

SHARECROPPING AND THE INTERLINKING
OF AGRARIAN MARKETS*

Avishay Braverman***
Joseph E. Stiglitz***

Econometric Research Program
Research Memorandum No. 299

February 1982

* This paper appears simultaneously as a World Bank, Development Economic Department, Public Finance Division discussion paper. The views presented in this paper are solely those of the authors and do not necessarily reflect the official opinions or views of The World Bank. We thank Hans Binswanger for helpful comments and Vivianne Lake for editorial assistance.

** The World Bank

*** Princeton University

Econometric Research Program
Princeton University
207 Dickinson Hall
Princeton, New Jersey

I. Introduction

One of the often noted features of less developed agrarian economies is the interlinkages among the land, labor, credit, and product markets.^{1/} The landlord often is the supplier of credit; he frequently purchases and markets the output of the tenant-farmers; and he often sells raw materials (fertilizers) and even consumption goods to his tenant-farmers.

How do we explain this phenomenon? And what are the welfare consequences of attempts to restrict these practices, which often seem to constitute restraints on free trade? These are the questions to which this paper is addressed.

In the past, theoretical discussions of interlinked contracts viewed them as a form of exploitation of less powerful agents by more powerful agents, e.g., Bhaduri [1973, 1977]. The argument, however, was never very convincing: if a landlord could exploit his tenants to the point of reducing them to their subsistence level (as these arguments often suggested), why could the landlord not do so simply by reducing the share on the share contract? What more could he get by these other devices?

Recent studies (Bell-Zusman [1980], Braverman-Srinivasan [1980], Mitra [1980], Newbery-Stiglitz [1979]), however, have begun to discuss other economic aspects of interlinking contracts in a world characterized by market imperfections, uncertainty, and the absence of certain markets. In this paper we present a general set of arguments applicable to both competitive and non-competitive environments, to situations where all the terms of the contract are determined in an optimal way, as well as to situations where many of the terms are specified institutionally.

Our analysis is based on two features commonly found in less developed agrarian economies:

- (a) Individuals are not paid on the basis of their input (effort) since this, in general, is not observable; and they conventionally do not rent land for a fixed sum since that imposes too much risk on them.^{2/} Hence the contractual arrangements involve at least some form of sharecropping;^{3/} therefore, workers do not obtain the full marginal product of their efforts.
- (b) The landlord cannot completely specify the actions to be taken by the worker; the worker has considerable discretion both with respect to the level of effort, its allocation, and the choice of technique of production. Some of these decisions, may, of course, be easily monitored by the landlord, but there are other actions, perhaps equally important, for which the cost of monitoring would be very high.

These two facts -- that the worker has considerable discretion over his own actions, and that, because of the nature of the contractual arrangements between the worker and the landlord, the worker's actions have an important effect on the landlord's expected profits -- have, in turn, some further important implications. In particular, it means that the landlord has an incentive to attempt to *induce* workers to behave in the way the landlord would like them to behave. The behavior of the worker is affected, in important ways, by the amount which he borrows and the terms at which he obtains credit, and by the goods he can purchase and the prices he pays.

It should be emphasized that our analysis applies equally well to situations where the terms of the tenancy contract (the share, plot size, etc.) are endogenous as well as to situations where they are determined institutionally.^{4/} The employment of sharecropping arrangements need not, however, be viewed (as interpreters of Marshall did^{5/}) as an inefficient contractual arrangement, even where it gives rise to the variety of problems which are the subject of this paper. When information is costly, and there are significant risks, sharecropping provides a method by which some of the risks are borne by the landlord, while, at the same time, maintaining incentives for the worker.^{6/}

This paper is divided into the following sections:

- Section II: Examines interlinked credit and tenancy contracts.
- Section III: Discusses cost sharing contracts as a form of interlinking labor and raw material input markets. Specified in this section are the different cost sharing rules implied by different assumptions regarding incentives and uncertainty.
- Section IV: Examines the interlinked marketing and tenancy contracts.
- Section V: Points out the possible interlinking between labor contracts and consumption good markets.
- Section VI: Presents the different equilibrium frameworks discussed in this paper, i.e., monopoly, monopsony, competition, and rationing equilibria.
- Section VII: Discusses the fact that while interlinking may allow for increasing *ex-ante* efficiency due to internalization of certain externalities, it can also create *ex-post* inefficiencies by reducing the desirable turnover rate of 'mismatched' agents.

II. Interlinked Credit and Tenancy Contracts

In this section we establish that whenever there is not a pure rental system such that the landlord's income depends, in part, on the actions of the tenant, and the actions of the tenant cannot be perfectly monitored, the returns to the landowner are affected by the borrowing decisions of the tenant.^{7/} In the following discussion we will be concerned both with the tenant's allocation of effort and his choice of technique of production, e.g., when and how often he weeds, when he plants and harvests, the type of seed he plants, the amount and kind of fertilizer he uses, when and how he applies it, etc. Some of these decisions may be easily monitored by the landlord, but there are other actions, perhaps equally important, for which the cost of monitoring would be very high. The fact that the tenant has some discretion over his effort and choices, and that his behavior can thus affect the returns to the landlord, is referred to as the moral hazard problem.

We assume that there is a pure sharecropping agreement. The tenant receives a share of α of the gross output, the landlord receives $1 - \alpha$. Output, Y , is a function of (a) the effort of the tenant, which we denote by e ; ^{8/} (b) environmental factors (the weather) denoted by θ ; and (c) the choice of technique such that an increase in Ω represents an increase in risk (see discussion below). Thus

$$Y = Y(e, \theta, \Omega) .$$

It will greatly simplify the analysis, however, if we write

$$Y = gf(e)$$

where g is a positive random variable with a density function

$$h = h(g, \Omega) .$$

The tenant chooses e and Ω to maximize his expected utility $EU(c, e, \Omega)$.

We postulate that utility is a concave function of consumption c and effort, e . In the present context $c = \alpha gf$ so the tenant chooses e and Ω to maximize

$$\max_{\{\Omega, e\}} \int U(\alpha gf(e), e, \Omega) h(g, \Omega) dg . \quad (1)$$

This leads to the two first order conditions^{9/}

$$\int (U_c \alpha gf' + U_e) h dg = 0 \quad (2)$$

and

$$\int U_h \Omega dg + \int U_\Omega dg = 0 . \quad (3)$$

Equations (2) and (3) can be solved for the equilibrium choice of technique and level of effort on the part of the tenant, for the given sharecropping contract. The landlord is assumed to be sufficiently wealthy and provided with a sufficient number of alternatives to diversify his risk portfolio so that he can be represented as risk-neutral, thereby maximizing expected income, $E(1 - \alpha)gf(e)$.

The question of particular interest to us is, how does the fact that the tenant has borrowed money from a moneylender affect the landlord? We shall show that only under very special conditions will the landlord

be unaffected: He may either be better-off or worse-off. In either case, there is a kind of externality. Following the presentation of the model, we shall discuss how in both competitive and non-competitive economies, an effort is made to internalize this externality.

Assume that the worker has borrowed some money from a creditor. What the individual is concerned with, of course, is not income, but consumption, c . If the amount that the individual is committed to repay is $B(1+r) \equiv \hat{B}$, then

$$c = \alpha Y - \hat{B}, \frac{10/}{}$$

and the individual now chooses effort and the choice of technique to maximize

$$\max_{\{e, \Omega\}} EU(\alpha g(e) - \hat{B}, e, \Omega) \quad (4)$$

We obtain the same first order conditions as before. The question is, therefore, what is the effect of an increase in borrowing, \hat{B} , on the tenant's level of effort and on his choice of technique. To simplify the analysis, we shall assume first that the *only* decision variable of the tenant is his effort supply, then we shall assume that effort is fixed and the tenant chooses only the technique of production.

1. The Impact of the Tenant's Borrowing on His Effort Supply

Assume that the tenant's only decision variable is his effort and supply and that $U_{c\Omega} = 0$.^{11/} Then, by total differentiation of (2) and using the concavity of U , it is evident that $\frac{de}{dB} > 0$ as

$$\frac{d \int (U_c \alpha g f' - U_e) h d g}{d B} = - E(U_{cc} \alpha g f' + U_{ec}) \geq 0 . \quad (5)$$

Since $U_{cc} < 0$, condition (5) implies the following proposition:

Proposition 1: Increased borrowing will increase the effort of tenants and hence, the return to landlords provided that $U_{ec} \leq 0$.

The condition $U_{ec} \leq 0$ is a very reasonable one. It states that increased consumption increases or leaves unchanged the marginal disutility associated with effort.^{12/}

Now consider the impact of two opposite institutional arrangements regarding the consequence of default: bonded labor and bankruptcy. A *bonded labor* clause in the loan agreement is an arrangement which states that if the tenant fails to repay his loan he must provide certain labor services to the moneylender. We assume this to be an undesirable outcome for the tenant; hence, this implies that he will try to avoid situations or decisions which would increase the probability that his output will fall below a certain level such that he would no longer be able to repay his debt and would have to offer bonded labor services. Clearly, therefore, the impact of adding a bonded labor clause to the loan agreement is to *increase* the tenant's effort.

One formal way to model the bonded labor clause is by assuming that the tenant's marginal utility of consumption, U_c , is very high, i.e., approaching infinity for very low values of c . (See Figure 2.) In the extreme, we can depict the tenant as choosing the minimum level of effort required to avoid bondage. Thus, e is chosen so that

$$\alpha f(e) \underline{g} = \hat{B} \quad (6)$$

when \underline{g} = minimum value of g . Thus

$$\frac{de}{d\hat{B}} = \frac{1}{\alpha f' \underline{g}} > 0 . \quad (7)$$

A *bankruptcy clause* is an arrangement whereby the borrower is allowed to default on his loan whenever his income is sufficiently low, and when he defaults he is guaranteed a level of consumption, \hat{c} , in excess of the starvation level.

The impact of adding a bankruptcy clause to the loan agreement is to *decrease* the tenant's effort since he does not have to bear fully the consequences of "bad" events. Formally, if the tenant utility function is not "too strictly" concave, the bankruptcy clause causes the utility function to become convex for certain regions (see Figure 3). This change from a concave utility function to a convex function, implies that the bankruptcy clause changes the tenant's attitude towards risk from risk-avertter to risk-lover.^{13/}

When bankruptcy is a possibility we can write

$$c = \max \{ \alpha g f(e) - \hat{B}, \hat{c} \} . \quad (8)$$

Let

$$\hat{g} = \frac{\hat{c} + \hat{B}}{\alpha f(e)} \quad (9)$$

be the critical value of g below which bankruptcy occurs. Then the tenant's objective function (4) becomes:

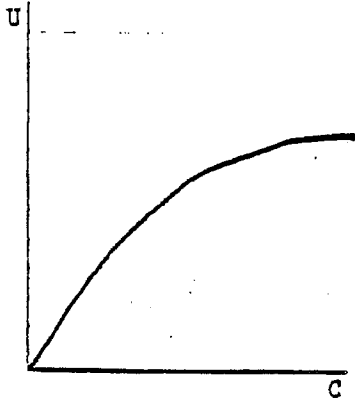


Figure 1
Risk-averse Farmer

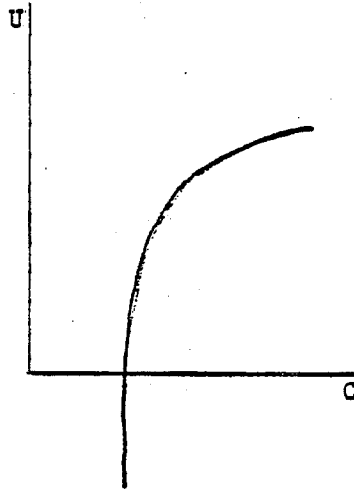


Figure 2
Risk-averse farmer who
borrows with bonded labor
clause. The marginal
utility of consumption
becomes infinite at low
levels of consumption.

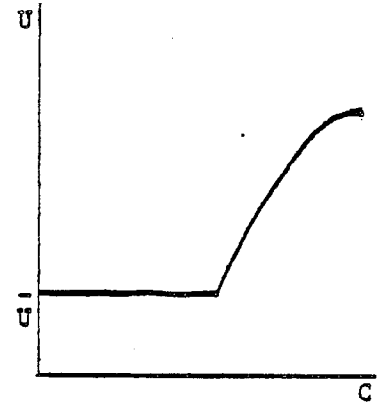


Figure 3
Risk-averse farmer who
borrows with bankruptcy
clause. Now, he may act
as a risk-lover.

$$\max_e \int_0^{\hat{g}} U(\hat{c}, e, \Omega)hdg + \int_{\hat{g}}^{\infty} U(\alpha gf(e) - \hat{B}, e)hdg \quad (4')$$

which leads to the first order condition

$$\int_{\hat{g}}^{\infty} [U_c \alpha gf' + U_e]hdg + \int_0^{\hat{g}} U_ehdg = 0 \quad (2')$$

and hence to (5')

$$\frac{de}{d\hat{B}} \geq 0 \text{ as } -U_c \alpha gf' \frac{1}{\alpha f(e)} - \int_{\hat{g}}^{\infty} [U_{cc} \alpha gf' + U_{ce}]hdg \geq 0 \quad (5')$$

Increasing borrowing makes bankruptcy more likely. This effect reduces the marginal return to effort and is expressed by the first term of (5') which is always negative. The sum total effect of increased borrowing on tenants' effort can still be positive only if the second set of terms dominates the first term. The following proposition and remark summarize this subsection.

Proposition 2: If the tenant's loan agreement includes a bonded labor clause, increased borrowing will increase the effort of tenants and, hence, the return to landlords.

Remark: If the tenant's loan agreement includes a bankruptcy clause instead of a bonded labor clause, increased tenant borrowing may not increase his effort supply.

Since landlords' expected returns are clearly dependent on the tenants' level of effort, it is clear that, in general, tenants' borrowing

has an effect on landlords' expected returns; this effect is beneficial under the bonded labor system, but if bankruptcy is possible then increased borrowing may have a deliterious effect on landlords' returns.

2. The Impact of the Tenant's Borrowing on His Choice of Technique of Production

Now, let us assume that the only set of decisions available to the worker is the choice of technique, Ω . Effort is fixed (e.g., to obtain any output requires a given level of effort; increased effort beyond that point bears little fruit). Since our main concern here is with risk taking, let us first consider a set of projects, all of which have the same mean, i.e.,

$$\int_0^{\infty} gh dg = \text{constant} \quad (10)$$

or

$$\int gh_{\Omega} dg = 0 . \quad (11)$$

Therefore, riskier projects represent mean-preserving spreads (MPS)^{14/} of less risky projects, i.e., letting H represent the distribution function, riskier projects are described by

$$\int_0^x H_{\Omega} dg \geq 0 \quad \text{for all } x > 0 \quad (12)$$

and

$$\int_0^{\infty} H_{\Omega} dg = 0 . \quad (13)$$

In Figure 4 we graphically express an MPS of the h distribution, i.e., the shifting of weight from the center to the tails. It is expressed both in terms of densities and cumulative distributions.

Now, recalling the separability assumption (footnote 11), it is easy to establish from the first order condition (3) that

$$\frac{d\Omega}{dB} \gtrless 0 \quad \text{as} \quad - \int_0^{\infty} U_c h_{\Omega} dg \gtrless 0. \quad (14)$$

Integrating twice by parts, and using (11) and (13), we obtain

$$\frac{d\Omega}{dB} \gtrless 0 \quad \text{as} \quad - \int_0^{\infty} U_{ccc} \int_0^x H_{\Omega} dg \gtrless 0. \quad (15)$$

Using (12), it is thus apparent that

$$\frac{d\Omega}{dB} \gtrless 0 \quad \text{as} \quad U_{ccc} \gtrless 0. \quad (16)$$

From (16) it is clear that an increase in borrowing will leave risk taking unaffected if and only if the utility function is quadratic, so $U_{ccc} = 0$. Otherwise, risk taking may either increase or decrease.

It is worth noting several special cases:

(a) Assume a *bonded labor* clause in the loan agreement, so that U_c for very low values of c is very high, i.e., approaching infinity. Then from (14) it is apparent that an increase in borrowing reduces risk taking: individuals are concerned with only the lower tail of the distribution where U_c is very high and h_{Ω} , the shift in the density,

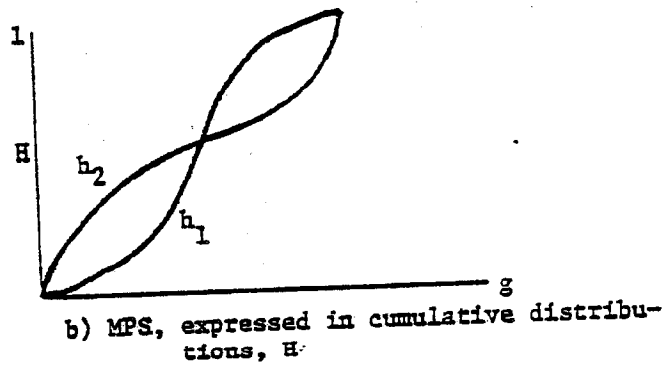
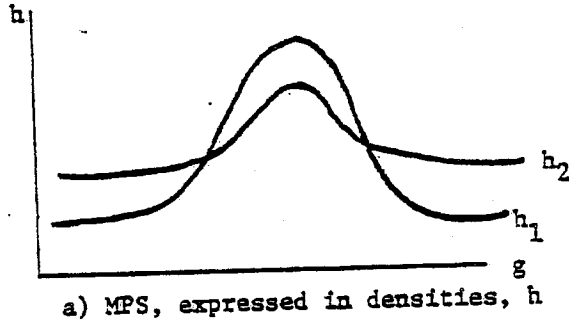


Figure 4
Mean Preserving Spread (MPS) in Distribution of g

is positive (see Figure 4a). Hence an increase in borrowing induces tenants to be more conservative.

In the limiting case described earlier, Ω^* is the smallest value of Ω such that

$$\alpha \underline{g}(\Omega^*) = \hat{B} \quad (17)$$

where $\underline{g}(\Omega^*)$ is the minimum value of g for the technique Ω^* . Thus,

$$\frac{d\Omega^*}{dB} = \frac{1}{\alpha \underline{g}'} < 0 \quad (18)$$

since $\underline{g}'(\Omega)$ is negative; increasing Ω means an increasing spread of risk which implies that the smallest value of g for given Ω declines.

(b) Assume that the individual has *decreasing absolute risk aversion*. Absolute risk aversion is defined by

$$A \equiv - \frac{U_{cc}}{U_c}$$

so

$$A' = - \frac{U_{ccc}}{U_c} + \frac{U_{cc}^2}{U_c^2}$$

Thus, decreasing absolute risk aversion implies $U_{ccc} > 0$. Therefore, from (16), risk taking is reduced by an increase in borrowing.

(c) Assume a *bankruptcy* clause in the loan agreement. If the individual's utility function is linear in consumption (in the absence

of bankruptcy, he would be risk neutral) he now becomes a risk lover; this holds more generally, provided he is not "too" risk averse (see Figure 3). Then the increase in borrowing may induce more risk taking.

According to our analysis, in which we focus on choices of techniques that leave the mean output unchanged but increase the spread of distribution, these changes in the choice of technique leave the risk-neutral landlord unaffected. Assume now, on the other hand, that the farmer has a choice of techniques in which an increase in risk also increases the mean output. If this effect is not too great, it will still be true that with bonded laborers or with decreasing absolute risk aversion, an increase in tenants' borrowing will result in a reduction in risk taking. This reduction in risk taking, however, will now have an effect on landlords, namely that expected income will be lowered.

Formally, we postulate that

$$Y = g\lambda(\Omega)f(e) \quad (19)$$

with $\lambda' > 0$ (recall that we have adopted the convention that an increase in Ω represents an increase in risk). Now the first order condition for the tenant's modified objective function (substitute (19) into (4) for Y), can be written as

$$\int [U_{h\Omega} + U_{\Omega} + U_c g\lambda'(\Omega)f(e)] dg = 0 \quad (20)$$

and

$$\frac{d\Omega}{dB} \geq 0 \text{ as } - \int [U_c h_{\Omega} + U_{cc} g \lambda' f] dg \geq 0 \quad (21)$$

Thus our earlier results are unaffected, provided λ' is sufficiently small (the bounds on λ' are determined by the magnitude of U_{ccc}). We can summarize this subsection with the following proposition and remark.

Proposition 3: With a bonded labor clause in the loan agreement or with decreasing absolute risk aversion, an increase in the tenant's borrowing will reduce his risk taking. He will, therefore, not select some techniques which allow for higher mean output as well as higher risk and by that reduce the returns of the risk-neutral landlord.

Remark: With a bankruptcy clause in the loan agreement the tenant may increase his risk taking with increased borrowing and, thus, may select riskier and higher mean output techniques, that under a bonded labor clause would not be chosen. This choice increases a risk-neutral landlord's returns.

The above arguments establish clearly that the return to the landlord will depend critically on whether his tenant has borrowed, and if so, how much. Formally, the landlord could effect the same behavior by charging a rent paid at the end of the production period and equal to \hat{B} , in addition to the share. What is important is that the individual's behavior is affected by the total magnitude of the sum of rents and loan repayments, and that it is important for the landlord to know their magnitude. 16/

3. Landlord's Terms of Loan

Let us first consider the case where an increase in borrowing reduces the expected return to the landlord -- a *negative externality*. While he would like to restrict the amount of borrowing, he would not want to eliminate it altogether. The restriction on the amount of borrowing obviously reduces the expected utility of the tenant; thus, in a competitive environment, the tenant will require an alternative in some other provision of the contract to compensate for any such restriction. He can affect this restriction, for example, by lending to the individual a given amount at a "favorable" interest rate, but then charging a prohibitively high interest rate beyond that point. To borrow supplementally from other lenders may then be very expensive: since the loan from his landlord has seniority over any supplemental loan, any potential lender would have to charge a very high interest rate.

If the amount which an individual borrows from other lenders is observable, then the competitive equilibrium contract will make the share (or other provisions of the contract) a function of the size of loans the worker has undertaken. In this case there would be no difference between the equilibrium which would emerge if the two markets

were linked together, or if they were separated. If there are costs of monitoring and collection, however, there is a natural advantage for the landlord to undertake the loan.

In the case where there is a *positive externality*, there will be an incentive for the landlord to subsidize loans and to encourage the tenant to become indebted to him, so that he will work harder to repay the loan. (Bardhan-Rudra [1978] report that in West Bengal landlords quite often offer tenants loans at interest rates below the market rate and sometimes interest free consumption loans.)

We now analyze formally the landlord's optimal contract. We let the tenant's utility function be written as $U^*(c_0, c_1, e)$ where $c_0 \equiv$ consumption in the 0th period = $K + B$. K denotes some amount the tenant has been able to save and B denotes the amount borrowed, $c_1 = \alpha f(e)g - B(1+r)$ and r denotes the interest charged to the tenant.^{17/} If ρ is the cost of capital to landlords, we can describe the optimal loan as the solution to the landlord's problem:^{18/}

$$\max_{B, B(1+r)} (1 - \alpha)f(e) + (1 + r - (1 + \rho))B \equiv \Pi \quad (22)$$

subject to

$$EU^*(K + B, \alpha f(e)g - (1 + r)B, e) \geq \bar{U} .$$

For simplicity we assume that U^* is separable in c_0 and c_1 ^{19/}, i.e.,

$U^* = u(c_0) + U(c_1, e)$. Then we obtain the following by using the envelope theorem and recalling $\hat{B} \equiv B(1+r)$:

$$-\frac{dU^*/d\hat{B}}{dU^*/d\hat{B}} = \frac{EU_c(c_1, e)}{u'(c_0)} = \frac{(1 - \alpha)f'(e)de/d\hat{B} + 1}{1 + \rho} = \frac{d\pi/d\hat{B}}{d\pi/d\hat{B}} \quad (23)$$

In contrast, in a competitive loan market, if the worker had equal access to the capital market as the landlord (an admittedly dubious assumption)

$$\frac{u'(c_0)}{EU_c(c_1, e)} = 1 + \rho \quad (24)$$

Comparing (23) to (24) we obtain the following proposition:

Proposition 4: The optimal contract offered by the landlord will entail farmers borrowing more (borrowing less) than they would in an unlinked market with equal access to capital, if $de/d\hat{B} > (<) 0$, i.e., if increased borrowing induces more (less) effort. ^{20/}

4. Default Clauses

The discussion in II.3 did not cover default clauses. As presented in previous subsections, a bonded labor clause increases the tenant's effort but reduces his risk taking. Thus, the two effects go in opposite directions in their impact on the return to the risk-neutral landlord. The bankruptcy clause produces the opposite result: it reduces effort and increases risk taking. Hence the landlord's preference for one clause over another depends on the extent of the significance of the moral hazard problem regarding effort supply compared with the tenant's choice of technique. For example, if effort can be relatively easily monitored and enforced, and the moral hazard problem mainly involves the tenant's choice of technique,

then a risk-neutral landlord will tend to prefer a bankruptcy clause to a bonded labor clause. On the other hand, if the moral hazard problem is more significant in the tenant's effort supply rather than in his choice of technique, then a bonded labor clause will be preferred by the landlord.

5. Externalities from the Landlord to the Lender in the Absence of Linkages

Our previous discussion emphasized the externality associated with the lending activity on the income of the landlord. There is also a reverse externality in situations where there is a positive probability of default, so long as the return to the lender is affected by default. (Normally, we would assume that default reduces the expected income of the lender, but it is possible that with bonded labor, it increases his expected income.) The analysis is similar to that presented earlier. What is relevant now, however, is not the mean output of the farm, but the probability that the income of the worker, after paying the landlord's share, is sufficiently low so that the farmer goes into default. This is clearly affected by the terms of the contract (the share, the plot size, the supply of complementary inputs), but the landlord, in choosing the optimal contract, ignores the impact on the lender. This, then, provides a further motivation for the interlinking of the two markets.

6. General Versus Partial Equilibrium

The preceding analysis shows that, for any fixed level of expected utility of workers, the landlord can increase his expected income by simultaneously controlling the credit market. This argument

establishes that the utility possibilities schedule, in an economy in which the two markets are linked together, will be above that of an economy in which (e.g., as a result of legal restrictions) the two are kept separate, and it establishes that in a competitive equilibrium such linkages will, in fact, exist. However, it does not necessarily imply that landlords are the only beneficiaries, or indeed, in general equilibrium, that landlords will be better-off at all. The new equilibrium with linkages may lie to the northeast of the one without linkages (point O, Figure 5), making both workers and landlords better-off, but it need not.

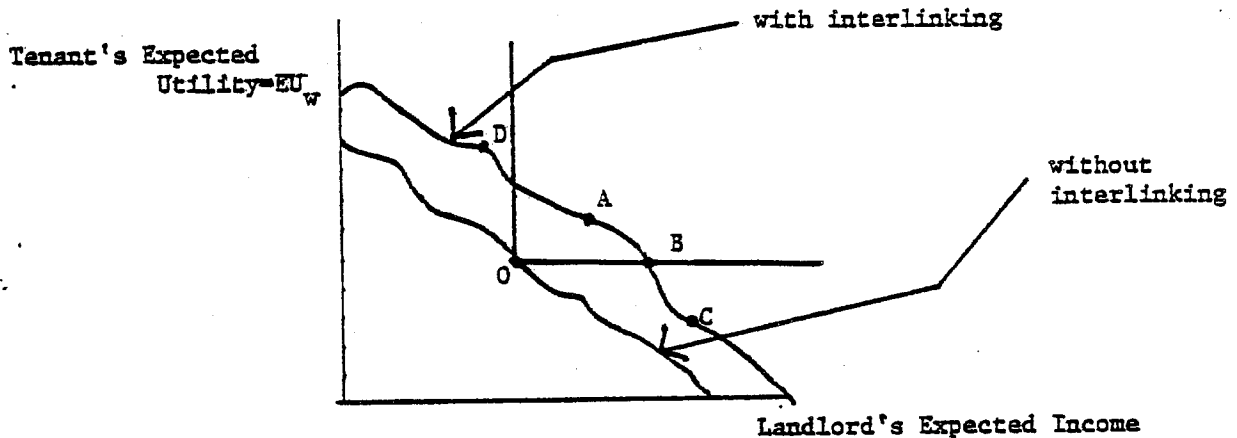


Figure 5

Welfare Comparison of Equilibrium with
Interlinking to Equilibrium without Interlinking

In Figure 5 we depict four possible situations:

- a) In A, the landlords and workers are both better-off; they share in the gains from interlinking markets;

b) In B, tenants have a subsistence utility level to which they are always driven; thus all the gains from interlinking accrue to landlords;

c) In C, tenants are worse-off as a result of interlinking markets; all the gains accrue to landlords -- and then some; while

d) D is the converse situation, where landlords are worse-off as a result of interlinking; all the gains accrue to tenants.

Under competitive conditions, we can ascertain the conditions for C or D to occur. We ask, what happens to the optimal plot size, at the fixed level of expected utility of tenants; and what happens to the optimal plot size, at the fixed level of expected profits of landlords. Denoting by l^* the optimal plot size, if l^* is decreased (increased) at the fixed level of expected utility of tenants, tenants will be better-off (worse-off) since demand for tenants will increase (decrease); similarly, if l^* is decreased (increased) at the fixed level of expected profits, landlords will be worse-off (better-off) as a result of interlinking markets.

The calculations of the relationship between l^* and borrowing are complicated, and are presented in Appendix A. There we show that interlinkage can, under not implausible conditions, make tenants worse-off. In particular, we establish a result (noted in Stiglitz [1974]) that with a Cobb-Douglas production function the share α equals the implicit share of labor, s_w . Hence, if interlinkage attempts to restrict credit (as it would if the conditions of Propositions 1 and 4 are satisfied) then tenants will be worse-off;

and to compensate them (leave them at the same level of utility) plot size must be increased; this reduces the demand for tenants, and hence the general equilibrium effect corresponds to the partial equilibrium effect. Conversely, if interlinkage attempts to encourage borrowing (see Propositions 1 and 4) then tenants will be better-off as a result of interlinkage; to leave them at the same level of expected utility, plot size must be reduced, and this increases the demand for labor, and, again, the general equilibrium effect conforms to the partial equilibrium effect. In more general cases, the partial and general equilibrium effects need not be qualitatively the same.^{21/}

III. Cost-Sharing as an Interlinking Device

A cost-sharing arrangement between a landlord and his tenant is a contract in which the cost of a raw material input (e.g., fertilizer) is shared in certain proportions by both the landlord and tenant.

Consider a world of sharecropping where landlords lease out land to tenants at a share rent, and the tenants determine their labor effort input as well as the input of other raw materials, e.g., fertilizers, seeds. (It is too costly for the landlord to monitor and properly enforce the tenants' actions.) It seems obvious that if the tenant receives only a fraction of the output, he will supply too little of the input if he bears the full cost himself; and similarly, the landlord will supply too little of the input, if he bears the full cost. Thus some type of cost sharing (some kind of interlinking in factor supplies) seems inevitable, within a sharecropping economy.

The prevailing wisdom among agricultural economists (e.g., Heady [1947], Adams and Rask [1968]) is that in such a setting the "ideal cost share"^{22/} regarding production efficiency is one in which the tenant's cost share of the raw material is equal to his output share. The rationale for such thinking is that by making the cost share equal to the output share, the tenant's "internal" price of fertilizer^{23/} equals the external market price of fertilizer. In a *first-best* world, this rule implies an efficient application of fertilizers. However, since the nature of the landlord-tenant scenario involves uncertainty and/or moral hazard, it sometimes implies rules other than the "equal share" rule.

The purpose of this section is to derive conditions which lead to the derivation of cost-sharing rules when there are:

- 1) neither risk-sharing nor incentive effects;
- 2) only uncertainty implying risk-sharing effects; or
- 3) only monitoring and enforcement problems implying incentive effects;
- 4) both risk-sharing and incentive effects.

The three latter cases are situations in a *second-best* world where moves toward efficiency entail internal pricing for fertilizer different from the external market pricing. In cases (3) and (4) there is a need to tax or subsidize the other activity that leads to an inappropriate externality, i.e., tenant's effort. Such internal pricing is made possible when the landlord links a cost-sharing contract with an output-sharing contract.

1. Tenant's Problem

All tenants are assumed to be identical. They lease from the landlord a plot of land whose size is assumed to be technologically fixed. The tenant determines his labor effort input, e , and fertilizer input, x , taking into account the terms of the contract as given. The terms of the contract include his output share, α , and his cost share, β . The production function is concave in the two factors of production, effort and fertilizer. Output is uncertain due to the changing states of nature. For simplicity we model uncertainty in multiplicative form. Hence, the tenant's income, Y , is:

$$Y = \alpha g f(e, x) - \beta P x$$

where g denotes the non-negative, multiplicative uncertainty factor distributed according to $h(g)$, with mean $E(g) = 1$, and P denotes the fertilizer market price; the output price is normalized to 1. The tenant maximizes his expected utility of income and labor effort, i.e.,

$$\max_{\{e, x\}} EU [Y(e, x), e] \equiv V(\alpha, \beta) \quad (25)$$

The two first-order conditions can be rewritten as:

$$f_x = \frac{\beta P}{\alpha} / \frac{EU_1 g}{EU_1} = \frac{\beta P}{\alpha P} \quad (26)$$

and

$$f_e = \frac{1}{\alpha} / \frac{EU_1 g}{EU_2} = \frac{1}{\alpha P} \cdot \frac{EU_1}{EU_2} \quad (27)$$

where $\rho \equiv EU_1 g / EU_1$ is the risk premium factor satisfying $0 < \rho < 1$ since $COV U_1(g)g < 0$.^{24/}

Conditions (26) and (27) imply the fertilizer and effort supply functions $x(\alpha, \beta)$, $e(\alpha, \beta)$. By substituting $x(\alpha, \beta)$ and $e(\alpha, \beta)$ into (25) at the optimum we obtain the tenant's indirect utility function $EU^*(\alpha, \beta) \equiv V(\alpha, \beta)$. We assume that the tenant has an alternative occupation yielding a given utility level \bar{V} . Thus, in order to accept a tenancy position, he requires that $V(\alpha, \beta) \geq \bar{V}$. In particular, we shall assume that $V(\alpha, \beta) = \bar{V}$, i.e., a utility equivalent contract world. (See discussion below in Section VI.)

2. The Landlord's Problem

We assume that the landlord is risk-neutral and, therefore, maximizes his expected profits. Since $Eg = 1$, we can write the landlord's problem as:

$$\max_{(\alpha, \beta)} \Pi = (1 - \alpha)f(e, x) - (1 - \beta)Px \quad (28)$$

subject to

$$V(\alpha, \beta) = \bar{V}.$$

The landlord's controls are the output share, α , and the cost share, β . From the utility equivalence constraint, we can derive the relation $\alpha(\beta)$ which implies the pairs of output share and cost share, maintaining the tenant on his iso-utility \bar{V} . Substituting $\alpha(\beta)$ into (28) we obtain:

$$\max_{\beta} \Pi(\beta) = \{1 - \alpha(\beta)\} f\{e(\beta), x(\beta)\} - (1 - \beta) Px(\beta) \quad (29)$$

From the first order condition of (29) we can derive the cost-sharing rules. We assume that $\Pi_{\beta\beta} < 0$ for the existence of the maximum.

3. Cost-Sharing Rules

Case 1: The Equal Shares Rule: Neither Risk Sharing nor Incentive Effects.

Consider first the case where there is no effort incentive effect, i.e., effort supply is perfectly inelastic at $e = \bar{e}$ and there is no uncertainty i.e., $\rho = 1$. Under such a structure, the tenant's first order condition (26) becomes

$$f_x = \frac{\beta}{\alpha} P. \quad (26')$$

Deriving the first order condition from (29) where $e = \bar{e}$, we obtain:

$$\Pi_{\beta} = [(1 - \alpha)f_x - (1 - \beta)P] x_{\beta|\bar{V}} - f \frac{d\alpha}{d\beta\bar{V}} + Px = 0 \quad (30)$$

Total differentiation of $V(\alpha, \beta) = \bar{V}$ implies $\frac{d\alpha}{d\beta\bar{V}} = \frac{Px}{f}$. Substituting this relation and (26') into (30) we obtain:

$$\frac{d\Pi}{d\beta} = \left\{ \frac{(1 - \alpha)\beta}{\alpha} - (1 - \beta) \right\} Px_{\beta|\bar{V}} = 0 \quad (31)$$

Equation (31) implies that the optimal solution is $\alpha = \beta$. Clearly the first order condition (26') then becomes $f_x = P$ which is the first-best rule for the application of fertilizers. This rule states that the tenant's internal price for fertilizer, $\frac{\alpha}{\beta} P$, equals the external market price P . Hence, the following proposition (first derived by Heady [1947]):

Proposition 5: In the absence of both incentive and risk-sharing effects, the landlord will choose his cost share in the fertilizer input to equal his output share, i.e., $\alpha = \beta$.

Case 2: No Incentive Effects: Only Risk-Sharing Effects

Consider now the objective function (29) with the absence of incentive effects, i.e., $e = \bar{e}$, but with the presence of output uncertainty, g . The tenant's first order condition with respect to fertilizer includes the risk premium factor as specified in (26). In addition, $\frac{d\alpha}{d\beta}$ also includes the risk premium factor ρ , i.e., $\frac{d\alpha}{d\beta} = \frac{1}{\rho} \frac{Px}{f}$. Evaluating the first order condition at the point $\alpha = \beta$ and collecting terms, we obtain:

$$\Pi_{\beta}|_{\alpha=\beta} = \left(\frac{1}{\rho} - 1\right) [(1 - \alpha)Px_{\beta}|_{\bar{v}} - Px] \quad (32)$$

Since $\rho < 1$, a sufficient condition for $\Pi_{\beta} < 0$ is for $x_{\beta}|_{\bar{v}} < 0$.

Now since $x(\beta) = x\{\alpha(\beta), \beta\}$,

$$x_{\beta} = \frac{\partial x}{\partial \alpha} \frac{d\alpha}{d\beta} + \frac{\partial x}{\partial \beta} \quad (33)$$

(This is a compensated change in the input share.)

It is clear that $\frac{\partial x}{\partial \beta}$, the direct effect of an increase in the tenant's cost share on his fertilizer input, is negative; increasing the internal price of fertilizer will reduce fertilizer usage by the concavity of the production function. The indirect effect, $\frac{\partial x}{\partial \alpha} \frac{d\alpha}{d\beta}$, can go in the other direction since $\left(\frac{d\alpha}{d\beta}\right)_{\bar{v}}$ is clearly positive, and if fertilizers and efforts are complements in production an increase in the output share α may increase the fertilizer input. However, as long as the direct effect

is stronger than the indirect effect, $x_{\beta\bar{V}} < 0$. Thus, under this condition $\Pi_{\beta|\beta=\alpha} < 0$. Since $\Pi_{\beta\beta} < 0$, for $\Pi_{\beta} = 0$ to be satisfied, the tenant's cost share β must be less than his output share, α . Hence:

Proposition 6: In the presence of uncertainty with a perfectly inelastic supply of effort (labor) by the tenant, (i.e., no incentive effects in the effort supply), and when the tenant is risk-averse while the landlord is risk-neutral, the landlord will choose the tenant's cost-share β to be lower than the tenant's output share α , i.e., $\beta < \alpha$, provided a compensated increase in input share leads to a reduction in the input.

Remark: The internal price of fertilizer is therefore $\frac{\beta}{\alpha} P < P$. The risk-neutral landlord subsidizes the tenant's fertilizer price in order to compensate for the under supply of fertilizer due to the risk aversion of the tenant.

In Appendix A we derive several sufficient conditions for $x_{\beta\bar{V}} < 0$.

- (i) Provided risk is not too large, inputs are always reduced.
- (ii) If the individual has constant absolute risk aversion, inputs are reduced.

In addition, for the case of constant relative risk aversion we obtain the stronger result that as risk aversion increases, β/α is monotonically reduced, i.e., the landlord increases his share of the cost relative to his output share.

Case 3: Only Incentive Effects

In this case, since there is no uncertainty, $\rho = 1$. However, the landlords cannot monitor or enforce the tenant's effort supply. Hence,

the first order condition of (29) evaluated at $\alpha = \beta$ becomes

$$\Pi_{\beta}|_{\alpha=\beta} = (1 - \alpha)f_e e_{\beta}|_{\bar{v}} \quad (34)$$

Hence, the following proposition:

Proposition 7: In the absence of uncertainty, but where effort supply is elastic (i.e., there is an incentive effect) the landlord will choose the tenant's cost share β to be lower (equal, bigger) than the tenant's output share, α , i.e., $\beta \stackrel{<}{>} \alpha$, as $e_{\beta}|_{\bar{v}} \stackrel{<}{>} 0$.

$e_{\beta}|_{\bar{v}}$ marks the sum total change in the tenant's effort due to change in his cost shares, i.e.,

$$e_{\beta}|_{\bar{v}} = \frac{\partial e}{\partial \alpha} \left(\frac{d\alpha}{d\beta} \right)_{\bar{v}} + \frac{\partial e}{\partial \beta} \quad (35)$$

Again we have to evaluate the direct and indirect effects, but now there is no clear presumption concerning the sign. The compensated increase in α does tend to increase effort; but the increase in the cost share reduces the inputs, and the reduction in these will (if x and e are complements) tend to reduce effort. Indeed, in the special case of a Cobb-Douglas production function effort is left unchanged, so $\alpha = \beta$. For the case where there is a low elasticity of substitution (high degree of complementarity), $e_{\beta}|_{\bar{v}} < 0$ so $\beta < \alpha$. (See Appendix B).

Case 4: Presence of Both Risk-Sharing and Incentive Effects

In this case, the first order condition of (29) evaluated at $\alpha = \beta$ becomes

$$\Pi_{\beta}|_{\alpha=\beta} = \left(\frac{1}{\rho} - 1 \right) [(1 - \alpha)Px_{\beta} - Px] + (1 - \alpha)f_e e_{\beta}|_{\bar{v}} \quad (36)$$

From the preceding discussion arises the following proposition:

Proposition 8: In the presence of both uncertainty and an elastic effort supply, $\beta < \alpha$ only if the incentive effects are such that (a) $e_{\beta|V} < 0$ or (b) the positive incentive effects are dominated by the negative risk-sharing effects.

There is wide empirical documentation regarding arrangements of cost sharing. Marshall [1959, p. 645] noted the existence as well as the usefulness of the practice of sharing inputs in the United States and France. Studies by Ladejinsky (1977) and Rao (1975) report a 50:50 equal share rule to be prevalent in India, while Ashok Rudra (1975) documented a wider variety of cost-sharing arrangements in West Bengal. Our theoretical attempt here is to provide insight into explaining why a wider variety of cost sharing rules exist. We have established that the share of costs ought to equal the share of output only under certain restrictive conditions. In particular, since the level of effort cannot be specified (at least perfectly) in the contract, and since increases in the level of effort will increase the landlord's profits, the landlord will seek to induce the worker to take greater effort. If fertilizer (or other inputs) are strongly complementary to labor, the landlord may seek to increase the level of effort by increasing the supply of these inputs, i.e., by lowering the cost share of the tenant.

There is an alternative set of instruments that have sometimes been suggested: controlling the input and output markets. We consider that in the next section.

IV. The Interlinked Marketing and Tenancy Contracts

In the discussion in previous sections we assumed that output and raw material prices are exogenously given to both landlords and tenants. Landlords and tenants, therefore, face identical prices; quite often, however, one observes that the landlord undertakes the marketing activity for his tenant and is involved in the provision of raw material inputs.^{25/} There are several reasons why the landlord markets the tenant's output. If the landlord requires the tenant to market his output solely through himself (the landlord) then he creates a simple way to monitor the output and guarantee that he obtains the agreed share. Another reason is that marketing activity exhibits increasing returns to scale; hence, it is efficient for a specialized agency to market output of many production units together. The landlord may provide such an agency. Besides this efficiency gain derived from the landlord's marketing of tenant output, it is widely believed that there may be a distributional loss to the tenant. By marketing the output, the landlord may explicitly (by buying the product from the tenant at a lower price than at the market price) or implicitly (by charging high marketing costs), extract further surplus from the tenant. However, in a utility equivalent contract equilibrium framework where the landlord both possesses sufficient controls and gains from pushing the tenant down to his reservation utility, there is no possibility to extract further surplus from the tenant. Hence, in such a world the following question arises: is the control of output and raw material prices a more effective instrument for the landlord to extract surplus and motivate the tenant compared with the share instruments? And

subsequently, what is the impact of interlinking marketing contracts with tenancy and cost-sharing contracts?

Consider again the tenant's problem, presented in Section III-1, in the absence of uncertainty. Assume that both the tenant and landlord face the same price for the raw material fertilizer, P_x , (e.g., the fertilizer purchased from the village cooperative). For notational convenience, we shall define the fertilizer units such that $P_x = 1$. However, the landlord buys the output from the tenant at the price P_T which is different from the market price at which the landlord sells the output, P_L . Thus, the tenant's income is

$$Y_T = P_T f(e, x) - \beta x, \quad (37)$$

and he maximizes

$$\max_{(e,x)} U(Y_T(e, x), e) \quad (38)$$

From the first order conditions we obtain:

$$f_x = \frac{\beta}{\alpha P_T} \quad (39)$$

and

$$f_e = \frac{U_2(Y_T, e)}{U_1(Y_T, e) \cdot \alpha P_T} \quad (40)$$

Hence, the tenant's decisions are fully determined by the set of controls $\beta, \alpha P_T$. Let us therefore define $\hat{\alpha} \equiv \alpha P_T$, and write the tenant's effort and input supply functions $e = e(\hat{\alpha}, \beta), x = x(\hat{\alpha}, \beta)$.

Now let us move to the landlord's problem and determine whether P_T plays a separate role for him, in addition to its role in determining $\hat{\alpha}$. The landlord who faces the output price, P_L , at the market place maximizes his income subject to the utility equivalence constraint, i.e.,

$$\max_{\{\alpha, \beta, P_T\}} (1 - \alpha)P_L f[e(\hat{\alpha}, \beta), x(\hat{\alpha}, \beta)] - (1 - \beta) x(\hat{\alpha}, \beta) \quad (41)$$

subject to

$$U[Y_T(\hat{\alpha}, \beta, P_T), e(\hat{\alpha}, \beta)] = \bar{V} .$$

(41) can be rewritten as:

$$\max_{\{\alpha, \beta, P_T\}} P_L f - x - Y_T \quad (42)$$

The last term is the tenant's income. Given the utility equivalence constraint, it can be expressed as $\phi[\bar{V}, e(\hat{\alpha}, \beta)]$ and substituting it into (42) we obtain:

$$\max_{\{\hat{\alpha}, \beta\}} P_L f(\hat{\alpha}, \beta) - x(\hat{\alpha}, \beta) - \phi(\bar{V}, \hat{\alpha}, \beta) = \Pi(\hat{\alpha}, \beta) \quad (43)$$

Observing (43) we realize that the landlord cares only about $\hat{\alpha}$ rather than about α and P_T separately. Hence

Proposition 9: In a utility equivalence world where shares are not restricted, the landlord can pay the tenant the market price for his output, i.e., $P_T = P_L$. However, if shares are restricted either by social norms or laws, the landlord can extract the tenant's surplus by paying him a price lower than the market place, i.e., $P_T < P_L$, without any loss in efficiency.

V. Interlinking of Labor and Consumption Good Markets

The argument of the previous section suggested that providing the landlord with additional instruments for exploiting workers through control of the product market would not, in fact, enable him to do so any better than he could have done by simply altering the "contract" which he imposed on his workers.^{26/} This is not true for the landlord's control of the consumption good market. We represent the typical worker by his indirect utility function $V = V(C, p)$. By the usual arguments, V and e are both homogeneous of degree zero in C and p : so long as the monopolist does not change relative prices, the fact that he may also own the store at which his workers buy their goods has no effect on his ability to exploit his workers.

The landlord will, however, wish to change the relative prices of goods, to encourage the consumption of goods which are complementary to effort, and discourage the consumption of goods which are complementary to leisure.^{27/} Thus, giving the landlord this extra degree of control will increase his return. In addition, this argument provides a rationale for landlords providing workers with meals and some in-kind payments, rather than full money wages.^{28/}

VI. Monopoly, Monopsony, Competition, and Rationing Equilibrium

For most of the analysis of this paper, we have not had to distinguish between a monopoly landlord and a competitive landlord. In either situation, the contract should be designed so as to maximize the expected profits of the landlord, given whatever level of expected utility the workers attain. The only distinction is the determination of the

level of expected utility of workers. In the monopoly solution, it is at the subsistence level of workers; in the competitive equilibrium, it is at whatever level equates demand and supply of tenants.

There is, however, another quite different regime. In a variety of circumstances, if the landlord maximizes his profit subject to workers attaining a given level of expected utility, the utility constraint will not be binding. Thus, in the efficiency wage model analyzed by Leibenstein [1957], Mirrlees [1976] and Stiglitz [1976] there is a wage which minimizes labor costs per efficiency unit. Even though labor could be obtained at a lower wage, a landlord would not do so, since that would increase his labor costs. Similarly, a landlord might be able to reduce the share or the size of plot he provides workers, but it would not pay him to do, since his expected profits might be reduced as a result of such a move.

In a competitive market, this has one important implication: there may exist equilibrium in which the supply of labor exceeds the demand — there is unemployment. (See Stiglitz [1976], Stiglitz-Weiss [1979].) Braverman-Srinivasan [1980] show, however, that for constant returns to scale production functions in labor and land, cutting plot size by the landlord (*ceteris paribus*) will increase his profits. This result followed from a derived property that tenant's effort per hectare increases with cutting plot size. It implies that with infinitely elastic supply of tenants at subsistence utility, tenants will be always pushed down to their subsistence utility level.

Our concern here, however, is with interlinking markets. It is

again clear (we omit the mathematical details) that interlinking may increase the expected profits of landlords (in either competitive or non-competitive situations), if, for instance, the landlord can induce a higher level of effort by providing loans at a subsidized rate. Although the welfare implications for landlords in this situation are clear, the implications for workers are ambiguous:

- (i) The number of workers employed may increase or decrease, depending on the effect of interlinkage on the optimal plot size; and
- (ii) Those workers who do succeed in getting land may be ~~better-~~ or worse-off.

Consider a case where the worker divides his consumption between alcohol, which decreases effort, and food, which increases it. Assume that by changing the relative price of alcohol to food, the landlord is able to induce a significant change in the relative proportion of income spent on the two goods (the elasticity of substitution between the two goods is very high). Then, not only may this increase the level of effort, but it may also increase the marginal return (to increasing plot size, share, etc.); if for instance, the efficiency wage increases significantly, as depicted in Figure 6, the worker may be better-off. Clearly, the level of effort could increase, and the marginal return to income decrease, so that the monopolist reduces the income of his worker and the interlinking of the consumption market and the labor market lowers the welfare of the worker.

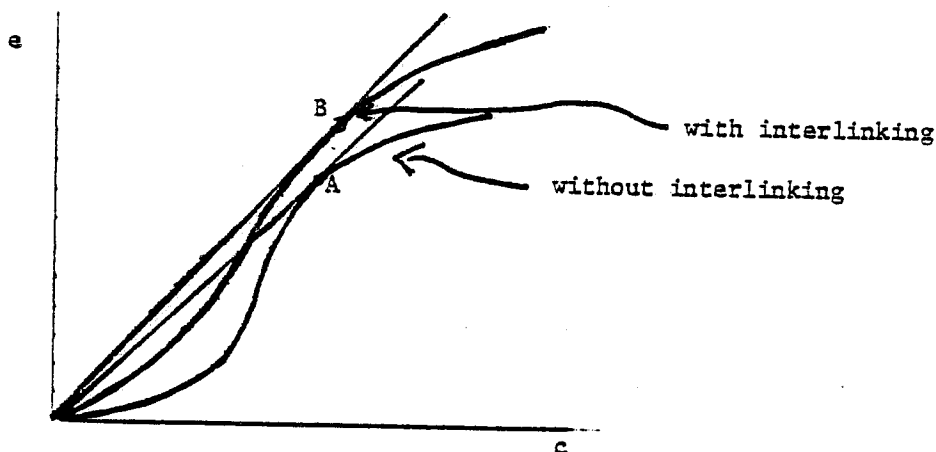


Figure 6

Example when interlinking goods and land/labor markets results in higher level of effort and higher levels of consumption for workers.

We have argued in this section that there is no fundamental difference in the structure of the analysis of interlinkage of markets between a competitive market and a market with a single landowner, but that there is a significant difference between those situations where the expected utility constraint of workers is binding and those where it is not. It is important to recognize, however, that whether the expected utility constraint is or is not binding is, itself, affected by the market structure, i.e., by whether there is a single landlord. It is also affected critically by the instruments for exploitation which

are at the disposal of the landlord. In our earlier discussion, we suggested, for instance, that the landlord might like to employ a non-linear lending schedule, where the rate of interest was a function of the amount borrowed. But if there is a secondary loan market, so individuals can re-lend to each other, the landlord may be forced to lend at a single rate. Then, if he lowers the rate to induce workers to borrow more and is either restricted from decreasing the share or plot size or finds it undesirable to do so, workers will enjoy an expected utility level exceeding their subsistence constraint. (If the landlord could impose a lump sum tax on his workers, he could again drive them back to their subsistence constraint.)

This analysis suggests why it may be in the interests of a monopsonist marketing agent to attempt to interlink the credit market with his marketing activity. Assume that he pays a single price for the output which he purchases from farmers. He sets this price so the marginal cost of purchasing an additional unit equals the marginal revenue he obtains from selling the good. But since the price he pays is, in general, less than the marginal cost, the tenants have (from his point of view) insufficient incentives to produce. If he can induce them to produce more at the given price, this will increase his profits. Thus it may for instance pay him to subsidize credit.

VII. Interlinking: A Move Towards *Ex-ante* Efficiency and *Ex-post* Inefficiency of Matching.

In the five preceding sections, we discussed only how interlinking contracts in rural markets may result in increasing efficiency.

This discussion clearly misses some other important economic aspects. One of these is the dynamic *ex-post* inefficiency and the increase in monopoly power of the landlord caused by the interlinking of contracts which may be solely due to the existence of imperfect information regarding the characteristics of heterogeneous agents. Since the discussion up to now has been based on the assumption that all agents, i.e., tenants, are identical, this issue did not arise before.^{29/}

Now, assume that tenants differ in their ability (whatever this variable may include, e.g., entrepreneurial skill, motivation, etc.): these attributes cannot be observed immediately. Rather, they can be revealed over time through the relationship between the landlord and tenant. For simplicity, if there are "good" and "bad" tenants, the landlords, over time, do not renew the contracts with the "bad" tenants. Consequently, the market for people looking for other tenancy jobs, or similarly for credit, is composed of "lemons" (See Akerlof [1970], Greenwald [1979], Stiglitz and Weiss [1979].) On the other hand, there are also many cases where "good" tenants do not get along with their landlords and would like to find other principals to contract with. If the market were not populated by "lemons," such a turnover would take place. However, when a mismatched "good" tenant considers leaving his landlord he realizes that because of imperfect information he becomes identified, to a large extent, as a possible "lemon." This reduces his reservation utility and the possibility of finding a better match. The fact that there is interlinking of contracts in which the landlord also controls credit, marketing and the provision of inputs to his tenant, strengthens the phenomenon of the captured market by the landlord vis-a-vis his tenant.

The *ex-ante* anonymity (regarding ability) of agents at the time of the contract is changed after a period of interaction between the landlord and his tenants into "full information" regarding the qualities of the transacting parties. However, this information is only available to the transacting parties themselves. Hence, over time, there is a dynamic inefficiency of mismatching of agents; although able tenants can perform better with different landlords, it is not worth their while to search.

Interlinkages of the kind we have discussed in this paper serve to exacerbate the problems of *ex-post* competitiveness for two reasons. First, it increases the information differential between the present landlord-cum-lender and alternatives: If the markets were not interlinked, an alternative landlord would only be concerned with the productivity characteristics of the worker (how hard he works). And an alternative lender would only be concerned with those characteristics which affect the probability of the individuals repaying the loan. An alternative landlord-cum-lender is concerned with both sets of characteristics. Secondly, although we have focused only on interlinkages among markets at one point of time, the same kinds of arguments can be used to show which interlinkages among markets at different points of time -- making the terms of contract at one date contingent on performance at earlier dates -- are desirable (see Stiglitz-Weiss [1980]) and that these intertemporal interlinkages clearly impede workers' mobility. This purely economic argument clearly should be added to the existing arguments in the political science and sociology literature regarding the impact of the creation of one-way dependency, and semi-feudal relations between landlords and tenants.

VIII. Conclusion

In this paper, we have discussed only the economic reasoning for interlinking contracts that arise due to moral hazard problems. We emphasized in Section II.6 that such interlinking may result in an increase in *static ex-ante* allocative efficiency. This argument was based to a large extent on assumptions of identical landlords and tenants. However, in a world populated by heterogenous agents, where information is acquired slowly over time and becomes known only to the partners involved in the contracts, there is inherent *ex-post inefficiency* of mismatching of principals and agents. This is so since turnover that will improve such mismatching inefficiency is reduced by the existence of "lemon" markets for tenancy and credit. Such reduction in the turnover is increased through interlinking and results in a deterioration of the tenant's position vis-a-vis his landlord who possesses, in a way, a "captured market" for tenants.

Thus, although we have argued that the presence of interlinkages need not be taken as evidence that agrarian markets in LDC's are non-competitive, it seems clear that such linkages have both distributive as well as allocative effects. Attempts to reduce the landlord's "power" by restricting his marketing or credit activities may, in certain circumstances, lower agrarian output and make tenants worse-off. In other circumstances,^{30/} total agrarian output might increase, tenants could be better-off, and only the landlords suffer. Further empirical work is clearly needed to distinguish which of the various possibilities is relevant in any particular situation. Yet, one of the conclusions of our study is that in many situations competitive and non-competitive

markets may look quite similar (say, with respect to the kinds of inter-linkages employed). Thus distinguishing among the various possibilities may require greater subtlety than is frequently employed in empirical and policy work in this area. What we hope our study has established is that simplistic models (whether competitive or non-competitive) which involve anonymous market places, homogeneous goods, perfect monitoring of inputs. etc., are likely to be very misleading.

APPENDIX A

Determination of the Equilibrium Plot Size, with Variable Shares
in Utility Equivalent Contract Equilibrium

Let $f(e\ell)$ = output per acre, so f/ℓ = output per worker.

Let α and ℓ be variable. The landlord must choose $\{\alpha, \ell\}$ to yield

$$EU_w = EU \left(\frac{\alpha f(e\ell)}{\ell} - \hat{\beta}, e \right) = \bar{U} \quad (A.1)$$

We thus obtain

$$\left. \frac{d\alpha}{d\ell} \right|_{\bar{U}} = - \frac{\alpha(f'e/\ell - f/\ell^2)}{f/\ell} = \frac{\alpha(f - f'e\ell)}{\ell f} = \frac{\alpha}{\ell} (1 - S_w) \quad (A.2)$$

where $1 - S_w = (f - f'e\ell)/f$ = implicit share of landlord.

Moreover, recalling the first order condition for effort

$$EU_c \alpha f' + EU_e = 0 \quad (A.3)$$

we observe that along the iso-utility contract, assuming for simplicity an additive utility function,

$$\frac{\ell}{e} \frac{de}{d\ell} = - \frac{\alpha f' [1 - \gamma - S_w] EU_c}{e\ell EU_c \alpha f''(e\ell) + EU_{ee}} = \frac{1 - S_w - \gamma}{\gamma + \nu} \quad (A.4)$$

where

$$\gamma = - \frac{f''e\ell}{f'}$$

$$\nu = \frac{U_{ee}e}{U_e}, \text{ elasticity of effort supply.}$$

Expected profits (per acre) of the landlord are $(1 - \alpha)f(e\ell)$.

Hence, the optimal contract is such that

$$f[(1 - \alpha) S_w (1 + \frac{d \ln e}{d \ln l} \Big|_{\bar{U}}) - \alpha(1 - S_w)] = 0, \quad (\text{A.5})$$

i.e.,

$$\frac{\alpha}{1 - \alpha} = \frac{S_w}{1 - S_w} (1 + \frac{d \ln e}{d \ln l} \Big|_{\bar{U}}) \quad (\text{A.6})$$

e.g., if

$$\left(\frac{d \ln e}{d \ln l} \Big|_{\bar{U}} \right) = 0, \quad \alpha = S_w$$

and from (A.4), if there is a Cobb-Douglas production function, i.e.,

$\gamma = 1 - S_w$, then

$$\frac{d \ln e}{d \ln l} \Big|_{\bar{U}} = 0.$$

Hence, for a Cobb-Douglas production function, the optimal share remains unchanged, as we change $(1 + r)B$. Thus, to obtain the same level of expected utility, as we increase the interest rate charged on a fixed level of borrowing, we increase plot size. Therefore interlinkage reduces the demand for labor; and it leads tenants to be worse-off.

More generally, we observe that

$$\sigma \equiv \text{elasticity of substitution} = \frac{1 - S_w}{\gamma}.$$

Substituting back into (A.4), we obtain

$$\frac{d \ln e}{d \ln l} \Big|_{\bar{U}} = \frac{(1 - S_w)(1 - \frac{1}{\sigma})}{\frac{1 - S_w}{\sigma} + v} \quad (\text{A.7})$$

$$= \frac{(1 - S_w)(\sigma - 1)}{(1 - S_w) + v\sigma} > 1 \text{ as } \sigma > \frac{2(1 - S_w)}{1 - S_w - v}$$

Hence

$$\frac{\alpha}{1 - \alpha} = \frac{S_w}{1 - S_w} + \frac{S_w(\sigma - 1)}{1 - S_w + v\sigma} \quad (\text{A.8})$$

Although (A.8) always characterizes the equilibrium, it is important to note that γ , α , S_w , σ , and v are all, themselves, endogenous variables (except in some special cases). We can still use (A.8), however, to obtain certain results concerning the effects of interlinking. First, let us assume that B is unchanged, but the rate of interest charged is increased. (The borrowing was for an emergency which occurred the preceding period.) Assume λ were unchanged to keep U at the same level, then α must be increased. Thus, e will be increased, both because of the increased α and the increased value of $(1+r)B$. If the elasticity of substitution exceeds unity, this increases S_w . Both the left-hand and the right-hand sides of (A.8) have thus increased. If the right-hand side has increased more, it means that at the contract which generates equal expected utility with unchanged plot size, α is too small; thus α must be increased, and plot size decreased. Therefore the demand for tenants will increase and their expected utility will also increase. This will occur if the elasticity of substitution is very large. But if the elasticity of substitution is just slightly greater than unity, the LHS will exceed the right, and hence α will need to be reduced and plot size correspondingly increased (if individuals are to be at the same level of expected utility). These changes will increase effort, but less than proportionately to the increase in plot size; hence $e\lambda$ will be reduced, which will reduce the RHS

of (A.8). c will continue to be reduced until the left- and right-hand sides of (A.8) are equal. Thus, in this case, interlinkage has resulted in an decrease in the demand for labor and workers expected utility is decreased.

Other cases are left as exercises to the reader.

APPENDIX B

Effects of Cost Shares on Effort and Inputs

The two first order conditions for the problem (25) are:

$$EU_1[\alpha g f - \beta P x, e] (\alpha g f_x - \beta P) = 0 \quad (B.1)$$

$$EU_1[\alpha g f - \beta P x, e] \alpha g f_e + EU_2[\alpha g f - \beta P x, e] = 0 \quad (B.2)$$

Taking the total differential of (B.1) and (B.2), we obtain (letting $\alpha = \alpha(\beta)$, by the utility equivalence relation)

$$\begin{bmatrix} EU_{11} Y_x^2 + EU_1 Y_{xx} & E\{U_{11} Y_e Y_x + U_1 Y_{ex} + U_{12} Y_x\} \\ E\{U_{11} Y_x Y_e + U_1 Y_{ex} + U_{21} Y_x\} & E\{U_{11} Y_e^2 + U_1 Y_{ee} + U_{12} Y_e + U_{22}\} \end{bmatrix} \begin{bmatrix} dx \\ de \end{bmatrix} = \begin{bmatrix} x \left(\frac{EU_{11} g Y_x}{EU_1 g} EU_1 - EU_{11} Y_x \right) + EU_1 \left(\frac{f_x}{f} - 1 \right) \\ x \left(\frac{EU_{11} g Y_e}{EU_1 g} EU_1 - EU_{11} Y_e \right) + \frac{EU_1 f_e x}{f} + \left(\frac{EU_{12} g EU_1}{EU_1 g} \right) - EU_{12} \end{bmatrix} \cdot (Pd\beta)$$

Two special cases:

(a) No effort elasticity. Then

$$\frac{dx}{d\beta} > 0 \text{ as } \left[\frac{EU_{11} g Y_x}{EU_1 g} - \frac{EU_{11} Y_x}{EU_1} \right] + \left(\frac{f_x}{f} - 1 \right) > 0$$

The second term is always negative. In the absence of uncertainty, the first term is zero. The first term is negative with constant absolute under aversions, since $EU_{11} Y_x = 0$,

and $EU_{11}gY_x = -A EgU_{11}Y_x < 0$

Thus, provided risk is not too great or risk aversion does not change too rapidly,

$$\frac{dx}{d\beta} < 0.$$

With constant relative risk aversion and separable utility functions, we can write (B.1) as

$$E\left(\frac{\alpha}{\beta} gf - Px\right)^{-R} \left(\frac{\alpha}{\beta} gf_x - P\right) = 0.$$

Taking the derivative with respect to R, we obtain

$$-E\left(\frac{\alpha}{\beta} gf - Px\right)^{-R} \left(\frac{\alpha}{\beta} gf_x - P\right) \ln\left(\frac{\alpha}{\beta} gf - Px\right) < 0,$$

since

$$\frac{d\left(\frac{\alpha}{\beta} gf - Px\right)}{dg} = \frac{\alpha}{\beta} f > 0. \quad \text{Hence } \frac{d\alpha}{dR} < 0.$$

(b) No risk. Then at $\alpha = \beta$.

$$\frac{d\alpha}{d\beta} < 0 \quad \text{as} \quad \alpha \left[f_{xx} \frac{f_x}{f} - \left(\frac{f_{xx}}{f} - 1 \right) f_{ex} \right] > 0.$$

Recall the definition of the elasticity of substitution

$$\sigma = \frac{f f_{ex}}{f_x f_{xx}}$$

Stiglitz, J.E. and A. Weiss [1980]. "Credit Rating in Markets with Imperfect Information, Part II," Unpublished mimeograph.

And let $S_x =$ share of factor $x = \frac{f_x x}{f}$, and

$\eta = -\frac{f_x}{f_{xx} x}$, the price elasticity of the demand for factor x ;

Thus

$$\frac{de}{dB} < 0 \text{ as } \frac{\eta}{\sigma} (1 - S_x) > 1$$

For a Cobb-Douglas production function $f = x^{S_x} e^{S_e}$. Hence,

$$\eta = \frac{1}{1 - S_x}$$

and

$$\frac{de}{dB} = 0.$$

Footnotes

1/ For a survey of such phenomena, see Bardhan [1980] and Binswanger, et al., [1981].

2/ Moreover, if there is some probability of their not being able to pay the fixed rent, which can be affected by the actions of the tenant, rental arrangements may not be desirable from the point of view of the landlord (see Stiglitz-Weiss [1979]).

3/ See Marshall [1959], Cheung [1969], Newbery [1977], Reid [1975], Stiglitz [1974], Bell-Zusman [1976], for earlier discussions of sharecropping.

4/ This applies to the situations which were previously discussed in the literature where interlinkage provides a mechanism by which legal restrictions (such as limits on usurious interest rates) and conventions (such as "fair" division of output between landlords and tenants) may be evaded. They can be viewed as special cases of the analysis provided here.

5/ Marshall [1959] recognized the importance of share contracts in a world dominated by market imperfections and the absence of certain markets (see Bliss-Stern [1980], Chapters 3 and 6, Jaynes [1979]).

6/ The optimal linear contractual arrangements are discussed in Stiglitz [1974] and Newbery [1977]; the optimal nonlinear contract is discussed in Stiglitz [1981]; in these studies the only variable which the worker alters is effort; in this paper, we also consider the problem of the choice of technique.

7/ The argument is, in fact, even stronger: these moral hazard problems arise even with rental tenancy arrangements, if renters have insufficient capital to pay the rent in advance, and if there is sufficient variability in output that it may not be feasible for the renter to repay the promised rent.

8/ It should also be clear that e could represent a vector of inputs, including fertilizer, machinery, etc.

9/ We ignore corner solutions throughout this paper.

10/ This formulation focuses only on consumption credit, i.e., the tenant who is paid at harvest time, and possesses no savings, borrows for consumption at the beginning of the production period. Our argument regarding the externalities from the credit market to the production process will be clearly strengthened if borrowing is for production credit and thus directly affects output (see footnote 17, below).

In addition, the modeling of consumption here is only of consumption at the end of the production period. Clearly, the tenant borrows B in order to consume it during the production period. We model the two-period utility function later in this section. However, assuming that the utility function is separable (so that effort is not affected by first period consumption) yields the same results as in the present formulation.

11/ Throughout the remainder of the paper we assume $U_{c\Omega} = 0$; if we write $U = U(c, e) - V(\Omega)$; $V(\Omega)$ can be thought of as the "cost" of technology Ω .

12/ In the absence of uncertainty, normality in income of consumption and leisure suffice for the proposition. Alternative conditions in the presence of uncertainty may be derived. A sufficient condition is that in addition to the normality condition the variance of income be small enough.

13/ This issue will be discussed in the next subsection.

14/ Consult Rothschild-Stiglitz [1970] and Diamond-Stiglitz [1974] for discussions of mean-preserving spreads.

15/ If all available technologies have the same mean, then for an interior solution (i.e., $\Omega > \underline{\Omega}$, when $\underline{\Omega}$ is the least risky technology), we require that $V'(\Omega)$ be sufficiently large.

16/ This may provide at least part of the explanation why linear contracts, combination of fixed rents and share rents, are rarely observed in rural developing economies. Note that a rent paid at the end of the production period can be viewed as a rent paid at the beginning of the period plus a loan from the beginning of the period to its end.

17/ In this paper we have ignored the direct effect of borrowing on production. This may easily be incorporated into our model. Assume that $Q = gf(e, x)$ output is a (random) function of effort and purchased inputs, but purchased inputs have to be paid for at the beginning of the production period. The individual's initial wealth is W_0 , and $C_0 = W_0 + B - xp$ (where p is the price of purchased inputs). Hence the tenant

$$\max_{\{B, x, e\}} E U(C_0, C_1, e)$$

where

$$C_1 = \alpha gf(e, x) - B(1 + r)$$

Maximizing U with respect to x , for given B and e , yields

$$V(B, e; r)$$

The structure of the analyses proceeds as in the consumption loans case. The only difference is that now, for instance, with separability of the utility function

$$\frac{d}{dB} E[U_c \alpha g f_e - U_e] = -\alpha g [(1+r) f_e E U_{cc} + \frac{dx}{dB} E (U_{cc} f_e f_x + U_c f_{ex})]$$

18/ In the calculations below, we take the share and the plot size as exogenously given; alternatively, we could view them as having optimally chosen. For purposes of the ensuing analysis it makes no difference.

19/ This is an important simplifying assumption; otherwise, the level of consumption at 0th period affects the level of effort, and our analysis of sections II.1 - II.2 has to be modified accordingly. With separability, the analysis of sections II.1 and II.2 becomes directly applicable to the problem at hand.

20/ The contract described in the preceding analysis entailed the landlord specifying B , the amount borrowed, and $\hat{B}=(1+r)B$, the amount paid back. The landlord does not, however, allow the tenant to borrow as much as he would like at the interest rate $r=\hat{B}/B - 1$. Effectively, the landlord is employing a non-linear interest rate schedule to maintain the individual on the same expected utility curve. In section 6 below, we consider what happens if the landlord is not allowed to use such schedules, and cannot decrease α or plot size to compensate for lowering in the interest rate. (Thus, the expected utility constraint will not be binding).

Note that if the landlord cannot restrict the level of credit or "force" credit, but can announce an r different from ρ , and can alter α , then instead of (23) we obtain

$$\frac{EU_c g}{EU_c} = \frac{1 - \frac{1-\alpha}{\alpha} \frac{f'e}{f} \frac{\partial \ln e}{\partial \ln \alpha} - \frac{(r-\rho)}{f} \frac{\partial B}{\partial \alpha}}{1 + \frac{(1+\alpha)}{\alpha} \frac{f'e}{f} \frac{\partial \ln e}{\partial \ln \hat{B}} \frac{\partial \ln \hat{B}}{\partial \ln r} \frac{f}{rB} + \frac{dB}{dr} \frac{(r-\rho)}{B}}$$

Whether the landlord will set $r \leq \rho$ depends on tenants' risk aversion, as well as the elasticity of effort with respect to share (α), with respect to indebtedness (\hat{B}), and the elasticity of indebtedness with respect to the interest rate.

21/ This is a general property which arises in a variety of situations where risk is involved. See, for instance, Newbery-Stiglitz (1981).

22/ Terminology of Adams and Rask [1968].

23/ Henceforth fertilizers will be used as an example of a raw material input.

24/ The larger g is, the larger is output gf ; hence, the larger is the tenant's income, and by the concavity of U , the smaller is the marginal utility of income.

25/ For simplicity we will focus in this section on interlinking of marketing of output and tenancy contracts while similar reasoning applies to discussion regarding marketing raw materials by the landlord to the tenant.

26/ This is Newbery's [1975] point in response to Bhaduri's [1973] assertion that interlinked credit and tenancy contracts are an obstacle to technological innovation. See Srinivasan [1979] and Braverman-Stiglitz [1980] on this issue.

27/ We omit the details of the calculations describing the optimal pricing policy of the monopolist. The analysis is exactly parallel to the standard analysis of the optimal set of commodity taxes. There, the problem for the government is to maximize the welfare of consumers, subject to a given budget constraint; here, we are concerned with the dual problem, the maximization of the revenue (of the monopolist) subject to the subsistence level of utility of workers, where the constraint may not be binding.

28/ There is an alternative argument for interlinking the consumption good market that is based on consumers' misperception of their "real" income associated with the whole interlinked contract, i.e., they may perceive certain subsidies which they receive immediately (e.g., credit, food), more intensely than the disadvantageous terms, the impact of which will be felt only later.

29/ See Allen [1980] and Braverman-Guash [1980] for analysis of interlinked credit and tenancy contracts as a screening service for tenants.

30/ When there is a single landlord, and the expected utility constraint is not binding.

References

- Adams, D.W. and N. Rask [1968]. "Economics of Cost-Share Leases in Less Developed Countries," *American Journal of Agriculture Economics*, Vol. 50, no. 4, November.
- Akerlof, G. [1970]. "The Market for 'Lemons': Qualitative Uncertainty and the Market Mechanism," *Quarterly J. of Economics*, August.
- Allen, Franklin [1980] "Control of Capital, Sharecropping, Ability and Information," mimeograph, Nuffield College, Oxford.
- Bardhan, P.K. [1980]. "Interlocking Factor Markets and Agrarian Development: A Review of Issues," *Oxford Economic Papers*, March.
- _____, and A. Rudra [1978]. "Interlinkage of Land, Labour and Credit Relations: An Analysis of Village Survey Data in East India," *Economic and Political Weekly*, February.
- Bell, C. and P. Zusman [1976]. "A Bargaining Theoretic Approach to Crop-sharing Contracts," *American Economic Review*, September.
- _____, [1980]. "On The Interrelationship of Credit and Tenancy Contracts," World Bank, Development Research Center, March.
- Bliss, C.J. and N.H. Stern [1980]. *Palanpur-Studies in the Economy of a North Indian Village*, New Delhi: Oxford University Press.
- Bhaduri, A. [1973]. "Agricultural Backwardness Under Semi-Feudalism," *Economic Journal*.

- Bhaduri, A. [1977]. "On the Formation of Usurious Interest Rates in Backward Agriculture," *Cambridge Journal of Economics*, Vol. 1, no. 4, pp. 341-52.
- Binswanger, H.P., V.S. Doherty, T. Balaramalan, M.J. Bhende, K.G. Kshirsagar, V.B. Rao and P.S.S. Raju [1980]. "Common Features and Contrasts in Labor Relations in the Semi-Arid Tropics of India," *Rural Labor Markets in Asia: Contractual Arrangements, Employment in Wages* (H. Binswanger and M. Rosenzweig (eds.), Yale University Press, forthcoming 1981.
- Braverman, A. and J.L. Guasch [1980]. "Capital, Signalling and Interlinked Credit and Tenancy Contracts," World Bank, Development Research Center, Draft.
- _____ and T.N. Srinivasan [1980]. "Interlinked Credit and Tenancy Markets in Rural Economies of Developing Countries," World Bank, Development Research Center, May.
- _____ and J.E. Stiglitz [1980]. "Landlords, Tenants and Technological Innovations," World Bank, Development Research Center, Draft.
- Cheung, S.N. [1969]. *The Theory of Share Tenancy*, Chicago: University of Chicago Press.
- Diamond, P. and J.E. Stiglitz [1974]. "Increases in Risk and in Risk Aversion," *Journal of Economic Theory*, July.
- Greenwald, B. [1979]. *Adverse Selection in the Labor Market*, New York: Garland Press.
- Heady, E. [1947]. "Economics of Farm Leasing Systems," *Journal of Farm Economics*, August.

Jaynes, D.J. [1978]. "Production and Distribution in Agrarian Economies,"
Yale University Economic Growth Center Discussion Paper.

Ladejinsky, W.[1977]. "Agrarian Reform in India," in ed. L.Y. Walinsky,
*The Selected Papers of Wolf Ladejinsky - Agrarian Reform as Unfinished
Business*, New York: Oxford University Press.

Leibenstein, H. [1957], *Economic Backwardness and Economic Growth*,
Wiley.

Marshall, A. [1959]. *Principles of Economics*, Cambridge University
Press.

Mirrlees, J.A. [1976]. "A Pure Theory of Underdeveloped Economies,"
in ed. L. Reynolds, *Agriculture in Developing Theory*, Yale
University Press.

Mitra, P. [1980]. "A Theory of Interlinked Rural Transactions,"
World Bank, Development Research Center, Draft.

Newbery, D.M.G. [1975] "Tenurial Obstacles to Innovation," *Journal
of Development Studies*, July.

_____ [1977]. "Risk Sharing, Sharecropping and Uncertain
Labour Markets," *Review of Economic Studies*, Vol. 44, no. 3, October.

_____ and J.E. Stiglitz [1979]. "Sharecropping, Risk Sharing
and the Importance of Imperfect Information," in "Risk, Uncertainty
and Agricultural Development," eds. J.A. Roumasset, J.M. Boussard and
J. Singh, SEARCA, A.D.C. Publication.

- Newbery, D.M.G. and J.E. Stiglitz [1981]. "Risk Aversion, Supply Response, and the Optimality of Random Prices - A Diagrammatical Analysis," *Quarterly Journal of Economics*, Forthcoming.
- Rao, C.H.H. [1975]. *Technological Change and Distribution of Gains in Indian Agriculture*, New Delhi: McMillan Company.
- Reid, J. [1973]. "Sharecropping as an Understandable Market Response: The Post Bellum South," *Journal of Economic History*, March.
- Rothschild, M. and J.E. Stiglitz [1970]. "Increasing Risk I: A Definition," *Journal of Economic Theory* 2.
- Rudra, A. [1975]. "Sharecropping Arrangements in West Bengal," *Economic Political Weekly*, Vol. 10, no. 39, September 27.
- Srinivasan, T.N. [1979]. "Agricultural Backwardness under Semi-Feudalism," *Economic Journal*, June.
- Stiglitz, J.E. [1974]. "Incentives and Risk Sharing in Sharecropping," *Review of Economic Studies*.
- _____ [1976]. "The Efficiency Wage Hypothesis, Surplus Labour and the Distribution of Income in LDC's," *Oxford Economic Paper*.
- _____ [1981]. *Information and Economic Analysis*, Oxford University Press, Forthcoming.
- _____ and A. Weiss [1979]. "Credit Rationing in Markets with Imperfect Information, Part I," Unpublished mimeograph.