Problems with seniority based pay and possible solutions

Difficulties that arise and how to incentivize firm and worker towards the right incentives

Master's Thesis
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Abstract:

Seniority based pay is a wage scheme where the wage of a worker is increasing over time. This wage scheme can bring many advantages for both the worker and the firm, but it may also create some problems. In this paper, I will elaborate on three main problems. The first problem is a screening problem, where the firm does not know true ability of the worker and therefore has the chance to hire a low ability worker or to dismiss a high ability worker. The second problem is a moral hazard problem: the worker does not want to exert effort. The last problem is the problem that will arise if the firm finds it more beneficial ex post to invest in technology, which makes the worker reluctant for the firm. I will explain the problems using principal-agent models and will provide possible solutions to these problems.

Preface:

I would like to thank my supervisor, Josse Delfgaauw, for the time and effort he has exerted in guiding me during the whole process of writing this thesis. Already in my first year as a student, he enthused me in the field of economics that he is working in: general economics and human resource management. I have always liked the micro-economic courses during my Bachelor. This was the main reason I preferred to join the Master that specializes in this area of economics and why I preferred to write my Master's Thesis about the interaction between a firm and its employees. Also during writing my Thesis I have learned a lot from my supervisor, of which I am very thankful. He always took the time to give me advice and to come with new insights in the models I use and the solutions I provide.

1: Introduction:

Job switching is more common in recent years. While people worked for the same company for a long period in the past, or just had a single career, it is more common these days to switch jobs after having worked for an employer for several years. Especially at younger age, people tend to switch employers more often. A paper from Topel and Ward (1992) shows that during the first ten years of their career, a worker will hold on average seven jobs. This is two thirds of his career.

For an employee, job switching could be beneficial. Employers, on the other hand, could prefer to hire employees who intend to work for their firm for a long period. Therefore, they would like to incentivize employees to stay at the firm. Offering a wage that increases with seniority is an example of a tool that must help firms to keep employees for a longer period. This *seniority based pay* is a common practice (see Bayo-Moriones et al., 2004). The firm offers a starting wage that is below marginal productivity, but this wage will increase over time to a level that is *above* marginal productivity. The total wage in the long run is on average at least as high as total productivity. The longer the employee stays at the current firm, the higher his wage will become.

This wage scheme has several advantages for the employer. It prevents the employee from switching jobs towards another firm (Mincer and Jovanovic, 1981). His wage is increasing over time, so the longer the employee works for the firm, the higher the difference will become between his wage and the outside option. This makes it less interesting to switch jobs. Furthermore it prevents the firm from hiring a shirking employee (Malcomson, 1984), since this employee knows that shirking leads to being dismissed, which leads to a low wage at the new employer. If the employee will be dismissed after a while, his will not receive the high wages of the future periods. Therefore the increasing wage makes it less interesting to shirk. For more advantages of this wage scheme, I would refer to the next section.

But seniority based pay also has disadvantages and creates some problems, which are often not taken into account. In this paper, I will state several problems of seniority based pay and I will come up with solutions. The problems of which I will go into depth are the screening problem, the moral hazard problem and the problem that comes up if it would be interesting for the firm ex post to invest in physical capital.

The screening problem is a problem that arises if the firm does not know true ability of the worker. Ex ante, the agent receives an imperfect signal about his ability. During the first period the worker will learn true ability, while the firm will not. The firm will only receive a private imperfect signal about true ability of the agent after the first period and has to decide whether or not to continue

with the agent in the second period. It is possible that the firm keeps workers who know they are not suited for the job (because they have low ability), but who are allowed to stay and earn the high wage since the firm has received a wrong signal. This will be a problem since the worker receives a high second-period wage but will not be productive enough to be beneficial for the firm.

The moral hazard problem is the problem that the worker does not have any incentives to work hard in the last period. The firm and the worker have contracted that the worker will work for the firm and will receive a wage accordingly, which is increasing over time. If it turns out that the worker did not work in that period, the firm has the possibility to dismiss the worker. This has to incentivize the worker towards exerting a high effort level. In the last period, however, the threat of being dismissed will not be present, since the collaboration will finish anyway. Therefore, the worker has the incentive not to work in the last period. The firm has to pay the worker the high wage, which makes this problem a costly problem for the firm.

The moral hazard problem is a well-known problem in academic literature, but the problem is bigger when having seniority based pay. The wage is at highest in the last period, which makes it even more interesting for the worker to shirk and makes it even more costly for the firm if the worker shirks.

The last problem I will explore is an investment opportunity problem. After contracting, the firm has the opportunity to invest in physical capital that will be much more efficient than the employee. The physical capital substitutes the human capital of the employee, which makes him obsolete. Investing in the physical capital would be beneficial for the firm, but the opportunity costs (high wage, while not receiving high revenues) would be a waste.

In this paper, I will illustrate these problems and I will provide possible solutions. I will work out my solutions in principal-agent models to show that both the employer (principal) and the employee (agent) have the right incentives after implementation of the solution. I will be focusing on *firm-specific human capital* variants of the screening and the moral hazard model. These models differ from the 'normal' models in that the presence of the agent in the first period increases productivity in the second period, because of an increase in the firm-specific knowledge of the employee over time.

In the end, I will compare the advantages with the disadvantages of seniority based pay to make a statement when seniority based pay will be the best wage scheme for both employer and employee.

The rest of this paper is organized as follows: section 2 provides an overview of the related literature. In section 3 I will explain seniority based pay clearly one more time. In section 4 I will show a screening problem of seniority based pay and I will provide possible solutions. Section 5 discusses a

moral hazard problem plus solutions. In section 6 I will show a problem that is related to the length of the contract. Section 7 states my conclusion, followed by a discussion for further research in section 8.

2: Related literature:

Firms benefit from keeping employees for a longer period. If firm-specific knowledge increases in tenure, workers become more valuable for their current employer over time (see Chan, 1996). The theory of this firm-specific human capital explains why seniority based pay is here an attractive wage scheme. The longer an employee works at the same firm, the more his firm-specific knowledge accumulates (Altonji and Shakotko, 1987; Topel, 1991), the higher the value of the employee to the firm. This creates quasi rents, which can be shared between firm and employee (Levine, 1993).

Many papers have shown the advantages of seniority based pay. Besides preventing employees to shirk or to quit and the above stated argument, it is a good *screening* and *selection* device for the firm.

Salop and Salop (1976) exploit the argument of being a good *selection* device. By offering a low starting wage, it will be cheap and therefore not very risky to employ a new employee. The firm then has the time to observe the employee and to learn about his true ability. The low wage can be seen as a reward for the mixed ability of the new employees (see Malcomson, 1984). After having observed all workers, the firm can offer those with the highest ability a long term contract with a rising wage scheme.

Besides functioning as a selection device for the firm, it also functions as a selection device for the *employee*. Only those employees who have the intention to stay for a long period at the firm, and therefore are unlikely to quit soon, will choose jobs where wage increases with seniority (Mincer and Jovanovic, 1981). Those who would like to switch jobs after several years would prefer a short-term wage contract.

When output is easy to observe, pay-for-performance will always be the best type of wage scheme. The more productive the worker will be, the higher his wage. Output is easy to observe, so productivity will be verifiable. However, often it is not easy to observe output. When output is hard to observe, wage schemes related to output are not optimal, since the measurement error will be high. Firms will then use more implicit incentives to motivate their employees. Therefore, seniority based pay could, under these circumstances, be a better wage scheme than, for example, piece rate

pay (Bayo-Moriones et al., 2004). By motivating the employee through this wage scheme, the firm could invest less in monitoring.

As a last argument, this wage scheme has the advantage to attract risk-averse workers (see Harris and Holmstrom, 1982; Bayo-Moriones et al., 2004; Rudanko, 2009). If a worker is not certain about his own ability and therefore about his productivity, he prefers seniority based pay over piece-rate pay, since piece-rate pay varies with actual output, while seniority based pay does not. For the firm, seniority based pay could then be a better wage scheme, provided that a risk-averse pool of workers is not problematic. It removes some of the income risk faced by the employee, while the employee removes the risk at the side of the employer: the employer will be more certain that the employee will not leave the firm at an earlier stage.

For the employee, this also has another advantage: the chance of being promoted will be higher when staying at the firm for a longer period. Again, the reason is the accumulation of firm-specific human capital. Especially at higher levels, having more experience with all the processes of the firm is an important feature for getting the promotion (Lazear and Oyer, 2004*b*). Chan (2006) has shown that internal employees are in favor over external recruits for getting the job at the higher level; and the higher the level, the stronger this effect. This matches the results of Lazear and Oyer (2004*a*). Empirical research of Denis and Denis (1995) has shown that only 15-20% of top positions are filled with external recruits.

Internal labor markets are very important for firms. They decrease competition with other employers for attracting the best recruits, since competition will only be present at the bottom of the pyramid (Baker et al., 1994). Only at this stage it is important to attract as many potential employees as possible. Once attracted, firms can keep the best recruits and offer them a long-term contract. They can educate or train them without being afraid that other firms will take away the employee after several years. The same goes in the opposite direction. A firm does not have to attract high ability employees from other firms by offering high wages when it has its own high ability employees (Lazear and Oyer, 2004*a* and 2004*b*).

Therefore other authors claim that wage schemes start with a high wage. Only in this way it is possible to attract sufficient potential employees (Greenwald, 1986; Rudanko, 2009). The higher the starting wage, the more recruits will be attracted. This reduces search costs. Once they are attracted, the firm can select the best employees and offer them a contract. The corresponding wage can go down, since the firm does not have to attract new employees anymore. However, evidence has shown that workers prefer a rising wage profile rather than a flat or a decreasing profile and

therefore accept a lower starting wage (see Loewenstein and Sicherman, 1991; Frank and Hutchens, 1993).

So far, I have described the advantages of seniority based pay for both employer and employee and I have shown that this wage scheme has several advantages for both employers and employees. But is this wage scheme also preferable for the employer? In the next sections, I will state several drawbacks, of which most are especially negative for the employer, and I will provide solutions to these problems. In the section after that, I will answer the question whether seniority based pay will also be the best for the employer.

3: The situation:

The problems I will state in this paper will all come up *during* the period of the contract between firm and employee, which starts right after the contract between these two parties has been signed and ends at the end of the last period stated in that contract. Before stating the problems, let me first describe the situation itself once more.

Seniority based pay is the wage scheme in which the employee first gets a wage that will be lower than his value of marginal product. Over time, the wage will increase up to a level that is above his value of marginal product. The employee must prefer this wage scheme over others, so the total wage over the whole period will be at least as high as when he gets paid a flat or decreasing wage scheme.

This wage scheme has several problems, of which I will go into depth in this paper. If the solutions I provide make use of a model, I will work with a two-period principal-agent model. This could either be a screening model or a moral hazard model. As I have stated before, I will make use of the *firm-specific human capital* variant of the screening and the moral hazard model. In these variants, the presence of the agent in the first period increases ability (screening) or productivity (moral hazard) in the second period, because of an increase in the firm-specific knowledge of the employee over time. This means that the difference between the 'inside' and the outside option increases over time for both the employer and the employee.

The two most well known problems that could arise with seniority based pay are that the employee does not have the required level of *ability* or he does not exert enough *effort* to produce enough output. In the next section I will elaborate the screening problem. The moral hazard problem will be explained in section 5.

4: The screening problem and possible solutions:

The screening problem:

The screening problem is the problem that the worker may not have the required level of ability. Seniority based pay works as a screening device. In the first period, the worker will receive a low wage and the firm learns about the ability of the worker. In the second period, the firm will only continue with the high ability workers. In theory, only high ability workers are attracted by this wage scheme. High ability workers do not mind starting with a low wage, because they know their ability and therefore know that they will receive a high wage in the second period. Low ability workers, on the other hand, know that they will be dismissed after the first period and therefore are less willing to work for the firm in the first place.

There will however be a problem for the firm if he is not perfectly able to determine the ability of the worker after the first period. The firm is not able to say with certainty whether the agent will be of high or low ability. But he has to decide: will I continue with the worker and offer him a high wage, or will I dismiss the worker? In the first case, the firm continues with a worker that could be of low ability. The firm has to pay a high wage, without receiving high revenues. Here we see a first problem with having seniority based pay:

Problem: the firm may contract a worker with an ability that is assessed to be high ex ante, but may turn out to be low afterwards. Therefore, the worker's productivity does not outweigh the higher wage costs over time.

It could also be possible that the firm dismisses a high ability worker. I will come back to this problem later on. I will first explore the problem which is stated above.

The problem here is that after contracting, the employee could turn out to be of low ability. The firm learns the true ability of the employee too late to be able to change the contract or to stop the cooperation without making any costs. Therefore, there still is an information advantage for the employee with regard to the firm. The employee does not have enough ability to produce the required amount of output that makes the cooperation profitable (or at least not unprofitable) for the firm, but the firm cannot take actions.

Let me introduce a model to make this situation clearer and to be able to search for the best solution.

The screening model:

This is a two-period principal-agent model, with a principal (the firm) and an agent (the worker). The agent receives a seniority-based wage, which means that he gets a low wage (w_L) in the first period and a high wage (w_H) in the second period. This wage is independent of other variables. The cost of working for the agent are dependent on his ability level $a \in \{a_L, a_H\}$ with $a_H > a_L$, which is unknown to both the agent and the principal. The costs of working are $(1-a)$, which means that working is more costly for the low ability agent than for the high ability agent.

The utility function for the agent is therefore:

$U_A = w_L - (1-a) + w_H - (1-a)$.

However, the agent does not know his ability level at the start of period 1 (which I will call t_0). The prior probability of having a high ability level (a_H) is 0.5. At t_0 the agent receives a signal $s \in \{s_L, s_H\}$ about his ability. This signal could state that $a = a_H$ (signal s_H) or $a = a_L$ (signal s_L). This signal is correct with probability $p > 0.5$. During period 1, the agent learns his true ability level.

The principal receives revenues from the working agent, which are increasing with the ability level of the agent. For the principal it is also unknown whether the agent will be of high or low ability. The firm only knows the prior distribution of ability before contracting. By setting the right wage scheme, the firm wants to hire only the workers who received a signal s_H, without knowing true ability. After the first period (which I will call t_1) the firm receives a private signal $S \in \{S_L, S_H\}$ which reports the true ability level of the agent, with probability $q > 0.5$ that the signal is correct. The signal of the principal is independently drawn from the signal of the agent.

The agent acquires firm-specific human capital during the first period. This will have no consequences for the first period, but it will raise his ability level and therefore his productivity level with factor γ in the second period.

The principal will get the following utility from a worker with a given level of ability, who works in both periods:

$U_P = R(a) - w_L + R(a+\gamma) - w_H$.

If the principal does not have a worker in a period, this will result in having revenue of zero.

The timing of the model is as follows:

- At t_0 the agent receives a signal $s \in \{s_L, s_H\}$ about his ability level. The firm sets wage levels w_L and w_H;
- Then period 1 starts (t_0-t_1) in which the agent could work for the firm, collects firm-specific human capital and learns his true ability. If the agent will choose not to work for the firm, he receives utility of his outside option U_A^{out};
- At the end of period 1, t_1, the principal pays wage w_L to the agent. The principal receives a signal $S \in \{S_L, S_H\}$ about the ability level of the agent. The principal decides whether to keep the worker, based on his signal;
- Period 2 starts (t_1-t_2). The agent will work again, but with a higher productivity than in period 1, because of its firm-specific knowledge;
- At the end of period 2 (t_2), the principal receives revenues of both periods $R(a) + R_2(a+\gamma)$, pays wage w_H to the agent and the contract ends.

We are interested in the case where the firm only wants to continue with the workers of whom he has received signal S_H and would dismiss a worker after having received signal S_L. If the principal will dismiss the worker after period 1, the agent will receive a severance pay. Besides this severance pay, utility for the agent in the second period will be zero.

The following conditions must hold at the side of the principal if he prefers this separating equilibrium:

1. The principal must be willing to hire the agent who received signal s_H;
2. The principal must not be willing to hire the agent who received signal s_L;
3. The principal must prefer at t_1 to continue with the agent after the principal has received signal S_H and not to continue with that agent after having received signal S_L.

The conditions at the side of the agent are:

1. The agent must prefer to work for the firm after having received signal s_H;
2. The agent must not prefer to work for the firm after having received signal s_L;
3. High ability workers must also prefer to work in the second period.

I will use backward induction for solving the model. Therefore, I will first look at the third condition of the principal. Note: the utility function of the principal is: $U_P = R(a) - w_L + R(a+\gamma) - w_H$, with the first two terms referring to the first period.

After the first period, at t_1, the firm receives a signal $S \in \{S_L, S_H\}$ about the ability of the agent. This signal is correct with probability q. The agent received a signal $s \in \{s_L, s_H\}$ which was correct with probability p. The principal will only hire the agents who have received signal s_H.

The expected utility of the principal in the second period after having received signal S_H will be (see appendix):

$$EU_{P,\,t2}\,(s = s_H, S = S_H) = P(a{=}a_H \mid s_H, S_H)\cdot[R(a_H) + R(\gamma) - w_H] + P(a{=}a_L \mid s_H, S_H)\cdot[R(a_L) + R(\gamma) - w_H]$$

$$= \frac{pq}{pq+(1-p)(1-q)}\,R(a_H) + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,R(a_L) + R(\gamma) - w_H$$

We can do the same for the case in which the firm has received signal S_L:

$$EU_{P,\,t2}\,(s = s_H, S = S_L) = P(a{=}a_H \mid s_H, S_L)\cdot[R(a_H) + R(\gamma) - w_H] + P(a{=}a_L \mid s_H, S_L)\cdot[R(a_L) + R(\gamma) - w_H]$$

$$= \frac{p(1-q)}{P(1-q)+(1-p)q}\,R(a_H) + \frac{(1-p)q}{P(1-q)+(1-p)q}\,R(a_L) + R(\gamma) - w_H$$

We can now work out the third condition that must hold on the side of the principal, which is stated above: the principal must prefer to continue with the agent after having received signal S_H and not after having received signal S_L. If the principal dismisses an agent after having received this signal, he will pay the agent a severance pay (*SP*):

$$EU_{P,\,t2}\,(s = s_H, S = S_H) = \frac{pq}{pq+(1-p)(1-q)}\,R(a_H) + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,R(a_L) + R(\gamma) - w_H \quad \geq -SP$$

and

$$EU_{P,\,t2}\,(s = s_H, S = S_L) = \frac{p(1-q)}{P(1-q)+(1-p)q}\cdot R(a_H) + \frac{(1-p)q}{P(1-q)+(1-p)q}\cdot R(a_L) + R(\gamma) - w_H \quad \leq -SP.$$

For the optimal level of w_H, this results in:

$$\frac{p(1-q)}{P(1-q)+(1-p)q}\cdot R(a_H) + \frac{(1-p)q}{P(1-q)+(1-p)q}\cdot R(a_L) + R(\gamma) + SP \leq w_H \leq \frac{pq}{pq+(1-p)(1-q)}\,R(a_H) + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,R(a_L) + R(\gamma) + SP$$

This is feasible when $\frac{pq}{pq+(1-p)(1-q)}\,R(a_H) - \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,R(a_L) \geq \frac{p(1-q)}{P(1-q)+(1-p)q}\cdot R(a_H) + \frac{(1-p)q}{P(1-q)+(1-p)q}\cdot R(a_L)$, so if

$$\left\{\frac{pq}{pq+(1-p)(1-q)} - \frac{p(1-q)}{P(1-q)+(1-p)q}\right\}\cdot R(a_H) \quad \geq \quad \left\{\frac{pq}{pq+(1-p)(1-q)} - \frac{p(1-q)}{P(1-q)+(1-p)q}\right\}\cdot R(a_L)$$

$R(a_H) > R(a_L)$, which means that $\frac{pq}{pq+(1-p)(1-q)}$ must be larger than $\frac{p(1-q)}{P(1-q)+(1-p)q}$ for the principal to be willing to continue with the agent only after having received signal S_H. As $pq > p(1-q)$ and $pq + (1-p)(1-q) \leq p(1-q) + (1-p)q$, this always holds. Hence, there are levels of w_H for which the principal prefers to separate the agents.

Now we know the expected utilities of the second period, we can provide the formula for the first two conditions: the principal must prefer to only hire the agent who received signal s_H.

We will create a separating equilibrium in which only the agents who received signal s_H will apply. With probability p, this signal is correct. Then the expected utility of the principal in the first period from an agent who received signal s_H is:

$EU_{P,\,t1}\,(s = s_H) = p \cdot R(a_H) + (1-p) \cdot R(a_L) - w_L$

Therefore, his total expected utility, the sum of the expected utility of both periods, from hiring the agent with signal s_H must be positive (since the outside option for the firm at t_0 is not hiring the agent and, hence, receiving no income):

$EU_P\,(s{=}s_H) = EU_{P,\,t1}\,(s{=}s_H) + P(S_H|s_H) \cdot EU_{P,\,t2}\,(s = s_H, S = S_H, a{=}a_H) + P(S_H|s_H) \cdot EU_{P,\,t2}\,(s = s_H, S = S_H, a{=}a_L) + P(S_L|s_H) \cdot (-SP) \quad \geq 0$

$P(S_H|s_H)$ is the probability that the principal receives a signal S_H, given that the agent has received signal s_H. There are two options. The agent received either a correct signal (which happens with probability p) or an incorrect signal (probability $1-p$). In the first case, the probability that the principal receives signal S_H is q, while in the second case it is $1-q$. Therefore, $P(S_H|s_H) = pq + (1-p)(1-q)$. With the same reasoning, we will find that $P(S_L|s_H) = p(1-q) + (1-p)q$, $P(S_L|s_L) = pq + (1-p)(1-q)$ and $P(S_H|s_L) = p(1-q) + (1-p)q$. Note that $P(S_H|s_H) + P(S_L|s_H) = P(S_H|s_L) + P(S_L|s_L) = 1$.

This results in the following (see appendix):

$p(1+q)R(a_H) + (1-p)(2-q)R(a_L) - w_L + [pq + (1-p)(1-q)] \cdot \{ R(\gamma) - w_H \} + [p(1-q) + (1-p)q] \cdot (-SP) \geq 0.$

This gives $w_H \leq \frac{p(1+q)R(aH) + (1-p)(2-q)R\,(aL) - wL - [p(1-q) + (1-p)q] \cdot SP}{pq+(1-p)(1-q)} + R(\gamma)$

As a third and last point, we have to state the requirements that must hold for the second condition: the principal must not be willing to hire an agent that has received signal s_L. This means that for the principal, the outside option (not hiring the agent) must be more interesting than hiring the agent. The formula of the expected utility of the principal from this type of agent will be almost the same as that of the agent that has received signal s_H. We will get the following:

$EU_P(s{=}s_L) = EU_{P,t1}(s{=}s_L) + P(S_H|s_L)\cdot EU_{P,t2}(a{=}a_H|\ s = s_L, S = S_H) + P(S_H|s_L)\cdot EU_{P,t2}(a{=}a_L|\ s = s_L, S = S_H) + P(S_L|s_L)\cdot(-SP) \leq 0$

which is true if:

$$w_H \geq \frac{(1-p)(1+q)R(aH) + p(2-q)R(aL) - wL - [pq+(1-p)(1-q)]SP}{p(1-q)+(1-p)q} + R(\gamma)$$

We can add both wage conditions together to find the optimal wage for the second period:

$$\frac{(1-p)(1+q)R(aH) + p(2-q)R(aL) - wL - [pq+(1-p)(1-q)]SP}{p(1-q)+(1-p)q} + R(\gamma) \leq w_H \leq \frac{p(1+q)R(aH) + (1-p)(2-q)R(aL) - wL - [p(1-q)+(1-p)q]\cdot SP}{pq+(1-p)(1-q)} + R(\gamma)$$

This holds when SP is small, as it always holds when $SP = 0$ as $(1-p)((1+q)R(a_H) + p(2-q)R(a_L) < p(1+q)R(a_H) + (1-p)(2-q)R(a_L)$ and $pq + (1-p)(1-q) \leq p(1-q) + (1-p)q$. Then the principal prefers to have the separating equilibrium in which he only wants to hire those agents who have received a high signal in the first period and of which the principal himself has received a high signal at the end of this period.

We see that there are several factors that influence the optimal wage level for the second period. At first, it depends on the level of revenues from a low and a high ability worker. Secondly, it depends on the extra revenues of firm-specific human capital. Thirdly, it depends on the wage in the first period. A fourth factor is the height of the severance pay for those agents of whom the principal has received signal S_L. Lastly, it depends on the probabilities that the received signals of the principal and the agent were correct.

Now we have looked at the conditions on the side of the principal, we can continue with the conditions on the side of the agent.

Only the agents that received a high signal must be attracted. So agents with signal s_H must prefer the contract of the firm, while agents who have received signal s_L must prefer the outside option.

The utility function in the first period of the agent that has received signal s_H is:

$U_{A,t1} = w_L - (1-a)$,

with a as the unknown factor. $a = a_H$ with probability p and a_L with probability $(1-p)$. Therefore, the expected utility for this agent is:

$EU_{A,t1}(s = s_H) = w_L - [p(1-a_H) + (1-p)(1-a_L)]$

The next step is to look at the expected utility for the agent in period 2. Only after the principal has received signal S_H the agent will work for the firm in the second period. If the principal has received signal S_L, the agent will be dismissed and will receive the severance pay. Since the agent knows his own ability in the second period, he is sure about his cost of working (1-a). As we have stated before, the utility of the agent in the second period is $U_{A,t2}$ ($s = s_H$) = w_H – (1-a). He knows a and he knows that he only receives this utility if the principal has received signal S_H. Therefore, we will get the following expected utility for the agent in the second period:

$$EU_{A,t2}(s = s_H) = P(S_H|s_H)\cdot P(a=a_H|s=s_H, S = S_H)\cdot EU_{A,t2}(a=a_H|\ s = s_H, S = S_H) + P(S_H|s_H)\cdot P(a=a_L|s=s_H, S = S_H)\cdot EU_{A,t2}(a=a_L|\ s = s_H, S = S_H) + P(S_L|s_H)\cdot(SP)$$

$P(S_H|s_H) = pq + (1-p)(1-q)$ is the probability that the principal has received signal S_H, given that the agent has received a signal with the same message. We can simplify this outcome to the following (see appendix for calculations):

$$EU_{A,t2}(s = s_H) = pq\cdot[w_H - (1-a_H)] + (1-p)(1-q)\cdot[w_H - (1-a_L)] + [p(1-q) + (1-p)q]\cdot SP$$

We can now add the expected utilities for this agent of both periods together. The outcome, the total expected utility, must be higher than the outside option for the agent to be willing to apply:

$$EU_A(s = s_H) = EU_{A,t1}(s = s_H) + EU_{A,t2}(s = s_H) \geq U_A^{out}$$

$$w_L - [p(1-a_H) + (1-p)(1-a_L)] + P(S_H|s_H)\cdot P(a=a_H|s=s_H, S = S_H)\cdot EU_{A,t2}(a=a_H|\ s = s_H, S = S_H) + P(S_H|s_H)\cdot P(a=a_L|s=s_H, S = S_H)\cdot EU_{A,t2}(a=a_L|\ s = s_H, S = S_H) + P(S_L|s_H)\cdot(SP) \geq U_A^{out}$$

The wage in the second period must then be:

$$w_H \geq \frac{Ua,out - wL + p(1+q)(1-aH) + (1-p)(2-q)(1-aL) - [p(1-q) + (1-p)q]SP}{pq + (1-p)(1-q)}$$

We can do the same calculations for the agent that has received a signal $s = s_L$. Here, the agent must prefer his outside option over his expected utility at this firm. See the appendix for the calculation. The total expected utility for this agent will then be:

$$EU_{A,t1}(s = s_L) + P(S_H|s_L)\cdot P(a=a_H|s=s_L, S = S_H)\cdot EU_{A,t2}(a=a_H|\ s = s_L, S = S_H) + P(S_H|s_H)\cdot P(a=a_L|s=s_L, S = S_H)\cdot EU_{A,t2}(a=a_L|\ s = s_L, S = S_H) + P(S_L|s_L)\cdot(SP) \leq U_A^{out}$$

which is true if:

$$w_H \leq \frac{Ua,out - wL + (1-p)(1+q)(1-aH) + p(2-q)(1-aL) - [pq + (1-p)(1-q)SP}{p(1-q) + (1-p)q}$$

If this condition holds, only the agents who received a high signal prefer to apply at the firm and to work in both periods.

As we can see, the condition depends on several factors. At first, it depends on the cost of effort of a low and a high ability worker. Secondly, it depends on the level of the low wage in the first period. Thirdly, it depends on the outside option. At fourth, it depends on the amount of the severance pay. And lastly, whether or not there will be a separating equilibrium depends on both the probability of the principal as well as on the probability of the agent that the received signal will be correct.

Summarizing: if we want to have a separating equilibrium in which only those agents apply who have received signal s_H and where the principal only wants to continue working with the agents after having received signal S_H, the following conditions must hold:

$$\frac{(1-p)(1+q)R(aH)+p(2-q)R(aL)-wL-[pq+(1-p)(1-q)]SP}{p(1-q)+(1-p)q}+R(\gamma) \quad \leq \quad w_H \quad \leq \quad \frac{p(1+q)R(aH)+(1-p)(2-q)R(aL)-wL-[p(1-q)+(1-p)q]\cdot SP}{pq+(1-p)(1-q)}+R(\gamma)$$

and

$$\frac{Ua,out-wL+p(1+q)(1-aH)+(1-p)(2-q)(1-aL)-[p(1-q)+(1-p)q]SP}{pq+(1-p)(1-q)} \leq$$

$$w_H \quad \leq \quad \frac{Ua,out-wL+(1-p)(1+q)(1-aH)+p(2-q)(1-aL)-[pq+(1-p)(1-q)SP}{p(1-q)+(1-p)q}$$

As can be seen, there are four requirements that must hold for w_H. It is hard to state whether all conditions will be fulfilled, since there are a lot of factors (probabilities p and q, revenues $R(a_H)$ and $R(a_L)$ and severance pay SP) which are unknown. Mathematically, it is hard to find a value, or a range of values, for w_H that will fulfill all conditions. In the rest of this paper, I assume that there is at least one value of w_H where all conditions will be fulfilled.

The screening model has now been introduced, including the requirements that must hold on both the side of the principal and the agent to be willing to participate and create a separating equilibrium. The separating equilibrium is such that an agent must prefer to work for the firm only after having received signal s_H. The firm will only continue with the agent after having received signal S_H.

Elaboration of the screening problem:

I will continue elaborating about the problem of this model. As I have stated in the introduction of this section, the problem with screening is that there is no certainty for the principal about the true ability of the agent. The principal receives a signal S_H about the ability of the agent, but this signal could be incorrect. It is only correct with probability q. Therefore, there is a chance that a low ability worker will work in the second period. He will receive a high wage, but the principal will not receive

high revenues from this worker. The principal knows this and will take this into account when calculating his expected revenues for the second period. The principal knows that there is a chance that he will hire a low ability agent. But by assumption, he prefers to only have high ability agents working at his firm.

The principal will not learn about the true ability of the agent before the end of the second period, but the agent will! The agent will learn his true ability after the first period. Although he knows that he will not produce high revenues, he prefers working at the firm over his outside option since he receives a high wage. This is not preferred by the principal. The principal would therefore be willing to pay for the information the agent has about his ability, if the benefits of getting this information will outweigh the costs. He can then try to separate both types of workers by inducing the high ability workers to stay and the low ability workers to leave the firm.

Possible solution: voluntary severance pay:

A solution here could be to introduce a *voluntary severance pay*. After the principal has received his signal at the end of the first period and has decided to continue only with those workers of whom he received signal S_H, he could offer this group of workers a voluntary severance pay. *This voluntary severance pay will only be offered to the group of workers of which the principal has received signal S_H. The group of workers of which the principal has received signal S_L and therefore will be dismissed does not receive this voluntary severance pay, but will receive the 'normal' severance pay (SP).*

The workers can then decide to accept the voluntary severance pay and leave the firm, or to continue working at the firm in the second period. Since the low ability workers have a higher cost of working ($1-a_L$) than the high ability workers ($1-a_H$, with $a_H > a_L$), there is a difference in utility for both types of workers in the second period. If the severance pay will be higher than the utility of the low ability worker but lower than the utility of the high ability worker, this will create a separating equilibrium in which the high ability workers prefer to stay at the firm, while the low workers prefer to accept the voluntary severance pay and leave the firm.

The voluntary severance pay should not create wrong incentives for the agents who received signal s_L, since the option to work for the firm becomes more interesting in this way. If these agents know that there is a chance of receiving a voluntary severance pay, this will increase their expected utility from working at this firm. The difference with the outside option will increase: working at this firm becomes more interesting. Therefore, we must also take into account that the voluntary severance pay may not attract workers who received signal s_L.

Neither should the voluntary severance pay create wrong incentives for the principal. If this severance pay would be lower than the 'normal' severance pay, the principal always has the incentive to state that he has received a high signal. Then all agents will 'continue' to the second period and will be offered the possibility to either accept the voluntary severance pay (which will be the best solution for the low ability workers) or to work in this second period (which will be best for high ability workers). This would always be best scenario for the principal. Therefore, for not creating these wrong incentives, the voluntary severance pay should be at least as high as the 'normal' severance pay: $V \geq SP$.

When do the principal and both types of agents prefer the voluntary severance pay in such a way that it creates a separating equilibrium in both periods? Once more: the voluntary severance pay must be of such a level that high ability workers prefer to stay and low ability workers prefer to leave the firm. The high ability worker will prefer to stay at the firm and not accept the severance pay if his utility in the second period $[w_H - (1-a_H)]$ is higher than the voluntary severance pay (V):

$$w_H - (1-a_H) \quad \geq \quad V$$

The low ability worker must prefer the severance pay over his utility of the second period:

$$w_H - (1-a_L) \quad \leq \quad V$$

Combined, this gives

$$w_H - (1-a_H) \quad \geq \quad V \quad \geq \quad w_H - (1-a_L)$$

Both conditions can be fulfilled at the same time, as this requires that $a_H \geq V \geq a_L$.

Furthermore, the voluntary severance pay may not attract workers who received signal s_L to apply at t_0. It could be interesting for this group of workers to apply and work in the first period and afterwards accept this severance pay. Note that the principal only will offer a voluntary severance pay after he has received signal S_H. The expected utility for this type of agents should be lower than their outside option:

$$EU_A\,(s = s_L) = EU_{A,\,t1}\,(s = s_L) + P(S_H|s_L)\cdot P(a=a_H|s=s_L,\, S = S_H)\cdot EU_{A,\,t2}\,(a=a_H|\ s = s_L,\, S = S_H) + P(S_H|s_L)\cdot P(a=a_L|s=s_L,\, S = S_H)\cdot EU_{A,\,t2}\,(a=a_L|\ s = s_L,\, S = S_H) + P(S_L|s_H)\cdot(SP) \quad \leq \quad U_A^{out}$$

with $EU_{A,\,t2}\,(a=a_L|\ s = s_L,\, S = S_H) = V$ gives:

$$= w_L - [(1-p)(1-a_H) + p(1-a_L)] + [p(1-q) + (1-p)q]\cdot\frac{(1-p)q}{p(1-q)+(1-p)q}\cdot[w_H - (1-a_H)] + [pq + (1-p)(1-q)]\cdot\frac{p(1-q)}{p(1-q)+(1-p)q}\cdot V + [pq + (1-p)(1-q)]\cdot SP \quad \leq \quad U_A^{out}$$

This is true if:

$$V \leq \frac{Ua,out - wL + (1-p)(1+q)(1-aH) + p(1-aL) - (1-p)q \cdot wH + [pq + (1-p)(1-q)]SP}{p(1-q)}$$

The voluntary severance pay could be higher without creating wrong incentives if the outside option of the agent will be higher or if the wage of the first period will be lower. Furthermore, the optimal level of the voluntary severance pay depends on the level of the wage in the second period, on the probabilities of receiving a correct signal for both the agent and the principal, and on the cost of effort.

If these conditions hold, only the agents that received a high signal will apply and will reveal their true ability after the first period. We will now have to look to the preferences of the principal. The principal must also prefer to pay the voluntary severance pay for creating the separating equilibrium.

The expected revenues for the principal in the second period in the old situation, without the severance pay, were:

$$EU_{P,\,t2}\,(S = S_H | s = s_H;\ \text{no } V) = \frac{pq}{pq + (1-p)(1-q)} \cdot R(a_H) + \frac{(1-p)(1-q)}{pq + (1-p)(1-q)} \cdot R(a_L) + R(\gamma) - w_H$$

If the principal introduces a voluntary severance pay, only the high ability workers will stay at the firm. The principal does not know the true ability, so he expects that a proportion *q* of the workers will be of high ability and proportion (1-*q*) of low ability. The high ability workers will produce high revenues and receive a high wage; the low ability workers will be paid the severance pay and leave the firm. The expected revenues of the principal in the second period with severance pay will therefore be:

$$EU_{P,\,t2}\,(S = S_H | s = s_H;\ SP) = \frac{pq}{pq + (1-p)(1-q)} \cdot [R(a_H) + R(\gamma) - w_H] + \frac{(1-p)(1-q)}{pq + (1-p)(1-q)} \cdot (-V).$$

Note that for the principal the voluntary severance pay will be a cost and therefore will be negatively affecting his expected utility. The firm prefers to introduce the severance pay if:

$$EU_{P,\,t2}\,(S = S_H,\ V) \geq EU_{P,\,t2}\,(S = S_H,\ \text{no } V)$$

$$\frac{pq}{pq + (1-p)(1-q)} \cdot [R(a_H) + R(\gamma) - w_H] + \frac{(1-p)(1-q)}{pq + (1-p)(1-q)} \cdot (-V) \geq \frac{pq}{pq + (1-p)(1-q)} \cdot R(a_H) + \frac{(1-p)(1-q)}{pq + (1-p)(1-q)} \cdot R(a_L) + R(\gamma) - w_H$$

If we simplify this equation, we will get the following outcome:

$$V \leq R(a_L) + R(\gamma) - w_H$$

The direct gain for the principal of introducing the severance pay is that he does not have to pay a high wage to the low ability agent. The loss for the principal is the loss of revenues this worker would have received from this worker. The higher the high wage or the lower the revenues of the low ability worker in the second period, the more a severance pay will be a beneficial solution for the principal. The more firm-specific capital this low ability worker would have collected in the first period, the more valuable he would have been in the second period, the less interesting a severance pay would be.

Solution: introducing a voluntary severance pay will be a solution to the screening problem if this severance pay:

- *is higher than the utility of a low ability agent in the second period*

  $V \geq w_H - (1-a_L)$

- *is lower than the utility of a high ability agent in the second period*

  $V \leq w_H - (1-a_H)$

- *does not incentivize an agent with signal s_L to apply at t_0*

  $V \leq \frac{Ua,out - wL + (1-p)(1+q)(1-aH) + p(1-aL) - (1-p)q \cdot wH + [pq + (1-p)(1-q)]SP}{p(1-q)}$

- *is lower than the net revenues a low ability worker would have brought the firm*

  $V \leq R(a_L) + R(\gamma) - w_H$

- *is higher than the 'normal' severance pay that the principal will offer to the agents of whom he has received a low signal (so that the firm has no incentive not to fire workers of whom it receives a low signal):*

  $V \geq SP$

The severance pay will then result in a separating equilibrium in the second period, in which the high ability workers prefer to stay at the firm, while the low ability workers prefer to accept the severance pay and leave the firm.

The more firm-specific human capital the low ability worker would have acquired during his first period, the more valuable he will be for the firm in the second period, the less interesting a severance pay would be.

Again: a lot of factors play a role in defining the optimal level of *V*. We have the same problem as we have seen in defining w_H: it is not easily possible to find a value of *V* that fulfills all conditions. Especially because w_H arises in the third and the fourth condition of *V*. Therefore I am not sure whether there will be at least one optimal value of *V*.

We now possibly have a solution for the problem of a low ability worker working for the firm in the second period, receiving a high wage without producing high revenues. This situation could be present because the principal receives a signal S_H, although the worker is of low ability. But the principal could also face the problem the other way around: he receives a signal S_L, although the worker is of high ability. The principal will dismiss the high ability agent, since he believes that the agent is of low ability.

Problem: the firm will dismiss a high ability agent after the first period, since he believes that the agent is of low ability.

This is not only a problem at the side of the principal (since he will miss the high revenues in the second period), but also at the side of the agent (since he will miss the high wage he would have expected to receive). Since the agent knows his ability with certainty after the first period while the principal does not, the best solution will be found if the agent takes actions to report his signal. The agent has to make sure to the principal that he is of high ability.

A solution for the high ability agent will be to not accept the severance pay. The severance pay here is the severance pay that the principal will give to the agents of whom he has received signal S_L and will dismiss as a consequence (*SP*). By not accepting the severance pay, the agent makes a credible statement about his ability level. He is willing not to accept the payment and to work in the second period, since he knows that this choice will be more beneficial for himself as well as for the firm.

Possible solution: the high ability agent should not accept the severance pay that the firm will give to him after having received signal S_L.

Not accepting the severance pay should only be beneficial for the high ability agent. If it would be beneficial for the low ability agent as well, an agent of this type could also decide to not accept the severance pay. Since the firm does not know true ability of the agents, a pooling equilibrium will exist in which both types of agents reject the severance pay. This will solve the problem, but it will make the first stated problem (the possibility that the firm will continue with a low ability worker) even bigger.

Therefore, I am interested in the conditions where only the high ability agents prefer not to accept the severance pay. The decision of whether or not to accept the severance pay will be made after the first period, when the agent is certain about his true ability. The high ability worker will not accept the severance pay after the first period if the utility of a high ability agent in the second period will be higher than the severance pay:

$w_H - (1-a_H) \quad \geq \quad SP$

For the low ability worker, it will be more beneficial to accept the severance pay if this severance pay will be higher than his utility in the second period:

$w_H - (1-a_L) \quad \leq \quad SP$

The high ability agent can make a credible statement by not accepting the severance pay if

$w_H - (1-a_L) \quad \leq \quad SP \quad \leq \quad w_H - (1-a_H)$.

There are values of *SP* that fulfill both conditions, as $a_H \geq SP \geq a_L$.

We see that this is the same condition as the condition that must hold with the *voluntary* severance pay. Note once more that the *voluntary* severance pay will be offered by the principal after he has received signal S_H, while the 'normal' severance pay will be offered after the principal has received signal S_L.

Solution: if a high ability agent will be dismissed after the first period and therefore will receive a severance pay, not accepting this severance pay will be a credible statement, if:

- *the severance pay will be lower than the utility of a high ability agent in the second period*
  $SP \quad \leq \quad w_H - (1-a_H)$
- *the severance pay will be higher than the utility of a low ability agent in the second period*
  $SP \quad \geq \quad w_H - (1-a_L)$

which is true if $a_H \geq SP \geq a_L$.
This will also influence the participation constraints of the agents that have received a high signal as well as those that have received a low signal at t_0 (EU_A ($s = s_H$) and EU_A ($s = s_L$), see page 14). These conditions must still hold with $a_H \geq SP \geq a_L$ to let the supposed solution really be solving the problem.

5. The moral hazard problem and possible solutions:

The moral hazard problem:

A second well-known problem is the *moral hazard problem*: the employee does not exert enough effort. The moral hazard problem is a problem that has been investigated by many authors (see e.g. Arrow, 1965; Harris and Raviv, 1976; Holmström, 1979; Stiglitz, 1983). There is an asymmetry in information among individuals. This asymmetry leads to the result that after contracting, one party

wants to take actions that increase his own payoff at the expense of the payoff of the other parties. Since these actions are not verifiable, they cannot be part of the optimal contract.

In our situation, the moral hazard problem lies at the side of the agent. The agent will choose his effort level. A higher effort level means a higher cost of effort. Since effort is not verifiable, it could not be stated in the contract that the agent has to exert high effort. Therefore, the agent has the incentive to exert low effort. This will increase the utility of the agent, but will decrease the utility of the principal.

This problem will especially come up in the last period of the contract. In earlier periods, shirking by the employee could result in being caught and dismissed. In that case, he will not get the high wages of the last periods and will start with a lower wage at the new employer. Therefore, with seniority based pay shirking will become less interesting. But not in the last period! In the last period the employee has nothing to lose by shirking, since his contract will finish after that period anyway. The threat of being dismissed is not present anymore and if the contract states that the firm must pay the wage to the employee after every period, the employee will get the high wage with certainty. The firm has lost all his bargaining power in this period and since exerting effort is 'costly' to the employee (disutility of working), the employee prefers shirking over exerting effort. Therefore:

Problem: the employee will shirk in the last period.

The problem here is that the employee prefers to shirk and the firm does not have the power to incentivize him towards exerting effort. Possible solutions must either incentivize the employee himself or must increase the power of the firm. I will show two possible solutions for the moral hazard problem: the firm can monitor its employees, or it can pay a pension to those employees who have worked hard during both periods working at the firm.

A good solution to look at is monitoring, which increases the power of the firm. Before introducing the moral hazard model itself, I will introduce the solution of monitoring.

Possible solution 1: monitoring:

One possible solution for the firm could be to monitor the agent. In the second section of this paper, I have stated that often seniority based pay will be used when output is *hard to observe*. Therefore monitoring would be a costly action. This still holds, but in the last period the level of firm-specific human capital of the worker is at its highest point. This means that in the last period the gains for the firm when the worker exerts effort can outweigh the cost of monitoring.

The moral hazard model:

The moral hazard model differs from the screening model by leaving out ability level and introducing effort level. The principal here receives revenues that are linearly increasing with the effort level of the employee. Again, his costs are the wage costs, which are low in the first period (w_L) and high in the second period (w_H). The agent chooses his effort level in each of the two periods, which could either be high (e_H) or low (e_L). The costs of working in this model are the costs of exerting effort. Again the worker will receive a wage w_L that is below his value of marginal product (VMP) in the first period and a wage w_H that is higher than VMP in the second period. As a consequence of the collection of firm-specific human capital, the worker will have a higher productivity in the second period. For himself this does not matter, but for the firm this will give a higher return from the effort exerted by the worker in the second period. The revenue to the firm of the second period will therefore be multiplied by factor $(1+x)$, with $x \in (0,1)$ standing for the extra productivity of worker effort.

The principal collects revenues that are increasing in the effort level of the agent. This means that revenues will be high if the agent works hard and will be low otherwise. The principal can observe the level of exerted effort of the agent. Since his revenues are increasing in effort, the level of effort chosen by the agent is not only observable, but also verifiable. I assume that the revenues give perfect information about the effort level of the agent; there is no uncertainty or noise.

As I already stated when introducing the moral hazard problem, the seniority based pay must only be interesting for agents who work hard in the first period. Agents who shirk in the first period will be dismissed. This can be stated in the contract between principal and agent, since effort level will be verifiable for the principal. The moral hazard problem will therefore not be present in the first period. It could however be present in the second period, since the principal now loses the threat of dismissing the agent. The agent will quit the firm after the second period anyway, since his contract has ended.

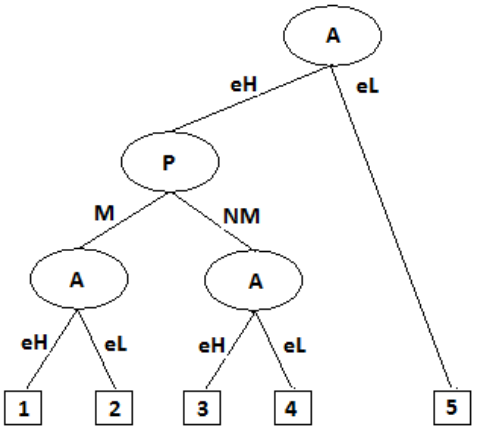
The timing of this model is as follows:

- At time t_0 the principal and agent sign a contract;
- Then period 1 starts (t_0-t_1) in which the agent chooses effort level (e_H or e_L) and 'collects' firm-specific human capital;
- At the end of period 1, which is t_1, the principal will collect revenue R(e_1) and pays wage w_L to the agent. If R(e_1) = R(e_L), the agent will be dismissed, without receiving an extra payment besides w_L;

- Then period 2 starts (t_1-t_2), the agent again chooses effort level. The agent will be more productive than in the first period, due to firm-specific human capital;
- At the end of period 2 (t_2), the principal collects revenues $(1+x)R(e_2)$ and pays wage w_H to the worker. The contract ends.

At the end of the first period, the principal has the option to choose to monitor the agent in the second period at cost *M*. In that case he will learn with certainty about the true effort level of the agent in this second period. If he observes the agent to exert low effort in the second period, he will pay a low wage accordingly. If he observes high effort he will pay a high wage. If the firm does not monitor at all, he has to pay the high wage anyway.

Working out this example will be easiest by using a game tree:



A is the agent, P is the principal. The agent chooses between exerting high effort (eH) or low effort (eL). The principal chooses to monitor (M) or to not monitor (NM) the agent. Numbers 1 to 5 are the nodes belonging to the payoffs for the principal and the agent.

We can derive these payoffs by taking a look at the utility functions.

The utility function of the principal: $U_P = R(e_1) - w_L + (1+x)R(e_2) - w_H$.

The utility function of the agent: $U_A = w_L - e_1 + w_H - e_2$.

$R(e)$ is the revenue to the firm from effort level *e* of the agent, $(1+x)$ stands for the higher productivity of the worker in the second period, as a result of the collection of firm-specific knowledge. Note that the agent will be dismissed after the first period if he chooses effort level e_L.

Nodes belonging to the outcomes of a game (in this case: the numbers 1-5) are called *terminal nodes*. The payoffs belonging to terminal nodes 1 to 5 will be:

Terminal node	U_P	U_A
1	$R(e_H) - w_L + (1+x)R(e_H) - w_H - M$	$w_L - e_H + w_H - e_H$
2	$R(e_H) - w_L + (1+x)R(e_L) - w_L - M$	$w_L - e_H + w_L - e_L$
3	$R(e_H) - w_L + (1+x)R(e_H) - w_H$	$w_L - e_H + w_H - e_H$
4	$R(e_H) - w_L + (1+x)R(e_L) - w_H$	$w_L - e_H + w_H - e_L$
5	$R(e_L) - w_L$	$w_L - e_L$

with $w_H - e_L > w_H - e_H > w_L - e_L > w_L - e_H$.

By backward induction, we will find the outcome of this game. We have to start with the effort choice of the agent in the second period. As we can see, the agent prefers payoffs 1 over 2 and 4 over 3. Therefore, the agent will exert high effort in the second period if the principal monitors him and will exert low effort otherwise.

We will continue with the decision of the principal. The principal prefers to monitor in the second period (prefers payoff 1 over 4) if the benefits of monitoring, the revenues from the higher effort level of the agent, exceed (or at least be not lower than) the cost of monitoring:

$(1+x)R(e_H) - w_H - M \geq (1+x)R(e_L) - w_H$ so if $(1+x)[R(e_H) - R(e_L)] \geq M$.

Note that the payoff for the firm in the first period will be the same for both situations and therefore will not be taken into account.

Lastly, we have to check whether the agent prefers to exert high effort in the first period. This will be true if in the game tree payoff 1 for the agent will be at least the same as payoff 5:

$w_L - e_H + w_H - e_H \geq w_L - e_L$, which is true if $w_H - e_H \geq e_H - e_L$.

We have now finished the game. By backward induction, we have seen when monitoring incentivizes the agent to work hard in both periods and is preferred by the principal. If the stated conditions hold, monitoring will be a solution to the moral hazard problem.

Solution 1: monitoring will be a solution to the moral hazard problem for the principal if it incentivizes the agent to work hard in the second period and if monitoring is not too costly for the firm.

For the principal:

- *The extra revenues of exerting high effort to the principal*
  multiplied by
- *The factor of productivity of the agent from the collection of firm-specific human capital*
  must exceed
- *The cost of monitoring.*

This means that monitoring will become more beneficial the higher the marginal revenues of firm-specific human capital will be.

For the agent, the utility from working in the second period and exerting high effort must outweigh the higher cost of effort of working hard instead of shirking in the first period.

In a model without firm-specific human capital, the factor of extra productivity (*x*) will be equal to zero. The benefits of monitoring are lower in this case, so monitoring then becomes less interesting for the firm. Therefore: without the existence of firm-specific human capital, the firm will less often choose to monitor the agent.

If the italic requirements hold, monitoring will be a good solution. However, what could a firm do if (one of) these conditions do *not* hold? Then it has to come up with a different solution.

I will now continue with a second possible solution: the firm could reward the employee if he worked hard in both periods, by paying his pension. As we will see, the pension will be another possibility to induce the employee to work hard in the second period.

Possible solution 2: let the firm pay the employee a pension in case the employee exerted high effort in both periods:

The pension can be seen as a bonus payment from the firm to the employee. This also has been investigated by Lazear (1979). The difference between our models is that I make use of the firm-specific human capital variant of the moral hazard model.

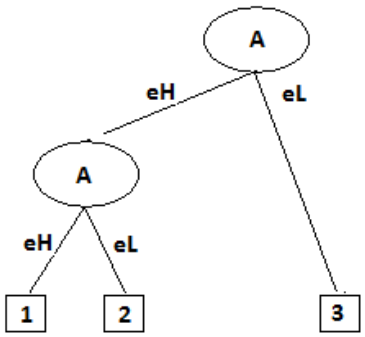
The employee will get a bonus if he worked hard in both periods, so if he showed the preferred behavior from the side of the firm. This pension will be paid after the second period and after the firm has verified that the worker has exerted high effort in both periods. Since the firm receives his revenues of the first period before he continues with the second period, he already knows at t_1 whether or not the employee has worked hard in the first period. He now can do the same at the end of the second period. The firm can observe his revenues of the second period, which are either high

or low. If the revenues are high, he knows that the employee has exerted high effort in the second period. As a bonus for working hard in both periods, the firm can pay the pension of the worker. However, if the firm observes low revenues in the second period, he only pays the high wage that he is obliged to.

Whether or not the pension gives the right incentives to the employee and is preferred by the firm will depend on several variables. I will adapt the model with monitoring to this new situation, to be able to see which requirements must hold to make the pension proposition a solution for the moral hazard problem.

When looking at the model with monitoring, I only make one adjustment: to leave out the monitoring decision of the firm. For the rest the model stays the same: the employee (the agent) works in the first period. He will be dismissed by the firm (the principal) after exerting low effort in the first period and will continue working after having exerted high effort. In the second period the agent again chooses effort level. If the agent exerts high effort in the second period he will receive a pension over the high wage he would receive anyway. This pension will be paid by the principal Exerting low effort in the second period means not receiving a pension. Since the revenues of the principal in the second period can verify the effort level of the agent and an eventual pension will be paid after verification, the pension is contractible.

We will get the following game tree:



The first decision node A stands for the choice of effort level of the agent in the first period, the second node for the effort level in the second period. As can be seen, the principal will not have any chance to interfere with the game during the game itself. It can only push the agent towards the right incentives by setting the wages and the amount of the pension in such a way that the agent chooses the right actions himself.

The utility functions of the principal and the agent will again be:

$$U_P = R(e_1) - w_L + (1+x)R(e_2) - w_H$$

$$U_A = w_L - e_1 + w_H - e_2$$

We will then get the following payoffs for terminal nodes 1 to 3:

Terminal node	**U_P**	**U_A**
1	$R(e_H) - w_L + (1+x)R(e_H) - w_H - P$	$w_L - e_H + w_H - e_H + P$
2	$R(e_H) - w_L + (1+x)R(e_L) - w_H$	$w_L - e_H + w_H - e_L$
3	$R(e_L) - w_L$	$w_L - e_L$

with *P* standing for the (amount of the) pension and $w_H - e_L > w_H - e_H > w_L - e_L > w_L - e_H$.

The game will again be solved by backward induction. Therefore, we have to start with the second decision node of the agent.

The firm would like the agent to exert high effort. This means that the agent must prefer the payoff of terminal node 1 over the payoff of node 2:

$$w_L - e_H + w_H - e_H + P \geq w_L - e_H + w_H - e_L$$

$$P \geq e_H - e_L$$

The agent prefers to exert high effort in the second period if the benefits (the pension) are higher than the extra cost of exerting high instead of low effort.

The agent prefers to exert high effort in the first period *and* in the second period if the payoff of node 1 is higher than the payoff of node 3, given the requirement that $P \geq e_H - e_L$. Since the principal is not willing to pay the agent a higher pension than will be necessary, *P* will be equal to $e_H - e_L$. Then, if payoff of the agent of node 1 must be higher than node 3:

$$w_L - e_H + w_H - e_H + P \geq w_L - e_L$$

$$w_L - e_H + w_H - e_H + (e_H - e_L) \geq w_L - e_L$$

$$w_H - e_H \geq 0$$

The agent prefers to exert high effort in *both* periods if the high wage of the second period exceeds the high effort cost of one of the two periods. The amount of the pension is equal to the difference in

the cost of exerting high and low effort by the agent. The higher the difference in costs of high and low effort, the higher the pension should be. The higher the cost of exerting high effort, the higher the high wage in the second period should be. *The amount of the cost of exerting low effort itself does not play a role in the decision of the agent between working hard or not. Only the difference between the cost of exerting high and low effort plays a role in the decision making.*

So far, we have assumed that the principal prefers the agent to exert high effort in both periods and that the principal is willing to pay the pension accordingly. We must compare the payoffs of the principal in the three situations to see whether this assumption holds: the principal must prefer the agent to work hard in both periods and pay the pension. This means that also for the firm his payoff of terminal node 1 must both exceed those of 2 and 3.

The principal prefers the agent to work hard in the second period if node 1 ≥ node 2:

$$R(e_H) - w_L + (1+x)R(e_H) - w_H - P \geq \quad R(e_H) - w_L + (1+x)R(e_L) - w_H$$

$$P \leq \quad (1+x)R(e_H - e_L)$$

The pension incentivizes the agent to work hard in the second period. The principal only wants to pay the pension if the pension will not be higher than the extra revenues of working hard by the agent. These extra revenues are increasing with the marginal benefits of firm-specific human capital. The higher these marginal benefits, the more the principal will prefer to introduce the pension as a motivational payment.

The principal wants the agent to exert high effort in both periods if node 1 ≥ node 3:

$$R(e_H) - w_L + (1+x)R(e_H) - w_H - P \geq \quad R(e_L) - w_L$$

which gives $P + w_H \leq R(e_H - e_L) + (1+x)R(e_H)$

On the left side, we see the total costs of incentivizing the agent towards exerting high effort in the second period. These are the high wage of the second period and the pension. On the right side are the total benefits, consisting of the difference between the benefits of high versus low effort in the first period, and the total benefits of high effort in the second period. We also see in this equation that the higher the marginal benefits of firm-specific human capital, the more beneficial a pension system will be for the principal.

We can now say when a pension system will give the right incentives to the employee and is preferred by the firm, and therefore will be a solution to the moral hazard problem.

Solution 2: a system in which the agent will receive a pension after the second period if he worked hard in both periods, where the pension is paid by the firm, will be a solution to the moral hazard problem for the agent if:

- *the high wage of the second period exceeds the cost of exerting high effort;*

and for the principal if:

- *the difference in extra revenues between high and low effort in the first period, plus*
- *the total revenues of high effort in the second period, exceed*
- *the level of the pension plus the amount of the wage costs in the second period.*

The pension will then be equal to the difference in costs of exerting high and low effort of the agent.

The higher the marginal benefits of firm-specific human capital, the more such a system will be beneficial.

Remarks regarding the moral hazard problem:

With these two solutions, the monitoring solution and the pension system, the firm has to take costly actions to induce the employee to work hard. Although the worker already receives a high wage in the second period, he always prefers to shirk if his level of effort is not verifiable. The firm can only incentivize the worker by accepting to invest.

Both monitoring and a pension result in making the effort level of the agent of the second period verifiable. By introducing a pension, the firm 'adds a period to the model'. The pension can be seen as a wage for the period after the second period, without requiring exerted effort in that period. By adding a period to the model, the firm can use the revenues of the second period as verification for the effort level of the agent in the second period. Although the firm is obliged to pay the high wage in the second period, he still holds his bargaining power.

6. Problem if the firm has the opportunity to invest in physical capital:

Seniority based pay is a long-term contract between the firm and the employee. Both parties commit to working together for a long period. This creates advantages, but also several problems. So far, the problems we have discussed were based at the side of the employee. In both situations of screening and moral hazard, the employee was not willing or not able to have a high productivity in the second

period. The causes of the problem are at the side of the employee, but the firm is the party that will feel the consequences.

In this section I will explore a problem where the cause is at the side of the firm. Human capital is not the only type of capital that brings profits to the firm. In a lot of businesses, the role of technology is increasing. Production lines have already been taken over by machines for decades, since machines work faster, are more productive, make fewer mistakes and continue working all day and all night. Besides, technology becomes smarter over time. Not only production lines could be taken over by machines, also the tasks where more brainwork is needed will be done more efficiently by robots.

A long-term contract such as seniority based pay could give rise to a problem. What would the firm do if, after some years, it would be more interesting for the firm to invest in technology, letting the work be done only by physical capital instead of human capital?

An example: a firm and a worker sign a long-term contract, with an increasing wage in seniority for the worker, for a period of 10 years. However, after 5 years the firm observes that it would be cheaper to invest in technology, which makes the worker obsolete. By investing in technology, the firm takes into account the high future wage costs of the worker as part of the long-term contract. It also takes into account that the worker would be very productive those last 5 years, since it has a lot of firm-specific knowledge. Hence: the presence of this worker in the first five years would increase its productivity in the years following. If investing in technology would still be interesting for the firm, after having taken into account these things, the firm will do that.

Problem: after some years the high ability worker is not needed anymore at his specific job, since the firm has invested in technology which substitutes human capital for physical capital.

Both the firm and the worker will feel the consequences of this problem. For the firm, the investment results in the fact that the worker does not produce high revenues anymore. Since this is part of his opportunity costs, the firm would not care about these costs if he was fully rational. The loss of revenue has already been taken into account when making the decision to change from human to physical capital. Still, the firm prefers to have the agent working and produce revenues, rather than letting him leave the firm. The worker has the firm-specific knowledge that makes him more productive than he was in the first period.

The agent prefers to work for the firm (maybe for implicit reasons: he likes to work at the firm), but the firm is not able to offer the first-best job to the agent, since the job can be done by machines more efficiently. He can continue working at another firm, but he will then again start with a low starting wage. Furthermore he does not want to leave the firm since he enjoys working there.

I assume the long-term contract the firm and the agent have signed to be binding. Therefore, both parties can only get away with the contract by making an agreement about a new contract, or at least agree to break down the current contract.

A first thought will be that the firm could do three things: it could offer the worker a severance pay (as we have seen in section 4), it could give the worker another job (which less suits its capabilities) or it can do nothing. I will show why a severance pay will not be a solution for this problem, but offering another job could, under some requirements.

Let me make the example more concrete by using the two-period screening model of section 4. I assume that both the severance pay and the credible statement of the high ability worker have been introduced. This results in the fact that in the second period, only high ability agents are working at the firm. Furthermore, I assume that the agent likes his job and therefore has *no* cost of working.

Now, *after* the severance pay has been paid out to the low ability workers and the high ability workers have made the statement, the firm has the opportunity to invest in technology. This technology will be much more productive and efficient and less costly to the firm than hiring the agent. The technology makes the worker redundant for his current job. Therefore the firm decides to invest in this technology. This decision was not foreseen by both the principal and the agent at t_0 and therefore could not have been taken into account when making decisions before or during the first period. We therefore only have to look at the payoffs of the second period when looking at incentives.

As I stated, the firm can do three things: it can offer the worker a severance pay, it can offer the worker a new job, or it can do nothing. If the firm does not do anything, the firm has no revenues from the agent, since the agent does not have a job anymore. The firm only has to pay the agent the high wage of the second period. If the firm pays a severance pay, this will result in the same as when doing nothing. The firm pays an amount of money; the worker does not produce anything. The only cost for the firm here is the severance pay. Since the worker only accepts the severance pay if this pay is higher than the high wage he would have received if the firm does not do anything, the severance pay will not be a solution to this problem.

Will offering a new job to the worker be preferred by both the worker and the firm? If the firm offers a new job to the worker, this will mean a breaking up of the contract. In a contract between an employer and an employee it is stated what responsibilities the worker has, what tasks he has to fulfill and what his wage will be accordingly. If the firm offers the worker a new job, this means that he will get new tasks and new responsibilities. Consequently, the firm has to break up with the

contract, but this will only be preferred by the worker if it increases, or at least not decreases, his utility.

The worker will receive a high wage, which is above his marginal productivity, in the second period if the firm does *not* offer the worker a new job. The utility of the worker in the second period would then be:

$U_{A, t2} = w_H$

If the worker gets a new job, he can renegotiate the wage. I will call the wage belonging to the new job w_{new}. I assume that at this new job the worker *will* have some costs of exerting effort. These costs could be related to the new type of job that does not suit his own preferences perfectly (while the 'old' job did) or new tasks that do not fit with the capabilities of the agent. The utility of the worker in the second period with the new job will therefore be:

$U_{A, t2} = w_{new} – (1-a_H)$

This results in the fact that the worker will only prefer to accept the new contract with the new job if $w_{new} – (1-a_H) \geq w_H$. The new wage must be higher than the high wage that already exceeds the value of marginal product of the worker. The firm will not make the new wage higher than necessary, so $w_{new} = w_H + (1-a_H)$.

Let me now go to the incentives of the firm. If the firm does not do anything, he will only have to pay the high wage to the worker. If he offers the worker a new job, he has to pay the new wage but will also receive revenues. Normally the revenues of the firm in the second period would be $R(a_H + \gamma)$, but since the worker will be placed into a new job, I assume that the worker will not be as efficient as he was. The new job does not fit to his skills perfectly, which results in that it will only produce a fraction α of his old revenues, with $\alpha \in (0,1)$. The utility function of the firm in the second period will then be:

$U_{P, t2} = \alpha R(a_H + \gamma) – w_{new} = \alpha R(a_H + \gamma) – [w_H + (1-a_H)] = \alpha R(a_H + \gamma) – w_H – (1 - a_H)$

The firm prefers to offer the new job if this utility level exceeds his utility of doing nothing, which is $(–w_H)$. The firm will only offer the worker a new job if $\alpha R(a_H + \gamma) – w_H – (1 - a_H) \geq – w_H$, so if $\alpha R(a_H + \gamma) \geq (1 - a_H)$.

Solution: offering a new job to the worker will be a solution to the problem if the revenues the worker will bring to the firm are higher, or at least not lower, than the cost of effort of the worker.

The revenues of the worker will be higher the better fit there will be with the past job (so: if α is high). The higher the firm-specific human capital of the worker, the higher the revenues will be, the more beneficial it is for the firm to keep the worker at the firm and provide him a job.

The firm-specific human capital also plays a role in decision-making in the first place. The higher the firm-specific human capital of the worker, the lower the extra benefits of investing in physical capital, the less interesting it is for the firm to invest.

Since both the new job offer and doing nothing will make the worker worse off, the best he can do is to ex ante state in the contract that it may not be possible for the principal to invest in physical capital without being fined.

7. Conclusion:

In this paper I have gone into depth about seniority based pay. This long-term wage scheme, where the wage of a worker increases over time, has advantages for both the firm and the employee. I have shown that there are also important problems coming up with this type of wage, which both parties have to take into account when deciding about whether or not seniority based pay will be the preferred wage scheme.

At first I have shown the screening problem. The employer only wants to have high ability employees working at his firm. Therefore he introduces a seniority based pay with a low starting wage, a high wage in the last period and the possibility to dismiss workers during the contracting period. Since the employer does not have perfect information about the ability of the employee, it could either be the case that he dismisses a high ability worker (since the employer believes the worker is of low ability); or that he continues with a low ability worker. I have shown that in the first case, offering a voluntary severance pay to those who will not be dismissed could be a solution to this problem. In the second case, a credible statement from the employee will be the optimal solution. This credible statement is not accepting the severance pay that he will receive when getting dismissed. I have worked this problem out in a model and have shown which conditions must hold for letting my solutions solve the problem.

Secondly I have shown the moral hazard problem. Since effort cannot be contracted upon and in the last period the employer does not have any bargaining power left, the employee has the incentive to shirk in the last period. This is not beneficial for the employer, since he will receive lower revenues. Also here, I have worked out the problem in a model. I have shown that both monitoring and a

pension could be possible solutions. Whether or not they will be a solution depends on the conditions that must hold.

Finally I have gone into depth about a problem with its cause at the side of the firm: ex post the firm has the opportunity to invest in physical capital, which makes the human capital of the worker redundant. Investing will here be beneficial for the firm, but not for the employee. I have shown that the principal has two possible solutions: offering a new job to the worker, or do nothing with the worker after investment. Since both solutions are not making the employee equally well of, a solution at the side of the employee will be to state in the contract that it is not possible for the firm to invest in physical capital without being fined.

In all situations, the firm-specific human capital that the worker has acquired over the years is an important factor in decision-making. The higher this factor, the more benefits the firm receives from this worker over time. So it increases benefits for the firm, but it therefore also creates incentive problems and increases bargaining power at the side of the employee. The firm is willing to pay more to keep these workers at his firm and to counteract bad behavior from them, the more firm-specific human capital they have acquired over time.

In the screening model, we have seen that the employer is willing to pay a lower voluntary severance pay (to separate the low ability workers from the high ability workers), the more firm-specific human capital the low ability worker has. The reason is clear: the more valuable a low-ability worker will be to the firm, the less willing the firm will be to dismiss this type of worker.

With the moral hazard model, I have shown that the possible solutions to this problem (monitoring and a pension) are both more beneficial when the worker has more firm-specific human capital. The more beneficial the worker is for the firm *if* he works, the more the firm is willing to pay *to let* this worker exert a high effort level.

And with the last problem, the investment in physical capital, we will see the same: the more firm-specific human capital the worker has, the more beneficial he will be for the firm, the less interesting it would be to invest in the first place. And the more beneficial the worker is to the firm, the more willing the employer is to offer the worker another job if he decided to invest.

8. Discussion:

To be able to come up with several solutions, I have worked with two models: the screening model and the moral hazard model. For both models I had to make assumptions. As a further research on

this paper, it would be good to also work out these problems in other models with other assumptions. In this way, it could be possible to find other solutions, which could be better solutions than those of this paper. A 'better' solution here will be a solution that needs less conditions to be met, or will have a higher total value.

My models are models with two periods. If we will make use of models with more than two periods, this could lead to other results. In the screening model, for example, having more periods could be more beneficial for the employer. He now has more periods to learn true ability and has more opportunities to dismiss the workers of which he believes to be low ability workers. In the moral hazard model, having more periods leads to a smaller 'last' period. This means that shirking by the agent in the last period will result in lower benefits for the agent and smaller losses for the principal. This makes it less interesting to shirk for the agent and less of a problem for the principal.

Additionally, a multiple-period model will have other opportunities. In my two-period model, introducing seniority based pay (with a low wage in the first and a high wage in the second period) will automatically lead to a linear increase in wage. If we work with models with more than two periods, this does not have to be the case. It is now possible to introduce a non-linear increase of the wage in seniority and test whether the problems still exist and if they are still significant. For example: if a concave function will be introduced, the wage will still be increasing in seniority, but with a diminishing marginal rate. If we use a three-period model (as an example), this will mean that the wage is increasing *more* between period 1 and 2 than between period 2 and 3. The seniority based pay could now be more or less interesting for the 'wrong' types (the low ability agent, or the agent that wants to shirk), dependent on the shape and the assumptions of the new wage scheme.

Another possibility for further research could be to work with models with a *continuous* range of ability and effort levels. If an agent can not only have one of two ability levels (a_L or a_H) but one of a whole range ($a \in (0,1)$), it could be easier and therefore less costly for the principal to separate between those agents. He can specify the required level of ability (for example: the principal would like to have only those agents with ability level $a > 0.7$). If it is possible for the agent or the principal to receive a signal that is more concrete, the principal could set wages in such a way that it only attracts those workers with the highest signals, hereby decreasing the probability of hiring a worker with an ability level that is too low. In the moral hazard model, introducing a range of effort levels ($e \in (0,1)$) will increase the choice of effort level for the agent. He does not have to choose only between working and shirking. Although the agent does not want to work hard in the last period, it could be easier for the principal incentivize him to exert *some* effort level and thereby increasing his benefits (or decreasing his losses) in the last period.

It would also be interesting to enrich this paper with empirical results. Seniority based pay is a wage scheme of which a lot has already been written about in the literature. It will be very valuable to observe how much this wage scheme will be used in practice; in which situations firms prefer this wage scheme; and which problems will arise. Maybe there are more problems that arise, which I did not take into account in this paper.

Tax problems could be an example. Every year, the government could decide to increase the level of the wage tax. An increase in the wage tax makes a long-term wage scheme less interesting for the employee. If he could anticipate on a future increase, the employee wants to be compensated for this loss of benefits. The more his wage increases, the less his net wage will be. If the tax costs are higher than the benefit of the high wage, this could lead to the result that the agent would prefer having a lower wage and more secondary benefits, like more days off.

Another problem is an increase in pensionable age. In The Netherlands, the government has just decided that this age will rise from 65 to 67[1]. This means that employees have to work for two more years; the last period will be extended. If a worker receives a wage that is increasing over time and it is not stated in the contract what to do in the situation of an increase in pensionable age, this will result in a big loss for the firm. Looking at my screening model, this would result in the fact that a severance pay (as a solution to the screening problem) must be higher, since it has to cover a larger period of high wages. In the moral hazard problem, it will mean that it is even more beneficial for the agent to shirk in the last period. It would be interesting to how the change of the pensionable age will affect both the firm and the employee in the reality and if this will have a significant effect on decision to introduce seniority based pay in the first place.

If we have more information about the practice, we can test the theoretical model and see how strong the assumptions are that make my model correct. Then we can see which assumptions have to be violated to reach practical outcomes. Furthermore we will be able to see which other problems will arise and under what circumstances. We can then adapt the model and see what will be best solutions for these cases. Of course, it will also be interesting to see how companies themselves deal with the problems that arise.

[1] Source: http://www.trouw.nl/tr/nl/4500/Politiek/article/detail/3284716/2012/07/11/Historisch-besluit-Senaat-stemt-in-met-verhogen-pensioenleeftijd.dhtml

A currently occurring situation in the Netherlands:

In the Netherlands, the government has made a proposal for relaxation of dismissal[2]. In the proposal, which could become a bill after the national elections in September, it will become easier and less expensive for employers to dismiss their employees. An employer does not have to ask permission anymore to finish the employment, and the severance pay the employer has to pay to the employee will decrease. This could have a significant impact on the decisions of an employer regarding hiring new workers and firing current employees.

Relating the proposal to the theory of this paper, this could result in the following:

- In the screening model, it will become cheaper for the principal to screen the agents and to dismiss those agents of whom the principal believes to be of low ability. Furthermore, it would become more interesting for the principal to dismiss the agents of whom he has received a high signal if this would still result in a separation where only the low ability agents will accept the severance pay. This will result in the principal employing more agents at t_0 and dismissing more agents at t_1. The threat of continuing with a low ability worker in the second period or not continuing with a high ability worker will go down;
- In the moral hazard model, the relaxation of dismissal will not have an impact on the moral hazard problem. Effort will still be unverifiable in the last period and the principal could not dismiss the agent after this period without being obliged to pay the high second-period wage. The relaxation will also not influence the decision whether or not to monitor or to introduce a pension;
- The third stated problem, investing in technology, will become even more interesting for the principal, since it is now easier to dismiss the agent. In my model, I assumed the contract between the principal and the agent to be binding, meaning that it is not possible for the principal to dismiss the agent without having to pay a high severance pay (which would be at least as high as the high second-period wage). In reality, when there are more than two periods, it will be easier for the principal to dismiss the agent if he has the opportunity to invest in physical capital. In the example of a 10-year employment, where the principal has the opportunity after 5 years to invest in physical capital, the severance pay with the relaxation of dismissal could be lower, which makes it more interesting to invest and to dismiss the agent;

[2] See: http://www.ontslagdossier.nl/index.php/nieuws-over-ontslagrecht/111-nieuws/213-lenteakkoord-hervorming-ww-en-ontslagstelsel and http://www.trouw.nl/tr/nl/4492/Nederland/article/detail/3257935/2012/05/19/FNV-Hervorming-ontslagrecht-verslechtert-positie-werkenden.dhtml

- In all models, however, for agents the willingness to participate in the first place will go down. Since it will be easier to be dismissed and the severance pay when being dismissed will decrease, this will result in a lower expected utility for the agent and therefore a lower willingness to start working at the firm in the first place.

Overall, the relaxation of dismissal would result in an increase of incentives of the principal that are not preferred by the agent. The willingness to participate of the agent will therefore go down. I expect that the relaxation of dismissal would result in seniority based pay being less often used as a preferred wage scheme for both parties. If it will be used as wage scheme, I expect that the increase in wage over time will be less than in the current situation. This will lead to a higher starting wage and a lower wage in the last period, compared with the current situation. It will be interesting to see what the real impact of this proposal of the Dutch government would be.

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Appendix:

Calculations of the simplified formulas in the screening model:

Expected utilities for the principal in period 2, after having received respectively signal S_H or S_L, from an agent who received signal s_H:

$EU_{P,\,t2}\,(s = s_H,\, S = S_H) = P(a{=}a_H \mid s_H,\, S_H)\cdot[R(a_H + \gamma) - w_H] + P(a{=}a_L \mid s_H,\, S_H)\cdot[R(a_L + \gamma) - w_H]$

with

$$P(a{=}a_H \mid s_H,\, S_H) = \frac{P(sH,SH|a{=}aH)\cdot P(a{=}aH)}{P(sH,SH|a{=}aH)\cdot P(a{=}aH) + P(sH,SH|a{=}aL)\cdot P(a{=}aL)} = \frac{pq\cdot 0.5}{pq\cdot 0.5 + (1-p)(1-q)\cdot 0.5} = \frac{pq}{pq + (1-p)(1-q)}$$

and

$$P(a{=}a_L \mid s_H,\, S_H) = \frac{P(sH,SH|a{=}aL)\cdot P(a{=}aL)}{P(sH,SH|a{=}aL)\cdot P(a{=}aL) + P(sH,SH|a{=}aH)\cdot P(a{=}aH)} = \frac{(1-p)(1-q)q\cdot 0.5}{(1-p)(1-q)\cdot 0.5 + pq\cdot 0.5} = \frac{(1-p)(1-q)}{(1-p)(1-q) + pq}$$

gives

$$EU_{P,\,t2}\,(s = s_H,\, S = S_H) = \frac{pq}{pq+(1-p)(1-q)}\,[R(a_H + \gamma) - w_H] + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,[R(a_L + \gamma) - w_H]$$

$$= \frac{pq}{pq+(1-p)(1-q)}\,R(a_H) + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}\,R(a_L) + R(\gamma) - w_H$$

$EU_{P,\,t2}\,(s = s_H,\, S = S_L) = P(a{=}a_H \mid s_H,\, S_L)\cdot[R(a_H + \gamma) - w_H] + P(a{=}a_L \mid s_H,\, S_L)\cdot[R(a_L + \gamma) - w_H]$

with

$$P(a{=}a_H \mid s_H,\, S_L) = \frac{P(sH,SL|a{=}aH)\cdot P(a{=}aH)}{P(sH,SL|a{=}aH)\cdot P(a{=}aH) + P(sH,SL|a{=}aL)\cdot P(a{=}aL)} = \frac{p(1-q)\cdot 0.5}{P(1-q)\cdot 0.5 + (1-p)q\cdot 0.5} = \frac{p(1-q)}{P(1-q) + (1-p)q}$$

and

$$P(a{=}a_L \mid s_H,\, S_L) = \frac{P(sH,SL|a{=}aL)\cdot P(a{=}aL)}{P(sH,SL|a{=}aL)\cdot P(a{=}aL) + P(sH,SL|a{=}aH)\cdot P(a{=}aH)} = \frac{(1-p)q\cdot 0.5}{(1-p)q\cdot 0.5 + p(1-q)\cdot 0.5} = \frac{(1-p)q}{(1-p)q + p(1-q)}$$

gives

$$EU_{P,\,t2}\,(s = s_H,\, S = S_L) = \frac{p(1-q)}{P(1-q) + (1-p)q}\,[R(a_H + \gamma) - w_H] + \frac{(1-p)q}{(1-p)q + p(1-q)}\cdot[R(a_L + \gamma) - w_H]$$

$$= \frac{p(1-q)}{P(1-q) + (1-p)q}\,R(a_H) + \frac{(1-p)q}{P(1-q) + (1-p)q}\,R(a_L) + R(\gamma) - w_H$$

Total expected utility of the principal from an agent who received signal s_H:

$EU_P\,(s = s_H) = EU_{P,\,t1}\,(s = s_H) + P(S_H \mid s_H)\cdot EU_{P,\,t2}\,(s = s_H,\, S = S_H) + P(S_L \mid s_H)\cdot EU_{P,\,t2}\,(s{=}s_H,\, S = S_L) \geq 0$

$EU_P(s{=}s_H) = EU_{P,\,t1}\,(s{=}s_H) + P(S_H \mid s_H)\cdot EU_{P,\,t2}\,(a{=}a_H \mid\, s = s_H,\, S = S_H) + P(S_H \mid s_H)\cdot EU_{P,\,t2}\,(a{=}a_L \mid\, s = s_H,\, S = S_H) + P(S_L \mid s_H)\cdot(-SP) \geq 0$

with $P(S_H|s_H) = pq + (1-p)(1-q)$, $P(S_L|s_H) = p(1-q) + (1-p)q$ and $P(S_H|s_H) + P(S_L|s_H) = 1$ gives:

$p \cdot R(a_H) + (1-p) \cdot R(a_L) - w_L + [pq + (1-p)(1-q)] \cdot \{ \frac{pq}{pq+(1-p)(1-q)} [R(a_H) + R(a_L) + R(\gamma) - w_H]\} + [pq + (1-p)(1-q)] \cdot \{ \frac{(1-p)(1-q)}{pq+(1-p)(1-q)} [R(a_H) + R(a_L) + R(\gamma) - w_H]\} + [p(1-q) + (1-p)q] \cdot (-SP)$

$= p \cdot R(a_H) + (1-p) \cdot R(a_L) - w_L + [pq + (1-p)(1-q)] \cdot \{ \frac{pq}{pq+(1-p)(1-q)} R(a_H) + \frac{(1-p)(1-q)}{pq+(1-p)(1-q)} R(a_L) + R(\gamma) - w_H\} + [p(1-q) + (1-p)q] \cdot (-SP)$

$= p \cdot R(a_H) + (1-p) \cdot R(a_L) - w_L + pq \cdot R(a_H) + (1-p)(1-q) \cdot R(a_L) + [pq + (1-p)(1-q)] \cdot \{ R(\gamma) - w_H\} + [p(1-q) + (1-p)q] \cdot (-SP)$

$= p(1+q)R(a_H) + (1-p)(2-q)R(a_L) - w_L + [pq + (1-p)(1-q)] \cdot \{ R(\gamma) - w_H\} + [p(1-q) + (1-p)q] \cdot (-SP) \geq 0.$

This gives $w_H \leq \frac{p(1+q)R(aH) + (1-p)(2-q)R(aL) - wL - [p(1-q) + (1-p)q] \cdot SP}{pq+(1-p)(1-q)} + R(\gamma)$

Expected utilities for the principal in period 2, after having received respectively signal S_H or S_L, from an agent who received signal s_L:

$EU_{P, t2}(s = s_L, S = S_H) = P(a=a_H|s_L, S_H) \cdot [R(a_H + \gamma) - w_H] + P(a=a_L|s_L, S_H) \cdot [R(a_L + \gamma) - w_H]$

with

$P(a=a_H|s_L, S_H) = \frac{(1-p)q}{p(1-q) + (1-p)q}$

and

$P(a=a_L|s_L, S_H) = \frac{p(1-q)}{p(1-q) + (1-p)q}$

gives

$EU_{P, t2}(s = s_L, S = S_H) = \frac{(1-p)q}{p(1-q) + (1-p)q} \cdot [R(a_H + \gamma) - w_H] + \frac{p(1-q)}{p(1-q) + (1-p)q} \cdot [R(a_L + \gamma) - w_H]$

$= \frac{(1-p)q}{p(1-q) + (1-p)q} \cdot R(a_H) + \frac{p(1-q)}{p(1-q) + (1-p)q} \cdot R(a_L) + R(\gamma) - w_H$

$EU_{P, t2}(s = s_L, S = S_L) = P(a=a_H|s_L, S_L) \cdot [R(a_H + \gamma) - w_H] + P(a=a_L|s_L, S_L) \cdot [R(a_L + \gamma) - w_H]$

with

$P(a=a_H|s_L, S_L) = \frac{(1-p)(1-q)}{pq+(1-p)(1-q)}$

and

$P(a=a_L|s_L, S_L) = \frac{pq}{pq+(1-p)(1-q)}$

gives

$EU_{P,\,t2}\,(s = s_L, S = S_L) = \frac{(1-p)(1-q)}{pq+(1-p)(1-q)} \cdot [R(a_H + \gamma) - w_H] + \frac{pq}{pq+(1-p)(1-q)} \cdot [R(a_L + \gamma) - w_H]$

$= \frac{(1-p)(1-q)}{pq+(1-p)(1-q)} \cdot R(a_H) + \frac{pq}{pq+(1-p)(1-q)} \cdot R(a_L) + R(\gamma) - w_H$

Total expected utility of the principal from an agent who received signal s_L:

$EU_P\,(s = s_L) = EU_{P,\,t1}\,(s = s_L) + P(S_H|s_L) \cdot EU_{P,\,t2}\,(s = s_L, S = S_H) + P(S_L|s_L) \cdot EU_{P,\,t2}\,(s=s_L, S = S_L) \quad \leq 0$

$EU_P\,(s=s_L) = EU_{P,\,t1}\,(s=s_L) + P(S_H|s_L) \cdot EU_{P,\,t2}\,(a=a_H|\ s = s_L, S = S_H) + P(S_H|s_L) \cdot EU_{P,\,t2}\,(a=a_L|\ s = s_L, S = S_H) + P(S_L|s_L) \cdot (-SP) \leq 0$

$(1-p)R(a_H) + pR(a_L) - w_L + [p(1-q) + (1-p)q] \cdot \frac{(1-p)q}{p(1-q)+(1-p)q} \cdot \{R(a_H) + R(\gamma) - w_H\} + [pq + (1-p)(1-q)] \cdot \{\frac{p(1-q)}{p(1-q)+(1-p)q} \cdot R(a_L) + R(\gamma) - w_H\} - [pq + (1-p)(1-q)] \cdot SP$

$= (1-p)R(a_H) + pR(a_L) - w_L + [p(1-q) + (1-p)q] \cdot \{\frac{(1-p)q}{p(1-q)+(1-p)q} \cdot R(a_H) + \frac{p(1-q)}{p(1-q)+(1-p)q} \cdot R(a_L) + R(\gamma) - w_H\} - [pq + (1-p)(1-q)] \cdot SP$

$= (1-p)(1+q)R(a_H) + p(2-q)R(a_L) - w_L + [p(1-q) + (1-p)q] \cdot [R(\gamma) - w_H] - [pq + (1-p)(1-q)] \cdot SP \leq 0.$

This gives: $w_H \geq \frac{(1-p)(1+q)R(aH) + p(2-q)R(aL) - wL - [pq+(1-p)(1-q)]SP}{p(1-q)+(1-p)q} + R(\gamma)$

Expected utilities in respectively the first and the second period, for an agent having received signal s_H:

$EU_{A,\,t1}\,(s = s_H) \quad = w_L - [p(1-a_H) + (1-p)(1-a_L)]$

$EU_{A,\,t2}\,(s = s_H) \quad = P(S_H|s_H) \cdot P(a=a_H|s=s_H, S = S_H) \cdot EU_{A,\,t2}\,(a=a_H|\ s = s_H, S = S_H) + P(S_H|s_H) \cdot P(a=a_L|s=s_H, S = S_H) \cdot EU_{A,\,t2}\,(a=a_L|\ s = s_H, S = S_H) + P(S_L|s_H) \cdot (SP)$

$= [pq + (1-p)(1-q)] \cdot \frac{pq}{pq+(1-p)(1-q)} \cdot [w_H - (1-a_H)] + [pq + (1-p)(1-q)] \cdot \frac{(1-p)(1-q)}{pq+(1-p)(1-q)} [w_H - (1-a_L)] + [p(1-q) + (1-p)q] \cdot SP$

$= pq \cdot [w_H - (1-a_H)] + (1-p)(1-q) \cdot [w_H - (1-a_L)] + [p(1-q) + (1-p)q] \cdot SP$

$EU_A\,(s = s_H) \quad \geq \quad U_A^{out}$

$EU_{A,\,t1}\,(s = s_H) + EU_{A,\,t2}\,(s = s_H) \quad \geq \quad U_A^{out}$

$= w_L - [p(1-a_H) + (1-p)(1-a_L)] + pq\cdot[w_H - (1-a_H)] + (1-p)(1-q)\cdot[w_H - (1-a_L)] + [p(1-q) + (1-p)q]\cdot SP$

$= w_L - p(1-a_H) - pq(1-a_H) - (1-p)(1-a_L) - (1-p)(1-q)(1-a_L) + [pq + (1-p)(1-q)]w_H + [p(1-q) + (1-p)q]\cdot SP$

$= w_L - p(1+q)(1-a_H) - (1-p)(2-q)(1-a_L) + [pq + (1-p)(1-q)]w_H + [p(1-q) + (1-p)q]\cdot SP \quad \geq \quad U_A^{out}$

This gives: $w_H \geq \frac{Ua,out - wL + p(1+q)(1-aH) + (1-p)(2-q)(1-aL) - [p(1-q) + (1-p)q]SP}{pq + (1-p)(1-q)}$

Total expected utility for an agent having received signal s_L. This should be lower than his outside option:

$EU_A\ (s = s_L) \quad \leq \quad U_A^{out}$

$EU_{A,\,t1}\ (s = s_L) + EU_{A,\,t2}\ (s = s_L) \quad \leq \quad U_A^{out}$

$EU_{A,\,t1}\ (s = s_L) + P(S_H|s_L)\cdot P(a=a_H|s=s_L,\ S = S_H)\cdot EU_{A,\,t2}\ (a=a_H|\ s = s_L,\ S = S_H) + P(S_H|s_L)\cdot P(a=a_L|s=s_L,\ S = S_H)$
$\cdot EU_{A,\,t2}\ (a=a_L|\ s = s_L,\ S = S_H) + P(S_L|s_L)\cdot(SP) \quad \leq \quad U_A^{out}$

$= w_L - [(1-p)(1-a_H) + p(1-a_L)] + [p(1-q) + (1-p)q]\cdot\frac{(1-p)q}{p(1-q) + (1-p)q}\cdot[w_H - (1-a_H)] + [pq + (1-p)(1-q)]\cdot$
$\frac{p(1-q)}{p(1-q) + (1-p)q}[w_H - (1-a_L)] + [pq + (1-p)(1-q)]\cdot SP$

$= w_L - [(1-p)(1-a_H) + p(1-a_L)] + (1-p)q\cdot[w_H - (1-a_H)] + p(1-q)\cdot[w_H - (1-a_L)] + [pq + (1-p)(1-q)]\cdot SP$

$= w_L - (1-p)(1-a_H) - p(1-a_L) + (1-p)qw_H - (1-p)q(1-a_H) + p(1-q)w_H - p(1-q)(1-a_L) + [pq + (1-p)(1-q)]\cdot SP$

$= w_L - (1-p)(1+q)(1-a_H) - p(2-q)(1-a_L) + [p(1-q) + (1-p)q]w_H + [pq + (1-p)(1-q)]\cdot SP \quad \leq \quad U_A^{out}$

This gives: $w_H \leq \frac{Ua,out - wL + (1-p)(1+q)(1-aH) + p(2-q)(1-aL) - [pq + (1-p)(1-q)SP}{p(1-q) + (1-p)q}$