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THE RATCHET EFFECT AND THE MARKET FOR SECOND-HAND WORKERS

by

Yoshitsugu Kanemoto and W. Bentley MacLeod*
Faculty of Economics, University of Tokyo
and Department of Economics, Queen's University

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ABSTRACT

If workers are in a long term relationship with some sunk investments, they may have an incentive to hide their ability early in the relationship to avoid having the firm increase the level of output expected from the worker in the future. We show that sufficient competition for older workers will eliminate this ratchet effect and allow the implementation of efficient piece rate contracts. When the difficulty of the job is unobserved by the firm, Gibbons (1987) has shown that all piece rate contracts will be inefficient. Together these results may explain why piece rates are common in some jobs such as agricultural work and sales, and not as popular for many manufacturing jobs.

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1. Introduction

Many long term employment relationships are characterized by relation–specific investments and the absence of a long term binding contract. If the worker's ability is not known ex ante, the firm may use his observation of the worker's output early in the relationship as a guide to setting performance standards in the future. Anticipating this behavior the worker may reduce output in early periods to disguise her ability and gain a better piece rate in the future. This possibility is the well known ratchet effect that has been carefully studied in a number of interesting papers.[1]

A characteristic of these models is that the worker's alternative in the second period is assumed not to depend on the ability of the worker. When the unobserved parameter is job difficulty, as studied in Gibbons (1987), this is a reasonable assumption. In this case Gibbons (1987) shows that efficient piece rate contracts are never part of an equilibrium, a result that can help explain workers' resistance to piece rate contracts in many industrial situations.

In practice piece rate contracts are used with apparently great success in a wide variety of situations, including agricultural jobs and in the form of commissions for sales persons. The distinguishing feature of these cases is that the job difficulty is normally well understood by the employer, and that there is an active market for workers of all ages. The existence of a market for older workers consisting of jobs that offer piece rate contracts implies that the worker's alternatives depend on her ability. This can be true even if the worker makes relation–specific investments which create strictly positive mobility costs. We show that for sufficiently low, but not insignificant, relation–specific investments

[1]For an excellent analysis of the ratchet effect in a regulatory environment see Baron and Besanko (1984), Freixas, Guesnerie and Tirole (1985), and Laffont and Tirole (1988).

competition for second–hand workers will guarantee the existence of efficient piece rate contracts in long term relationships.

Our model extends Greenwald's (1986) analysis to allow contingent wage payments. In the absence of contingent wages Greenwald shows that the existence of private information for worker ability results in adverse selection in the labor market. Only workers are ever fired, while workers of high ability are retained by the firm, generating inefficient turnover in equilibrium.

Other work on long term employment contracts and asymmetric information include Waldman (1984), Lazear (1986a,b), Ricart i Costa (1988) and MacLeod and Malcomson (1988). The papers by Waldman (1984), Ricart i Costa (1988) and MacLeod and Malcomson (1988) all consider the signaling effect that the job held by the worker has on her market alternatives.[2] In each of these papers the job that the worker holds is public information and is a major determinant of the worker's future income, and they are therefore more relevant to the study of managerial jobs. Lazear (1986a) highlights the importance of the no commitment assumption. He shows that if the firm and worker can commit themselves to stay together for two periods, then this will eliminate the ratchet effect. Our results complement this case by showing that sufficient ex post competition can be a perfect substitute for a binding two period contract.

The organization of this paper is as follows. We introduce a simple two period model with asymmetric information in Section 2. The equilibrium two period contract is obtained in two steps. First, Section 3 characterizes the equilibrium contract in period 2. Second, Section 4 obtains the equilibrium contract for period 1. The main results of the paper are presented in this section, followed by

[2]Also see Lazear (1986b) who studies the case where with a strictly positive probability the market knows the ability of the worker better than her current employer.

a concluding discussion in Section 5.

2. The Model

Consider a two period model in which firms compete for a fixed number of workers. We assume that the number of potential jobs exceeds the number of workers. This means that competition among firms reduces their (ex ante) profits to zero. We suppose however that each time the worker takes on a new job a cost C is borne by the worker. This can be interpreted as a mobility cost or the cost of retraining. The purpose of this cost is to capture the fact that once in a job the firm has some monopsony power over the worker. The standard ratchet effect occurs when the firm tries to exploit this ex post monopsony power as it learns more about its employee. Even with mobility costs, competition for second–hand workers reduces the possibility of the ratchet effect.

The lifetime utility of a worker is given by:

$$U = \sum_{t=1}^{2} [w_t - V(e_t) - C_t]\rho^{t-1}.$$

Here $w_t, e_t \in \mathbb{R}_+$ is the income and effort. $V(\cdot)$ is the disutility of effort satisfying $V'(e) > 0$, $V''(e) > 0$ for $e > 0$, $V(0) = V'(0) = V''(0) = 0$, with $V'(e) \to \infty$ as $e \to \infty$. These assumptions will ensure that in equilibrium the worker always supplies a positive level of effort, and that there exists a well–defined efficient effort level.

A worker can enter either the primary sector or the secondary sector. For each new primary sector job that the worker takes on, a mobility cost of C will be paid. As noted above, this cost can be interpreted as a cost of moving to the job, or as a training cost borne by the worker. This cost will have the effect of making a long term attachment more valuable. Secondary sector jobs by assumption will be assumed to be easily available everywhere, or to correspond to the state of unemployment. The utility level in the secondary sector is fixed at zero. In the primary sector, the output of the worker in period t is $y_t = \theta e_t$, where θ is the productivity of the worker in his/her job. Productivity will take on two possible values $\theta \in \{\underline{\theta}, \overline{\theta}\}$, where $0 < \underline{\theta} < \overline{\theta}$, with $\varphi = \Pr(\theta = \underline{\theta})$.

The first–best effort level for this production process maximizes $y - V(y/\theta)$ and is given by $V'(\underline{e}^*) = \underline{\theta}$ and $V'(\overline{e}^*) = \overline{\theta}$. Corresponding output levels are denoted by $\underline{y}^* = \underline{\theta e}^*$ and $\overline{y}^* = \overline{\theta e}^*$. Let $\underline{U}^* = (1+\rho)(\underline{y}^* - V(\underline{e}^*))$ and $\overline{U}^* = (1+\rho)(\overline{y}^* - V(\overline{e}^*))$ be the lifetime utility for the low and high ability workers respectively, when the worker provides the first best effort level and collects all the surplus.

The productivity parameter θ represents the ability of the worker. Each firm has a common prior for θ, given by φ. The worker knows θ at the beginning of the game, but this parameter is never directly observable by the firm. The firm hiring the worker in the first period will observe the worker's first period output, from which it may form new beliefs about the worker's ability. This firm will be called the incumbent firm.

The profit of a firm is given by $\Pi = E\{\sum_{t=1}^{2} (y_t - w_t)\rho^{t-1}\}$, with a default profit of zero if there is no employment. Both workers and firms have the same discount rate.

Firms compete for the services of the worker over two periods. At the beginning of each period all firms simultaneously offer a piece rate contract $w_t(y_t)$ for the coming period t. Since there are only two types of workers, it can be assumed without loss of generality that the contract consists of two points, $\underline{c} = (\underline{w}, \underline{y})$ and $\overline{c} = (\overline{w}, \overline{y})$. This is possible because the firm is free to offer a contract $w(y)$ that pays a very low wage if $y \notin \{\underline{y}, \overline{y}\}$. This contract will ensure that the worker chooses $\underline{y}$ or $\overline{y}$.[3] Let $\mathscr{C}$ denote the set of possible contracts, and $\mathscr{C}^2$ the set of

[3]It is straightforward to show that this market will have a unique optimal solution. Furthermore,

contract pairs offered by the firm. Given a contract $c \in \mathscr{C}$, the high (low) ability worker's one period utility will be given by $\overline{U}(c) = w - V(y/\overline{\theta})$, ($\underline{U}(c) = w - V(y/\underline{\theta})$).

After the firms have made their contract offers, the worker chooses a firm and the level of effort (output) for the coming period. Once the worker has agreed to work for a particular firm the terms of the agreement become binding for one period. The firm employing the worker can observe the worker's output, but competitors cannot. The current employer may use this information to infer the ability of the worker for use in period 2.

At the beginning of the second period the firms again offer contract pairs to the worker. The worker may decide to stay with the current firm or move to a new firm. Changing firms however entails paying the moving cost C once again. This game may be illustrated as follows:

Period 1			Period 2	
Nature chooses worker ability	firms offer contracts $w_1(y_1)$	worker chooses firm and effort level	firms offer contracts $w_2(y_2)$	worker chooses firm and effort level

The outcome of this game is modeled as a perfect Bayesian Nash equilibrium (PBNE). In equilibrium agents choose actions to maximize their payoffs for every possible history, given their beliefs on how the game will evolve in the future. Second, their beliefs are consistent with the Bayes rule along the equilibrium path.[4]

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any equilibrium involving three or more contracts can be dominated by one using only two contract points. More generally our results will still be valid in economies with more than two types. In those case the number of contract choices must simply equal the number of worker types.

[4]See for example Freixas, Guesnerie and Tirole (1985) for a good discussion of a Bayesian Nash equilibrium.

In this game only the incumbent firm obtains new information to update his beliefs. Let φ' be the incumbent firm's belief of his worker's ability at the beginning of period 2. If a separating equilibrium where all the high ability workers choose a different contract from the low ability workers is obtained in period 1, then the incumbent firm will set $\varphi' = 0$ or 1 depending on whether $\bar{c}$ or $\underline{c}$ has been chosen in the first period. At a pooling equilibrium both types of workers will choose the same contract, in which case the incumbent does not obtain any new information and $\varphi' = \varphi$.

In equilibrium the worker will stay with the same firm for two periods, and therefore the PBNE concept will place no constraints on the beliefs of other firms in period 2. This however does not matter in our model because it will turn out that the contract that these firms offer will not depend on their beliefs.

3. The Second Period Market

To study the set of equilibria for this game one begins with the second period market. Consider first the problem faced by the firms in the market, (i.e., the firms that did not employ the worker in the first period). Because of our assumption that there exist more jobs than workers, an equilibrium contract must earn a zero profit. It is then easy to show that the contract offered specifies the first best effort levels, $\underline{y}^*$ and $\bar{y}^*$. Otherwise a contract with the first best effort levels exists which is preferred by workers and earns a strictly positive profit. This yields the following lemma.

Lemma 1. The contract offered by firms in the market is

$$c^* = (\underline{c}^*, \bar{c}^*) = \{(\underline{y}^*, \underline{y}^*), (\bar{y}^*, \bar{y}^*)\}.$$

Utility levels of low and high ability workers from this contract are respectively

$$\underline{U}(\underline{c}^*) - C = \underline{y}^* - V(\underline{y}^*/\underline{\theta}) - C$$

and

$$\overline{U}(\overline{c}^*) - C = \overline{y}^* - V(\overline{y}^*/\overline{\theta}) - C\ .$$

Proof:

We first show that this contract is an equilibrium offer, and next we prove that no other contracts can be an equilibrium. The rest of the lemma then follows immediately from the definition of the utility function.

The first half requires the following two conditions: (i) the profit from this contract is zero and (ii) if this contract is offered, no other contracts that can attract workers are profitable. Recall that $\overline{y}^*$ maximizes $y - V(y/\overline{\theta})$ and $\underline{y}^*$ maximizes $y - V(y/\underline{\theta})$. One consequence of this is that a high (low) ability worker obtains a higher utility level from $\overline{c}^*$ ($\underline{c}^*$) than from $\underline{c}^*$ ($\overline{c}^*$). Hence, self selection of workers between the two contracts occurs, which immediately implies that the profit from the contract is zero.

Next, suppose contract (w, y) yields a strictly positive profit, $y - w > 0$. In order for this contract to attract a low ability worker, it must satisfy

$$w - V(y/\underline{\theta}) \geq \underline{y}^* - V(\underline{y}^*/\underline{\theta}).$$

This however means that

$$y - V(y/\underline{\theta}) > w - V(y/\underline{\theta}) \geq \underline{y}^* - V(\underline{y}^*/\underline{\theta}),$$

which contradicts the fact that $\underline{y}^*$ maximizes $y - V(y/\underline{\theta})$. A similar argument proves that this contract cannot attract a high ability worker. Thus if contract c^* is offered, no other contracts can be profitable.

Now, let us turn to the latter half of the lemma. Suppose contract $c = \{(\underline{w}, \underline{y}), (\overline{w}, \overline{y})\}$ with $c \neq c^*$ is an equilibrium contract. Because $\underline{y}^*$ is a unique maximand of $y - V(y/\underline{\theta})$, a low ability worker strictly prefers contract $(\underline{y}^*, \underline{y}^*)$ to any other contract. In the same way, a high ability worker strictly prefers $(\bar{y}^*, \bar{y}^*)$ to any other contract. Hence, a firm could profitably offer $\{(\underline{y}^*-\underline{\epsilon}, \underline{y}^*), (\bar{y}^*-\bar{\epsilon}, \bar{y}^*)\}$ for $\underline{\epsilon}$ and $\bar{\epsilon}$ sufficiently small to make either the low ability or the high ability worker strictly better off without.

Q.E.D.

Thus the unique equilibrium offer by firms in the market is the contract $c^* = \{(\underline{y}^*,\underline{y}^*), (\bar{y}^*, \bar{y}^*)\}$, as illustrated in Fig. 1. The utility levels from this contract are represented by indifference curves passing through $(\underline{y}^*-C, \underline{y}^*)$ and $(\bar{y}^*-C, \bar{y}^*)$. If the mobility cost C is sufficiently large, therefore, the utility level that this contract yields may be lower than the default utility that a worker obtains in the secondary sector. In such a case the worker can move to the secondary sector and receive 0. Thus competition for the worker in period 2 ensures that she receives at least a utility $\bar{u} = \max\{0, \bar{U}(c^*) - C\}$ if she is of high ability or $\underline{u} = \max\{0, \underline{U}(c^*) - C\}$, if she is of low ability. An important implication of Lemma 1 is that the contract offered by firms in the market does not depend on their assesment of worker ability. We will see that in equilibrium no worker will enter the second–hand market.

Now consider the problem faced by the incumbent firm. If it offers any contract resulting in less than $\bar{u}$ or $\underline{u}$, then the worker would go either to the secondary market or to some other firm in the primary sector. Since there is a moving cost, however, the incumbent firm will always make a positive profit on any contract that yields $\bar{u}$ $(\underline{u})$ to a high (low) ability worker. In order to keep the worker, the incumbent need only guarantee the high (low) ability worker $\bar{u}$ $(\underline{u})$. Given these observations and the revelation principle,[5] we can write the incumbent

[5]See Myerson (1979) for a statement of the revelation principle and its application to a single period contract (bargaining) problem.

firm's optimization problem in the second period as follows. If the incumbent firm's posterior belief φ' on worker type, it chooses $c = \{\underline{c}, \overline{c}\}$ to maximize

$$\varphi'\{\underline{y} - \underline{w}\} + (1-\varphi')\{\overline{y} - \overline{w}\}, \tag{3.1}$$

subject to

$$\overline{U}(\overline{c}) \geq \overline{u}, \tag{3.2}$$

$$\underline{U}(\underline{c}) \geq \underline{u}, \tag{3.3}$$

$$\overline{U}(\overline{c}) \geq \overline{U}(\underline{c}), \tag{3.4}$$

$$\underline{U}(\underline{c}) \geq \underline{U}(\overline{c}). \tag{3.5}$$

The objective (3.1) is the expected profits to the firm. Inequalities (3.2) and (3.3) are the participation (or individual rationality) constraints generated by the potential competition in the market. Inequalities (3.4) and (3.5) are the incentive constraints for the two types of worker. Notice that the distinguishing feature of this model is that the individual rationality constraint depends on the worker's type, while the standard model (for example in Freixas, Guesnerie and Tirole (1985)) assumes both types of worker face the same alternative opportunities. Of course, at one extreme where mobility costs are very high, our model coincides with the standard model with $\overline{u} = \underline{u} = 0$. If the mobility costs are low, however, the default utility of the high ability type is higher than that of the low ability type.

Consider first the case of $C \geq \overline{U}(\overline{c}^*)$ in which default utilities of both types are zero. In the absence of incentive constraints (3.4) and (3.5), the firm would choose contract $\hat{c} = \{(V(\underline{y}^*/\underline{\theta}), \underline{y}^*), (V(\overline{y}^*/\overline{\theta}), \overline{y}^*)\}$ with first best levels of efforts. As one can see in Fig. 2, however, at this contract the high ability worker would always prefer the contract offered to the low ability type. The optimal contract is therefore given by

$$c(\varphi') = (\underline{c}(\varphi'), \overline{c}(\varphi')) = \{(V(\underline{y}(\varphi')/\underline{\theta}), \underline{y}(\varphi')), (\overline{w}(\varphi'), \overline{y}^*)\} \tag{3.6}$$

in the figure. At this contract the low ability worker gets zero utility, and produces an output $\underline{y}(\varphi')$ that is less than first best. The high ability worker gets some rent to induce self–selection, and performs at the first best level of output. Note that contract $c(\varphi')$ depends on the firm's belief φ'. If the proportion of low ability type φ' is smaller, distortion in the low type contract becomes less important relative to the profit made from the high type contract, which makes the output for the low type smaller.

Next, consider the other extreme where the default utilities of both types are strictly positive with $\bar{u} = \bar{U}(\bar{c}^*) - C$ and $\underline{u} = \underline{U}(\underline{c}^*) - C$. This case occurs when mobility costs are sufficiently low to satisfy $C < \underline{U}(\underline{c}^*)$. From Fig. 1, one can see that the optimal contract for the incumbent firm is $\{(\underline{y}^* - C,\ \underline{y}^*),\ (\bar{y}^* - C,\ \bar{y}^*)\}$. Hence the contract that the incumbent firm offers does not depend on its belief φ', and therefore there is no ratchet effect.

In the intermediate case where only the low ability worker's default is zero, the second period contract may or may not depend on the firm's belief φ'. If self selection is possible at the first best effort levels as in Figure 3, contract $\{(V(\underline{y}^*/\underline{\theta}),\ \underline{y}^*),\ (\bar{y}^* - C,\ \bar{y}^*)\}$ which does not depend on φ' will be an equilibrium. If the mobility cost is small, this case will occur, but for a large mobility cost the high ability worker will have an incentive to choose the low type contract. In such a case the contract offer depends on belief φ'.

The following two propositions summarize these results.

Proposition 1. **The incumbent firm's equilibrium contract does not depend on its belief if $0 \le C \le \underline{U}(\underline{c}^*) + [\bar{U}(\bar{c}^*) - \bar{U}(\underline{c}^*)]$. In particular, if $0 \le C \le \underline{U}(\underline{c}^*)$, then the equilibrium contract is $\{(\underline{y}^* - C,\ \underline{y}^*),\ (\bar{y}^* - C,\ \bar{y}^*)\}$; and if $\underline{U}(\underline{c}^*) < C \le \underline{U}(\underline{c}^*) + [\bar{U}(\bar{c}^*) - \bar{U}(\underline{c}^*)]$, then it is $\{(V(\underline{c}^*/\underline{\theta}),\ \underline{y}^*),\ (\bar{y}^* - C,\ \bar{y}^*)\}$.**

Proof:

Discussions in the main text above have shown that if $0 \le C \le \underline{U}(\underline{c}^*)$, then the equilibrium contract is $\{(\underline{y}^* - C,\ \underline{y}^*),\ (\bar{y}^* - C,\ \bar{y}^*)\}$.

If $\underline{U}(\underline{c}^*) < C \le \underline{U}(\underline{c}^*) + [\overline{U}(\bar{c}^*) - \overline{U}(\underline{c}^*)]$, then the low type contract must guarantee that the low ability worker's utility is zero. Ignoring the incentive constraints, the profit maximizing contract is then $\{(V(\underline{y}^*/\underline{\theta}), \underline{y}^*), (\bar{y}^*-C, \bar{y}^*)\}$. This contract satisfies the incentive constraint for the high ability worker because inequality $C \le \underline{U}(\underline{c}^*) + [\overline{U}(\bar{c}^*) - \overline{U}(\underline{c}^*)]$ implies that

$$\bar{y}^* - V(\bar{y}^*/\bar{\theta}) - C \ge V(\underline{y}^*/\underline{\theta}) - V(\underline{y}^*/\bar{\theta}) .$$

It is obvious that the incentive constraint for the low ability worker is satisfied.

Q.E.D.

Proposition 2. If $C > \underline{U}(\underline{c}^*) + [\overline{U}(\bar{c}^*) - \overline{U}(\underline{c}^*)]$, then the incumbent firm's equilibrium contract offer depends on its belief φ'. In particular, if $C \ge \overline{U}(\bar{c}^*)$, then the equilibrium contract is $c(\varphi') = (\underline{c}(\varphi'), \bar{c}(\varphi')) = \{(V(\underline{y}(\varphi')/\underline{\theta}), \underline{y}(\varphi')), (\bar{w}(\varphi'), \bar{y}^*)\}$. If $\underline{U}(\underline{c}^*) + [\overline{U}(\bar{c}^*) - \underline{U}(\underline{c}^*)] < C \le \overline{U}(\bar{c}^*)$, then the equilibrium contract is $c(\varphi')$ for $\varphi' \ge \tilde{\varphi}$ and $\{\underline{c}(\tilde{\varphi}), (\bar{y}^*-C, \bar{y}^*)\}$ for $\varphi' < \tilde{\varphi}$, where $\tilde{\varphi}$ satisfies $\bar{w}(\tilde{\varphi}) = \bar{y}^* - C$.

Proof:

From discussions in the main text, it is obvious that if $C \ge \overline{U}(\bar{c}^*)$, then the equilibrium contract is $c(\varphi')$.

If $\underline{U}(\underline{c}^*) + [\overline{U}(\bar{c}^*) - \overline{U}(\underline{c}^*)] < C \le \overline{U}(\bar{c}^*)$, then $\bar{u} = \overline{U}(\bar{c}^*) - C$ and $\underline{u} = 0$. Using the same argument as in the proof of Proposition 1, one can show that the first best effort levels cannot satisfy the incentive constraints. Let us first consider the optimal contract $c(\varphi')$ obtained when $\bar{u} = \underline{u} = 0$. If $\bar{w}(\varphi') \ge \bar{y}^* - C$, then the high ability worker's utility from this contract is higher than or equal to the default utility $\bar{u} = \overline{U}(\bar{c}^*) - C$. In such a case the equilibrium contract is $c(\varphi')$.

If $\bar{w}(\varphi') < \bar{y}^* - C$, then this contract does not satisfy the individual rationality constraint for the high ability worker. The wage for her must therefore be raised to $\bar{y}^*-C$, and the high type contract is $(\bar{y}^*-C, \bar{y}^*)$. The corresponding low type contract is $\{V(\underline{y}(\tilde{\varphi})/\underline{\theta}), \underline{y}(\varphi)\}$, where $\tilde{\varphi}$ satisfies $\overline{w}(\tilde{\varphi}) = \overline{y}^* - C$.

Q.E.D.

4. The First Period Equilibrium Contracts

In period 1 the firms will offer contracts, followed by the worker's response, with all agents anticipating the consequences of these choices for the second period equilibrium. When mobility costs are small, competition for second–hand workers results in the high ability worker having a higher default utility than the low ability worker in period 2. This reduces the incentive for the high ability worker to conceal her type, since, even if her type is known, she can obtain the default utility. In particular, Proposition 1 shows that if $0 \leq C \leq \underline{U}(\underline{c}^*) + [\overline{U}(\overline{c}^*) - \overline{U}(\underline{c}^*)]$, then the worker's utility in period 2 is independent of the incumbent firm's belief. Consequently, there is no incentive for the worker of either type to disguise her ability in period 1 to obtain a better deal in period 2. Thus we have the following proposition.

Proposition 3: Suppose that $0 \leq C \leq \underline{U}(\underline{c}^*) + [\overline{U}(\overline{c}^*) - \overline{U}(\underline{c}^*)]$. Then separation of the two types occurs in period 1. In particular, if $0 \leq C \leq \underline{U}(\underline{c}^*)$, then the unique equilibrium is characterized by

$$c^1 = \{(\underline{y}^* + \rho C, \underline{y}^*), (\overline{y}^* + \rho C, \overline{y}^*)\}$$
$$c^2 = \{(\underline{y}^* - C, \underline{y}^*), (\overline{y}^* - C, \overline{y}^*)\} .$$

If $\underline{U}(\underline{c}^*) < C \leq \underline{U}(\underline{c}^*) + [\overline{U}(\overline{c}^*) - \overline{U}(\underline{c}^*)]$, then it is

$$c^1 = \{(\underline{y}^* + \rho(\underline{y}^* - V(\underline{y}^*/\underline{\theta})), \underline{y}^*), (\overline{y}^* + \rho C, \overline{y}^*)\}$$
$$c^2 = \{(V(\underline{y}^*/\underline{\theta}), \underline{y}^*), (\overline{y}^* - C, \overline{y}^*)\} .$$

Proof:

Proposition 1 has obtained the equilibrium contract in period 2. The equilibrium contract in period 1 follows immediately from the fact that separation of the two types occurs in period 1 and competition among firms drives down the discounted sum of profits to zero.

Q.E.D.

Notice that this result does not depend on restricting the number of types to two. Set $y^*(\theta)$ equal to the first best output for a worker of type θ. Even if the types are taken from the continuum $[\underline{\theta}, \overline{\theta}]$, the arguments we have used will imply that Proposition 3 continues to hold with the following change. If $0 \le C \le \underline{U}(\underline{c}^*)$, then the optimal contracts for the intermediate values of θ are

$$c^1(\theta) = (y^*(\theta) + \rho C, y^*(\theta))$$
$$c^2(\theta) = (y^*(\theta) - C, y^*(\theta)).$$

If $\underline{U}(\underline{c}^*) < C \le \underline{U}(\underline{c}^*) + [\overline{U}(\overline{c}^*) - \overline{U}(\underline{c}^*)]$, then there exists $\tilde{\theta}$ which satisfies

$$y^*(\tilde{\theta}) - C = V(y^*(\tilde{\theta})/\tilde{\theta}) ,$$

and the equilibrium contracts are

$$c^1(\theta) = (y^*(\theta) + \rho C, y^*(\theta))$$
$$c^2(\theta) = (y^*(\theta) - C, y^*(\theta))$$

for $\theta \in [\tilde{\theta}, \overline{\theta}]$, and

$$c^1(\theta) = (y^*(\theta) + \rho(y^*(\theta) - V(y^*(\theta)/\theta)), y^*(\theta))$$
$$c^2(\theta) = (V(y^*(\theta)/\theta), y^*(\theta))$$

for $\theta \in [\underline{\theta}, \tilde{\theta}]$.

If the mobility cost is large, the second period contract depends on the firm's belief φ' as shown in Proposition 2. The high ability worker may then have an incentive to conceal her type in the first period. Because the analysis of this case parallels that of Freixas, et.al. (1985), we report the results without proof. In period 1 three types of equilibria are possible: (1) a pooling equilibrium where both types choose the same contract, (2) a separating equilibrium where they choose different contracts, and (3) a semi-separating equilibrium where the high ability worker randomizes between the two contracts. If $\bar{\theta} - \underline{\theta}$ is sufficiently small, then the equilibrium cannot be efficient. This is the reason why Gibbons (1987) finds that piece rate contracts are inefficient when there are a continuum of types. When $\bar{\theta} - \underline{\theta}$ is large, then as Freixas, Guesnerie and Tirole (1985) show, there will always be a separation of types in period 1 resulting in the implementation of the first best.

5. Concluding Discussion

We have shown that the existence of a market for senior workers can alleviate the ratchet effect even in the presence of a relation-specific investments. The existence of a market for senior workers will ensure that the default payoffs of the worker will depend on the worker's ability. In this case the incumbent firm cannot use any information gained by observing first period performance to adjust second period piece rates. This result contrasts with the case of job difficulty studied by Gibbons (1987). He shows that workers will in general under performance in the first period of the relationship to hide the true difficulty of the job from the employer.

The major implication of this analysis is that it can help explain under what situations firms will use piece rate contracts. When the difficulty of the job is well understood by the firm, worker are of different abilities, and the ex post labour market is sufficiently competitive, then piece rate contracts are efficient and feasible. Examples of this include agricultural work and sales. If the alternatives facing the worker do not depend on the information that is private to the worker, this will create an incentive to hide this information in early periods. It is this effect that generates a ratchet effect, and makes efficient piece rate contracts impossible.

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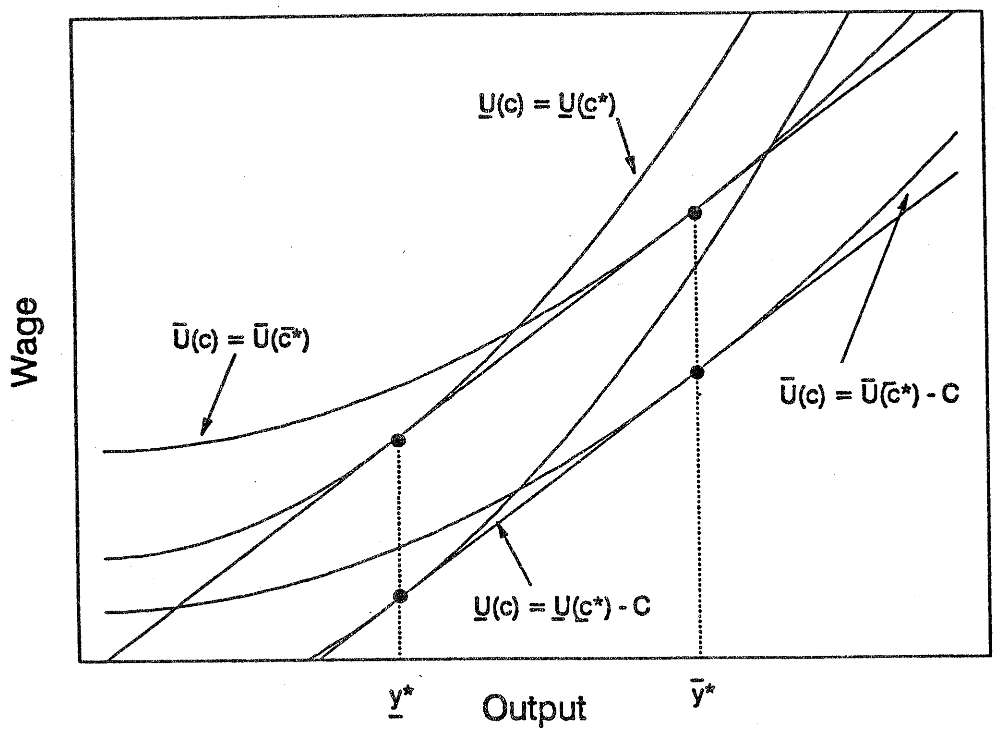
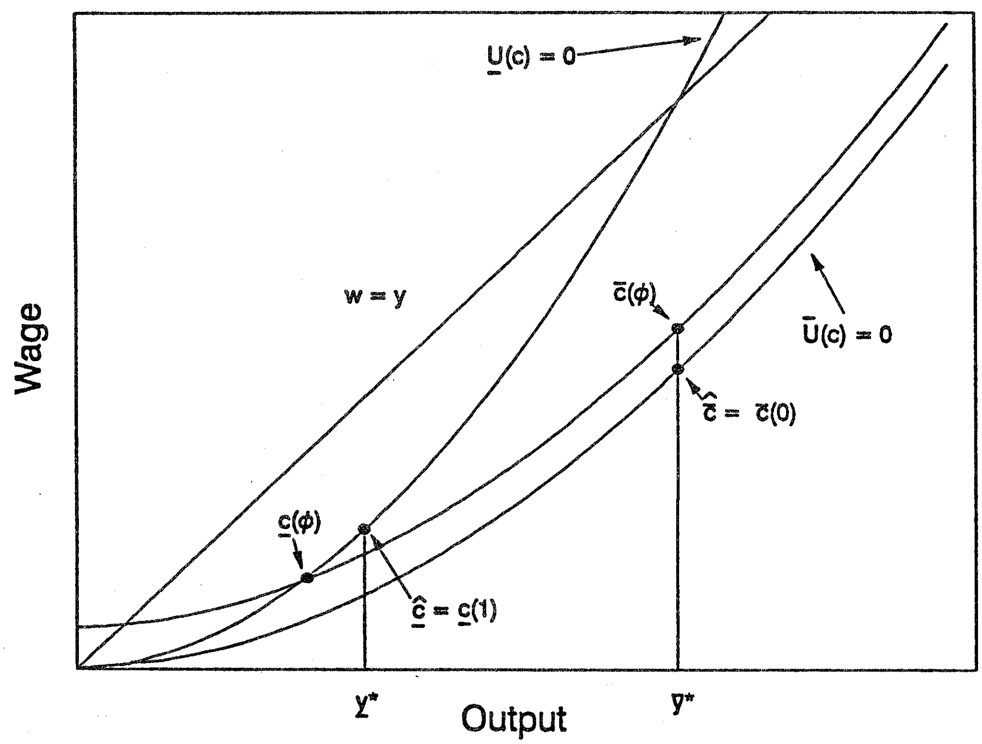


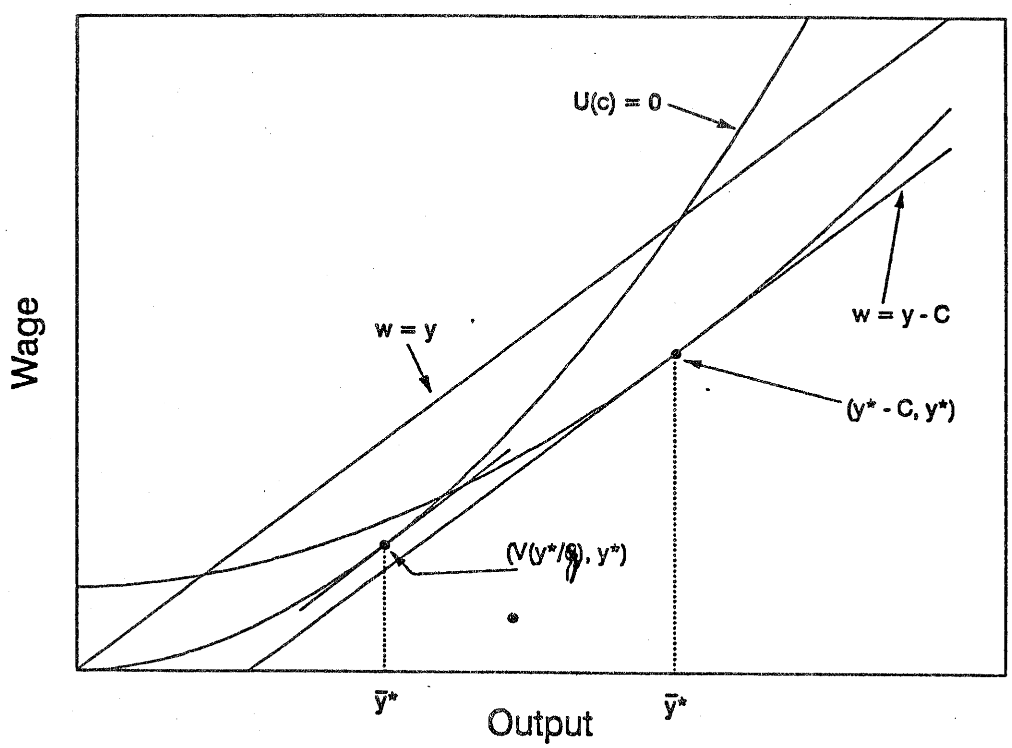
Optimal Second Period Contracts

Figure 1



Contracts in Period 2 with Adverse Selection

Figure 2



Second Period Contract: Intermediate case

Figure 3