Journal of Development Economics
Vol. 59 (1999) 445–461

JOURNAL OF Development ECONOMICS

Daily wages and piece rates in agrarian economies

Jean-Marie Baland [a,*], Jean Drèze [b], Luc Leruth [c]

[a] *CRED, University of Namur, 8 Rempart de la Vierge, 85000 Namur, Belgium*
[b] *STICERD, LSE and Delhi School of Economics, Delhi, India*
[c] *CORE and Department of Business Administration, University of Liège, Liège, Belgium*

Received 1 March 1997; accepted 1 September 1998

Abstract

The paper presents an analysis of the coexistence of daily-wage and piece-rate contracts in agrarian economies. We show that, when individual effort is taken into account, daily-wage labourers typically form a convex set in the space of working ability. The most able and the least able labourers work on piece rates, as they can thus choose their own level of effort. We also prove that, on a monopsonistic labour market, the use of both contracts in equilibrium results from the profitability of market segmentation. Imperfect substitutability between workers under different contracts and the downward rigidity of daily wages can also explain the coexistence of the two types of contracts in more general settings, e.g., perfect competition. © 1999 Elsevier Science B.V. All rights reserved.

JEL classification: O53; J41; J43

Keywords: India; Labour contracts; Agricultural labour

* Corresponding author. Tel.: +32-81-724-866; Fax: +32-81-724-840;
E-mail: jean-marie.baland@fundp.ac.be

PII: S0304-3878(99)00020-6

1. Introduction

The coexistence of daily-wage and piece-rate contracts is a widely observed feature of labour markets. [1] In the village of Palanpur in Uttar Pradesh (North India), agricultural wage labour contracts fall into one of these two categories. [2] In 1983–1984, daily-wage contracts accounted for 59% of all labour contracts, while piece-rate contracts for 41% (Mukherjee, 1994). A daily-wage contract usually involves working at a given pace of work for a fixed wage and a fixed number of hours, all of which are identical across employers or labourers. Under a piece-rate contract, the labourer chooses his or her own preferred pace of work and length of the workday, and is paid according to the amount of work accomplished. An obvious advantage of piece-rate contracts is the reduction of some supervision costs: since a labourer working under a piece-rate contract is paid according to the amount of work completed, the employer need not be concerned about the pace of work. In fact, piece-rate labourers in Palanpur usually work without supervision (except for occasional spot-checks). On the other hand, piece-rate contracts often lead to a serious problem of quality control, making them best suitable for tasks where quality control is relatively unproblematic, such as digging. [3] Moreover, piece contracts also tend to be more flexible. In Palanpur, for example, the daily wage is often rigid downwards during the slack season while no such rigidity applies to piece-rate contracts. This creates an incentive to resort to piece-rate contracts during that period of the year.

These arguments, all based on the imperfect substitutability of labour under both types of contract, cannot readily account for the use of both piece-rate and daily-wage contracts by the same employer for the same task. Ten such instances have been recorded for Palanpur in 1983–1984. This is not small, bearing in mind that (1) not all tasks are undertaken under both types of contracts, and (2) Palanpur has only 116 land-owning households, most of which own only small amounts of land, and of which 86 have offered at least one labour contract during the survey year. The use of both daily-wage and piece-rate contracts by the same employer

[1] See, for instance, Bardhan and Rudra (1981), Binswanger et al. (1984), Reddy (1985), Drèze and Mukherjee (1989) and Mukherjee (1994) for analyses of agrarian labour markets in India, Uy (1979) and Roumasset and Uy (1980) for a study of Philippine sugarcane labour markets and Pencavel (1977), Seiler (1984) and (Petersen, 1991a,b) for labour markets in developed economies.

[2] For a more detailed discussion, see Bliss and Stern (1982), Drèze and Mukherjee (1989) and Mukherjee (1994).

[3] Supervision costs and quality control considerations may explain why the relative frequency of daily-wage and piece-rate contracts varies significantly between different activities. In Palanpur, for instance, harvesting usually involves piece-rate contracts, while agricultural operations such as sowing or applying fertilizer are overwhelmingly based on daily-wage contracts. However, there are also many agricultural operations (e.g., weeding wheat, digging sugarcane fields) for which piece-rate and daily-wage contracts coexist (see also Roumasset and Uy, 1980).

for the same task has also been observed in other studies (e.g., Chakravarti, 1997 but also, in the context of developed economies: Seiler, 1984 and Petersen, 1991a,b).

Some attempts have been made to explain this feature by taking into account the heterogeneity of work abilities: workers with better skills would tend to take advantage of their superior abilities by choosing to work on piece-rate contracts, while workers below a certain level would rather accept daily-wage contracts. Both types of contracts are therefore used to sort out workers according to their ability (see in particular Lazear, 1986 and its extension to oligopsonistic market by Matutes et al., 1994). In Palanpur, differences in work abilities between labourers are striking: earnings on piece contracts (measured during the wheat harvest) vary a lot, with the most skilled workers earning as much as five times the amount earned by the least-skilled ones. Relatedly, empirical studies based on developed economies have emphasized the fact that piece-rate workers' earnings, on average, substantially exceed those of daily workers, often by more than 20% (see Pencavel, 1977 and Seiler, 1984).

One general result emerging from all these studies is that the market will sort out workers into two sets: the highly skilled ones who opt for piece-rate contracts and the less skilled ones who prefer daily wages. They thus fail to explain another observation made in Palanpur labour markets (as well as in Chicago's industrial labour market: Pencavel, 1977): piece-rate workers are actually of two types, the highly skilled ones and the least skilled ones, and only medium skilled workers tend to work under daily contracts. [4] Among less skilled workers in Palanpur, one often finds old persons as well as young teenagers.

In this paper, we show that in order to explain this market segmentation, one cannot simply define a worker's ability as the given number of tasks she can accomplish. We therefore take explicitly into account a measure of individual effort and define it as the number of tasks performed per unit of time for a given level of worker's ability. Thus, while her ability is exogenously given by nature (and differentiated across workers), a worker can decide on the level of effort she is ready to make. [5] For example, a highly skilled worker may indeed (as in other papers) prefer a piece-rate contract because it allows her to choose her own level

[4] Relatedly, in Palanpur, while over the year 1983–1984, the average daily earnings on piece contracts (equal to Rs 9.9) was higher than the average daily wage (Rs 8.0) (see Mukherjee, 1994, p. 45) and during the slack season, daily wage rates were higher. The latter pattern is compatible with the idea of this paper according to which less skilled workers choose to work on piece contracts.

[5] Although Stiglitz (1975) provides such an explicit analysis of effort, he considers only two types of workers, and thus fails to generate heterogeneity among piece-rate workers. Moreover, even though he points out the possibility of contract differentiation in equilibrium, he does not specify the conditions under which such differentiation occurs, nor does he describe the possible equilibria and how they might relate to the distribution of abilities among workers or the structure of the labour market.

of effort, i.e., to work faster, thereby achieving higher earnings per day than under a daily wage contract. However, a less skilled worker may also prefer a piece-rate contract with lower earnings per day because the daily contract requires too much time and effort, given her (low) ability.

In Section 2, we develop a model to investigate the relationship between worker characteristics and contractual choice. We show that piece-rate contracts are chosen by the most-skilled and the least-skilled, while daily workers form a convex set in the space of working ability. In Section 3, we examine the circumstances under which particular contract types, or combinations of contract types, are likely to emerge in equilibrium. We also show that at least three factors determine the choice of contract and hence the resulting market segmentation: the non-substitutability of tasks performed under each contract type, the benefits of labour-market segmentation for employers, and the possible downward rigidity of money wages.

2. A model of daily-wage and piece-rate contracts

2.1. The supply of labour

We begin our analysis by modelling workers' behaviour. In a nutshell, a worker considers the level of utility he or she can attain under each type of contract and then chooses the contract which yields the highest level of utility. Workers are differentiated according to an exogenously given working ability, θ, distributed over $\Re^+$, with strictly positive density, $f(\theta)$, and:

$$\int_0^{+\infty} f(\theta)\mathrm{d}\theta = 1.$$

As explained in Section 1, the working ability considered here does not simply represent the actual number of tasks accomplished by the worker. Rather, it reflects the effort required from a worker in order to perform one 'task'. More precisely, the ratio t/θ represents the level of effort of a worker of ability θ when performing t tasks within a given time span. [6] For simplicity, we assume that a worker is always able to accomplish any number of tasks, at the cost of increased effort. Let ω be the 'piece rate', i.e., the payment made to a labourer per task performed. The daily earnings of a worker performing t tasks under a piece-rate contract is then equal to ωt.

[6] Note that alternatively, the ratio t/θ may be interpreted as the amount of time necessary for a worker with ability θ to accomplish t tasks.

A worker's utility depends on effort and income. More precisely, the utility of a worker of ability θ performing t tasks at a piece rate ω is given by:

$$U = U(t/\theta, \omega t), \tag{1}$$

where $U(\cdot)$ is defined on the space of effort and income with $U_1 < 0$, $U_2 > 0$. The utility function is taken to be twice differentiable and strictly concave:

$$U_{11} < 0,\ U_{22} < 0,\ U_{11}U_{22} - U_{12}^2 > 0. \tag{2}$$

Leisure ('non-effort') and income are assumed to be complementary:

$$U_{12} \leq 0. \tag{3}$$

Under a piece-rate contract, a worker is free to choose the number of tasks he accomplishes in a day. Maximizing Eq. (1) with respect to t yields the following first-order condition:

$$U_1(t^*/\theta, \omega t^*)(1/\theta) + U_2(t^*/\theta, \omega t^*)\,\omega = 0. \tag{4}$$

The first proposition below characterizes the relationship between the optimal number of tasks, $t^*(\omega,\theta)$, and worker's ability θ.

Proposition 1: *The optimal number of tasks performed under a piece-rate contract increases with worker's ability.*

Proof: see Appendix A.

A higher level of ability therefore implies a higher number of tasks under piece-rate contracts. It also involves a higher level of utility, since differentiating the utility function given in Eq. (1) with respect to θ (and applying the envelope theorem) gives:

$$\frac{\mathrm{d}U}{\mathrm{d}\theta} = -U_1 \frac{t^*}{\theta^2} > 0. \tag{5}$$

A daily-wage contract specifies a given number of tasks, τ, to be performed in a day. If w is the daily wage rate, the utility function of a labourer working under a daily-wage contract can be written as:

$$U = U(\tau/\theta, w). \tag{6}$$

It is obvious that the utility function under a daily-wage contract is also monotonically increasing in θ.

When deciding whether to opt for a piece-rate contract or a daily-wage contract, the worker compares the utility levels attainable in each case. For given values of (w, τ, ω), a worker of ability θ prefers a piece-rate contract if and only if:

$$U\left(\frac{t^*}{\theta}, \omega t^*\right) > U\left(\frac{\tau}{\theta}, w\right) \tag{7}$$

where t^* represents the optimal number of tasks as given by condition (4) above. If the daily wage is less than the daily income, a worker can earn from the piece-rate ω by performing τ tasks (the pace of work under daily-wage contracts), he will never choose to work on a daily-wage contract. Hence, a necessary condition for a labourer to accept a daily-wage contract is that the daily wage should be no less than what can be earned by working at the same pace under a piece-rate contract:

Proposition 2:

$$w \leq \omega\tau \Rightarrow U\left(\frac{\tau}{\theta},w\right) \leq U\left(\frac{t^*}{\theta},\omega t^*\right), \quad \forall\theta.$$

We are now able to state the conditions under which a daily-wage contract will be preferred to a piece-rate contract by some workers. Suppose that $w=\omega\tau$. Then, the workers who are indifferent between the two contracts are those of ability θ^{s} such that $t^*(\theta^{s},\omega)=\tau$. As $f(\theta)$ is strictly positive over $\Re^+$, for all relevant values of (w,τ,ω), such a θ^{s} always exists. By Proposition 1, θ^{s} is unique. For workers of ability θ^{s}, the pace of work under daily-wage contracts happens to be the *preferred* pace of work. For all other workers, piece contracts are strictly preferred.

If $w>\omega\tau$, all workers of ability θ^{s}, and, by continuity, all workers with a working ability in the neighbourhood of θ^{s} choose daily-wage contracts. The next proposition allows us to characterize further the set of workers who prefer daily contracts.

Proposition 3: *If there exists a worker who prefers piece-rate contracts to daily-wage contracts, then either (i) all workers better skilled than him or (ii) all workers less skilled than him also prefer to work on piece-rate contracts.*

Proof: see Appendix A.

This proposition has an important corollary: if $w>\omega\tau$, the set of workers who choose to work on piece rates consists of the most as well as the least skilled workers. The set of workers who prefer to work on daily-wage contracts is therefore a convex set, say $[\theta_{d},\theta_{u}]$, with $\theta_{u}>\theta^{s}>\theta_{d}$ and $U(\tau/\theta,w)=U(t^*/\theta,\omega)$ for both θ_{d} and θ_{u}. As explained in Section 1, workers with low ability prefer to work on piece-rate contracts because the pace of work on daily-wage contracts is too demanding for them. On the other hand, workers of high ability prefer piece-rate contracts because these allow them to take advantage of the opportunity to work fast and earn high wages.

2.2. An example

We can illustrate the above propositions with the help of a simple example, which allows for explicit solutions. Consider the following utility function on piece-rate contracts:

$$U\left(\frac{t}{\theta},\omega t\right) = -\frac{1}{2}\left(\frac{t}{\theta}\right)^2 + \omega t. \tag{8}$$

Maximizing Eq. (8) with respect to t, one obtains:

$$t^* = \omega\theta^2. \tag{9}$$

The optimal number of tasks is increasing in both the level of ability and the piece rate. The utility of a worker under a piece-rate contract is equal to:

$$U\left(\frac{t^*}{\theta},\omega t^*\right) = \frac{1}{2}\omega^2\theta^2. \tag{10}$$

To choose a contract, each worker compares the latter to the utility level he obtains under a daily contract, which is given by:

$$U\left(\frac{\tau}{\theta},w\right) = -\frac{1}{2}\left(\frac{\tau}{\theta}\right)^2 + w. \tag{11}$$

The indirect utility functions for different levels of ability are shown in Fig. 1. For a given level of ability, the contract chosen is the one which corresponds to the highest level of utility.

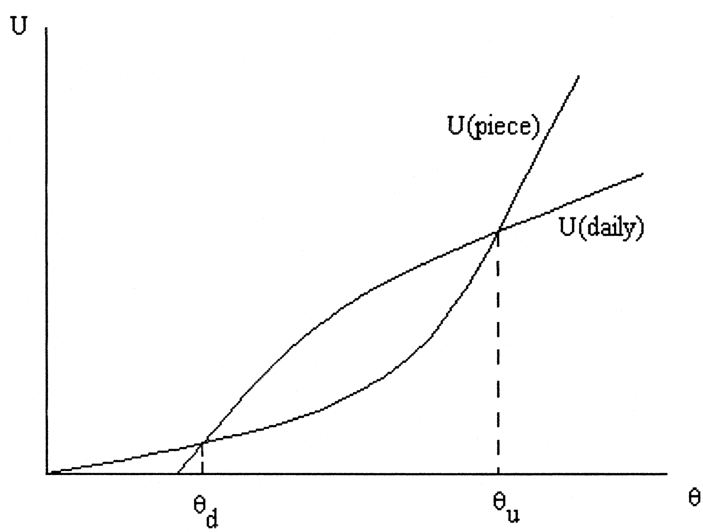

Fig. 1. Choice of contract at different levels of ability.

Using Eqs. (10) and (11) above, one can compute the levels of ability θ_d and θ_u of these workers who are indifferent between the two types of contracts:

$$\theta_d = \frac{w - \sqrt{w^2 - \tau^2\omega^2}}{\omega^2}, \quad \theta_u = \frac{w + \sqrt{w^2 - \tau^2\omega^2}}{\omega^2} \quad \text{for } w > \omega\tau. \tag{12}$$

Note that, as follows from Proposition 2, for $w < \omega\tau$, there is no level of ability such that daily contracts are preferred to piece contracts. In Fig. 2 below, we plot θ_d and θ_u for given values of ω and τ. At any level of w, the corresponding interval $[\theta_d, \theta_u]$ represents the set of workers who prefer to work on daily-wage contracts.

Using Eqs. (9) and (12), the relationship between the number of tasks accomplished and worker's ability (for given w and ω) when both contracts coexist is illustrated in Fig. 3.

2.3. Labour market equilibrium

In this section, we consider a number of hypotheses concerning the demand side of the labour market, and the corresponding outcomes.

2.3.1. Monopsonistic employer

Let us first consider the case of monopsonistic labour demand. The unique employer maximizes profits by choosing the piece rate, ω, the daily wage, w, and the pace of work for daily-wage labourers, τ. This employer has three choices: (i) offering piece-rate contracts only, (ii) offering daily-wage contracts only, and (iii) offering both. In the following, we assume, for simplicity of exposition, constant returns to scale with respect to the number of tasks performed, but the main results readily extend to the case of diminishing returns. We also assume that all costs of production, other than labour costs, are equal to zero.

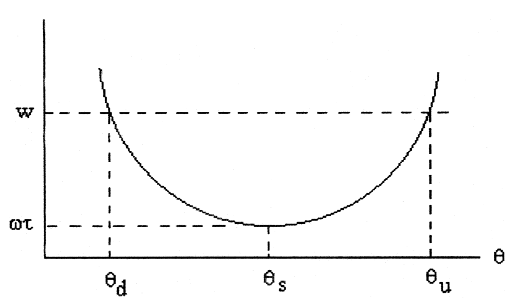

Fig. 2. Choice of contract in the (θ, w) space.

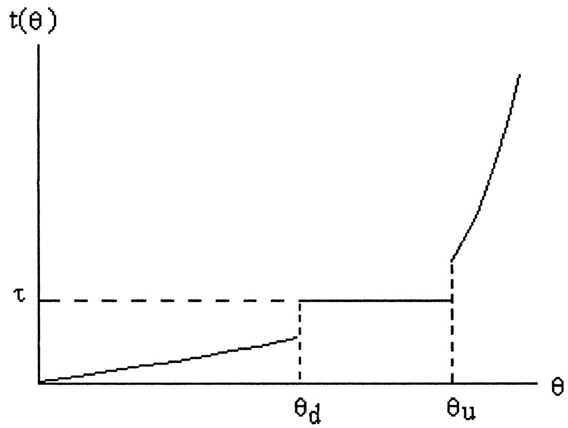

Fig. 3. Number of tasks performed at different levels of ability.

Formally, when he offers piece-rate contracts only, profits may be written as:

$$\Pi(\text{piece}) = (1-\omega)\int_{\theta_0}^{+\infty} t^*(\theta,\omega)f(\theta)\mathrm{d}\theta \tag{13}$$

where the price of output has been normalised to 1 and θ_0 is the lowest skill level such that the labourer prefers to accept the contract rather than not to work at all: [7]

$$U\left(\frac{t^*(\theta_0,\omega)}{\theta_0},\omega t^*(\theta_0,\omega)\right) = U(0,0).$$

If he offers daily-wage contracts only, profits may be written as:

$$\Pi(\text{daily}) = (\tau - w)\int_{\theta_1}^{+\infty} f(\theta)\mathrm{d}\theta \tag{14}$$

where θ_1 is the lowest skill level such that a labourer prefers to accept the contract rather than not work at all.

Finally, if the employer offers both contracts, profits are:

$$\Pi(\text{mixed}) = (1-\omega)\int_{\theta_0}^{\theta_d} t^*(\theta,\omega)f(\theta)\mathrm{d}\theta + (\tau - w)\int_{\theta_d}^{\theta_u} f(\theta)\mathrm{d}\theta + (1-\omega)\int_{\theta_u}^{+\infty} t^*(\theta,\omega)f(\theta)\mathrm{d}\theta \tag{15}$$

where, as before, the interval (θ_d,θ_u) is the set of labourers who prefer to work on piece-rate rather than daily-wage contracts. [8] Note that, when both contracts are

[7] Note that if a labourer of ability θ prefers to accept the contract than not work at all, then all workers with ability higher than θ also prefer to accept it, because labourers' utility increases with θ.

[8] We have written Eq. (15) under the assumption that θ_d is positive, θ_u finite and $\theta_0 < \theta_u$. It is easy to write the corresponding expressions for employer's profits when $\theta_d = 0$, or $\theta_u = +\infty$, or $\theta_0 > \theta_d$.

offered, the employer has no power to assign particular labourers to a particular contract because θ is not observable.

Without further restrictions, an explicit solution to the employer's profit-maximization problem cannot be computed. We are, however, able to establish some important features of the solution.

Proposition 4: *For a monopsonistic employer, it is always more profitable to hire labourers under both types of contracts than exclusively under piece rates.*

Proof: see Appendix A.

The intuition behind this proposition is as follows. Consider a situation in which only piece-rate contracts are offered: the marginal product of a task for the employer is equal to one, which is higher than the marginal disutility of a task for labourers, equal to ω. The divergence between those two marginal rates of substitution makes it possible and profitable for the employer to simultaneously offer a daily-wage contract involving a (marginally) higher wage and a faster pace of work that some workers are willing to accept.

The next question is whether there are situations where it can be optimal for the employer to offer daily-wage contracts only. The answer is yes. Suppose the employer offers a daily-wage contract only, with wage w and pace of work τ. Suppose also that there is at least one ability level θ such that $t^*(w/\tau, \theta) \geq \tau$. This means that there exists workers (of high ability) who would choose to work at a pace higher than τ, when given the option of working on a piece-rate contract with the same reward per task (i.e., $\omega = w/\tau$). This arrangement would be mutually beneficial if the employer could restrict the piece-rate contract offer to those labourers. However, he cannot do so and a piece-rate contract may also be chosen by some of the least-skilled labourers with some loss of profit for the employer. Thus, even though high-ability labourers are prepared to work more, the employer may stick to offering the daily-wage contract only since it allows him to extract more work from the low-ability workers. [9]

In short, with a monopsonistic employer, two outcomes are possible. First, the employer may choose to offer only daily-wage contracts. In that case, the daily-wage contract can be interpreted as a device aimed at extracting more work from the lower-ability workers. Second, the employer may choose to offer both

[9] Formally, the reasoning used in the proof of Proposition 4 cannot be extended to rule out the exclusive use of daily-wage contracts, because the set of labourers who would switch to piece-rate contracts, if offered, is not convex.

daily-wage and piece-rate contracts. The advantage of doing so follows from the idea that it is in the interest of a monopsonistic employer to segment the market. [10]

2.3.2. Competition

Let us now consider the case of perfect competition among employers. As before, we assume that employers cannot offer different wages to different workers (i.e., wages are not ability-specific). [11] In this situation, all workers are hired on piece-rate contracts. Indeed, in order for a price-taking employer to be indifferent at the margin between piece-rate and daily-wage hiring, the wage cost per task must be the same under both types of contract. All labourers would then prefer piece-rate contracts, since earnings per task are the same and piece rate contracts have the advantage that the number of tasks to be performed can be chosen. Thus, under perfect competition, daily-wage contracts are dominated by piece-rate contracts, which sets a single price for ‘tasks’ in the economy.

This reasoning is based on the assumption that tasks performed under daily-wage and piece rate contracts are perfect substitutes (in the sense that output is a function of the total number of tasks, no matter how they have been performed). As discussed earlier, however, there are at least two reasons why this assumption may not apply: tasks performed under piece-contracts may be of lower quality, and daily wage contracts entail supervision costs. To see the implications of these asymmetries, suppose the supervision cost of one task performed under daily wages is c (where c is constant and smaller than the price, normalized to one), and that one task performed under piece-rate contracts entails a cost of d in terms of lost quality (with d smaller than one). We also assume constant returns to scale (with the normalization that each task produces one unit of output). An employer’s net profit per task performed is then

$$\pi(\text{daily}) = 1 - c - \left(\frac{w}{\tau}\right) \tag{16}$$

in the case of a daily-wage contract, and

$$\pi(\text{piece}) = 1 - d - \omega \tag{17}$$

in the case of a piece-rate contract. Perfect competition ensures that, at equilib-

[10] One can develop similar arguments to analyze the case of a duopsonistic labour market, where different employers compete a la Bertrand to hire the labour force. If we assume, following Matutes et al. (1994), that prospective employers first choose the type(s) of contract they offer and then set a wage rate for the type(s) of contract they have chosen, there is a possibility that in equilibrium each employer specializes in one type of contract.

[11] Interestingly, this seems to be a common feature of labour markets in agrarian economies even when worker’s abilities are to some extent observable; see Drèze and Mukherjee (1989) for further discussion with reference to India.

rium, the daily wage and the piece rate are set to a level such that profits are equal to zero. As a result, the equilibrium values of w and ω are:

$$w^* = \tau(1-c) \text{ and } \omega^* = (1-d). \tag{18}$$

Moreover, from Proposition 2 and the discussion based on it, we know that, as soon as labor earnings per task are higher under daily-wage contracts than under piece-rate contracts, some workers necessarily choose to work on daily-wages. [12] Now, let $k=(1-c)/(1-d)$ denote the ratio of labour earnings under daily-wage and piece-rate contracts (using Eq. (18)). The following possibilities emerge. [13]

(1) If $k \leq 1$, that is $d \leq c$, then all workers are hired on piece-rate contracts (this follows from the same reasoning as in the first paragraph of this section).

(2) If $k > 1$, then at least some labourers work on daily contracts. For values of k sufficiently close to 1, at least some labourers will also work on piece rate contracts (by continuity and because, for $k \leq 1$, all workers prefer piece-rate contracts). If k is large enough, however, it is possible for piece-rate contracts to be entirely displaced by daily-wage contracts.

2.3.3. Rigidity of real wages

Before concluding, we should briefly mention an additional reason for the possible coexistence of daily-wage and piece-rate contracts: the downward rigidity of daily wages. So far, we assumed that labourers work under their preferred contract, and that there is no involuntary unemployment. Daily wages can be rigid, however, as has been observed in Palanpur during the slack season, leading to involuntary unemployment of daily wage workers. On the other hand, the market for piece-rate contracts is considerably more competitive, giving those workers the option of working on piece rates. [14] A ‘dual labour market’ situation emerges, involving the coexistence of rationing of daily-wage contracts with competitive allocation of piece-rate contracts, the latter acting as a second-best employment option. Similarly, in India’s industrial sector, piece-rate contracts have been increasingly used by employers in recent years as a means of circumventing minimum wage laws and other ‘rigidities’ of the formal labour market based on time rates.

When piece-rate contracts act as substitute contracts in a context of downward rigidity of daily wages, the set of labourers actually employed on daily wages need not be convex (in the space of working ability). The set of labourers who prefer daily-wage contracts to piece-rate contracts is still convex, following our earlier

[12] Remember that, to simplify the discussion, we assumed that $f(\theta)$ is strictly positive over $\Re+$, so that the set of such workers is necessarily non-empty.

[13] These results can be generalized to the case where supervision costs are non-linear, so that the marginal rate of substitution between tasks performed under both contracts is not constant.

[14] See Drèze and Mukherjee (1989) for further discussion of the evidence, and also of possible reasons for the greater flexibility of piece-rate contracts.

reasoning, but the properties of the set of labourers actually employed on daily-wage depends on how employers choose their employees from that set. In the models developed earlier, there is no reason why this choice should be based on the employees' respective working abilities, since supervised labourers all work at the same pace and in the same way. In practice, however, as employers often have at least some knowledge of workers' abilities, they may try to select the better-skilled labourers, who are easier to supervise. In that case, the set of labourers employed on daily wages will remain convex (more precisely, it will consist of all labourers above a certain ability level among those who prefer daily-wage to piece-rate contracts).

3. Concluding remarks

The preceding analysis suggests at least four possible interpretations of piece-rate contracts. First, piece-rate contracts may simply be better contracts, in the sense that, compared with daily-wage contracts, they represent a mutually beneficial arrangement which gives labourers the freedom to choose their own pace of work and obviates the need for supervision. If tasks performed under both types of contracts are perfect substitutes (i.e., there is no quality-control issue for piece-rate contracts), and if there is competition among employers, daily-wage contracts are entirely superseded by piece-rate contracts. Supervision costs under daily contracts, if any, reinforce the superiority of piece-rate contracts.

Second, piece-rate contracts may be 'supplementary contracts', which coexist with daily wage contracts because the benefits of piece rate contracts mentioned above are achieved at some cost to the employer in terms of task quality (so that daily-wage contracts are not entirely redundant). When there is competition among employers, we have shown that both contracts coexist if the supervision costs per task under daily contracts are lower than the quality costs per task under piece-rate contracts, but not so low that all labourers end up working on daily-wage contracts.

Third, piece-rate contracts can play the role of a segmentation device in the context of a monopsonistic labour market. In the case where tasks performed under piece-rate and daily-wage contracts are perfect substitutes, we have shown that a monopsonistic employer may either (1) offer both types of contract (the market-segmentation scenario), or (2) offer daily-wage contracts only (because they make it possible to extract more tasks from the workers than they would choose to perform under piece-rate contracts).

Fourth, piece-rate contracts can act as 'substitute contracts', in a situation of wage rigidity and involuntary unemployment of daily-wage labour. In this case, piece rate contracts represent a second-best employment option for labourers who are unable to find work on daily wages (aside from being preferred to daily-wage contracts by some labourers).

We have also shown that, when daily-wage and piece-rate contracts are simultaneously offered, the set of labourers who work for daily wages is generally convex in the space of abilities. In other words, those who work on piece-rate contracts consist of the set of workers who are more able than all daily-wage workers, or less able than all daily-wage workers. The high-ability workers prefer piece-rate contracts because these enable them to work more and earn more (i.e., the piece-rate contracts give them an opportunity to take full advantage of their high working ability). The low-ability workers prefer piece-rate contracts because they find the pace of work on daily-wage contracts too stressful. Among labourers working on piece-rate contracts, the number of tasks performed increases monotonically with working ability.

Acknowledgements

We are grateful to Vicky Barham, Louis Gevers, Peter Lanjouw, Anindita Mukherjee, Rohini Pande and two anonymous referees of this journal for their helpful comments and suggestions.

Appendix A

Proof of Proposition 1. Total differentiation of Eq. (4) with respect to t^* and θ gives:

$$\left(-\frac{U_1}{\theta^2}-\frac{t^*\omega}{\theta^2}U_{21}-\frac{U_{11}}{\theta^3}t^*\right)\mathrm{d}\theta+\left(\frac{U_{11}}{\theta^2}+2\frac{\omega}{\theta}U_{21}+\omega^2U_{22}\right)\mathrm{d}t^*=0 \quad \text{(A1)}$$

$\Leftrightarrow$

$$\frac{\mathrm{d}t^*}{\mathrm{d}\theta}=\frac{\dfrac{U_1}{\theta^2}+\dfrac{t^*\omega}{\theta^2}U_{21}+\dfrac{U_{11}}{\theta^3}t^*}{\dfrac{U_{11}}{\theta^2}+2\dfrac{\omega}{\theta^2}U_{21}+\omega^2U_{22}}. \quad \text{(A2)}$$

From Eqs. (2) and (3), it follows that both the numerator and the denominator in the last expression are negative. Hence, $\mathrm{d}t^*/\mathrm{d}\theta$ is positive.

Proof of Proposition 3. If $w>\omega\tau$ (if not, the proposition trivially holds since all workers prefer to work on a piece-rate contract), a worker of ability θ^{s} necessarily chooses daily-wage contracts, since the pace of work on daily-wage contracts coincides with his preferred pace of work, and earnings per task are higher on daily-wage contracts. For this particular worker, it is easy to deduce from Eq. (5) that the slope of the utility function with respect to the ability level (which may be interpreted as the 'marginal value of ability') is larger under daily-wage contracts than under piece-rate contracts:

$$\frac{\mathrm{d}U(\tau/\theta,w)}{\mathrm{d}\theta} = -U_1(\tau/\theta,w)\frac{\tau}{\theta^2} \geq \frac{\mathrm{d}U(t^*/\theta,\omega t^*)}{\mathrm{d}\theta}$$

$$= -U_1(t^*/\theta,\omega t^*)\frac{t^*}{\theta^2},$$

$$\text{for } \theta=\theta^{\mathrm{s}} \text{ as } t^*(\theta^{\mathrm{s}},\omega)=\tau,\ w>\omega\tau,\ U_{12}\leq 0. \qquad \text{(A3)}$$

Moreover, from Proposition 1, all workers whose level of ability is lower than θ^{s} and who choose to work on a piece-rate contract, choose an optimal number of tasks lower than τ. Thus, for all workers such that $\theta<\theta^{\mathrm{s}}$, $t^*/\theta<\tau/\theta$. Since $U_{11}<0$, it follows that inequality (A3) above also holds for all such workers:

$$\forall\theta:\theta<\theta^{\mathrm{s}},\quad \frac{\mathrm{d}U(\tau/\theta,w)}{\mathrm{d}\theta} > \frac{\mathrm{d}U(t^*/\theta,\omega t^*)}{\mathrm{d}\theta}. \qquad \text{(A4)}$$

Hence, if any of those workers prefers a piece-rate contract to a daily-wage contract, so do all agents with a lower ability level.

Let us now consider a worker whose level of ability, θ', is such that he earns the same income under both types of contract, i.e., $w=\omega t^*(\theta',\omega)$. Since $w>\omega\tau$ by assumption, $t^*(\theta',\omega)>\tau$, and that worker will choose a daily-wage contract. As $U_{11}<0$ and $\tau/\theta'<t^*(\theta',\omega)/\theta'$, it follows that:

$$\frac{\mathrm{d}U(\tau/\theta,w)}{\mathrm{d}\theta} = -U_1(\tau/\theta,w)\frac{\tau}{\theta^2} < \frac{\mathrm{d}U(t^*/\theta,\omega t^*)}{\mathrm{d}\theta}$$

$$= -U_1(t^*/\theta,\omega t^*)\frac{t^*}{\theta^2},\quad \text{for } \theta=\theta'. \qquad \text{(A5)}$$

From Proposition 1, all workers with a level of ability higher than θ' also choose to supply more tasks than τ if they work on piece-rate contracts. The daily wage is therefore lower than their daily earnings as piece-rate workers. It follows that inequality (A5) also holds: i.e., for all $\theta>\theta'$, the 'marginal value of ability' is higher on piece-rate contracts than on daily-wage contracts. If any of those workers prefers a piece-rate contract, so do all workers with a higher ability level. Finally, all workers with a level of ability between θ^{s} and θ' choose to work as daily workers since, for θ: $\theta^{\mathrm{s}}<\theta<\theta'$, $\tau/\theta'<t^*(\theta,\omega)/\theta$ and $w>\omega t^*(\theta,\omega)$.

Proof of Proposition 4. We will prove this proposition by showing that any employment offer consisting of a single piece-rate contract is always dominated by a combination of piece-rate and daily-wage contracts. Consider a given piece rate $\omega_0<1$ (note that, if $\omega_0\geq 1$, the monopsonistic employer has no reason to hire anyone on piece rates) and one of the many pairs (w,τ) such that $w=\tau\omega_0$. Consider a worker with ability θ^s. From Eq. (4), we have:

$$U_1\left(\frac{t^*}{\theta^s},\omega t^*\right)\left(\frac{1}{\theta^s}\right)+U_2\left(\frac{t^*}{\theta^s},\omega t^*\right)\omega=0 \tag{A6}$$

and the marginal rate of substitution between tasks and income for that worker is:

$$\mathrm{MRS}(t,\omega_0 t)=-\frac{U_2}{U_1}\theta^s=\frac{1}{\omega_0}>1 \tag{A7}$$

In other words, for one unit of extra income, a worker of ability θ^s is ready to supply strictly more than one unit of task. By continuity, the same inequality applies for all θ sufficiently close to θ^s.

On the other hand, from the employer's point of view the marginal value of a task, in terms of income, is equal to one. It follows that there exists a daily-wage contract (w',τ') which is profitable to the employer and preferred to the piece-rate contract by a convex set of labourers including those with ability θ^s (as the set of labourers who prefer daily-wage contracts is convex). Formally, there exists $k>1$ such that the daily-wage contract $(w',\tau')=(\omega_0\tau+\alpha,t^*(\omega_0,\theta^s)+k\alpha)$ is mutually beneficial for sufficiently small values of α.

References

Bardhan, P.K., Rudra, A., 1981. Terms and conditions of labour contracts in agriculture: results of a survey in West Bengal 1979. Oxford Bulletin of Economics and Statistics 43, 89–111.

Binswanger, H.P., Doherty, V.S., Balaramaiah, T., Bende, M.J., Kshirsagar, K.G., Rao, V.B., Raju, P.S.S., 1984. Common features and contrasts in labor relations in the semi-arid tropics of India. In: Binswanger, H.P., Rosenzweig, M.R. (Eds.), Contractual Arrangements, Employment and Wages in Rural Labor Markets in Asia. Yale Univ. Press, New Haven.

Bliss, C.J., Stern, N.H., 1982. Palanpur: the Economy of an Indian Village. Oxford Univ. Press, New Delhi.

Chakravarti, A., 1997. Social power and everyday class relations: agrarian transformation in North Bihar. Mimeo, Delhi School of Economics, to be published as monograph.

Drèze, J.P., Mukherjee, A., 1989. Labour markets in rural India: theories and evidence. In: Chakravarty, S. (Ed.), The Balance between Industry and Agriculture in Economic Development 3: Manpower and Transfers. Proceedings of the Eighth World Conference of the International Economic Association. Macmillan Press, in association with IEA.

Lazear, E.P., 1986. Salaries and piece-rates. Journal of Business 59 (3), 405–431.

Matutes, C., Regibeau, P., Rockett, K., 1994. Compensation schemes and labor market competition: piece rate versus wage rate. Journal of Economics and Management Strategy, Summer 1994, 225–253.

Mukherjee, A., 1994. The labour market in Indian villages. IED Discussion Paper Series No. 34. Boston University.

Pencavel, J.H., 1977. Work effort, on-the-job screening, and alternative methods of remuneration. In: Ehrenberg, R.G. (Ed.), Research in Labour Economics, Vol. 1. JAI Press, Greenwich, CT, pp. 225–258.

Petersen, T., 1991. Payment system and the structure of inequality: conceptual issues and analysis of salespersons in department stores. Mimeo, University of California, Berkeley.

Petersen, T., 1991b. Reward systems and the distribution of wages. The Journal of Economics, Law and Organization 7, 130–159, Special issue.

Reddy, C.R., 1985. Rural labour markets in Varhad: a case study of agricultural labourers in rain-fed agriculture in India. Rural Employment Policy Research Programme Working Papers, No. 75. WEP, ILO, Geneva.

Roumasset, J., Uy, M.J., 1980. Piece rates, time rates and teams. Journal of Economic Behavior and Organization 1, 343–360.

Seiler, E., 1984. Piece rate vs. time rate: the effects of incentives on earnings. Review of Economics and Statistics 63 (3), 363–375.

Stiglitz, J., 1975. Incentive, risk and information: notes towards a theory of hierarchy. Bell Journal of Economics 6, 552–579.

Uy, M.J., 1979. Contractual choice and internal organization in Philippine sugarcane production. MA thesis, University of the Philippines, Diliman.