1,$$

$$\mu_1 A_2 + \mu_2 B_2 = \{(m-b)(1-b)H - (m-b)(1-b)\mu_1\}A_2 + \\ \{[(m-b)J-\theta](1-b) - (m-b)(1/b)\mu_2\}B_2.$$

Solving the above system of equations,

$$\mu_0 = bZ^*,$$

$$\mu_1 = (1-b)(m-b)b(1/m)H,$$

$$\mu_2 = (1-b)b(1/m)\{(m-b)J-\theta\}.$$

Now optimal investment for the typical firm is given by

$$k = bZ^* + Q_1\alpha + Q_2\beta \quad (29)$$

$$\begin{aligned} \text{Where } Q_1 = \frac{m-b}{m} [m(1-m)m + (m-b)(m-1+b)A_1]H + \\ \frac{m-1+b}{m} B_1[(m-b)J-\theta] \end{aligned}$$

$$\text{and } Q_2 = \frac{(m-b)^2}{m} (m-1+b)A_2H + \frac{1}{m} [(1-m)m + (m-b)(m-1+b)B_2] [(m-b)J - \theta]$$

Average investment in Case II is

$$\bar{k} = bZ^* + Q_1d + Q_2s \quad (30)$$

Putting for k and \bar{k} in (23), (24), (25) and (26) the second period optimal values for firm and average industry prices and outputs are found to be

$$p = \frac{\bar{Z} - bZ^*}{b} + \frac{1}{m} [(m-b)H - Q_1] \alpha + \frac{1}{m} [(m-b)J - \theta - Q_2] \beta - \frac{(m-b)}{mb} Q_1d - \frac{(m-b)}{mb} Q_2s \quad (31)$$

$$\bar{p} = \frac{\bar{Z} - bZ^*}{b} + \frac{1}{mb} [b(m-b)H - mQ_1] d + \frac{1}{mb} [b(m-b)J - b\theta - mQ_2] s \quad (32)$$

$$q^d = \theta l_0 + bZ^* + Q_1\alpha + (Q_2 + \theta) \beta \quad (33)$$

$$\bar{q}^d = \theta l_0 + bZ^* + Q_1d + (Q_2 + \theta) s \quad (34)$$

As in Case I, here also the complete information counterpart of price and output are solved by setting $e \cdot (\bar{p}/\Omega) = \bar{p}$, $e \cdot (\bar{k}/\Omega) = \bar{k}$, $V(\bar{p}/\Omega) = 0$ and $V(\bar{k}/\Omega) = 0$. Industry wide average price, output and investment are found to be respectively,

$$\bar{p}^* = -\theta l_0 - \ln \frac{m-1}{m} + 2R + \bar{R} - \theta s \quad (32')$$

$$\bar{q}^{d*} = b[\theta_0 + \ln \frac{m-1}{m} - 2R - \bar{R}] + b\theta s \quad (34')$$

$$\bar{k}^* = (b-1)\theta l_0 + b \ln \frac{m-1}{m} - 2bR - b\bar{R} + (b-1)\theta s \quad (30')$$

A comparison with the corresponding co-efficients show that unconditional expectations of \bar{p} , \bar{q} and \bar{k} under incomplete information are greater for \bar{p} , \bar{k} and less for \bar{q} than that of the same under complete information. Under complete information co-efficients of d in both the average price and investment equations are zero. In the incomplete information case co-efficients of d in the average price, output and investment equations are zero whenever either of (a) $r_{\beta} - > 0$ or (b) $r_{\alpha} - > 0$ and $\rho = 0$. The co-efficients of s in average price, output and investment equations under complete and incomplete information generally differ. These differences in respect of complete information vis-a-vis its incomplete information counterpart arise due to the effect of incomplete information about average price and investment on a typical firm's decision making process in the two periods.

Case III

In the rest of this section I will consider Case III whence the typical firm is constrained by the availability of credit in both the periods. In this Case I will not derive the pricing as well as investment formulae. These can very easily be had from the previous two cases — equations (23) and (16) respectively. Substituting for k from (16) and \bar{k} from (17) in (23) the optimal price is found to be

$$p = (\tilde{Z} - k_0) / b + \frac{1}{m} [(m - b) H - 1] \alpha + \frac{1}{m} [(m - b) J - \theta] \beta - \frac{m - b}{mb} d \quad (35)$$

Taking expectation across firms average price becomes

$$\bar{p} = (\bar{Z} - k_0) / b + \frac{1}{mb} [b(m - b)H - m]d + \frac{1}{m} [(m - b)J - \theta]s \quad (36)$$

The individual firm and average industry outputs after substituting for k and \bar{k} are respectively

$$q^d = (\theta l_0 + k_0) + \theta\beta + \alpha \text{ and} \quad (37)$$

$$\bar{q}^d = \theta(l_0 + k_0) + \theta s + d \quad (38)$$

In the same way as in the other two cases, the incomplete information values for average price and quantity are found to be

$$\bar{p}^* = -(\theta l_0 + k_0)/b - \frac{1}{b}d - \frac{\theta}{b}s \quad (36')$$

$$\bar{q}^{d*} = (\theta l_0 + k_0) + d + \theta s \quad (38')$$

Though the average output is same as in the case of complete information, average price under incomplete information differs from its complete information counterpart. The reason that the incomplete information price differs from its complete information counterpart is same as in Case II. However for average output and average investment the complete and incomplete information values are same because of the fact that the typical firm's output and investment being constrained by the availabilities of working and fixed capital loans, incomplete information has no role to play in the firm's decision making process as far as output and investment are concerned.

Section III

In this section I will consider the effects of different types of disturbances to the availabilities of credit on the average price and quantity variables. The disturbances may arise for both types of credit. It may be uniform in the industry or may vary considerably among firms. One thing should also be borne in mind that the results largely depends upon the correlation between two types of credit, ρ . The effects of the disturbance to

allocation of credit will depend upon the specific case under consideration. I will give the results for each case under different assumptions about the disturbances. For the sake of convenience, the co-efficients for d and s in the average price and quantity equations will henceforth be denoted by $\phi_{\bar{d}}^{\bar{p}}$, $\phi_{\bar{s}}^{\bar{p}}$, $\phi_{\bar{d}}^{\bar{q}}$, and $\phi_{\bar{s}}^{\bar{q}}$, respectively.

One thing should be noted at the very outset that in Case I, $\phi_{\bar{d}}^{\bar{p}}$, $\phi_{\bar{s}}^{\bar{p}}$, $\phi_{\bar{d}}^{\bar{q}}$, and $\phi_{\bar{s}}^{\bar{q}}$, do not depend upon r_{α} , r_{β} , r_m , ρ and m . As a result different types of shocks as also a change in m have no effect on these co-efficients. The industry wide shocks d and s have same effects on average price and output as discussed earlier.

Uniform disturbances to working capital credit

Uniform disturbances to working capital credit implies $r_{\beta} = \sigma_w / \sigma_s \rightarrow 0$. Other parameters are held constant. Case I gives same results as in the general discussion about the effects of d and s on average price and output. Now I consider the other cases. When $r_{\beta} \rightarrow 0$, it can be shown that $H \rightarrow 0$. whatever may be ρ and $J \rightarrow -\theta \frac{(m-b)(1-\rho^2) + m[r_{\alpha}^2 + (1-\rho^2)]}{b^2 [r_{\alpha}^2 + (1-\rho^2)]}$

Then in the average price equation (32), $\psi_{\bar{d}}^{\bar{p}} \rightarrow 0$ and $\phi_{\bar{s}}^{\bar{p}} \rightarrow -\frac{\theta}{mb} \frac{(m-b)(2m-b)(1-\rho^2) + [m(m-b) + b^2] r_{\alpha}^2}{(r_{\alpha}^2 + 1 - \rho^2)} < 0$.

In the average output equation (34), $\phi_{\bar{d}}^{\bar{q}} \rightarrow 0$ and

$$\phi_{\bar{s}}^{\bar{q}} \rightarrow 0m + \frac{\theta(b-1)}{b(r_{\alpha}^2 + 1 - \rho^2)} [(m-b)\{(m-b)(1-\rho^2) + m(r_{\alpha}^2 + 1 - \rho^2)\} + b^2(r_{\alpha}^2 + 1 - \rho^2)] > 0.$$

These are expected results. For the otherwise symmetric firms constrained by the availability of working capital credit a uniform disturbance to working capital credit means an increase in s results in an increase in β on an average. It results in an increase in output and a decrease in the individual optimal price directly for it relaxes the working capital loans constraint and indirectly through a decrease in the individual estimate of the average price. The individual estimate of the average price in this case doesn't depend upon α , because a uniform shock to working capital credit implies that industry wide shock is same as that of the firm. So the typical firm doesn't expect other firms to raise investment in fixed capital subject to the availabilities of loans for this purpose.

In Case III, in the average price formula (36)

$$\bar{\phi}_d^p \rightarrow -\frac{1}{b} \text{ and } \bar{\phi}_s^p \rightarrow -\frac{\theta}{m}$$

$$[(m-b) \frac{(m-b)(1-\rho^2) + m(r_\alpha^2 + 1 - \rho^2)}{b^2(r_\alpha^2 + 1 - \rho^2)} + 1].$$

both being negative. In the average output equation (38), $\bar{\phi}_d^q \rightarrow 1$ and $\bar{\phi}_s^q \rightarrow \theta$, both being positive. The typical firm being constrained by the availabilities of credit for both types of credit increases in d and s will reduce average price and increase average output. The effect of a change in d is same as in the complete information case as was mentioned earlier. The effect of a change in s on average price operates both directly and indirectly in a similar fashion as in Case II.

Uniform disturbances to credit for fixed capital

Uniform disturbances to credit for investment implies that $r_\alpha = \sigma_u / \sigma_d \rightarrow 0$ with other parameters held constant. In Case II, the average price equation (32) shows that

$$\phi_{d}^{\bar{p}} \rightarrow \frac{-\theta \rho r_m r_R^2}{mb^3 (r_{\beta}^2 + 1 - \rho^2)} \quad [b^2 [m(m-b)m-1+b] (r_{\beta}^2 + 1 - \rho^2) + (m-1+b)(m-b)(2m-b)(1-\rho^2)]$$

$$\text{and } \phi_s^{\bar{p}} \rightarrow \frac{-\theta}{mb^3 (r_{\beta}^2 + 1 - \rho^2)(r_{\beta}^2)} \quad [(m-b)(2m-b)(1-\rho^2) + b^2 (r_{\beta}^2 + 1 - \rho^2)] \quad [[m(m-1)+b] r_{\beta}^2 + b^2(1-\rho^2)]$$

In the average output equation,

$$\phi_{d}^{\bar{q}} \rightarrow \frac{(m-b) \theta \rho r_m r_{\beta}^2}{mb^2 (r_{\beta}^2 + 1 - \rho^2)^2} \quad [b(m-b+b^2)(r_{\beta}^2 + 1 - \rho^2) + (m-1+b)(2m-b)(1-\rho^2)]$$

$$\text{and } \phi_s^{\bar{q}} \rightarrow \frac{\theta}{mb^2 (r_{\beta}^2 + 1 - \rho^2)^2} \quad [(m-b)(2m-b)(1-\rho^2) + b^2 (r_{\beta}^2 + 1 - \rho^2)] + \theta$$

The restrictions on the parameters show that $\phi_s^{\bar{p}}$ is unequivocally negative while $\phi_{d}^{\bar{p}}$ depend very much on ρ . The co-efficient of $d > 0$ according as $\rho < 0$. In general a non-zero $\phi_{d}^{\bar{p}}$ in this case vis-a-vis its counterpart in case of a uniform disturbance to working capital credit occurs due to the fact that a non-uniform disturbance to working capital credit implies that α also enters the estimate of the price for a typical firm if $\rho \neq 0$. As a result it also appears in the average industry price. But when $\rho = 0$, then as the repercussion of the binding constraint on working capital credit does not operate, it cannot affect optimal investment and hence, does not affect the average industry price.

By the same logic $\phi_{d}^{\bar{q}}$ is indeterminate in sign and $\phi_s^{\bar{q}}$ is positive.

In Case III, the average price equation (36) shows that

$$\phi_{d}^{\bar{p}} \rightarrow \frac{-1}{mb(r_{\beta}^2 + 1 - \rho^2)} [(m - b)\theta\rho r_m r_{\beta}^2 + mb(r_{\beta}^2 + 1 - \rho^2)]$$

$$\text{and } \phi_s^{\bar{p}} \rightarrow \frac{-\theta}{mb^2(r_{\beta}^2 + 1 - \rho^2)} [(m - b)(2m - b)(1 - \rho^2) + b^2(r_{\beta}^2 + 1 - \rho^2)]$$

For average output $\phi_d^{\bar{q}} = 1$ and $\phi_s^{\bar{q}} = \theta$. In this case one also finds that the coefficient of $\phi_d^{\bar{p}}$ is not unequivocal. If ρ is non-negative ($\rho > 0$) then the coefficient is negative while a strictly negative ρ makes the coefficient indeterminate in sign. This is because of the fact that in contrast to Case II, in this case there are two effects of a change in d , one operates directly when all firms in the industry are fixed capital loans constrained and indirectly as the firms are also working capital loans constrained and operates through the estimate of average price if ρ is non-zero. The negative sign of s is as expected as in earlier cases. But on average output loosening of both the constraints has positive effect.

Uniform disturbances to both types of credit

Uniform disturbances to both types of credit implies that $r_{\alpha} \rightarrow 0$ as well as $r_{\beta} \rightarrow 0$ with other parameters held constant. In Case II, in the average price equation $\phi_d^{\bar{p}} \rightarrow 0$ and that of $\phi_s^{\bar{p}} \rightarrow \frac{-\theta}{mb} [(m - b)(2m - b) + b^2] < 0$. For average output $\phi_d^{\bar{q}} \rightarrow 0$ and $\phi_s^{\bar{q}} \rightarrow \frac{\epsilon}{mb} [(m - b)(b - 1)(2m - b + b^2) + bm] > 0$. The effects on average price and output are unequivocal and as expected.

In Case III, in the average price equation $\phi_d^{\bar{p}} \rightarrow -(1/b) < 0$ and $\phi_s^{\bar{p}} \rightarrow \frac{-\theta(m - b)(2m - b)}{b^2} < 0$. In the average output equation $\phi_d^{\bar{q}} \rightarrow 1$ and $\phi_s^{\bar{q}} \rightarrow \theta$, both being positive. These are also expected results.

Change in the competitiveness of the industry

An increase in the competitiveness of the industry means an increase in m . Then I will consider the effects on the average price and output under different types of disturbances. First I will consider the case when disturbance to working capital credit is uniform. The result will differ in each case listed earlier.

In Case II, it can be shown that when disturbance to working capital credit is uniform, then for the average price

$$\text{equation } \frac{\delta \bar{p}}{\delta m} = 0 \text{ and } \frac{\delta \bar{\psi}_s}{\delta m} = \frac{-\theta}{m^2 b (r_\alpha^2 + 1 - \rho^2)}$$

$[(3m^2 - b^2) r_\alpha^2 + 2(m^2 - b^2)(1 - \rho^2)] < 0$. For the average

output equation $\frac{\delta \bar{q}}{\delta m} = 0$ and

$$\frac{\delta \bar{\psi}_s}{\delta m} = \frac{\theta(b-1)}{m^2 b (r_\alpha^2 + 1 - \rho^2)} \quad [(3m^2 - b^2) r_\alpha^2 + 2(m^2 - b^2)(1 - \rho^2)] > 0.$$

In case III, for the average price equation $\frac{\delta \bar{p}}{\delta m} = 0$ and

$$\frac{\delta \bar{\psi}_s}{\delta m} = \frac{-\theta}{m^2 b (r_\alpha^2 + 1 - \rho^2)} \quad [(3m^2 - b^2) r_\alpha^2 + 2(m^2 - b^2)(1 - \rho^2)].$$

For the average output equation, $\frac{\delta \bar{q}}{\delta m} = 0$ and $\frac{\delta \bar{\psi}_s}{\delta m} = 0$.

When the disturbance to availability of fixed capital is uniform implying $r_\alpha \rightarrow 0$, then it can be shown that in Case II,

for the average price equation, $\frac{\delta \bar{p}}{\delta m} = \frac{-\theta \rho r_m r_\beta^2}{m^2 b^3 (r_\beta^2 + 1 - \rho^2)}$

$[b^2(m^2 - b + 1) + b(2m - b)(m - 1 + b) + m(m - b)(4m - 2 + b)](1 - \rho^2) + b^2 r_\beta^2 \leq 0$ according as $\rho > 0$. and

$$\frac{\delta\phi_s^{\bar{p}}}{\delta m} = \frac{-\theta}{mb^3 (r_\alpha^2 + 1 - \rho^2)^2} [\{ 2 (m^2 - b^2) [m (m - 1) + b]$$

$$+ m (2m - 1) (m - b) (2m - b) + b^2 [m^2 - m + m^2 - b^2] r_\beta^2 (1 - \rho^2) + b^2 r_\beta^4 + 2b^2 (m^2 - b^2) (1 - \rho^2)^2] < 0.$$

For the average output equation $\frac{\delta\phi_d^{\bar{q}}}{\delta m} = \frac{-\theta\rho r_m r_\beta^2}{m^2 b^2 (r_\beta^2 + 1 - \rho^2)^2}$

$$[b [m (m - b) + b^2 (m - b + 1)] (r_\beta^2 + 1 - \rho^2) + [b (m - b) (m - 1 + b) + m (2m - b) (2m - 1)] (1 - \rho^2)] < 0$$

and $\frac{\delta\phi_s^{\bar{q}}}{\delta m} = \frac{\theta}{m^2 b^2 (r_\alpha^2 + 1 - \rho^2)^2} [2 (m^2 - b^2) + b] (1 - \rho^2) + (m^2 - b^2) r_\beta^2] > 0$

In Case III, for the average price equation,

$$\frac{\delta\phi_d^{\bar{p}}}{\delta m} = \frac{\theta\rho r_m r_\beta^2}{m^2 b (r_\alpha^2 + 1 - \rho^2)} \begin{matrix} > \\ < \end{matrix} 0 \text{ according as } \rho \begin{matrix} > \\ < \end{matrix} 0 \text{ and}$$

$$\frac{\delta\phi_s^{\bar{p}}}{\delta m} = \frac{\theta}{m^2 b^2 (r_\alpha^2 + 1 - \rho^2)} [b^2 r_\beta^2 - 2 (m^2 - b^2) (1 - \rho^2)], \text{ the}$$

sign of which depends upon ρ — when absolute value of ρ is

unity $\frac{\delta\phi_s^{\bar{p}}}{\delta m}$ is positive while any other value of ρ makes it

indeterminate in sign. For the average output equation

$$\frac{\delta\phi_d^{\bar{q}}}{\delta m} = 0 \text{ and } \frac{\delta\phi_s^{\bar{q}}}{\delta m} = 0.$$

Lastly I will consider the case when the disturbances to the availabilities of both types of credit are uniform implying $r_\alpha \rightarrow 0$ and $r_\beta \rightarrow 0$. In Case II, for the average price equation,

$$\frac{\delta \bar{\phi}_d^{\bar{p}}}{\delta m} = 0 \text{ and } \frac{\delta \bar{\phi}_s^{\bar{p}}}{\delta m} = \frac{-2\theta}{m^2 b} (m^2 - b^2) < 0. \text{ For the average}$$

$$\text{output equation } \frac{\delta \bar{\phi}_d^{\bar{q}}}{\delta m} = 0 \text{ and } \frac{\delta \bar{\phi}_s^{\bar{q}}}{\delta m} = \frac{\theta}{m^2 b} [b(b-1)$$

$$(2m^2 - b + b^2) + 2m(m-b)(b-1)] > 0. \text{ In Case III for the}$$

$$\text{average price equation, } \frac{\delta \bar{\phi}_d^{\bar{p}}}{\delta m} = 0 \text{ and } \frac{\delta \bar{\phi}_s^{\bar{p}}}{\delta m} = \frac{-\theta(4m-3b)}{b^2 \bar{q}} < 0.$$

$$\text{For the average output equation, } \frac{\delta \bar{\phi}_d^{\bar{q}}}{\delta m} = 0 \text{ and } \frac{\delta \bar{\phi}_s^{\bar{q}}}{\delta m} = 0.$$

The negative effects of an increase in m on $\bar{\phi}_s^{\bar{p}}$ can be explained in the following way. When individual firms respond to shocks to working capital loans constraint average price is also responsive to the corresponding industry wide shock. But the firms have only imperfect information about industry wide conditions, most firms fail to predict the actual average price correctly, though in a rational expectations equilibrium on an average they predict the average price correctly. As the degree of competition increases, a higher than average price will reduce sales volume. So the firms will suffer loss. Thus with increased competition the firms in the industry will expect other firms to respond less to shocks. Accordingly the effect on output is higher. This is true for all firms in the industry, hence for the industry average price and output. With $r_\beta \rightarrow 0$, or $\rho = 0$, the indirect effect of α on the estimate of \bar{p} doesn't work in Case II for the reasons already discussed and this is independent of the degree of competition prevailing in the industry. Thus co-efficient of α in price or output equations is zero. Thus $\bar{\phi}_d^{\bar{p}}, \bar{\phi}_d^{\bar{q}}$ have no effect on average price and output. But when $r_\alpha \rightarrow 0$ the indirect effect operating through estimate of \bar{p} is non-zero and hence $\bar{\phi}_d^{\bar{p}}, \bar{\phi}_d^{\bar{q}}$ is negative

(positive) according as ρ is positive (negative). The explanations of the effects of a change in m on the co-efficients are same in Case III.

Section IV

In this concluding section I will give a brief summary of the main results of this paper. It has been shown in Section II that in a setting of monopolistic competition incomplete information about the industry wide shock to the availability of working capital loans will make the average price (in an unconditional expectation sense) higher than if there is complete information. In general, the effects of the industry wide shocks to the availabilities of loans for fixed and working capital loans on average price will differ in the presence of incomplete information. The same holds good if a typical firm and hence the industry as a whole is constrained by the availabilities of both fixed and working capital loans. If, however a typical firm (and hence the industry as a whole) is constrained by the availability of the fixed capital loans the unconditional expectation of average price as well as the effects of the shocks to the availabilities of fixed and working capital loans on the average price and output are same with or without complete information. Then I have shown that in a situation of incomplete information the effects of stochastic shocks to the availabilities of two types of loans on individual and average price and quantity depend on the properties of the stochastic disturbances — whether the shocks are uniform or not, whether the shocks are correlated or not etc.

In Section III, I have considered the effects of a change in the competitiveness of the industry on average price and output. It has been shown that because of the presence of forecast error in average price, increased competition leads to decreased sensitivity of stochastic shocks to average price.

Notes

¹Williamson (1987) provides a very good survey of the literature on financial intermediaries and economic activity.

²There is however a sizeable microeconomic literature on investment in duopolistic or oligopolistic literature, e.g. Brander and Spencer (1983) and Okuno-Fujiwara and Suzumura (1987).

³Such a demand function can be obtained if the utility function is assumed to be CES. For derivation see Blanchard and Kiyotaki (1987), Blanchard and Fischer (1989), Nishimura (1992).

⁴It is also the logarithm of the optimal profit function.

⁵The second order condition of optimality requires that

$$\theta < m/(m - 1).$$

⁶ V_p —for short.

⁷For detailed derivation see Sargent (1987).

⁸Taking partial derivatives of $\pi(\cdot)$ w. r. t. k and \bar{k} ,

$$\frac{\delta \pi(\cdot)}{\delta k} = \frac{m - 1}{\theta [m + \theta (1 - m)]} > 0$$

$$\text{and } \frac{\delta \pi(\cdot)}{\delta \bar{k}} = - \frac{m - b}{[m + \theta (1 - m)][b + \theta (1 - b)]} < 0$$

as $m > b > 0$ by assumption and $\theta < m/(m - 1)$ by the second order condition.

⁹It can be shown that the second order condition of optimality in this case requires that $-(1/m)$ be negative, which is automatically satisfied because of the restriction on m .

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