The Economic Journal, **96** (*June* 1986), 482–498
Printed in Great Britain

ACCESS TO CAPITAL AND AGRARIAN PRODUCTION ORGANISATION*

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There are two problems, both universal, that entrepreneurs in any economy must contend with. Firstly, an agent generally has access only to a limited amount of working capital. Secondly, workers hired by an agent are subject to moral hazard, and this necessitates their supervision. This paper models, for an agrarian economy, the constraints imposed on entrepreneurs' activities by these two problems and endogenously determines the various organisational forms of production, as well as the allocation of resources that will obtain. With a simple model we endeavour to explain a diverse set of empirical observations pertaining to the less developed countries in terms of the general processes that determine the distribution of income among the various agents and the hierarchical relationships that develop among them.

Agricultural production typically involves a period of several months between the time the inputs are purchased and the time the output is marketed. Access to working capital and hence to the credit market thus plays an important role in a farmer's production decisions; the distribution of access to credit, in turn, tends to be an important determinant of income distribution. In poor agrarian economies, credit is invariably rationed according to the ability to offer collateral.[1] The amount of working capital a farmer can mobilise, therefore, depends on the amount of land he owns, which is often a good proxy for his overall wealth and, thus, his ability to offer collateral. Further, since hired hands have a propensity to shirk, they need to be supervised, and, therefore, the labour time that can be hired on the market is only an imperfect substitute for one's own time. The time endowment of a farmer thus becomes a crucial constraint on his decisions and, consequently, how he allocates it becomes an important determinant of the organisation of production.

The theoretical framework constructed in this paper focuses on the effects of the constraints discussed above on the behaviour of utility-maximising agents. In the partial equilibrium form of our model, we show that agents, through their optimal time allocation, determine the organisation of production they adopt. In this we follow in the footsteps of Roemer (1982) who was the first to formally analyse class structure (i.e. classification of agents according to their activities) in terms of non-uniform distributions of the means of production. Access to credit, as modelled here, is functionally equivalent to ownership of

* We are grateful to Hans Binswanger, Charles Blackorby, Sam Ho, Tracy Lewis, Phil Neher, John Roemer, an anonymous referee and an Associate Editor of this JOURNAL for valuable comments on an earlier draft of this paper.

[1] Good recent sources on this are Von Pischke *et al.* (1983) and Rudra (1982, ch. 4). Binswanger and Siller (1984) offer an insightful analysis of how differential ownership of collateral (mainly land) determines differential access to credit and gives rise to credit-rationing in an agrarian setting.

the means of production. We show that the introduction of moral hazard on the part of hired labour increases the explanatory power of Roemer's scheme.

The framework is used to understand the formation of agrarian class structure. It is also used to provide an explanation of the inverse relationship between farm size and the labour input per acre. In its general equilibrium form, the framework allows us to carry out comparative static exercises that help us to analyse in a formal way the consequences of institutional policy actions. We have examined the effects of land and credit reform on social welfare, income distribution, the number of people in poverty, the proletarianisation of marginal cultivators and the welfare of the landless class.

I. THE PARTIAL EQUILIBRIUM

In this section, we assume that the factor prices are exogenously given and then consider the optimisation problem facing an agent who is constrained by the credit available to him and by his time endowment. The optimal time allocation made by each agent determines the mode of cultivation he will adopt.

We assume that the production process entails the use of two inputs land (h) and labour (n), both of which are essential. The production function, $f(h, n)$, is assumed to be linearly homogeneous, increasing, strictly quasi-concave and twice-continuously differentiable in its arguments. We can write the output, q, of a farm as

$$q = \epsilon f(h, n), \tag{1}$$

where ϵ is a positive random variable with expected value unity, embodying the effect of such stochastic factors as the weather. Land and labour can be hired in competitive markets at (exogenously given) prices v and w, respectively. The price, P, of output is also exogenously given – determined, say, in the world market.

We assume that production entails the incurrence of fixed set-up costs, K. While we are abstracting from all inputs other than land and labour, we introduce K as a proxy to represent the fixed component of the costs associated with other inputs. An example might be the fixed costs associated with the sinking of tube-wells for irrigation. K is a set-up cost associated with each farm. While the production function itself is linearly homogenous, these costs, required to initiate production, will render unprofitable the cultivation of extremely small plot sizes. We shall see later on that these costs are also partly responsible for the existence of a class of pure agricultural workers in the economy. The amount of working capital, $\bar{B}$, to which a farmer has access, is typically determined by the assets he possesses – mainly the amount of land, $\bar{h}$, he owns.[1] Note that since land can be leased in or leased out, h can be greater than or less than $\bar{h}$. Thus the scale of operation of a farmer is bounded by the working capital constraint.

$$vh + w(n-l) \leqslant \bar{B} - K + v\bar{h} + wt \tag{2}$$

[1] In most agrarian economies the total wealth of an agent is strongly correlated with land-ownership. The use of other assests besides land for collateral would not change our results qualitatively. Note that we take the distribution of land-ownership as exogenously given. Binswanger and Rosenzweig (1982) offer a compelling explanation for the relative infrequency of land sales in the less-developed countries.

where n is the total amount of labour applied, l the amount of labour he himself supplies, h is the amount of land he cultivates, and t the amount of time he sells on the labour market. The use of owned land and own labour in cultivation are valued at the going prices. In writing down (2) we have implicitly assumed that all capital outlays are incurred at the beginning of the production period.[1] The interest rate per crop season (which does not play a substantive role in our model), is assumed to be exogenously fixed at some level $r \geqslant 0$.

It is well recognised that the potential for moral hazard on the part of hired workers makes their supervision imperative. Implicit in (1) is the assumption that n is the number of efficiency units of labour applied. The presence of the stochastic variable ϵ in (1) renders it impossible to infer from the knowledge of any two of q, h and n, the value of the third. Thus even a supervisor will have the incentive to shirk and will need to be monitored – unless he is a residual claimant (Alchian and Demsetz, 1972). It follows that the entrepreneur must himself undertake the task of supervision – the only substantive implication of uncertainty in our model, since we shall be abstracting from risk preferences.

We assume that each agent is endowed with one unit of time. Let R denote the amount of leisure ('rest') he consumes (to be endogenised below). The agent can then allocate the remaining amount of time $(1-R)$ across three activities:

(a) selling his services (for an amount of time t) in the labour market,
(b) working on his own farm (for an amount of time l),
(c) supervising hired labour on his farm (for an amount of time S, say).

We assume that the amount of time required of the entrepreneur to supervise L hired workers is an increasing and strictly convex function of L:

$$S = s(L) \quad (s' > 0, S'' > 0), \tag{3}$$

with $s(0) = 0$ and, to ensure that the supervision of hired labour is not prohibitively costly for all L, $s'(0) < 1$. Strict convexity of the supervision function is rationalised on the traditional grounds that it renders finite the size of the enterprise despite linear homogeneity of the production function. We discuss later the consequences of relaxing the assumption of strict convexity of $s(L)$.

The time endowment constraint facing an entrepreneur may now be written.

$$1-R-t-s(L) \geqslant 0. \tag{4}$$

The left-hand side of (4) is the amount of time, l, the entrepreneur works on own farm as a labourer.

To complete the specification of the model we posit that all agents have identical preferences defined over the present value earnings, Y, of the period and leisure. For tractability, the utility function is posited to have the additive structure:

$$U(Y, R) = Y+u(R), \tag{5}$$

[1] Seasonal consumption loans by landlords – a frequent practice in subsistence agriculture – could be construed as advance wage payments. Tenants, however, are not necessarily required to pay the rent in advance. But requiring this to be so in our two-factor model provides a way of simulating the working capital necessitated by the existence, in reality, of numerous intermediate inputs.

with $u' > 0$, $u'' < 0$. Further, we shall take it that the marginal utility of leisure is infinite at $R = 0$. Note that the linearity of the utility function in income implies that the agent is risk-neutral.

We now turn to the optimisation problem facing an agent. For the moment we shall examine the agent's choices assuming that he opts to cultivate. We shall subsequently analyse his choice between being a cultivator and an agricultural worker. First, note that according to (3) the supervision time required of the entrepreneur depends only on the aggregate amount of labour he hires. Thus the time spent on supervision cannot be lowered by operating two separate plots of land rather than one. The existence of positive set-up costs associated with each operation then renders it suboptimal for an agent to operate two or more separate farming establishments.[1] We first consider the problem confronting an agent who has sufficient capital to cultivate. (Later, we will address the question as to whether he will, in fact, *opt* to do so.) An entrepreneur seeking to maximise his expected utility by cultivation will thus solve

$$\max_{R,h,t,L} P\beta f(h, l+L) + wt - v(h-\bar{h}) - wL - K + u(R), \tag{6}$$

$$\text{s.t. } B + wt \geqslant vh + wL, \tag{7}$$

$$l \equiv 1 - R - t - s(L) \geqslant 0 \quad (L \geqslant 0, t \geqslant 0), \tag{8}$$

where $\beta \equiv 1/(1+r)$ is the discount factor per crop period, and

$$B \equiv \bar{B} - K + v\bar{h}.$$

Given our assumptions on $u(\cdot)$ and $f(\cdot, \cdot)$, the problem stated in (6) has the classic Kuhn–Tucker form and admits of only one solution. Thus for given v, w and B there exists a unique solution to the optimisation problem in (6). This solution can be parameterised by the working capital, B, available to the entrepreneur and the various exogenous prices. We shall denote the solution by the quartet $[R^*(B, v, w), h^*(B, v, w), t^*(B, v, w), L^*(B, v, w)]$, and the associated expected utility by $U^*(B, v, w, K)$, which is non-decreasing in B. Note that since the constant term $v\bar{h}$ appears additively in the maximand (6), we can always write $U^*(B, v, w, K) = U^+(B, v, w, K) + v\bar{h}$, where U^+ is non-decreasing in B – a property we note here for future reference.

The following proposition demonstrates that there are four potential modes of cultivation that can arise:[2]

PROPOSITION 1. *The solution to* (6) *admits of four distinct modes of cultivation, separated by three critical values,* B_1, B_2, B_3 (*with* $0 < B_1 < B_2 < B_3$) *of* B, *such that the entrepreneur is a*

(I) *Labourer-cultivator* ($t > 0, l > 0, L = 0$) for $0 \leqslant B < B_1$,

(II) *Self-cultivator* ($t = 0, l > 0, L = 0$) for $B_1 \leqslant B < B_2$,

(III) *Small capitalist* ($t = 0, l > 0, L > 0$) for $B_2 \leqslant B < B_3$,

(IV) *Large capitalist* ($t = 0, l = 0, L > 0$) for $B \geqslant B_3$.

[1] If we allow the supervision requirement on each plot to depend only on the number of hired workers on that plot, it is conceivable that an agent might contemplate operating two separate farms, However, this feature would render our model intractable. In view of this, we can interpret K as the set-up cost per farm and also as the set-up cost per agent.

[2] The proof of this and the following proposition is given in Eswaran and Kotwal (1984).

The intuition for Proposition 1 becomes clear if we reason through, as we do below, how different activities become optimal at different levels of capital.

An agent with severely restricted access to capital can lease in only a small amount of land; the marginal revenue product of his labour on this piece of land would be correspondingly small. He thus finds it optimal to sell his services on the labour market for part of the time, thereby augmenting his working capital. He then earns a return on this capital by expanding his operation. Such agents are the labourer-cultivators, who are wage-earners cum entrepreneurs. The amount of leisure they consume is determined by the condition that the utility derived from the marginal unit of leisure equals the income from cultivation that is foregone as a result. Since the latter is constant for a linearly homogeneous production function, it follows that all labourer-cultivators consume the same amount of leisure.

The greater the working capital a labourer-cultivator has access to, the greater the amount of land he can rent and, therefore, the larger is the marginal product of his own labour. Since all labourer-cultivators consume the same amount of leisure, it follows that those with larger budgets will sell less of their labour services and devote more time to cultivation. The agent with a budget $B = B_1$ altogether ceases to transact in the labour market: he devotes all of his non-leisure time to cultivation. If hired and own labour had the same price, an agent with a budget marginally greater than B_1 would hire outside help. This, however, is not so. While the wage rate earned by the agent in the labour market would be w, the cost to him of hiring the first worker on his own farm is $w+s'(0).u'(R)$, which is strictly greater than w since $s'(0) > 0$. Thus this agent will not hire outside help; he will expend his entire budget on hiring land and opt to be a self-cultivator. Agents with greater access to working capital will (self-)cultivate larger farms by consuming less leisure.

Since each agent has a limited amount of time endowment, the price of own-labour (i.e. the marginal utility of leisure foregone) becomes increasingly higher at higher levels of working capital. The ratio of the effective price of hired to own labour, i.e. $[(w+s'(0)\ u'(R)]/u'(R)$, declines. An agent with some sufficiently high budget $B_2(> B_1)$ will thus find it optimal to hire and supervise outside help, apart from applying some of his own labour on the farm. This agent marks the transition from the class of self-cultivators to the class of small capitalists. We thus see that the capitalist mode of cultivation emerges as a natural response to the need of entrepreneurs to circumvent their time-endowment constraints. Agents with budgets greater then B_2 will hire greater amounts of labour and spend more time in supervision. At some level of working capital $B_3(> B_2)$ it pays the agent to specialise in supervision, all labour is hired labour and the agent maximises the returns to his access to working capital by only supervising hired hands. Agents with $B \geqslant B_3$ comprise the class of large capitalists.

In proposition 1 we have merely derived all the modes of cultivation that are potentially observable. We have presumed that the agent in question in fact opts to cultivate. Whether or not he will do so will depend on whether or not his maximised utility $U^*(B, v, w, K)$, in cultivation exceeds his maximised utility in the next best alternative: being a pure agricultural worker. As an agricultural worker, the maximised utility, $U_0^*(v, w, \bar{h})$, of an agent who owns (and leases out) an amount of land $\bar{h}$ is given by

$$U_0^*(v, w, \bar{h}) = \max_R w(1-R) + u(R) + v\bar{h}. \tag{9}$$

The agent will opt to cultivate if and only if

$$U^*(B, v, w, K) > U_0^*(v, w, \bar{h}). \tag{10}$$

If set-up costs, K, were zero, all agents (including those with $B = 0$) will opt to cultivate if the technology is at all viable at prices (P, v, w). However, if set-up costs are positive and sufficiently large, agents with meagre working capital would find it more attractive to join the labour force on a full-time basis than to cultivate on a scale so small as to be unprofitable. Those agents for whom (10) is violated will form the class of pure agricultural workers. There thus emerges a fivefold class structure in our model of an agrarian economy.[1] In reality, cultivation may not be feasible for the poorest agents because they have to assure themselves of a minimum subsistence before they can expend resources to engage in cultivation. Thus a pure labourer class could obtain even in the absence of scale economies. However, for expediency in modelling we shall continue with our assumption of positive set-up costs in cultivation.

For the rest of this section we shall assume that all the modes of cultivation we have discussed are manifest. In other words, if B_{max} denotes the largest amount of capital that a single entrepreneur can profitably utilise in agriculture, then $B_{max} > B_3$. The quantity B_{max} is determined as the smallest value of B for which the capital constraint ceases to bind in (6), and will depend on P, v and w in general.

We now turn our attention to the land-to-labour ratio of farms as a function of the entrepreneurs' access to working capital. The following proposition records our results comparing the land-to-labour ratio and the average productivity per acre across farms spanning the four modes of cultivation.

PROPOSITION 2. *As a function of B,*

(a) the land-to-labour ratio is constant over the labourer-cultivator class and strictly increasing over all other classes,

(b) the (expected) output per acre of farms is constant over the labour cultivator class and strictly decreasing over all other classes.

[1] In a *tour de force* in Marxian economics, Roemer (1982) was the first to derive analytically a a fivefold class structure in an economy in which agents have differential access to the means of production. There is one essential difference between Roemer's analysis of class structure and ours. If only a single crop is produced, the class in Roemer's framework which is the analogue of what we call self-cultivators in our formulation is a set of measure zero. This arises from his implicit assumption that own and (unsupervised) hired labour are perfect substitutes. We have seen above that if agents are arranged in the order of increasing budgets, the agent with a budget B_1 will be the first one to self-cultivate. Further, if $s'(0) = 0$ he would also be the only one to self-cultivate since all agents with budgets exceeding B_1 will find it optimal to hire outside help. If the distribution of the access to capital across the agents of the economy is continuous, it follows that self-cultivators would form a set of zero measure. In our formulation, this anomaly does not arise. As long as hired labour requires supervision, there exists an interval $[B_1, B_2]$ of strictly positive length such that all agents with budgets in this range would choose to self-cultivate. Bardhan (1982) presents an enlightening empirical analysis of agrarian class structure in West Bengal, India, based on Roemer's theoretical framework.

Intuition for the above proposition can be readily had. By equating the marginal utility per dollar spent on the two factors, the agents are, in effect, setting the ratio of the marginal products of land and labour equal to the ratio of their perceived prices. The perceived price of land is the same for all agents, and equals its market price. We have seen that all labourer-cultivators consume the same amount of leisure, so that the perceived price of (own) labour is constant for all $B \leqslant B_1$. Since the price ratio of the factors (land and own labour) is constant for $B \leqslant B_1$, production from a linearly homogeneous technology will use the factors in a fixed ratio. We have also seen that, beyond B_1, increases in B induce the entrepreneurs to consume less leisure, resulting in a rising perceived price of own labour. Since the price of land is constant, we shall observe a bias towards land in the use of factors under self-cultivation: the land-to-labour ratio will increase with B. In the capitalistic mode of production, this effect is further reinforced by the fact that the cost of supervising hired labour increases at an increasing rate with the amount of labour hired. Part (*b*) of the above proposition follows directly from part (*a*) and the linear homogeneity of the production function. To the extent that our thinking is conditioned by the implicit assumption that markets are perfect, these results would appear counter-intuitive. If agents were not constrained in their borrowing, for example, it would be Pareto-efficient for those agents currently operating inefficiently large farms to lease out some of their land to agents with smaller (and hence more efficient) farms. In equilibrium, we would then expect all agents to operate farms of identical sizes.

We now briefly discuss how the results of these propositions would be affected by relaxing our assumptions regarding the nature of the supervision function $s(L)$ and the set-up costs K. Our results are driven by the assumption of increasing marginal disutility of effort. Even if the supervision function $s(L)$ were not strictly convex in L but the cost of supervision in terms of the entrepreneur's utility were so, these results would still obtain. Thus if, as might be argued for share tenancy, the supervision function is linear, the results of Propositions 1 and 2 would be quite unaffected except for one minor qualification: the land-to-labour ratio is constant for the small capitalist class. On the other hand, if the supervision function is strictly concave, the labour costs in terms of the entrepreneur's utility may not be convex. The results of Proposition 2 may then not obtain.

It is conceivable that the set-up costs (e.g. irrigation) increase with the size of the plot cultivated. This would be equivalent to altering the effective price of land with the plot-size. If the set-up costs increase less than proportionately with the plot-size then the effective price of land is declining with the plot-size, and the results of Proposition 2 are further strengthened. If the set-up costs rise proportionately with the plot-size then again our results are intact, since the effective price of land is constant. Finally, if the set-up costs rise more than proportionately with the plot-size, the results are ambiguous because the effective prices of both land and labour are rising with the scale of operation.

Among the hypotheses alternative to the one proposed in this paper for the inverse relationship between size and labour usage per acre, the most celebrated one is the Dual Labour-Cost hypothesis of Sen (1975). According to Sen, small farms make extensive use of family labour whereas larger farms engage a greater proportion of hired labour. Family workers perceive a lower cost to working on their own farms due to psychological and other factors, and this results in greater use of labour per acre compared to larger farms. Ahmed (1981), Cline (1970) and Ghose (1979) provide evidence that a negative relationship between size and labour per acre can exist even within samples comprised of only family operated farms and also within samples comprised of farms that operate with only hired labour. In other words, the inverse relationship exists independently in the self-cultivation and the capitalist modes of production – consistent with our result in Proposition 2. Our results are also consistent with the implications of Sen's hypothesis that family farmers (i.e. self-cultivators) perceive a lower cost of labour than do capitalist farmers.

The empirical evidence on the inverse relationship between farm size and land productivity is, however, less clear. In Brazil, Cline (1970) and Kutcher and Scandizzo (1982) have found a clear evidence for the inverse relationship. In India, the evidence is mixed. The less capital intensive agriculture depicted in Farm Management Surveys of 1955–6, which Bharadwaj (1974) analysed, shows a more prominent inverse size-productivity relationship than does the much more capital intensive agriculture of present day Punjab (Rao, 1977; Bhalla and Chaddha, 1981; Rudra, 1982). In a recent paper Carter (1984) has confirmed the existence of the inverse relationship between farm size and productivity in data gathered in Haryana (India) during the years 1969–72. Rao (1977) observes that the inverse relationship is weakening, and perhaps becoming direct, over time in the prosperous regions of India that have adopted the new High Yielding Variety technology. In Mexico (World Bank, 1978) the size-productivity relationship for foodgrains such as rice and wheat certainly seems to have changed from being inverse to being direct over the past thirty years. It is our contention that the greater use of physical capital over time is responsible for this change in Mexico and Punjab (India). Labour-displacing capital not only mitigates the scale diseconomies introduced by the heavy supervision requirement of large farms, but it also introduces scale economies due to indivisibilities. Since only large farms can utilise such capital, it is not surprising that the more recent data reveal a positive size–productivity relationship.

II. THE GENERAL EQUILIBRIUM

In this section we set up a general equilibrium version of the model we considered in the previous section. Agents are allowed to choose the activities they undertake, their choices being dictated by the going prices and their access to working capital. The present value of the output price, $P\beta$, is normalised to unity. The factor prices are determined as those which clear the labour and land-rental markets, given the decisions of the agents in the economy. The general equilibrium framework, in which factor prices and class structure are endogenously thrown up, enables us to evaluate the income-distribution and welfare effects of policy actions such as land reform and credit reform. Since analytic results are difficult to obtain in general equilibrium, we are forced to resort to specific functional forms.

We assume that the production function in (1) takes the Cobb–Douglas form.

$$f(h, n) = Ah^{\frac{1}{2}}n^{\frac{1}{2}} \quad (A > 0), \tag{11}$$

and that the sub-utility function $u(R)$ has the constant-elasticity form

$$u(R) = DR^{\frac{1}{2}} \quad (D > 0). \tag{12}$$

As discussed in previous sections, an agent's access to capital in an agrarian economy is largely determined by the amount of land he owns. We posit that an agent whose owned-land holding is $\bar{h}$ has available to him a maximum amount of credit, $\bar{B}(\bar{h})$, given by

$$\bar{B}(\bar{h}) = \theta\bar{h}+\phi \ (\theta \geqslant 0, \phi \geqslant 0). \tag{13}$$

If ϕ is positive, even landless agents have access to some credit.

We assume that the total amount of land in the economy is exogenously given to be H, and that it is distributed across $N_0 + N_1$ agents, N_1 of whom own strictly positive amounts of land; the remaining N_0 agents are landless. The distribution of ownership across the landed agents is not necessarily egalitarian. We can index a landed agent by the proportion, p, of the landed agents who own smaller holdings than he does. We posit that the proportion, $F(p)$, of that is held by all landed agents $p' < p$ is given by Pareto distribution:

$$F(p) = 1-(1-p)^{\delta} \quad (0 < \delta \leqslant 1). \tag{14}$$

The larger the value of the parameter δ, the more egalitarian is the distribution of ownership across the N_1 landed agents. The amount of land, $\bar{h}(p)$, agent p owns is obtained from the density function associated with (14):

$$\bar{h}(p) = H\delta(1-p)^{\delta-1}. \tag{15}$$

Together, (13) and (15) determine the amount of credit available to every agent in the economy.

Finally, we assume that the supervision function, $s(L)$, is a quadratic in the amount of hired labour:

$$s(L) = bL+cL^2 \quad (0 < b < 1, c \geqslant 0). \tag{16}$$

We are now ready to address the choice facing a typical agent: Given his owned land holding (and, therefore, the credit he has access to), the set-up costs, K, and parametric prices v and w, should he lease out his land and join the labour force, or should he cultivate? In case he opts for the latter, there is no presumption that his operational holding will equal his owned holding. Consider agent p of the landed class. If he cultivates, he will solve the optimisation problem (6), with $f(h, n)$ given by (11), $u(R)$ by (12), $s(L)$ by (16) and $B[\bar{h}(p)] = \phi-K+(\theta+v)\,\bar{h}(p)$. The solution to (6) will thus be parameterised by $B[\bar{h}(p)]$, v and w. This solution, described at length in the previous section, will generate the agent's demand for land, $h^*\{B[\bar{h}(p)], v, w\}$ and (net) demand for labour, $\tilde{L}^*\{B[\bar{h}(p)], v, w\} \equiv L^*\{B(\bar{h}(p), v, w\}-t^*\{B[\bar{h}(p)], v, w\}$. He will choose to cultivate or become a pure agricultural worker, respectively, depending on whether

$$U^*\{B[\bar{h}(p)], v, w, K\} \gtrless U_0^*[v, w, \bar{h}(p)]. \tag{17}$$

Recalling that $U^*(B, v, w, K) = U^+(B, v, w, K) + v\bar{h}$ and that $U_0^*(v, w, \bar{h}) = U_0^*(v, w, 0) + v\bar{h}$, (17) may be rewritten as

$$U^+\{B[\bar{h}(p)], v, w, K\} \gtrless U_0^*(v, w, 0). \tag{18}$$

Since the left-hand side is non-decreasing in B and hence in p, it follows that if when agent p opts to cultivate then all agents p', with $p' > p$, will do likewise. The marginal cultivator, $p_m(v, w, K)$, is determined as the agent for whom (17) holds with equality: he is indifferent between being a cultivator and a pure agricultural worker. If $p_m(v, w, K) > 0$, then landed agents with $p < p_m(v, w, K)$ and all of the landless agents will be pure agricultural workers.

It is possible, however, that $p_m(v, w, K) = 0$, i.e. all landed agents opt to cultivate. Further, it is also possible that the landless agents might prefer to cultivate by leasing in land. This would be the case if

$$U^+(\phi - K, v, w, K) > U_0^*(v, w, 0). \tag{19}$$

Note that since all of the landless agents are identical in every respect, their choices will also be identical.

We are now ready to write down the conditions that characterise the general equilibrium of this agrarian economy. Given the optimising choices of individual agents elaborated on above, these conditions are essentially the market clearing conditions for land and labour:

$$N_0\, h^*(\phi - K, v, w) + N_1 \int_0^1 h^*\{B[\bar{h}(p)], v, w\}\, dp - H = 0, \tag{20a}$$

$$N_0 \tilde{L}^*(\phi - K, v, w) + N_1 \int_0^1 \tilde{L}^*\{B[\bar{h}(p)]v, w\}\, dp = 0, \tag{20b}$$

with

$$p_m(v, w, K) \geqslant 0, \quad U^+\{B[\bar{h}(p_m)], v, w, K\} - U_0^*(v, w, 0) \geqslant 0, \tag{20c}$$

$$p_m(v, w, K) = 1 \quad \text{if} \quad U^+[B_{\max}, v, w, K] - U_0^*(v, w, 0) < 0, \tag{20d}$$

where $B_{\max}$, as defined in the previous section, is the largest amount of capital that can be profitably utilised in agriculture. In writing down (20c) we have followed the convention that if one of the inequalities is strict the other must hold with equality. Condition (20d) says that cultivation is the less attractive option for all agents in the economy, i.e. cultivation is not viable at these prices.

The simultaneous solution to conditions (20a)–(20d) determines the general equilibrium. Exogenous to the model are the parameters A (of the production function), K (the set-up cost), b and c (of the supervision function), D (of the utility function), θ and ϕ (of the borrowing constraint), δ (of the land-ownership distribution function), N_0 (the number of landless agents), N_1 (the number of landed agents), and H (the total supply of land). Endogenous to the model are the land-rental and wage rates (v and w), each agent's net demand for land and labour, the utilities of the agents, the proportion of the landed agents who become pure agricultural workers (p_m) and, more generally, the class structure of the economy. These in turn determine the income distribution and welfare of the society. As our measure of welfare, we adopt the Benthamite welfare function:

$$W = N_0 \tilde{U}(\phi - K, v, w, K) + N_1 \int_0^1 \tilde{U}\{B[\bar{h}(p), v, w, K\} \, dp, \tag{21}$$

where

$$\tilde{U}\{B[\bar{h}(p)]v, w, K\} \equiv \max(U^*\{B[\bar{h}(p)]v, w, K\}, U_0^*[v, w, \bar{h}(p)]). \tag{22}$$

This completes the specification of the general equilibrium model. For parametric prices, the demand and supply choices of each agent we can determine analytically. To solve the market clearing equations (20a)–(20d), however, we have had to resort to numerical methods. We now present the general equilibrium comparative statics of the model.[1]

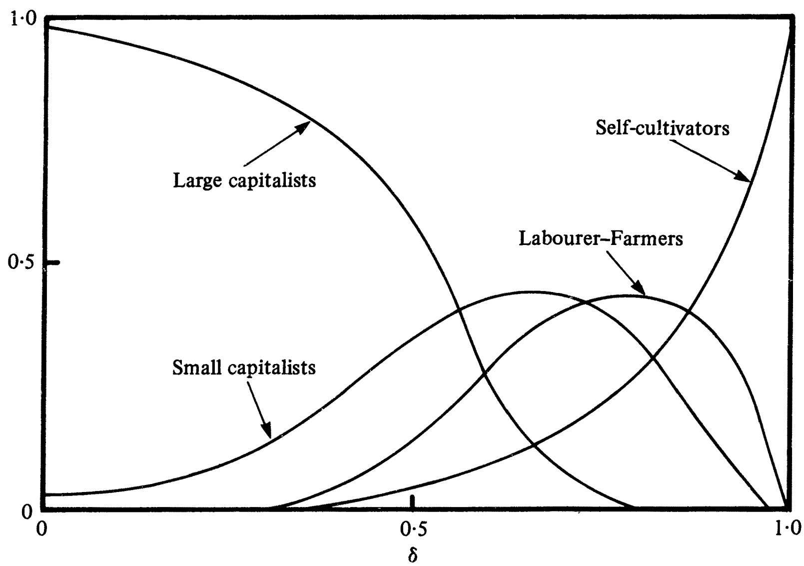

Fig. 1. Proportion of land operated under various modes of cultivation as a function of δ. Parameter values: $A = 5$, $b = 0{\cdot}1$, $D = 0{\cdot}1$, $K = 0{\cdot}5$, $\theta = 1$, $\phi = 0$, $H = 0{\cdot}5$, $N_0 = 0$, $N_1 = 1$.

Figs. 1 and 2 show the percentage of total land operated in equilibrium under different modes of production as a function of the parameter, δ, which characterises the distribution of land ownership. The parameter values are noted at the bottom of the figures. Fig. 1 corresponds to a case when there are no landless people, while Fig. 2 corresponds to a case when there are landless agents. We can see from the two figures that if the ownership distribution is extremely unequal ($\delta \approx 0$), the dominant mode of production is large capitalist farming

[1] In the exercises that follow, our intention is to obtain some comparative static results numerically, since analytic methods are infeasible. The parameter values are chosen with the purpose of illustrating various possible general equilibrium outcomes. Note, however, that we cannot interpret specific parameter values as being 'large' or 'small'.

whether or not there exists a class of landless people. The 'latifundia' agriculture of north-east Brazil would correspond to this case. At the other extreme, in the agrarian areas of present-day Taiwan and Japan, which are characterised by relatively uniform distributions of land ownership ($\delta \approx 1$) and an absence of landless rural workers, the dominant mode of production is self-cultivation as shown in Fig. 1. In the limit when the distribution is perfectly uniform ($\delta = 1$), the credit available will be identical for all cultivators. This symmetry will yield, for moderate values of the set-up cost, an equilibrium involving only self-cultivators, owning and operating identical amounts of land. This is consistent with Rosenzweig's (1978) empirical finding in Indian agriculture that participation in the labour market declines with decreases in landholding

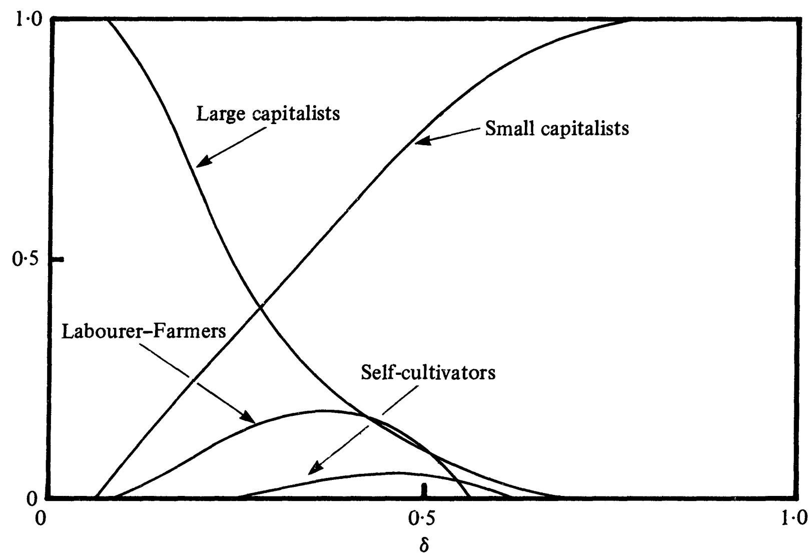

Fig. 2. Proportion of land operated under various modes of cultivation as a function of δ. Parameter values: $A = 5$, $b = 0{\cdot}3$, $c = 0{\cdot}01$, $D = 0{\cdot}1$, $K = 0{\cdot}5$, $\theta = 1$, $\phi = 0$, $H = 1$, $N_0 = 0{\cdot}5$, $N_1 = 1$.

inequality. If there exists a class of landless workers, however, the egalitarian landed class will be able to hire these workers to supplement their own labour and the landed agents will thus all be capitalists – a situation depicted in Fig. 2 for values of δ approaching unity.[1] Note that when the dominant mode of cultivation is large capitalism – as is the case here when distribution of land ownership is highly skewed ($\delta \approx 0$) – there must exist, correspondingly, a sizeable class of agricultural labourers. This is consistent with Bardhan's (1982) findings in West Bengal, India. He observed that the proportion of wage labourers in the rural labour force is 'positively and very significantly associated with the index of inequality of distribution of cultivated land in the region'.

We now turn our attention to the question of land reform, which we define,

[1] Note that although small capitalist production dominates for $\delta = 1$ in Fig. 2, if there were a larger number of landless agents the dominant mode of production could conceivably be large capitalism.

in a narrow sense, to be an increase in the land distribution parameter δ. Fig. 3 allows us to evaluate the impact of land-reform on social welfare (using the Benthamite welfare measure defined above), the relative income distribution (as measured by the Gini index G_i) and absolute poverty, z (measured as the proportion of total population below an arbitrarily selected poverty line income, Y_p). In the figure we also present the Gini coefficient for the land-ownership distribution, $G_h[= (1-\delta)/(1+\delta)]$. We see from the figure that an increase in the distributional parameter δ (i.e. greater equity) not only unambiguously reduces the Gini coefficient on income and reduces the proportion of the rural population below the poverty line, but it also simultaneously causes an increase in social welfare.[1] The increase in social welfare is a direct consequence of the inverse relationship between farm size and land productivity

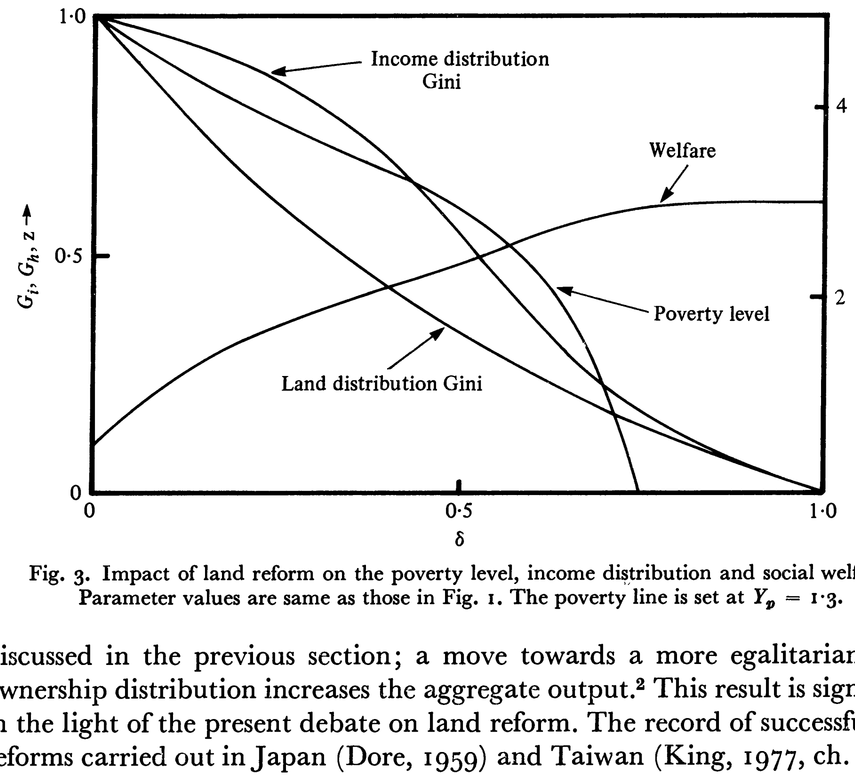

Fig. 3. Impact of land reform on the poverty level, income distribution and social welfare. Parameter values are same as those in Fig. 1. The poverty line is set at $Y_p = 1{\cdot}3$.

discussed in the previous section; a move towards a more egalitarian land-ownership distribution increases the aggregate output.[2] This result is significant in the light of the present debate on land reform. The record of successful land reforms carried out in Japan (Dore, 1959) and Taiwan (King, 1977, ch. 9) and Cline's predictions (Cline, 1970) on the impact of land redistribution on Brazilian agricultural output are quite consistent with our general equilibrium results.

[1] Notice that in Fig. 3, G_i exceeds G_h. In the absence of set-up costs, the opposite would be true since the profits per acre would be declining in the farm size (Rao, 1977, p. 148). For significant set-up costs, however, this would not remain so.

[2] Note that land reform, by equalising access to credit across agents, increases the number of cultivators. This would increase the aggregate set-up cost incurred by the economy. If the set-up cost K is inordinately large, it is conceivable that social welfare could in fact decline following a land reform. This, however, is unlikely. Moreover, if the class of pure labourers arises due to minimal consumption requirements (as pointed out in the text) rather than due to set-up costs in cultivation, social welfare will unambiguously increase following land reform.

An interesting outcome of land reform in the presence of a landless class is depicted in Fig. 4. The utility of a landless worker increases continuously as the distribution of ownership is made more uniform among the *landed* agents. This follows from the increase in the demand for labour and, thus in wages that results from the land reform, since smaller farms demand greater amounts of labour per acre. This is supported by the empirical results of Rosenzweig (1978); he found, in Indian agriculture, that rural wages decrease with inequality in land-ownership. For extremely unequal distributions (low values of δ) we see from Fig. 4 that any increase in δ brings about substantial increases in the

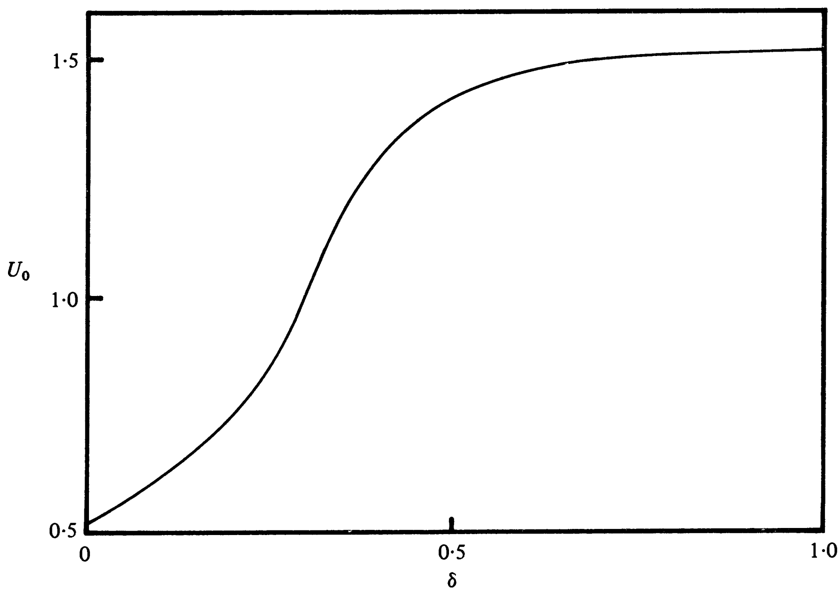

Fig. 4. Impact of land reform amongst only the landed agents on the utility level of a landless agent. Parameter values are same as those in Fig. 2.

welfare of landless workers. The relationship becomes concave as the distribution gets more uniform. Clearly, the benefits of land reform for the landless are quite marked when the ownership distribution among the landed is highly skewed.

Fig. 5 illustrates the results of a credit reform in which the total volume of the credit is held constant, while θ (the parameter which determines the extent to which the access to credit is dependent on land ownership) is varied. When $\theta = 0$, the access to credit is completely independent of land ownership; when θ is large, the access to credit is, of course, extremely sensitive to land ownership. In order to ensure that the aggregate credit, B_T, available to the agrarian economy is constant, we vary ϕ according to the rule $\phi = B_T - \theta H$; thus when θ changes, credit is merely redistributed, remaining constant in aggregate. The results show that social welfare monotonically decreases and the proportion of rural population under the poverty line monotonically increases with an increase in θ. (Since the change in welfare following credit reform is mainly

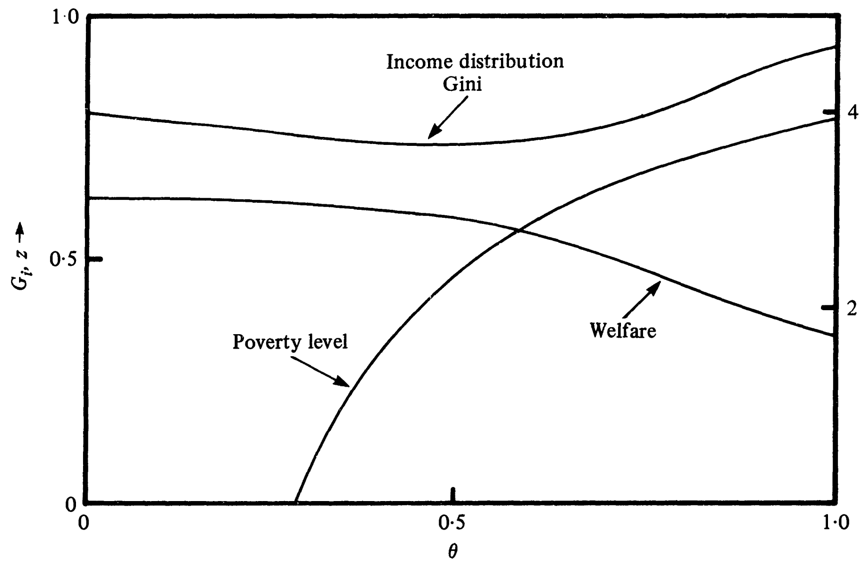

Fig. 5. Impact of credit reform on poverty, income distribution and social welfare. Total credit is fixed at $B_T = 0{\cdot}5$. Other parameter values: $A = 5$, $b = 0{\cdot}3$, $c = 0{\cdot}1$, $D = 0{\cdot}1$, $K = 0{\cdot}2$ $\delta = 0{\cdot}1$, $N_0 = 0$, $N_1 = 1$, $Y_p = 1{\cdot}0$.

due to the change in aggregate output, we may interpret the welfare function in Fig. 5 as an approximation of GNP.) This provides the theoretical rationale for the argument that the creation of institutions capable of accepting as collateral future crops rather than owned land-holdings would prove to be an effective tool for removing poverty as well as for improving efficiency.

III. CONCLUSIONS

The cornerstones of the model presented in this paper are the two constraints facing each agent in his optimisation problem: (1) the amount of working capital (or credit) available to him and (2) his limited time endowment. The constraint on the availability of working capital arises from the characteristics of capital markets in which credit is rationed according to the ability to offer collateral. The fact that the total time available to an agent is fixed matters because the (unsupervised) time purchased from another agent on the market is an imperfect substitute for one's own time. The allocative process is thus influenced by imperfections in two key markets – imperfections in the sense that agents cannot purchase desired amounts of working capital or effective labour at given prices.

In an economy in which agents are bound by the above two constraints, we have demonstrated that in equilibrium there is a misallocation of resources: land-to-labour ratios differ across farm sizes and there is scope for welfare- and output-improving transfers of resources across agents. It is important to note that this misallocation arises because of imperfections in two markets. If agents could borrow unlimited amounts of capital at a given interest rate, all farms would be of the same size, using land and labour in the same proportion – thus yielding a Pareto-efficient outcome. If, on the other hand, there were no moral hazard on the part of hired labour (i.e. hired and own labour were perfect substitutes), then in the absence of set-up costs, differently credit-constrained agents would operate farms on different scales but with the same land-to-labour ratios[1] – again achieving a Pareto efficient outcome. With a constant returns to scale technology, a Pareto inefficient allocation of resources requires imperfection in at least two markets – for example, labour and land markets, or credit and land markets, etc.

The modern theory of organisation revolves around the issue of moral hazard of hired labour. The hierarchical relationship between an employer and his employee within a capitalist firm has been rationalised as a way of mitigating moral hazard in team production (Alchian and Demsetz, 1972). In our model, however, workers are not hired because of any technological superiority of team-production. An agent who has access to large amounts of credit cannot earn positive returns on it by re-lending the money unless he has a more effective way of curbing moral hazard on the part of the potential borrower than does the credit agency. Therefore, when an agent engaged in self-cultivation is given access to a larger amount of credit, he must use the additional credit for cultivation on a larger scale. Given the increasing marginal cost of his own time, he seeks to stretch his time constraint by hiring labour, which must be supervised. The agents who are selling their services on the labour market are those whose lack of access to credit prevents them from becoming cultivators. Hierarchical relationship can thus come about due to a non-uniform distribution of access to credit rather than any technological superiority of team-production. Our argument remains valid even when set-up costs are zero. Agriculture is one sector for which the explanation of hierarchical employment relationships on the basis of a presumed technological advantage of team-production is not compelling. Since the various production activities are necessarily spread out over time, it is possible for individual agents to operate as efficiently as would a team (Dorner, 1972, p. 103).

Our model implies that richer employers typically consume smaller amounts of leisure. This implication, however, is not generally borne out. The reason for this is not hard to see. Those agents with access to large amounts of credit have incentives to come up with organisations and technologies that facilitate production on a large scale. The creation of pyramidal hierarchies and the use of labour-displacing mechanisation are two examples of how such agents can use more hired factors to economise on their supervision time.

We conclude by observing some serious limitations of the model presented in this paper. If the supervision requirement increases at a decreasing – rather than increasing – rate with the size of the hired labour force, our results on the welfare effects of land and credit reform may not obtain. The same qualification must be made if the set-up costs have a variable component that increases less than proportionately with the plot-size cultivated. The irrigation technology

[1] With positive set-up costs and an otherwise linearly homogenous production function, it would be socially optimal to have only a single farm if supervision were redundant.

employed is particularly relevant to this point. Finally, note that tenancy in our model is explicitly fixed rental tenancy. An attempt to introduce share tenancy into our framework would pose two problems. First, it would require a precise understanding of the way in which share tenancy alters the supervision technology. Secondly, it might violate our assumption that the credit ceiling of a cultivator is determined by the amount of land he owns; a share tenant may obtain his credit from the landlord. It is, however, conceivable that share tenancy arises to circumvent imperfections in capital markets. In particular, it may be an arrangement whereby the tenant acquires access to the use of land prior to the payment of its rental. Since the crop would stand on the landlord's own land, tenancy would be tantamount to accepting future crops as collateral. If this is so, it is yet another indication that imperfections of capital markets can have significant consequences for agrarian institutions.

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Date of receipt of final typescript: August 1985

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