

Verifiable wage offers and recontracting: effect on wage and consumption profiles

Kit-Chun Lam^{a,1}, Pak-Wai Liu^{b,*}

View metadata, citation and similar papers at core.ac.uk

^a People's Republic of China

^b Department of Economics, Chinese University of Hong Kong, Shatin, N.T., Hong Kong,
People's Republic of China

Accepted 29 March 2000

Abstract

This paper analyzes the effect of recontracting and matching verifiable wage offers on the intertemporal structure of contract wage and consumption profile for a two-period economy. A contract firm provides specific training for a worker during the first period, which increases his productivity if he stays in the second period, but the worker may quit to accept an alternative wage offer after a successful search. Wage offers are private to the worker but can be presented to the contract firm for matching. This paper shows that when capital markets are imperfect and wage offers are verifiable, the contract firm recontracts and matches any wage offers the worker receives up to the second-period productivity. The ex ante contract wage profile will be flat. Inefficient quits will be eliminated and there will be complete ex ante consumption smoothing. It is significant to note that the result of rising wage profile derived in numerous contract models is fragile with respect to assumptions on mechanism of interfirm labor mobility. © 2000 Elsevier Science B.V. All rights reserved.

JEL classification: D82; D83; J31

Keywords: Wage offer; Recontracting; Wage profile

* Corresponding author. Tel.: +852-2609-7044; fax: +852-2603-5249.

E-mail address: pakwailiu@cuhk.hk (P.-W. Liu).

¹ Tel.: +852-2339-7554.

1. Introduction

This paper analyzes the effect of verifiable wage offers and recontracting on properties of the optimal contract between a worker and a firm. Specifically, it shows that when capital markets are imperfect and wage offers received by the worker can be verified by the firm and recontracting is allowed, the *ex ante* intertemporal wage profile and consumption profile will be flat, in contrast to the rising wage and consumption profiles, which entail when wage offers are private.

Early studies on wage structure making use of the labor contract framework including Freeman (1977), Harris and Holmstrom (1982), Weiss (1984), and Haltiwanger and Waldman (1986) are concerned with wage insurance. In their models the contract provides insurance against the uncertainty workers face concerning their own future productivity. There is no asymmetry of information. Their models either constrain wages to prevent all workers from being bid away by other firms or obtain *ex post* labor immobility as an equilibrium result. The main results of these studies: the wage profile rises upward as the threat of quitting induces the wage bids to go up.

Later models on wage insurance allow *ex post* interfirm labor mobility and asymmetric information between workers and firms. In Arnott and Stiglitz (1985), information on job satisfaction are private to the workers who will quit if they discover they are dissatisfied with their jobs. The contract provides insurance by paying the workers more than their productivity early on and less later. Ito (1988), on the other hand considers a model in which wage offers and search cost are private to the workers to derive a trade-off between productive efficiency and risk sharing. However, his model is a one-period model, which does not allow an analysis of the intertemporal wage structure.

In these earlier models with the exception of Weiss (1984), the labor contracts do not deal with consumption smoothing as most of them are only concerned with insurance against workers' uncertain productivity. However, intertemporal consumption smoothing in a contract should be a major concern as it has to be reconciled with the rising wage profile derived in all these models. Bernhardt and Timmis (1990) addresses this concern as they explicitly analyze consumption smoothing via a multi-period wage contract of workers with general and specific skills when capital markets are imperfect. They show that the intertemporal wage profile smoothens consumption and deviates from the productivity profile. However, their model is set up along the same line as the wage insurance models; their wage contract is renegotiation-proof with a constraint on no defection.² Also, they assume that the workers' stochastic alternative wages are common knowledge. Hence, in the equilibrium, workers do not search for a better match and there is no turnover.

² Renegotiation contracts in the sense of Hart and Tirole (1988).

In the more recent models of Lam et al. (1987, 1995) and Arvin and Arnott (1992), workers receive private wage offers and quit if the alternative spot wage exceeds the contract wage so that there is ex post interfirm labor mobility. Consumption smoothing is considered within an intertemporal wage contract when capital markets are imperfect. Lam et al. (1987) find that the optimal wage profile trades off productive efficiency (efficient separation) and consumption smoothing, deviates from the productivity profile, and is upward sloping. Lam et al. (1995) further shows that under different capital market assumptions, either intertemporal consumption smoothing or wage insurance across staying and quitting dominates in the wage contract. If workers cannot borrow in the capital market, consumption smoothing dominates and the equilibrium contract will prescribe a rising wage profile, which is flatter than the productivity profile, the latter being generated by investment in specific training in the firms. If workers can borrow, however, wage insurance dominates and the wage profile will be steeper than the productivity profile. In both cases the rising wage profile mediates the tension between consumption smoothing/insurance and productive efficiency. However, the rising wage profile will disappear if the contract includes a severance payment in the form of a quit penalty.

This paper follows the long line of models in the literature on wage structure in labor contracts, which evolve from information symmetry and ex post labor immobility to information asymmetry on wage offers and ex post interfirm mobility. It further extends the work of Lam et al. (1995) by analyzing the impact of recontracting and matching of outside wage offers received by the workers on the contract wage profile. It starts with the same basic two-period model in which identical workers enter into ex ante contracts with contract firms that stipulate the level of specific training that contract firms provide in the first period and intertemporal wage. Specific training enhances workers' second-period productivity in the contract firms, but workers may quit if they receive better outside wage offers. The novelty of this paper is that it allows renegotiation of the wage contract. At the end of the first period, after uncertainty on the outside wage offers is resolved, workers may present verifiable wages offers, which are better than the second-period contract wage to the contract firm, and renegotiate the second-period wage.

There is an extensive literature on contract renegotiation. A strand of the literature studies the implications of renegotiation on the structure of the optimal contract when there is moral hazard (e.g., Fudenberg and Tirole, 1990; Hermalin and Katz, 1991) or adverse selection (e.g., Hart and Tirole, 1988; Laffont and Tirole, 1990). Another strand studies commitments not to renegotiate and the implementation of renegotiation-proof contracts (e.g., Demougin, 1989; Rubinstein and Wolinsky, 1992; Bensaid and Gary-Bobo, 1993). Yet another strand studies the strategic behavior of signing sub-optimal contracts with the anticipation that they will be subsequently renegotiated (Huberman and Kahn, 1988a, 1988b). The framework of contract renegotiation has been applied to different types of con-

tracts. Contracts that have been extensively studied within this framework include agency contracts (e.g., Demougin, 1989; Fudenberg and Tirole, 1990; Hermalin and Katz, 1991; Ma, 1994), procurement contracts (e.g., Laffont and Tirole, 1990; Hart and Tirole, 1988) and investment contracts (e.g., Hart and Moore, 1988; Huberman and Kahn, 1988b). With the exception of Dewatripont (1989), relatively little work has been done on the impact of renegotiation on optimal labor contracts.

Dewatripont (1989) analyzes the optimal employment in the labor contract when workers and firms can precommit *ex ante* not to renegotiate the contract as well as when *ex post* Pareto improving renegotiation is possible. The main result is that the optimal employment is Walrasian. In his study, however, there is no analysis on the wage structure.

In this paper, we focus on the effect of contract renegotiation on the contract wage profile. In our model, there is no pre-commitment when the contract is written not to renegotiate. This is justified on two grounds. First, the law makes it extremely difficult to write a contract that precludes its future renegotiation.³ Second, renegotiation will be voluntary if it is *ex post* Pareto improving. After uncertainty is resolved, the two parties may want to renegotiate away productive inefficiency, which they found optimal *ex ante*, as a device to improve consumption smoothing, as long as the outcome is Pareto improving.⁴ In our simple wage contract, renegotiation is *ex post* Pareto improving. It is assumed to be costless as workers present verifiable wage offers to the contract firms, which will simply decide to match or not to match. If the contract firms decide to match, the second-period wage is said to be recontracted.

In this paper, we will show that the structure of the wage profile and consumption profile will change drastically if wage offers received and presented by the workers are verifiable by the contract firms. It will be shown that as long as the second-period contract wage is below the worker's second-period productivity in the firms, recontracting is *ex post* Pareto improving. The firms will exploit the opportunity at the end of the first period to match any wage offers the workers receive up to their second-period productivity in the firms as this will retain the workers and allow the firms to recoup part of the returns to investment in their specific training. When this is possible, the structure of the *ex ante* wage profile will be completely altered. The *ex ante* contract wage profile will become flat, although the *ex post* wage profile may rise as a result of wage offer matching by the firms. This is an entirely new result in the literature of intertemporal wage contracts.

It is significant to note that the allowance of verifiable wage offers with matching introduces an extra degree of freedom in the contract just as the

³ For a discussion and an explanation of this point, see Huberman and Kahn (1988a).

⁴ For a discussion of voluntary Pareto improving renegotiation, see Dewatripont (1989).

introduction of severance payment (Lam et al., 1995), and it destroys the rising contract wage profile commonly derived in human capital models (Oi, 1962; Becker, 1964) and wage insurance models in earlier studies. The result of rising wage profile is fragile with respect to assumptions on the mechanism of interfirm labor mobility.

To complete the analysis, this paper also repeats the analysis under the assumption of perfect capital markets. It will be shown that the wage profile remains rising and is steeper than the productivity profile. Since the second-period contract wage is now higher than the worker's second-period productivity in the firms, firms will not match wage offers that exceeds the contract wage.

The rest of the paper is organized as follows. The model is presented in Section 2. Section 3 reports the result of a rising wage profile when wage offers are private and capital markets are imperfect. Section 4 derives the flat wage profile when wage offers are verifiable and matched by the contract firm. The perfect capital markets case is analyzed in Section 5. The paper concludes in Section 6.

2. The model

The economy produces a single numeraire commodity with labor as the sole factor using constant returns to scale technology. The price of the commodity is stationary and is normalized to one.⁵ There are no productivity shocks. Firms are competitive, risk neutral and maximize expected profit.

Labor is supplied inelastically by workers with their unit of working time normalized to one. Workers are identical except with respect to their match qualities with different firms. Their intertemporal utility function $U(\cdot)$ is additively separable. The von Neumann–Morgenstern utility function $u(\cdot)$, defined over consumption, has the usual properties, $u' > 0$, $u'' < 0$ and $u'(0) = \infty$. For simplicity, we assume both the subjective discount rate and the interest rate are zero.

Workers live for two periods, indexed 1 and 2. At the beginning of the first period, a worker enters into a wage contract with a contract firm, which pays him wages w_1 and w_2 in the two periods. In the first period, time is spent working and investing in specific skills in the firm. All training costs are time costs. Specific training, which is observable to both parties, is given by the time-equivalent unit x with $0 \leq x \leq 1$. It augments the worker's productivity in the same firm in the

⁵ By virtue of the assumption of stationary output price, uncertainty in the product market is removed and the contract firm will not lay off workers. Many studies, which focus on wage insurance but not unemployment, simply assume that the contract binds the firm from discharging workers. See, for example, Harris and Holmstrom (1982), Weiss (1984), Arnott and Stiglitz (1985), Haltiwanger and Waldman (1986) and Berkovitch (1986). Ito (1988) gives a detailed argument on why it is important to study a model with voluntary quits as opposed to a model with involuntary unemployment.

second period, written as $h(x)$. Where h is the specific skill production function with a strictly concave technology, $h' > 0$ and $h'' < 0$. Moreover, $h(0) = m$, where m is the worker's first-period productivity per unit time in the contract firm. At the end of the first period, the worker will search for alternatives. Search is assumed to be costless. Heterogeneity of abilities among workers and of technologies employed by firms generate job-specific differences in productivities (Topel, 1986). The outside wage offers the worker may receive, which are stochastic, therefore depend on match qualities with the alternative firms. Wage offers may be private or observable and verifiable by the firm. The distribution of maximum wage offers that the worker receives at the beginning of the second period is denoted by $F(\tilde{w}_2)$ where \tilde{w}_2 is the stochastic maximum wage offer. The distribution is non-degenerate and its supports are assumed to be in $(0, \infty)$. It is continuously differentiable with density function $f(\tilde{w}_2)$. Depending on the outcome of his search, the worker either stays with the contract firm in the second period and receives contract wage w_2 or quits to join an alternative firm.

3. Private wage offers

Before we consider verifiable wage offers, let us first report the result on the wage profile when wage offers are private for the purpose of comparison. Assume that the worker has no access to capital markets.⁶ The worker's intertemporal utility function is the sum of sub-utilities in the two periods.

$$\begin{aligned} U(w_1, w_2) &= u(w_1) + F(w_2) u(w_2) + \int_{w_2}^{\infty} u(\tilde{w}_2) f(\tilde{w}_2) d\tilde{w}_2 \\ &\equiv u(w_1) + Eu(w_2) \end{aligned}$$

The expectation operator E with expectation taken over staying and quitting in the second period is introduced to simplify notations, which is defined as follows:

$$Eu(w_2) \equiv F(w_2) u(w_2) + \int_{w_2}^{\infty} u(\tilde{w}_2) f(\tilde{w}_2) d\tilde{w}_2.$$

The following problem can be solved:

$$\text{Max}_{x, w_1, w_2} \quad u(w_1) + Eu(w_2) \quad (1)$$

⁶ This assumption is justified on the ground that human capital cannot be used as collateral in borrowing. See also Bernhardt and Timmis (1990) and Arvin and Arnott (1992) for the same assumption. We can assume that the worker can save and lend but cannot borrow in capital markets. Under this assumption, it can be shown that the worker will not save and lend as the contract firm will tailor the wage profile to suit his consumption plan. The problem is identical to the case where he can neither lend nor borrow. For this result, see Harris and Holmstrom (1982). See also Lam et al. (1987) and Bernhardt and Timmis (1990).

subject to

$$(1 - x)m - w_1 + F(w_2)(h(x) - w_2) = 0 \quad (2)$$

$$w_1, w_2 \geq 0 \quad (3)$$

where Eq. (2) is the individual rationality constraint of the contract firm, which specifies that expected profit is zero under perfect competition. Constraint (3) requires non-negative consumption. The first-order conditions are

$$x: \mu(-m + F(w_2)h'(x)) = 0, x \in (0, 1) \quad (4)$$

$$\leq 0, x = 0$$

$$\geq 0, x = 1$$

$$w_1: u'(w_1) - \mu = 0 \quad (5)$$

$$w_2: F(w_2)u'(w_2) + \mu[f(w_2)(h(x) - w_2)F(w_2)] = 0 \quad (6)$$

and Eq. (2) where μ is the LaGrange multiplier associated with Eq. (2).

Proposition 1. *If the worker has no access to capital markets and wage offers are private, the contract will set wage above productivity in the first period and below it in the second period. The wage profile is flatter than the productivity profile and is rising.*

Proof. See Lam et al. (1995).

The equilibrium contract is a trade-off between consumption smoothing and “stay incentive” to reduce inefficient quits. Consumption smoothing requires that w_2 be set relatively low but when w_2 is below second-period productivity, productive inefficiency appears as the worker will be quitting when his productivity is higher inside the contract firm than outside. Therefore, to reduce inefficient quits, w_2 must be set relatively high. The productivity profile provides a bound for the wage profile. It is not optimal to have the wage profile steeper than the productivity profile because if w_2 exceeds second-period productivity (and therefore w_1 is below first-period productivity) there will be efficiency loss due to less consumption smoothing as well as due to excessive stays for the worker will be induced to stay in the current firm when his alternative productivities in outside firms are higher. Under the equilibrium contract, there will be incomplete consumption smoothing over the two periods if the worker stays in the firm as shown by the rising wage (consumption) profile.

The interior solution of specific training x is given implicitly by

$$h'(x) = m/F(w_2). \quad (7)$$

Since the model allows quits, the possibility that the worker might quit in the second period after training causes the firm to reduce the amount of training in the contract. This is evident in Eq. (7) since the higher the probability of quit (i.e., the

lower the probability of stay $F(w_2)$, the larger the marginal production of specific training $h'(x)$. By concavity of h , the smaller will be the investment in specific training x . The possibility of quits attenuates investment in specific training in the contract and hence the intertemporal productivity profile.

4. Verifiable wage offers

We have operated on the assumption that outside wage offers received by the worker are private. However, in some cases, outside wage offers are verifiable so that the information is symmetric to both the firm and the worker. This is plausible if the worker receives outside wage offers in written form, which can be presented, to the contract firm for verification. Specifically, we will consider the case where the worker only presents an outside wage offer that exceeds his second-period contract wage to the contract firm to negotiate for a matching offer. Outside wage offers that are inferior to the second-period contract wage will be kept private.⁷ The worker has an incentive to request a matching offer since there may be fixed costs involved in job change. Empirically we observe that workers do present outside wage offers they receive to negotiate for matching wage increases from their employers.

At the end of the first period, when the contract firm verifies that the worker has received an outside wage offer, it also has an incentive to consider matching because the contract wage profile is flatter than the productivity profile. At the end of the first period, the cost of the firm's investment in the worker's specific training represented by the difference between the worker's first-period wage and his first period productivity is sunk. Hence, to recoup at least part of the investment return in the second period, the firm will recontract by revising the second-period contract wage w_2 upward to match whatever outside wage offer the worker may receive so as to retain him as long as the wage offer does not exceed his second-period productivity $h(x)$ in the firm. Obviously if the worker receives an outside wage offer that exceeds his second-period productivity in the firm, the firm will not match. It should be pointed out that recontracting is viable only because wage offers are verifiable and the wage profile is flatter than the productivity profile so that the worker's second-period contract wage is below his second-period productivity. Had wage offers been unverifiable or had the wage profile been steeper than the productivity profile, no recontracting would have been possible.

⁷ The assumption of presenting only superior outside wage offers for verification by the contract firm is more realistic than the assumption that all outside wage offers, regardless of whether they are inferior or superior to the second-period contract wage, are observable by the firm.

When the firm matches any stochastic wage offer \tilde{w}_2 that falls in the range $w_2 < \tilde{w}_2 \leq h(x)$, the worker’s utility is not affected as it does not matter whether the stochastic wage offer is realized by his accepting the outside offer and quitting the firm or by his accepting the matching offer and staying in the firm. The individual rationality constraint of the contract firm, however, will be altered as shown below.

$$(1 - x)m - w_1 + F(w_2)(h(x) - w_2) + \delta \int_{w_2}^{h(x)} (h(x) - \tilde{w}_2)f(\tilde{w}_2)d\tilde{w}_2 = 0$$

where

$$\delta = \begin{cases} 0, & \tilde{w}_2 > h(x), \tilde{w}_2 \leq w_2 \\ 1, & \tilde{w}_2 \leq h(x), \tilde{w}_2 > w_2 \end{cases}$$

The third term on the LHS represents the second-period expected profit of the contract firm when the worker’s outside wage offer is matched up to $h(x)$. If the stochastic wage offer of the worker exceeds w_2 and is no greater than his second-period productivity in the contract firm, the firm will match the outside offer to retain the worker so as to recoup some of the investment returns, and $\delta = 1$. Conversely, if the stochastic wage offer exceeds second-period productivity in the firm, the firm will not gain anything by matching. There will be no offer matching, and $\delta = 0$. Furthermore, if the stochastic wage offer is no greater than the second-period contract wage w_2 , the worker will keep it private and again there is no matching, and $\delta = 0$.

The maximization problem is modified to be

$$\text{Max}_{x, w_1, w_2} u(w_1) + Eu(w_2) \tag{8}$$

subject to

$$(1 - x)m - w_1 + F(w_2)(h(x) - w_2) + \delta \int_{w_2}^{h(x)} (h(x) - \tilde{w}_2)f(\tilde{w}_2)d\tilde{w}_2 = 0 \tag{9}$$

$$w_1, w_2 \geq 0 \tag{10}$$

The first-order conditions are

$$x: \eta(-m + F(w_2)h'(x) + \delta[F(h(x)) - F(w_2)]h'(x)) = 0, x \in (0, 1) \tag{11}$$

$$\leq 0, x = 0$$

$$\geq 0, x = 1$$

$$w_1: u'(w_1) - \eta = 0 \tag{12}$$

$$w_2: F(w_2)u'(w_2) - \eta F(w_2) + \eta(1 - \delta)f(w_2)(h(x) - w_2) = 0 \tag{13}$$

and Eq. (9) where η is the LaGrange multiplier associated with Eq. (9).

We have the following proposition.

Proposition 2. *If the worker has no access to capital markets and wage offers are verifiable, the contract will set wage above productivity in the first period and below it in the second period. The wage profile is flat.*

Proof. Suppose $h(x) - w_2 \leq 0$, then the second-period contract wage will be at least as great as the worker's second-period productivity in the firm. In this case an outside wage offer cannot be larger than w_2 and no greater than $h(x)$ at the same time. The condition for $\delta = 1$ is not met and there is no offer matching. Thus, δ must be zero and the maximization problem in Eqs. (8)–(10) is reduced to the problem in Eqs. (1)–(3) for which Proposition 1 holds. *Ipsa facto*, it is not possible to have contract wage greater than or equal to productivity in the second period. Therefore, $h(x) - w_2 > 0$, and there is offer matching ($\delta = 1$) for stochastic wage offers, which fall in the range $w_2 < \tilde{w}_2 \leq h(x)$. Now both the second and the third terms of the contract firm's rationality constraint (9) are positive, necessarily implying that $(1 - x)m - w_1 < 0$. Hence, the contract sets wage above productivity in the first period but below it in the second period.

Solving Eqs. (12) and (13) together for $\delta = 1$ yields $u'(w_1) = u'(w_2)$ or $w_1 = w_2$, which implies a flat wage profile.⁸ Q.E.D.

It is clear that when verifiable wage offers are matched by the contract firm, productive inefficiency will be eliminated *ex post*. With the contract firm matching outside offers, the second-period contract wage does not have to be set high to reduce inefficient quits as the worker will no longer be quitting when his productivity is higher inside the contract firm than outside. Matching wage offers therefore mediates the tension between productive inefficiency and consumption smoothing. Specifically, it provides an extra degree of freedom in the wage contract and allows it to completely smooth out *ex ante* consumption over time as shown by the flat wage profile, $w_1 = w_2$. As compared with the case of private wage offers that generates a rising wage profile (Proposition 1), the flattening of the wage profile to achieve complete consumption smoothing *ex ante* is possible because productive inefficiency is eliminated by wage offer matching of the contract firm. It should be noted, however, whether there is complete consumption smoothing *ex post* for the worker staying in the firm depends on the wage offer the worker actually receives. *Ex post* consumption over time will also be completely smooth if the wage offer he receives falls below w_2 and no matching is necessary. However, if the worker receives a wage offer that exceeds the second-

⁸ It should be noted that the wage profile is flat because of the assumption of zero subjective discount rate and interest rate. Otherwise the wage profile will have a non-zero slope depending on the subjective discount rate and interest rate.

period contract wage, the firm will match the offer up to $h(x)$, and the ex post consumption profile will be rising over time with w_1 as the first-period consumption and the outside wage offer as the second-period consumption.

When wage offers are verifiable and recontracting takes place, the ex ante contract wage profile will no longer be rising as derived in many previous studies under different assumptions although the ex post wage profile within the contract firm can still be rising, and the ex post wage profile when there is interfirm mobility will certainly be rising. This result is consistent with empirical observations that wage growth across jobs is typically larger than wage growth within jobs.

It should be noted that wage offer matching is ex post Pareto improving. Under all circumstances, the worker's ex post utility is the same regardless of whether the contract firm matches his outside wage offer as he will always receive the same wage in the second period. However, the contract firm is better off by matching offers, which are in between w_2 and $h(x)$, as some of the investment returns can be recouped. Since matching of wage offers is ex post Pareto improving, it is voluntary. The total social output will increase as the worker will no longer be quitting the contract firm where his productivity is higher than outside. In the second period the worker will always work in a firm in which his productivity is the highest.

5. Contracts with lending and borrowing

For the sake of completeness in our analysis, let us examine a contract with lending and borrowing. The worker is assumed to have access to capital markets in which they can borrow against assured future income. The maximum loan he can borrow in the first period is the sum of contract wages of $w_1 + w_2$. There is no collateral and no default.

When the worker can lend and borrow, his utility function is

$$\begin{aligned} U(w_1, w_2, c_1, c_2) &= u(c_1) + F(w_2)u(c_2) + \int_{w_2}^{\infty} u(\tilde{c}_2)f(\tilde{w}_2)d\tilde{w}_2 \\ &= u(c_1) + Eu(c_2) \end{aligned}$$

where c_i is the worker's consumption in the i -th period and \tilde{c}_2 his stochastic consumption if he quits. Consider the case of private wage offers. The problem can be characterized by

$$\text{Max}_{x, w_1, w_2, c_1, c_2} \quad u(c_1) + Eu(c_2) \quad (14)$$

subject to

$$(1 - x)m - w_1 + F(w_2)(h(x) - w_2) = 0 \quad (15)$$

$$c_1 \in \operatorname{argmax}_{c_1 \in C_1} U(w_1, w_2, c_1, c_2) \quad (16)$$

$$c_2 = w_1 - c_1 + w_2 \quad (17)$$

$$\tilde{c}_2 = w_1 - c_1 + \tilde{w}_2 \quad (18)$$

$$c_1, c_2 \geq 0 \quad (19)$$

$$c_1 \leq w_1 + w_2 \quad (20)$$

The worker chooses c_1 from the consumption set C_1 to maximize his utility given the contract as shown in constraint (16). The budget constraint of the worker if he stays and if he quits are given by Eqs. (17) and (18), respectively.

The wage contract can be characterized by the following proposition.

Proposition 3. *If the worker can lend and borrow and wage offers are verifiable, the contract will set wage below productivity in the first period and above it in the second period. There will not be any matching of outside wage offers.*

Proof. Lam et al. (1995) show that when capital markets are perfect, the wage profile is rising and is steeper than the productivity profile. Since contract wage exceeds productivity in the second period, outside wage offers, which exceed the second-period contract wage, will also be greater than the second-period productivity, and therefore will not be matched by the contract firm. Outside wage offers that are lower than the second-period contract wage will not be presented by the worker for matching. Q.E.D.

6. Conclusion

In this paper, we analyze the effect of verifiable wage offers with recontracting on the contract wage profile and consumption profile. It shows that when recontracting is ex post Pareto improving, the contract firm will match verifiable wage offers the worker receives up to his productivity in the firm, and the optimal contract wage profile will be flat.

It is significant to note that the result of rising wage profile derived in numerous contract models is fragile with respect to assumptions on mechanism of interfirm labor mobility. When wage is constrained to prevent workers from being bid away by other firms and there is no ex post interfirm mobility as in the early models of wage insurance, the threat of quitting is sufficient to bid wage up to yield a rising wage profile. When ex post turnover is allowed, the realization of

stochastic private outside wage offers induces the wage profile to rise, albeit attenuated by consumption smoothing. However, if we allow verifiable wage offers to be matched, the contract wage profile will become flat and ex ante consumption smoothing will be complete.

Acknowledgements

The authors gratefully acknowledge the helpful comments of an anonymous referee. All remaining errors are our responsibility.

References

- Arnott, R., Stiglitz, J.E., 1985. Labor turnover, wage structures, and moral hazard: the inefficiency of competitive markets. *Journal of Labor Economics* 3 (3), 434–562.
- Arvin, B.M., Arnott, R.J., 1992. Wage profiles and imperfect capital markets: a positive analysis. *Canadian Journal of Economics* 25 (3), 521–537 (August).
- Becker, G.S., 1964. *Human Capital*. Columbia Univ. Press, NY.
- Bensaid, B., Gary-Bobo, R.J., 1993. Commitment value of contracts under renegotiation constraints. *Econometrica* 61 (6), 1423–1429 (November).
- Berkovitch, E., 1986. Implicit labor contract to explain turnover. *Journal of Labor Economics* 4 (3), 341–354.
- Bernhardt, D., Timmis, G.C., 1990. Multiperiod wage contracts and productivity profiles. *Journal of Labor Economics* 18 (4), 529–563 (October).
- Demougin, D.M., 1989. A renegotiation-proof mechanism for a principal-agent model with moral hazard and adverse selection. *Rand Journal of Economics* 20 (2), 256–267 (Summer).
- Dewatripont, M., 1989. Renegotiation and information revelation over time: the case of optimal labor contracts. *Quarterly Journal of Economics* 104, 589–619.
- Freeman, S., 1977. Wage trends as performance displays productive potential: a model and application to academic early retirement. *Bell Journal of Economics* 8 (2), 419–443.
- Fudenberg, D., Tirole, J., 1990. Moral hazard and renegotiation in agency contracts. *Econometrica* 58 (6), 1279–1319 (November).
- Haltiwanger, J., Waldman, M., 1986. Insurance and labor market contracting: an analysis of the capital market assumption. *Journal of Labor Economics* 4 (3), 355–375, Pt. 1 (July).
- Harris, M., Holmstrom, B., 1982. A theory of wage dynamics. *Review of Economic Studies* 49 (3) 315–333 (July).
- Hart, O., Moore, J., 1988. Incomplete contracts and renegotiation. *Econometrica* 56 (4), 755–785, (July).
- Hart, O., Tirole, J., 1988. Contract renegotiation and Coasian dynamics. *Review of Economic Studies* 55, 509–540.
- Hermalin, B.E., Katz, M.L., 1991. Moral hazard and verifiability: the effects of renegotiation in agency. *Econometrica* 59 (9), 1735–1753 (November).
- Huberman, G., Kahn, C.M., 1988a. Strategic renegotiation. *Economics Letters* 28, 117–121.
- Huberman, G., Kahn, C.M., 1988b. Limited contract enforcement and strategic renegotiation. *American Economic Review* 78 (3), 471–484 (June).
- Ito, T., 1988. Labor contracts with voluntary quits. *Journal of Labor Economics* 6 (1), 100–131 (January).

- Laffont, J.J., Tirole, J., 1990. Adverse selection and renegotiation in procurement. *Review of Economic Studies* 57 (4), 597–625 (October).
- Lam, K.C., Liu, P.W., Wong, Y.C., Asymmetric Information on Job Search, Insurance, Moral Hazard and Efficiency of Wage Contracts, Economics Department Working Paper No. 1. Hong Kong: Chinese University of Hong Kong, October 1987.
- Lam, K.C., Liu, P.W., Wong, Y.C., 1995. Wage structure when wage offers are private. *Labor Economics: An International Journal* 2, 19–32.
- Ma, C.A., 1994. Renegotiation and optimality in agency contracts. *Review of Economic Studies* 61, 109–129.
- Oi, W.Y., 1962. Labor as a quasi-fixed factor. *Journal of Political Economy* 70, 538–555 (December).
- Rubinstein, A., Wolinsky, A., 1992. Renegotiation-proof implementation and time preferences. *American Economic Review* 82 (3), 600–614 (June).
- Topel, R., 1986. Job mobility, search, and earnings growth. *Research in Labor Economics* 8, 199–233.
- Weiss, Y., 1984. Wage contracts when output grows stochastically: the roles of mobility costs and capital market imperfections. *Journal of Labor Economics* 2 (2), 155–173 (April).