2 Theories of Sharecropping

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1 Introduction

This chapter is an attempt to examine some of the different explanations for the existence of sharecropping. I discuss the roles of risk-sharing, incentive provision, wealth constraints, and screening. A common feature of the different theories is an emphasis on uncertainty and on asymmetries in information. I attempt to evaluate as well as describe some models of tenancy where share contracts are a useful resource allocation device. The emphasis is on theoretical considerations, and I do not attempt a systematic treatment of the historical[1] or empirical[2] aspects. Neither do I provide a mountain-top survey, revealing broad patterns and hitherto unseen connections. Instead, I attempt to cut through some of the thickets of individual models enough to expose their essentials. As will be seen, no sweeping conclusions emerge.

Some of my interpretations and analyses are no doubt idiosyncratic. Still, in analysing the specific models presented here, I have benefited from many other surveys and syntheses. These include works by Newbery and Stiglitz (1979), Binswanger and Rosenzweig (1984), Jaynes (1984), Quibria and Rashid (1984), Richards (1986), and Mohan Rao (1986). I have tried to avoid going over the same ground as these studies, and hope there will be enough that is new here even for someone who has read all the above.[3] Finally, for anyone who has not, this piece is meant to be fairly self-contained.

The remainder of this chapter is organized as follows. In Section 2 it is argued that the Walrasian paradigm, where in all individuals behave as price-takers, has no place in explanations of sharecropping. The share in a share contract is not a price, of course. Furthermore, the Walrasian model makes sense only as an approximation to situations where someone sets prices. This approximation may not hold when asymmetries in information are the underlying rationale for sharecropping.

In Section 3, explanations for sharecropping based on risk-sharing are examined. In some cases, wage and fixed-rent contracts appropriately combined can do as well as share contracts in spreading risk. Sharecropping comes into its own only when there are multiple risks of some kinds, or indivisibilities, or incentive problems.

Incentive-based explanations are the focus of the models considered in Section 4. For share contracts to be better than fixed-rent contracts, which are efficient in terms of incentive provision for the tenant, there must be some other factor as well. Different possibilities are the need for risk-sharing, input provision by the landlord with its own incentive problems, and constraints on the tenant's ability always to make a fixed rent payment. Several diverse models are considered in this section, although they all have incentive problems as an underlying common thread. This is the longest section in the chapter, and reflects the importance of providing incentives for a tenant to make more efficient decisions. Also, some issues in modelling landlord monitoring of tenant decisions are considered, since monitoring is widespread in practice.

Section 5 considers explanations based on screening of potential tenants with heterogeneous abilities that cannot be observed by landlords. The screening explanation alone seems to be unsatisfactory, but, combined with imperfect credit markets and default possibilities, it is more convincing. The last category of explanation, in Section 6, is based on the sharing of input costs, which in turn results from capital market imperfections.

We may see that these classifications are somewhat arbitrary. I might have dealt with the explanation based on conflicts between insurance and incentive provision under "risk-sharing" in Section 3, rather than under "incentives" in Section 4. I might also have created a category of explanations based on credit/capital market imperfections, which would have included models from Sections 4, 5, and 6. I could have provided a wholly different categorization based on imperfections in markets for insurance, labour, credit, and capital. The virtue of my classifications is directness—I have tried to emphasize proximate or significant causes in the various multifaceted explanations of sharecropping.[4] Having gone through the various models in Sections 3–6, I do not "pick a winner." This is because I do not think that there is a single explanation, no matter how ingenious or complicated, of the existence of share contracts or sharecropping. Sharecropping has existed in various times and places in various forms. It has disappeared over time and reappeared. Sometimes the tenant's share is one-half; sometimes it is not. Sometimes the output share equals the cost share; sometimes it does not. Sometimes productivity is higher on sharecropped land than on other types of tenancy or with self-cultivation; sometimes it is not. Sometimes share-croppers are poor; sometimes they are prosperous. Sometimes sharecroppers produce risky cash crops; sometimes they produce for subsistence. I do not think a single theory can capture all of these aspects of sharecropping!

What will emerge from Sections 2–6, however, is that I think some approaches and some models are better than others. While sometimes these judgements are based on casual empiricism, mostly they rely on the internal logic and consistency of the models themselves. Hence I hope this piece will provide a basic sifting of theories of sharecropping.

2 The Nature of Share Contracts and Sharecropping Equilibrium

There are two points I wish to make in the section as a preliminary to discussing specific explanations of sharecropping. First, the output share in a share contract is not a price-like variable. Second, models of sharecropping where everyone is price-taker, especially in the market for land, do not seem to be logically satisfactory. Below, I expand on these observations and their implications for the nature of an equilibrium with sharecropping.

The first point—that the output share in a share contract is not a price-like variable, and should not therefore be treated as a given by individuals who are otherwise price-takers in a competitive model—has been made by Newbery (1974). He was commenting on Bardhan and Srinivasan's (1971) general equilibrium formalization of the misallocation arising from sharecropping, argued by Marshall in his famous footnote. Since then, numerous authors have made similar observations, and offered various solutions.[5]

The basic problem with the ''Marshallian'' model is that the tenant taking the share as given will demand land up to the point where its marginal product is zero, whatever the share.[6] In general, there will not be an equilibrium share that clears the market for land, since the landlord has a supply function for land that will be to the left of the demand function, unless land is unrealistically abundant.

There are ways around this problem that maintain the assumption that all individuals take the share as given. Jaynes (1982) provides an elegant solution that illustrates the problems with the usual model. To describe this, I introduce the following notation. The production function is $Q(L, T)$, with constant returns to scale, where L is labour input and T is the quantity of land. We may write it as $Tq(\lambda)$, where $\lambda = L/T$. Jaynes assumes that individuals are contract-takers, where a contract specifies a pair (λ, α), and α is the tenant's share of output. Hence this implies that everyone takes the share in share contracts as given. However, they also take as given the labour–land ratio associated with a contract: they do not choose how much they would like of the other input given their own input. Furthermore, if there are many contracts available, each with a different labour–land ratio, the corresponding output share may differ as well. This last is the crucial assumption, as Jaynes shows: if the tenant's share decreases as he uses more land with a given labour input, he will no longer demand land till its marginal product is zero. A similar constraint will apply to the landlord's demand for labour. Formally, Jaynes allows for a continuum of contracts, (λ, α), which, if indexed by λ, define the share as a function of $\lambda, \alpha = a(\lambda)$. The tenant and landlord's first-order conditions with respect to λ are, respectively,

$$a'(\lambda)q(\lambda) + a(\lambda)q'(\lambda) = a(\lambda)q(\lambda)/\lambda \tag{1}$$

and

$$\{1 - a(\lambda)\}q'(\lambda) = a'(\lambda)q(\lambda). \tag{2}$$

Together, these determine the equilibrium contract $(\lambda^*, a^*(\lambda^*))$. Note that $a^{*\prime}(\lambda^*) > 0$; otherwise neither equality can be satisfied since, in general, $0 < q'(\lambda) < q(\lambda)/\lambda$. Hence if $a'(\lambda) = 0$ there is no equilibrium: the point made by Newbery and others. On the other hand, Jaynes shows that, with a share that varies with the labour–land ratio, and usual assumptions on utility functions, the equilibrium is identical to a standard competitive (i.e. Walrasian) equilibrium, with markets for labour and land, and individual price-takers in each market. Hence there is no need for the array of share contracts if there are wage and rental rates determined by supply and demand. This is a result that carries over to the case of uncertainty, discussed in the next section. In any event, Jaynes's construct is not meant to provide a realistic solution to modelling the determination of equilibrium shares. His own explanation (Jaynes 1982, 1984) relies on a form of capital market imperfection[7] and does not assume that all individuals take the output share in share contracts as a given.

Another way round non-existence of equilibrium while maintaining the assumption of share-taking behaviour is that of Alston, Datta, and Nugent (1984), but this has its own problems.[8] A better alternative is to do away with the assumption of share-taking behaviour. This is what is normally done in models of sharecropping. I shall argue that it is more logical to assume that one side, typically the landlord,[9] sets the parameters of the contract. Furthermore, it is not really logical to assume that landlords who set the parameters of share contracts take wages and rental rates as given by the market. This is not to say that landlords can do whatever they like. They must be able to attract tenants at the terms they offer. And this may also depend on what other landlords offer.

The basis of the argument is as follows. In the usual competitive model where everyone is a price-taker—i.e. the Walrasian model—prices are set to clear markets by a fictional auctioneer. Of course, this is not taken as a literal description of the resource allocation process. Instead, the usual justification is that the Walrasian outcome is close to the equilibrium where some individuals actually set prices, and there are appropriately large numbers, so that no single individual has much aggregate influence. The latter formulation is usually that of a game where the individuals in the economy are the players, so that there is no need for a *deus ex machina* such as an auctioneer. There are rigorous demonstrations of approximation results and equivalence in the limit, as numbers become infinite.[10] However, these results are generally available for models without asymmetries of information. And the explanations that I shall present subsequently, especially in Sections 4 and 5, depend critically on imperfect or incomplete information. Hence, even if it is possible sensibly to assume price-taking behaviour—and for moral hazard models it may not be—it does not seem reasonable in such models.

As I have said, it is usual in models of sharecropping to assume that the landlord sets the share. For example, in cases where the landlord cannot observe the tenant's effort—treated in detail in Section 4—he chooses the tenant's share to provide appropriate incentives for effort. It is crucial that he recognizes the tenant's response to changes in the share: share-taking behaviour by the landlord will not give sensible results. However, such behaviour is sometimes combined with price-taking behaviour in a "competitive" rental market, that is, where an auctioneer determines the equilibrium fixed rent to land.[11] This does not seem plausible. Roughly, the landlord is behaving very differently towards two different contracts in the same market—land. More formally, a landlord offering a share contract may plausibly incorporate a fixed payment to or from the tenant. If $\tilde{Q}$ is the (random) output, α the tenant's share, and C the fixed payment, the share contract specifies that the tenant gets $\alpha\tilde{Q} + C$. For any such contract, we assume that the landlord anticipates the tenant's response to the contract parameters (α, C) and chooses these parameters to maximize his own expected benefit. This presumably includes share contracts with α very close to 1, and C negative. But if $\alpha = 1$, we have a fixed-rent contract. To say that in this case the landlord's assumption about the tenant's behaviour and his own decision process change drastically seems implausible. Instead, it seems more realistic to assume that, if the landlord agrees to a fixed-rent contract with the tenant, he will do so under the same sort of conditions as for a share contract, anticipating the tenant's labour input decision and contract acceptance conditions. A similar argument applies to wage contracts, where $\alpha = 0$ and C is positive.

In the above, for simplicity of exposition, I suppressed the quantity of land. One might tackle its determination in the usual way that firm size is determined in conventional microeconomic theory, by assuming initially increasing and then decreasing returns to farm size. This allows the endogenous determination of the quantity of land per tenant, and the number of tenants per landlord (or perhaps the number of landlords per tenant). With only decreasing, constant, or increasing returns, however, the issue of farm size is problematical, as it usually is in a competitive equilibrium.

Let us conclude this section with a simple example of what a competitive equilibrium will look like in our framework. General questions of the nature, existence of efficiency of equilibrium and the role of exclusivity of contracts are discussed in a series of papers by Arnott and Stiglitz.[12] I describe the model of Shetty (1988), considered in more detail in Section 4. There are more potential tenants than landlords. The optimal landlord–tenant ratio is 1. Each potential tenant has the same reservation expected utility, determined by some other opportunities. Tenants are divided into several classes, according to their wealth levels; otherwise they are identical. There is moral hazard, so landlords choose contract parameters anticipating the tenants' effort responses. Wealthier tenants are more desirable, because they are less likely to default on agreed payments, and because they work harder in equilibrium. Hence landlords compete for wealthier tenants. Now the individuals with the lowest wealth who actually become tenants compete for tenancy. Hence they receive only their reservation expected utility; otherwise a landlord could undercut and still get the same tenant. Landlords with such tenants obtain a certain expected utility—endogenously determined. Landlords with other, wealthier, tenants must get the same expected utility; otherwise the landlords with poorer tenants could profitably steal away the wealthier, more productive, ones. Hence the wealthier tenants obtain a higher equilibrium expected utility: they get the full benefit of their higher productivity. This model, therefore, shows what a competitive equilibrium looks like in a simple model. Moral hazard implies that landlords choose contract parameters. There is no role for price-taking behaviour, however: in particular, landlords do not take as given the rental rate for land. However, the wealthiest tenants get fixed-rent contracts, and the rental rate, while chosen by landlords, is determined in equilibrium by the return to landlords with the poorest tenants. Competition equalizes returns across landlords (and tenants with the same wealth), since differences in returns will lead to undercutting by some landlord through variation in the contract terms. This is competitive behaviour in the sense of monopolistic competition: each landlord assumes that what he does will have no effect on what other landlords do, presumably because he is small relative to the market. The behavioural assumptions are consistent in such a model, and we do not have to worry about how prices are actually determined, since they are chosen implicitly or explicitly by landlords, subject to competitive pressures. Hence this type of formulation seems a good way to approach formal modelling of a competitive equilibrium with share contracts.

3 Sharecropping and Risk-sharing

The idea that share contracts might have risk-sharing advantages over fixed-rent and wage contracts was suggested by Cheung (1968, 1969a, 1969b). The basis for the argument is that a fixed-rent contract causes the worker as tenant to bear all the production risk, in the absence of insurance markets or other means for diversifying risk. In a similar situation, the landlord would bear all the risk if he or she hired the worker at a fixed wage. Hence if both landlord and worker are risk-averse, neither arrangement is optimal in terms of risk-bearing. A share contract, on the other hand, assigns some risk to each of the contracting parties, and might be preferable. This analysis assumes that there is no incentive problem, so that inputs such as labour are observable and can be specified in the contract. With this assumption, however, the strongest form of the risk-sharing explanation does not hold. This was demonstrated by Reid (1976), and by Newbery and Stiglitz in a sequence of articles.[13] The most general statement of the critique of the risk-sharing explanation is in Newbery and Stiglitz (1979). They demonstrate that, if there are constant returns to scale in production, and no indivisibilities, there will be a mix of wage and fixed-rent contracts on two subplots that gives the same pattern of returns in every state of the world to the landlord and to the tenant as does a share contract for the whole plot. Their formalization is as follows.

Let α be the tenant's share in a share contract, r the rental rate, and w the wage rate. Let L and T be the agreed-on amounts of land and labour, and let $\tilde{Q}(L,T,\theta)$ be the production function, where θ is a random variable denoting the state of the world. Suppose that a fraction k of the land is rented out and the remainder is cultivated at a fixed wage. The worker/tenant's income will be

$$\tilde{Q}(kL,kT,\theta) - rkT + w(1-k)L = k\tilde{Q}(L,T,\theta) - rkT + w(1-k)L, \quad (3)$$

by the assumption of constant returns to scale (CRS). Now, if k^* is chosen such that

$$rk^*T - w(1-k^*)L = 0, \quad (4)$$

then the worker/tenant's income is $k^*\tilde{Q}(L,T,\theta)$, which is what a sharecropper with share k^* would receive in each state of the world. Now suppose that there are markets for labour and land with the above prices, w and r. Would a share contract improve matters for the tenant? For this to be the case, it must be that $\alpha > k^*$. Now, however, if the same steps are repeated for the landlord, he will get $(1-k^*)\tilde{Q}(L,T,\theta)$ with the specified mix of wage and fixed-rent contracts. He will prefer a share contract if $1-\alpha > 1-k^*$, or $\alpha < k^*$. Hence there is no share contract that would improve matters for both landlord and tenant over the specified mix of wage and rent contracts; the best they can do is replicate the pattern of returns with a share contract with $\alpha = k^*$. In other words, sharecropping does not provide superior risk-sharing.

The above analysis sidesteps the issue of precisely how the wage rate, rental rate, and share are determined. In that sense it is very general. However, it would be useful to clarify how w, r, and α come about, and also briefly to look at the interaction between risk-sharing and input allocation. Having done this, I shall offer some further interpretation of the results, and examine its scope.

One possible assumption, of course, is that landlords and tenants/ workers are price-takers with respect to the wage and rental rates. In that case, Newbery (1977) has shown that the competitive equilibrium is constrained Pareto-efficent; that is, a central planner specifying labour and land inputs, base consumption levels, and output shares for all market participants[14] cannot achieve a Pareto improvement. Now if share contracts are also made available, whether both landlord and tenant take the share as given or the landlord offers a particular share, the previous argument still holds: the tenant will only accept a share $\alpha \geq k^*$, the landlord will only accept or offer a share $\alpha \leq k^*$. Hence only $\alpha = k^*$ can prevail in equilibrium, with no effect on resource allocation.

A similar argument may be given for the case where the landlord specifies land and labour inputs as well as the contract terms for his tenant, subject to providing the tenant with his reservation expected utility. We can generalize the result by allowing for side-payments in the share contract.[15] The contract-setting monopolist can do as well with a mix of fixed-rent and wage contracts as with a share contract—the latter is not needed.

As a final case, consider a monopolistic landlord who takes the wage rate as given, but chooses the rental rate based on the tenant's demand for land, $T_{\mathrm{d}}(r)$; in other words, the tenant is a price-taker in the market for land. Now the resulting equilibrium will not even be constrained-efficient: there is the standard monopolistic misallocation.

In this case a share contract that achieves the competitive outcome, plus a side-payment, can make both sides better off. In some sense this is merely the result of a better input allocation. However, the point to be made is that here, while risk-sharing is partly the result of contractual choice given the input levels, the amount of risk depends on those inputs.[16] The two decisions are really intertwined. Thus the result on the irrelevance of sharecropping for risk-sharing must be interpreted as conditional in some contexts, where there are additional inefficiencies with wage and fixed-rent contracts alone.

Before we further consider the scope of the irrelevance result, a summary interpretation is in order. The essence of the argument is that any linear function of output will slope between 0 and 1 and constant term between $-rT$ and wL can be attained for the tenant through a mix of fixed-rent and wage contracts. Since share contracts are linear in output, in general, allowing share contracts does not expand the set of attainable returns. It may be noted that linear sharing rules are in general not optimal.[17] Hence a share contract with some nonlinearity might improve risk-sharing over a mix of wage and rent contracts. Subsistence constraints or tied provision of inputs might effectively introduce such nonlinearities, but there is no obvious evidence in this regard.

The assumption of constant returns to scale has been used in the analyses presented so far. Allen (1984) shows that in a sense this assumption is unnecessary. The point is simple. The arguments above assumed that production would be carried out separately for the two subplots given to fixed rent and wage cultivation. However, if the two plots can be cultivated together, output can be the same under the mixed wage and rent agreement as under sharecropping, even with economies of scale. Essentially, any share contract can be reinterpreted as assigning output from some fraction of land to the landlord and from the remainder to the tenant. There is a corresponding assignment of output from fractions of labour, so that there is an implicit exchange of land for labour, with an implicit relative price, the rent–wage ratio. Typically, this need not be a market price, and in the examples Allen presents[18] the worker or tenant did not usually have access to wage-earning opportunities at parametrically given rates. Still, these contracts specified an exchange of labour for land, and could be interpreted either as share contracts or as a combination of wage and rent contracts, with identical resource allocation patterns.[19]

A second, more important, limitation of the irrelevance result is that it assumes only that output is risky. If there are multiple sources of risk, share contracts can improve matters over a combination of fixed-rent and wage contracts. This is demonstrated by Newbery (1977) and Newbery and Stiglitz (1979). I outline their analysis below.

Suppose that the wage and rental rate are competitively determined; that is, everyone behaves as a price-taker with respect to the markets for labour and land. Suppose also that the wage rate is subject to some randomness.[20] This may be due partly to the same factors that affect output. However, there may be additional sources of uncertainty in the agricultural labour market, such as the demand for non-agricultural labour. Let $\tilde{w}$ be the random wage. Then the worker/tenant's income from mixing fixed rent and wage contracts in proportions $k : 1 - k$, with L units of labour and T units of land, will be

$$k\tilde{Q} - rkT + \tilde{w}(1 - k)L$$

There are now two random variables, and as long as $\tilde{Q}$ and $\tilde{w}$ are not perfectly correlated, this is a linear function of $\tilde{Q}$ only if $k = 1$. On the other hand, a share contract still specifies $\alpha\tilde{Q} + C$ for the tenant. Hence there are now patterns of returns with share contracts that cannot be achieved with a combination of wage and rent contracts.

The above argument assumes that the share tenant's opportunity cost of labour is not subject to randomness, but is just the disutility of his labour. If the sharecropper can sell his labour at $\tilde{w}$, or has to hire in workers at $\tilde{w}$, then his income will also be subject to the additional randomness arising from labour market uncertainty. Newbery and Stiglitz look at this more complicated case. They show that the share tenant will optimally combine four contracts: a fixed-rent contract, a share contract, a wage contract, and a fixed-rent contract with a share sublease. The income from the last of these involves no labour market randomness, which is why it is undertaken. It is shown that if $\tilde{Q}(L, T, \theta) = \theta Q(L, T)$, that is if production risk has a multiplicative form, then the above combination will lead to production efficiency and optimal risk-sharing.[21] On the other hand, this is not the result with only wage and rent contracts. The result that share contracts increase the set of contingent consumption possibilities is true even if production risk is non-multiplicative, only full efficiency is not then attained.

Another case where share contracts may improve risk-sharing is if there are non-tradable inputs. Examples in some circumstances are managerial and supervisory labour,[22] and the services of draft animals. The reason for absence of these markets may be moral hazard. Here we focus on the situation where a potential tenant has a fixed amount of a non-tradable input, so there is no explicit incentive problem. Pant (1983) has considered such a model, but without uncertainty; and fixed-rent contracts, which would then be optimal, are arbitrarily ruled out. Bell (1986) considers a world with uncertainty, and argues that risk-sharing might be improved with share contracts in addition to wage and fixed-rent arrangements. Suppose there are competitively determined wages and rental rates. In the absence of a market for the non-tradable input, the competitive equilibrium will not be constrained-efficient in general. The reason is that marginal products and implicit risk prices are not equated across individuals with different endowments of the non-tradable input. Then it turns out that, if there are households that would work only for wages in the presence of wage and fixed-rent contracts, one can find share contracts that will induce these households to choose some degree of share tenancy and at the same time are profitable for landlords. The intuition is that these households can now use their endowments of non-tradables, without being exposed to the greater risk of fixed-rent contracts. Bell demonstrates this explicitly in the context of a bargaining model.[23] The above analysis is in the presence of parametric rental and wage rates. As Bell points out, if the landlord chooses all contract parameters, subject to providing the tenant/worker with his reservation utility, he can anyway appropriate the imputed rents attributable to the non-tradable. In this case, if a mix of wage and fixed-rent contracts is offered, and the subplots are cultivated together, sharecropping offers no risk-sharing advantage (cf. Allen 1984 above.)

A final rationale for sharecropping in the context of risk-sharing relies on a different labour market imperfection from wage uncertainty. Suppose true labour input is not observable. Then wage contracts provide no incentives for effort. The above analyses have all assumed that the amount of land and labour could be specified in the contract and enforced. If this is not the case, a share contract will be the preferred risk-sharing arrangement, as it also provides uniform incentives—albeit imperfect ones—for effort. A mix of a fixed-rent and a wage contract would provide correct incentives on the part of the land that was rented out, but no incentives on the part cultivated with wage labour.[24] The focus is now equally if not more on incentives rather than risk-sharing, and these issues are dealt with in the next section.

4 Sharecropping and Input Incentives

In this section we shall concentrate on labour, probably the most important input,[25] and the subject of the most debate—going back to Adam Smith—about the link between sharecropping and incentives. The well-known[26] argument is that sharecropping leads to inefficient labour input decisions because the sharecropper receives only a fraction of his marginal product of labour. The efficient solution, it has been argued, is fixed-rent or wage contracts. The theories we shall examine here provide explanations of why sharecropping might be preferred to fixed-rent contracts or in some cases wage contracts. The common assumption is that labour input cannot be measured, and hence cannot be controlled by the landlord.[27] While hours worked may be observable, actual effort may not be; in any case, it is more difficult to measure. By labour input I mean the effective input, taking account of effort variation. Initially, I consider a set of models where labour input is not observable at all by the landlord. Later, I discuss models where the landlord can imperfectly monitor the input, but at a cost.[28] With one exception, the models are static, in that the input decision is made just once, resulting, subject to uncertainty, in an output—there has been no modelling (that I know of) of the various stages and types of labour inputs involved in agricultural production.

Non-observability of labour does not in itself imply a rationale for sharecropping; the incentive problem can be dealt with by fixed-rent contracts, which provide efficient incentives. This assumes that there are no other market imperfections. Hence the theories presented here involve various types of such imperfections. The first set assumes that the tenant is risk-averse and there is no insurance market. The landlord therefore plays a dual role, providing land and insurance, and the optimal contract from his or her perspective involves a trade-off between incentive provision and insurance provision. This model was introduced to the sharecropping literature by Stiglitz (1974a), but it is a special case of the pure moral hazard principal-agent framework that goes back to Ross (1973) and Mirrlees (1974).[29] The second theory is a formalization by Eswaran and Kotwal (1985c) of ideas in Reid (1976, 1977) and Bliss and Stern (1982). It is based on provision of labour inputs (interpreted as supervisory and managerial) by both landlord and tenant. Hence there is a two-sided incentive problem. The third group has two very different models, that of Hurwicz and Shapiro (1978) and that of Shetty (1988), which both rely on wealth constraints to explain sharecropping.[30] Hence the focus in these models is on capital market imperfections:[31] the tenant cannot borrow to cover bad years.

We begin with the incentives–insurance trade-off model. We assume for simplicity that the landlord is risk-neutral. This is not at all necessary. Other simplifying assumptions are as follows. There is only one landlord and one tenant. The latter has a utility function $U(Y) - L$, where Y is income and L is labour input. The tenant's reservation utility is K. The amount of land given on rent is fixed, so is suppressed in the model. The production function is $\tilde{Q}(L, \theta) = \theta Q(L)$, where θ is a random variable with mean 1, representing exogenous uncertainties that are typical of agricultural production. As usual, $Q' > 0$ and $Q'' < 0$. The tenant's income, Y, is a function of output, as determined by the contract offered by the landlord. For example, for a fixed-rent contract, $Y = \theta Q(L) - R$, where R is the rental payment to the landlord. For a pure share contract, $Y = \alpha\theta Q(L)$, where α is the tenant's share. If there is a side-payment as well, $Y = \alpha\theta Q(L) + C$. The general theory of such models demonstrates that the optimal contract need not be differentiable, and in fact can be almost anything, depending on the parameters of the model.[32] While contracts that involve linear functions of output may be optimal, there are no economically obvious assumptions that ensure this in the one-shot framework. However, Holmstrom and Milgrom (1987) have provided a dynamic analysis where linear contracts are always optimal, and we consider this and the relevance for sharecropping below. Otherwise, this literature on sharecropping just assumes that the set of possible contracts is restricted to the examples above: one can appeal to bounded rationality, perhaps, for justification.

One approach has been to compare fixed rent and "pure" share contracts (with no side-payment). While a fixed-rent contract is optimal if the tenant is risk-neutral,[33] it causes a risk-averse tenant to bear all the risk. The argument is then that a share contract provides some incentives, while at the same time reducing the tenant's risk. It is not clear, however, that the share contract *will* be better. For example, if the tenant is close to being risk-neutral, the landlord may not find it worthwhile to sacrifice incentives for labour input by using a share contract. It should be noted that the landlord cares about insuring the tenant because by doing so he can lessen the bite of the latter's reservation utility constraint. However, it may be less costly to do this by reducing the fixed rent and maintaining efficient incentive provision. This intuition suggests that sufficient risk aversion on the part of the tenant will tilt the scales in favour of a share contract. Newbery and Stiglitz (1979) analyze the resource allocation consequences of a pure share contract in this case. We shall concentrate on what seems a more appealing analysis, where the landlord chooses α and C for the optimal linear contract, $\alpha\theta Q(L) + C$. This includes the fixed rent and pure share contracts as special cases. This kind of analysis was done by Stiglitz (1974a), and has been extended in several directions by (for example) Braverman and Stiglitz (1982, 1986a).

Using the notation developed above, the landlord's problem in this framework is

$$\max_{\alpha, C, L} \underset{\theta}{E}\{(1-\alpha)\theta Q(L) - C\}$$

$$\text{s.t.} \quad \underset{\theta}{E}[U\{\alpha\theta Q(L) + C\}] - L \geq K$$

$$\underset{\theta}{E}[U'\{\alpha\theta Q(L) + C\}\alpha\theta Q'(L)] - 1 = 0. \tag{5}$$

The first constraint is the tenant's acceptance condition. The second constraint is the tenant's first-order condition for labour input choice given the contract parameters, and its presence is the crux of the incentive issue: the landlord cannot directly monitor or control labour input. We shall assume throughout that first-order conditions characterize the solution uniquely.[34]

Given the side payment, C, which may be negative, the landlord can drive the tenant down to his reservation utility level, K. Hence the two constraints may be solved for $L(\alpha, K)$ and $C(\alpha, K)$, and substituting these in the landlord's objective function, one obtains his first-order condition (omitting arguments and using subscripts for partial derivatives):

$$-Q + (1-\alpha)Q'L_\alpha - C_\alpha = 0, \tag{6}$$

or, rearranging,

$$\alpha = 1 - \frac{Q + C_\alpha}{Q'L_\alpha} \tag{7}$$

It is possible to show, from the constraints, that $C_\alpha = -QE(U'\theta)/E(U')$, which is negative and less than Q in magnitude with risk aversion.[35] Hence $Q + C_\alpha$ is positive, and whether α is less than 1, from the above formula, depends on the sign of L_α.[36] Now, intuitively, one would expect it to be the case that, since there is an incentive problem, in equilibrium increasing the share would increase effort. In that case $\alpha < 1$, and the model predicts that a share contract (usually with a side-payment) will be used. However, it is hard to establish $L_\alpha > 0$ in general, and I am not aware of a fully general result. Even $U''' < 0$,[37] which is in turn implied by decreasing absolute risk aversion (DARA), is not sufficient. DARA has been suggested by Arrow (1971) as a plausible condition.

I have given this issue some attention, because, while without side-payments α must lie between 0 and 1, it is not completely obvious in this case. Certainly $\alpha > 1$ could not be interpreted as a share contract. It may also be noted that the model gives no general prediction of the size of the share, in particular whether it is close to one-half, the most commonly observed value. In this respect its predictions are weak. The model also predicts that labour input will be lower than if it could be observed and controlled by the landlord, but this does *not* imply that there is a more efficient outcome given the lack of observability of labour input.

As noted, many of the above simplifying assumptions are unnecessary. Allowing for a risk-averse landlord, the choice of plot size by the landlord, competition among landlords, or more general utility or production functions does not change the character of the prediction that share contracts will be used. The assumption of possible side-payments deserves some comment. I have assumed it for logical theoretical reasons: an either–or choice of a fixed-rent or pure share contract by the landlord seems unduly restrictive. The empirical evidence is less clear-cut, since explicit side-payments are not often observed. However, one would expect them to be disguised if there are cost-sharing arrangements or production or consumption loans.[38]

We next turn to some more dynamic considerations in the context of this basic incentive model of sharecropping. In the sharecropping literature, there have been two points made in a multi-period context. First is the argument, going back at least to J. S. Mill (1848), that sharecropping involves inferior incentives for investment by the tenant. Second is Johnson's (1950) suggestion that the incentive problem described above in a static framework will be mitigated or dealt with entirely by offering short-term leases with renewal contingent on satisfactory overall performance. There is also a large general literature on repeated principal–agent relationships that is relevant for landlord–tenant contracts. Finally, there is the specific contribution of Holmstrom and Milgrom (1987) that looks at labour input and production as processes over time.

We begin with the general models of dynamic agency. The first such studies were those of Radner (1981) and Rubinstein (1979). Both show that, in an infinitely repeated version of the basic one-period model, the first-best solution (efficient insurance and incentives) can be achieved if there is no discounting of the future. There is a class of contracts that do this, by punishing the agent (tenant) for a period of time if aggregate output falls below expectations. The implication for explanations of sharecropping is that share contracts may not be inefficient in a repeated context: the incentive problem is fully dealt with. Note that fixed-rent contracts will still not be optimal. Also, the share contract in this framework must be supplemented by possible penalties based on the history of output.

It is interesting that recent work (e.g. Allen 1985b) shows that, if borrowing and lending is possible on perfect credit markets, then long-term contracts will be no better than a sequence of short-term contracts in the repeated model. In the models of Radner and others, however, borrowing and lending are not possible. In this sense, sharecropping and its durability are more explicable in agricultural contexts where credit markets are absent or imperfect, for there the incentive problem is efficiently handled, and so there is no cost to this institution.

The suggestion of Johnson that the incentive problem in sharecropping can be overcome by evicting tenants who do not perform satisfactorily over time may be looked at as an example of the above repeated models. However, there is a difference in that, if the relationship is not infinite, the conclusion of those models may not hold: there is a probability that the tenant may not be around to enjoy future good times. Also, severing the contractual relationship is a less efficient way of providing incentives than are monetary penalties, since the landlord gains nothing from the termination,[39] and it may reduce incentives for land-improving labour input.

Newbery (1975) has provided a partial formalization of Johnson's idea. He shows that, if the sharecropper has to provide an average return to the landlord comparable to the latter's opportunity cost, say, the return from a fixed-rent contract, he will choose an efficient amount of labour. The payment to the landlord still varies with output, so the tenant's risk is reduced from that in a fixed-rent contract. However, since this model does not explicitly model termination for poor performance, it is more in the spirit of the Radner-type models. An alternative formulation is that of Bardhan and Singh (see Bardhan 1984 Ch. 8). This is a two-period model with a pure share contract. Without side-payments, the landlord cannot in general drive the tenant to his reservation utility level. Hence there is a real loss to the tenant if he is evicted.[40] Furthermore, a contract that involves eviction if output is below a certain level provides increased incentives for effort. In this model, the conflict between static and dynamic incentives is also formalized. Some first-period labour is assumed to increase second-period output through land or other improvements. Setting the satisfactory performance level too high is costly in terms of reducing incentives for this kind of labour input.

I shall close the discussion of this set of models with a presentation of the work of Holmstrom and Milgrom (1987). This is based on Hart and Holmstrom's (1987) exposition, but it is couched in terms of landlord and tenant, and choice of rental contract.

Production and effort in his framework are modelled as processes over time. This seems especially descriptive of agriculture, where final output is the result of different stages and types of labour throughout the year. Furthermore, the landlord and tenant will be able to monitor the stages of growth of the crop from start to end. Specifically, the agent controls the drift rate μ of a one-dimensional Brownian motion $\{\tilde{Q}(t); t \in [0, 1]\}$, which is the analog for stochastic processes of the normal distribution. Formally,

$$\mathrm{d}\tilde{Q}(t) = L(t)\,\mathrm{d}t + \sigma\,\mathrm{d}B(t), \qquad t \in [0, 1] \tag{8}$$

where B is standard Brownian motion (zero drift and unitary variance). Hence the instantaneous variance, $\sigma\,\mathrm{d}t$, is assumed constant. $L(t)$ is here the rate of effort of the tenant, and $\mathrm{d}\tilde{Q}(t)$ is the incremental output.

The tenant has a utility function with constant absolute risk aversion, that is, of the exponential form

$$U\left[Y(\tilde{Q}) - \int \delta\{L(t)\}\right] = -\exp\left\langle -a\left[Y(\tilde{Q}) - \int \delta\{L(t)\}\right]\right\rangle \tag{9}$$

where δ is the instantaneous cost of effort and a is the coefficient of absolute risk aversion. Here $Q = \tilde{Q}(1)$, the output at the end of the period, that is, the quantity harvested. The function $\delta(L)$ is assumed convex. The integral is with respect to time, to give the total cost of effort, measured in income-equivalent terms.

The key to the model is that the tenant can observe the growth of the crop, $\tilde{Q}(t)$, and adjust effort $L(t)$ appropriately, based on the entire path of this growth. It turns out that this large expansion of the tenant's choice set limits the landlord's options dramatically, and that the optimal rule is linear. Hence share contracts emerge naturally. For example, if the cost of effort is $L^2/2$, the optimal contract turns out to be $\alpha\tilde{Q} + C$, where

$$\alpha = \frac{1}{1 + a\sigma^2}. \tag{10}$$

Hence the prediction is that the tenant's share goes down as his aversion to risk increases, or as production uncertainty increases. If either of these factors is non-existent, then $\alpha = 1$: a fixed-rent contract is optimal.

This concludes discussion of the first group of models. I shall now describe a model where both landlord and tenant provide different types of labour inputs and these are not publicly observable.

The model is due to Eswaran and Kotwal (1985c). There is one landlord and one potential tenant. Each is risk-neutral, so insurance or risk-sharing do not enter. The plot size is fixed, so we may suppress the quantity of land in what follows. Eswaran and Kotwal allow for material inputs, purchased at a market price; but while these are relevant for the numerical simulations they carry out, their existence is not essential to the qualitative explanation, so we ignore them here. Hence we focus on labour inputs. Output is given by $\theta\hat{Q}(M, E)$, where M is managerial input, E is effective labour input, $\hat{Q}$ is expected output, and θ is a random variable with expected value 1. E is in turn given by

$$E = E(S, L; \varepsilon) \tag{11}$$

where S is supervisory input, L is the amount of labour hired, and ε is a parameter $(0 \leq \varepsilon \leq 1)$ that captures the relative importance of supervision in a unit of effective labour. If the technology of supervision improves, it becomes less important, so ε decreases. Substituting in for E, we obtain the production function

$$\theta Q(M, S, L; \varepsilon).$$

This is assumed concave in the inputs. It is assumed that L is easily observable, but managerial and supervisory effort are not. Furthermore, it is assumed that the landlord and tenant have differential abilities in providing these inputs. The landlord is better at management. One hour of the tenant's time devoted to management is equivalent to a fraction γ of the landlord's time so spent. Similarly, one hour of the landlord's time devoted to supervision is equivalent to a fraction δ of the tenant's time so spent. The justifications are that the landlord has better access to information, markets, and institutions, while the tenant is better able to supervise family labour, possibly a large component of L. The final assumptions about labour inputs M, S, and L are that they have constant opportunity costs v, u, and w $(w \leq u, v)$ and that the landlord and tenant each have a fixed amount of labour that can be allocated to M or S.

There are three contractual options considered. First, the landlord can self-cultivate by hiring (unskilled) labour at the wage w and providing management and supervision himself. Second, he can lease out the land to a tenant for a fixed rent; the tenant then hires labour L and provides M and S himself. Finally, the landlord and tenant can enter into a share contract in which the former provides M and the latter S. The share contract provides the opportunity for specialization in tasks where each person has an absolute advantage. However, there is an incentive problem for each, since M and S are unobservable, and neither receives its full marginal product. The analysis proceeds by calculating the expected net income of the landlord for each of the three types of contracts. The landlord will pick the contractual form that gives him the highest expected payoff.

The fixed-wage contract requires the landlord to solve

$$\max_{M,S,L} Q(M, \delta S, L) - wL + (1 - M - S)v \tag{12}$$

where output is the numeraire, his endowment of labour is scaled to be one unit, and M, S, and $M + S$ lie between 0 and 1.[41] Let this maximum be π^{lw}.

Under the fixed-rent contract, the tenant solves

$$\max_{M,S,L} Q(\gamma M, S, L) - wL + (1 - M - S)u - R \tag{13}$$

with constraints as above, and R the fixed-rent total. Let this maximum be π^{tr}. Assuming that this is greater than the tenant's opportunity cost, u, and that there is competition among potential tenants for land, the rental amount will be

$$R = \pi^{tr} - u. \tag{14}$$

Hence the landlord's expected payoff is

$$\pi^{lr} = R + v = \pi^{tr} + (v - u). \tag{15}$$

The share contract is more complicated. Eswaran and Kotwal model it as follows. Expected output net of the optimal hired labour cost is

$$\pi(M, S) = \max_{L} Q(M, S, L) - wL. \tag{16}$$

The share contract assigns on average $\alpha\pi(M, S) + C$ to the tenant and the remainder to the landlord. Given the share contract, the landlord and tenant non-cooperatively choose M and S respectively to solve

$$\max_{M}(1 - \alpha)\pi(M, S) + (1 - M)v - C \tag{17}$$

and

$$\max_{S} \alpha\pi(M, S) + (1 - S)u + C, \tag{18}$$

subject to the endowment constraints on M and S. The resulting Nash equilibrium[42] is $M^*(\alpha), S^*(\alpha)$. The landlord, given these functions of the share, α, chooses the parameters α and C[43] to solve

$$\max_{\alpha, C}(1 - \alpha)\pi\{M^*(\alpha), S^*(\alpha)\} + \{1 - M^*(\alpha)\}v - C, \tag{19}$$

subject to giving the tenant the latter's opportunity income, u. The landlord's resulting expected payoff is denoted π^{ls}.

Finally, the landlord compares π^{lw}, π^{lr}, and π^{ls}, and chooses the contract type that gives him the highest expected payoff. An explicit analytical solution is not possible, so Eswaran and Kotwal do numerical simulations, and see how varying the parameters affects contractual choice. For example, they find that, if both γ and δ are low, sharecropping is preferable to the landlord; if γ is high, a fixed-rent contract is best; if δ is high, a fixed-wage contract is best. This is all straightforward. The important point is that the numerical example establishes that all three contractual forms are possible for different parameter values. There are several other interesting comparative-statics exercises in the paper—readers are referred to it for details.

The final point I wish to bring out is that the numerical examples suggest that, when sharecropping is the preferred mode, the share will be around one-half. This may be roughly interpreted as reflecting the ''partnership'' nature of sharecropping in this model.

The chief virtue of the model is that it incorporates the observation that sharecropping is often associated with active participation by the landlord and with pooling of managerial skills or other non-marketable inputs. Since both sides supply such inputs, of which they have different effective endowments, neither a fixed-rent nor a wage contract may be optimal. Another useful prediction is that, with varying conditions, one contractual form or other may dominate. The model is also rich in other qualitative predictions, at least for the Cobb–Douglas production technology. A more detailed justification of the model is in the paper.

There are also several possible criticisms. First, the nature of the share contract is not clear. The tenant is assumed to have an absolute advantage in supervision because it is easier to supervise family labour. However, the cost of this labour is subtracted off before shares are calculated. Furthermore, this is also treated as a cost for the tenant, so presumably L is only outside labour. In any case, it is effectively assumed that there is full cost-sharing, i.e. in proportion to the output share.[44] This is perhaps not realistic. It is argued in the paper that the results would be similar with the more usual output-sharing. However, since the results are based on numerical calculations, this conclusion is not obviously justified. This problem extends to the model's prediction based on numerical calculations that the share will be around one-half. In spite of these strictures, however, Eswaran and Kotwal's approach is rich and worthy of extension.

The third set of models—those of Hurwicz and Shapiro (1978) and Shetty (1988)—are very different in other respects, but they share as their driving force the idea that there are wealth or income constraints on the tenant. This is certainly realistic. What it does is rule out fixed-rent contracts for tenants who are sufficiently constrained. Share contracts then play a role.

The Hurwicz–Shapiro framework is, in fact, very different from the other models in this section. There is no uncertainty in production, so risk is not a factor. A single landlord deals with a tenant whose disutility of effort is unobservable.[45] Hence, if Q is output, $Y(Q)$ the tenant's income as a function of output, and d the disutility of producing that output, the tenant's ''indirect'' utility function is of the form

$Y(Q) - d(Q;k)$

where k is some real-valued parameter known to the tenant but not to the landlord. For example, d may be quadratic, of the form

$$d(Q;k) = kQ^2. \tag{20}$$

The results of the published paper are for this case, but they are derived for any positive d with $d', d'' > 0, d''' \geq 0$ in unpublished work (Hurwicz and Shapiro 1977). Note that the so-called indirect utility function is obtained simply by inverting the production function $Q = Q(L)$, and substituting for labour L in the utility function. The landlord's payoff is $Q - Y(Q)$, so is also linear in income. The constraint on the tenant's reward function is that his income cannot be negative, so $Y(0) = 0$, $Y(Q) \geq 0$. This is what rules out a fixed-rent contract, since then $Y(Q) = Q - R$ is negative for $Q < R$, which will occur for some k.

It should be noted at this point that Hurwicz and Shapiro do not stress this feature or interpretation of the constraint on the tenant's reward function. However, if this constraint were not there, the asymmetric information would not matter since the landlord could attain efficiency by a fixed-rent contract. This has been pointed out by Allen (1985a).

A major departure from the usual literature in Hurwicz and Shapiro is in the objective of the landlord faced with incomplete information. He does not maximize expected utility in a Bayesian manner. Instead, he is assumed to minimize "regret." In this formulation, this amounts to choosing $Y(Q)$ to maximize

$$\min_k \{\pi(Y,k)/\hat{\pi}(k)\} \tag{21}$$

where $\hat{\pi}(k)$ is the best payoff for the landlord if he has complete information (essentially, the total surplus), and $\pi(Y,k)$ is his payoff given the payment rule $Y(Q)$ and parameter k, determined by the tenant maximizing $Y(Q) - d(Q;k)$ with respect to Q. The lower the ratio $\pi/\hat{\pi}$, the greater the landlord's "regret." Since he does not observe k, he chooses $Y(Q)$ to minimize the regret in the worst possible case, which is given by the minimum over k.

Hurwicz and Shapiro proceed to show, without further restrictions on $Y(Q)$,[46] that the unique solution is $Y(Q) = \frac{1}{2}Q$, i.e. a share contract with a 50–50 split! The proof of this result is long and involved, and the intuition is not obvious. Clearly, it depends on the special objective function of the landlord. Also, it depends on disutility of producing higher outputs increasing fast enough. A very rough explanation of the result is that the landlord is constrained to a linear payment rule by his lack of information plus his desire to avoid the worst. The share of one-half is not general, in fact, since if the tenant's utility of income is concave the landlord's optimal share is three-fourths.

To some extent, then, this model remains a curiosity, but it suggests an interesting alternative to dealing with situations of incomplete information, and, like Holmstrom and Milgrom's work, leads to linear sharing rules in a natural manner.

Shetty's (1988) model is along more familiar lines. His main goal is to provide an explanation for the tenancy ladder hypothesis.[47] He does this by showing that, in a model where tenants vary in wealth, where this wealth can be collateral for amounts due as rent, and where default on fixed-rent commitments is possible, richer tenants will get fixed-rent contracts and earn higher profits than poorer tenants who get share contracts.

The formal model involves risk-neutral landlords and tenants, so risk-sharing and insurance do not matter. Hence, if a tenant's wealth is enough to cover fixed-rent commitments even if output is low, he will get a fixed-rent contract. This is preferable to other contracts because effort cannot be observed, and only a fixed-rent contract provides efficient incentives for labour input. Neglecting other inputs,[48] and using the notation from the first model presented in this section, the nominal payment the tenant receives or retains is $\alpha\theta Q(L) + C$. However, this cannot be less than the negative of this wealth, W. Hence the tenant's effective income is

$$\max\{\alpha\theta Q(L) + C, -W\}. \tag{22}$$

In words, if $\alpha\theta Q(L) + C$ is negative, the tenant draws on his assets to pay the landlord. He can do this until the lower bound $-W$ is reached. Similarly, the landlord's effective income is

$$\min\{(1-\alpha)\theta Q(L) - C, \theta Q(L) + W\}. \tag{23}$$

It is easily seen that the total is always $\theta Q(L)$, the actual output. The effect of the possibility that the tenant cannot fully meet his obligations is that each party's income is no longer linear in output, but only piecewise linear. In fact, the tenant's return is convex and that of the landlord is concave.

As in the first model of this section, the landlord chooses α and C to maximize his expected income, given the tenant's utility-maximizing choice of labour input. (There is disutility of effort, as usual.) Shetty actually considers potential tenants with different wealth levels and identical reservation utilities. Wealth is observable, and landlords compete for wealthier tenants, whose expected return is higher. There is one plot per landlord, and plot size is fixed. Hence, while the tenant of marginal wealth level who is hired gets his reservation utility, the expected income of landlords from wealthier tenants is equated to that from poorer tenants. One may simply write this formally as maximizing the tenant's expected utility with respect to α and C subject to the constraints of the landlord's competitive expected income and the tenant's choice of labour input, the latter given the contract terms. The solution is mathematically similar. Of course, if W is high enough, then, as Shetty shows, fixed-rent contracts will be used; i.e., $\alpha = 1$, $R = -C < W$. In this case the bite of the incentive constraint is removed, and the efficient outcome is reached. If wealth is below the critical value, Shetty argues that sharecropping will emerge. The argument is that the optimal contract in this case will not simply involve reducing the fixed-rent payment, since a contract that involves no default can be improved on by a contract that involves increasing α and reducing C. (Note: C is negative if there is a fixed payment to the landlord.) Hence the optimal contracts for poorer tenants will involve default. Shetty also shows that the level of θ, say θ_1, at which the tenant cannot make the agreed-on payment, $(1-\alpha)\theta Q - C$, to the landlord is decreasing in wealth.

While this reasoning establishes that a fixed-rent contract will not be used for tenants below a certain wealth level, it does not demonstrate that the actual contract will be a share contract, i.e. with α between 0 and 1.[49] To show this, consider the landlord's choice of contract, subject to providing the tenant with utility K^*—which, owing to competition for tenants, will be above reservation utility K for tenants with more wealth than the marginal tenant—and the tenant's labour input decision. This problem is

$$\max_{\alpha, C, L} \; E\{(1-\alpha)\theta Q(L) - C|\theta \geq \theta_1\} + E\{\theta Q(L) + W|\theta < \theta_1\}$$

$$\text{s.t.} \quad E\{\alpha\theta Q(L) + C|\theta \geq \theta_1\} + E(-W|\theta < \theta_1) - L = K^*$$

$$E\{\alpha\theta Q'(L)|\theta \geq \theta_1\} - 1 = 0. \tag{24}$$

Now, as in the initial analysis of this section, the constraints may be solved for $L(\alpha), C(\alpha)$, which can then be substituted in the landlord's objective function. His first-order condition is thus

$$\{-Q + (1-\alpha)Q'L_\alpha\}E(\theta|\theta \geq \theta_1) - C_\alpha E(1|\theta \geq \theta_1) + Q'L_\alpha E(\theta|\theta < \theta_1) = 0.^{50} \tag{25}$$

Now from the tenant's utility constraint, and using his first-order condition for labour input,

$$E\{\theta Q(L) + C_\alpha|\theta \geq \theta_1\} = 0. \tag{26}$$

Substituting in (29) and using $E(\theta) = 1$, the landlord's choice of α is given by

$$Q'(L)L_\alpha\{1 - \alpha E(\theta|\theta \geq \theta_1)\} = 0. \tag{27}$$

But the first two terms are non-zero. Hence

$$\alpha = 1/E(\theta|\theta \geq \theta_1). \tag{28}$$

Since the denominator is greater than $E(\theta) = 1$,[51] the optimal α is less than 1. Hence we do have a share contract.

Thus Shetty's model predicts that poorer tenants who may default will receive share contracts. This is established in a model with wealth constraints and heterogeneous (in terms of wealth) tenants—both realistic assumptions—and with a characterization of the monopolistically competitive equilibrium. All of these are useful features.

I shall conclude this section with a discussion of costly monitoring of labour input. In all the models considered here, with the exception of Eswaran and Kotwal, it was assumed that the incentive problem arose from the non-observability of labour. One might interpret this as approximating the case where actually supervising the tenant's labour input is totally uneconomical. It is interesting to examine the implications of monitoring that is costly but worthwhile undertaking. This is because several analyses (e.g. Lucas 1979 and Alston, Datta, and Nugent 1984) have tried to provide explanations of sharecropping based on such costly monitoring. In essence, one might argue that the incentive problem is not fundamentally different if monitoring is imperfect, that is, if the landlord through his effort cannot tell precisely what the tenant or worker's effort is, but can only get a better estimate of that effort. This argument seems basically sound.

The focus here is therefore on the proper modelling of monitoring technology and costs.

The general approach to monitoring in moral hazard situations is that the landlord observes some noisy signal of the tenant's or worker's effort. Such a signal is in general informative—in fact, output itself can be thought of in this way—and the payment rule will be based on it.[52] Of course, when the landlord has this extra information, the tenant will work harder in equilibrium. It is not obvious what might correspond to this in the real world. An example might be the landlord saying that the tenant has not worked very hard, and reducing the latter's share as punishment. I do not know if anything like this occurs in practice. The special case of perfect monitoring is perhaps easier to interpret. Then the landlord can exactly observe labour input. He specifies the efficient level in the contract, and if it is not provided he punishes the tenant somehow. Thus the contract payment depends on labour input as well as output. Here, of course, there is no incentive problem as such.[53] Note that a risk-averse worker will receive a fixed wage, provided he supplies the agreed-upon labour input—any other contract imposes risk. In the literature on sharecropping, the assumption of perfect monitoring is therefore not made, since it would either do away with the rationale for share contracts, if worthwhile, or be irrelevant if uneconomical. However, the models I am aware of do not treat imperfect monitoring as the observation of an additional noisy signal, perhaps because of the lack of evidence that contracts are written this way. Instead, it is usually assumed that the worker or tenant supplies more effort the more he is monitored. For example, the Eswaran–Kotwal formulation was $E = E(S, L)$. Lucas (1979) has a similar formulation except that labour time and effort are not distinguished, so $L = L(S)$, and only fixed-wage workers are monitored. The problem with such a treatment is as follows. Suppose that supervision of amount S leads to a noisy signal $\tilde{L}$ of true labour input L. S determines the precision of $\tilde{L}$. Then in general the worker or tenant's payment should be $Y(Q, \tilde{L}; S)$, where S will affect the choice of the function Y since it affects the value of $\tilde{L}$ as a variable for determining payment. For example, a linear payment rule might be $\alpha Q + \beta\tilde{L} + C$, where α, β, and C depend on S, for a given S. Now given α, b, C, the tenant chooses his labour input L. This depends on S, but through the contract form rather than exogenously. In summary, how supervision or monitoring affects labour input depends on the rewards and penalties attached to the results of supervision: these are endogenous, so the relationship between monitoring and effort is endogenous. Hence there is a problem with the Eswaran–Kotwal and Lucas specifications. Note that the above model is completed by the landlord choosing α, β, C, and S, taking into account the tenant or worker's optimal response. The optimal S will depend on costs of supervision, which may be low if the landlord is supplying managerial input as well.[54]

Alston, Datta, and Nugent avoid some of the above problems. They allow for probabilistic detection of "shirking," that is, underprovision of contracted labour by the landlord, although this is well defined only for wage labour, since the sharecropper in their model does not contract the amount of labour.[55] The probability is essentially that of paying a fine or penalty. The less the labour input, the higher this probability. The penalties, however, are not optimally determined by the landlord, but are exogenously given functions. For wage contracts the penalty is assumed to increase with the extent of shirking. Similarly, for share contracts the penalty is assumed to decrease as effort increases. There is a logical problem here as well, since, even if penalties are exogenous, if the landlord knows what penalty to impose he must know how much labour input was supplied, but this contradicts the original notion of probabilistic detection.

The above model also has another difficulty, shared by that of Lucas. These analyses assume that monitoring cost functions differ for different types of contracts. However, they do not allow for any differences in production technology or inputs that might explain such differences. The example of a landlord supplying managerial inputs and therefore having lower monitoring costs was noted above. If the production technology is the same, then what differs from contract to contract are the benefits of monitoring, not the cost function. For example, a landlord who gives a tenant a fixed-rent contract could equally monitor him as well as a sharecropper. However, there is no benefit to supervising the former, while it pays to check on the share tenant. If the landlord supplies implements or bullocks to the sharecropper, he will also incur the cost of monitoring their use to prevent abuse. Again, however, this is not a difference in cost functions: the landlord could monitor the tenant's use of his own implements, but he gains nothing from doing so—it is the benefits that differ. As a modelling strategy, therefore, it seems to make better sense to specify a cost function for monitoring that does not exogenously depend on the form of contract. The equilibrium amount of monitoring, its cost, and the nature of the contract are all simultaneously determined.

This concludes the section on incentives. It seems that there are several avenues for fruitful theoretical research. First, there is the application of the dynamic model of Holmstrom and Milgrom. Second, further work should be done on the nature of equilibrium when the landlord contributes non-marketable inputs. Finally, monitoring, which is empirically important in share contracts, remains to be properly integrated into incentive models.

5 Sharecropping and Screening

The basic idea behind this explanation is that the landlord cannot directly observe some characteristic of potential tenants that affects productivity, such as entrepreneurial or other ability. Then, by offering a menu of contracts, including share contracts, the landlord can get individuals of different ability to select different contracts. Tenants are thus "screened" according to ability. In general, someone—landlord or tenant, depending on market structure—will be better off than if only wage and fixed-rent contracts were available. Note that the lowest-ability individuals might not receive a contract at all—they might be screened out of the market.

The screening model has several attractive features in terms of the stylized facts. First, it explains the coexistence of sharecropping with fixed-rent and wage contracts. Second, it fits with the observation that share tenancy is often associated with lower productivity than fixed-rent tenancy (see e.g. Bell 1977), since the model predicts that the more able (and more productive) tenants will choose fixed-rent contracts and the less able will choose sharecropping. Third, and related to the second point, the model seems to agree with the agricultural ladder hypothesis, which is based on the observation that, as agricultural workers gain physical and human capital, they progress from wage labour to sharecropping, then to renting, and finally to owner-operation (see e.g. Spillman 1919, and Cox 1944).

Hallagan (1978) and Newbery and Stiglitz (1979) independently introduced similar models of screening or self-selection by contractual choice.[56] Critiques were provided by Allen (1982) and Basu (1982). Based on his critique, Allen (1982) extended the basic model to allow for heterogenous landlords. Finally, Allen (1985a) provided a rather different screening model, which was distinguished by having default possibilities and more than one time-period. I shall begin by presenting a version of Hallagan's model and shall then discuss the critiques of Basu and Allen. Next, I shall do the same with Newbery and Stiglitz's analysis. Finally, I shall present and discuss Allen's work.

Hallagan (1978) does not construct a formal model, but what follows captures the essential features of his argument. We initially assume that there is a single landlord with two identical plots of land. He chooses not to, or is constrained not to, cultivate them himself. There are several potential tenants, of whom one has higher ability than the rest. However, one person can just manage a single plot by himself, so the landlord must give his plots to two different tenants. He would like one to be the high-ability person, who has a higher productivity. To abstract from risk-sharing effects, all individuals are assumed to be risk-neutral. Hence, while there is uncertainty in production, this need not be treated explicitly, since only expected values matter. Also, incentive considerations are mostly avoided, although we appeal to them to avoid indeterminacy of the contractual form in some instances. Hence input choices need not be treated explicitly. Finally, there are no binding wealth constraints, so, for example, a tenant can always make the payment specified by a fixed-rent contract. Reviewing the above assumptions, we may note that the other major explanations of sharecropping—risk-sharing, incentives and input provision, and wealth constraints—have been ruled out so that we may concentrate on the screening explanation.

We now begin with the formal model. Each potential tenant, including the high-ability person, has a reservation expected income of $\bar{Y}$. Thus, implicitly, the high-ability person's skills are specific to tenant farming. This is not essential, as I shall point out below. The high-ability individual's expected output from farming is Q_1, while that of any of the low-ability individuals is Q_2, $Q_2 < Q_1$. The actual outputs are $\tilde{Q}_1, \tilde{Q}_2$ because of uncertainty: this means that ability cannot be deduced from actual output. We assume that disutility of labour is the same in tenant farming and the best alternative occupation, and that there are no other inputs. Hence a tenancy contract will be acceptable if it provides expected income $Y(Q_i) \geq \bar{Y}$. We assume that if this holds with equality, the tenancy is chosen. Also, we assume that $Q_i > \bar{Y}$, so that farming is worthwhile.

Initially, suppose that the landlord knows everyone's ability. Acting as a monopolist, he will charge a rent R_i such that $Q_i - R_i = \bar{Y}$, and his expected income will be $Q_1 + Q_2 - 2\bar{Y}$. Note that there is an indeterminacy, in that sharecropping contracts would also suffice. If α_i is the tenant's share, the landlord can set α_i such that $\alpha_i Q_i = \bar{Y}$, and achieve the same expected income. Hence we assume that there is some incentive effect, enough to ensure that the fixed rent contracts are better.

Now suppose that the landlord cannot observe anyone's ability. Also, because of the uncertainty in production, he cannot infer ability from actual output. Then he cannot discriminate as above, where he charges $R_1 > R_2$ to the more able tenant, because the latter would always claim to be of lower ability and ask for the lower rent. On the other hand, charging R_1 will attract only the more able tenant and the other plot will go unrented. Below it is demonstrated that the landlord can do better than collecting $R_1 = Q_1 - \bar{Y}$, or $2R_2 = 2Q_2 - 2\bar{Y}$, by offering a choice of a fixed-rent and a share contract: the more able individual will prefer the fixed-rent contract, and will choose it, while the less able individuals will prefer the share contract, and one of them will become a sharecropper.

Let the contract menu be (R_s, α_s), where 's' stands for screening. Then, for the above contract selection to occur, it must be true that

$$Q_1 - R_s \geq \alpha_s Q_1, \tag{29}$$

$$\alpha_s Q_2 \geq Q_2 - R_s. \tag{30}$$

These are known in the literature as the self-selection or incentive compatibility constraints. The first inequality says that the more able person prefers the fixed-rent contract, the second that the less able person prefers the share contract. The inequalities may be rearranged slightly to give

$$(1 - \alpha_s)Q_1 \geq R_s \tag{31}$$

and

$$(1 - \alpha_s)Q_2 \leq R_s. \tag{32}$$

Hence we see that the two inequalities are compatible, since $Q_1 > Q_2$. This would not be the case if they were reversed: it cannot be that the more able person prefers the share contract and the less able one the fixed-rent contract.

Now, assuming that the landlord rents both plots, he chooses (R_s, α_s) to maximize his expected income,

$$R_s + (1 - \alpha_s)Q_2,$$

subject to the self-selection constraints above, and the contract acceptance constraints

$$Q_1 - R_s \geq \bar{Y} \tag{33}$$

and

$$\alpha_s Q_2 \geq \bar{Y}. \tag{34}$$

Since both self-selection constraints cannot be simultaneously binding, we consider each possibility in turn. If that for the more able person is binding, $R_s = (1 - \alpha_s)Q_1$, and the landlord's expected income is $(1 - \alpha_s)(Q_1 + Q_2)$. This is maximized by setting α_s as small as possible, i.e. $\alpha_s = \bar{Y}/Q_2$, so that the less able person will just accept the share contract. Note that then $Q_1 - R_s = \alpha_s Q_1 > \bar{Y}$, so that the more able person is better off than with his alternative. The landlord's expected income is

$$(1 - \bar{Y}/Q_2)(Q_1 + Q_2) = Q_1 - \bar{Y}Q_1/Q_2 + Q_2 - \bar{Y}. \tag{35}$$

If, on the other hand, the less able person is indifferent between the two contracts, then $R_s = (1 - \alpha_s)Q_2$; but α_s must be the same, from the acceptance constraints, so that the landlord's expected income is $2Q_2 - 2\bar{Y}$, which is lower. Hence the first possibility is better. In fact, this is a special case of a more general result (see, e.g. Cooper 1984 for a good exposition) that the self-selection constraint will be binding on the person who has an incentive to pretend to be someone else: we noted above that the more able person would claim to be less able, faced with rental contracts (R_1, R_2). This is demonstrated here to elucidate the workings of the model.

It remains to check that the screening contract is better for the landlord than the alternatives. Clearly, it is better than charging R_2 to each tenant, since $2R_2 = 2Q_2 - 2\bar{Y}$. It is better than just collecting $R_1 = Q_1 - \bar{Y}$ from the more able tenant if

$$Q_2 - \bar{Y}Q_1/Q_2 > 0 \tag{36}$$

or

$$Q_2/\bar{Y} > Q_1/Q_2. \tag{37}$$

This condition is violated if the more able person is much more productive than the others. In that case, the equilibrium still involves screening, since individuals of different ability are distinguished *ex post*, but there is no role for sharecropping. Instead, there is adverse selection: the lower-ability individuals are shut out of the tenancy market. If the last inequality is satisfied, however, the equilibrium involves screening, with an essential role for share contracts in that process.

The above model involves one important simplification from Hallagan's argument: wage contracts are neglected. This was done for expositional convenience and does not alter the fundamental structure of the screening model, or sharecropping's role in it. I next describe what happens when wage contracts are allowed.

We may introduce wage contracts indirectly. In the above model, suppose that the share contract also has a fixed side-payment, C, so that the share tenant receives $\alpha_s \tilde{Q}_2 + C$. Then it turns out to be optimal for the landlord to set $\alpha_s = 0$ and $C = \bar{Y}$, that is, to offer a fixed-wage contract. Screening thus is achieved by offering a choice between a fixed-rent and a fixed-wage contract. However, sharecropping in general has a role if there are three or more types of potential tenants, for then wage and rent contracts together will not suffice for complete screening. If that is optimal for the landlord, he will use share contracts as well. The formal model for three or more types is similar to the above two-ability model. If there are n ability levels, there will be $n(n-1)$ self-selection constraints, but at most $n-1$ will be binding in equilibrium: each ability level will be indifferent between that individual's contract and the one chosen by those in the next lowest ability level. The most able and least able individuals will choose rent and wage contracts respectively, and those in between will choose different share contracts, distinguished by different share and side-payment combinations. I shall not present the general model here, since it adds no new insights. Instead, I turn to Basu's critique of Hallagan's screening model.

Basu allows for competition among landlords, and this destroys the screening result in Hallagan's model. Note that this is not perfect competition in the sense of price-taking behaviour: instead, it is monopolistic competition. In terms of the simplified two-ability model presented above, suppose there are two landlords. Then the equilibrium cannot be the screening equilibrium, since there the landlord renting to the high-ability persons earns more on that plot of land. With more than one landlord, they will bid up the "price" of the high-ability person so that the return on any plot of land is the same, namely, $Q_2 - \bar{Y}$, the return from renting to the less able person. Hence $R = Q_2 - \bar{Y}$ for the more able tenant. But this is exactly what the less able tenant pays in expected terms with a share contract $\alpha = \bar{Y}/Q_2$, so he might as well receive a fixed-rent contract. The same argument applies to a situation with many landlords, many potential tenants, and more than two ability levels: equilibrium will involve all tenants receiving fixed-rent contracts, and landlords getting a rent equal to the expected surplus of the tenant of marginal ability. There is no screening and no role for share contracts.

Allen (1982) makes a similar point to Basu. He introduces competition as price-taking behaviour. He allows plot size to vary, which is not strictly in Hallagan's model. He also assumes a competitive market for labour. He then argues, as a special case of the general result, that competitive equilibrium is Pareto-efficient; in the equilibrium individuals will hire land and labour in or out so that the standard marginal conditions are satisfied. Hence there is no role for share contracts since fixed-rent contracts achieve efficiency. The crux of the argument is that incomplete information about ability does not matter, since each person as producer knows his own ability and will make efficient input decisions based on that knowledge.[57] Hence there is no role for screening. While Allen's formulation is more general in allowing for variable amounts of land and labour, the assumption of price-taking behaviour by all market participants seems unrealistic. The usual justification in terms of the limit of monopolistic competition or other strategic behaviour may not hold when there is asymmetric information. In any case, it is clear that the screening explanation needs a stronger basis than is provided by Hallagan.

Newbery and Stiglitz (1979) independently suggested screening as a rationale for sharecropping. Their model is more general, in that they also allow for the landlord to vary the plot size. This turns out to be a crucial feature if sharecropping is to serve a screening function when there is some form of competition among landlords. Newbery and Stiglitz assume that ability multiplies labour effort in the production function, but this is inessential to their argument. I present a simplified version of their model, ignoring labour input, since it is fixed in their formulation, and concentrating on the case of two ability levels and a choice between fixed-rent and share contracts. Again, these simplifications are for expositional ease—the model is more general. I shall not present a full solution of the model, but instead shall focus on why the Newbery–Stiglitz formulation avoids some problems of Hallagan's model.

Let us assume that the production function form and amount of land are such that each landlord will want to have more than one tenant, and that there are more landlords than high-ability potential tenants. The typical higher-ability person's average production function is $Q_1(T)$, where T is the amount of land. The lower-ability person's average production function is $Q_2(T)$, with $Q_1(T) > Q_2(T)$ and $Q_1'(T) > Q_2'(T)$.[58] Furthermore, as usual $Q_i' > 0$ and $Q_i'' < 0, i = 1, 2$. Let r_i be the rental rate for a tenant of type i, and T_i be the amount of land he is given. Thus, the landlord with perfect information about potential tenants' abilities offers two different rental "packages," (r_1, T_1) and (r_2, T_2).[59] He seeks to maximize $r_1T_1 + r_2T_2$ subject to the availability of his land, $T_1 + T_2 = \bar{T}$,[60] and to the contract acceptance constraints of the tenants, which are

$$Q_1(T_1) - r_1T_1 \geq \bar{Y} \tag{38}$$

and

$$Q_2(T_2) - r_2T_2 \geq \bar{Y}. \tag{39}$$

It is easy to see that the solution will involve the landlord equating marginal products on the two plots, and setting rental rates so that each tenant gets just $\bar{Y}$.

Now suppose that there is competition among landlords.[61] Then this will force the return per acre, that is the rental rate, on all land to be the same.[62] Hence any landlord is restricted to offering contracts (r, T_1) and (r, T_2). In this case, both acceptance constraints may or may not be binding at the equilibrium,[63] depending on the precise form of the production functions.[64] Now if the landlord does not observe potential tenants' abilities, he still may offer contracts of the above form, and it is possible that each type will prefer a different contract. However, the landlord can do better by offering a fixed-rent and a share contract, as I now demonstrate.

Suppose that the typical landlord offers contracts (r, T_1) and (α, T_2). The self-selection constraints are

$$Q_1(T_1) - rT_1 \geq \alpha Q_1(T_2) \tag{40}$$

and

$$\alpha Q_2(T_2) \geq Q_2(T_1) - rT_1. \tag{41}$$

Competitive behaviour by landlords requires that

$$r = (1 - \alpha)Q_2(T_2)/T_2,^{65} \tag{42}$$

so that the return per acre from each contract is equalized. This is equivalent to

$$rT_2 = (1 - \alpha)Q_2(T_2). \tag{43}$$

Hence

$$rT_2 < (1 - \alpha)Q_1(T_2), \tag{44}$$

so that

$$\alpha Q_1(T_2) < Q_1(T_2) - rT_2. \tag{45}$$

If the self-selection constraint for the higher-ability tenant is binding in equilibrium, it follows that

$$Q_1(T_1) - rT_1 < Q_1(T_2) - rT_2. \tag{46}$$

In words, the self-selection constraint would be violated by the pair of rental contracts $(r, T_1), (r, T_2)$. What I have shown is that, while screening could be accomplished by offering a choice of two rental contracts, it can be done more effectively from the landlord's perspective by offering a choice between a fixed-rent and a share contract. And screening is possible even with competition, as long as the landlord has an additional dimension of control, namely the size of the plot to be rented.

The above formulation allows landlords to choose contract parameters subject to contract acceptance and the equalizing effect of competition among landlords for high-ability tenants. This is not competition in the sense of price-taking behaviour. Allen's (1982) critique of screening in Hallagan's model based on price-taking behaviour in all markets applies equally to the Newbery–Stiglitz model *if* price-taking behaviour is assumed in the latter as well. The equilibrium is then Pareto-efficient, and there is no role for share contracts or for screening. However, as argued in Section 2, this seems unrealistic.

Next we examine some flaws of the above models as explanations of sharecropping. One seemingly attractive feature of these screening models, as noted in the beginning of this section, is that they are consistent with the agricultural ladder hypothesis. However, as Basu points out, Spillman's version of this is quite different, being "a rather Shakespearean account of the stages of a farmer's life. It focuses more on the development of farmer's skills over time than on inter-farmer differences in one situation." On the other hand, there is cross-sectional evidence of a similar pattern (e.g. Cox 1944, and Brown and Atkinson 1981), which one might also call an agricultural ladder.

A more telling criticism does emerge from a consideration of what happens over time. In screening models, ability or land quality is generally revealed sooner or later, through self-selection of contract terms. In the real world, one would also expect such knowledge to be gained gradually by direct observation. Once this happens, screening is unnecessary and only wage and rent contracts are needed. Hence, the validity of such models in agricultural contexts where there is little in-migration and limited use of new techniques is questionable: one would expect abilities and land qualities to be well known. This seems to be the major problem with the above screening models.

Allen (1985a) presents an ingenious model that avoids the above strictures. His model predicts that share contracts will be used even after potential tenants are screened. Furthermore, only three types of contracts are used, although a continuum of ability levels is allowed for. While the possibility of default plays an essential role in this model, its interesting predictions depend on the initial lack of information about potential tenants' abilities, and the resulting screening. Hence we consider the model here, rather than in Section 3 or Section 6.

Allen's model assumes that there is a continuum of abilities, A, in the interval $[0, A_u]$. Everyone's labour supply is fixed. The production function for a person of ability A with land T is $AQ(T)$, where Q has the usual properties. Uncertainty is abstracted from, though we may think of AQ as expected output. Each person knows his own ability, but this cannot be known by anybody else until he has been seen to produce for one period. It will then be known to all the landlords in the locality. However, if the person moves, landlords elsewhere will again be initially unaware of his ability.

There is an infinite number of discrete production periods, and contracts are agreed on each period. However, at the end of each period, a tenant may choose to default on the agreed-upon payment to the landlord. He must then move to another place to avoid penalties. Initially, no moving costs are assumed, but this is not essential.

People are risk-neutral, and their utility of consumption is

$$U = \sum_{t=1}^{\infty} \delta^{t-1} c_t \tag{47}$$

where $\delta(<1)$ is the discount factor. There is no saving or wealth of tenants. Finally, it is necessary to assume that each period there is some exogenously determined turnover of population in any locality. This ensures that there are always people to be screened.

There are two stages of contracting. First, when ability is unobserved, the contract involves a payment R_s to the landlord for T_s units of land. Since landlords will offer a menu of such contracts for screening, we may think of R_s and T_s as functions of A. The landlord's opportunity cost of land is r per unit; hence it must be that

$$R_s(A) \geq rT_s(A). \tag{48}$$

With competition among landlords, this will hold with equality, and the tenant's (expected) utility,

$$AQ\{T_s(A)\} - R_s(A),$$

is maximized. Since ability is unknown, the menu of contracts must satisfy the self-selection constraints,

$$AQ\{T_s(A)\} - R_s(A) \geq AQ\{T_s(A')\} - R_s(A') \quad \text{for all } A, A'. \tag{49}$$

There are several other constraints. Potential tenants have opportunity cost W per period. If the contract when ability is known is $\{R(A), T(A)\}$, it must be true that

$$AQ\{T_s(A)\} - R_s(A) + \frac{\delta}{1-\delta}[AQ\{T(A)\} - R(A)] \geq \frac{W}{1-\delta}. \tag{50}$$

The left-hand side is the utility of tenancy, and the right-hand side is the utility of working elsewhere: these are calculated using equation (47). If this inequality is binding, it defines a marginal level of ability A_0: it turns out the tenancy contract will be accepted if and only if $A \geq A_0$. Next, suppose a person of ability A_0 receives just enough land to cover his opportunity cost if he undertakes the tenancy for one period, then defaults. Let this amount be $T_0(A_0)$, which is defined by

$$A_0 Q(T_0) = W. \tag{51}$$

To avoid this problem and consequent losses, the landlord is restricted to

$$T_s(A) \le T_0(A_0). \tag{52}$$

Also, obviously,

$$T_s(A) \ge 0. \tag{53}$$

Finally, for a contract to be enforceable in this model, it must be worthwhile for tenants to make the agreed-upon payment. The benefit of default, the screening period payment, must be less than the cost, the present value of the loss from being rescreened in another area. Thus we have the following constraint, which is essential to the model:

$$R_s(A) \le \delta\langle AQ\{T(A)\} - R(A) - [AQ\{T_s(A)\} - R_s(A)]\rangle. \tag{54}$$

Note that at the first stage $R(A)$, $T(A)$ are taken as given.

The second stage of contracting is when abilities are known. The contracts then solve the following problem, which is similar to the previous one with the constraints imposed by asymmetric information omitted:

$$\max_{R(A),T(A)} \quad AQ\{T(A)\} - R(A)$$

$$\text{s.t.} \qquad R(A) \ge rT(A),$$

$$R(A) \le \delta\langle AQ\{T(A)\} - R(A) - [AQ\{T_s(A)\} - R_s(A)]\rangle,$$

$$T(A) \ge 0, \tag{55}$$

with $R_s(A)$ and $T_s(A)$ being given.

I shall now outline the implications of this model. The complete solution is quite complicated (see Allen 1985a for details), but I can highlight some insights. First, in the screening period, the incentives of the marginal tenant of ability A_0 provide the binding constraint. To prevent this default, the screening contract must have $T_s(A) = T_0(A_0)$. Also, competition among landlords ensures that $R_s(A) = rT_s(A)$. Hence the equilibrium contract is

$$\left.\begin{aligned} R_s(A) &= rT_0(A_0) \\ T_s(A) &= T_0(A_0), \end{aligned}\right\} \tag{56}$$

so every tenant gets the same contract in the screening period. Note that ability subsequently becomes known not through self-selection of contracts, since there is only one, but through direct observation.

In the subsequent periods, if the default constraint in (55) does not bind for a tenant, it must be that $R(A)$, $T(A)$ maximizes $AQ(T) - rT$, since $R(A) = rT(A)$. But this implies that the marginal product of land is equated to its opportunity cost. Hence this is a standard fixed-rent contract: the landlord could equivalently allow the tenant to select T given the rental rate r. On the other hand, if the default constraint binds, it determines the amount of land offered, which will be such that the marginal product at that value exceeds the "rental rate" r: hence this cannot be interpreted as a fixed-rent contract. Let the equilibrium amount of land in this case be $T^*(A, A_0)$—it depends on A_0 through the influence of the screening contract on the default constraint. Then the corresponding equilibrium payment is

$$R(A) = \frac{\delta}{1+\delta} AQ\{T^*(A, A_0)\} - C \tag{57}$$

where

$$C = \frac{\delta}{1+\delta} [AQ\{T_0(A_0)\} - rT_0(A_0). \tag{58}$$

Hence the contract for such tenants is a share contract with an associated side-payment to the tenant.

The question remains as to when the default constraint is binding. Allen provides an example with a quadratic production function, where the lowest-ability persons do not become tenants, those of middle ability become sharecroppers, and those of high ability get fixed-rent contracts. However, as he demonstrates, in general this need not be true, in that, while the lowest two groups are always non-tenants and sharecroppers respectively, thereafter there may be alternating groups who get share and fixed-rent contracts: hence there is no obvious "ladder." Furthermore, for the production function $Q = \sqrt{T}$, no fixed-rent contracts will be used.

Finally, Allen argues convincingly that the introduction of uncertainty, risk aversion, variations in technology across regions, or moving costs[66] does not substantively change the predictions of the model.

I shall now evaluate this framework. As noted, the model predicts that sharecropping will be used even after tenants are screened.

This is because there is the possibility of default. On the other hand, default is constrained by the cost of being rescreened elsewhere. Hence, in Allen's model, sharecropping persists, unlike the previous self-selection models. Second, while there are potentially many ability levels, all share contracts are predicted to involve a share $\delta/(1+\delta)$. This deals with the problem in other models of "too many share contracts." There are additional attractive features. First, the predicted share is close to one-half for reasonable values of the discount factor; for example, $\delta = 0.9$ implies a share of 0.47. Second, since the model relies on the absence of direct enforcement mechanisms such as saving and the use of collateral, their introduction in the course of economic development would explain a concurrent decline in share tenancy.

There remain some shortcomings, of course. The model still predicts a continuum of different side-payments. Furthermore, as noted, for plausible production functions it predicts no use of fixed-rent contracts. Finally, it does not give clear-cut predictions about the variation of contract type with ability. However, overall, it does seem that Allen's work focuses on some important features of the institutional setup in less developed agriculture, and provides extremely useful insights into the role of sharecropping.

6 Sharecropping and Cost-sharing

Input cost-sharing is a common arrangement in share contracts.[67] If sharecropping exists for reasons such as risk-sharing, incentive provision, or screening, cost-sharing might be a convenient way of ensuring that such inputs are used at efficient levels by the tenant, even if the landlord could directly specify input levels. In a simple model, if the cost share is set equal to the output share, then the use of the input will satisfy the usual condition that marginal (value) product equals price.[68] Although the tenant receives only a fraction of the product, he pays only the same fraction of the cost. An argument that runs in the other direction, from cost-sharing to sharecropping, is less obvious. This is made by Jaynes (1982, 1984) and is based on imperfections in the market for the shared input, which is interpreted as capital. I shall now discuss this model as a rationale for share contracts.

The formal model has no uncertainty in it. The production function is thus $Q(L, T, I)$, where L and T are labour and land, as before, and I is some other input such as fertilizer or seeds. The price of I is p. The tenant's output share is α, and his cost share is β. There is a fixed payment of C, and his wealth is W. Hence his utility is

$$U(\alpha Q + W - \beta pI + C, L), \tag{59}$$

which is increasing in the first argument, income, and decreasing in the second argument, labour input. The tenant is assumed to choose I independently. Hence his input choice satisfies

$$\alpha Q_I - \beta p = 0. \tag{60}$$

Jaynes's justification for this is that the tenant cannot be forced to contribute more or less capital to the productive venture than he deems optimal. The landlord is assumed to maximize his utility, which is linear in income, subject to (60), and to providing the tenant with his reservation utility level, $K(W)$. The landlord's income is

$$(1 - \alpha)Q(L, T, I) - (1 - \beta)pI - C - rT.$$

Here r is the opportunity cost of land. The landlord's choice variables are α, β, C, L, and T (and, notionally, I as well).

Jaynes also allows for monitoring costs, but this is not essential. His main point is that the cost-sharing, captured by $\beta < 1$, potentially occurs because the landlord does not have enough capital himself, and hence seeks households with sufficient wealth. Jaynes shows that at the landlord's optimum $\alpha = \beta$, and hence there is output-sharing if there is cost-sharing. Cost-sharing emerges because the landlord is implicitly capital-considered and the tenant is explicitly so constrained as well.

Jaynes also addresses the question of why landlords do not offer fixed-rent contracts. He says that in that case the landlord would still have to provide some credit to the tenant. This would have to earn the landlord its opportunity cost, and the tenant would get only the return to his own labour, reducing him to a wage labourer. However, the last two clauses do *not* follow. If the tenant is still providing some capital of his own, he would get some return on that. In any case, if the landlord is capital-constrained and has to compete for wealthier tenants, such tenants should be able to earn the same with fixed-rent contracts as with Jaynes's sharecropping–cost-sharing solution. With fixed-rent contracts, the landlord would simply make a lump-sum loan, rather than subsidizing the input at the margin. Provided the tenant can borrow enough, B, from the landlord so that $pI \leq W + B$

when $Q_I = p$, the optimum can be achieved. If B is not large enough, then the landlord will also not be able to provide enough of a subsidy through cost-sharing to ensure $Q_I = p$. To summarize, the efficient solution can be achieved in Jaynes's model with fixed-rent contracts and without cost-sharing, but with a production loan from the landlord.

Several other points are worth noting. First, if, unlike in Jaynes's model, labour input cannot be determined by the landlord, a fixed-rent contract has the advantage of providing efficient incentives for labour input. Second, fixed-rent contracts may no longer be optimal if there is uncertainty and the tenant is risk-averse, but then, it is sharecropping that leads to cost-sharing, rather than the other way around. Third, Jaynes's justification for the tenant independently choosing the level of input I seems weak. If the landlord can observe and enforce the level of input I, he might as well do so. (He has monopolistic power in choosing all other variables, subject to attracting the tenant.) On the other hand, if he cannot observe the level of input I, then he cannot sensibly agree to provide a fraction of the cost. In fact, Bardhan and Singh (1982, 1987)[69] have shown that in this case an attempt at cost-sharing at the margin will not necessarily have the desired effect. This seeming problem with justifying cost-sharing itself—either it is unnecessary or it does not have the desired effect—is carefully dealt with by Braverman and Stiglitz (1986a). They show that, if the tenant's input decision is made after he obtains additional private information about productivity, the landlord will prefer cost-sharing to specifying the input level. This is because cost-sharing delegates the input decision to the person with better information. Note that in general, $\alpha \neq \beta$ in this model. Furthermore, if there is no incentive problem and no uncertainty, the optimal contract involves a fixed rent and no cost-sharing at the margin—the landlord may simply make a lump-sum production loan. This is because the tenant will then make fully efficient decisions. Hence it is incentives and uncertainty that drive the result that share contracts will be used, and cost-sharing follows from that.

I conclude this section, therefore, by stating that it seems that, while capital constraints and cost-sharing are important and can both be usefully incorporated into models of sharecropping, they do not explain the institution itself. At best, we can say that both sharecropping and cost-sharing are the result of uncertainty and asymmetries in information.

7 Conclusion

I have already offered something of a conclusion in the introduction: sharecropping is a diverse phenomenon, and explanations of sharecropping are necessarily going to be diverse. The common theme, however, is, that sharecropping is a response to uncertainty and asymmetries in information. One may also view it as a response to different types of market failure, in labour, insurance, credit, and capital markets. Typically, however, these market failures can be traced back to imperfect or incomplete information as the cause. It does not follow, though, that institutions such as sharecropping will lead to outcomes that are efficient relative to the structure of information. While this may be the case, often there will be general equilibrium distortions that can be corrected by government tax and subsidy policies that are also constrained by available information, and hence are strictly feasible. Briefly, this is because, in a many-commodity, second-best world, taxes or subsidies on observable commodities can favourably affect choices of unobservables such as labour input—pecuniary externalities matter. This is an issue that has been treated by Arnott and Stiglitz in several papers (1984, 1985, 1986). This is aside from gains that might be made by improving the information structure (e.g. accreditation, licensing) and thereby mitigating market imperfections. Hence there are two general sorts of policies that might usefully be pursued in the context of agriculture with sharecropping. The detailed policy implications of the models considered above seem well worth pursuing—but in another place.

Notes

1. The classical and neoclassical literature starts with Smith (1776), and includes Young (1788), Sismondi (1818), Jones (1831), Mill (1848), and Marshall (1920). Historical studies include Alston (1981), Alston and Higgs (1982), H. Higgs (1894), R. Higgs (1974), Reid (1975), Winters (1974), and Wright (1978).

2. Descriptive and empirical studies include Ahmed (1974), Bardhan (1977, 1984), Bell (1977), Bliss and Stern (1982), Hendry (1960), Huang (1971, 1975), Issawi (1957), Johnson (1971), Jodha (1984), Pant (1983), Rao (1971), Roumasset (1984), Roumasset and James (1979), Ruttan (1966), and Shaban (1987). An interesting collection of studies is in Byres (1983), and an excellent recent work is that of Robertson (1987).

3. For example, I touch on some of the ''neglected themes'' mentioned by Binswanger and Rosenzweig.

4. Binswanger's and Rosenzweig's Figure 1–2 (1984) provides a schematic representation of the kind of classification I have provided, though it is not identical.

5. See, for example, Reid (1976), Lucas (1979), Bell and Braverman (1981), Quibria (1982), Alston, Datta, and Nugent (1984), and Quibria and Rashid (1984). A good basic survey is in Bliss and Stern (1982).

6. There are parallel problems or paradoxes as well in terms of the landlord's decisions. See Lucas (1979) and Bell and Braverman (1981). Also see the discussion of Jaynes below.

7. See Section 6 on sharecropping and cost-sharing.

8. They assume that only a single share contract, specifying α, is available. In their model, the tenant faces some exogenous expected penalty that is inversely related to the labour-land ratio. This places a constraint on his demand for land. The landlord, on the other hand, is constrained in a different manner. In the Jaynes model, if faced with a given share, the landlord would wish to always increase the labour-land ratio, unless the marginal product of labour falls to zero. Here, instead, the landlord assumes that however much land he chooses to provide on share terms, the labour-land ratio will be the same, i.e. rather than taking the tenant's labour input decision as given, he assumes the tenant will always adjust his labour input to maintain the labour-land ratio on sharecropped land. This is not a usual type of competitive assumption. There are other difficulties as well: the landlord does not benefit from penalties on the tenant, so it is not clear what these are; the landlord does not even realize that this monitoring affects the share tenant's behaviour; the exogeneity of penalties and differences in monitoring cost functions are not well motivated (see Section 4). Hence, while the model provided by Alston, Datta and Nugent is ingenious, it seems unsatisfactory in some respects.

9. An alternative is an explicit bargaining approach. See Bell's Chapter 4 below.

10. See, for example, the Symposium on the Limits of Non-co-operative Equilibrium in the *Journal of Economic Theory*, 1980. An early, non-rigorous attempt in the context of sharecropping is Koo (1973).

11. For example, Lucas (1979) does this in the last model in his paper.

12. See Arnott and Stiglitz (1984, 1985, 1986). By exclusivity, I mean that the landlord can require that his tenant does not contract with other landlords as well.

13. Stiglitz (1974a), Newbery (1975, 1977), and Newbery and Stiglitz (1979).

14. So the central planner is also unable to make state-contingent adjustments.

15. Thus, let (α, C) be the optimal contract for the landlord, with inputs (L, T), so that the sharecropper gets $\alpha\tilde{Q}(L, T, \theta) + C$. Suppose that the landlord can instead offer a rental contract at rental rate r for cultivation with inputs (kL, kT), and a wage contract at wage rate w for the remaining $\{(1-k)L, (1-k)T\}$. The tenant's return in state of the world θ is then

$$\tilde{Q}(kL, kT, \theta) - rkT + w(1-k)L = k\tilde{Q}(L, T, \theta) - rkT + w(1-k)L,$$

by the assumption of CRS. For this to duplicate the returns from the share contract, it must be that $k = \alpha$. Then, for the side payments to be equal,

$$w(1-\alpha)L - r\alpha T = C.$$

Clearly, the landlord can always find a w and r so that this holds. In fact, even if he must offer a market-determined wage, w, he can select an appropriate rental rate. The key here is that the landlord has some monopoly power. If both w and r for this tenant are set by the market, then of course he cannot be necessarily driven to his reservation utility level, and instead the landlord must compete by adjusting the share and side-payment; we are back to the Newbery model, with the addition of side-payments.

16. The production decision is akin to investing in an asset with risky returns.

17. A linear sharing rule is optimal only if the utility functions have absolute risk aversions whose reciprocals are linear. See Wilson (1968).

18. These are thirteenth-century England, nineteenth-century Germany, Chile, and Peru.

19. Newbery (1977) and Newbery and Stiglitz (1979) also look at economies of scale and indivisibilities. They see these as limiting the scope of their result on the irrelevance of share contracts for risk-sharing. However, *if* the conditions Allen describes hold, their result is more general.

20. Alternatively or additionally, the rental rate could be random. Bell (1986) has suggested that the timing of the randomness may be such that the wage is known when cultivation decisions are made. Then the following argument does not hold. Newbery and Stiglitz also discuss this point.

21. A rigorous demonstration is in Newbery (1977), where it is also shown that the equilibrium share will be $\alpha^* = LQ_L/Q$, i.e. the imputed share of labour with no uncertainty.

22. Eswaran and Kotwal (1985c) look at these inputs, but the emphasis is on incentive problems, so their analysis is treated in the next section.

23. Such models are considered in Chapter 4 below.

24. This assumes that monitoring is prohibitively costly. This is relaxed in the next section.

25. One can treat other inputs similarly from an analytical point of view.

26. Mostly through Marshall's footnote.

27. If it can, there is no incentive problem, of course.

28. Empirically, monitoring is often important.

29. The literature is enormous. See the recent survey by Hart and Holmstrom (1987) for an excellent exposition and a partial bibliography.

30. Mazumdar (1975) and Sen (1981) make similar points, but not centrally to their analyses.

31. The Shetty and Eswaran–Kotwal models are actually also pure moral hazard models (or 'hidden action', in Arrow's terminology), but they do not rely on risk aversion. The Hurwicz–Shapiro model is a 'hidden information' model (see Arrow 1985).

32. Again we may refer to Hart and Holmstrom (1987) for details.

33. This is easily shown; see, for example, Harris and Raviv (1979).

34. For a discussion of such issues, see Hart and Holmstrom (1987).

35. Roughly, since $U'' < 0$, U' and θ are negatively correlated, so $E(U'\theta) - E(U')E(\theta) < 0$ and $E(\theta) = 1$.

36. With risk neutrality, $C_\alpha = Q$ and $\alpha = 1$, as we would expect: a fixed-rent contract is used. Otherwise, note that equation (9) does not give an explicit formula for the share, since the right-hand side also depends on α.

37. The analysis involves obtaining an expression for L_α, which turns out to be quite messy. Similar sorts of comparative statics with uncertainty are common in the literature; see e.g. Arrow (1971).

38. See Chapter 12 below, and Robertson (1987).

39. This point is made by Singh (1983) in a two-period model.

40. Alternative models, where agents get more than their opportunity cost and hence suffer if dismissed, are those of Stiglitz and Weiss (1983) and Shapiro and Stiglitz (1984).

41. The parameter ε is suppressed in what follows.

42. This is a situation where each person's choice is the best response to the other's equilibrium choice. It is easy to show that this equilibrium exists. It is assumed unique.

43. It is plausible that he can precommit these, but not his input M.

44. This applies to materials in their model as well.

45. This is hence a hidden information model in Arrow's terminology.

46. In the published proof, differentiability is imposed. In general, $Y(Q)$ may be kinked or discontinuous.

47. See Section 5 below on screening for more discussion of this hypothesis. Also see Wright (1978: 176).

48. In Shetty's model these are constant, and there is cost-sharing in the proportion of the output share.

49. The following derivation turns out to contain an error. The correct result is that α exceeds one, unless restricted to not do so. See Ray and Singh (1998) for a correct analysis, discussion and references.

50. Note that, while θ_1 is a function of L, C, and α, the derivatives with respect to θ_1 cancel out, from its definition.

51. This is easy to demonstrate mathematically. The intuition (for which I am grateful to Steve Stoft) is that the center of gravity of the distribution is shifted to the right by removing the left tail.

52. For general results, see Holmstrom (1979, 1982). For an application, see Singh (1985).

53. It is not clear if share contracts that specify labour inputs (e.g. as in Cheung's observations) are of this form, with penalties for non-fulfilment. Possibly, observed labour time is always supplied as contracted, and effort is still unobservable, so the incentive problem remains.

54. This is thus a different idea from Eswaran and Kotwal, where there are no such economies of scope. I am grateful to Lee Alston (private correspondence) for this idea on why supervision costs might be low.

55. Fixed-rent contracts are considered in their model, presumably because of asset or wealth limitations, since everyone is risk-neutral. However, these are not made explicit.

56. The idea can actually be traced to Reid (1976).

57. The details of the model are not presented, since it is a standard Walrasian one.

58. The assumption that marginal products are also ordered by ability is typically necessary in screening or self-selection models; see e.g. Cooper (1984). It is consistent with ability being multiplicative; i.e., $Q_i(T) = Q(A_iT)$.

59. In an analogy to conventional theory, the landlord is acting as a perfectly discriminating monopolist.

60. I assume that the endowment T is such that this constraint is always binding.

61. Again, this is a form of monopolistic competition since landlords still choose contract parameters.

62. Here I follow Newbery and Stiglitz. An alternative notion of competition could be that the total return from any contract is equalized. For fixed plot size, of course, the two are the same.

63. I omit a detailed analysis.

64. The self-selection constraints are then

$$Q_1(T_1) - rT_1 \geq Q_1(T_2) - rT_2$$
$$Q_2(T_2) - rT_2 \geq Q_2(T_1) - rT_1.$$

These can both be satisfied, e.g. if T_i maximizes $Q_i(T) - rT$.

65. Since plot size is variable, this equality does not completely determine the landlord's choice, unlike in the fixed-plot size case.

66. That is, provided these costs are not too high, they only change the side-payment, which may then be of either sign. If they are high enough, they may lead to irrelevance of the additional constraints in the screening period. Thus, Bell's (1986) criticism on this point is only partially valid.

67. See e.g. Ladejinsky (1977), Rao (1975), and Rudra (1975).

68. This argument was made by Heady (1947) and formalized by Adams and Rask (1968).

69. See also Bardhan (1984: Ch. 7).

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