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Labor tying

Anindita Mukherjee [a], Debraj Ray [b,*]

[a] George Washington University, Washington, DC 20052, USA
[b] Boston University, Institute for Economic Development, 264 Bay State Road Boston, MA 02215, USA

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Abstract

We study labor-tying in a competitive agricultural economy. The co-existence of seasonal fluctuations in income and imperfect credit markets suggests that tied contracts should dominate casual labor markets. However, empirical observation from India suggests that this is far from being the case, and indeed, that there is a declining trend in labor tying. We consider a model that permits deviations ex-post from mutually agreed implicit contracts. In equilibrium, casual labor markets are always active despite the presence of seasonality, and a variety of implications are derived that link economic growth, changing information flows, and the decline of labor tying over time.

Keywords: Labor tying; Seasonality; Implicit contracts; Agriculture; Rural labor markets

JEL classification: J41; J43; O12

1. Introduction

The term 'tied laborer' or 'attached laborer' is popularly used in the literature to identify any laborer who commits his labor to some particular farmer for an extended period. The period is to be contrasted with that for casual laborers, who are hired by the day and sometimes to complete an operation lasting a few days.

We may think of two broad categories of attached laborers. There are those who perform special tasks that require some judgement and precision, and are

* Corresponding author

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difficult to monitor [1]. The need for the efficient execution of such tasks is apparent. It is also clear that such laborers must be given appropriate intertemporal incentives [2].

In the second category of attached labor, there are no special tasks performed. Attached labor might be used to perform the tasks of casual laborers (see, e.g., Bardhan and Rudra (1981), Bhalla (1976), Rudra (1982a), Breman (1974) or Sundari (1981)). Tied labor contracts need not necessarily carry with them any special duties, but may simply serve to lower wage costs [3].

In this paper, we limit our attention to this second category of tied labor, though the framework of the model that we develop can be easily extended to include the first. [4]

Three general observations on labor markets in India motivate our inquiry. First, this second category of attachment has been dominant in the past. Second, the incidence of tying has undergone a steep secular decline to low current levels. Finally, there is marked regional variation in the levels of attachment in this category.

There is ample evidence in the literature on the organization of villages in social/economic anthropology that in certain Indian villages, the *entire* agricultural labor force could be partitioned into the tied labor pools of different landlords on the basis of the *jajmani* system. The following description may be found in Lewis and Barnouw (1958). [5]"Under this system each caste group within a village is expected to give certain standardized services to the families of other castes. ...Each man works for a particular family or group of families with which he has hereditary ties. ...The family or family head served by an individual is known as his *jajman*, while the man who performs the service is known as the *jajman's kamin* or *kam karne-wala* (literally, worker)."

Another widespread form of labor tying, somewhat less structured and formalized, may be loosely referred to as patron–client relations (see Beteille, 1979). Under this system, too, the employer is ideally supposed to ensure the general

[1] Such tasks include ploughing, regulating the flow of irrigation water from pumpsets, driving and looking after tractors, supervision and recruitment of casual labor, operating threshers, etc. In this context, see, e.g., Bailey (1957), Binswanger et al. (1984), Freeman (1977), Government of India (1960), Reddy (1985), Rudra (1982a,b), Sundari (1981) and Thorner and Thorner (1957), Bhalla (1976), and Mukherjee (1992).

[2] See Shapiro and Stiglitz (1984) and especially the work of Eswaran and Kotwal (1985).

[3] Basant (1984), Ghosh (1980) and Rudra (1982b) demonstrate on the basis of large-scale survey data on Indian agricultural labor markets that the daily wage equivalents of tied laborers are often lower than the casual wage rate. Similar evidence from surveys of smaller scale may be had from Bardhan and Rudra (1981) and Breman (1974). See also the interesting recent study by Anderson-Schaffner (1992) linking attached labor and servility.

[4] We do this in an earlier version of our paper (Mukherjee and Ray, 1992).

[5] This description is in agreement with accounts in Srinivas (1955), Srinivas (1960), Beteille (1979), Hopper (1957), and Hopper (1965).

Table 1
Secular decline in the proportion of attached laborers in Thanjavur, India.

Village	Year	Percentage of laborers	
		Semi-attached	Casual
Kumbapettai	1952	52	48
	1976	21	79
Kirippur	1952	74	26
	1976	20	80

Source: Gough (1981)

well-being of the employee, and in particular help the employee out in times of financial crisis such as sickness, death or drought. In return, the labourer is expected to give maximum importance to the needs of this employer as regards the allocation of his time. A large number of the *kamins* or clients carried out casual tasks, were paid a daily wage (in addition to their traditional payments) and were free to work for others when the *jajman* or patron did not need them. [6] This corresponds precisely to the latter type of labor tying as defined by us.

Hopper (1957), Lewis and Barnouw (1958), Breman (1974) Gough (1981) and Vyas (1964), along with a number of other studies, describe the secular decline of this traditional patron–client system. Table 1 documents proportions of tied laborers in the villages surveyed by Gough in 1952 and 1976.

Apart from the secular decline in the proportion of semi-attached laborers, there is also marked regional variation in the proportion of attached labourerers who carry out casual tasks. While surveys in West Bengal (Bardhan and Rudra, 1981) and Tamil Nadu (Sundari, 1981) find significant proportions of attached laborers in fully monitored, or casual tasks, contemporary surveys in other parts of India find a relative absence of such arrangements. This applies to the villages located in the semi-arid parts of India studied by the ICRISAT [7] and also to studies by Chen (1991) and Reddy (1985). The same applies to a more recent survey of agrarian relations in Uttar Pradesh, Bihar and Punjab by Mukherjee (1992).

In contrast to these empirical observations, standard economic theory predicts widespread labor tying, whatever the nature of the tasks performed by attached laborers. Given that the technology of traditional agriculture involves steep fluctuations in labor use, and the impoverished state of the agricultural laborers, it is very simple to furnish a theoretical explanation for labor tying in terms of implicit contract theory. [8] The theory predicts that recruitment of attached labor should always be optimal whenever there is *any* interseasonal variation in

[6] See, e.g., Sundari (1981), Gough (1981), Breman (1974), and Hopper (1957).

[7] ICRISAT is an acronym for the International Crops Research Institute for the Semi Arid Tropics.

[8] See Azariadis and Stiglitz (1983) or Rosen (1985) for surveys of the theoretical literature on implicit contracts.

Table 2
Proportions of tied laborers in ICRISAT villages. [a]

Village	Type of farm	Percentage of farms employing farm servants
Aurepalle	Type 1	13
	Type 2	47
Shirapur	Type 1	6
	Type 2	7
Kanzara	Type 1	0
	Type 2	7

[a] All the attached workers in these villages appear to carry out non-monitored tasks. Type 1 farms are small and medium farms while Type 2 farms are large farms.
Source: Pal (1993)

economic activity, as there certainly is in agriculture; *and* if workers are more risk-averse than employers, which is a plausible assumption. [9]

Note that *perfectly foreseen* seasonal variations in labor use do not change this observation. There is scope to tie labor, even if they will only be used in the peak season (this will be formally equivalent to an interlinked credit–labor deal). According to the standard theory, there is no reason why (predicted) peak season labor should be acquired on a casual basis.

Of course, in the presence of *uncertainty* in labor demand the entire labor force may not be tied because keeping a large inventory of labor unused may involve unnecessary expenditure. However, even with this amendment (see Bardhan, 1983), the casual labor market will not function *at all* unless the state of nature is unexpectedly good. Put another way, while this amendment allows for casual labor, it still does not rule out the possibility of a large tied labor force.

How large is large? To form an idea regarding the degree of uncertainty in labor demand, consider the village level studies conducted by the ICRISAT in India. [10] The fluctuations in the percentage use of hired labor over a period of ten years has been measured for three study villages. The gap between the highest and the lowest value is 30 percent for the most drought prone village –Shirapur. In the other two villages, the corresponding ranges are 22 percent and 25 percent respectively. These numbers suggest that the level of labor tying can climb to 70 percent without any risk of loss to the farmer. But the level of labor tying in the ICRISAT villages is nowhere near this figure. See Table 2.

[9] Note that the uncertainty explanation may predict low levels of labor tying under the assumption that farmers are themselves risk-averse and face uncertain demand or supply in some other market. But in our view, it is difficult to maintain the assumption that employers are more risk-averse than workers in the particular context of our study.

[10] See page 120 of Walker and Ryan (1990).

In general, the empirical literature on rural labor markets clearly reveals that casual laborers and not tied laborers constitute the majority of agricultural laborers in Indian villages, except in the pockets where agriculture is highly mechanized. [11]

Alternative explanations for labor tying stem from the existence of recruitment costs. This is a cost incurred by a farmer due to the effort involved and loss incurred due to possible delays in the process of recruiting labour. This introduces a wedge between the total *wages* paid by the farmer and the farmer's total *costs* [12] when hiring casual labor. These recruitment costs might induce the farmer to give up a part of such costs to tie labor. Thus recruitment cost models complement the implicit contract theory, and add to the predicted incidence of labor tying.

Our paper seeks to bridge this gap between theory and observation. In doing so, we obtain a fairly complete general equilibrium model of labor tying, with other implications that are of interest in themselves. Throughout the paper, we focus on one basic form of labor tying, that which provides insurance or credit against fluctuations, and requires the carrying-out of ordinary production tasks. As noted above, the model can easily be extended to incorporate non-monitored tied labor.

Our analysis is based on a natural incentive problem which labor tying creates. Typically, tied wages must be smoothed over time relative to spot market fluctuations. But then there *must* be periods where the tied wage falls short of the spot wage. [13] In such situations it pays the worker to break the tied contract. There is, in fact, empirical evidence that such contractual non-fulfilment is considered a distinct possibility by farmers. [14] In the case of such default we presume that the renegade is punished by contract termination.

Termination of the *current* contract does not mean, of course, that the laborer will be unable to obtain a tied contract from some other employer in the future. It all depends on the ease with which default histories can be shared among employers. In stagnant societies, where personal histories are easy to keep track of, such information sharing is widespread. This is also true of industrialized economies where information-sharing is of a very high order, though obviously through entirely different channels. It is precisely in 'intermediate' societies, which are going through rapid change and growth, yet do not possess an advanced information technology, that it becomes very difficult to keep track of individual histories. Our interest is in such situations.

We make, then, the extreme assumption that a renegade laborer faces exactly the same probability of reabsorption into the tied labor market as any other laborer

[11] See Bhalla (1987), Bharadwaj (1974), Breman (1974), Gough (1983), Sundari (1981) and others for a discussion of the empirical evidence.

[12] See Bardhan (1979).

[13] See Malcolmson and Macleod (1989) and the references in this paper for a general theoretical treatment.

[14] See, in this context, Section B, Chapter VI, Government of India (1960), or Binswanger et al. (1984).

currently seeking a job. It follows that the existence of excessive labor tying jeopardizes its existence! A high probability of being reabsorbed into tied employment reduces the scope of punishments that follow a deviation from the agreed terms of the contract. This feature significantly lowers the incidence of labor tying.

It is possible to drop the extreme assumption that reabsorption probabilities are independent of past history. The ability to keep tabs on a worker's history increases the proportion of tied labor (see Section 5.2 for a discussion).

Indeed, this last observation and our general approach furnishes a possible explanation for the observed secular decline of the incidence of labor tying arrangements in developing countries such as India, mentioned earlier. Increased growth and change has three effects.

First, it reduces the ease of informational flow as personalized ties give way to impersonal, anonymous transactions. This softens the punitive power of contract termination by increasing the chances of reabsorption. To compensate for this, the incidence of labor tying arrangements must fall. We believe that the study of information diffusion in the face of economic change has general implications for the evolution of institutions, and this is only one instance of its effects.

Second, growth in economic activity increases the *absolute* number of all types of arrangements, tied or untied. Thus for the same *percentage* of tied labor, the probability of reabsorption into tied arrangements goes up. To compensate, the fraction of tied labor must decline. (Section 5.1 provides a more detailed exposition.)

Finally, growth might serve to tighten labor market conditions, creating larger fluctuations in the spot wages of a seasonal activity. This feature *increases* labor tying in equilibrium, and it is only this last feature that is present in other theoretical models (see, e.g., Bardhan (1983) and Eswaran and Kotwal (1985)). By encompassing the other features, our approach sheds some new light on the observations.

We now summarize some of the specific findings. We study a full equilibrium system, not a particular employer's decision. The model incorporates seasonality in agricultural production, but no uncertainty. We show that

1. It is possible to completely characterize economic situations where agriculture is seasonal, workers are risk averse, and employers are risk neutral, yet there is no labor tying in equilibrium (Proposition 1).
2. In contrast, the casual labor market must always be active (Proposition 2), irrespective of the degree of agricultural seasonality, or the degree of risk aversion of workers.
3. Moreover, in no equilibrium is a tied worker given *full* insurance, in the sense of interseasonal equality of tied wages. Despite the obvious gains from such equality, the employers will always find in their interest to pay seasonal bonuses to attached labor, though, of course, such bonuses are not as large as the seasonal wage gap.
4. Tied laborers are strictly better off than their casual counterparts. [15]

5. Simple closed-form descriptions of the final outcome may be obtained, including a formula for the percentage of tied labor that is predicted by the model (Proposition 3). These solutions permit numerical computation under parametric specifications; they also make it easy to carry out a number of comparative statics arguments.
6. 'Balanced growth' in the economy; i.e., growth that increases both labor supply and demand proportionately without affecting the pattern of spot wages, reduces the incidence of labor tying. On the other hand, the model also incorporates the standard finding that a seasonally tighter labor market increases the percentage of tied arrangements.

The model is described in Section 2. Section 3 highlights the importance of casual labor. In Section 4 we provide a full description of the equilibrium, and some illustrative comparative statics. Section 5 describes some extensions of the basic model. Section 6 concludes the paper and discusses the relation between our theoretical predictions and available empirical observations.

2. The model

2.1. The farmers

Consider a closed agricultural economy producing a homogeneous output, the price of which is normalized to unity.

It takes one 'year' to produce this commodity from land and labor. The year consists of a *slack* season followed by a *peak* season.

It will be assumed that slack and peak labor are applied in fixed proportions α:1 (where $0 < \alpha < 1$), and this composite unit of labor will be termed (one unit of) *effective labor*. Output Y is assumed to be a function of effective labor, [16]

$$Y = F(n),$$

where $F(\cdot)$ is a twice continuously differentiable, increasing, strictly concave function. [17]

All farmers discount profits at the end of each slack or peak season by a discount factor $\delta \in (0, 1)$, and are taken to be risk-neutral expected profit maxi-

[15] Eswaran and Kotwal (1985) also obtain this result, though for entirely different reasons.

[16] At this stage of the exercise it is assumed that all other inputs are fixed and available equally to all farmers. Relaxation to permit heterogeneity among farmers is a straightforward exercise. The model also permits an extension to other variable inputs such as supervisory labor, which are ignored here for ease of exposition.

[17] We assume also the end-point conditions $\lim_{n \to 0} F'(n) = \infty$ and $\lim_{n \to \infty} F'(n) = 0$.

mizers [18]. We idealize competition by assuming a large number of identical farmers and by postulating that the labor used by each of these farmers is infinitesimally small with respect to the aggregate. While we do not distinguish between different farmers, it will often be useful to introduce notation that separates the average economy-wide choices from the decisions made by a particular farmer.

Denote by C the discounted cost of using one unit of effective labor. We emphasize right away that C will be endogenized in the sequel. Each farmer's objective is

$$\max \delta F(n) - nC.$$

The cost of a unit of labor will depend on the type of labor used as input and the wages to each of these types. Accordingly, we now describe the types of labor contract used in this economy.

2.2. *Types of labor contract*

There are *two types* of labor contracts in this economy: the *casual* labor contract and the *tied* labor contract.

The casual contract is characterized by spot market hire. The laborer's relation with the employer ends as soon as the season is over.

The tied laborer is assumed to be hired for the *entire agricultural year*, on a contract that is commonly regarded as potentially renewable. We take it that such offers are made only at the onset of each agricultural year. There are two possibilities. A tied laborer might be required to be available for work for the landlord only in the peak season. In the slack season he gets some payment from the employer, but is free to augment this by earning in the spot market. The other possibility is that the tied worker is paid *and* his services used the year around. Note that the latter contract (in which work is done for the entire year) can be exactly mimicked in our model by the former contract, in which the landlord 'additionally' hires his tied laborer in the slack season as a casual laborer. For ease of notation, then, we stick to the first type of contract.

We reiterate that 'tied labor' here is fully substitutable with casual labor so far as *tasks* are concerned.

The tied contract spells out terms of payment (x_*, x^*) to tied laborers, in return for peak season work. The first entry represents a slack season payment; the second represents the peak season payment.

[18] Slack and peak seasons are not of the same lengths. Hence the discount factors applied should vary over these two seasons. We do not take this into account for ease of exposition, but the analysis loses nothing if different discount factors were to be accommodated.

Both laborer and employer are free to not renew the contract at the end of the year. We assume that there is always a flow of quits due to factors not explicitly modelled here. This exogenous quit rate will be denoted by q. [19] It should be observed that q is really an exogenous probability of nonrenewal of contract (even if all goes well during the contractual period), rather than a quit from an *ongoing* contract.

Apart from exogenous quits, *deliberate* deviations or non-fulfilment of the contract itself is also a possibility. At this point we depart from the standard analysis of tied contracts by recognizing explicitly that an employer might not have access to any extra-economic device to ensure fulfilment of contracts.

What *economic* devices might an employer have access to? *Non-renewal* of contract in future years is surely one possibility. The farmer might also refuse to pay the laborer for the season in which breach occurred. We suppose that both these instruments are available, though only the former is really important for the argument. The laborer who contemplates a breach of contract must therefore trade these future losses for current gain. We reiterate that the computation of these future losses depends on the macro-environment (including the overall prevalence of tied contracts). A contract which ensures fulfilment by the means of these economic incentives will be called an *incentive-compatible contract.*

We now turn to a description of the characteristics of laborers.

2.3. The laborers

We assume that a typical laborer is risk-averse (or more precisely, since this analysis is going to abstract from uncertainty, averse to fluctuations in income). They receive utility from income and leisure, and discount future utilities after each peak or slack season.

Fluctuation-aversion is captured, as usual, by postulating a utility function of labor that is strictly concave in income earned. Workers possess one unit of leisure that is supplied indivisibly to the labor market. The utility function of income w conditional on labor supply is given by $u(w)$; $u(w)$ is assumed to be defined on nonnegative incomes, strictly concave and twice continuously differentiable. [20] Laborers enjoy a fixed utility u_0 from uninterrupted leisure for a season. There-

[19] An exogenous quit rate is a standard postulate (see, e.g. Shapiro and Stiglitz (1984)) designed to keep some vacancies open in equilibrium for all types of jobs. These may arise due to noneconomic reasons or changing socio-economic circumstances not captured in our model. See Binswanger et al. (1984), Alexander (1973), Sundari (1981) and others for empirical evidence that contracts are frequently not renewed. It should be noted that if the entire economy is growing, the growth factor serves as an approximate substitute for such quits, keeping a pool of vacancies open in equilibrium (see Section 5.1).

[20] We normalize $u(0)$ to be 0. It is also assumed that $\lim_{w \to 0} u'(w) = \infty$ and $\lim_{w \to \infty} u'(w) = 0$.

fore, to work during any season as a casual laborer, the worker must be paid at least a wage w_0, where $u(w_0) \equiv u_0$.

So for any wage at least equal to w_0, the laborers supply one unit of labor inelastically. Each laborer's supply of labor is infinitesimally small with respect to the whole. The total volume of labor supply forthcoming from the economy for any $w \geq w_0$ is L_0. Thus the aggregate supply curve of labor may be written as follows:

$$\begin{aligned} L(w) &= L_0 \quad \text{for all } w \geq w_0 \\ &= 0 \quad \text{otherwise.} \end{aligned} \tag{2.1}$$

At this point we introduce a critical assumption. We postulate that laborers have no access to credit facilities that would permit the smoothing of their consumption over seasons. Indeed, if this were possible, the very motivation for labor-tying would be nonexistent. If the slack season payment may be viewed as a loan, then the potential employer is their only source of credit [21].

Indeed, we will make the extreme assumption of equating the *incomes* of laborers in each season to their *consumptions* in that season. Of course, the stipulation that *no* smoothing is possible is an exaggeration, quite unnecessary for the formal analysis. In any case, some smoothing is always possible through savings. But there must be some imperfection in credit and savings markets for our model to have any meaning.

2.4. Availability of different jobs and lifetime utilities

Consider the start of any slack season. Two types of jobs are available to a presently unemployed laborer: tied and casual. The chances of obtaining a tied job are, of course, proportional to the ratio of such vacancies to the total number of job seekers. We denote this probability by p; it will be endogenized in the sequel. We have, then, the possibilities of:

1. employment as a tied laborer with associated payments (x_*, x^*). Such contracts are available with probability p. Recall that these contracts permit the laborer to work as a casual laborer in the slack season, possibly with the very same employer providing the tied contract.
2. remaining in the spot market with probability $(1-p)$. This option means that the worker will receive the utility of a casual laborer over slack and peak seasons (given full casual wage flexibility). If casual wages are given by $(\underline{w}, \overline{w})$, this utility is $u(\underline{w}) + \delta u(\overline{w})$.

[21] Similar, though not identical, ideas have been put forward by Basu (1983), where no lender lends outside a pool of laborers over whom he exercises some 'power', and by Ray and Sengupta (1989) and Floro and Yotopoulos (1991) who point out that credit markets may be segmented according to lender and borrower characteristics.

We reiterate that while these wages and probabilities are treated as exogenous at the moment, later they will be derived endogenously on the basis of the agents' behaviour given the parameters described in Sections 2.1 and 2.3.

Let V_* denote the lifetime utilities of such a laborer facing these probabilistic options and let W_* denote his lifetime utility conditional on being offered a tied labor contract. Assume, without loss of generality, that $u_* \equiv u(\underline{w} + x_*) + \delta u(x^*)$ is not less than $\underline{u} \equiv u(\underline{w}) + \delta u(\bar{w})$, otherwise tied labor contracts will not ever be taken up [22]. Now it is easy to see that the two lifetime utilities are related in the following way:

$$V_* = pW_* + (1-p)(\underline{u} + \delta^2 V_*) \tag{2.2}$$

and

$$W_* = u_* + \delta^2(qV_* + (1-q)W_*). \tag{2.3}$$

Eqs. (2.2) and (2.3) are largely self-explanatory, but an additional word of explanation is offered here. The equations presume that no worker wishes to *voluntarily* quit his job between the slack and peak seasons. This presumption will be borne out in equilibrium, therefore no generality is lost by using this expository simplification.

Let z be the vector of variables $(\underline{w}, \bar{w}; x_*, x^*; p, q)$ facing the agents in the economy. Given (2.2) and (2.3), it is possible to derive closed-form solutions to V_* and W_* as functions of z. In other words, we only need to know z in order to know the lifetime utilities.

2.5. The employer's choice of contract

An individual employer takes as *given* the economy-wide prevalence of wages in different contracts, as well as the employment probabilities and the quit rate. That is, he takes $z \equiv (\underline{w}, \bar{w}; x_*, x^*; p, q)$ as given. The employer's task is to hire laborers using a contract (or contracts) most advantageous to him.

The reader will already see what is to be the basic component of the equilibrium notion. It is that each employer's choice of contract, given z, must be 'aggregated' across employers to give rise to z itself! To work toward this, it is necessary to describe first the behaviour of employers as a response to the *going* vector z.

Consider an individual employer in a regime where the going vector is z. Recall that each farmer is infinitesimally small with respect to the aggregate, so his choices will not affect the going vector. Suppose he is considering the offer of a tied contract to currently unemployed laborers in the slack season. Denote by $(\underset{\sim}{x}, \bar{x})$ his offer, and by $\underset{\sim}{W}$ the expected lifetime utility of a laborer who accepts that offer.

[22] An equivalent assumption is, of course, $W_* \geq V_*$.

A closed-form expression for $\underset{\sim}{W}$ is easy to find. Assuming for the moment that no laborer will willingly deviate from contractual terms (this will indeed be true in the sequel), and writing $\underset{\sim}{u} \equiv u(\underline{w} + \underset{\sim}{x}) + \delta u(\tilde{x})$,

$$\underset{\sim}{W} = \underset{\sim}{u} + \delta^2 q V_* + \delta^2 (1-q) \underset{\sim}{W}. \tag{2.4}$$

That is, the laborer enjoys the contract for the current year (obtaining utility $\underset{\sim}{u}$), and in the next year, continues the contract with probability $(1-q)$, obtaining $\underset{\sim}{W}$, or discontinues with probability q, obtaining V_*. These latter terms are suitably discounted. Note that the worker's lifetime utility upon quitting is V_*, depending upon the going wages (x_*, x^*) rather than those offered by the individual farmer under consideration. The chance of being re-employed by the same farmer controlling an insignificant proportion of the market is zero.

For the contract to prevail (and indeed, this will justify (2.4)), it must be, first, *acceptable* to the worker, and second, *incentive-compatible*, so that its fulfilment is ensured. The *acceptability constraint*

$$\underset{\sim}{W} \geq V_* \tag{2.5}$$

requires no explanation. Consider the incentive constraint.

Incentive-compatibility requires that the tied laborer should not want to breach the contract at the onset of the peak season, after having received $\underset{\sim}{x}$ in exchange for the commitment of his labor in the peak season. In case the labourer does breach, he receives the spot market income for the current peak season. But next year he no longer has the tied job with the current farmer. A labourer who fulfils his contract receives the tied wage in the peak season. At the end of the peak season, he continues as a tied labourer with probability $1-q$ or joins the casual labour force with probability q and his expected lifetime utility from that point onward is determined accordingly. Formally,

$$u(\underline{w} + \underset{\sim}{x}) + \delta u(\tilde{x}) + \delta^2 (1-q) \underset{\sim}{W} + \delta^2 q V_* \geq u(\underline{w} + \underset{\sim}{x}) + \delta u(\overline{w}) + \delta^2 V_*$$

or

$$u(\tilde{x}) + \delta(1-q) \underset{\sim}{W} \geq u(\overline{w}) + \delta(1-q) V_*. \tag{2.6}$$

The equations embody our assumption that in the case of a deviation, the employer terminates the contract, with no payment for the peak season in which the deviation occurred. The worker is then returned to the casual labor market.

Implicit in these equations is also the presumption that the worker returns 'unscarred', and can obtain any type of contract thereafter in the same way as any other laborer. An evicted laborer has 'continuation utility' V_*. This assumption requires further exploration, which we defer to Section 5.2.

A contract $(\underset{\sim}{x}, \tilde{x})$ satisfying (2.5) and (2.6) will be called an *incentive-compatible contract* for the tied laborer. Note the explicit tradeoff between current gains and future losses.

In what follows, we take it that the employer must *always* respect the incentive-compatibility constraint whenever he offers a tied contract. Of course, this is not an assumption at all if the peak season casual labor market is active! But this constraint is imposed *even if* the going size of the casual labor market is zero. This is because the equilibrium concept should be 'robust' to the presence of 'small' activity in the casual market. An equilibrium not satisfying this constraint would be destroyed by a tiny perturbation of the model.

The employer's objective may now be described: find the cost-minimizing incentive-compatible contract $(\underset{\sim}{x}(z),\ \tilde{x}(z))$ [23], and then settle on the mix of contracts in the following way. Observe that the farmer's choice of casual workers versus tied laborers depends on which is lower: $\delta\overline{w}$ or $\underset{\sim}{x}(z)+\delta\tilde{x}(z)$. So the unit cost of effective labor, $C(z)$ is given by

$$C(z)\equiv\alpha\underline{w}+\min\{\underset{\sim}{x}(z)+\delta\tilde{x}(z),\delta\overline{w}\}. \tag{2.7}$$

This is the unit cost which the farmer will use to choose the number of effective units of labor that he hires.

2.6. Equilibrium

Denote by T the economy-wide *volume* of tied labor and by $\underline{L}$ and $\overline{L}$ the volumes of casual labor hired in the slack and the peak seasons respectively. Let $\mathscr{L}$ denote the vector $(T,\underline{L},\overline{L})$.

An *equilibrium* is a vector $(z,\mathscr{L})$ such that the following are satisfied: first,

$$(\underset{\sim}{x}(z),\tilde{x}(z))=(x_*,x^*) \tag{2.8}$$

simply states that the going contractual offers are 'self-fulfilling', that is an individual farmer reacting to these offers will choose the same offers himself. We reiterate that the definition of a 'self-fulfilling' contract *includes* the incentive-compatibility constraint whether or not the casual labor market is active in the peak season. This is because the equilibrium should be robust to small variations in casual market activity. (Recall the discussion following (2.6).)

Next,

$$p=\frac{qT}{L_0-(1-q)T},\quad j=1,2, \tag{2.9}$$

states that the perceived probability of gaining employment in any category of tied labor must equal the total number of vacancies in that category divided by the total number of job-seekers.

[23] Notice that the incentive constraints are strictly concave, given the strict concavity of the utility function. Therefore, the minimization problem described above will have a unique solution making it legitimate to write the cost-minimizing choice of the farmer as a function of z.

Finally, we have the macroeconomic balance conditions:

$$\underline{L} \leq L_0, \quad \underline{w} \geq w_0, \quad (L_0 - \underline{L})(\underline{w} - w_0) = 0; \tag{2.10}$$

and

$$\bar{L} \leq L_0 - T, \quad \bar{w} \geq w_0, \quad \left(L_0 - T - \bar{L}\right)(\bar{w} - w_0) = 0. \tag{2.11}$$

These conditions state that the spot wages in slack and peak adjust so that there is no excess demand for effective labor when the discounted cost of effective labor is evaluated at the equilibrium z. It also ensures that workers either do not wish to or are not able to displace another by undercutting contractual terms. As an explanation note that given (2.10) and (2.11), laborers will not be *willing* to undercut the casual wages. The laborers will not be *able* to undercut the wages for tied labor even if they want to, because the incentive compatibility of contracts, (2.8), ensures that the contractual wages are the 'lowest-possible' incentive-compatible wages.

3. Equilibrium labor tying and casual labor

A basic characteristic of the model is that it yields, in a natural way, the *co-existence* of tied and casual labor under a minimal set of assumptions. Moreover, we show that the casual labor market is never wiped out entirely. Unlike the standard models, *this is true in spite of the absence of uncertainty in labor demand and irrespective of the degree of seasonality, or the risk aversion of workers.*

We have already noted in the Introduction that the standard model of agricultural labor tying must fundamentally rely on uncertain variations in labor demand to explain *any* casual labor at all. We argued that such models greatly overestimate, a priori, the incidence of labor tying. The results here are more 'primitive': because of the incentive constraint, there must always be casual labor market activity in equilibrium, otherwise (given the high re-employment probabilities as a tied laborer) it will be impossible to meet that constraint at all! To be sure, the presence of uncertainty will only augment this result. We now turn to a more detailed analysis of these and other features.

Define a *trivial contract* for a tied laborer as involving payments $(0, \bar{w})$. The interest lies, of course, in equilibria featuring tied contracts that do *not* involve these trivial payments. Accordingly, we make the convention that a trivial contract is put under the heading of casual labor. Whenever we refer to a tied contract we will imply *non-trivial* tying.

It will be useful to start with a simple preliminary observation:

Fact: If a non-trivial labor tying contract is offered in equilibrium, then $x^* < \bar{w}$ *and* $x_* > 0$.

The Fact above is intuitively obvious. First of all note that if in an economy $\underline{w} = \overline{w}$, or the wages exhibit no seasonality, then the only possible contracts are the trivial contracts. Therefore, consider only $\underline{w} \neq \overline{w}$. Slack labor demand being strictly less than the peak level of labor demand, we will have $\underline{w} < \overline{w}$. Labor tying is designed to provide insurance to the worker against fluctuations. The way in which this happens is that the slack season payment is raised above the casual level and the opposite occurs for peak season payments. However, full insurance will not, in general, occur, as we shall soon see.

Armed with this Fact, we now turn to our main analysis. The first task is to provide a complete characterization of the parameters that will yield non-trivial labor tying within this model. That is, we provide a condition that is *both* necessary *and* sufficient for *some* positive level of labor tying in equilibrium. This is done in

Proposition 1. There is labor tying in equilibrium (equivalently, $T > 0$) if and only if

$$\delta^2(1-q)u'(w_0) > u'\left(\max\{w_0, F'(L_0) - \alpha w_0/\delta\}\right). \tag{3.1}$$

We interpret the proposition, relegating a formal proof to the appendix. Imagine a variant of the economy modelled here, with labor tying ruled out by assumption, so that only casual labor contracts are observed. Call this the *benchmark economy*. What would be the equilibrium casual wage in the benchmark economy? Given that slack labor demand is linked to peak demand by a fixed proportion less than unity, it must be the case that slack labor demand is less than L_0, *so that the slack casual wage always equals the reservation wage* w_0, in the benchmark economy. [24]

The peak casual wage might be w_0 or greater, depending on the technology and other parameters. A little manipulation will reveal that the exact formula for the peak casual wage w^0 in the benchmark economy is given by

$$w^0 \equiv \max\{w_0, F'(L_0) - \alpha w_0/\delta\}.$$

So (3.1) translates into

$$\delta^2(1-q)u'(\text{benchmark slack wage}) > u'(\text{benchmark peak wage}).$$

That is, not only must there exist seasonality in the benchmark economy, but there must exist *sufficient* seasonality (in the sense of (3.1)); for (3.1) *implies* that the benchmark peak wage must exceed the benchmark slack wage if labor tying is to take place, but the converse is *not* true. Put another way, there is no reason to expect that the economy will exhibit labor tying *whenever* there are seasonal fluctuations, even if all workers are risk-averse and all employers are risk-neutral.

[24] In fact, this will turn out to be true of all equilibria in the original economy as well.

The reason for this is the presence of the incentive constraint. The incentive constraint requires the employer who offers a tied contract to offer a premium to the worker under such a contract, otherwise the worker will default. This is costly for the employer. On the other hand, a standard insurance argument implies that there are gains to be made by the employer whenever he offers tied contracts in the presence of seasonality. Proposition 1 provides a precise statement of when it will be possible for the gains to balance the losses. Note, moreover, that while Proposition 1 describes the *equilibria* of the economy, its conditions are stated *entirely* in terms of the parameters of the model, and no endogenous variables are present, which is as it should be.

So labor tying may or may not be observed. But what about the casual labor market? Is it perhaps possible that an extremely high level of seasonality or risk-aversion is capable of eliminating this market altogether? The answer is no, and it is stated as

Proposition 2. In any equilibrium, the casual labor market is always active.

Proposition 2 reveals how the incentive constraint is fundamental to our analysis. If there were no casual labor in equilibrium, then one could use the complete characterization of Proposition 1 to argue that there cannot be any unemployment either (voluntary or involuntary). Recall that the worker is of infinitesimal size and the vacancy pool induced by quits is of the same measure as the number of job-seekers. This means that if a worker is expelled from a tied contract, he will find another tied contract with probability one. So the tied contract cannot be incentive-compatible. For by the Fact, there is always an incentive for the worker not to fulfil the contract in the peak season, and expulsion carries no punishment value! This contradiction establishes the proposition.

4. Equilibrium: A full description and illustrations

In Section 3 we have described the parametric configurations that can give rise to labor tying in an economy. In this section we will completely characterize an equilibrium according to the definition given in Section 2.6. A full characterization is useful for three reasons. First, interesting properties of any equilibrium are explicitly revealed, such as the fact that employees *never* receive full insurance. Second, it becomes straightforward to conduct comparative statics analysis with respect to the parameters of the models. Given the regional and temporal variations observed in patterns of labor-tying, such exercises have significant implications. Finally, our description of the equilibrium yields explicit formulae, which permit us to compute actual percentages of tied labor for empirically plausible parametric specifications.

4.1. Description of the equilibrium

Proposition 3. There exists a unique equilibrium, which is characterized as follows:

1. *If condition (3.1) fails to hold, the equilibrium is simply the equilibrium of the benchmark economy, with only casual labor hired at the wages* $(\underline{w}, \overline{w})$ *of the benchmark economy.*
2. *If condition (3.1) does hold, the equilibrium is characterized by co-existence of tied and casual labor. The equilibrium casual wages* $(\underline{w}, \overline{w})$ *must equal the benchmark casual wages* (w_0, w^0)*. The equilibrium tied wages are characterized completely by the following two conditions:*

$$\text{employer indifference } x_* + \delta x^* = \delta w^0; \tag{4.1}$$

$$\text{partial employee insurance } \delta^2(1-q)u'(w_0 + x_*) = u'(x^*). \tag{4.2}$$

The probability of obtaining tied employment, p, is given by

$$p = 1 - \frac{u(w^0) - u(x^*)}{\delta(1-q)\{u(w_0 + x_*) - u(w_0)\}} \in (0,1), \tag{4.3}$$

and the corresponding proportion of tied labor, T/L_0 *is given by*

$$\frac{T}{L^0} = \frac{p}{q + p(1-q)}. \tag{4.4}$$

Proposition 3 provides a complete description of the equilibria of the economy. It is stated in two parts. The first says little more than Proposition 1, adding that the equilibrium is simply the equilibrium of the benchmark economy. This is hardly surprising, for the latter equilibrium is simply the one that obtains when tied labor is ruled out by assumption.

The second part characterizes an equilibrium with tied labor, when condition (3.1) *does* hold. The characterization is in several parts. The first, which we call 'employer indifference', states that the discounted wage bill for tied laborers and casual laborers must exactly be the same. Of course, tied laborers receive an extra amount in the slack and a lesser amount in the peak (relative to casual labor), so all this implies that in *utility* terms, tied labor must be strictly better off relative to their casual counterparts.

The reason for employer indifference comes from Proposition 2 and the supposition that tied and casual labor perform the same tasks (in this model). Because (by Proposition 2) there *must* always be casual labor in equilibrium, employers must be indifferent between the hiring of either type of labor whenever there is coexistence. However, this indifference cannot be resolved in an arbitrary way (see below). Only a *particular* percentage of tied labor is consistent with equilibrium. Employer indifference would, however, break down if *supervisory* tied labor were to be included as well. Cost considerations are only secondary in hiring supervisory labor and hence, the discounted sum of wages of a unit of supervisory labor may well exceed that of a casual labor. Indeed, top-level supervisory work is non-monitorable by definition, [25] and would require payment of a premium *over and above* the premium required to ensure contractual fulfilment.

With employer indifference already explained, it is easy to explain why casual wages in the presence of labor tying equals those in the benchmark economy. To begin with, note that the cost per unit of effective labor must remain invariant at $w_0 + \delta w^0$, otherwise there will either be excess demand, or excess supply of effective labor. Next, observe that there will always be some unemployment in the slack season casual labor market because of the nature of the technology. Therefore, equilibrium slack season casual wage cannot be different from w_0. It follows straightaway that the peak season casual wage equals w^0.

The next condition, called partial employee insurance, describes how tied wages are determined. These are stated in terms of the first-order conditions of the optimization problem determining the tied contract. Observe that *irrespective* of the degree of concavity of the utility function, a tied laborer never receives complete insurance. This is due to the incentive constraint. In the absence of the incentive constraint complete insurance *is* optimal. In its presence, however, complete insurance would mean equalization of slack tied wage to peak tied wage. This, together with the necessity to provide the 'incentive premium' in the peak season, would lead to a sub-optimal situation. [26] On the other hand, there is a cost-saving aspect of insurance, and (4.2) dictates the exact amount of insurance provided in the optimum.

The last two conditions (4.3) and (4.4) yield the percentage of tied labor in the economy. One might ask: if employers are absolutely indifferent between tied and casual labor, how is it that this percentage is *exactly* determined within the model? The answer is based on the observation that this percentage determines the reservation utility of a laborer conditional on quitting (or being expelled from) a tied contract. If there is 'too much' tied labor, then the probability of re-employment as a tied laborer is 'high'. Consequently, to meet the incentive constraint and deter tied employees from defaulting on their peak season obligations, tied peak wages must be very attractive. In addition, if the employer must provide insurance, the tied wage bill becomes too high and the employers *strictly* prefer to hire casual labor. This contradicts the supposition that there is tied labor to start with!

If there is 'too little' tied labor, exactly the opposite argument holds. The low reservation utilities of tied labor enables the farmers to offer tied contracts

[25] See Eswaran and Kotwal (1985).

[26] An earlier version of this paper (Mukherjee and Ray, 1992) contains an example where in spite of a strictly concave utility function for laborers, it is impossible to find an incentive-compatible and profitable contract giving full insurance to the employers, even for arbitrarily high levels of seasonality.

involving low wage bills, enabling them to make strictly positive 'savings' (with respect to casual laborers' wage bills) from labor tying. This leads to high levels of labor tying, which, in turn, induces high probabilities of re-employment as tied labor. Then the argument in the previous paragraph applies, and equilibrium labor-tying cannot rise above a certain critical level.

4.2. An explicit solution and some simple comparative statics

As an illustration, consider a simple utility function which satisfies the assumptions put forward in Section 2:

$$u(w) = w^{\gamma}, \quad 0 < \gamma < 1.$$

Under this form of the utility function, we can find an explicit solution for the percentage of tied labor in the terms of the parameters of the model. With such a solution in hand, it is easy to demonstrate a number of comparative statics properties.

An advantage of our particular specification is that the emerging equilibrium configuration will depend only on the *ratio* of the slack season wage to the peak season wage. So, for instance, the necessary and sufficient condition for the existence of labor tying reduces to

$$\lambda > \left[\delta^2(1-q)\right]^{-1/(1-\gamma)}, \tag{4.5}$$

where λ is simply the ratio of peak to slack wages in the benchmark economy. This is a simple formula which is capable, with some modification, of empirical application. [27]

As an illustration, suppose that the quit rate equals 0.2, the coefficient γ equals 0.5, and the discount factor equals 0.9. Then the ratio of peak to slack income must exceed 2.4 before any labor tying can occur. If some self smoothing of consumption can occur, the required ratio is even larger.

We next derive formulae for calculating the optimal contractual terms under the given preferences. Subject to (4.5), the equilibrium payments to tied laborers are given by:

$$x_* = \frac{\delta'\delta w^0 - w_0}{1+\delta'}, \tag{4.6}$$

$$x^* = \frac{w_0 + \delta w^0}{\delta(1+\delta')}. \tag{4.7}$$

where $\delta' = \delta^{(1+\gamma)/(1-\gamma)}(1-q)^{1/(1-\gamma)}$.

[27] One important modification arises from the need to explicitly recognize that the slack and peak season are of different time lengths, so one cannot apply the same discount factor across seasons. Though we eschew a formal treatment of this for expositional ease, this is easily done. It will also be necessary to correct wage rates for involuntary unemployment, especially in the slack season.

These expressions tell us something about the nature of the equilibrium tied contract as the parameters of the system change. Consider, for instance, an increase in the discount factor δ. One would anticipate that this loosens the incentive constraint, permitting employers to offer more insurance and so increasing the utility of the tied worker in equilibrium. This is verified by an examination of (4.6) and (4.7). It is easy to check that the ratio $(x_* + w_0)/w_0$ rises, while the ratio x^*/w_0 falls as δ increases (the algebraic details are omitted).

An increase in seasonality, as measured by the ratio λ, has similar effects. It increases the ratio of the slack tied wage to the slack spot wage $((x_* + w_0)/w_0)$, while lowering the ratio of the peak tied wage to the peak spot wage (x^*/w^0). These implications are easily seen from (4.6) and (4.7). Note, moreover, that it is perfectly possible for a change in seasonality to have *opposite effects* on the utilities of tied and casual workers.

The formula for the probability of obtaining a tied job may be derived as

$$p = \frac{(1+\delta\lambda)^{\gamma}(1+\delta') - (1+\delta')^{\gamma}\delta'^{(1-\gamma)} - (1+\delta')^{\gamma}(\delta\lambda)^{\gamma}}{\delta'(1+\delta\lambda)^{\gamma} - \delta'^{(1-\gamma)}(1+\delta')^{\gamma}}. \tag{4.8}$$

Finally, the proportion of tied laborers t may be recovered from p using (4.4) according to the formula

$$t = \frac{p}{p+q-pq}. \tag{4.9}$$

Intuition leads us to expect that as *seasonality* increases, labor tying increases. It is possible, though tedious, to verify this from (4.8) and (4.9) by direct differentiation. Some numbers may be more illuminating in this regard. Fix the quit rate at 0.2, the coefficient γ at 0.5, and the discount factor at 0.9, and let us vary the extent of seasonality λ. We know that λ must exceed 2.4 for there to be any tying at all. With a seasonality factor of 3, labor tying climbs to 23% of the labor force. With $\lambda = 4$, the proportion of labor tied climbs further to 40%. With $\lambda = 5$, the ratio is 49%. It should be noted that the proportion of tied labor is bounded *away* from unity even as seasonality gets very large. Algebraic verification of this claim is easy. In this example, the upper bound is around 85%. The casual labor market must be active at some minimal level, independent of the degree of seasonality.

A change in risk- or fluctuation-aversion is embodied in our model by a corresponding change in γ. This has effects similar to a change in seasonality, with an increase in γ mimicking a fall in the extent of seasonality.

A decrease in the quit rate will lead to an increase in labor tying, but for different reasons. If the quit rate falls, it implies a lesser number of vacancies for tied-job seekers. In other words, the probability of finding a tied job falls. This makes the incentive constraint easier to satisfy and consequently increases labor tying. Low (exogenous) quit rates are more likely to be associated with a stagnant economy, and by blocking off the access to tied jobs, they can dramatically increase the proportion of tied labor. In the example with $\gamma = 0.5$, $\lambda = 3$ and $\delta = 0.9$, a change in the quit rate from 20% to 3% causes the proportion of tied labor to rise from 23% to fully 84% of the labor force.

Likewise, a fall in the discount factor will lower the level of labor tying. The obvious intuition behind this result is that if the laborers value future less, it is more difficult to provide them incentives not to shirk.

5. Two extensions of the basic model

5.1. A growing economy

In this section, we consider the implications of growth for labor tying.

We retain the description of the economy exactly as put forward in Section 2 of this paper, except for one change. Let us assume, in this economy, both labor supply and labor demand (that is, the marginal productivity of labor), are growing in such a manner as to *balance* each other. In other words, labor supply and productivity change from year to year, but the benchmark wages do not. We assume that all the agents know the growth rates. In that case, the constraints faced by laborers and farmers remain unchanged over time, and more importantly, they know that it does. The notion of the equilibrium is also left unchanged in the sense that in equilibrium there should be no excess demand or supply of labor and the equilibrium payments and probabilities of employment replicate themselves in a self-fulfilling way.

Thus, the economy is, in some sense, stationary and is reasonable sense to look for stationary equilibria in which the tied payments (x_*, x^*) and the proportion of tied laborers (t) remain unchanged from year to year. In that case the incentive and acceptability constraints remain unchanged, and the equilibrium payments (x_*, x^*) and the equilibrium probability of labor tying p will be exactly the same as those described by Eqs. (4.1) to (4.3). The *proportion* of tied laborers will, however, change because in this new environment a different relation connects the proportion of tied laborers to the probability of finding a tied 'job'.

Suppose the labor supply and the number of jobs in the economy is growing at the rate of g. Then in each year there are gt additional tied jobs for each job in the previous year. But similarly the labor supply is also $1 + g$ times the supply in the previous year. This implies

$$p = \frac{qt + gt}{1 - t + qt + g}. \tag{5.1}$$

This represents a higher probability of reabsorption relative to the equilibrium represented in the main body of the paper if the proportion of tied labourers is left unchanged. Consequently, in the new equilibrium, t, the proportion of tied labourers must be lower relative to that in the previous equilibrium. Formally,

$$t = \frac{p + pg}{p + q + g - pq} \tag{5.2}$$

is lower than the number yielded by (4.4) where $g = 0$, and is indeed monotonically decreasing in g.

When is this effect of growth particularly significant? To understand this, take the derivative of t with respect to g in (5.2). We see that

$$\left.\frac{\mathrm{d}t}{\mathrm{d}g}\right|_{g=0} = \frac{(1-q)(p-1)}{\left(\sqrt{p}\,(1-q) + q/\sqrt{p}\right)^2},$$

which suggests that the effect of growth is most dramatic when both the exogenous quit rate is low *and* the necessary and sufficient condition for tying is barely met (p is *also* low). For instance, in stagnant, poor economies where mobility is low and so is the discount factor, these requirements will be met. Note that these conditions do not necessarily imply that the proportion of tied labor will be very high, because this varies inversely with q and directly with p.

To illustrate this point, consider a variant of the example in Section 4.2, amended to include growth. We will take δ to be relatively low, equal to 0.8, $\gamma = 0.5$, the seasonality factor equal to 3, and the quit rate equal to 3%. In this case, 55% of the labor force is tied in the absence of growth. With a growth rate of 2% per annum ($g = 0.02$), the percentage of tied labor drops sharply to 43%. With a larger growth rate of 5% per annum, the corresponding figure is 33%.

5.2. Information flows and labor tying

In this subsection we carry out another extension of the basic model, to explore the notion that rapid growth and change may disrupt the flow of information, thereby reducing labor tying. [28]

To increase the flow of information, we relax the assumption that all laborers are 'faceless' and the farmer has no knowledge of the work history of his employees. Assume that a past history of breach becomes known with probability π, $0 \leq \pi < 1$. This parameter reflects the difficulty (or ease) with which information regarding 'misbehaviour' of a particular laborer diffuses among the farmers.

[28] Does the modern computerized economy possess greater information about its citizens than a timeless, unchanging village economy? The answer is clearly ambiguous. Less ambiguous is the assertion that in the transition from the latter to the former, the flow of information might actually decline, as long as the age-old nexus of personalized transactions is not adequately replaced with other forms of information processing.

This distinction between laborers who have a record of *honest* behavior as opposed to those who reneged on a past contract (or, were *dishonest*) will matter only when they are being considered by a farmer for a tied job. If the farmer is successful in identifying the laborer as dishonest, the laborer will not be given a tied contract. Otherwise the laborer is given the benefit of the doubt and gets the tied contract. For expositional ease, we make the additional assumption that if a dishonest laborer gets a tied job, his reputation is *laundered*, that is, the employers make no distinction between him and a tied laborer with an unblemished past.

Thus we see that a laborer who does not fulfil his contract not only faces eviction into the spot market but also faces greater difficulty being reabsorbed as a tied laborer.

After this extension is incorporated in the analysis, *all* the previous results remain unchanged except the quantitative prediction regarding the proportion of tied laborers. To see this, let us write down the expected lifetime utilities and the acceptability and incentive constraints attached to labor tying. We keep all previous definitions and notations unchanged and introduce three new notations. The first of these is, of course, π. Next, note that with this new assumption, a reneging laborer will have a different expected lifetime utility in the start of the slack season. Let us name this D_*. Finally let $p' \equiv (1-\pi)p$ be the probability of reabsorption for the reneging tied laborer and note that the probability of reabsorption p now has a slightly changed interpretation as the probability with which an honest casual laborer may be employed as a tied laborer.

Now we can write down the explicit expression connecting the expected lifetime utility (D_*) for the casual laborer with a dishonest record to the other lifetime utilities. It is

$$D_* = p'W_* + (1-p')\underline{u} + \delta^2(1-p')D_*. \tag{5.3}$$

The relations connecting the other two lifetime utilities do not change. Using these, it can be shown that

$$V_* - D_* = \frac{(1-\delta^2)p\pi}{(1-\delta^2(1-p))(1-\delta^2(1-p'))} \cdot \left[W_* - \frac{\underline{u}}{1-\delta^2}\right] \geq 0. \tag{5.4}$$

In this extension, the farmer wishes to hire laborers with an honest past. Therefore the acceptability condition must satisfy, as before,

$$W_* \geq V_*. \tag{5.5}$$

The incentive compatibility condition is, however,

$$u(\underline{w}+x_*) + \delta u(x^*) + \delta^2(qV_* + (1-q)W_*)$$
$$\geq u(\underline{w}+x_*) + \delta u(x^*) + \delta^2 D_*,$$

or

$$\delta q(V_* - D_*) + \delta(1-q)(W_* - D_*) \geq u(\bar{w}) - u(x_*). \tag{5.6}$$

These conditions look very similar to the incentive and acceptability conditions in Section 2, so elaborate explanations are unnecessary. We only want to add a clarification. It appears on the face of it that the farmers' decision to recruit only laborers with an honest past unnecessarily raises wage costs, because there are not really two types of laborers with different intrinsic characteristics. However, it will emerge that in equilibrium the acceptability condition is fulfilled whenever the incentive compatibility condition is, so this distinction will not make any difference.

As in the previous extension, the concept of an equilibrium remains unchanged. Then we have:

An equilibrium with positive levels of labor tying exists iff (3.1) is true and the equilibrium wage configurations are identical to those described in Proposition 3.

To see this, note first of all that *in equilibrium*, incentive compatibility implies acceptability. This may be verified computationally. The intuition is that in equilibrium, acceptability is ensured whenever $u_* \geq \underline{u}$. This, together with the profitability condition, necessitates that the farmer should provide some insurance to make the contract attractive to both parties.[29] It immediately follows that the incentive condition implies acceptability.

Given this, Propositions 1 and 2 follow.

To see that a similar set of first-order conditions hold, recall the individual farmer's objective and note that this extension has ultimately changed nothing in it except the incentive constraint (since the acceptability constraint may be ignored in equilibrium). This incentive constraint may be written as

$$\delta(1-q)(\underset{\sim}{W} - V_*) + \frac{\delta p \pi (u_* - \underline{u})}{(1-\delta^2(1-p'))(1-\delta^2(1-p)(1-q))} \geq u(\bar{w}) - u(\underset{\sim}{x}) \tag{5.7}$$

which demonstrates that nothing has changed except an additive constant. So, the relation (4.2) connecting the slack and peak season wages remains unchanged. The same applies to relation (4.1) because this extension does not in any way break down the perfect substitutability of tied labor for casual labor.

There is one change in the results. Note that (5.7) is less stringent than (2.6), *which implies that the equilibrium proportion of tied laborers should increase in* π. This is perfectly intuitive. If deviants can be separately identified, there is no

[29] This statement is equivalent to the 'Fact' of Section 3.

need for the reabsorption probability into tied labor to also be low for honest workers. Our main analysis assumed $\pi = 0$. It can now be seen that as there is a breakdown in information transmission (so that π declines), the equilibrium proportion of tied labor will fall. As discussed above, growth and change in the early stage of economic development may cause precisely this sort of informational reduction.

6. Conclusion

In conclusion, we summarize our results and also compare our main findings with secondary empirical data.

In this paper we have characterized the equilibrium level of labor tying in an agricultural economy. In this economy the co-existence of seasonality coupled with relatively higher risk-aversion among laborers facilitates the existence of implicit contracts. Nevertheless, as discussed above, such insurance encourages contractual nonfulfilment in situations where the spot wage exceeds the tied wage. We examine incentive-compatible equilibria, which necessitates an analytical framework different from the standard implicit contract theory. The model is rich in terms of empirical predictions. In particular:

1. The casual labor market is *always* active, despite the presence of seasonality and the scope for income smoothing;
2. Indeed, unless the degree of seasonality exceeds some positive lower bound (exactly characterized in our model), there will be no labor tying at all;
3. A higher level of seasonality in labor market activity, in the sense of an increase in the ratio of peak to slack spot wages, implies a higher proportion of tied labor;
4. Balanced intertemporal increases in labor supply and demand ('balanced growth') *reduces* the proportion of tied labor;
5. A reduction in information regarding worker histories reduces the proportion of tied laborers;
6. An increase in turnover rates implies a reduction in the proportion of tied laborers. That is, any social or economic factor such as the breakdown of patron–client relations or increased migration of laborers which increases turnover of tied labourers, will lead to fall in the proportion of tied contracts offered;
7. Incomes of tied laborers will be equal to the incomes of casual laborers, although they will enjoy a strictly higher level of utility; and
8. Incomes of tied laborers exhibit less fluctuation as compared to casual laborers, although they are not fully insured.

Economic growth has features described in items 3, 4, 5 and 6, as discussed above. The effect of economic growth can therefore be quite complex. But the predictions above generally suggest that economic growth will lead to a reduction in tied labor contracts. We have already discussed studies on this subject in the Introduction. There is also a sizeable literature on casualization of labor relations which refers to the resumption of land for self-cultivation following the introduction of the new seed-fertilizer technology, to which references may be found in Bardhan (1977). Beteille (1979) also confirms that the breakdown of patron–client relations together with the decline of use of exchange labor has led to the emergence of casual laborers as the most important category of hired laborers in Indian agriculture.

An exception occurs if economic growth also brings about a marked increase in the seasonality of wage patterns. That a higher level of seasonality, in the sense of a higher interseasonal wage ratio, implies a higher level of labor tying has earlier been demonstrated both theoretically and empirically by Bardhan (1983). Therefore, the assertion that labor tying is, on average, falling is not in conflict with the observation that in certain parts of India labor tying may be on the increase. Moreover, such an increase may also be due to the increased use of nonmonitored labor (Sundari, 1981; Mukherjee, 1992). Finally, it is possible that other aspects of seasonality may actually decline with economic development, *and* that this leads to an increase in labor tying. For instance, multiple cropping might lead to an increase in labor tying by lowering the costs of hoarded labor (Bardhan, 1984, Ch. 4)).

The wages received by attached laborers (performing casual tasks), particularly in the peak season, are generally lower than the wage received by casual laborers. Bardhan and Rudra (1981) show that in 78% of the villages in West Bengal where tying was observed, attached laborers received lower wages as compared to casual laborers in the peak seasons. [30] Breman (1974) mentions that laborers receive lower wages in the peak season when they work for the employer they are attached to as compared to their earnings from other employers. On the other hand, tied laborers enjoy greater security as compared to non-tied laborers in the slack season. That is, the incomes of laborers is smoothed to some extent. [31]

Our results pertaining to increased growth, mobility or information dissemination should be viewed as theoretical pointers toward an explanation for a general secular decline in the numbers of attached laborers performing casual tasks. Finally, the theory suggests the need to differentiate this group of laborers from those performing non-monitored tasks, whose importance may well increase with the pace of economic development and technological change.

[30] See this study for a detailed discussion of various categories of labor tying. Our observations here refer to 'semi-attached labor' as defined by these authors.

[31] Even in situations where consumption loans are not available, it is well-known that laborers enter attached labor relations in order to improve security.

7. For further reading

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Appendix A

Lemma 1. For any z, the solution to the problem

$$\min \underset{\sim}{x} + \delta \tilde{x},$$

subject to

$$\overline{w} \geq \tilde{x}, \tag{A.1}$$

$$u(\tilde{x}) + \delta(1-q)\underset{\sim}{W} \geq u(\overline{w}) + \delta(1-q)V_*, \tag{A.2}$$

$$\delta\overline{w} \geq \underset{\sim}{x} + \delta\tilde{x}, \tag{A.3}$$

is identical to that of the problem

$$\min_{\underset{\sim}{x},\tilde{x}} \underset{\sim}{x} + \delta\tilde{x},$$

subject to (A.2), (A.3) and

$$\underset{\sim}{W} \geq V_*. \tag{A.4}$$

Proof. We show that the two feasible sets are the same. Let $(\underset{\sim}{x}, \tilde{x})$ satisfy (A.1) to (A.3). To verify (A.4), simply note from (A.2) and (A.1) that $\delta(1-q)(\underset{\sim}{W} - V_*) \geq u(\overline{w}) - u(\tilde{x}) \geq 0$.

Conversely, let $(\underset{\sim}{x}, \tilde{x})$ satisfy (A.2) to (A.4). The constraint (A.4) can be equivalently written as $(1-\delta^2(1-p)(1-q))(\underset{\sim}{u} - \underline{u}) - p(u_* - \underline{u}) \geq 0$ which implies, under our assumption that $u_* \geq \underline{u}$, $\underset{\sim}{u} \geq \underline{u}$. Now, suppose on the contrary that (A.1) is not satisfied. Then $\overline{w} < \tilde{x}$. By (A.3), we get, therefore, $\underset{\sim}{x} < 0$. Then $\underset{\sim}{u} \geq \underline{u}$ is equivalent to $\delta(u(\tilde{x}) - u(\overline{w})) \geq u(\underline{w}) - u(\underline{w} + \underset{\sim}{x}) \Rightarrow \delta(\tilde{x} - \overline{w})u'(\overline{w}) \geq (\underline{w} - \underset{\sim}{x} - \underline{w})u'(\underline{w}) \Rightarrow \delta(\tilde{x} - \overline{w}) > -(\underset{\sim}{x}) \Rightarrow \delta\overline{w} < \underset{\sim}{x} + \delta\tilde{x}$. This contradicts (A.3) and completes the proof. □

Proof of Fact. Suppose that a nontrivial labor tying contract exists for fully tied laborers. Then $(\underset{\sim}{x}, \tilde{x}) \neq (0, \overline{w})$ and $\underset{\sim}{x} + \delta\tilde{x} \leq \delta\overline{w}$. So, by Lemma 1, $\tilde{x} < \overline{w}$ and $\underset{\sim}{x} > 0$. □

Lemma 2. In any equilibrium, the equilibrium casual wages $(\underline{w}, \overline{w})$ are equal to the benchmark wages w_0 and w^0.

Proof. If there is no tied labor in equilibrium, then it is obvious that the equilibrium is the same as that of the benchmark economy and we are done.

Otherwise, $T > 0$. First of all note that there can never be full employment in the slack season because $\alpha < 1$. Therefore $\underline{w} = w_0$.

Now consider the case where $0 < T < \overline{L}_0$. Because tied and casual labor are perfectly substitutable, $\delta\overline{w} = x_* + \delta x^*$. But then, the cost of a unit of effective labor remains unchanged and it follows that the total amount of effective labor employed must be the same as that in the benchmark economy. Therefore, $\alpha w_0 + \delta w^0 = \alpha\underline{w} + \delta\overline{w}$. Moreover, $\underline{w} = w_0$. Therefore $\overline{w} = w^0$.

Finally, let $T = \overline{L}_0$. In that case, the spot market is inactive in the peak season. But it is active in the slack season and $\underline{w} = w_0$. Further, in case a tied laborer joins the spot market in the peak season he will get a wage exactly equal to his marginal productivity. This equality occurs at $\overline{w} = w^0$. This completes the proof. □

Proof of Proposition 1. Consider the following problem, to be called problem B:

$$\min_{\underset{\sim}{x}, \tilde{x}} \underset{\sim}{x} + \delta \tilde{x}, \tag{A.5}$$

subject to

$$w^0 \geq \tilde{x}, \tag{A.6}$$

$$\delta(1-q)u(\underset{\sim}{x}) + u(\tilde{x}) \geq \delta(1-q)u(w_0) + u(w^0), \tag{A.7}$$

$$\delta w^0 \geq \underset{\sim}{x} + \delta \tilde{x}. \tag{A.8}$$

We claim that (B) has a solution with $\underset{\sim}{x} + \delta \tilde{x} < \delta w^0$ if and only if (3.1) holds.

Suppose, first, that (B) has a solution with $\underset{\sim}{x} + \delta \tilde{x} < \delta w^0$. Then it must be that $w^0 > \tilde{x}$ and so, by (A.7), $0 < \underset{\sim}{x}$. Using (A.7) again and the strict concavity of $u(\cdot)$, together with $\underset{\sim}{x} + \delta \tilde{x} < \delta w^0$, we get

$$u'(w^0)(w^0 - \tilde{x}) < u(w^0) - u(\tilde{x}) \leq \delta(1-q)\big(u(w_0 + \underset{\sim}{x}) - u(w_0)\big)$$
$$< \delta(1-q)u'(w_0)\underset{\sim}{x} \leq \delta^2(1-q)u'(w_0)(w^0 - \tilde{x})$$

which, together with the definitions of w_0 and w^0, establishes (3.1).

Conversely, suppose that (3.1) holds. For $\epsilon > 0$, define $\underset{\sim}{x}(\epsilon) \equiv \epsilon$ and $\tilde{x}(\epsilon) \equiv w^0 - \epsilon/\delta$. For the pair $(\underset{\sim}{x}(\epsilon), \tilde{x}(\epsilon))$, (A.6) and (A.8) are met. We show that for small ϵ, (A.7) is met with *strict inequality*. To see this, note that for some $\theta(\epsilon) \in (\tilde{x}(\epsilon), w^0)$ and $\eta(\epsilon) \in (0, \underset{\sim}{x}(\epsilon))$, we have:

$$\frac{u(w^0) - u(\tilde{x}(\epsilon))}{\epsilon} = \frac{u'(w^0)}{\delta} - u''(\theta(\epsilon))\frac{\epsilon}{2\delta^2} \tag{A.9}$$

and

$$\frac{\delta(1-q)\big[u\big(w_0 + \underset{\sim}{x}(\epsilon)\big) - u(w_0)\big]}{\epsilon}$$
$$= \delta(1-q)u'(w_0) + \delta(1-q)\frac{\epsilon}{2}u''(\eta(\epsilon)). \tag{A.10}$$

Combining (A.9) and (A.10) and using (3.1), we see that for the choice of sufficiently small $\hat{\epsilon} > 0$, (A.7) holds with *strict* inequality. Consequently, we can choose $(\underset{\sim}{x}, \tilde{x})$ such that (A.6) to (A.8) are met, with (A.8) holding with strict inequality (simply take $\underset{\sim}{x} = \underset{\sim}{x}(\epsilon)$ and $\tilde{x}$ less than but 'close to' $\tilde{x}(\epsilon)$).

This completes the proof of the claim.

Now we finish the main proof. Suppose that there is labor tying in equilibrium. Recall from Lemma 2 that $\underline{w} = w_0$ and $\overline{w} = w^0$ in equilibrium. Then using the fact that labor tying is nontrivial, it is easy to see that a nontrivial solution must exist to Problem (B). By the claim, (3.1) holds.

Conversely, suppose that (3.1) holds but that there is no labor tying in equilibrium. Then it is easy to see that each employer's labor-tying problem, via Lemma 1, reduces to (B) (simply set $p = 0$ and use Lemma 2 to argue that $\underline{w} = w_0$, $\overline{w} = w^0$). But by the claim, there exists a non-trivial solution to (B), which contradicts condition (2.8) of the equilibrium, and we are done. □

Proof of Proposition 2. Suppose not. By the Inada conditions on $F(\cdot)$, some positive employment takes place in equilibrium. So if the casual labor market is inactive, it must be that $T > 0$. By Proposition 1, (3.1) must hold. This in turn implies that $p = 1$. That is, there is no involuntary unemployment because, by (3.1), $F'(L_0) > w_0$.

Let W_* be given by the equilibrium. Now observe that by (2.2) and using $p = 1$,

$$V_* = W_*$$

in both the cases above. Using this in the incentive constraint (2.6), and recalling the condition (2.8) of the equilibrium,

$$u(x^*) + \delta(1-q)W_* \geq u(\overline{w}) + \delta(1-q)V_* \geq u(\overline{w}) + \delta(1-q)W_*$$

so that $u(x^*) \geq u(\overline{w})$. But this contradicts the Fact. □

Lemma 3. If $\delta^2(1-q)u'(\underline{w}) > u'(\overline{w})$, then there exists a unique pair (x_*, x^*) such that

$$\delta^2(1-q)u'(\underline{w} + x_*) = u'(x^*), \tag{A.11}$$

$$x_* + \delta x^* = \delta\overline{w}, \tag{A.12}$$

$$x_* > 0, \tag{A.13}$$

$$x^* < \overline{w}. \tag{A.14}$$

Proof. Define a function $g(w)$ by

$$\delta^2(1-q)u'(g(w)) = u'(w). \tag{A.15}$$

Then it is clear that $g(w)$ is continuous and monotonically increasing. Moreover, $g(\overline{w}) + \delta\overline{w} > \underline{w} + \delta\overline{w}$ by the condition of Lemma 4. Also, $g(\underline{w}) < \underline{w} < \overline{w}$, so $g(\underline{w}) + \delta\underline{w} < \underline{w} + \delta\overline{w}$. So by the monotonicity of $g(w) + w$, there is a unique $w^* \in (\underline{w}, \overline{w})$ such that $g(w^*) + \delta w^* = \underline{w} + \delta\overline{w}$. Clearly, $g(w^*) > \underline{w}$ (because $w^* < \overline{w}$). Defining $x_* \equiv g(w^*) - \underline{w}$, we are done. □

Lemma 4. In any equilibrium with non-trivial labor tying, the constraint (A.2) must hold with equality.

Proof. Suppose that (A.2) is not binding for an optimal pair $(\underset{\sim}{x}, \tilde{x})$. Consider a new pair, for small $\epsilon > 0$, $(\underset{\sim}{x}', \tilde{x}')$ such that $\underset{\sim}{x}' = \underset{\sim}{x} + \epsilon$ and $\tilde{x}' = \tilde{x} - \epsilon/\delta$. Then $\underset{\sim}{x}' + \delta\tilde{x}' = \underset{\sim}{x} + \delta\tilde{x}$ and it is easy to check that $\underset{\sim}{W}'$, defined for $(\underset{\sim}{x}', \tilde{x}')$ in the same manner as $\underset{\sim}{W}$, will satisfy $\underset{\sim}{W}' > \underset{\sim}{W}$, so that constraints (A.1) to (A.3) hold with strict inequality for $(\underset{\sim}{x}', \tilde{x}')$. Now define $(\underset{\sim}{x}'', \tilde{x}'')$ by $\underset{\sim}{x}'' = \underset{\sim}{x}'$ and $\tilde{x}'' = \tilde{x}' - \eta$ for η small but positive. Then, too, constraints (A.1) to (A.3) hold and $\underset{\sim}{x}'' + \delta\tilde{x}'' < \underset{\sim}{x} + \delta\tilde{x}$. This is a contradiction to the supposition that $(\underset{\sim}{x}, \tilde{x})$ is the optimal solution. □

Proof of Proposition 3. (i) If condition (3.1) fails to hold, then, by Proposition 1, there is no labor-tying in equilibrium. Consequently, the equilibrium is simply that of the benchmark economy.

(ii) If condition (3.1) does hold, then the equilibrium involves labor tying. By Lemma 2, the casual wages $(\underset{\sim}{w}, \overline{w})$ equal (w_0, w^0), the casual wages of the benchmark economy. By the identical nature of casual and tied jobs, (4.1) must hold. Since labor tying is non-trivial, the first-order conditions to the employer's minimization problem in Lemma 1 must hold with equality, and thus we get (4.2). Moreover, Lemma 3 tells us that a pair (x_*, x^*) satisfying (4.1) and (4.2) must exist uniquely.

It only remains to determine the probability of tied employment p. To do this, first use Lemma 4 to argue that (A.2) holds with equality. Rewriting (A.2) with equality at equilibrium, we get

$$u(w^0) - u(x^*) = \delta(1-q)[W_* - V_*] \tag{A.16}$$

and by writing out the closed form expressions for W_* and V_*, we get

$$W_* - V_* = \frac{(1-p)(u_* - \underset{\sim}{u})}{1 - \delta^2(1-p)(1-q)}. \tag{A.17}$$

Combining (A.16) and (A.17) we get

$$p = 1 - \frac{u(w^0) - u(x^*)}{\delta(1-q)[u(w_0 + x_*) - u(w_0)]}$$

which is nothing but (4.3).

Finally, we need to check that (4.3) makes sense. Clearly, $p < 1$ as given by (4.3). So all we need to do is make sure $p > 0$. To do this, we make use of (4.1), (4.2) and the strict concavity of $u(\cdot)$ in the following calculation:

$$\begin{aligned} u(w^0) - u(x^*) &< u'(x^*)(w^0 - w^*) \\ &= \frac{u'(x^*)}{\delta}(x_* + w_0 - w_0) = \delta(1-q)u'(w_0 + x_*)x_* \\ &< \delta(1-q)[u(w_0 + x_*) - u(w_0)] \end{aligned}$$

and the proof is complete. □

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