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WP 48 December 1988

World Institute for Development Economics Research of the United Nations University

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The nature of labour market in traditional rural societies has attracted a lot of attention in the recent years. One issue that has appeared particularly intriguing is the process of wage determination. After a good deal of theorising as well as detailed empirical research, the matter still remains largely unresolved. This paper takes a fresh look at this issue, focussing specifically on the casual or daily labour market of the kind typically observed in rural South Asia. In contrast to much of current thinking which emphasizes the role of employers' behaviour, we examine the point of view of workers and suggest the hypothesis that the process of wage determination is best seen as an act of 'implicit co-operation' among them. The basic approach is motivated in section I by noting, very briefly, the inadequacies of some of the major alternative approaches. Section II sets out the empirical context and assumptions underlying the formal model which is developed in section III. The model is informally extended in section IV in order to examine certain real-life features of rural labour markets, and finally some concluding remarks are offered in section V.

I The Point of Departure:

Since the early days of development economics it has been widely believed that the normal apparatus of supply and demand cannot be employed to explain the process of wage determination in rural labour markets of poor agrarian economies. This belief was fostered by the general acceptance of a couple of stylised facts.

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* The author is deeply indebted to Kausik Basu for many helpful suggestions and advice at various stages of research on this paper, and also to Tariq Banuri, Amit Bhaduri, Jacques Drèze, Jean Drèze, James Friedman, Robert Pringle and Amartya Sen for helpful comments. The author alone is, however, responsible for any remaining error.

Firstly, it was noted that the real wage was fairly inflexible, specially in the downward direction. This observation led to the notion of a horizontal supply curve of labour which came to form the backbone of Lewis-type dual economy models. Secondly, it was observed that the wage rate generally exceeded the opportunity income of labour which was expected to be close to zero in densely populated areas with very little opportunities of non-farm employment. This divergence was presumed to give rise to involuntary unemployment, though much of it was believed to remain hidden in the form of disguised unemployment.

Early theorising on rural wages was concerned primarily with accounting for these stylised facts. In doing so, some theories (e.g. the so-called 'subsistence' theories) denied the role of economic calculations altogether and invoked the notion of social norm as the basis of rural wages. Others, generally known as the 'efficiency wage' theories, did allow for the logic of economic calculus and tried to show that it could be rational for the employers to offer a wage rate which lies above the opportunity income of labour and remains insensitive to moderate changes in supply and demand.[1]

Over time, however, new facts have emerged which none of these theories can adequately explain. A growing body of detailed field research has called into question the empirical validity of the first stylised fact. It is now generally recognised that wage rates do vary a great deal both over time and across adjacent areas. Moreover, these variations seem to correspond fairly closely to the balance of supply and demand for labour.[2]

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1. The most influential of these theories is the nutrition-based efficiency wage model initiated by Leibenstein (1957) and developed in great details by Bliss and Stern (1978). Other variants build upon the notions of turnover cost, labour disciplining etc. which underlie the efficiency wage theories developed for the industrialised economics. But their relevance for a typical rural labour market in the developing world has always seemed minimal. For excellent critical evaluations of efficiency wage theories in the context of rural labour markets, see Binswanger and Rosenzweig (1984a) and Drèze and Mukherjee (1987), among others.

2. The evidence is well-documented in K. Bardhan (1977), chap. 4 of P. Bardhan (1984) and the various micro-studies reported in Binswanger and Rosenzweig (1984).

With this change in the perception of reality, the fashion of theorising has now swung in the opposite direction. It is now being suggested that the neoclassical theory of supply and demand does after all give a good enough account of how rural wages are formed (e.g. Binswanger and Rosenzweig, 1984a; Lal, 1984). A natural corollary of this theory is that there is no such thing as involuntary unemployment in the rural areas i.e., the labourers actually bid up or down the wage rate until it is equated with opportunity income at the margin. In other words, the second stylised fact is also being thrown overboard along with the first.

We shall maintain in this paper that while the first stylised fact clearly deserves to be rejected, it will be wrong to abandon the second. Neither casual observation nor detailed field surveys lend credence to the idea that the bulk of those who 'fail' to find agricultural employment in lean seasons do so voluntarily as their reservation wage happens to exceed the going wage rate.[3] In fact, there is striking evidence of involuntary unemployment in the very set of studies from which Binswanger and Rosenzweig (1984a) purport to draw support for the neoclassical paradigm. In one such study, Ryan and Ghodake (1984) have noted from a sample of villages in semi-arid India that the male (female) workers failed to obtain wage employment 39 per cent (50 per cent) of the times they tried to do so in slack periods. No amount of friction or temporary mismatch can explain 'market failure' on such a massive scale. The fact of the matter is that the current resurgence of the neoclassical approach is not based on a direct refutation of the existence of involuntary unemployment. The mere observation that supply and demand affect the wage rate is taken as a prima facie evidence in its support. This will clearly not do. What is needed is a theory of wage formation that can simultaneously explain the existence of involuntary unemployment on the one hand and responsiveness to the forces of supply and demand on the other. It is precisely the objective of this paper to offer such a theory.

We should mention though that the need for developing such a theory has not gone entirely unheeded in the literature. At least a couple of recent theoretical enquiries has made significant contribution in this

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3. See, for example, the findings of Bardhan (1984, p. 60).

regard. In one of them, Dasgupta and Ray (1986) have extended the nutrition-based efficiency-wage hypothesis to the framework of competitive equilibrium, and shown that involuntary unemployment can exist in a competitive market which is sensitive to the forces of supply and demand. It is however important to note that they happen to adopt a somewhat broader concept of involuntary unemployment than what is conventionally implied by this term. They classify a person as involuntarily unemployed if his well-being is lower than that of a similar person who is employed at the going wage rate. This situation is consistent with the unemployed person's reservation wage being above the market wage, in which case he will not be called involuntarily unemployed in the conventional sense (i.e., in the sense of the failure of labour market to clear). However, even the conventional kind of involuntary unemployment can plausibly occur in their model (in 'Regime 2', pp. 1024-5).

While this approach has many interesting features, it does suffer, in common with the earlier efficiency wage models, from a certain lack of concordance with facts. In particular, its prediction that workers of different abilities will be paid different wages runs counter to the very common phenomenon observed in different parts of Asia that a near-uniform wage rate prevails for a given task in a given locality. We shall be concerned with this phenomenon in section IV where the relevant evidence will be cited and an attempt will be made to understand it in the light of our own approach.

A rather different line of enquiry has been pursued, in a formal theoretical framework, by P. Bardhan (1984) and, more informally, by K. Bardhan (1977, 1983). The central idea is that of seasonality of agricultural operations and the way it affects the nature of labour contracts. Specifically, the employers' need for ensuring timely and reliable supply of labour in the peak season is supposed to generate labour-tying arrangements whereby particular workers are given privileged employment in the lean season in return for a commitment to supply labour in the peak season. Such arrangements give rise to the institution of semi-attached labour and are also presumed to affect the process of wage formation. Bardhan's model purports to show that this process will lead to a wage rate which induces involuntary unemployment while being duly

sensitive to supply and demand (Bardhan 1984, p. 61). As it happens, however, the sensitivity part is indeed displayed by the model, but not the existence of involuntary unemployment. The employers are shown to have an incentive to create a divergence between marginal product and the wage rate, but not between wage rate and the marginal supply price of labour. Since the workers thus remain on the supply curve at the margin, the question of involuntary unemployement does not arise.

In her informal exposition of much the same ideas, K. Bardhan suggests that the market will fail to clear because the workers will try to secure lean season employment not by bidding down the current wage, but by offering to work at a lower wage in the peak season (Bardhan 1983, p. 43). There are at least two problems with this argument. In the first place, the idea of bidding down the peak wage does not seem to be borne out by facts. In their detailed study of labour-tying contracts in West Bengal, Bardhan and Rudra (1981) have found that the peak season wage falls below the market rate only for those semi-attached labourers who had previously taken consumption loan or land allotment from their employers. In such cases, the wage differential is really a hidden interest or rental charge, so that one cannot speak of bidding down the real value of peak wages. In fact, when labour commitment is not based on loan or land, the peak season wage rate for tied labour is typically above the market rate (Bardhan and Rudra 1981, p. 98). Secondly, it is not at all clear why the workers should not bid down the wage rate in the lean season. If involuntary unemployment exists i.e., if the wage rate stays above the reservation level at the margin, some workers are bound to be rationed out. Why wouldn't they try to improve their prospect of present employment by accepting a slightly lower wage today, while offering the same future commitment of labour as others? This part of the story is not explained.

And this is precisely the point of departure for the present enquiry. All the models that seek to explain non-market-clearing wage rate have one thing in common: they all look for an explanation from the employers' side of the market. On the other hand, it is the personal experience of the present author from his observation of rural societies in South Asia that it is the workers rather than employers who resist the wage rate from being

pushed down to the competitive level.[4] Moreover, they do so with full awareness that they may not find any work on a given day and may end up with an income far less than the going wage. The theoretical task is to explain this behaviour and it is to this task that this paper is addressed.

We start by rejecting the usual assumption that workers treat the going wage rate parametrically, responding passively to whatever rate the 'market' comes up with. On the other hand, we do not go to the other extreme of assuming that they collectively bargain with employers. The near-absence of collective bargaining in rural South Asia has been widely noted, and explained by the absence of institutional mechanisms for ensuring explicit collusion through enforceable contracts. It is a basic hypothesis of this paper that in the specific institutional setting of rural South Asia, workers' behaviour is best understood as individual choice of wage rates based on strategic considerations. Each worker decides what wage rate to seek in exchange of his services, but in doing so he contemplates the likely actions of others and the way those actions are going to affect his own probability of employment. In a casual labour market, where new contracts are made every day, such strategic behaviour naturally assumes the properties of a 'repeated non-cooperative game'. It is well-known in the game-theoretic literature that 'implicit co-operation' of self-enforcing nature is possible in a repeated game even if there is no mechanism for explicit co-operation at any stage. This result is central to our analysis. It will be shown in this paper that the wage rate achieved through such implicit co-operation may well lie above the competitive level and yet be sensitive to the forces of supply and demand.

II The Empirical Context, Assumptions and the Concept of Equilibrium

The model proposed in this paper is not intended to describe the process of wage determination in any arbitrary rural labour market. Its

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4. Others have noticed this too. For example, Bardhan and Rudra (1981) were told by 95% of the workers in their sample that they never tried to secure employment by undercutting the going wage rate. In a separate survey, Rudra (1982) was told by 79% of employees and 99% of employers that undercutting was resisted by the workers themselves. See also Drèze and Mukherjee (1987).

specific domain is a kind of rural society which is characterised by two particular attributes viz., (i) 'closed' labour market and (ii) 'settled' technology.

The assumption of 'closed' labour market is an abstraction of the familiar idea that the village labour markets happen to be highly segregated. The workers of a certain village (or in some cases a cluster of tiny villages) do not normally seek daily farm-employment outside their village (or cluster). Such traditional boundaries are of course often transcended in the case of non-farm employment as well as long-term regular jobs on the farms; but 'casual' wage employment in agriculture, which is the market we are studying here, does seem to respect fairly narrow geographical boundaries.[5]

The assumption of 'settled' technology is meant to capture the idea that workers are aware of the demand conditions prevailing in the market in which they traditionally operate. This notion should, however, be distinguished from 'static' technology. It is not being suggested that the model is incapable of dealing with technological change. All that is required is that workers should be fully aware of the impact of such changes on the conditions of demand. The case of 'transition', where the impact of change is yet to become fully evident, raises interesting theoretical problems which will be discussed in section IV in an informal extension of the basic model.

Together, the assumptions of closed market and settled technology imply that a given stock of workers (N) face a given demand condition. Demand may of course vary from day to day within a crop year, depending on the periodicity of agricultural operations; but everybody is assumed to know what the demand conditions are at any particular time of the crop calender. However, in order to develop the core idea as simply as possible, the question of seasonality is abstracted from in the basic model of section III. The implication of shedding this abstraction is explored in section IV.

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5. A large body of evidence is cited in Drèze and Mukherjee (1987). Rudra (1984) and Bardhan and Rudra (1986) have discussed why workers and employers find it mutually advantageous to respect the boundaries of closed market.

The configurations of supply and demand determine the 'probability of employment' which, as we shall see, is a crucial element in our analysis. Each worker's perception of his 'probability of employment' plays a big part in determining what wage rate he will demand in return for his services. In specifying the probability of employment under various circumstances, we shall generally assume that with given demand conditions, each person's probability of employment depends only on his wage bid relative to that of others. This is essentially a neutrality assumption which requires that non-wage characteristics such as skill, caste, kinship, patron-client relationship etc. have nothing to do with the prospect of employment. The assumption of neutrality with respect to skill is however only a temporary one, designed to keep things simple in the basic model of section III. The complications arising from differential skill will be discussed in section IV. Insofar as other personal characteristics are completely ignored, we are in effect restricting the scope of our model to those situations where a system of exchange based on patron-client relationships is being replaced by an impersonal labour market characterised by unattached casual labour.[6]

Armed with the neutrality assumption, we can now proceed to add some flesh to the notion of probability of employment. For the ith worker, the probability is denoted by $\theta_i(\underline{w})$, where $\underline{w}$ denotes the vector of wage demands from all workers. First consider the simplest case of a common wage rate w restricted to the meaningful case of $w \geq w^c$ where w^c represents the competive wage. Thanks to the neutrality assumption, every worker will enjoy the same probability of employment in this case, given by the ratio between demand and supply of labour at w. We thus have the first property of θ:

$$\text{(i)} \quad \theta_i(w) = \frac{l(w)}{n(w)}\,; \text{for all } i = 1, \ldots, n \text{ and all } w \geq w^c \qquad (1)$$

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6. The erosion of traditional patronage systems has been widely noted by many observes of rural South Asia. What is more significant though is the emergence of a new kind of labour attachment associated with agricultural growth (Bhalla 1976, Bardhan and Rudra 1981, Rudra 1987). The neutrality assumption obviously does not hold in these cases. However, taking rural South Asia as a whole, the category of unattached casual labour still remains the most preponderant type of wage labour in agriculture.

when w^c is such that $l(w^c) = n(w^c)$ and l and n refer to the demand and supply curves of labour respectively.

From the usual assumptions of downward sloping demand curve and non-decreasing supply curve of labour, we also get a second property for the common wage case:

The higher the common wage rate, the lower is the probability of employment for each worker i.e.,

$$\text{(ii)} \quad \theta_w = \frac{\partial \theta_i(w)}{\partial w} < 0 \text{ ; for all i, for } w \geq w^c \tag{2}$$

Now consider the case of non-uniform wage-bids given by the vector $\underline{w}$. Let us arrange the wage-bids in an ascending order and designate each worker by the rank of his wage, so that the i'th worker refers to the person whose wage bid occupies the i'th position from the bottom. Let the curve plotting this ranked vector meet the demand curve at the wage rate w_e. Now if everyone were to ask for the wage rate w_e, then the demand for labour would be equal to $e = l(w_e)$. It means that anyone who bids less than w_e is assured of getting a job, on the safe assumption that the employers will try to minimise the wage bill. We can also say that anyone who bids exactly w_e will have a positive probability, albeit less than unity if the total number of workers bidding w_e or less exceeds the number e.

We now have the following properties of θ, in the case of non-uniform wage bids:

(iii) For a non-uniform (ranked) wage vector $\underline{w}$,

$$\theta_i(\underline{w}) > 0 \text{ for all i such that } w_i \leq w_e \tag{3}$$

and $$\theta_i(\underline{w}) = 1 \text{ for all i such that } w_i < w_e \tag{4}$$

where w_e is an element of $\underline{w}$ which satisfies the equation $l(w_e) = e$.

The concept of equilibrium

In contrast to the Walrasian story of competitive equilibrium, we do not assume that the workers are passive price-takers. In our story, each worker consciously takes a decision on which wage-rate to bid, and in doing so he takes into account what he expects others to do. An equilibrium is established when each worker finds that it does not pay to revise his bid, given the bids of others. This is the familiar concept of Nash equilibrium. It does not rule out the possibility of arriving at a competitive equilibrium, where the supply and demand curves intersect each other. But a Nash equilibrium need not necessarily coincide with a competitive equilibrium even when full competition is assumed to exist on both sides of the market. We shall define the concept more formally below.

Consider that worker i is contemplating to bid w_i. On the basis of his perceived wage-vector $\underline{w} = (w_1, \ldots, w_i, \ldots w_N)$, consisting of his own bid as well as the expected bids of others, he estimates what his own probability of employment, $\theta_i(\underline{w})$, will be; and his expected pay-off P_i is then given by

$$P_i(\underline{w}) = \theta_i(\underline{w}).w_i + [1 - \theta_i(\underline{w})]\, c_i \qquad (5)$$

where c_i refers to his opportunity income.

We assume that the objective of each worker is to maximise his expected pay-off.[7] Specifically, his strategy is to choose a wage bid, given the bids of others, such that his own expected pay-off is maximised.

If he contemplates a wage bid w_i' instead of w_i and all others are assumed to bid the same wages as specified in $\underline{w}$, the new wage vector is denoted by $(\underline{w} \setminus w_i')$. Now, if for any given $\underline{w}$, there exists a $w_i' \neq w_i$ such that $P_i(\underline{w} \setminus w_i') > P_i(\underline{w})$, then clearly $\underline{w}$ cannot be an equilibrium vector, because i has an incentive to bid w_i' rather than w_i when all others are bidding exactly as specified in $\underline{w}$. This gives rise to the following definition of equilibrium.

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7. We could have assumed instead that the objective is to maximise expected utility; but it does not add anything, except to the algebra.

Definition D.1: A wage vector $\underline{w}$ is said to be in equilibrium if and only if $P_i(\underline{w}) \geq P_i(\underline{w} \setminus w_i')$ for all $i = 1, \ldots, N$.

III Equilibrium Wage and Comparative Statics

First consider the single-period case where the labourers are thinking about each market day as it comes, without any regard for the past or the future. It is easy to prove the following proposition regarding the nature of equilibrium in this case.

Proposition P.1: If a Nash equilibrium exists in the single-period labour market, then the equilibrium wage must coincide with the competitive wage.

Proof: Appendix, part I.

Intuitively, it is immediately obvious that no single wage rate above the competitive level can be sustained in equilibrium, for if others are bidding such a wage it will always be possible for any one individual to ensure unit probability for himself and raise his pay-off by slightly undercutting the rest. Of course, one must also consider the possibility of a non-uniform wage vector rather than a single wage rate ruling in equilibrium. But it can also be shown that non-uniform wages cannot be sustained in equilibrium in a single-period game. Thus, if equilibrium exists, there is no escape from the competitive wage.[8]

The competitive outcome may not, however, be a particularly happy one from the point of view of workers. To see the point most starkly, consider the case where every worker has the same opportunity income c. Clearly the competitive wage will be equal to c, and it is also clear from (5) that any wage rate above c will afford a strictly higher pay-off to every worker compared to the competitive pay-off, so long as the probability of employment at the higher wage remains positive. It would have been possible

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8. This argument is similar to Bertrand's (1883) analysis of price-choosing oligopoly.

to achieve such a collectively superior outcome if each worker had the confidence that no one will resort to undercutting.[9] But, lacking such confidence, they are driven to the strictly inferior outcome c. This is a classic case of the familiar problem of Prisoners' Dilemma.

One way of avoiding this problem is to co-operate in an explicit manner with a binding contract not to undercut each other. But we have foreclosed this avenue by assuming that rural workers do not have any institutional means of co-operating in this manner through enforceable contracts. There is however an alternative avenue opened up by the repeated nature of casual labour market. The problem of co-operation in a single period game consists in the fact that if a person decides to be selfish (i.e., increases his own pay-off by undercutting his colleagues) he cannot be punished in the absence of enforceable contracts. But in a repeated game, it may be possible to punish deviant behaviour by pursuing a vindictive strategy in future - a strategy that will impose on the renegade a much bigger future loss. The possibility of such punitive action may encourage each worker to experiment with non-competitive wage bids in the quiet confidence that no one will dare to undercut. In this way self-enforcing co-operative outcome may become achievable even in the absence of explicit collusion.[10]

Game theorists have considered many alternative strategies for achieving co-operative outcome in a repeated non-cooperative game. One particular strategy, called "trigger strategy", will be employed here in the framework of infinitely repeated game.[11] The justification for using the framework of infinite repetition is discussed in the concluding section.

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9. Throughout this paper, an outcome will be called collectively superior if it entails a higher pay-off for at least some workers and no lower for others, compared to an alternative outcome. This notion of superiority is to be distinguished from the more general notion of Pareto superiority which relates to the economy as a whole, embracing both workers and employers.

10. As Aumann (1985) for a lucid exposition of a long line of theorems purporting to show that co-operative outcome is possible in a repeated non-cooperative game.

11. The term "trigger strategy" was coined by Radner (1980); but the idea goes back to Luce and Raiffa (1957) and the first full-blown applications are to be found in Friedman (1971) and Kurz (1976).

One further point ought to be noted here. In principle, the equilibrium achieved through "implicit co-operation" may consist of either a non-uniform wage vector or a uniform wage rate. However, as discussed in the next section, the "uniform wage rate" scenario is empirically the more relevant one, and we shall show in this section that an equilibrium can indeed be sustained by trigger strategy. We shall also explore the properties of this equilibrium and see how far these properties correspond with certain well-known features of rural labour markets in South Asia. Furthermore, we shall try to argue in the next section that the empirical fact of "uniform wage rate" is not a mere happenstance - the very logic of "implicit co-operation" makes such an outcome more likely than an equilibrium with non-uniform wage rates.

Finally, we shall proceed by making the following simplifying assumption.

Assumption A.1: Every worker has the same opportunity income c so that the supply curve is horizontal and the competitive equilibrium occurs at the wage rate $w = c$.

We have noted earlier that any wage rate above c is collectively superior to c, provided $\theta(w) > 0$. Since there may exist many such wage rates, each of which is collectively superior to c, the workers must of course agree on a rule for choosing a particular wage if they are to avoid competition. But we shall come to this problem later. For the present, we are concerned with the question of whether a co-operative outcome is at all feasible without enforceable contracts. For this purpose, take any wage rate $w^* > c$ and note what happens if everybody contemplates the following strategy in an infinitely repeated wage game:

"I shall bid w^* on the first day no matter what anybody else does. I shall also continue to bid w^* everyday as long as everybody is seen to have bid w^* everyday in the past. However, if anybody ever bids a lower wage, I shall bid c in the next period and continue to bid c for ever".

There is a clear message in this strategy. Each worker is inviting others to behave 'well' i.e., not to undercut w^*, with a promise on the one

hand and a threat on the other. He promises that he will behave well if others do and lays down the threat that if anyone ever deviates from w* he will try to push the wage rate down to the floor for ever. This type of strategy is known in the game theory literature as a "trigger strategy". Any deviation from the intended norm triggers a punitive action; hence the name.

It is clear from the nature of trigger strategy that if everybody decides to start his bidding on the first day in accordance with this strategy, then at no stage will anyone have the reason to deviate from w*. In other words, market equilibrium will be established at this wage. This is known as the 'trigger strategy equilibrium'; and it is easy to check that it satisfies the condition of Nash equilibrium given in definition D.1. The important question is: under what conditions can each person be expected to adopt the trigger strategy? There are essentially two conditions that must be satisfied for this to be possible.

First, the threat of punitive action must be credible i.e., each worker must be convinced that others can actually force the wage rate down to the threat level (c) if he decides to deviate on his own.[12] As it happens, this condition of credibility is easily satisfied in the present case. Recall that the competitive wage rate c is also a Nash equilibrium in the single-period context. That is to say, if everybody other than i is bidding c, then i can do no better than bidding c himself. Thus the threat embodied in the trigger strategy is a genuine one.

The second condition is that each worker must feel that it is not worthwhile to court the punitive action. The workers may not always feel that way because even if the threat of punitive action is credible, it will still pay a worker to deviate if he estimates that his immediate gain from undercutting will outweigh any future loss. The condition under which the balance of this trade-off will prevent deviation can be derived as follows.

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12. In game-theoretic jargon, this condition is known as 'subgame perfectness'.

Let α be the common discount factor for each worker so that x dollars tomorrow is worth αx dollar today. If the rate of discount is denoted by β then α is given by $1/(1+\beta)$ and it takes a value within the closed interval $[0,1]$. The discounted value of all pay-offs from the trigger strategy wage rate w* is then given by

$$S(w^*) = P(w^*) + \alpha P(w^*) + \alpha^2 P(w^*) + \ldots = \frac{1}{1-\alpha} P(w^*) \tag{6}$$

$$\text{where } P(w^*) = \theta(w^*) \cdot w^* + \{1 - \theta(w^*)\} c \tag{7}$$

Now suppose that some worker is pondering the consequences of deviating from trigger strategy on any day t. He knows that when everybody else is bidding w* he can ensure unit probability of employment for himself by undercutting the rest (recall (3)). In fact, if he chooses a wage rate w′ such that $P(w^*) < w' < w^*$, he can also increase his earnings on day t. Moreover, the closer he gets to w*, without actually reaching it, the higher is his pay-off. Thus, each worker can do better <u>for the day</u>, given that others are bidding w*, by bidding

$$w' = w^* - \varepsilon \tag{8}$$

where ε is a positive number arbitrarily close to zero.

While gaining something extra on day t, the worker must of course reckon that from day t+1 onwards he will have to be satisfied with pay-off c. Thus the implication of deviating on day t is that upto day t-1 his pay-off is P(w*), on day t it is w′ and from then on only c. The discounted value of all this is

$$\frac{1-\alpha^t}{1-\alpha} \cdot P(w^*) + \alpha^t w' + \frac{\alpha^{t+1}}{1-\alpha} c \tag{9}$$

Only if the value of (9) is less or equal to than S(w*) in (6) for all workers at all t, will w* be a viable trigger strategy. This condition can be shown, after some manipulation, to be equivalent to the inequality[13]

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13. This is a particular case of the general feasibility condition for trigger strategy equilibria, developed e.g. in Friedman (1986, p. 88).

$$\alpha \geq \frac{w' - P(w^*)}{w' - c} \tag{10}$$

Recall that a potentially deviant worker will have the incentive to bring w' indefinitely close to w^* without actually reaching it. The limiting case is thus given by the relationship,

$$\alpha \geq \frac{w^* - P(w^*)}{w^* - c} \tag{11}$$

Recalling (7), this inequality reduces to

$$\alpha \geq 1 - \theta(w^*);\ w^* > c \tag{12}$$

We may now state the following proposition regarding the existence of trigger strategy equilibrium.

Proposition P.2: When the assumption (A.1) holds and the discount factor satisfies the inequality (12), it is possible to sustain an equilibrium wage above the competitive level by implicit co-operation.

Next we seek a characterisation of the equilibrium wage. Let w^+ be the wage rate that solves the equation

$$\alpha = 1 - \theta(w) \tag{13}$$

Recalling (4), it is easy to see that (12) is satisfied for all $w \leq w^+$ and fails to be satisfied for all $w > w^+$. Thus any wage rate satisfying the inequality $c \leq w \leq w^+$ and no wage rate above w^+ can be sustained as a trigger strategy. Also note that if w^+ is chosen as the trigger strategy, then the workers will be indifferent between deviating from and sticking to it. We assume that they will actually stick to it in this case. Thus the range of all feasible equilibria (including both competitive and 'implicitly' co-operative ones) is given by the closed interval $[c, w^+]$.

In order to identify the equilibrium wage within the feasible range, we now introduce one axiom of behaviour and one additional assumption.

Axiom X.1: If there are more than one trigger strategy equilibria and one of them is strictly collectively superior to others (i.e., each worker's pay-off is maximised in that equilibrium), then each worker will individually choose the pay-off-maximising outcome.

Assumption A.2: The discounted pay-off function S, given by (6), is continuously differentiable in the domain $[c, w^+]$.

The axiom is simply an implication of rational behaviour, and the assumption is not particularly demanding either; it can be easily checked that continuity and differentiability of labour demand function ensure the same properties for S.

Now the continuity of S implies that it attains a global maximum at some point in the closed domain $[c, w^+]$. If the maximum occurs at an interior point, then by axiom X.1 the equilibrium wage ($\hat{w}$) is given by the solution of

$$\frac{dS}{dw} = \frac{1}{1-\alpha}\left(\theta_w . w + \theta - \theta_w . c\right) = 0$$

$$\text{or, } w = c - \frac{\theta}{\theta_w} \tag{14}$$

$$\text{or, } \frac{w}{w-c} = -\frac{\theta_w}{\theta/w} \tag{15}$$

Recall that $\theta = \frac{l(w)}{N}$, where l, the demand for labour, varies with wage, but the supply of labour N is fixed since by assumption A.1, everybody is willing to work at a wage rate above the opportunity income c. Therefore, (15) leads to

$$\frac{w}{w-c} = -\frac{l_w}{l/w} = |e_w \tag{16}$$

where e_w is the elasticity of labour demand at w. Thus interior equilibrium will obtain if the elasticity of labour demand attains the value w/(w-c) at some point in the interval $[c, w^+]$.

Otherwise, the maximum will occur at one of the boundary points. But it cannot occur at the lower boundary point c since, as can be seen from (6) and (7), any wage rate above c gives a higher pay-off as long as the probability of employment remains positive. Therefore, the equilibrium must occur at the wage rate w^+, where the probability of unemployment just equals the discount factor.

We now have the following proposition regarding the nature of equilibrium wage.

Proposition P.3: When a casual labour market satisfies inequality (12), axiom X.1 and assumptions (A.1) and (A.2), equilibrium occurs either at w^+ or at $\hat{w}$ where w^+ is given by the solution of (13) and $\hat{w}$ by the solution of (14).

Given the equations (13) and (14), it is possible to evaluate the effects of various parametric shifts on the level of equilibrium wage. The evaluation is made slightly complicated by the fact that there are two possible equilibria so that one must consider not only the two cases separately but also the possiblity of one kind of equilibrium giving way to another. The algebra of all this is contained in the Appendix (Part II). Here we shall simply state the results and indicate the intuition behind them. Four kinds of parametric shifts are considered: shift in labour demand due to technological change, and changes in labour supply, opportunity income and discount factor.

(1) If labour demand rises due to a technological change, the equilibrium wage will generally rise. There is an exception when the labour demand curve has an extremely flat convexity (in a sense defined more rigorously in the Appendix) and the interior solution prevails. This possibility of perverse result is not altogether puzzling, however. We have noted from expression (16) that the interior solution depends on the elasticity of demand for labour. When the demand curve shifts, the elasticities may change in such a way that higher probability of employment at a lower wage will more than compensate for the decline in wage. In this case, the pay-off-maximising wage rate will have to go down, but it can only happen if the demand function is very flatly convex. It is, however, easy to show

that workers' earrings will certainly rise even if the wage rate goes down following a demand-enhancing technological change.

(2) An increase in labour supply entails a lower wage when boundary solution prevails either before or after the change. However, if interior solution occurs at both points, then there is no effect on the wage rate. This may seem somewhat puzzling, but the fact is that a change in supply does not affect the elasticity of employment probability in (15) and hence cannot affect the income-maximising wage rate.

(3) Higher opportunity income of labourers raises the wage rate when interior solution prevails either before or after the change, but has no effect if boundary solution occurs at both points. The latter result however needs some qualification. In our simple formulation of the model, opportunity income of labourers does not affect either of the two variables, α and θ, which determine the boundary solution. But in actual fact, it may have an effect on the rate of discount. Insofar as higher opportunity income, arising from, say, greater access to non-farm income, raises the level of living, it will also entail a lower rate of discount. And as our next result shows this will have the effect of raising the boundary solution as well.

(4) A lower discount factor i.e., a higher rate of discount, entails a lower wage if boundary solution occurs either before or after the change (with no effect in the case of interior solution at both points). It means that the greater the eagerness for present consumption the lower is the limit (w^+) of sustainable trigger strategy wage. The rough intuition of this result is that the workers will find it harder to resist the temptation of undercutting a higher wage if they are too eager to consume today, because the probability of current employment is lower and the current gain form undercutting is greater at a higher wage.

The poor agricultural labourers of South Asia are generally expected to have a rather high subjective rate of discount, and can hence be expected to impose a rather low limit on the range of feasible trigger strategy wages. But lower the limit, the greater is the likelihood that the boundary solution will be binding. In that case, as we have seen, there is

no scope for perverse response to changes in supply and demand - higher demand will always raise the wage rate and higher supply will push it down. Higher opportunity income will also, as expected, raise the wage rate through its effect on the rate of discount. All these are in conformity with the observed behaviour of rural labour markets in South Asia.

IV Theory and Facts: Some Further Considerations:

In this section, we shall further explore the explanatory power of the approach developed in this paper. This part of the exercise is exploratory in nature and devoid of formal rigour. Yet, we believe, this discussion will show that the approach of "implicit co-operation" has immense potential in trying to make sense of some of the puzzling aspects of rural labour markets which have so far defied any rational explanation. In particular, we shall see that it can shed considerable light on the following two features of rural labour markets frequently observed in South Asia:

(i) Despite wellknown heterogenity among the labour force in respect of skill and other personal characteristics, the wage rate for a given task at a given time within a particular locality is remarkably uniform for all workers. This is attested to by a large number of micro studies.[14] Some aggregative studies, such as those of Bardhan (1984, chap. 4), do find variation with respect to personal characteristics. But as Bardhan himself notes, the data in these studies do not refer to task-specific wage rates, but to the average earning of a wage earner per man-day in the reference week. Consequently, "It is quite possible that the wage rate for a specific task does not significantly differ for workers with varying backgrounds, but that they get different tasks in different proportions, affecting their average rate of wage earning" (p. 66). In fact, in their detailed survey of

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14. In their extensive review of micro-studies, Drèze and Mukherjee (1987) have noticed that this is one of the few commonalities that stand out striking amidst the diversity of labour market conditions in rural Asia. See the findings of Bardhan and Rudra (1981), Binswanger et al. (1984), Rao (1984), Reddy (1985) and ICRISAT (1987), all of them on India; Muqtada and Alam (1983) on Bangladesh; and White and Makali (1979) on Java.

West Bengal villages, Bardhan and Rudra (1981) had earlier noted the uniformity of task-specific wages as one of their principal findings.

(ii) While the wage rate varies widely across localities as well as between seasons, often in close conformity with the conditions of supply and demand, there is a noticeable stickiness in adjustment to secular variations in underlying conditions. The clearest example of this is the lagged adjustment of money wage to the rate of inflation.[15] The real wage too does not seem to respond very quickly to changes in the trend variables affecting supply and demand; it was after all this observation that inspired the constant real wage assumption of dual economy models. Thus we have this perplexing phenomenon of plasticity of wages in some respects and rigidity in others.

Uniformity of Wage Rate

We have shown in the preceding section that a non-market-clearing uniform-wage equilibrium can come about through "implicit co-operation". We did not, however, rule out the possibility that a non-uniform wage-vector could also emerge in equilibrium. Yet, as we have noted, the predominant tendency in real life is towards uniformity of wage rate. One must, therefore, ask: if "implicit co-operation" is the mechanism through which rural wages are determined, why should it have a tendency towards establishing a uniform wage rate?

We do not pretend to have a complete answer to this question. However, we believe, a plausible argument can be made for the case that the very logic of "implicit co-operation" might have a tendency to impose uniformity.

If the workers are allowed to contemplate non-uniform wage vectors as possible trigger strategies, it immediately creates a possibility of conflict of interest. When only a single wage rate is considered as

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15. See the evidence cited in Bardhan (1977) for India, and Papanek and Dey (1982) for Bangladesh.

the trigger strategy, every worker enjoys the same probability (and pay-off) at the stipulated wage rate, which facilitates the attainment of a collectively superior outcome if it exists. This happy state of affairs no longer obtains when non-uniform wage strategies are admitted. There will now be different probabilities of employment (and different pay-offs) for different workers; and each might find that he is best off with a wage vector that is not judged best by others. How can this conflict of interest be resolved?

In principle, the workers could possibly come to a compromise through a bargaining process; but the hazards of this process ought to be recognised. For one thing, there can be many different types of bargaining solutions depending on what one considers to be the plausible characteristics of a bargaining equilibrium. Game theorists have identified many such solutions, or rules of the game, each of which appears quite plausible on its own. This creates the problem that different solutions may favour different participants, so that even if people decided to bargain, they would first have to solve the super-bargaining problem of which rules of the game to adopt; only then can they sit down to thrash out a bargaining outcome within the chosen framework. An additional problem is that many of these solutions allow for multiple equilibria, so that even if a particular rule of the game is accepted, it is not clear how a particular outcome will be reached. This difficulty is compounded many times over for a daily labour market where fresh rounds of bargaining will be needed every day. If the hassle of daily bargaining is to be avoided, the only alternative is to adhere to some kind of norm. But if a norm is to consist of a non-uniform wage vector, giving different probabilities of employment to different workers and putting some workers at a relative disadvantage for all time to come, it is difficult to see how it can be sustained as a self-enforcing long-term equilibrium. Some element of fairness would seem to be essential for the viability of a self-enforcing norm. The principle of uniform wage satisfies this requirement uniquely by giving everyone an equal probability of employment.

Therefore, if the workers wish to improve upon the competitive outcome, and at the same time do not want to enter the acrimonious and possibly self-defeating process of bargaining, the decision to maintain

uniformity of wages is the safest bet. Note, however, that such an outcome would require a kind of satisficing behaviour, because by sticking to the principle of uniformity, each worker may have to give up the goal of 'maximal pay-off' which he would have received if somehow he could enforce his particular choice of non-uniform wage vector. It would seem plausible to expect such behaviour in this case because it serves the cause of co-operation by upholding the principle of fairness.[16]

It should be noted at this stage that the argument for uniformity via the notion of fairness comes up against a very serious difficulty when we allow for differential skill among workers. In the story we have been trying to tell, fairness is achieved by equalising the probability of employment. But the need for equal probability would be satisfied by the principle of uniform wage only for a homogenous workforce of equal skill. If different workers are known to be endowed with different levels of skill, equalisation of probability would require that the wage rates vary positively with the level of skill. How is it then that in actual rural labour markets wage rates seldom vary among workers (of a given sex in a given task)? What seems to happen in the real world is that instead of receiving a higher wage the more skilled workers tend to receive more assured employment; in a regime of involuntary unemployment and quantity rationing they typically receive the first call from the employers - and therein lies their reward for greater skill.[17] How can this observation be reconciled with the theory of wage determination expounded in this paper?

We need to introduce a small dose of incomplete knowledge. Assume, everyone knows that Mr. X is an outstanding worker, but there is some uncertainty as to exactly how much more he is worth compared to others (because typically there will be some degree of asymmetric information

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16. The idea that satisficing behaviour, or more generally bounded rationality, may be necessary to sustain co-operation as a self-enforcing equilibrium, has been emphasised, albeit in a somewhat different context, by Radner (1980).

17. This is a widely noted phenomenon. One example is a study by Rudra (1982) who was told by 91% of employers in one area and 67% in another that the better workers are employed on a privileged basis, but without any premium on the wage rate.

regarding the skill levels of individual workers). In other words, it is not known for certain, either by X himself or by the rest, exactly how large a wage differential is needed to equalise the probability of employment. This uncertainty creates a problem in sustaining a non-competitive equilibrium through implicit co-operation. Note that the rest of the workers recognise that X is an outstanding worker and hence must be allowed a higher reward if co-operation is to be achieved. But if this reward is to come through higher wage, the uncertainty regarding the probability-equalising wage-differential will be liable to breed suspicion of undercutting. By bidding a wage rate above the rest but below the equalising wage, X may gain the double advantage of higher wage on the one hand and assured employment on the other. This is certainly not what the rest of the workers would have bargained for by agreeing to X receiving a higher wage. Yet, so long as there is incomplete information on the appropriate differential, the possibility of X gaining the double advantage cannot be altogether ruled out. It may therefore be rational for the others to confine X's reward to the single advantage of assured employment by calling upon him to accept the same wage as the rest.

As for X, he is also aware that if he tries to maintain a wage differential, and then errs on the low side, he will be inviting the suspicion of undercutting. On the other hand, if he errs on the high side, he may find himself priced out of the market. Therefore, if he is as eager as the rest for avoiding the competitive floor, he would probably be happy to go along with the common wage. This way, he at least gets a higher reward through assured employment, a singularly good fortune not enjoyed by the others. Once again, it involves satisficing behaviour,[18] but co-operation is saved by the display of fairness - Mr. X gets an advantage he rightly deserves, but is prevented from gaining a double advantage which would be grossly unfair. Finally, as far as the employers are concerned, they are of course delighted to have a better worker for the same price.

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18. By assuring Mr. X of unit probability of employment, and thereby reducing their own, other workers may be doing worse than they would have done if they could maintain the probability-equalising wage-differential. On the other hand, Mr. X could conceivably have secured a higher pay-off with the correct wage-differential even with a reduced probability of employment. Thus both parties may have to display a readiness to desist from full-blooded maximisation.

Therefore, a uniform wage rate is likely to prevail in equilibrium in the case of heterogenous labour as well.

The preceding argument shows that the empirical prevalence of uniform wage rate can be seen as an outcome of the very logic of implicit co-operation. Uniformity affords a measure of fairness - unconditionally in the case of homegenous labour, and with the assumption of asymmetric information in the case of heterogenous labour - without which implicit co-operation may be difficult to sustain. Therefore, if one believes in the theory of implicit co-operation, one should also expect a uniform wage rate to prevail in equilibrium. By contrast, other theories of wage determination - both competitive theory and efficiency wage theories - predict that wage rates should vary depending on the level of skill - a prediction that is not borne out by facts.

Plasticity and Rigidity: the Dual Characteristics of Rural Wages:

We have seen that the equilibrium wage achieved through implicit co-operation is generally responsive to the forces of supply and demand. This result is, however, predicated on a certain assumption about workers' knowledge without which the very concept of Nash Equilibrium and its comparative static properties become untenable. Consider two workers A and B. Each of them chooses his wage bid conditional upon his expectation of the other's bid. Therefore, the equilibrium wage w* must have the following property: in choosing w*, A expects B to choose w* as well and his prediction turns out to be right (and similarly for B). But A knows that B's choice is also conditional upon his (B's) own expectation about A's choice, so if A has correctly predicted B's choice then he must know that B knows that A will choose w*. Similarly, since B has also correctly predicted A's choice, he too must know that A knows that B will choose w*. Combining the perspectives of A and B, the informational requirement for equilibrium can now be stated as follows: A(B) knows that B(A) will choose w*, A(B) knows that B(A) knows that A(B) will choose w* ... and so on. This, in formal game theory, is described as "common knowledge".[19] The

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19. A pioneering discussion of this concept can be found in Lewis (1969).

factors determining the choice of w* must be common knowledge, if w* is to be established as a Nash equilibrium.

Since the value of w* depends inter alia on the probability function θ, we can say that θ must be a part of common knowledge if the trigger strategy equilibrium (which is a Nash equilibrium) is to obtain in the labour market. Note that this is a much stronger requirement than each worker separately knowing the θ function. In addition to knowing θ, each must know that others also know about the same θ and also must know that others know that he knows. The twin assumption of 'closed labour market' and 'settled technology' introduced in section II serve to ensure the existence of this common knowledge. Without it, neither the existence of equilibrium nor the responsiveness of the equilibrium wage to shifts in supply and demand can be predicted by our theory.

We shall argue that the notion of common knowledge in crucial for understanding the plasticity/rigidity paradox of rural wages. The comparative statics of our theory of "implicit co-operation" predict plasticity, only because in assuming the existence of equilibrium we implicitly assumed the existence of common knowledge. It is plausible to argue that in the absence of common knowledge, the very logic of implicit co-operation would tend to demand rigidity of wage rate.

Consider a technical change which expands the demand for labour. Until its effect on the probability function has become a matter of common knowledge, there will be a serious disincentive for every worker to revise his wage bid even if he has somehow made an estimate of the new probabilities. If he is not confident that others have made the same estimate, he cannot be sure that wage bids will be revised all around in the same manner. Consequently, he runs the risk of either pricing himself out of the market by bidding too high a wage relative to others, or triggering off a punitive action by undercutting the rest. Faced with this dilemma, it is not altogether clear how the workers will actually behave in the period of 'transition'; but it is eminently plausible that in order to save the basis of co-operation, a rule of the game will emerge over time whereby no action is taken until everyone is sure (through day-to-day social contacts) that the precise nature of changes has become a matter of common knowledge.

Similar considerations apply to the inflationary adjustment of money wages. When inflation becomes a continuing process, but the rate of inflation varies in an 'unanticipated' manner, it is difficult to know exactly how much adjustment against current inflation is being contemplated by different workers. Lagged adjustment would be rational in this case because passage of time will allow past inflation to become a part of common knowledge.[20]

The situation is, however, quite different when, instead of secular changes, one considers spatial or seasonal variations. If the supply-demand configurations are different in two separate labour markets, but their respective configurations have persisted for a long time, then their repective probability functions have also become a matter of common knowledge. Similarly, seasonal changes in demand that take place within the context of a settled technology are likely to become common knowledge through years of experience. Variations in wage rate should reflect this. The analytics of modelling seasonal variations may, however, be a good deal more complicated than what was encountered in our simple model. Instead of a single wage, there will now be different wages for different seasons. Or alternatively, the task may be simplified by treating each season as a separate game. The only requirement for this is that each season's demand curve and hence the probability function should be independent of other seasons' wages. Given this assumption of independent games, one can now invoke the comparative statics of our simple model to predict that the wage rate will be responsive to seasonal variations in demand. In particular, we should expect to find fairly rigid differentials in seasonal wage rates being reproduced year after year in an environment of settled technology. A striking example of this is found in some villages surveyed by Rudra(1982), where seasonality took the form of a discrete jump in wage rates, with the differential remaining fixed over several consecutive years.

However, it is not always the case that seasonal adjustment occurs so neatly. Sometimes the daily wage remains fairly sticky, while adjustment is

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20. However, adjustment can be expected to be quicker here than in the case of fundamental technological changes affecting the conditions of demand. Papanek and Dey (1982) have noted, for example, that money wage adjusts to prices with an average lag of about two years in rural Bangladesh.

made by varying the mix of labour contracts. The major types of contracts, apart from the daily wage system, are piece rates and harvesting shares. They offer more flexible forms of remuneration than the daily wage system; and in particular the piece rates are often separately negotiated between individual employers and employees (Drèze and Mukherjee, 1987). As a result, by varying the mix of contracts the average rate of remuneration can be made not only flexible over time but also non-uniform across individuals, while the basic daily wage remains rigid and uniform.

It is significant to note that these flexible contracts are becoming more prominent in those areas which are experiencing rapid technological change.[21] One way to understand this phenomenon is to view it as a strategy of dealing with the breakdown of common knowledge in a period of 'transition'. The process of technological change frequently alters the seasonal pattern of labour demand. In a period of transition, when the impact of these changes is yet to become common knowledge, new differentials in seasonal wage rates are difficult to establish. The flexible contracts offer an opportunity to grope through this period of fragmented knowledge by experimenting with personalised deals, while the basis of 'implicit co-operation' is preserved by leaving untouched the trigger strategy wage rate.[22]

In sum, the plasticity-rigidity dualism of rural wages can be viewed as a problem of common knowledge in the context of 'implicit co-operation'. Plasticity can be expected when common knowledge can be assumed to prevail, while rigidity is a feature of transitional breakdown in common knowledge. Moreover, rigidity in the basic daily wage can be expected to go hand in hand with a search for more flexible contracts as a means of groping through the period of transition.

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21. See the evidence cited in Drèze and Mukherjee (1987).

22. The growing importance of flexible contracts tends usually to be explained in terms of employers' incentive to offer these contracts in order to ensure quality or to minimise risk. It is, however, arguable that the employers always had the incentive to do so; the fact that these contracts are only now becoming popular in technologically progressive areas is perhaps because the workers now find them useful as a means of dealing with 'transition'.

V Concluding Remarks

It has been argued in this paper that the process of wage formation in rural labour markets is best seen as an implicit co-operation among workers aiming to achieve as good a deal as possible. Such implicit co-operation is self-enforcing in nature, sustained by the adoption of trigger strategies and made feasible by the repeated nature of the casual labour market, the most predominant form of market in rural South Asia. It is interesting to observe that the idea that rural wages might have the features of a 'trigger strategy' wage, has often suggested itself, albeit rather vaguely, to the researchers engaged in detailed field work. Its implication has seldom been fully grasped, but the idea has often remained just below the surface, trying to rear its head, whenever the researchers have taken care to ask the labourers themselves why they don't undercut each other inspite of being involuntarily unemployed. For instance, the present author was told by some labourers in Bangladesh that undercutting even by one person will bring the whole market down in future so that everybody will suffer in the end.[23] Similar responses have been reported by Rudra (1982) and Drèze and Mukherjee (1987). Nearly a century ago, the Famine Enquiry Commission of India also noted that the labourers "... have obstinately refused to work for cash wages below the customary rate, for fear that such rate would then be permanently reduced" (Government of India, 1898, p. 295).[24] Apparently, trigger strategies have been in operation since long; game theorists have caught up with it only recently, but the theorists of rural labour market hardly.

A priori plausibility is not, however, the only virtue of the hypothesis of "implicit co-operation". It has been argued in this paper that this hypothesis can consistently explain, or at least help to explore, a large number of known features of Asian labour markets, viz. non-market-clearing wage combined with responsiveness to supply and demand, uniformity of wage rate despite heterogenity among workers, plasticity of wage rate in some situations combined with rigidity in others, and the

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23. It was this astute observation of a group of unemployed labourers that sent the author in the trail of the present research.

24. This citation is by courtesy of Jean Drèze.

coexistence of a rigid and uniform daily wage system with more flexible forms of labour contracts.

In conclusion, we shall comment briefly on a few issues which have a bearing on the approach developed in this paper.

(a) In trying to understand wage behaviour from the point of view of workers, we have throughout kept the employers firmly in the background. They respond passively by choosing the level of employment, but do not take any active part in the determination of wages. This might legitimately invite the question: why don't the employers confront the workers in a bargaining game and try to prevent them from reaching the trigger strategy equilibrium? This should seem easy if the employer enjoys monopsony power; but even if there are several employers, they could still collude either explicitly, or implicitly like the workers.[25] If such bargaining were indeed to take place, what would be the bargaining counter for the employers? One extreme possibility is that they would threaten to stop production altogether. But more realistically, they would probably threaten to replace local workers (partly or wholly) by outsiders. This will have the effect of altering the position of demand curve facing local workers, thus changing their calculations of probabilities. In choosing a wage rate, they will then have to reckon with the probable response of employers, and this will give the employers a leverage with which to bargain and manipulate. But note that threatening to employ outsiders is a direct violation of the 'closed market' assumption. This does not mean that the boundaries of closed market will not be violated under any circumstances. But it does mean that as long as the employers value the imperatives of closed market above all else, it will remain feasible for workers to determine the wage rate through 'implicit co-operation'.[26] Once the boundaries of closed market break down, the theory of implicit co-operation will not in any case hold, if only because common knowledge cannot be expected to prevail in a state of flux where unknown outsiders are

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25. A game-theoretical model of this type, embracing both employers and workers, has been developed by Datt and Ravallion (1988).

26. The logic of employers' preference for a closed market has been explained by Bardhan and Rudra (1986) as "... a rational response to imperfect information on worker characteristics, costs of enforcement of contracts with unfamiliar people, and the general absence of credit and insurance markets" (p. 114).

intruding the local market in unknown quantities.

(b) The second issue relates to the nature of unemployment in a regime of implicit co-operation. A trigger strategy equilibrium is by definition a state of non-market-clearing wage - there will be workers who will fail to find a job, but would like to have one as their reservation wage would be less than the market wage. This is of course the quintessential feature of involuntary unemployment. But it is equally true that despite their failure to find a job at a market wage that lies above their reservation level, the unemployed workers will not try to improve their prospect of immediate employment by offering to work at a lower wage; in this respect there is manifestly an element of voluntariness in their state of unemployment. Consequently, one does seem to have a problem of labelling here.[27]

We should, however, point out that the voluntary aspect of such unemployment as would obtain in a trigger-strategy equilibrium should be strictly distinguished from the traditional notion of voluntary unemployment. When a person is voluntarily unemployed in the traditional sense, he is better-off (or at least not worse off) by staying out of the market, but here the unemployed person ends up with a reservation wage that is strictly lower than the market wage. The welfare implications of these two situtations are quite distinct.

(c) It has been suggested in the paper that the possibility of implicit co-operation arises from the repeated nature of casual labour market. What has not been mentioned so far is that repitition in itself is not enough. Our model assumed an infinitely repeated game, and this infiniteness property happens to be particularly crucial. The idea that co-operative outcome can be achieved in an infinitely repeated non-cooperative game is a familiar one in game theory, known among the cognoscenti as the 'Folk Theorem'. But it is equally well-known that this result will not typically

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27. The same problem of labelling has bedevilled much of the discussion of involuntary unemployment in the context of industrialised economies as well, whenever such unemployment has been claimed to be a feature of equilibrium. For a perceptive analysis of this problem and a forceful defense of the notion of equilibrium involuntary unemployment, see Hahn (1987).

hold in a finite horizon game, however far one may extend the horizon. The actors in real life, however, do have a finite horizon, if only because they live a finite life; so, how much faith can one place in the approach developed in this paper?

The first point to note is that the impossibility of co-operation in finite horizon is not an inexorable fate. Suitable conditions have been found under which co-operation can still be possible, although questions may be raised about the generality of some of these conditions.[28] In any case, our intention here is to pursue a somewhat different line. The difficulty of co-operation in finite horizon arises essentially from the fact that people have an incentive to deviate from the norm in the final period, because if they deviate at that time they cannot be punished in future, for there is no future.[29] However, in a game that involves the formation of a social norm (such as the implicit agreement to adhere to a trigger strategy wage), it is not reasonable to assume that there is no future after the final period. An individual may die but the society lives on, carrying his progeny. If people are concerned about the wellbeing of their progeny, then there is certainly a future worth caring about. A person will not deviate in the final period of his own finite horizon, if he wishes to bequeath to his progeny a kind of society which he would himself like to have in his lifetime.

This perspective helps retain the infinite horizon framework of our model despite the finite life of individual actors. The analytics may need some revision, however; for example, it may seem desirable to replace the single discount rate by different rates for different generations to account for the fact that people may have less care for future generations than for their own. But the basic insights of the approach are unlikely to be altered fundamentally.

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28. See, for example, Basu (1987), Friedman (1985), Kreps et al. (1982) and Radner (1980).

29. It can be shown by the method of backward induction that if co-operation is ruled out in the final period, it will also be ruled out at each preceding period.

APPENDIX

Part I: Proof of Proposition P.1:

The proof proceeds in two steps. First we show that a uniform wage-vector i.e., a single wage rate must prevail in equilibrium, and secondly that a wage rate different from the competitive wage cannot prevail in equilibrium.

First step:

Consider any arbitrary wage-vector $\underline{w} = (w_1, \ldots, w_N)$ with the restriction that $w_i \geq c_i$ for all $i = 1, \ldots, N$. Arrange the wage-vector in the ascending order so that we have $w_{i+1} \geq w_i$.

Recall from (4) that anyone with a wage rate below w_e has unitary probability of employment, where w_e is such that $l(w_e) = e$. In fact, the probability will remain unity however close one comes to w_e without actually reaching it, so that a worker starting with $w_i < w_e$ will continually approach w_e in order to increase his pay-off. Thus, by Definition D.1, a wage-vector in which $w_i \neq w_e$ for any $i < e$ cannot be an equilibrium vector.

What about the other side of e? Can there be an equilibrium with $w_j > w^e$ for some $j > e$? In order to answer this question, we first impose the restriction, in view of the preceding paragraph, that $w_i = w_e$ for all $i \leq e$. With this restriction, the jth worker is aware that exactly e number of workers will be demanded by the employers and at least e number of workers are also available to work for the wage rate w_e. Therefore, if w_j exceeds w_e, he has no chance of getting a job. Thus w_j must be equal to w_e as long as $w_e \geq c_j$. If c_j happens to exceed w_e, then the jth worker will remain voluntarily unemployed.

Thus only a single wage rate can prevail in equilibrium.

Second step:

Now consider any single wage rate w. The demand for labour at this wage rate is given by $\tau = l(w)$. Arrange the opportunity incomes (c_i) of the workers in the ascending order and identify c_τ. If competitive equilibrium prevails, then we shall have the equality $w = c_\tau$; otherwise the inequality $w > c_\tau$ will obtain. The question is, can this inequality prevail in equilibrium?

If $w > c_\tau$, then assuming some continuity in the distribution of c_i's, we should expect to find some worker j whose c_j falls between w and c_τ. In that case the number of workers (n) willing to work at w will exceed the number demanded (τ); so the probability of employment will be $\theta_i(w) = \frac{\tau}{\eta} < 1$, for all i.

Now take a worker k such that $c_k < w$. (Since by assumption c_τ is less than w, there must be some worker of this type). Recalling the pay-off function (5), and noting the inequalities $\theta_i(w) < 1$ and $c_k < w$, it is clear that $P_k(w) < w$. If k now chooses a wage rate w_k' such that $P_k(w) < w_k' < w$, then by (3) it will follow that his probability of employment will be $\theta_k(w \backslash w_k') = 1$ and his pay-off $P_k(w \backslash w_k') = w_k'$. Now, by construction, $w_k' > P_k(w)$. Therefore, by definition D.1, a wage rate $w > c_\tau$ cannot prevail in equilibrium.

Thus if equilibrium exists (and it will do so under certain regularity conditions), the equilibrium wage must coincide with the competitive wage.

Part II: Comparative Statics of Trigger Strategy Equilibria:

Probability of employment can be expressed as $\theta = l(w,s)/N$ where l is the labour demand function, N is supply of labour and s is a shift parameter representing technological change. (Note that N does not depend on w because all potential workers will be willing to work at the trigger strategy wage, which is by definition greater than the common opportunity income c). Accordingly, the equations for equilibrium wage i.e., (14) for $\hat{w}$

and (13) for w^+, can be written in the implicit funtion form as

$$\text{For } \hat{w};\quad \Phi(w, s, N, c) = w - c + \frac{\theta}{\theta_w} = 0 \qquad (a.1)$$

$$\text{For } w^+;\quad \pi(w, s, N, c) = \alpha + \theta - 1 = 0 \qquad (a.2)$$

Comparative statics are carried out below for three separate case: (i) Interior solution prevails both before and after the change, (ii) Boundary solution prevails both before and after the change, and (iii) Switching of regime i.e., one type of solution gives way to another.

(A) The Case of Interior Solution ($\hat{w}$):

First note the following result derived from the second-order condition of maximisation of S (given by (6)).

$$\frac{d^2S}{dw^2} = \frac{1}{1-\alpha}(\theta_{ww}.w + 2\theta_w - \theta_{ww}c) < 0$$

Noting from (14) that $w - c = -\theta/\theta_w$ and recalling that $\theta_w < 0$, the above inequality yields

$$2\theta_w^2 - \theta.\theta_{ww} > 0 \qquad (a.3)$$

Effect of a shift in s:

From (a.1) using the Implicit Function Rule,

$$\frac{\partial w}{\partial s} = -\frac{\Phi_s}{\Phi_w} = -\frac{\theta_s\theta_w - \theta.\theta_{ws}}{2\theta_w^2 - \theta.\theta_{ww}}$$

Recalling that the denominator is positive by (a.3), and noting that $\theta = \frac{1}{N}$, we get,

$$\frac{\partial w}{\partial s} \gtreqless 0 \text{ according as } l_s.l_w \gtreqless l.l_{ws} \qquad (a.4)$$

Thus, the effect of technological change on the wage rate depends crucially on the shape of labour demand function. To explore this dependence in more concrete terms, let us represent technological change as a multiplicative shift parameter in the production function and stipulate that labour demand is given by the profit-maximising condition

$$w = sf'(l), \text{ where } f'(l) > 0,\ f''(l) < 0 \qquad (a.5)$$

whereupon,

$$l_w = \frac{1}{sf''(l)} < 0 \qquad (a.6)$$

$$l_s = -\frac{f'(l)}{sf''(l)} > 0 \qquad (a.7)$$

or, using (a.5) and (a.6),

$$l_s = -wl_w/s$$

$$\text{so that } l_{ws} = l_{sw} = -\frac{1}{s}(l_w + w.l_{ww}) \qquad (a.8)$$

Clearly, as long as the labour demand curve is concave or linear i.e., $l_{ww} \leq 0$, we shall have $l_{ws} > 0$ and, noting (a.6) and (a.7), we shall also have $l_s l_w < l.l_{ws}$. By (a.4), this will mean $\partial w/\partial s > 0$.

Even if the demand function is convex i.e., $l_{ww} > 0$ but the value of l_{ww} does not exceed the absolute value of l_w/w, we shall still have $l_{ws} > 0$ (by (a.8)) and hence $\partial w/\partial s > 0$. Furthermore, even if convexity is such as to create a negative l_{ws}, we may still have $\partial w/\partial s > 0$ as long as the absolute value of l_{ws} does not exceed the absolute value of $l_s l_w/l$ (by (a.4)).

It follows that except in the case of an extremely flat-looking convex labour demand curve, the wage rate will rise as a result of demand-enhancing technological change.

Effect of changes in N and c:

$$(1)\quad \frac{\partial w}{\partial N} = -\frac{\phi_N}{\phi_w} = -\frac{\theta_N\theta_w - \theta\theta_{wN}}{2\theta_w^2 - \theta\theta_{ww}}$$

But since $\theta = 1/N$, $\theta_N = -1/N^2$, $\theta_w = l_w/N$, and $\theta_{wN} = -l_w/N^2$, the numerator must be zero.

$$\therefore \frac{\partial w}{\partial N} = 0 \qquad (a.9)$$

$$(2)\quad \frac{\partial w}{\partial c} = -\frac{\phi_c}{\phi_w} = \frac{\theta_w^2}{2\theta_w^2 - \theta\theta_{ww}} > 0 \text{ (recalling (a.3))} \qquad (a.10)$$

(B) The Case of Boundary Solution (w^+):

Applying the Implicit Function Rule on (a.2), and noting that $l_w < 0$, it is elementary to check that for a demand-enhancing technological change i.e., $l_s > 0$,

$$\frac{\partial w}{\partial s} = -\frac{l_s}{l_w} > 0 \qquad (a.11)$$

$$\text{Also, } \frac{\partial w}{\partial N} = \frac{1}{l_w} < 0 \qquad (a.12)$$

$$\frac{\partial w}{\partial a} = -\frac{N}{l_w} > 0 \qquad (a.13)$$

(C) The Case of Switching of Regimes:

The question we are asking is whether the direction of change in the wage rate is different here from what we found earlier i.e., whether the comparative static properties become qualitatively different in the event of a switching of regime.

Let the new limit of trigger strategy wage following a parametric shift be denoted by w^{++} and if an interior solution prevails after the shift let it be denoted by $\hat{w}$. We thus have to consider two types of switch: (a) $\hat{w}$ giving way to w^{++}, and (b) w^{+} giving way to $\hat{w}$.

First consider those changes which shift the pay-off curve (S) upward. These are: rise in s, c and α, and fall in N. Recall that in each of these cases $w^{++} \geq w^{+}$ (with equality holding only for a change in c). Also, if interior solution obtains both before and after such shifts, then $\hat{w} \geq \hat{w}$ (with equality holding for changes in N and α), except in the case of perverse s-effect, We shall ignore the perverse case for the moment, and take it up at the end.

When a-type switch occurs, we have, to begin with, $w^{+} > \hat{w}$. But since $w^{++} \geq w^{+}$, we must have $w^{++} > \hat{w}$. Recall that if interior solution were to occur after the change, we would have had $\hat{\hat{w}} \geq \hat{w}$. Thus we find that as a consequence of $\hat{w}$ giving way to w^{++}, the weak inequality $\hat{\hat{w}} \geq \hat{w}$, is replaced by the strict inequality $w^{++} > \hat{w}$.

Next consider the b-type switch. Now $\hat{\hat{w}}$ obtains after the shift; and let the implicit function defining $\hat{\hat{w}}$ in terms of the parameter values yield the function value $\tilde{w}$ for the old values of parameters. The 'interior regime' comparative statics suggests that $\hat{\hat{w}} \geq \tilde{w}$. Moreover, since boundary solution w^{+} obtains at the old parameter values, it must be the case that $\tilde{w} > w^{+}$; otherwise $\tilde{w}$ could have obtained as the interior solution. Thus $\hat{\hat{w}} \geq \tilde{w} \geq w^{+}$ or $\hat{\hat{w}} > w^{+}$, i.e., once again the consequence of switching of regime is that the weak inequality $w^{++} \geq w^{+}$ is replaced by the strict inequality $\hat{\hat{w}} > w^{+}$.

By similar argument it can be shown that when S shifts downwards, the a-type switch means that $\hat{\hat{w}} \leq \hat{w}$ is replaced by $w^{++} < \hat{w}$, and b-type switch means that $w^{++} \leq w^{+}$ is repalced by $\hat{\hat{w}} < w^{+}$.

Thus, when the s-effect is not perverse the consequence of switching of regime can be summed up as follows: (i) for all those cases where a change of wage rate is predicted for the 'same regime' case, the direction of change is preserved when a switching of regime occurs, (ii) when no

change in wage-rate is predicted by the old regime, there actually occurs a change in the direction predicted by the new regime. For example, when the supply of labour (N) goes up, there is no effect on the wage rate if interior solution occurs at both points; but if interior solution switches to boundary solution, then the wage rate must fall, as predicted by the 'boundary regime' comparative statics.

Finally, we come to the case of perverse s-effect i.e., the case of $\partial\hat{w}/\partial s < 0$. Through similar reasoning as above, it can be shown that (i) the perverse effect cannot emerge when a-type switch occurs following an upward shift of S or b-type switch occurs following a downward shift, and (ii) in other cases, i.e. when b-type switch is associated with upward shift of S or a-type switch occurs with downward shift of S, the possibility of perverse effect still remains, but it is no longer inevitable. In short, the possibility of perverse s-effect, which is a limited possibility in any case, is further restricted by the switching of regimes.

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