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Turnover Costs, Efficiency Wages and Cycles

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ABSTRACT. – This paper studies the implications of our recent work on two labour market imperfections for the cyclical properties of wages and employment. One of these imperfections is turnover costs. We explore the implications of the interaction of turnover costs with investment decisions for the form of wage contracts and hence for the cyclical properties of wages. The other imperfection is the difficulty of verifying employee performance. We consider the implications of this for the payment of efficiency wages and the consequence for the cyclical properties of wages and employment.

Coûts des rotations, salaires d'efficience et cycles économiques

RÉSUMÉ. – Cet article étudie les implications découlant de nos travaux récents portant sur deux imperfections de marché liées aux propriétés cycliques des salaires et de l'emploi. Les coûts de roulement constituent une de ces imperfections. Nous explorons les implications qu'engendre l'interaction des coûts de roulement avec les décisions d'investissement de la firme quant à la forme des contrats salariaux et des propriétés cycliques qui en découlent. La deuxième imperfection a trait à la difficulté de vérifier la performance de l'employé. Nous examinons les implications de cette imperfection en ce qui a trait au versement de salaires d'efficience et les conséquences pour les propriétés cycliques des salaires et de l'emploi.

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1 Introduction

There are many reasons for doubting that the cyclical behaviour of labour markets can be understood in terms of a market in which wages simply equate demand and supply. One of these is the incompleteness of employment contracts that results from information imperfections. Here we survey the implications of our recent research on two labour market imperfections for the cyclical properties of wages and employment.

One of these imperfections is turnover costs. Turnover costs may be real resource costs involved in finding, interviewing and providing essential training for new employees. They may be transfer costs in the form of severance and redundancy pay, either agreed between employer and employee as part of the employment contract or imposed by law. They may also result from legal restrictions and delays in terminating employment contracts. EMERSON [1988] has documented the extent of these restrictions in practice. Such turnover costs make changing the number of employees costly, with a consequent impact on the dynamics of wages and employment.

The other imperfection we consider arises from the difficulty of verifying employee performance in courts and labour tribunals. The basic issue is that, if performance is not readily verifiable, it will be at best costly, and at worst impossible, to enforce legally a contract that makes payment conditional on a specified level of performance. The implication is that, within their contractually enforceable duties, employees retain some degree of control over performance. There is ample evidence that this is an important issue. Without it, there would be no need for employers to be concerned about motivation because performance would be enforced by contract. In fact, personnel departments devote considerable resources to issues of motivation and morale. Based on a survey of 26 employers in Britain, KAUFMAN [1984] reports: "Employers invariably felt that work effort was endogenous and depended upon worker motivation and satisfaction. As a result, they believed that there was substantial variation in both the quantity and quality of output for a constant input of labour hours. ... (T)hey relied heavily on the goodwill of their employees." For a sample of 19 New Jersey firms, BLINDER and CHOI [1990] report: "Every firm believed that workers sometimes shirk on the job." HALL [1993] received exactly the same response from 39 firms in the North East of England. In interviews with 153 Connecticut firms, Bewley [1993] confirmed that effects on motivation and morale were a major influence on pay policy. Hall also asked more directly about verifiability. Over half his respondents were unequivocal that performance could not be monitored in an objective, verifiable way. The sample sizes involved in these studies are not large but the overwhelming nature of the evidence underlines the degree of control employees have over performance without breaching their contractually enforceable duties.

Section 2 discusses the implications of turnover costs, Section 3 those of the need to motivate employees who retain control over their performance.

2 Turnover Costs

Turnover costs may be in money or in time. The former underlie models of "lock in". The latter underlie the matching models of employment of BLANCHARD and DIAMOND [1989, 1990], PISSARIDES [1985, 1987], and MORTENSEN and PISSARIDES [1994]. The existence of turnover costs implies that, once an employee is hired, the wage the firm would be prepared to pay to retain the employee may be higher than the lowest wage for which the employee would stay. If so, there is an *ex post* rent to continuing the match. Unless constrained by a contract previously agreed, the division of that rent is the result of bilateral monopoly bargaining constrained by the *outside option* possibilities of (i) the employee finding another job if the wage offered is too low and (ii) the firm closing down, or hiring an alternative employee, if the wage is too high. We start by analysing the outcome of such *ex post* bargaining.

SHAKED and SUTTON [1984] provide the basic framework for analysing bilateral bargaining with outside options. In the context of an infinite horizon stationary model with a risk neutral employee, they derive the unique subgame perfect bargaining equilibrium. Let $y(s)$ denote the firm's revenue net of nonlabour costs, w the wage it pays and $\pi(w,\, s) = y(s) - w$ its profit, with s (for *state*) a vector of such things as the prices of outputs and nonlabour inputs, productivity in the job, and factors affecting the outside opportunities of firm and employee. BINMORE, RUBINSTEIN and WOLINSKY [1986] show that, as the time between successive offers in the bargaining process goes to zero, the equilibrium wage as a function of the state, $w^*(s)$, can be represented by the solution (the *generalized Nash solution*) to

$$(1) \qquad \max_w [w - w^o]^\alpha [\pi(w,\ s) - \pi^o]^{1-\alpha} \text{ subject to}$$

$$(2) \qquad \underline{w}(s) \le w \le \overline{w}(s),$$

where w^o and π^o are the payoffs to the employee and the firm respectively while continuing to bargain, $\underline{w}(s)$ and $\underline{\pi}(s)$ are the payoffs they can get if they break off negotiations with each other and take their next best alternatives, $\overline{w}(s) \equiv y(s) - \underline{\pi}(s)$ is the highest wage the firm would be prepared to pay to retain the employee, and α $(0 < \alpha < 1)$ represents the relative *bargaining powers* related to the discount rates of the parties. The inequalities in (2) are the outside option constraints. The solution is

(3)

$$w^*(s) = \begin{cases} \underline{w}(s), & \text{if } w^o + \alpha[y(s) - w^o - \pi^o] \le \underline{w}(s); \\ \overline{w}(s), & \text{if } w^o + \alpha[y(s) - w^o - \pi^o] \ge \overline{w}(s); \\ w^o + \alpha[y(s) - w^o - \pi^o], & \text{otherwise.} \end{cases}$$

The top and middle lines of (3) are the cases in which the employee's and the firm's outside option constraints respectively bind. The bottom line of (3) is the *rent sharing* outcome that occurs when neither of these constraints binds. Implicit in (3) is that employment occurs if and only if it is efficient (that is, $y(s) > \underline{w}(s) + \underline{\pi}(s)$).[1] In the bottom line of (3), both wage and profit are increasing functions of the rent $y(s) - w^o - \pi^o$, so jobs with more rent pay a higher wage, and have higher profit, than those with less rent. Moreover, then $w^*(s) > \underline{w}(s)$, so any unemployed have strictly lower current utility than the equally productive employed.

MacLeod and Malcomson [1994] show that the bargaining equilibrium can also be represented by (3) with finite horizon bargains when (as in the case of employment) bargaining is concerned with continuing trade. This framework can, as in MacLeod and Malcomson [1993b], be used to extend the same basic results to (symmetrically observed) *shocks* represented by changes in s, which provides the basic building block for analysing the implied cyclical properties of wages. The parties continue to share the rent as long as neither outside option constraint binds so a shock that changes the rent changes both wage and profit in the same direction. If w^o and/or π^o are also affected by the shock, the bargained wage responds in obvious ways. However, reversal of any shock will reverse the resulting wage change and wages do not display nominal rigidity. There is thus no "stickiness" in wages and no asymmetry between upwards and downwards shocks. For matching models, Blanchard and Diamond [1990] conclude that *ex post* bargaining of this sort results in a large procyclical movement of wages over the cycle, "an unpleasant implication in view of the actual behavior."

These models, however, ignore an important aspect of production, the fact that firms invest in capital equipment to increase labour productivity. Without turnover costs, investments that are general in the sense of Becker [1964] shift the labour demand curve but have no other implications for wage determination or the cyclical properties of wages. In contrast, with turnover costs *ex post* wage negotiation becomes inefficient because of the hold-up property analysed by Grout [1984] and Williamson [1985]. To illustrate this, we can include such investment as one element of s. Investment increases the *ex post* rent $y(s) - w^o - \pi^o$. Sharing of that rent as in the bottom line of (3) implies that the employee captures some of the returns on the investment, which results in the firm investing inefficiently.

MacLeod and Malcomson [1993b] show that a simple form of wage contract that corresponds closely to the form many wage contracts actually take can be used to overcome this inefficiency. General investments are as productive with an alternative as with the current employee, the typical case for investments other than those in training. As long as the turnover costs are money costs, this implies that $y(s)$ and $\underline{\pi}(s)$ increase by the same amount as a result of a change in investment, and thus $\overline{w}(s) = y(s) - \underline{\pi}(s)$ is independent of the amount of investment. Moreover, $\underline{w}(s)$ is also

1. In the bargaining model of Fernandez and Glazer [1991], not all subgame perfect equilibria are efficient despite information being symmetric. The inefficient equilibria, however, involve the two parties knowing they will reach a particular agreement at a particular date in the future but failing to reach agreement before then. Since both parties know this, it seems implausible for reasons given in Hicks [1963] for them not to agree straightaway on an efficient equilibrium that is strictly better for both. Formally, the inefficient equilibria are not renegotiation proof, see MacLeod and Malcomson [1994]. This seems a situation in which subgame perfection alone is not a sufficient criterion for reasonable play.

independent of the amount of investment. Thus, as long as the outcome of bargaining is given by either the top or the middle line of (3), the payoff to the worker will be independent of the firm's investment and the firm will receive all the marginal return on any investment.

There is a simple condition that allows this to be achieved. Suppose $y(s) - \pi^o > w^o$ for all s. The economic import of this condition is that there is a deal between the employee and the firm that would be mutually beneficial in all relevant states if their only alternatives yielded w^o and π^o, the payoffs they get while continuing to bargain (for example, if there were no other potential employers or employees for them to make matches with). It is shown in MacLeod and Malcomson [1993b] that, if the parties have a contract specifying a wage w^c that satisfies

$$w^o < w^c < y(s) - \pi^o, \text{ for all } s, \tag{4}$$

the rent sharing outcome given by the bottom line of (3) never occurs. Formally, the solution (3) is replaced by

$$w^*(s) = \begin{cases} \underline{w}(s), & \text{if } w^c \leq \underline{w}(s); \\ \overline{w}(s), & \text{if } w^c \geq \overline{w}(s); \\ w^c, & \text{otherwise.} \end{cases} \tag{5}$$

The intuition for this is as follows. The rent sharing solution given by the bottom line of (3) arises as the result of a threat to stop production if agreement is not reached. But, when there is a contract with a wage that satisfies (4), such a threat is credible for neither firm nor employee because both would be better off having production occur and the wage w^c paid than stopping production. Formally, the difference between (5) and (3) arises because not having a contract is equivalent to having a contract that specifies $w^c = 0$ and the worker would be no better off working for a wage of zero than not working at all. In that case, the contract wage does not satisfy (4) and the threat to stop production is credible. (The formal argument makes use of a strictly positive disutility of working but this can be arbitrarily small.) But, if the threat to stop production is not credible, employment will take place at the contract wage w^c unless either the firm or the employee would do better by finding an alternative partner. If one of them would but it is nevertheless efficient for the match to continue, the contract is renegotiated by just enough to stop that party quitting, as indicated in the upper and middle lines of (5). If $\underline{w}(s) > \overline{w}(s)$, there is no wage at which a mutually beneficial deal can take place and separation is efficient. In that case, both parties receive their outside option payoffs.

With the outcome (5) the firm's investment will be efficient. The reason is that none of $\underline{w}(s), \overline{w}(s)$ and w^c are affected by the level of investment, so the wage $w^*(s)$ is independent of the level of investment and the employee, therefore, captures none of the return on the firm's investment. The contract that achieves this specifies (like the typical wage contract) merely a fixed wage that is renegotiated by mutual consent only when one of the outside option constraints binds. There is no need for breach penalties.

The essential intuition for this contract resulting in efficient investment is as follows. As long as neither outside option constraint binds, the wage remains unrenegotiated and so is independent of the firm's investment. The firm then clearly gets all the return on any investment. When one of the outside option constraints binds, the wage is renegotiated to the corresponding outside option value. The employee's outside option value is independent of the level of investment so, when this constraint binds, any additional rent resulting from investment goes to the firm. Moreover, the firm's outside option value fully reflects the return on a general investment so, when that constraint binds, the firm gets the return on the investment too. The effect of adopting this contract is that the wage is unaffected by shocks that leave the outside option constraints satisfied but is renegotiated (upwards or downwards) when one of the constraints binds.

This has important effects on the cyclical properties of wages. As MacLeod and Malcomson [1993b] show, in a dynamic model it is in many cases sufficient that the contract wage w^c is the wage actually paid in the previous period. This can be seen intuitively from (4), though in a dynamic model the present discounted values of the employee's and the firm's future payoffs must also be taken into account. The wage w_{t-1} negotiated at $t-1$ necessarily satisfies the dynamic equivalent of (4) at $t-1$ for the realized value of s at $t-1$. Thus, as long as the lowest anticipated productivity $y(s)$ at t is not substantially below actual productivity at $t-1$, w_{t-1} will also satisfy the dynamic equivalent of (4) at t. A contract that specifies a wage that remains unchanged until renegotiated by mutual consent then achieves efficient investment. This is precisely the formal position with typical wage contracts under English law, as reasserted in *Rigby v. Ferodo Ltd.* (IRLI 516, 1987).

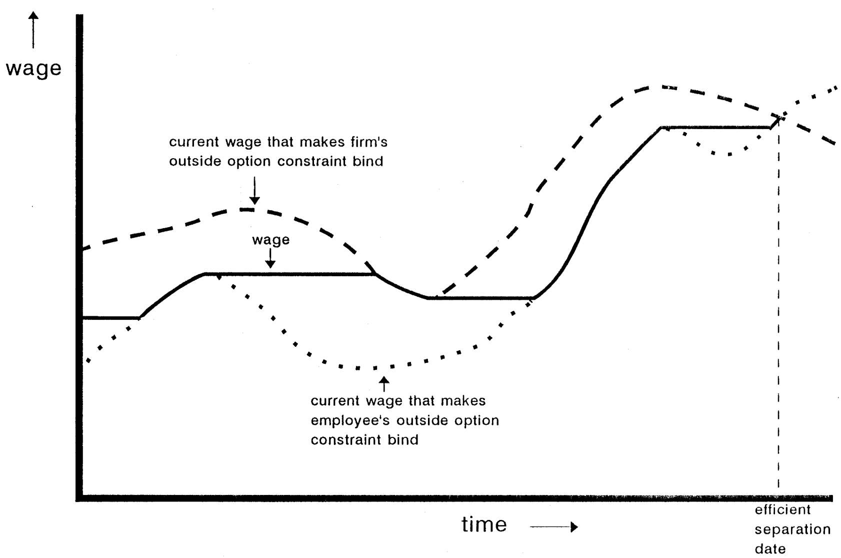

FIGURE 1

It is then straightforward to see the cyclical properties of the wage. Figure 1 illustrates how this responds over time to changes in the values of the outside options. The wage remains unchanged unless one of the parties can get a better deal elsewhere. If one of them can, the wage is renegotiated by just enough to prevent separation occurring, until such time as it is efficient to separate. The wage thus demonstrates some, but not complete, rigidity in the face of shocks. The model fits neatly the evidence from BEAUDRY and DINARDO [1991] that the best labour market conditions since the start of the job have a strongly significant effect on a person's current wage, whereas current labour market conditions and those prevailing at the start of the job have a smaller impact. Figure 1, of course, refers to the wage of somebody already employed. With new hires, there is no existing contract so that, if the hiring market is perfectly competitive, their wages will adjust to equate supply and demand. The wages for new hires will then be more flexible than those for existing employees, as found by BILS [1985].

To induce efficient investment, the contract wage can typically be specified equally well in either real or money terms so that, if there is any cost to writing a contract that indexes the wage, contracting will be in nominal terms. This may not, however, apply if inflation is high. The reason is that the payoff w^o that the employee receives while bargaining continues may be given in real terms. Thus, if inflation is high, a contract wage w^c equal to last period's nominal wage w_{t-1} may not satisfy the left hand inequality in the dynamic equivalent of (4) at t. Indexation is then required to ensure that this inequality holds. This conclusion fits with the evidence from COUSINEAU *et al.* [1983] that the probability of escalator or COLA clauses being included in collective bargaining agreements is significantly positively correlated with the level and variance of inflation.

If the firm's investment is to some degree specific (in the sense that investment increases $y(s)$ by more than $\underline{\pi}(s)$), there is a positive reason for *not* indexing the contract wage. As long as the contract is not renegotiated, or is renegotiated only because the *employee's* outside option constraint binds, the firm still gets all the return on its investment. But if it is renegotiated because the *firm's* outside option constraint binds, the firm does not capture all the returns on the investment because a specific investment increases $\underline{\pi}(s)$ by less than $y(s)$ and the wage $\overline{w}(s)$ is thus affected by the level of investment. If there is any risk that indexation will overstate nominal changes in the value of the firm's outside option, it increases the probability that the firm's outside option constraint binds. There is then a positive reason not to index. Note that an investment will be to some degree specific in this sense if the turnover cost takes the form of time for the firm to hire a replacement employee, as in the matching models of BLANCHARD and DIAMOND [1989, 1990], PISSARIDES [1985, 1987] and MORTENSEN and PISSARIDES [1994], because during the time the job is vacant the firm will not earn a return on its investment.

With contracting in nominal terms it is straightforward to see why wages respond asymmetrically to shocks. The bargained wage changes only when one of the outside option constraints binds. With nominal contracts and inflation, the payoffs will (as in Figure 1) most of the time be closer to the employee's outside option than to the firm's so on average it takes a smaller upward shock to make the lower constraint bind than downward shock to make the upper constraint bind. Thus the response to an upward shock of a given magnitude will, on average, be larger than to a downward shock of the same magnitude. Hence, the asymmetric response.

Nominal contracting of this sort also has implications for the way markets as a whole respond to shocks. In a market with contracts entered into at different dates, a small increase in demand increases the outside option value for employees but results in renegotiation only of contracts for which the employees' outside options were previously (close to) binding. In aggregate this will appear as a partial adjustment to a new equilibrium following a shock. Moreover, with a sequence of such shocks, contract renegotiations are staggered somewhat as in Gray [1976] and Taylor [1979], but with the time between renegotiations for any match determined not exogenously, but endogenously by an outside option constraint becoming binding. Thus the present framework has the potential for providing a micro-theoretic basis for staggered contract models and for the apparent slow adjustment of wages to shocks in aggregate.

So far, we have concentrated on the implications of turnover costs for wages rather than employment. The level of employment is typically different with turnover costs than without them because the costs of hiring and dismissing employees affect when it is efficient for new hiring and for separations to occur. But a central characteristic of the turnover costs models discussed here is that employment continues if and only if it is privately efficient in the sense that the sum of the payoffs to the parties exceeds the sum of their outside option values. This condition is, moreover, independent of any requirements for firms to make redundancy payments, seek approval from government agencies, etc. The reason is that, when the employee and firm can jointly do better by ending the employment than by continuing it, there is always some deal that makes separation mutually beneficial. This is most apparent in the case of redundancy payments. Such payments are pure transfers between the firm and employee and so cannot affect the conditions under which separation is efficient for the two parties. If the firm must make a redundancy payment, the wage at which it is better for it to end the employment is higher than if no redundancy payment was required. If the wage is not high enough to make it worth the firm paying the redundancy payment and yet it is still efficient to separate, the employee will be prepared to accept voluntary severance for a payment that is sufficiently less than the full redundancy payment that the firm would be prepared to pay it. Of course, the firm would *ex post* always prefer not to have to pay redundancy pay because doing so reduces profits but this should not affect the timing of redundancies.

The same applies to government imposed delays on making redundancies provided that the costs imposed can be avoided by voluntary severance. If separation is efficient, there is always a voluntary severance payment that will induce the employee to quit and, since this is a pure transfer, it does not affect the circumstances under which severance is efficient.

What about hiring? Provided potential employees are free to negotiate starting wages, government imposed redundancy payments or delays on severance should make no difference to hiring as long as employees and firms have the same effective discount rates and risk aversion characteristics. (*Effective* in this context means after taking account of any borrowing/saving and insurance transactions the parties can make in financial markets.) Then the expected present value of the voluntary severance payments needed to ensure efficient separation given the government imposed rules is the same to both parties and can thus, as emphasized by LAZEAR [1990], be perfectly compensated by a lower initial wage. (The initial wage does not necessarily need to be lowered by the full expected present value because it may remain unrenegotiated for a period of time.) The conclusion is that, in the present model, government imposed restrictions that reduce "flexibility" in labour markets have no effect on employment unless either the initial wage runs up against a minimum wage floor or there are imperfections in other markets that prevent efficient intertemporal transfers or efficient risk sharing.

We emphasize this conclusion not because it is implausible that there are other imperfections of these kinds but because it is at variance with the conclusions of BENTOLILA and BERTOLA [1990] and BERTOLA [1990] for a similar model. The essential difference between those models and the present model is simply that, in deriving their conclusions, Bentolila and Bertola treat the wage as *given*. The argument just presented merely extends the analysis to consider the effect on wage determination.

The results of this section can be summarized as follows. When account is taken of investment as well as turnover costs, an efficient contract can explain why wages may not respond to small shocks, may respond asymmetrically to upwards and downwards shocks, and may display nominal rigidities. The model then fits well the evidence from BEAUDRY and DINARDO [1991] that the best labour market conditions since the start of a job have a strongly significant effect on current wages whereas current labour market conditions have a smaller impact. Turnover costs, however, do not *per se* induce any inefficiency in employment even if they are government imposed. Other imperfections are required for such inefficiency to occur.

3 Motivating Employees

The second imperfection we discuss is the difficulty of verifying employee performance in court. When performance is unverifiable, firms cannot ensure satisfactory performance by writing it into an employment contract because such a contract cannot be enforced legally. Here we consider the implications of it being too costly to make verifiable performance above some minimum level, such as merely turning up for work. Firms must, therefore, find other ways to motivate employees.

The results surveyed here can be explained in terms of what is essentially the SHAPIRO and STIGLITZ [1984] and the BULOW and SUMMERS [1986] efficiency wage model but in discrete time and with continuously variable effort. Let sa_t denote the output of an employee who takes action (that is, exerts effort) a_t in period t, with $a_t \in [\underline{a}, \overline{a}]$ and s an index of productivity. Let $v(a_t)$ denote the employee's disutility of effort, strictly convex and normalized so that $v(\underline{a}) = 0$. The firm monitors the employee's action in each period with probability p, but neither output nor the results of monitoring are verifiable in court. There is probability $(1-\alpha)$ that the firm and employee separate each period for reasons exogenous to the model.

To induce an employee to work hard the firm can use either the carrot or the stick. The stick was analysed by Shapiro and Stiglitz — it is the threat of being fired if caught working at less than some "satisfactory" level of effort. But, as shown in MacLeod and Malcomson [1989], a firm can also use the carrot of a bonus payment if the employee is *not* caught working at less than the satisfactory level. This bonus could be the result of a piece rate, commission payment, or periodic bonus though, since output is not verifiable, none of these would be legally enforceable. It must, therefore, be designed so the firm finds it worth paying, just as in Shapiro-Stiglitz the stick must be designed so the employee finds it worth working.

Let $\underline{w}_t$ be the (legally enforceable) base wage agreed for an employee in period t but independent of anything else that happens in period t, and b_t the bonus. If both are paid, the employee has income in period t of $w_t = \underline{w}_t + b_t$. Also, let $\bar{U}_t$ and $\bar{\Pi}_t$ denote the discounted values at t of the future utility of the employee and profit of the firm, respectively, if they separate at the end of period $t-1$. For convenience, let x denote the profile of income and effort $\{w_t,\ a_t,\ t \geq 1\}$. Suppose the parties make an informal agreement to stick to a particular x until they separate for exogenous reasons. The employee's lifetime utility from t on if both parties stick to the agreement is

$$(6) \qquad U_t(x) = w_t - v(a_t) + \delta[\alpha U_{t+1}(x) + (1-\alpha)\bar{U}_{t+1}], \text{ for all } t.$$

The firm's expected discounted profit from t on if both stick to the agreement is

$$(7) \qquad \Pi_t(x) = sa_t - w_t + \delta[\alpha \Pi_{t+1}(x) + (1-\alpha)\bar{\Pi}_{t+1}], \text{ for all } t.$$

When will they stick to an agreed x? A necessary condition for the employee to do so is that the remaining expected lifetime utility from this is at least as high as the utility of getting the base wage $\underline{w}_t$ while putting in effort $a_t = \underline{a}$ (and so, since $v(\underline{a}) = 0$, incurring no disutility of effort) plus, if not caught, the expected utility of continuing as if the agreement had not been broken (an event that happens with probability $1-p$) or, if caught, the expected utility of being fired (the worst penalty the firm can impose) and receiving $\bar{U}_{t+1}$ from $t+1$ on. Formally, this requires

$$U_t(x) \geq \underline{w}_t + (1-p)[b_t + \alpha\delta U_{t+1}(x) + (1-\alpha)\delta\bar{U}_{t+1}] + p\delta\bar{U}_{t+1}, \text{ for all } t.$$

Substitution for $U_t(x)$ from (6) and use of $w_t = \underline{w}_t + b_t$ allows this to be written

$$(8) \qquad \alpha\delta[U_{t+1}(x) - \bar{U}_{t+1}] \geq \frac{v(a_t)}{p} - b_t, \text{ for all } t.$$

Condition (8) requires the expected future gains from not ending the match prematurely (the left hand side) to be at least as great as the disutility from putting in the agreed effort divided by the probability of being caught, less the bonus that is lost if caught (the right hand side). It corresponds to the *no shirking condition* in Shapiro and Stiglitz.

If the firm can commit itself to always paying a bonus of $b_t = v(a_t)/p$ as long as the employee puts in effort a_t, then (8) is satisfied when $U_{t+1}(x) = \bar{U}_{t+1}$ and the employee always has expected lifetime utility from employment in the firm the same as that available elsewhere. AKERLOF and KATZ [1989] and MURPHY and TOPEL [1990] assume that the firm will do as it promises so as to maintain a reputation for honesty that will enable it to hire employees at lower cost in the future. But for a genuinely profit maximizing firm, a reputation for honesty is worth only as much as the future profits it generates. A complete analysis must take account of this.

A necessary condition for the firm to stick to an agreed x is that for all t the expected profit from doing so is at least as great as the profit from not paying the bonus even though sa_t has been produced, losing the employee as a result and thus having expected future profits of $\bar{\Pi}_{t+1}$. Formally,

$$\Pi_t(x) \geq sa_t - \underline{w}_t + \delta\bar{\Pi}_{t+1}, \text{ for all } t.$$

Substitution for $\Pi_t(x)$ from (12) and use of $w_t = \underline{w}_t + b_t$ allows this to be written

$$\alpha\delta[\Pi_{t+1}(x) - \bar{\Pi}_{t+1}] \geq b_t, \text{ for all } t. \tag{9}$$

This *no cheating condition* for the firm corresponds to the *no shirking condition* for the employee. (There are no economies of scale here. A firm with n jobs needs n times as much future profit to prevent it cheating on all n employees at the same time.)

Conditions (8) and (9) are incentive compatibility conditions. Addition of these two gives an overall incentive compatibility condition

$$\alpha\delta[U_{t+1}(x) + \Pi_{t+1}(x) - \bar{U}_{t+1} - \bar{\Pi}_{t+1}] \geq \frac{v(a_t)}{p}, \text{ for all } t. \tag{10}$$

The left hand side of this is the sum of the expected future gains to both parties from not having the match end prematurely. Addition of (6) and (7) gives

$$\begin{aligned} U_t(x) + \Pi_t(x) = & sa_t - v(a_t) + \delta\{\alpha[U_{t+1}(x) + \Pi_{t+1}(x)] \\ & + (1-\alpha)[\bar{U}_{t+1} + \bar{\Pi}_{t+1}]\}, \text{ for all } t, \end{aligned} \tag{11}$$

from successive application of which it is clear that the wage terms on the left hand side of (10) cancel, so that condition depends only on the effort part of the agreement, a_τ for $\tau > t$. For (8) and (9) to be satisfied, it is clearly necessary that (10) is satisfied. Since its right hand side is strictly positive for effort above the minimum possible level $\underline{a}$ (disutility is normalized so that $v(\underline{a}) = 0$), (10) implies that to induce effort above $\underline{a}$ there must be strictly positive expected future gains from the match. Thus (10) restricts the set of effort profiles that are incentive compatible. Note that, as long as the agreed effort profile satisfies (10), one can find a bonus payment b_t that will ensure both (8) and (9) are satisfied.

For the employee and the firm to agree to a particular x in the first place it must be better for both of them than they could get elsewhere. This requires that the following individual rationality conditions are satisfied.

(12) $$U_t(x) \geq \bar{U}_t, \text{ for all } t;$$

(13) $$\Pi_t(x) \geq \bar{\Pi}_t, \text{ for all } t.$$

The argument above establishes that (10), (12) and (13) are necessary conditions for an agreement x to be adhered to. The perhaps more surprising result is that, following the argument in MacLeod and Malcomson [1989], they are also sufficient for x to be a subgame perfect equilibrium. Thus *any* x satisfying these three conditions is an equilibrium outcome.

What are the implications for the payment of efficiency wages? Use of (8) in (6) for $t = 1$ (the first period of the match), together with $w_t = \underline{w}_t + b_t$, implies

(14) $$U_1(x) \geq \underline{w}_1 + \left(\frac{1}{p} - 1\right) v(a_1) + \delta \bar{U}_2.$$

If, as in Shapiro and Stiglitz, employees cannot post bonds (which is equivalent to requiring $\underline{w}_1 \geq 0$), it follows that, for p sufficiently small, there is a limit to how high a_1 can be without (14) requiring $U_1(x) > \bar{U}_1$. Then those hired would have higher expected lifetime utility than those not hired, the efficiency wage result. Of course, it is always possible to choose a_1 close enough to $\underline{a}$ that $v(a_1)$ is near enough to zero to have $U_1(x) = \bar{U}_1$. If, however, that requires $a_1 < \tilde{a}$, where $\tilde{a}$ is defined by $v'(\tilde{a})/p = s$, the firm could make higher profits by offering an efficiency wage. The reason is that the marginal revenue s from increasing a_1 is more than the extra bonus $v'(a_1)/p$ needed to ensure (8) and (12) both remain satisfied. Note that nothing said here depends on the stationarity of wages over time – the rising wage profiles analysed by Akerlof and Katz [1989] have not been ruled out. Thus, even allowing for (non-enforceable) bonuses, it is profit maximizing for the firm to pay efficiency wages whenever

$$\left(\frac{1}{p} - 1\right) v(\tilde{a}) + \delta \bar{U}_2 \geq \bar{U}_1,$$

if workers cannot post bonds.

There are, however, several points to make about this as an explanation for efficiency wages. First, even without bonds, efficiency wages may be unnecessary if p is sufficiently large. In particular, if $p = 1$, the term in $v(a_1)$ in (14) disappears and there is no need for $U_1(x) > \bar{U}_1$ since certainly $\bar{U}_1 \geq \delta \bar{U}_2$. Second, the absence of bonds cannot be deduced from the need to prevent firms cheating by pocketing the bond and falsely firing the employee for malfeasance because (9) ensures that the firm cannot increase its profits by cheating in this way. Third, as Baker *et al.* [1988] note, the assumption that bonds are not feasible "is inconsistent with commonly observed franchise fees that can run into the hundreds of thousands of dollars for jobs such as managing a hamburger stand." Fourth, if limits on the feasibility of bonds were indeed the reason for firms paying efficiency wages, $\underline{w}_1$ would be set at the lowest possible level, that is, at subsistence. (The same applies to the wage in any alternative job with no monitoring problem in which an employee may start out in order to build up an implicit bond, as suggested by MURPHY and TOPEL [1990].) There is precious little evidence that this is the case. The folklore about high paying jobs is that they offer attractive wages and fringe benefits right from the start, not just for older employees. This is supported by the findings of KRUEGER and SUMMERS [1988] that wage premiums across industries for the young and the old are highly correlated, as are wage premiums for employees with one year or less of job tenure and those with more than ten years.

The infeasibility of bonds is not, however, the only reason for efficiency wages in the model. Since *any* outcome satisfying (10), (12) and (13) is an equilibrium, it is clear that, even if bonds are feasible, there are equilibria with $U_1(x) > \bar{U}_1$ as well as equilibria with $U_1(x) = \bar{U}_1$. To explore this further, it is instructive to consider equilibria that are efficient in maximizing the joint return to employment given in (11). This joint return is maximized by setting $a_t = a^*$, defined by $v'(a^*) = s$, unless that violates the incentive compatibility constraint (10). Let $\hat{a}_t$ denote the smaller of a^* and the a_t that makes (10) hold with equality given future payoffs. Then setting $a_t = \hat{a}_t$ maximizes the joint payoff in period t given future payoffs. If bonds are feasible, there is always some agreement with $a_t = \hat{a}_t$ better for both than an agreement with $a_t \neq \hat{a}_t$. Moreover, unless $s\hat{a}_t - v(\hat{a}_t) \geq \bar{U}_t + \bar{\Pi}_t - \delta(\bar{U}_{t+1} + \bar{\Pi}_{t+1})$, the parties would jointly do better by both following whatever alternatives yield expected payoffs $\bar{U}_t - \delta\bar{U}_{t+1}$ and $\bar{\Pi}_t - \delta\bar{\Pi}_{t+1}$ in period t and then resuming their match at $t+1$, unless separated for exogenous reasons or better alternatives come along. (If efficient, there is always an agreement that would make this worthwhile for both parties.) Use of this in (11) gives

$$U_t(x) + \Pi_t(x) \geq \bar{U}_t + \bar{\Pi}_t + \delta\alpha[U_{t+1}(x) + \Pi_{t+1}(x) - \bar{U}_{t+1} - \bar{\Pi}_{t+1}], \text{ for all } t,$$

and, with (10) used to substitute for the term in square brackets on the right hand side,

$$U_t(x) + \Pi_t(x) \geq \frac{1}{p}v(\hat{a}_t) + \bar{U}_t + \bar{\Pi}_t, \text{ for all } t. \tag{15}$$

Maximization of joint returns thus requires that firm and employee jointly receive payoffs of at least $v(\hat{a}_t)/p$ more than they could get from their alternative activities. If the employee does not receive any of this in the form of an efficiency wage, the firm must receive it in the form of supernormal profits. It follows from (8) that, if the employee receives the excess return, there is no need to use bonus payments. If the firm receives it, a bonus of $b_t = v(\hat{a}_t)/p$ is required. This gives a straightforward empirical prediction. Where employees get the excess return in the form of efficiency wages, wage payments are based on time rates. Where firms get it, some form of bonus payment (which may take the form of a piece rate, commission or periodic bonus) or alternatively a bond is required. Both these outcomes (and, indeed, the intermediate ones) are equilibria. This applies to all t including $t = 1$. So, in an efficient equilibrium, one party or the other must get the return above opportunity cost implied by (15). The question of whether or not efficiency wages are paid is simply a question of whether the market settles on an equilibrium in which in period 1 the employee gets this return or on an equilibrium in which the firm does.

What might determine which party gets this excess return? Suppose the market has L employees and J available jobs. Total employment cannot be greater than $\min\{J, L\}$. Suppose $L > J$. Then employment will be maximized if each time an employee quits for exogenous reasons, the vacant job is filled straightaway. In a stationary economy that is anonymous in the sense that agents have no information about why the previous matches of potential partners came to an end, this would imply $\bar{\Pi}_t = \bar{\Pi}_1 = \Pi_1(x)$. But then (15) implies $U_1(x) \geq \dfrac{1}{p}v(a_1) + \bar{U}_1$, so employees receive the excess return in the form of efficiency wages. MacLeod and Malcomson [1993a] formalize this argument. A symmetric argument applies if $L < J$. Then employment is maximized by having the excess return go to firms in the form of supernormal profits. The general principal is that employment is highest if agents on the *long* side of the market receive the excess returns. In a tight labour market, one should expect firms to receive excess profits. In a slack one, one should expect to see efficiency wages. In the latter case, bonds would not be used even if they could be. (It is important not to confuse an efficiency wage with a high wage in time series. The efficiency wage in a slack market may be lower than the market clearing wage in a tight market.)

The economic rationale for this is straightforward. For efficient effort, incentive compatibility requires that either firms or employees (or both) receive a premium from continuing a match. Such a premium can exist only if an agent does not form a new match as soon as an old one comes to an end. From an efficiency point of view, it is costless to leave agents on the long side of the market unmatched – since they are on the long side they cannot *all* be matched. In contrast, it is costly to leave agents on the short side unmatched. An efficient equilibrium, therefore, involves the former.

Having the long side of the market receive the excess returns may be efficient but what can prevent these returns from being competed away? To prevent that requires a market convention that excess supply is not *per se* an acceptable reason for reducing rewards, a convention that must be backed up by an effective sanction for those breaking it. In the efficiency wage case, if employees fear that in a future slack market a firm could negotiate a wage giving them a lower payoff, their current surplus will be too low to prevent them shirking. To prevent shirking, any firm that tries to cut wages must lose out as a result. The survey evidence provided in Kaufman [1984], Blinder and Choi [1990] and Bewley [1993] indicates that this is precisely what the notion of fairness so prevalent in labour markets does. Of the managers interviewed by Blinder and Choi, 79% perceived "a wage reduction to take advantage of labor market slack" as unfair, 95% thought their workers would perceive it as unfair. This illustrates just how deeply the convention is ingrained on *both* sides of the market. Note that the same did not necessarily apply to wage reductions to save the firm from failure or to align wages with those of competitors. Moreover, 84% thought a reputation for an unfair wage policy would result in increased labour turnover, 95% that it would result in reduced work effort, so there is a real cost to breaking the convention. Kaufman shows this is equally true in Britain, even in nonunionized firms. The position is symmetric in a tight labour market. The market convention must then ensure that a tight market is not *per se* a sufficient condition for reducing profits. For further discussion of this, see MACLEOD and MALCOMSON [1993c].

The argument extends to the case in which the number of potential jobs, instead of being given exogenously, is determined endogenously on the basis of profitability. To see this, consider a range of jobs with different productivities s. There exists a minimum value of s for which the incentive compatibility constraint (10) can be satisfied if employees receive efficiency wages and all vacant jobs are refilled straightaway. Call that $\underline{s}$. Denote the number of jobs with $s \geq \underline{s}$ by $J(\underline{s})$. Since (10) is a necessary condition for employment, it is certainly not possible to fill more jobs than $J(\underline{s})$. If $L > J(\underline{s})$, the same argument as above establishes that employment is highest in an efficiency wage equilibrium. This corresponds to the equilibrium identified by Shapiro and Stiglitz. See MACLEOD and MALCOMSON [1993a] for details. MACLEOD and MALCOMSON [1993c] extends the argument to the case in which additional high productivity jobs can be created at a cost and considers the implications for dual labour markets and dual economies.

The discussion so far has concentrated on when the need to motivate employees results in efficiency wages. Alternatives certainly exist. Bonuses, as already argued, may be used instead. MALCOMSON [1984, 1986] showed that tournaments can be effective even when performance is unverifiable. But tournaments result in *ex post* gains for the winners that compensate them for the *ex ante* risk of losing. This provides a classic scenario for the exercise of MILGROM [1988] type influence activities because employees who do badly typically gain more from being placed above their true rank than their employer loses from ranking employees incorrectly. As shown in FAIRBURN and MALCOMSON [1994], influence activities can destroy the effectiveness of tournaments when performance is unverifiable. Use of promotions instead of monetary prizes overcomes this only if employees are sufficiently different for it to be efficient for the firm to assign them to different tasks. The promotion scheme of MACLEOD and MALCOMSON [1988] also depends on employees being sufficiently heterogeneous. The conclusion is that, with relatively homogeneous employees operating in anonymous markets, efficiency wages are the most efficient way to provide motivation when workers are plentiful relative to jobs or the cost of creating additional jobs is high. The rest of this section, therefore, explores further the properties of efficiency wage equilibria.

In the Shapiro-Stiglitz equilibrium, $\Pi_t(x) = \bar{\Pi}_t$ and competition between potential employees forces condition (15) to hold with equality. Then

$$U_t(x) - \bar{U}_t = v(\hat{a}_t)/p, \text{ for all } t. \tag{16}$$

A number of consequences follow. As has been pointed out in the literature, if some jobs have less effective monitoring (lower p) than others, they must offer higher wages (and thus higher lifetime utility) to induce the same effort. But this is not the only reason why different jobs may offer different lifetime utilities. The efficient level of effort in a job, $\hat{a}_t$, varies with s. If jobs have different productivities s, it is efficient that some have higher effort than others. But (16) implies that higher effort jobs offer not only higher wages to compensate for the greater effort but higher lifetime utility. Thus utilities may differ across different jobs not just because the monitoring technology is different but also because the efficient effort level is different. There is, however, no reason to suppose that in equilibrium the relationship between effort and the wage satisfies the unit elasticity condition of SOLOW [1979]. For an individual firm with agreement x, unilaterally lowering the wage so that the no shirking condition is no longer satisfied results in employees reducing effort to the lowest level, so the effort/wage relationship is not continuous. Even a negotiated change in the agreement that maintains incentive compatibility must satisfy (16), and it would be pure coincidence if the elasticity of the relationship between wage and effort that keeps (16) satisfied were equal to one.

The effect of stochastic shocks on efficiency wage equilibrium are analysed in MACLEOD, MALCOMSON and GOMME [1994]. The model investigated there has two types of stochastic shocks, shocks idiosyncratic to individual jobs and aggregate shocks common to all jobs. Different jobs have different productivities. In each period, only those at the most productive end of the distribution are filled. There is a constant probability that next period productivity in a particular job will change its position in the distribution. If productivity becomes sufficiently low, the job no longer remains profitable and the employee is made redundant (job destruction). At the same time, some jobs that were unprofitable become profitable, so new vacancies are created (job creation). Overlaying this are aggregate productivity shocks that affect how many jobs in total it is profitable to fill. Workers who do not get one of these jobs are unemployed.

Equilibrium is affected by both aggregate and idiosyncratic shocks. One way to illustrate the effects of the latter is by analysing the effects of an increase in the probability of an idiosyncratic shock hitting a job. This corresponds to a fall in α, increasing the probability that an employee will lose his/her job for reasons that have nothing to do with shirking and thus reducing the present discounted value of keeping the job at any given wage. To prevent shirking, the value of keeping the job must be increased. Individual jobs therefore offer higher wages which increases equilibrium unemployment.

A favourable aggregate shock makes it profitable to fill more jobs, reducing the unemployment rate. It also reduces labour turnover in existing jobs because productivity in any individual job would have to fall further before that job becomes unprofitable. Thus job destruction is reduced. Job creation on the other hand is boosted by the increase in employment. The model is thus consistent with the countercyclical job destruction and procyclical job creation found by DAVIS and HALTIWANGER [1990].[2]

The effect of a favourable aggregate shock on the wage is, however,

2. We are grateful to an anonymous referee for comments on this issue.

ambiguous. For each existing job, it lowers the probability of layoff because productivity in that job would have to fall more before it becomes unprofitable. For a given unemployment rate, that increases the future utility to the employee from retaining the job, thus enabling the firm to lower the wage without inducing the employee to shirk. But the unemployment rate also falls, thus reducing the cost of being fired for shirking. This has a counteracting effect on the wage that may or may not (depending on the parameter values) swamp the forces tending to reduce the wage. It is thus possible that a short run increase in aggregate productivity could reduce wages.

That is an extreme case but it nevertheless points to a more general property. The force tending to reduce the wage makes the relationship between wages and employment traced out as a result of shocks to labour demand *more* elastic than the labour supply curve. This contrasts with STRAND's [1992] conclusion for the original Shapiro-Stiglitz model that there is a tendency for employment to be rigid over the business cycle but that conclusion is for a model with an acyclic idiosyncratic contribution to gross job reallocation that is at odds with the evidence in DAVIS and HALTIWANGER [1990].

To assess the plausibility of the magnitudes involved, MACLEOD, MALCOMSON and GOMME [1994] simulate a simple version of the model with two effort levels ("working" and "shirking"), two demand states and labour supply completely inelastic above the reservation wage. The percentage standard deviations in GNP and in real wages were calibrated to those for the US economy over the period 1954-89. The percentage standard deviations of these variables and of employment and unemployment for both the US economy and the simulated model are reported in Table 1. In interpreting these results it is important to remember that the labour supply assumption implies that, if employee performance were verifiable so there were no efficiency wages, the variations in employment and unemployment would be zero as long as the aggregate shocks always leave the economy on the vertical section of the labour supply curve (that is, the wage is above the reservation wage for employment). With that in mind, it seems that the

TABLE 1

Percentage Standard Deviations for US Economy and Simulation

	US economy	Simulation
Output	3.32	3.29
Employment	2.76	1.55
Real wage	1.76	1.74
Unemployment	29.81	26.52

Notes: For the US economy, all data are quarterly 1954-89 and logged, except the unemployment rate which is detrended with a quadratic time trend. Output is measured by GNP in constant 1982 dollars; employment by business sector employees; unemployment by the unemployment rate for all workers 16 years and over. The real wage was constructed by dividing compensation of employees (deflated by the GNP deflator) by hours of all employees (business sector). The data was generated from a simulation consisting of 5000 quarterly observations.

efficiency wage model does a very good job of capturing the variability in unemployment. It does a somewhat less good job of capturing the variability of employment. However, because of the equilibrium relationship between unemployment and the real wage in shirking models, the variability of employment in the model would be larger if labour supply was not assumed completely inelastic and, in the simulation, no attempt was made to calibrate the distribution of job productivities to estimated labour demand elasticities.

4 Concluding Remarks

Both the imperfections studied here can make the responses of wages to shocks smaller than in a model without them. When investment decisions are combined with turnover costs, efficient contracts may result in wages having nominal rigidities, not responding at all to small shocks, and responding asymmetrically to upwards and downwards shocks. The model then fits well with the evidence in BEAUDRY and DINARDO [1991] that the best labour market conditions since the start of a job have a strongly significant effect on current wages, whereas current labour market conditions have a smaller impact.

When nonverifiability results in the payment of efficiency wages, wages do always respond to shocks, though the wage-employment locus resulting from labour demand shocks is more elastic than the labour supply curve. An exploratory simulation exercise, however, indicates that the model can do a good job of reflecting the response of unemployment to output shocks found in the US economy, as well as generating other characteristics of labour markets.

In these respects, both imperfections seem to have something to offer in understanding the cyclical properties of wages and employment. As yet, however, we know of no attempt to combine them in one model.

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