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Adverse Selection and Wage Gains

Christian Holzner

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Christian Holzner<sup>1</sup>

Ifo Institute for Economic Research, Poschingerstr. 5, 81679 Munich, Germany  
Tel: +49(0)89/9224-1278; Fax: +49(0)89/92241608; E-mail: holzner@ifo.de

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## **Abstract**

The paper shows that for severe enough search frictions, a market for employed workers with wage gains emerges despite the presence of adverse selection. Asymmetric information about a worker's productivity between the worker's current employer and the outside market enables the current employer to keep its best employees from joining the outside market by promoting them or by making them counter offers. Since outside wage offers are uncertain, firms promote or make counter offers only to their best workers. The resulting adverse selection, though, leads to an initial breakdown of the market for employed workers. As low-productivity workers are laid off over time, tenure serves as a positive signal about a worker's productivity. After enough badly performing workers were laid off, the signal is strong enough to counteract the negative effect of adverse selection and a market for employed workers emerges.

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# 1 Introduction

Since the current employer is better informed about a worker's productivity than the outside market, he can prevent that his best employees quit by making them a counter offer. The resulting adverse selection can lead to a breakdown of the market along the lines of Akerlof (1970). Greenwald (1986), Gibbons and Katz (1994), and Acemoglu and Pischke (1998), among others, circumvented this problem by introducing an exogenous reason to quit in order to ensure that the market does not break down. The wage in the outside market, though, is lower than the wage at the current employer, because of the persisting adverse selection. Empirically, however, we observe not only wage cuts but also wage gains if workers move to another employer.

This paper explains both wage cuts and wage gains in the presence of adverse selection. The assumption that makes the difference is that outside wage offers are uncertain and not observed by a worker's current employer. This implies that the firm will promote or make counter offers only to its best-performing workers but not to workers with average productivity, if the probability is large enough that a worker will not get an outside offer, i.e. stay with the firm at the old wage. The non-promoted workers are available to the outside market. Initially, though, the market for employed workers breaks down. The reason for this is that nobody will search since the potential outside wage offer is – due to the presence of adverse selection – below the worker's current wage. The negative effect of adverse selection on the average productivity of workers available to the outside market can, however, be overcome as more and more badly performing workers are laid off over time. The fact that these layoffs are publicly observable enables outside firms to use the also observable tenure of a worker as a positive productivity signal on which they can base their wage offer. Workers getting such an outside wage offer experience a wage gain whereas workers who are laid off experience a wage cut.

The model can also explain an empirical finding by Farber (1994), namely that the hazard of job termination increases up to a maximum at 3 months of employment and declines thereafter. The literature so far (see Jovanovic 1979 and Pissarides 1994) can only explain a declining hazard. The explanation given in this paper is as follows. Initially, the hazard is zero, because the cost of recruitment implies that a firm will wait some time before laying off a worker. During that time tenure will not carry any information about a worker's productivity, implying that the market for employed workers breaks down. The hazard becomes positive as the first workers are laid off. After the first layoffs, the market for employed workers generally does not resume immediately, since it takes some time to ensure that enough badly performing workers are laid off such that the pool of searching workers has a sufficiently high productivity to enable outside firms to offer wages above the worker's current wage. The point where the on-the-job market emerges coincides with the maximum of the hazard of job ending. Thereafter, the hazard declines, not because the probability of finding a job declines, but because the likelihood that an employed worker is of the bad type and hence is laid off declines.

As mentioned above, the best-performing workers are promoted or get counteroffers by their current employer in order to prevent them from searching or quitting. Thus, for high productivity workers the option to get an outside wage offer is enough to induce their current firm to increase their wage. Furthermore, since more and more badly performing workers are laid off over time, it follows that the productivity of the pool of employed workers and of the pool of searching workers increases over time. With an increase in the productivity of searching workers over time the outside wage offer increases, too. The consequent promotion of the best-performing workers then implies that wages increase with tenure. A similar explanation for the wage-tenure effect is given by Jovanovic (1979), who assumed that productivity is match-specific

and revealed to the worker and the firm over time.

While the explanation based on the theory of firm-specific human capital developed by Becker (1964) and Hashimoto (1981) is seen by many empirical researchers as the key source for why wages increase with tenure, there are also empirical studies by Abraham and Farber (1987), Altonji and Shakotko (1987) and more recently Altonji and Williams (1997) supporting Jovanovic and my explanation based on the revelation of productivity over time. They show that the measured positive cross-sectional return to seniority found in studies of Mincer and Jovanovic (1981) and Bartel and Borjas (1981) among others is largely a statistical artifact due to the correlation of high seniority with an omitted variable representing the quality of the worker, job or worker-employer match.

The search literature so far does not distinguish between the temporary breakdown of the market for employed workers and generic search frictions, although the sources are very different. A temporary breakdown of the on-the-job market is the consequence of adverse selection caused by the promotion strategy of the current employer who tries to prevent its most productive workers from quitting. Search frictions are, however, usually explained by the uncoordinated application decision of workers (see Moen 1997, Acemoglu and Shimer 1999, Burdett, Shi and Wright 2001).

Furthermore, I provide conditions under which it is optimal for the current employer to make a counter offer. This is important because the early on-the-job search models by Burdett (1978), Jovanovic (1984), Pissarides (1994) and Burdett and Mortensen (1998) assume that the current employer does not react to outside wage offers. Thus, workers receiving higher outside wage offers climb up the wage ladder. Postel-Vinay and Robin (2002) assume the opposite, namely that the current employer observes and reacts to an outside wage offer by making a counter offer. The resulting Bertrand competition between firms drives the wage up so that the firm with the highest produc-

tivity wins the bidding game. While these models assume how the current employer reacts to an outside offer, I explicitly model it by taking adverse selection into account. Although it is quite obvious that making a counter offer to all employees is optimal if outside wage offers are observable, it turns out that if outside wage offers are not observable, it is optimal that average-productivity workers are never given a counter offer. Furthermore, if search frictions are large enough, then it is optimal to ignore any outside wage offer.

The outline of the paper is as follows. The next section presents the basic model and derives the main results. Section 3 shows that promoting is equivalent to making counter offers and that the results hold if I allow for performance-related contracts and an environment where workers know more about their type than their current employer.

## 2 Adverse Selection and Wage Gains

A large number of new market entrants enter the labor market every period and with some probability survive until the next period. They differ in the probability  $\theta$  to produce output  $y$ , where the distribution of types is given by an arbitrary density function  $z(\theta)$  on the support  $[0,1]$ . New market entrants do not know their type. In section 3, I allow for workers to have a better signal about their type than the employing firm has. In the basic model new market entrants have the same prior belief about their type as firms have. The prior belief equals the average production probability of all new market entrants, i.e.

$$v_0 = \int_0^1 \theta z(\theta) d\theta.$$

The beliefs are updated by Bayes' rule. Since updating can only take place after an production period, denote  $v_S$  the belief after  $S$  periods of employment.

Workers maximize their life-time utility when they trade off a higher wage with a lower matching probability as well as with an increased layoff probability in the future. Although not explicitly modelled I assume that an evolutionary game has taken place that guarantees that only the market that maximizes workers' life-time utility survives (see Moen 1997, Acemoglu and Shimer 1999). In other words, firms post wages anticipating the expected queue length of workers applying for that vacancy and their expected layoff probability. The evolutionary game ensures that firms make zero profit and maximize the workers' life-time utility. The outcome of such a directed search model is a fixed probability  $(1 - \lambda)$  with which a worker employed for  $\tilde{S}$  periods gets an outside wage  $w$ , where  $\lambda \in [0, 1]$ . The probability of getting a wage  $w$  is only zero if no labor market for workers employed for  $\tilde{S}$  periods exists. If, however, a labor market exists, then the probability of getting a wage  $w$  is  $(1 - \lambda)F(w)$ .

Search frictions are essential for a market with wage gains to emerge. If workers had an outside wage  $w$  with certainty, then the current employers would promote all workers whose expected current and continuation productivity exceeds the outside wage  $w$ . The resulting adverse selection makes an outside wage  $w$  that exceeds the initial wage impossible. Thus, without search frictions, the market for employed workers would break down forever.

Firms exist forever and discount future payments with a factor  $\beta \in (0, 1)$ , which includes the exit probability of a worker. They have to pay an advertisement cost  $u$  for posting a vacancy. With probability  $f$  per period a firm meets a worker, where  $f$  is linked to the matching probability  $(1 - \lambda)$  of the evolutionary game mentioned above. For such an equilibrium to exist I assume that the advertisement cost of a vacancy is below the average productivity of new market entrants, i.e.  $u < Y(v_0)$ , which is assumed to hold for the remainder of the paper.

Firms offer fixed wages that cannot be negotiated downward.<sup>1</sup> If wages could be

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<sup>1</sup>A good literature review justifying downward wage rigidity is given in Weiss (1991) and Bewley

negotiated downward, then nobody would be laid off and tenure could not be used as a positive production signal. Adverse selection caused by the promotion strategy of the current firm then implies that only a market for the least productive workers exists. Wage gains would not occur. The assumption of downward wage rigidity seems more restrictive than it actually is, as I discuss in section 3.

Finally, free entry of firms in the evolutionary game mentioned above ensures that the value of a vacancy is driven down to zero implying that the expected profit of a match equals the cost of a vacancy, i.e.

$$f(O(v_s, \xi)) = u, \quad (1)$$

where  $O(v_s, \xi)$  denotes the expected value of employing a worker with belief  $v_s$ . I further assume that firms can condition their wage offers on the periods  $\xi$  an applicant has been employed for. This assumption can be justified by the common practice of recruiting firms to ask for references from past employers. Firms, thus, post a menu of wages, one for each class of workers, where the classes differ in the periods  $\xi$  that workers have been employed for. These wage offers are not observed by the worker's current employer until they are accepted. This assumption can be justified by the interest of outside firms to conceal their outside offers, since making them observable would trigger a counter offer of the current employer, leading to a break down of the market.

The value of employing a worker with belief  $v_s$  is given by the worker's expected productivity  $Y(v_s)$  minus his current wage  $w_s$  plus the expected discounted continuation payoff  $\beta Y(O(v_s, \xi))$ .

$$O(v_s, \xi) = \max_{w_s} [Y(v_s) - w_s + \beta Y(O(v_s, \xi))] \quad (2)$$

After each production period, the following sequential game between the worker and  


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(1999).



his current firm starts:

1. A firm decides whether or not to lay off a worker. The firm cannot recall a worker.
2. If a worker was not laid off, the firm decides whether or not to promote him, i.e. chooses  $w^+$ .
3. The employed worker decides whether or not to search.
4. Outside firms observe the labor market status of all workers and decide on the wage offers for those laid off and for those still employed.
5. Workers with an outside wage offer decide whether or not to leave the current employer.

The sequential game is solved by backward induction. A worker will leave his current firm if and only if his outside wage offer  $w^+$  is higher than his current wage  $w$ , where the current wage is either the promotion wage  $w^+$  or the last period's wage  $w_{t-1}$ , if a worker was not promoted. If the worker does not stay with the firm, then the firm will open a new vacancy next period.

If the expected productivity  $Y(\theta)$  of those workers searching is sufficiently high to ensure that outside firms can make an outside wage offer that exceeds the workers' current wage, then they will offer the following outside wage,

$$w^+ = Y(\theta) + \beta Y(\theta) \quad (2)$$

where free entry ensures that firms make zero profit. Employed workers will start to search if and only if the expected outside wage offer  $w^+$  is above their current wage  $w$ .

Firms will promote a worker, i.e. pay him the potential outside offer  $w^+ = w^+$ ; if and only if the payoff of a promoted workers is higher than the payoff of paying him the

last period's wage  $w_{t-1}$  and taking into account that he will get and accept an outside offer with probability  $1 - \theta$  i.e. stay with probability  $\theta$

$$Y(w_{t-1} | v_t) = \xi + \beta Y [O(v_t | \xi)] R \theta [Y(w_{t-1} | v_t) + \beta Y [O(v_t | w_{t-1})]] \quad (3)$$

Note that it is optimal for the firm to pay a promotion wage equal to the outside wage offer, since  $w_t^* = w_{t-1}$  just prevents a worker from searching for an outside job. Thus, promotion is used to ensure that the most productive workers do not search.

The promotion-threshold productivity  $Y(w_{t-1} | v_t^*)$ , given the worker earned wage  $w_{t-1}$  last period is defined such that the current firm is exactly indifferent between promoting the worker or paying him the last period's wage, i.e.

$$\begin{aligned} Y(w_{t-1} | v_t^*) &= \xi + \beta Y [O(v_t^* | \xi)] \\ &= \theta [Y(w_{t-1} | v_t^*) + \beta Y [O(v_t^* | w_{t-1})]], \end{aligned} \quad (4)$$

where  $v_t^* | w_{t-1}$  is the promotion-threshold belief. Promotion leads to adverse selection on the market for employed workers, since the very best workers are promoted and kept off the labor market, whereas the average productive workers are not promoted and therefore search.

Finally, the least productive workers are laid off if and only if their expected current payoff plus their continuation payoff is negative. The timing of the game implies that a worker is not promoted and laid off at the same time, hence the layoff decision is based on the wage of the last period  $w_{t-1}$ , i.e.

$$Y(w_{t-1} | v_t) = w_{t-1} + \beta Y [O(v_t | w_{t-1})] - P < 0. \quad (5)$$

The layoff-threshold productivity  $Y(w_{t-1} | v_t^{\text{off}})$ , given the worker earned wage  $w_{t-1}$  last period, is defined such that the worker's believed productivity makes the current firm just indifferent between continuing employing this worker or laying him off and searching for a new worker which has a value of zero, i.e.

$$Y(w_{t-1} | v_t^{\text{off}}) = w_{t-1} + \beta Y [O(v_t^{\text{off}} | w_{t-1})] - P = 0, \quad (6)$$

where  $v(\xi_{t-1})$  is the corresponding layoff-threshold belief.

Note that the fact that a firm can always layoff a worker and open a new vacancy with a value of zero implies that the continuation payoff  $V^0(v_{t-1})$  cannot be negative. It follows that the layoff-threshold productivity is below or just equal to the last period's wage.

A laid off worker starts to search as unemployed for a new job. Given his employment history, outside firms form a new belief about him. Thus, the laid off worker can be treated as a new market entrant with a different prior belief. I therefore focus in the following analysis on workers who are not laid off but remain with their first employer or move directly from one job to another.

In order to prove under which conditions a market for employed workers with wage gains emerges, consider first the following lemmas.

**Lemma 1** The market for employed workers breaks down as long as nobody is laid off.

**Proof:** If nobody has been laid off so far, then the market belief about the employed workers' productivity equals the initial belief  $v_0$ . A potential outside wage offer  $w^o$  could therefore be no higher than the initial wage  $w_0$ . Since due to the downward wage rigidity the employed workers earn at least their initial wage, they would not start to search for an outside job. Thus, no market for employed workers exists as long as nobody is laid off.  $\square$

It immediately follows that the probability  $1 - \alpha$  of getting an outside wage offer is zero if nobody was laid off until  $\tilde{\xi}$ . Consequently, the current employer will not promote anyone up until  $\tilde{\xi}$  as can be seen by looking at the promotion condition (3).

**Lemma 2** From some point  $0 < P < P^E$  onward, badly performing workers will be laid off.

**Proof:**  $Y(v_0) \geq u$ , which was assumed to guarantee existence, implies together with the free entry condition (1) for the market for new entrants that the initial wage is positive, i.e.  $w_0 > 0$ .

Lemma 1 implies that workers earn the initial wage  $w_0$  as long as nobody is laid off, especially that  $w_{OD1} = w_0$ . The timing of the game further implies that nobody is promoted and laid off at the same time. Hence, the layoff decision (5) at 0 is based on the initial wage  $w_0$ , i.e.  $Y(v_0) \geq w_0 + \beta Y[O(v_0, 0)] \geq 0$ .

The costly search process implies that there is an option value for the current employer to wait before laying off a worker, i.e.  $0 \leq V$ . This can be seen by looking at workers earning the initial wage. The free entry condition (1) for new market entrants together with the definition of the layoff-threshold productivity imply

$$w_0 = Y(v_0) + \beta Y[O(v_0, 0)] \geq u = Y(v_0) + \beta Y[O(v_0, 0)]$$

This holds only for  $v_0 \geq v(w_0)$ , implying that nobody is laid off at  $\tilde{s} = 0$ .

$w_0 > 0$  implies that  $v(w_0) > 0$ . Furthermore, there are some unlucky workers who never produce. The belief of these workers approaches zero as  $\tilde{s} \rightarrow E$ , i.e.  $\lim_{\tilde{s} \rightarrow E} v^{\min} = 0$ , because the density function  $z(\cdot)$  has its support on  $[0, \infty)$ . Given  $v(w_0) > 0$ , it follows that as  $\tilde{s} \rightarrow E$  a point in time  $0 \leq \tilde{s} < E$  exists with such a low belief  $v^{\min} \leq v(w_0)$ . Thus, workers with belief  $v^{\min}$  are laid off at 0.  $\square$

This is shown in figure 1, where workers at nodes that can only be reached with dashed lines are laid off. Note that nobody who was employed and produced something at  $\tilde{s} < 1$  is laid off at  $\tilde{s}$  because his expected productivity went up and he need not be promoted. Therefore, employing him further is at least as profitable as employing him at  $\tilde{s} < 1$ . The fact that the continuation payoff cannot be negative implies that nobody is laid off whose believed productivity is above his current wage.

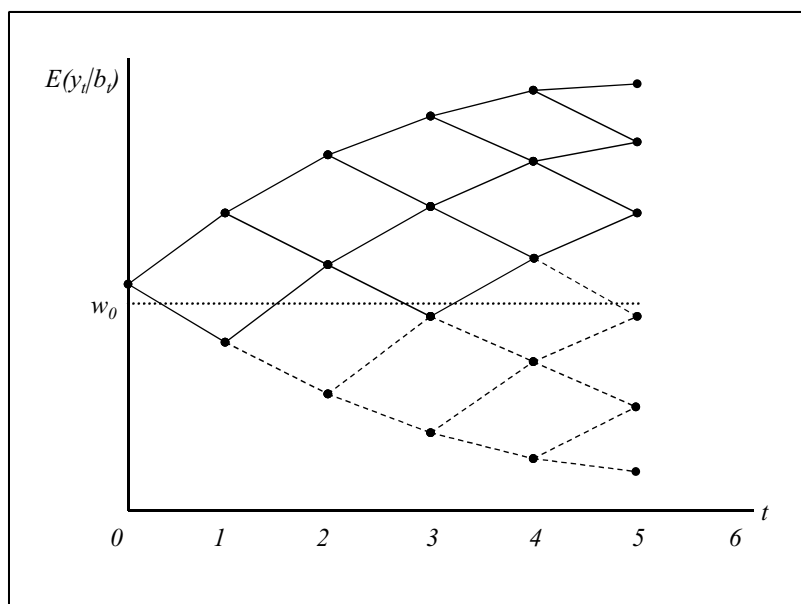


Figure 1: Low productivity workers are laid off.

Figure 1 also illustrates that there are periods besides the initial period where nobody is laid off. In the shown example the first workers are fired at  $\check{S} = 2$ . At  $\check{S} = 3$ , however, nobody is laid off, since the continuation payoff of the workers with the lowest expected productivity is large enough to outweigh the negative current payoff.

**Lemma 3** "Average"-productivity workers are never promoted.

**Proof:** Assume for the moment that an outside wage offer exceeding the initial wage exists. Given this outside wage offer, workers are not promoted according to condition (3) if and only if

$$Y(v_{\check{S}}) \cdot v_{\check{S}} + \check{Z} Y [O(v_{\check{S}} | \check{S})] \leq \% [Y(v_{\check{S}}) \cdot v_0 + \check{Z} Y [O(v_{\check{S}} | 0)]] .$$

This condition holds with strict inequality for the layoff-threshold belief  $v_{\check{S}} = v(\check{c}_0)$ . Thus, a promotion-threshold  $v^{\dagger}(\check{c}_0) \in (v(\check{c}_0), v_0)$  exists such that this condition holds with equality. Workers with belief  $v_{\check{S}} \in (v(\check{c}_0), v^{\dagger}(\check{c}_0))$  are not promoted. I define these workers as being of "average" productivity. If no wage offer exceeding the initial wage exists, then Lemma 1 implies that nobody is promoted.  $\square$

If an outside wage  $w$  exceeding the initial wage emerges at some point, then Lemma 3 implies that the current employer does not promote workers with an expected productivity  $Y(v^*(w))$  or below. These “average”-productivity workers will start to search if an outside wage  $w$  exceeding the initial wage exists. Thus, the last part needed to establish the existence of an on-the-job market with wage gains is to show under which conditions a wage  $w$  greater than the initial wage can exist for some  $h \in \mathbb{F}(\text{OCE})$ .

**Theorem 1:** If search frictions, i.e.  $\beta$  are large enough, then at some  $h \in \mathbb{F}(\text{OCE})$  a market for employed workers with wage gains emerges and continues to work forever.

**Proof:** In order to ensure that the outside wage  $w$  exceeds the initial wage, i.e.  $w > v_0$ , it has to be the case that the average productivity of those employed workers who are not promoted, i.e. workers with belief  $v^*(w) < v_h < v^*(w)$ , exceeds the average productivity of the new market entrants, i.e.

$$v_h^f = \frac{\int_{v^*(w)}^{\infty} v_h \{ (v_h) x v_h \} R v_0,}{\int_{v^*(w)}^{\infty} v_h \{ (v_h) x v_h \} R v_0} \quad (7)$$

where  $\{ (v_h) \}$  is the density function of the beliefs of workers employed for  $h$  periods that is derived from the underlying productivity type distribution  $z(\dagger)$  by Bayes' rule. Thus, a market for employed workers exists if the promotion-threshold condition (4) together with inequality (7) are fulfilled for some  $\beta \in \mathbb{F}(\text{OCE})$ .

Note first, if no worker is promoted, i.e.  $v^*(w) = 1$ , the outside wage  $w$  exceeds the initial wage, i.e.  $w > v_0$ , because the average productivity of the pool of workers still employed has increased after some worker were laid off. Formally,

$$v_0^f = \frac{\int_{v^*(w)}^{\infty} v_0 \{ (v_0) x v_0 \} R v_0}{\int_{v^*(w)}^{\infty} v_0 \{ (v_0) x v_0 \} R v_0} = v_0 \quad \text{for } \beta = 0.$$

$v^*(w) \in \mathbb{F}(\text{OCE})$  was proven in Lemma 2. Furthermore, Bayes' rule guarantees that the integral over  $\int_{v^*(w)}^{\infty} v^*(w) \{ (v^*(w)) x v^*(w) \} R v_0$  is not empty since the belief of workers who always produced lies above  $v_0$ .

Secondly, the profit generated from a worker with belief  $v^j(w_0) = 1$  is certain, implying that  $\tilde{z}(1 - \theta_0) = \frac{\tilde{z}}{1 - \tilde{z}} (v^j(w_0))$ . Thus, the promotion threshold condition (4) simplifies to

$$v^j(w_0) = \theta_0 [v^j(w_0)].$$

Since  $v^j(w_0) \in \mathbb{R}^+$ , this equality defines a staying probability  $\theta_0^F(0)$  for which a market for employed workers emerges as soon as the first workers are laid off, i.e.  $h = 0$ . The same holds for  $\theta_0^S > \theta_0^F$ .

For  $0 < \theta_0^F < \theta_0^S$  the market for employed workers can (but need not) emerge after enough badly performing workers were laid off such that the searching workers have, on average, a sufficiently high productivity to enable outside firms to offer wages above the initial wage despite the presence of adverse selection, i.e.  $v^j(w_0) > 1$ . Formally, the following can be true

$$\int_{v^j(w_0) \wedge (v_0)}^{z_1} v_h \{ (v_h) \} x v_h \mathbb{R} \quad \int_{v^j(w_0) \wedge (v_0)}^{z_1} v_0 \{ (v_0) \} x v_0 \quad \text{for } h \in \mathbb{R}^+.$$

This would imply an outside wage offer  $\tilde{w} \in \mathbb{R}^+$  such that the promotion-threshold condition (4) holds for some  $\theta_0^F(0)$ .

Since, according to Lemma 3, workers with belief  $v^j(w_0) > 1$  are not promoted and since not all of them find a job because of the existing search frictions, it follows that the market continues to work next period. Even more so because the average productivity of the employed workers improves further over time as more and more workers with bad performance are laid off.  $\square$

The intuition behind Theorem 1 is simply that large search frictions decrease the firm's willingness to promote, because it is harder for non-promoted workers to get an outside wage offer. Thus, less high-performance workers are promoted and start to search. The fact that more high-performance workers search increases the average productivity of the searching workers and enables outside firms to offer a market emerging wage.

The model can also explain an empirical finding by Farber (1994), namely that the hazard of job termination increases up to a maximum at 3 months of employment and declines thereafter. Initially, the hazard is zero, because the cost of recruitment  $u_Q$  implies that a firm will wait some time before laying off a worker. The hazard becomes positive as the first workers are laid off. After the first layoffs, the market for employed workers generally does not resume immediately, since it takes some time to ensure that enough badly performing workers are laid off such that the searching workers have on average a sufficiently high productivity to enable outside firms to offer wages above the worker's current wage. The point where the on-the-job market emerges coincides with the maximum of the hazard of job ending. Thereafter, the hazard declines, not because the probability  $(1 - \theta)$  of finding a job declines, but because the likelihood that an employed worker is of a bad type and hence is laid off declines. The later follows from the property of Bayes' rule, namely that a worker's belief converges asymptotically to its true value.

As mentioned above, the best-performing workers are promoted by their current employer in order to prevent them from searching or quitting. Thus, for high productivity workers the option to get an outside wage offer is enough to induce firms to increase their wage. Furthermore, since more and more badly performing workers are laid off over time, it follows that the productivity of the pool of employed workers and of the pool of searching workers increases over time. With an increase in the productivity of searching workers over time, the outside wage offer increases, too. The subsequent promotion of the best-performing workers then implies that wages increase with tenure.

**Corollary 1:** Wages weakly increase with age as long as workers are not laid off.

Besides the workers that are promoted, there are workers of "average" productivity whose wages increase if they change to another employer. The assumption of downward



wage rigidity ensures that workers experience wage cuts only after layoffs.

It is also worth mentioning that higher search frictions, i.e. a higher  $\theta$ , lead to a higher initial wage  $w_0$ . To see this, note that workers with an expected productivity  $Y$  ( $v^* (w_0)$ ) or below are not promoted. Since these workers remain with their employer with probability  $\theta$ , it follows that the value of employing such a worker increases if search frictions are higher. Thus, the expected continuation payoff  $\beta Y [O (v_0 O_0)]$  of a new market entrant increases with  $\theta$ . The zero profit condition implies that the initial wage increases by the same amount as the continuation payoff.

### 3 Extensions

Counteroffers instead of promotion

In the basic model described above, firms sit down with their workers after each production period and decide whether or not to promote the worker. The current employer decides on the promotion, taking into account that a searching worker receives an outside wage offer with probability  $1 - \theta$ . The model can also be rewritten such that firms react to workers claiming to have an outside wage offer. The timing of the game after each production period is then as follows:

1. A firm decides whether or not to lay off a worker. The firm cannot recall a worker.
2. Outside firms observe the labor market status of all workers and decide on the wage offers for those laid off and for those still employed.
3. Employed workers – with and without outside offers – decide whether or not to ask for a counter offer. And if they ask, they decide which wage to ask for.
4. The current employer decides on whether to make a counter offer or not.

5. Workers with an outside wage offer decide whether or not to leave the current employer.

If workers with an outside offer are distinguishable, then firms make counter offers only to those workers that have an outside offer. It follows that workers without an outside offer would be better off if they pretended to have one. Thus, the employed workers without an outside offer will mimic workers with outside offers and ask for a counter offer equivalent to the outside offer. Since the current employers cannot distinguish between workers with and without outside wage offers, they base their decision of whether to make a counter offer or not on the same trade off as a firm that decides ex-ante which workers to promote. Thus, the counter offer strategy is identical to the promotion strategy described in the basic model above. This implies the following corollary.

**Corollary 2:** "Average"-productivity workers never get a counter offer. If search frictions are large enough, then nobody gets a counter offer.

The way a current employer reacts to outside wage offers is crucial. If the current employer does not react to outside wage offers as assumed in the early on-the-job search literature (see Burdett 1978, Jovanovic 1984, Pissarides 1994, Burdett and Mortensen 1998), then all workers receiving higher wage offers from outside will quit. These high quit rates are inefficient and it is irrational of the current employer not to react to outside wage offers, except if outside wage offers are not verifiable and search frictions are so high that it pays not to promote at all.

#### Wage-tenure contracts

In order to reduce the inefficient high quit rate in Burdett and Mortensen (1998), Coles and Burdett (2003) allow firms to react to the excessive quitting behavior by posting flexible wage contracts. They show that firms will post wage contracts that

increase with tenure in order to minimize the number of quits. Firms do, however, not directly react to outside wage offers. Since all workers are homogenous it makes no difference whether the firm promotes workers not knowing if they have an outside offer or commits to a promotion strategy up-front by posting an increasing wage-tenure contract. However, if workers differ in their productivity, then committing ex-ante to an increasing wage-tenure contract cannot be efficient. The reason is that the current employer would like to renegotiate the contract downward with workers who performed badly instead of laying them off. Workers would also like to renegotiate the contract before becoming unemployed. This can be avoided by promoting on a case-by-case basis.

#### Piece-rate contracts

If workers are risk neutral, they could be paid the output they produce. If workers additionally pay an entry fee equivalent to the recruitment cost, firms would make zero profit. This would be nothing else than allowing wages to be negotiated downward. Subsequently, nobody would be laid off and no market for employed worker with wage gains would emerge.

If workers are risk averse, they might be offered a contract which combines a fixed payment with piece-rates instead of a fixed wage. The reason why risk-averse workers might prefer such a contract is that it provides a partial insurance against early layoffs. To see this, note that a performance-related contract ensures that a badly performing new market entrant is less costly to the firm than the same workers with a fixed wage contract, which pays the corresponding certainty equivalent. Thus, a worker with a performance-related contract expects to be laid off later in his working life.

Since there are only two possible outcomes per production period, i.e.  $\{0, 1\}$ , I can assume without loss of generality that the output-related contract that maximizes a

risk averse worker's utility is linear in output, i.e.  $w(v_s) = \tilde{Z}(v_s) + \bar{w}(v_s)$ . The optimal performance relation depends, of course, on the worker's belief about his expected productivity. If a worker knows as much about his type as his future employer, then the question of using performance-related contracts as a sorting device does not arise. The case that workers have a better signal about their type is discussed below.

The assumption that the fixed part  $\bar{w}(v_0)$  of the performance-related contract cannot be negotiated downward is still necessary in order to ensure that workers who performed badly are eventually laid off. Given that a worker is paid according to the initial contract  $w(v_0)$ , he is laid off if and only if

$$Y[(1 - \tilde{Z}(v_0)) + v_s] + \bar{w}(v_0) + \tilde{Z}(v_s - v_0) > P_0,$$

which resembles the layoff decision (5) in the basic model.

Workers will search for a new job if the certainty equivalent of the outside offer exceeds the certainty equivalent of the current wage. Thus, the outside offer need not be more expensive than the initial wage. It could just be that the contract is more appropriate for these workers, since they know now more about their type. It could also be that the outside market is able to sort employed workers with more type-specific contracts and is thus able to counteract the adverse selection caused by the promotion strategy of the current employer. This implies that a market with performance-related contracts might even emerge sooner than one with fixed-wage contracts, although workers are laid off later.

Workers have a better signal about their type

In the basic model, I assumed that new market entrants have the same information about their type than the market in whole. This simplification allowed me to focus solely on the asymmetric information between the current employer and the market and to abstract from any screening firms might engage in. With risk-averse workers

who have a better signal about their type than firms have, screening can work via two channels. The first channel is via performance-related wage contracts where high type workers can be separated from low type workers by offering contracts that are highly performance-related. The second channel uses the risk associated with being fired. Higher earnings – whether in form of a fixed wage or in form of a performance-related contract – make it more likely to be laid off in the future, implying that risk averse workers who believe that they are less productive prefer lower earnings.

If the new market entrants cannot be separated, then the resulting pooling equilibrium of the evolutionary game will maximize the utility of the highest productivity type workers in order to ensure that they stay in this market. For the first employer the analysis is then generally the same as in the basic model above, with one exception. The second employer might be able to separate the searching workers. If outside wage offers are, therefore, different for different types, then the promotion decision the current employer faces is more complicated. Given the firm's own belief about its worker's productivity it has to form expectations about where, i.e. in which of the different markets the worker will search in, if he does not get promoted. The current firm can only be sure not to lose a worker if it offers him a contract equivalent to the highest outside offer. The promotion decision has to trade off all possible outside offers and the probability  $\rho_f$  that the worker is searching in a market that offers a contract worth the same or more than  $w^0(v_S)$ . The current firm chooses the promotion contract  $w^\dagger(v_S)$  such that,

$$w^\dagger(v_S) = \arg \max_{w \in [H, F]} \rho_f \left[ Y(v_S | w) \cdot w + \sum_{j=1}^J \rho_j \left[ Y(v_S | w) \cdot w^j + \sum_{k=1}^K \rho_k \left[ Y(v_S | w) \cdot w^k \right] \right] \right]$$

The worker is not searching at all if he is promoted and paid the highest outside offer  $\bar{w}(v_S)$ . And he is searching with certainty if he is not promoted and paid according to his last period contract  $w(v_{SD1})$ . If he is offered a contract worth between  $w(v_{SD1})$  and  $\bar{w}(v_S)$  he will search with probability  $\gamma_f$  and get an outside offer with probability  $\gamma_o$ . As in the basic model, for large enough search frictions an on-the-job market with wage gains emerges. If the new market entrants can be separated, then the resulting separating equilibria can be treated as single pooling equilibria.

As mentioned above, self-selection can be induced by using a high layoff probability implied by a high wage to deter low type workers from applying. Thus, the self-selection constraint can be a sufficient condition for firms not to adjust their wage downward, a point already mentioned by Weiss (1991, p. 2) where he writes: "If lowering the wage they [firms] offer significantly lowers the average ability of the job applicants they face, firms may find that lowering their wage makes them worse off."

## 4 Conclusion

This paper focuses on the asymmetric information that exists between the current employer and the outside market regarding a worker's productivity. In a competitive market with downward wage rigidity, adverse selection induced by the promotion or counter-offer strategy of the current employer would imply a breakdown of the on-the-job market. The literature so far assumed this problem away by introducing an exogenous reason to quit, which implies that outside wage offers are lower than the wage at the current employer. The empirical observation, however, is that many workers gain by moving to another employer.

The explanation for wage gains given in this paper is that tenure serves as a positive signal about a worker's productivity, since workers who are believed to be less productive are laid off over time. The assumption that enables the emergence of a market

for employed workers is that outside wage offers are uncertain and not observed by a worker's current employer. This implies that the firm will promote or make counter offers only to its best-performing workers but not to workers with average productivity, given the probability that a worker will not get an outside offer is large enough.

Furthermore, I provide conditions under which it is optimal for the current employer to make a counter offer. This is important because the early on-the-job search models assume that the current employer does not react to outside wage offers. Thus, workers receiving higher outside wage offers climb up the wage ladder. Or they assume the opposite, namely that the current employer observes and reacts to an outside wage offer by making a counter offer. While these models assume how the current employer reacts to an outside offer, I explicitly model it by taking adverse selection into account. Although it is quite obvious that making a counter offer to all employees is optimal if outside wage offers are observable, it turns out that if outside wage offers are not observable, it is optimal that average-productivity workers are never given a counter offer. Furthermore, if search frictions are large enough, then it is optimal to ignore any outside wage offer.

The model can also explain that the hazard of job ending is increasing up to a maximum at 3 months and declines thereafter. Initially, the hazard is zero, because the cost of recruitment implies that a firm will wait some time before laying off a worker. The hazard becomes positive as the first workers are laid off. The point where the on-the-job market emerges coincides with the maximum of the hazard of job ending. Thereafter, the hazard declines because the likelihood that an employed worker is of bad type and hence is laid off declines.

The results derived are very general and hold for performance-related contracts as well as in an environment where a worker has a better signal about his type than his current employer has.

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