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Share tenancy as strategic delegation

Tridip Ray *

Department of Economics, Uris Hall, Cornell University, Ithaca, NY 14853, USA

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Abstract

The paper develops a new explanation of sharecropping based on the idea of an incentive equilibrium. It considers a set-up in which a few landlords in a village confront the choice of cultivating their farms by adopting different tenurial arrangements, ranging from owner operation, through the fixed-rental system to sharecropping. These landlords are the only sources of employment in the village, and compete in the wages they pay to their workers. In such an environment sharecropping is explained as a form of strategic delegation where a landlord gets extra benefit by having a share tenant and giving him suitable incentives. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

A large literature has been developed to explain the existence of share tenancy. [1] Several authors have searched for conditions under which share tenancy is preferable to fixed-rent contract or owner operation. The dominant opinion

* Tel.: +1-607-256-7055; fax: +1-607-255-2818; e-mail: tr17@cornell.edu

[1] To cite a few references: Cheung (1968, 1969), Bardhan and Srinivasan (1971), Stiglitz (1974), Bell and Zusman (1976), Hallagan (1978), Newbery and Stiglitz (1979), Allen (1982, 1985), Bardhan (1984), Eswaran and Kotwal (1985), Shetty (1988), Basu (1992), Sadoulet et al. (1994). Excellent surveys are provided by, for example, Binswanger and Rosenzweig (1984), Otsuka and Hayami (1988), Singh (1989).

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currently is that share tenancy is a response to uncertainty and asymmetries in information.

The present paper attempts to provide a very different explanation for share tenancy. It is shown that if the labor market is not perfect, then share tenancy can be explained as a form of strategic delegation. What makes this approach distinct is that, contrary to the conventional arguments, the present model explains share tenancy even in environments in which there is no uncertainty or asymmetric information.

It is somewhat surprising to observe that in the entire share tenancy literature, so little attention is paid to the imperfections in the labor market. [2] But many authors have written about the monopsonistic or oligopsonistic nature of the rural labor market in backward agrarian economies (Bardhan and Rudra, 1978; Rudra, 1982; Bardhan, 1984; Binswanger et al., 1984). In such a milieu share contract emerges as a strategic delegation device of the kind discussed by Fershtman and Judd (1987), and, therefore, its existence is shown to be compatible with an *incentive equilibrium.*

The analysis of Vickers (1984), Fershtman and Judd (1987) and Sklivas (1987) have helped us develop the basic insight that in strategic environments it pays for the principal to design an incentive scheme for his agent which is different from the principal's objective function because this creates strategic advantages. Recall that the main inefficiency problem in share tenancy arises because the sharecropper receives only a fraction of her marginal product of labor. To put it differently, the trouble is that the share tenant (the agent) faces an objective which is different from the landlord's (the principal) objective. Now putting these two observations together we get a clear intuition for the existence of share tenancy in a strategic environment.

There seems to be very little precedence to the argument that is developed here. Basu (1993, p. 195) had briefly speculated along these lines. [3] But he left it at the level of a conjecture. Others who have talked of share tenancy have invariably relied on uncertainty or informational asymmetry. In this paper, we isolate the precise conditions under which the delegation argument works, spell out the close link between this explanation and strategic complementarity and try to develop the empirical implications of this model.

We consider a set-up in which a few landlords in a village confront the choice of cultivating their farms by adopting different tenurial arrangements, ranging

[2] The view that share tenancy substitutes for the absence or imperfections of a market for some factor inputs like managerial skills (Bell and Zusman, 1979), bullocks (Bliss and Stern, 1982), credit (Jaynes, 1984), etc., is of course discussed in the literature.

[3] ''... if it is accepted that landowners operate in strategic environments, it can no longer be considered irrational for a landowner to appoint an agent and give him an objective function different from that of the landowner. Thus, there seems to be some possibility here of building up a new explanation of rent-sharing arrangements.''

from owner operation, through the fixed-rental system to share tenancy. These landlords are the only sources of employment in the village, and they compete in the wages they pay to their workers.

The aim of the paper is to analyze this oligopsonistic interaction in the rural labor market and to see what type of tenurial contract emerges in equilibrium. It turns out that if a landlord leases out his land he *never* specifies a fixed-rental contract. We show that under some parametric configurations share tenancy in all farms is the *only* subgame perfect equilibrium outcome of the game. We can also identify sets of parameter values under which there will be owner operation in all farms or share tenancy in some farms and owner operation in others.

For clarity and ease of exposition we analyze the case of two landlords in the text relegating the general case of three or more landlords to Appendix A.

Section 2 lays out the basic framework and describes the full game. Then we solve the game in the standard backward fashion. Thus, assuming that the decision about organization of production is already taken, we analyze in Sections 3 and 4 what happens under owner operation and tenancy, respectively. Then Section 5 takes up the full game for analysis. Finally, we conclude in Section 6.

2. The basic framework

Imperfections in the labor market are a common feature of backward agricultural economies. Extremely unequal distribution of land, massive unemployment or under-employment, low geographical mobility due to high travel or migration costs, and lack of alternative employment opportunities faced by the village workers give rise to monopsonistic or oligopsonistic power in the hands of a few large farmers (Bardhan, 1984, p. 60; Binswanger and Rosenzweig, 1984, p. 35).

In the Bardhan–Rudra 1979 survey they found that in about 21% of their sample villages 4 or fewer employers account for most of the casual labor employment in the village, and in about 45% of the sample villages 7 or fewer employers account for most of the casual labor employment in the village. [4]

Similar studies by Rudra (1982) and Binswanger et al. (1984) have found that in many villages a small number of big employers dominate the demand side of the labor market.

In view of the above discussion, let us consider the following kind of duopsonistic structure in the rural labor market. In an agricultural region (say, a village) there are two landlords producing the same crop (say, foodgrain) by using labor. We assume that these two landlords are the only sources of employment in

[4] ‘‘This may suggest that in a very large number of villages the hirers of casual labor enjoy some degree of monopsony or oligopsony power.’’ (Rudra and Bardhan, 1983, p. 9).

this village so that they enjoy market power. We assume in particular that the two landlords compete in the wages they pay to their workers.

Let the production function for foodgrain for each landlord be

$$Q = F(L), \tag{1}$$

where L is the amount of labor employed. It is assumed as usual that F is differentiable with $F(0) = 0$, $F'(L) > 0$, and $F''(L) < 0$.

In recognition of their duopsonistic interaction in the labor market let us assume that the labor supply curve faced by landlord i is given by

$$L_i = L_i(w_1, w_2), \qquad i = 1,2, \tag{2}$$

where w_i is the wage rate paid by landlord i. We assume that for each i, L_i is differentiable in (w_1, w_2), and $\partial L_i / \partial w_i > 0$, $\partial L_i / \partial w_j < 0$, $i \neq j$.

This formulation of the labor supply curve faced by each landlord deserves some comments. The standard assumption of horizontal labor supply curve used in the development literature is not supported by careful empirical studies. For instance, Bardhan (1979) and Rosenzweig (1984) have shown that the wage response of labor supply in a poor agrarian economy is significantly positive. Thus it seems reasonable to assume that a landlord can attract more workers to work on his farm by paying a higher wage.

But unlike the text-book Bertrand model, a landlord cannot attract all the workers by paying a wage just higher than the rival landlord. Transportation or travel costs (or reluctance to go to a long distance for work) may be a significant deterrent. Workers generally prefer to work on a farm closer to their residences and need to be compensated with higher wages to move to a distant farm to work. This distance factor is more significant for female workers. [5,6]

The price of foodgrain is taken to be unity. Wages are measured in terms of foodgrain. We assume that the landlords are price-takers in the foodgrain market. Then we can write the profit function of landlord i as

$$\pi_i(w_1, w_2) = F\big(L_i(w_1, w_2)\big) - w_i L_i(w_1, w_2), \qquad i = 1,2. \tag{3}$$

The landowners' objective is to maximize profit from this farm operation. In pursuing this a landlord can organize his farm operation in a number of ways. He can act as an owner operator (or a capitalist farmer) and hire workers from the labor market to work on his farm. Or he may want to get rid of the entrepreneurial responsibilities and enter into some form of tenurial arrangement—fixed-rent contract, share contract or a mixture of the two.

[5] See the coefficients of the explanatory variable 'DSTANCE' in the estimates of wage determination and labor supply equations in Tables 11.7, 11.8 and 11.9 of Rosenzweig (1984).

[6] Bardhan (1979, p. 81–82) observed that about 22% of the casual agricultural laborers surveyed were willing to accept wage employment inside but *not* outside the village. And for those who reported preparedness to accept jobs outside the village, the desired margin of wage on a job outside the village over the current one was 87%.

When the landlord cultivates the land himself he takes the wage decisions. But if he opts for a tenurial arrangement then the wage decisions are delegated to the tenant. That is, the tenant has to choose the wage rate, employ the workers, sell the product and pay the rent.

Formally, the game we are considering is as follows. In period 1, the landlords decide their mode of farm operation from the two alternatives—owner operation and tenancy. If the land is leased out, then in period 2 the landlord specifies the tenurial contract and in period 3 the tenant chooses the wage rate and produces the crop. If the land is not leased out, then the landlord decides on the wage rate in period 3 (no move is made in period 2).

3. Owner operation

In this section, we assume that both the landlords opt to be owner operators and choose wages to maximize their own profits.

Landlord 1 chooses w_1 and landlord 2 chooses w_2. Given such a pair of choices, the profit of landlord i is given by Eq. (3).

The landlord i's reaction function is derived from $\partial\pi_i/\partial w_i = 0$. This gives:

$$F'(\cdot)\frac{\partial L_i(w_1,w_2)}{\partial w_i} - L_i(w_1,w_2) - w_i\frac{\partial L_i(w_1,w_2)}{\partial w_i} = 0, \qquad i = 1,2. \tag{4}$$

The reaction functions are upward sloping (indicating *strategic complementarity*) in the (w_1,w_2) space, that is, one landlord responds to a wage hike of the rival landlord by increasing his own wage offer. [7]

The reaction functions are shown in Fig. 1 which also depicts two isoprofit curves of each landlord. N depicts the Nash equilibrium and the Nash equilibrium values of w_1 and w_2 are denoted by w_1^N and w_2^N.

Let us denote by π_{iN} the profit landlord i earns in the Nash equilibrium when both the landlords cultivate their lands themselves. Then

$$\pi_{iN} = F\left(L_i\left(w_1^N,w_2^N\right)\right) - w_i^N L_i\left(w_1^N,w_2^N\right), \qquad i = 1,2. \tag{5}$$

4. Tenancy

A tenancy contract specified by landlord i is defined by the pair (α_i, K_i), where α_i is the proportion of output the tenant keeps and K_i is the lump-sum he has to

[7] The condition for strategic complementarity is $\partial^2\pi_i/\partial w_i \partial w_j > 0$, $i \neq j$ (Basu, 1993, p. 70). This has a natural interpretation: an increase in w_j should increase landlord i's marginal profit (see Dixit, 1986, p. 110).

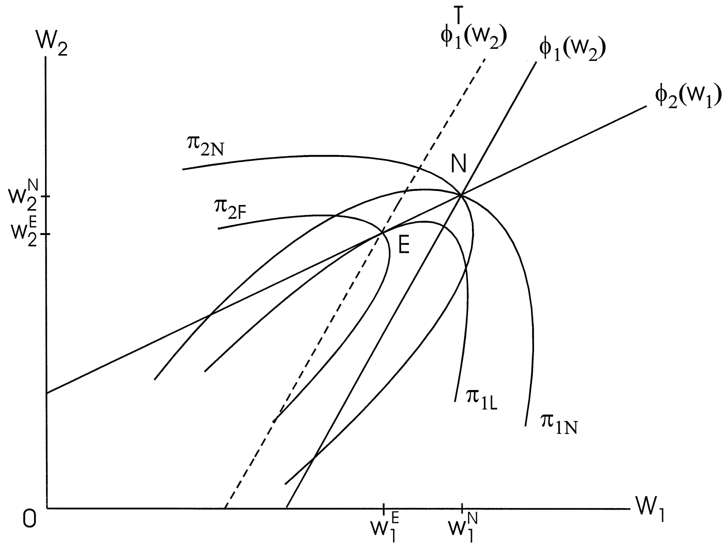

Fig. 1.

pay to landlord i. That is, if landlord i and tenant i agree to the contract (α_i, K_i), and the wage rates happen to be w_1 and w_2, then tenant i's earning is

$$R_i(\alpha_i, w_1, w_2) = \alpha_i F(L_i(w_1, w_2)) - w_i L_i(w_1, w_2) - K_i, \qquad i = 1,2, \quad (6)$$

and landlord i's earning (from his farm) is $(1-\alpha_i)F(L_i(w_1, w_2)) + K_i$.

Suppose in addition that landlord i can earn X_i amount elsewhere (his next best opportunity) when he can leave the responsibility of farming to a tenant. So his total earning from the contract (α_i, K_i) is $(1-\alpha_i)F(L_i(w_1, w_2)) + K_i + X_i$.

We call a contract (α_i, K_i) to be a share tenancy contract if $0 < \alpha_i < 1$, whereas a *fixed-rental contract* is the one where $\alpha_i = 1$ and $K_i > 0$.[8]

So if landlord i opts for a tenancy contract, his problem is

$$\begin{cases} \max\limits_{\{K_i, \alpha_i\}} (1-\alpha_i) F(L_i(w_1, w_2)) + K_i + X_i \\ \text{subject to } \alpha_i F(L_i(w_1, w_2)) - w_i L_i(w_1, w_2) - K_i \geq Y_i, \end{cases}$$

where Y_i is the tenant i's reservation income.

[8] Notice that in case of share tenancy we are allowing K_i to be non-zero. In share contracts this fixed payment K_i is usually not mentioned explicitly, but it may be there implicitly in the form of production or consumption loans, cost sharing arrangements, or the tenant's support for the landlord in local politics. It is also possible that K_i is extracted from some other deal, e.g., credit market or goods market, thereby giving rise to interlinkage. For a detailed discussion on this point, see Otsuka and Hayami (1988) (p. 33 and footnote 8) and Singh (1989, p. 45–46).

Clearly K_i will be chosen by landlord i to simply ensure that the tenant's participation constraint is satisfied. Using this landlord i's net earning becomes $(1-\alpha_i)F(L_i(w_1,w_2)) + K_i + X_i = \pi_i(w_1,w_2) - Z_i$, where $Z_i = Y_i - X_i$ is landlord i's net cost of having a tenant. We should clarify that this is not labor cost, but a sort of supervision cost. In many models of tenancy Z_i is assumed to be zero, but we allow Z_i to be non-zero as well.

So now the problem of landlord i is reduced to the choice of α_i so as to maximize this net earning subject to the reaction of the rival landlord. This choice problem of the landlord, under alternative reactions of his rival, is discussed in two subsections. In Section 4.1 we consider a situation where one landlord (say, landlord 1) opts for tenancy whereas the other one (landlord 2) remains an owner operator. Then in Section 4.2, we analyze what happens if both opt for tenancy.

4.1. Tenancy in farm 1 and owner cultivation in farm 2

We consider the two stage game where landlord 1 chooses α_1 in period 1 and in period 2 tenant 1 and landlord 2 simultaneously choose, w_1 and w_2, respectively.

We analyze the game in the standard backward fashion. In period 2, with α_1 given, [9] tenant 1 will choose w_1 to maximize $R_1(\alpha_1,w_1,w_2)$. So she sets $\partial R_1/\partial w_1 = 0$. In other words, her reaction function is implicitly given by:

$$\alpha_1 F'(\cdot)\frac{\partial L_1(w_1,w_2)}{\partial w_1} - L_1(w_1,w_2) - w_1\frac{\partial L_1(w_1,w_2)}{\partial w_1} = 0. \tag{7}$$

Since farm 2 is operated by owner cultivation, landlord 2's reaction function continues to be given by Eq. (4) (with $i=2$). In period 2 the Nash equilibrium is given by the values of w_1 and w_2 which solves Eqs. (7) and (4) (with $i=2$). Let $w_1(\alpha_1)$ and $w_2(\alpha_1)$ be the solution. Given this equilibrium in period 2, landlord 1 chooses α_1 in period 1 so as to maximize $\pi_1(\alpha_1) = F(L_1(w_1(\alpha_1),w_2(\alpha_1))) - w_1(\alpha_1)L_1(w_1(\alpha_1),w_2(\alpha_1)) - Z_1$.

We demonstrate in Appendix A that the solution, α_1^E, is such that $0 < \alpha_1^E < 1$, that is, we have a share contract in farm 1 in the subgame perfect equilibrium.

Some intuition for this result can be seen from Fig. 1. Comparing Eq. (4) (for $i=1$) and Eq. (7) observe that tenant 1's reaction function will be to the left of landlord 1's reaction function if and only if $0 < \alpha_1 < 1$. Since lower isoprofit curves correspond to higher levels of profit, E is the highest profit point (the Stackelberg leadership point) for landlord 1 given landlord 2's reaction function

[9] It is instructive to argue at the outset that $\alpha_1 \neq 0$. If landlord 1 chooses $\alpha_1 = 0$, tenant 1's net earning is $R_1 = -w_1L_1(w_1,w_2) - K_1$. In order to maximize R_1 tenant 1 will choose w_1 so that $L_1 = 0$. But then $\pi_1 = 0$, and landlord 1's net earning becomes $\pi_1 - Z_1 = -Z_1$. But by giving some positive incentive ($\alpha_1 > 0$) landlord 1 can ensure $\pi_1 > 0$. Hence landlord 1 will never choose $\alpha_1 = 0$.

$\phi_2(w_1)$. To achieve this profit landlord 1 needs to choose α_1 such that tenant 1's reaction function goes through point E. Thus, he must choose $0 < \alpha_1 < 1$. Notice that for $\alpha_1 = 1$, tenant 1's reaction function coincides with that of landlord 1.

The nature of the competition in the labor market is such that when one farm reduces its wage, the optimal response of the rival farm is to reduce its wage too (*strategic complementarity*). Then, if one landlord can *credibly commit* to pay a lower wage, labor supply to him falls due to the own wage effect, but rises because of the cross wage effect when the rival farm reduces its wage. Thus the net effect of a wage reduction is very little or no change in the labor supply. So wage bill of the landlord decreases and hence profit increases.

But how can a landlord *credibly commit* to reduce wage? He can do so only by delegating the farm operations to a share tenant. A sharecropper has less output incentive and hence demands less labor and pays less wage. Since both the landlord and the fixed-rent tenant has full output incentive, they cannot reduce wage credibly. This is the intuition for the result.

Let π_{1L} denote profit to landlord 1 when he is the Stackelberg leader and π_{2F} denote profit to landlord 2 when he is the follower. Then

$$\begin{aligned}\pi_{1L} &= F\big(L_1\big(w_1(\alpha_1^E),w_2(\alpha_1^E)\big)\big) - w_1(\alpha_1^E)L_1\big(w_1(\alpha_1^E),w_2(\alpha_1^E)\big),\\ \pi_{2F} &= F\big(L_2\big(w_1(\alpha_1^E),w_2(\alpha_1^E)\big)\big) - w_2(\alpha_1^E)L_2\big(w_1(\alpha_1^E),w_2(\alpha_1^E)\big).\end{aligned} \tag{8}$$

Clearly, when $\alpha_1^E = 1$, $\pi_{1L} = \pi_{1N}$. Since as a Stackelberg leader landlord 1 always has the option of choosing $\alpha_1^E = 1$, we must have $\pi_{1L} > \pi_{1N}$.

4.2. Tenancy in both farms

In this subsection we consider the situation where in both the farms production and wage decisions are taken by the tenants.

The game is as follows. In period 1, landlord 1 and landlord 2 choose α_1 and α_2, respectively. Then in period 2, tenant 1 and tenant 2 choose w_1 and w_2, respectively. The equilibrium we want to characterize is subgame perfection. We proceed in the backward fashion.

In period 2, the reaction functions of the tenants are implicitly given by setting $\partial R_i/\partial w_i$ equal to zero. This gives

$$\alpha_i F'(\cdot)\frac{\partial L_i(w_1,w_2)}{\partial w_i} - L_i(w_1,w_2) - w_i\frac{\partial L_i(w_1,w_2)}{\partial w_i} = 0, \qquad i = 1,2. \tag{9}$$

Proceeding as in the previous subsection, we get that (see Appendix A) $0 < \alpha_i^S < 1$, where α_i^S is the subgame perfect equilibrium value of α_i, $i = 1,2$. Thus we indeed have share tenancy contracts in both farms in the *incentive equilibrium.*

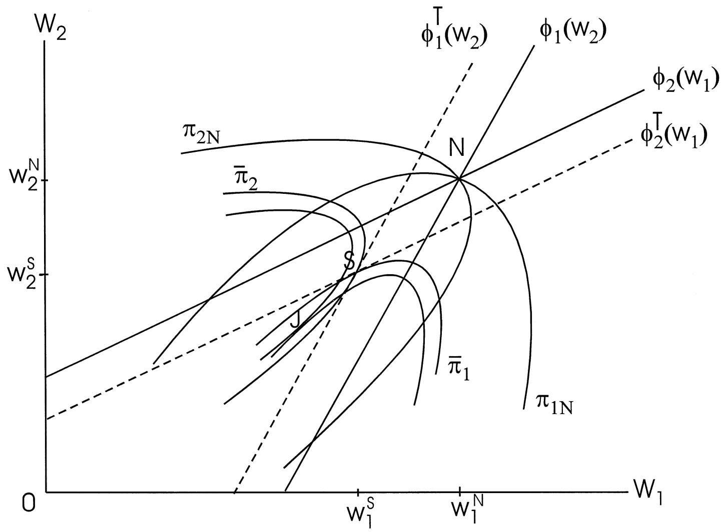

Fig. 2.

In Fig. 2, S depicts the subgame perfect equilibrium outcome.

Let $\overline{\pi}_i$ denote the profit of landlord i in the subgame perfect equilibrium when both farms are cultivated by tenants. Then

$$\overline{\pi}_i = F\left(L_i\left(w_1^S, w_2^S\right)\right) - w_i^S L_i\left(w_1^S, w_2^S\right), \qquad i = 1,2. \tag{10}$$

Recall from the last subsection that π_{iF} denotes the profit to landlord i when he is the follower. Since being a follower is always feasible for landlord i in the two-stage game considered in this subsection, we must have $\overline{\pi}_i > \pi_{iF}$.

From the analysis of this section we derive the following interesting proposition.

Proposition 1. *In the strategic environment under consideration if a landlord leases out his land he always opts for a share contract and not for a fixed-rental contract*.

But will the landlord lease out his land? We will answer this question in the next section.

5. Existence of share tenancy

In the last two sections the landlords' organization of production was taken as given. We did it on purpose in order to pave the way for the discussion in this section. Following Basu (1995), here we are going to endogenize this organization decision by analyzing the subgame perfect equilibrium of the full game described at the end of Section 2.

We need to consider what happens after each possible period 1 history. Recall that landlord i's net cost of renting land to a tenant is Z_i. Considering this renting cost, Z_i, the two landlords' payoffs that arise in the subgame perfect equilibria of the subgames that occur after the four possible period 1 histories are summarized in the payoff matrix below:

		Landlord 2: O	Landlord 2: T
Landlord 1	O	π_{1N}, π_{2N}	$\pi_{1F}, \pi_{2L} - Z_2$
	T	$\pi_{1L} - Z_1, \pi_{2F}$	$\overline{\pi}_1 - Z_1, \overline{\pi}_2 - Z_2$

where O denotes owner operation and T stands for tenancy contract.

Now it is easy to see that an outcome is a subgame perfect equilibrium of the full game if and only if it induces a Nash equilibrium in the game described by the above payoff matrix.

In Section 4, we have argued that $\pi_{iL} > \pi_{iN}$ and $\overline{\pi}_i > \pi_{iF}$.

Now we have several cases to consider. Recall that $Z_i = Y_i - X_i$, where Y_i and X_i are the reservation incomes of tenant i and landlord i, respectively.

Case 1: $Z_i \leq 0$, $i = 1,2$.

This case arises if we assume that a landlord can himself earn a lot elsewhere if he can leave the responsibility of farming to someone else. Using $\pi_{iL} > \pi_{iN}$ and $\overline{\pi}_i > \pi_{iF}$, it is easy to see that (T,T) is the only Nash equilibrium. So we have

Proposition 2. *If the net cost of leasing the land to a tenant is nonpositive for the landlords, then both landlords opting for share tenancy is the only subgame perfect equilibrium of the full game.*

Case 2: $Z_i > 0$, $i = 1,2$.

This case is quite possible if the landlord needs to do some significant amount of supervision or monitoring.

Then depending on the parameter values of the model we have the following possibilities: both landlords choose *owner operation* if $\pi_{iN} > \pi_{iL} - Z_i$, $i = 1,2$; both landlords opt for *share tenancy* if $\overline{\pi}_i - Z_i > \pi_{iF}$, $i = 1,2$; and, finally, landlord i opts for *share tenancy* and landlord j opts for *owner operation* if $\pi_{iL} - Z_i > \pi_{iN}$ and $\pi_{jF} > \overline{\pi}_j - Z_j$, $i \neq j$.

The following proposition summarizes this case.

Proposition 3. *If the net cost of having a tenant is strictly positive then, under different parametric configurations—both landlords working as owner operators, both of them opting for share tenancy and one of them having a share tenant while the other choosing owner operation—are all possible subgame perfect equilibrium outcomes of the full game. Share tenancy is more likely to appear the lower is the net cost of having a tenant.*

6. Discussion and conclusion

Following the method outlined in Section 4 we can show that if a *monopsonistic* landlord leases out his land, he opts for a fixed-rental contract and not for a share contract (of course his choice between owner operation and tenancy depends on the net cost of having a tenant). This makes it clear that share contract emerges because of strategic reasons.

It is demonstrated in Appendix A that the analysis and results are valid for the general case of n landlords. When a landlord credibly commits to pay a lower wage, labor supply to him does not fall because of optimal rival response to reduce wages as well in the presence of *strategic complementarity*. In fact this rival response is multiplied n-fold when there are n rival landlords. That is why the cropshare of the tenant falls with increase in the number of landlords or cross wage responsiveness of the labor supply function. Since the own wage effect dampens this favorable effect on labor supply, the share of the tenant increases with increase in the own wage responsiveness of the labor supply function.

The above discussion (and the intuitive analysis of Section 4) explains the crucial role of strategic complementarity in making the strategic delegation argument work. It plays a similar role in the models of price competition in Fershtman and Judd (1987) and Sklivas (1987).

In this environment of perfect information and imperfect labor market, the first-best for the landlords is to maximize their joint profits subject to the participation constraints of the tenants. In Fig. 2, joint-profit maximization occurs at J where the isoprofit curves of the landlords are tangent to each other. Thus, leasing out their lands on the basis of share contracts the landlords move towards a collusive arrangement.

Sharecropping is a widely diverse phenomenon. It has existed in various times under widely different circumstances and in several forms. A single theory cannot explain all the aspects of share tenancy. That is why in the literature we find alternative explanations of share tenancy each highlighting some specific aspect of it. In this paper we have explored the possibility of the existence of share contract as a response to imperfections in the labor market. We have shown that if the labor market is oligopsonistic the landlord gets extra benefit by having a share tenant and giving him suitable incentives to take strategic advantage over the rival landlord.

Finally, it is interesting to note some of the broader empirical implications that fall out of this model: Share tenancy is more likely in villages where the landholding is more concentrated, where there are fewer producers, and in regions where laborers are less mobile between villages, or alternative employment opportunities are fewer.

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Appendix A

- *To show that $0 < \alpha_1^E < 1$:*

Using Eq. (7) we can derive

$$\frac{\mathrm{d}\pi_1}{\mathrm{d}\alpha_1} = \left[\left(L_1(w_1,w_2) + w_1\frac{\partial L_1}{\partial w_1}\right)\left(\frac{1-\alpha_1}{\alpha_1}\right)\right]\frac{\mathrm{d}w_1}{\mathrm{d}\alpha_1} + \left[(F'(\cdot) - w_1)\frac{\partial L_1}{\partial w_2}\right]\frac{\mathrm{d}w_2}{\mathrm{d}\alpha_1}.$$

Eq. (4) (for $i=2$) implicitly defines the reaction function of landlord 2: $w_2 = \phi_2(w_1)$. α_1 does not appear as an argument of ϕ_2 since this equation does not involve α_1. Therefore, $\mathrm{d}w_2/\mathrm{d}\alpha_1 = \phi_2'(w_1)(\mathrm{d}w_1/\mathrm{d}\alpha_1)$, i.e., $(\mathrm{d}w_2/\mathrm{d}\alpha_1)/(\mathrm{d}w_1/\mathrm{d}\alpha_1) = \phi_2'(w_1)$.

The first-order condition for landlord 1's profit maximization is $\mathrm{d}\pi_1/\mathrm{d}\alpha_1 = 0$. Then we get

$$-\left[\frac{(F'(\cdot)-w_1)\dfrac{\partial L_1}{\partial w_2}}{L_1(w_1,w_2)+w_1\dfrac{\partial L_1}{\partial w_1}}\right]\phi_2'(w_1)=\frac{1-\alpha_1}{\alpha_1}. \tag{A.1}$$

In the presence of monopsonistic power wage is set such that the value of marginal product of labor is greater than the wage rate, i.e., $F'(\cdot)-w_1>0$. Also $\phi_2'(w_1)>0$ because of strategic complementarity. Thus the left-hand and right-hand sides of expression (A.1) are of the same sign if and only if $0<\alpha_1<1$. So we conclude that $0<\alpha_1^E<1$.

- *To show that $0<\alpha_i^S<1$, $i=1,2$:*

Proceeding as above we get that landlord i's optimal choice of α_i is characterized by the following equation:

$$-\left[\frac{(F'(\cdot)-w_i)\dfrac{\partial L_i}{\partial w_j}}{L_i(w_1,w_2)+w_i\dfrac{\partial L_i}{\partial w_i}}\right]\phi_j'(w_i)=\frac{1-\alpha_i}{\alpha_i},\ i\neq j,\qquad i,j=1,2. \tag{A.2}$$

Again using $F'(\cdot)-w_i>0$, $\phi_j'(w_i)>0$, $\partial L_i/\partial w_i>0$, and $\partial L_i/\partial w_j<0$, we conclude that $0<\alpha_i^S<1$, $i=1,2$.

- *General case of n landlords:*

Suppose there are n landlords, each facing the labor supply function

$$L_i=L_i(w_1,\dots,w_n),\qquad i=1,\dots,n,\text{ with }\frac{\partial L_i}{\partial w_i}>0\text{ and }\frac{\partial L_i}{\partial w_j}<0,\ i\neq j.$$

Then the profit function of landlord i is

$$\pi_i(w_1,\dots,w_n)=F(L_i(w_1,\dots,w_n))-w_iL_i(w_1,\dots,w_n),\qquad i=1,\dots,n.$$

Suppose there is tenancy in farms 1 to k, and owner operation in farms $(k+1)$ to n. (This is just to simplify notation. As the analysis below shows, it does not matter which particular farm has tenancy.)

We consider the following two stage game:
stage 1: for $i=1,\dots,k$, landlord i chooses α_i,
stage 2: for $i=1,\dots,k$, tenant i chooses w_i, for $j=k+1,\dots,n$, landlord j chooses w_j.

In stage 2, the Nash equilibrium is given by the values of $w_1,\dots,w_n$ which solve the following n equations:

$$\alpha_i F'(\cdot)\frac{\partial L_i(\cdot)}{\partial w_i} - L_i(\cdot) - w_i\frac{\partial L_i(\cdot)}{\partial w_i} = 0, \qquad i=1,\dots,k, \tag{A.3}$$

$$F'(\cdot)\frac{\partial L_j(\cdot)}{\partial w_j} - L_j(\cdot) - w_j\frac{\partial L_j(\cdot)}{\partial w_j} = 0, \qquad j=k+1,\dots,n. \tag{A.4}$$

Let the solution be $w_l = w_l(\alpha_1,\dots,\alpha_k)$, $l=1,\dots,n$.

Given this equilibrium in period 2, landlord i chooses α_i in period 1 so as to maximize $\pi_i(\alpha_1,\dots,\alpha_k) = F(L_i(w_1(\alpha_1,\dots,\alpha_k),\dots,w_n(\alpha_1,\dots,\alpha_k))) - w_i(\alpha_1,\dots,\alpha_k)L_i(w_1(\alpha_1,\dots,\alpha_k),\dots,w_n(\alpha_1,\dots,\alpha_k)) - Z_i$, $i=1,\dots,k$.

Using Eq. (A.3) we can derive

$$\frac{\partial \pi_i}{\partial \alpha_i} = \left(L_i(w_1,\dots,w_n) + w_i\frac{\partial L_i(\cdot)}{\partial w_i}\right)\left(\frac{1-\alpha_i}{\alpha_i}\right)\frac{\partial w_i}{\partial \alpha_i} + \left(F'(\cdot) - w_i\right) \times\left[\sum_{j\neq i}\frac{\partial L_i}{\partial w_j}\frac{\partial w_j}{\partial \alpha_i}\right].$$

The first-order condition for landlord i's profit maximization is $\partial\pi_i/\partial\alpha_i = 0$. Then we get

$$-\left[\frac{\left(F'(\cdot)-w_i\right)}{L_i(w_1,\dots,w_n) + w_i\dfrac{\partial L_i}{\partial w_i}}\right]\left[\sum_{j\neq i}\frac{\partial L_i}{\partial w_j}\frac{\partial \phi_j}{\partial w_i}\right] = \frac{1-\alpha_i}{\alpha_i}, \qquad i=1,\dots,k, \tag{A.5}$$

where $\partial\phi_j/\partial w_i = (\partial w_j/\partial\alpha_i)/(\partial w_i/\partial\alpha_i) > 0$, because of strategic complementarity.

So we get $0<\alpha_i<1$, for $i=1,\dots,k$, that is, any landlord who opts for tenancy chooses the share contract, and not the fixed-rental contract.

The above analysis shows that no matter what the other landlords do, the gross profit (π_i) is higher under share tenancy. So when $Z_i \leq 0$, net profit $(\pi_i - Z_i)$ is also higher under share tenancy no matter what the other landlords do. Then all landlords opting for share tenancy is the only subgame perfect equilibrium when $Z_i \leq 0$.

Rearranging Eq. (A.5) we can write

$$\alpha_i = \frac{1}{1-\left[\dfrac{\left(F'(\cdot)-w_i\right)}{L_i(w_1,\dots,w_n) + w_i\dfrac{\partial L_i}{\partial w_i}}\right]\left[\displaystyle\sum_{j\neq i}\frac{\partial L_i}{\partial w_j}\frac{\partial \phi_j}{\partial w_i}\right]}. \tag{A.6}$$

Assume that the landlords face symmetric labor supply functions, i.e., $\partial L_i/\partial w_j = \partial L_j/\partial w_i$. We can show that $\partial\phi_j/\partial w_i$ increases as $\partial L_i/\partial w_j$ increases. Then we can tell from Eq. (A.6) that other things remaining the same, as n or $\partial L_i/\partial w_j$ increases, α_i falls, and as $\partial L_i/\partial w_i$ increases, α_i increases.

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