Efficiency wages and severance payments with endogenous shocks

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Abstract

We show that employers use severance payments to commit to higher effort in an efficiency-wage model with an endogenous layoff probability, determined by employer and employee effort. Yet as severance payments increase the rent necessary to induce worker effort, employees are not fully compensated for the loss in lifetime utility if laid off. Other instruments are used as far as severance payments prove imperfect for self-commitment by the employer.

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1 Introduction

Strategic decisions of firm owners or managers are rarely discussed in detail in most labor market models. However, economic success of companies not only depends on the cyclical environment a firm faces, but also on the quality of leadership. Job security of workers is strongly affected by managers' decisions, too. Lately, the discussion about management failure has come to the fore, for example, in the automobile sector. In spring 2005, the BMW-group reported high profits for 2005, while General Motors got into financial troubles and unveiled plans to cut down 12,000 jobs in Europe. Worker councils and union representatives accused the management of GM of failures, for which employees have to pay.

Job security is especially relevant for workers if they enjoy rents compared to unemployment. Managers pursuing the goal of shareholder value may not fully consider the interests of employees. Severance payments could compensate the employees for their foregone rent, and induce managers to incorporate the interest of their workforce into their decisions.

This paper investigates an efficiency-wage model based on Shapiro and Stiglitz (1984). We show when severance payments or even additional employment protection regulations can be endogenously rationalized. To account for the ideas discussed above, we extend the basic model in two ways. First, we incorporate that managers' decisions determine the success of the company and therefore firms' employment by having management decide about their effort. Second, we assume that the effort decision by the employee may affect the layoff probability. Given these assumptions, our model supports the empiric facts that higher severance payments result in longer job duration (see Garibaldi and Pacelli (2004)) and that employment protection may reduce employee's incentives for providing effort (see Riphahn (2004)).

The aim of our paper is twofold. First, we want to give an explanation for the existence of employment protection in terms of severance payment. Severance payments are used to credibly commit to higher job security of employees, who accept lower wages. Thereby, wages can be reduced by more than necessary to compensate for the increase in labor costs due to severance payments. Despite the different setup, this basic mechanism is similar to that in

Pissarides (2001). He investigates a matching model with risk-averse workers and risk-neutral firms. By offering severance payments, the employer insures the employee. In our model all agents are risk-neutral so that severance payments cannot be explained as insurance against uncertain income, but are used to solve the incentive problem of the employer. Second, we compare severance payments to other instruments for employer's self-commitment, which are not a direct transfer. Such instruments are, for example, over-investment in firm-specific capital or additional employment protection. We show that severance payments are preferable. Other instruments will be used only as far as severance payments prove as imperfect for self-commitment by the employer.

The idea of self-commitment is well known in the literature on efficiency wages. Saint-Paul (1995) and Fella (2000) consider large firms and let job-security depend on the hiring decision of the employer in previous periods. If the employer hires more workers, the probability to be laid off in case a shock occurs increases for each employee. This increases wages necessary to induce worker effort. Therefore, employers want to commit to a stable employment relationship by granting severance payments. However, both papers neglect the negative effect severance payments may have on employees' incentives to provide effort. This is done by Staffolani (2002). He assumes that workers found shirking cannot be excluded from employment protection and investigates the macroeconomic aspects of firing restrictions. Thereby, his analysis concentrates on state-mandated severance payments which are set proportionally to wages. In contrast, in our setting severance payments and wages are both specified by employers.

Self-commitment can also be attained via other means than severance payments. Saint-Paul (1996) considers an efficiency-wage model where employers commit themselves to stable employment relationships for their main staff by using a second tier of workers to adjust to fluctuations in demand. Katsimi (2003) discusses the possibility of self-commitment by investment in firm-specific capital. She finds that employers use over-investment in firm-specific training to credibly commit to lower labor turnover. We show that such a strategy can only be optimal if severance payments are not appropriate.[1] Dewit et al. (2003), for

[1] Rühmann and Südekum (2002) consider a reverse relationship. In their model severance payment, and

example, have taken up the idea of self-commitment and employment protection in another type of model. Based on the theory of strategic competition by Fudenberg and Tirole (1984), they explain why managers might invest in countries with strict employment protection regulations as a strategic investment.

We proceed as follows. The model is described in Section 2. We first introduce the assumptions (Section 2.1) and characterize the decisions of employers and workers concerning their effort (Section 2.2). In Section 2.3, the resulting employment contract consisting of wages and severance payments is derived. We extend the model for other instruments in Section 3. In section 4, we summarize the main results of the paper.

2 Model

2.1 Description

We consider an economy populated by a large number of potential employers and employees. Time is continuous and workers and employers have an infinite planning horizon. Both are risk neutral and discount future payments with interest rate r. Workers can be employed or unemployed while each employer offers one job, that is, we concentrate on the individual employment relationship. Employed workers decide whether to put forth effort, which is associated with costs $e = \bar{e}$ per period, or to shirk with costs $e = 0$.[2] The employer determines his effort level x. Shirking is observed with the exogenous hazard rate q.

Productivity of filled jobs equals $pe/\bar{e}$. Idiosyncratic shocks occur to the firm with hazard rate $\lambda(x, e)$. In case of a shock, the firm is shut down and the worker laid off. We assume that λ is weakly decreasing at a diminishing rate in the effort levels chosen by the employer, i.e. $\lambda_x \leq 0$, $\lambda_{xx} \geq 0$.[3] The rate at which shocks occur is weakly lower if the employee puts forth effort, $\lambda(x, \bar{e}) \leq \lambda(x, 0)$. In addition we assume that, if a worker shirks, an increase in effort by the employer is less effective since, for example, the employer receives less information

therefore a longer expected job tenure, can induce higher human capital investments by the worker.

[2] We assume that if the employee decides to shirk it is always optimal to provide no effort at all. Thereby, effort choice reduces to a dichotomous decision as, for example, in Rocheteau (2002).

[3] Subscripts denote partial derivatives, $\lambda_x = \frac{\partial \lambda}{\partial x}$.

about the actual situation of the firm, i.e. $\lambda_x(x, \bar{e}) \leq \lambda_x(x, 0)$.

At the beginning of the employment relationship, employers offer employees individual employment contracts, i, which beside wages, w^i, may entail severance payments, S^i. The worker is entitled to the severance payment S^i only in case of a layoff due to an idiosyncratic shock, while she does not receive any severance payment if found shirking.[4]

We now compute the respective Bellman equations for workers and employers. Concerning workers we have to distinguish between the value of employment if the worker puts forth effort or shirks. Instantaneous utility of a worker is equal to the difference between the wage, w^i, and her costs of effort. The present-discounted value of prospective lifetime income of an employee providing the required effort level, E^{NS}, is described by

$$rE^{NS} = w^i - \bar{e} + \lambda(x, \bar{e})[U + S^i - E^{NS}], \tag{1}$$

where U is the prospective lifetime income of an unemployed worker. The interest payment on the present value of lifetime income, rE^{NS}, equals current income, $w^i - \bar{e}$ plus the loss in prospective lifetime income, $U + S^i - E^{NS}$, in case a shock occurs. If the worker shirks instead, the Bellman equation reads

$$rE^S = w^i + q[U - E^S] + \lambda(x, 0)[U + S^i - E^S], \tag{2}$$

incorporating the possibility of being dismissed because of shirking.[5]

Employers set wages to induce workers to provide effort $\bar{e}$. The corresponding value of a firm $J(x)$, which equals expected lifetime income of the respective employer, is determined by the Bellman equation

$$rJ(x) = p - w^i - x + \lambda(x, \bar{e})[-S^i - J(x)], \tag{3}$$

[4] We assume that if an employee is caught shirking the employer is able to proof the misconduct in court if necessary. For a model with judicial mistakes see, for example, Galdon-Sanchez and Guell (2003). Goerke (2002) assumes that in case of individual dismissals, it is not possible to deter shirkers from receiving severance payments, but that collective dismissals can be identified as layoffs.

[5] Prospective lifetime income is independent of being dismissed as a shirker or being laid-off because of a idiosyncratic shock. In each case prospective lifetime income is given by non-labor income while unemployed and the option value of finding a new job. Severance payments are added separately to this income.

where $p - w^i - x$ equals current profits and $-S^i - J(x)$ describes the capital loss including severance payments in case a shock occurs.

For the subsequent discussion, we define joint surplus Ω of a single employer-employee-pair as the sum of the value of a firm and the rent that a worker putting forth effort enjoys. The latter is given by the difference between lifetime income E^{NS} and the lifetime income of an unemployed person U. Using Bellman equations (1) and (3) joint surplus can be described by

$$r\Omega(x) = r(J(x) + E^{NS} - U) = p - \bar{e} - x - rU + \lambda(x, \bar{e})[-\Omega(x)]. \tag{4}$$

Interest payments on joint surplus equal the productivity of the job minus effort provided by both parties and opportunity costs rU. The last term gives the loss of the rent Ω in case a shock occurs. Unlike effort provided, wages and severance payments do not show up in joint surplus as they represent pure redistribution between the partners of the match.

2.2 Effort choice

In this section, we first analyze the decision of the employer. After that, we will specify the rent that has to be awarded to the worker to induce her to provide the effort level $\bar{e}$.

The employer chooses effort x at any point in time to maximize the value of the firm. For a given wage and severance payment and effort $\bar{e}$ by the worker, the corresponding first-order condition reads

$$-\lambda_x(x^*, \bar{e})[J(x^*) + S^i] = 1,$$

which, by using (3) can be rewritten as

$$-\lambda_x(x^*, \bar{e}) \left[\frac{p - w^i - x^* + rS^i}{r + \lambda(x^*, \bar{e})} \right] = 1. \tag{5}$$

The employers optimal effort decision is a function of the components of the employment contract, wage and severance payment, $x^*(w^i, S^i)$, where[6]

$$\frac{\partial x^*}{\partial w^i} = -\frac{1}{r} \frac{\partial x^*}{\partial S^i} = \frac{-\lambda_x(x^*, \bar{e})^2}{\lambda_{xx}(x^*, \bar{e})(r + \lambda(x^*, \bar{e}))} < 0. \tag{6}$$

[6]For calculations, see Appendix A.

An increase in wages decreases the profit the employer can extract from the firm and therefore he will reduce his own effort. On the other hand, an increase in severance payment will induce the employer to amplify his effort in order to reduce the probability of paying S^i. That is, severance payments can be used as a device of self-commitment by the employer concerning his own effort.

Having discussed employer's effort choice, we now examine the employee's effort decision and determine the necessary rent to deter her from shirking. To induce workers to provide effort $\bar{e}$, wages w^i have to be set so that prospective lifetime income of a non-shirker is at least as high as the corresponding lifetime income of a shirker, $E^{NS} \geq E^S$. Both, E^{NS} and E^S are increasing in wages w^i, while lifetime-income of a non-shirker exhibits a steeper slope. Therefore, for a given severance payment, the minimum efficiency wage just equates lifetime utility of a non-shirker and a shirker, $E^{NS} = E^S = E$.

Using equations (1) and (2), we calculate the rent $R = E - U$ that must be guaranteed to an employed worker to induce her to exert the effort level $\bar{e}$ as

$$R(x^*, S) := E - U = \frac{\bar{e} + [\lambda(x^*, 0) - \lambda(x^*, \bar{e})]S^i}{q + \lambda(x^*, 0) - \lambda(x^*, \bar{e})}. \tag{7}$$

If worker's effort did not influence the probability of idiosyncratic productivity shocks, the last equation would reduce to $\bar{e}/q$, as in Shapiro and Stiglitz (1984). In this case, workers get compensated for the loss they incur by providing effort compared to shirking. If the effort decision by the worker influences the rate at which the firm closes down, the worker has an additional incentive to provide effort to retain her rent with higher probability. However, the rent of an employee now increases in severance payments, as a layoff becomes less severe for the employee,

$$\frac{\partial R}{\partial S^i} = \frac{\lambda(x^*, 0) - \lambda(x^*, \bar{e})}{q + \lambda(x^*, 0) - \lambda(x^*, \bar{e})} \tag{8}$$

where $0 \leq \frac{\partial R}{\partial S^i} < 1$. The extent, at which the necessary rent increases in severance payments thereby depends on the probability that a shirking worker is found being idle, q. The higher this probability, the lower the increase in the rent as workers loose their entitlement to severance payments with higher probability.

When a worker is laid off, her loss in lifetime income is given by $E - U - S^i$. Given equation (7), the loss equals

$$E - U - S^i = \frac{\bar{e} - qS^i}{q + \lambda(x^*, 0) - \lambda(x^*, \bar{e})}. \tag{9}$$

Therefore, to secure workers from financial losses in case of a layoff ($E - U - S^i = 0$), severance payments still have to equal $\frac{\bar{e}}{q}$ as in standard efficiency-wage models. In this case, the incentive to provide effort to reduce the probability of a firm-specific shock no more exists for the worker and the rent just offsets her expected saving on effort costs, $\bar{e}/q$.

Using equation (1), the necessary efficiency wage on firm level, $w^{eff,i}$, is given by

$$w^{eff,i} = \bar{e} + rU - \lambda(x^*, \bar{e})S^i + (r + \lambda(x^*, \bar{e}))R(x^*, S^i). \tag{10}$$

The efficiency wage compensates the worker for opportunity costs rU and effort provided $\bar{e}$. In addition, wages entail a premium to induce the employee to provide the required effort level $\bar{e}$. The premium equals the annuity of the rent a worker enjoys compared to unemployment.

Inserting the efficiency wage into equation (5), in equilibrium optimal effort chosen by the employer can also be described by

$$-\lambda_x(x^*, \bar{e}) \left[\frac{p - x^* - \bar{e} - rU}{r + \lambda(x^*, \bar{e})} - (R(x^*, S^i) - S^i) \right] = 1, \tag{11}$$

where the term in brackets equals joint surplus of the employer-employee-pair minus the difference between the rent of the employee and stipulated severance payments. The latter expression will be helpful in interpreting the results in the next section.

2.3 Employment contract

At the beginning of the employment relationship, the employer decides about the terms of the labor contract, wage w^i and severance payment S^i. His objective is to maximize the value of the firm subject to the constraint of granting the employee the rent necessary to induce her to provide effort, i.e. $E^{NS} - U \geq R(x^*, S^i)$. As the optimal effort of the employer is a function of wages and severance payments, the resulting repercussions have to be taken into consideration. The optimization problem therefore reads

$$\max_{w^i,S^i} J(x^*(w^i,S^i),w^i,S^i) \text{ s.t. } E^{NS}-U \geq R(x^*(w^i,S^i),S^i).$$

and the corresponding Lagrangian is given by

$$\begin{aligned}
\mathscr{L}(w^i,S^i,\mu) &= \frac{p-w^i-x^*(w^i,S^i)-\lambda(x^*(w^i,S^i),\bar{e})S^i}{r+\lambda(x^*(w^i,S^i),\bar{e})} \\
&\quad +\mu\left[\frac{w^i-\bar{e}+\lambda(x^*(w^i,S^i),\bar{e})S^i}{r+\lambda(x^*(w^i,S^i),\bar{e})}-R(x^*(w^i,S^i),S^i)\right], \qquad (12)
\end{aligned}$$

where μ is the Lagrange multiplier. Applying the Envelope theorem, i.e. $\frac{\partial J}{\partial x}\big|_{x=x^*}=0$, the first order conditions are[7]

$$\begin{aligned}
\frac{\partial \mathscr{L}}{\partial w^i} &= -\frac{1}{r+\lambda(x^*,\bar{e})} \\
&+ \mu\left[\frac{1}{r+\lambda(x^*,\bar{e})}-\frac{\lambda_x(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})}[E^{NS}-U-S^i]\frac{\partial x^*}{\partial w^i}-\frac{\partial R}{\partial x^*}\frac{\partial x^*}{\partial w^i}\right]=0 \qquad (13)\\
\frac{\partial \mathscr{L}}{\partial S^i} &= -\frac{\lambda(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})} \\
&+ \mu\left[\frac{\lambda(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})}-\frac{\lambda_x(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})}[E^{NS}-U-S^i]\frac{\partial x^*}{\partial S^i}-\frac{\partial R}{\partial x^*}\frac{\partial x^*}{\partial S^i}-\frac{\partial R}{\partial S^i}\right]=0 \qquad (14)\\
\frac{\partial \mathscr{L}}{\partial \mu} &= 0. \qquad (15)
\end{aligned}$$

Inserting equation (14) into (13) and using equation (6)[8], we get

$$\mu=\frac{1}{1-\frac{\partial R}{\partial S^i}}=\frac{q+\lambda(x^*,0)-\lambda(x^*,\bar{e})}{q} \qquad (16)$$

where the last equality follows from equation (8). The Lagrange multiplier equals one in equilibrium in case the rent R does not depend on the level of severance payments, which corresponds to the case that the effort decision by the employee does not affect the rate of firm-specific shocks λ. Otherwise the Lagrange multiplier is greater than one. In equilibrium,

[7] For calculations, see Appendix B.
[8] For calculations, see Appendix C.

the Lagrange multiplier indicates how an exogenous increase in the rent R or lifetime utility of an unemployed U affects the value of the firm. Therefore, as long as the effort decision of employees does not affect the hazard-rate λ, lifetime income of workers and firms-owners are interchangeable by a factor of one. Otherwise firm value decreases by more than the increase of lifetime income of workers.

Next, we calculate severance payment in equilibrium. Inserting equation (16) into the first order condition (13) yields after some rearrangements[9]

$$\left(\frac{\bar{e}}{q} - S^i\right) = \frac{\lambda(x^*, 0) - \lambda(x^*, \bar{e})}{q\left[\lambda_x(x^*, \bar{e}) - \frac{(r+\lambda(x^*,\bar{e}))(\lambda_x(x^*,0)-\lambda_x(x^*,\bar{e}))}{q+\lambda(x^*,0)-\lambda(x^*,\bar{e})}\right]\frac{\partial x^*}{\partial w^i}}. \tag{17}$$

Given our assumption of effort levels being independent or complements, $\lambda_x(x^*, 0) \geq \lambda_x(x^*, \bar{e})$, the term in brackets in the denominator is negative. Therefore, as $\frac{\partial x^*}{\partial w^i} < 0$, equation (17) can only be fulfilled for

$$S^i < \frac{\bar{e}}{q},$$

if $\lambda(x^*, 0) > \lambda(x^*, \bar{e})$ or

$$S^i = \frac{\bar{e}}{q},$$

in case worker's effort decision does not affect the rate of firm-specific shocks, respectively. That is, workers incur a financial loss if they are made redundant in the first case, while, in the latter case, optimal severance payments fully compensate workers for their loss in lifetime income when made redundant.

In this setting, severance payments are not neutral with respect to labor costs. First, in exchange for an increase in severance payments, employers can cut down wages to the extent that severance payments constitute deferred renumeration. Concerning labor costs, these two effects cancel out. But, second, effort exerted by employers increases in offered severance payment, which is described by equation (6) and reinforced by the possible decrease in wages. Employees anticipate a longer job tenure. As long as severance payments are lower than $\bar{e}/q$, this implies an additional gain for the employee, so that, for a given rent R efficiency wages can be decreased by more than the first effect. Third, the decrease in wages is counteracted

[9]For calculations, see Appendix D.

by the increase in the rent that results when severance payments are increased, which by itself leads to higher efficiency wages.

In case employees' effort decision does not affect the hazard rate λ, the latter effect vanishes as the rent is independent of severance payments. Employers use severance payments to commit themselves to a high effort level while paying the resulting efficiency wage to ensure effort by employees.

In contrast, if the employee's effort decision also increases the rent that has to be guaranteed to induce the worker to exert effort, the employer will choose to only partly secure workers of income losses in case of a layoff. He balances self-commitment and the need to award a higher rent to the employee. The two incentive problems of the employer and the employee are no longer separable in this general setting.

If neither the effort of employers nor the effort level of employees affect the rate of idiosyncratic shocks, severance payments are indeterminate in equilibrium. In this case only the first effect mentioned above still works. Wages and severance payments would just be two instruments to transfer funds from the employer to the employee. Therefore, in this case the Lazear result applies (see, Lazear (1990), Burda (1992)).

These findings are summarized in the following remark:

Remark 1: *Employers use severance payments as a self-commitment device to reduce efficiency wages. In case employee's effort does not affect the rate of idiosyncratic shocks, severance payments fully offset the loss in lifetime income of a worker laid-off. Otherwise workers are only partly insured against the loss in income.*

The discussion about optimal severance payments can be directly linked to the question, whether employers maximize the joint surplus of a specific match. As neither wages nor severance payments affect joint surplus of an employer-employee pair, the employer's effort level which maximizes joint surplus is independent of the specific setting and implicitly given by

$$-\lambda_x(x^p, \bar{e}) \left[\frac{p - x^p - \bar{e} - rU}{r + \lambda(x^p, \bar{e})} \right] = 1, \tag{18}$$

while the level of effort actually provided by the employer is given by equation (11). In case the hazard rate λ does not depend on the effort level of the employee, employers maximize joint surplus in equilibrium. By setting the severance payment equal to the worker's rent R, only the employer is affected when a shock occurs. As employers implicitly maximize total surplus of the employer-employee-pair, a marginal increase in the rent necessary to induce effort $\bar{e}$ would lead to an equivalent decrease in the value of the firm, leaving joint surplus unaffected. If effort of the employee affects the hazard rate of firm-specific shocks, employers do not maximize joint surplus of the employer-employee-pair. Severance payments equal to $\bar{e}/q$, which would induce employer's effort that maximizes joint surplus, is too expensive from the employer's point of view, as R is increasing in severance payments. In equilibrium, the employer balances the increase in overall surplus and the increase in the employee's rent, so that his effort level falls short of the value x^p. If employees enjoy rents, profit maximization and surplus maximization may not coincide.[10]

Remark 2: *The effort level chosen by the employer maximizes joint surplus of the employer-employee pair only if the rate of idiosyncratic shocks is independent of employees' effort. Otherwise, the employer's effort level falls short of the effort level maximizing joint surplus. The incentive problems of employer and employee are no longer separable.*

3 Extension

Until now we have only allowed for severance payments as a commitment device. In this section, we introduce an additional instrument, which is not a transfer to workers. For example, this instrument can be interpreted as over-investment in firm-specific capital or as additional firing costs. We show that direct transfers such as severance payments are preferred by the employer. Other means for self-commitment are only used in case severance payments are imperfect for self-commitment.

[10] See Schmitz (2004) for a similar result.

In general, we assume that the additional instrument is associated with initial costs I, which have to be paid by the employer at the beginning of the employment contract. The initial investment may influence current productivity of the match, $p(I)$. We define a neutral investment strategy by a rate of return $p'(I) = r + \lambda(x^I, \bar{e})$, where x^I is optimal effort of the employer. That is the expected net present value of marginal investment is zero.[11]

In case of firm-specific capital investments, I can be thought of as sunk investment costs, while $p'(I) > 0$ and $p''(I) < 0$. Interpreting the additional investment as firing costs we can conceive of payment I as an additional fund set up at the beginning of the employment relationship. The employer receives interest payments rI, so that $p'(I) = r$. When a layoff occurs, the employer forfeits the additional fund.[12]

The Bellman-equation for firms now reads

$$rJ(x) = p(I) - w^i - x + \lambda(x^*, \bar{e})(-S^i - J(x)). \tag{19}$$

The employer's choice of effort x^I is implicitly defined by

$$-\lambda_x(x^I, \bar{e}) \left[\frac{p(I) - w^i - x^I + rS^i}{r + \lambda(x^I, \bar{e})} \right] = 1. \tag{20}$$

In this setting, the optimal effort level is also influenced by the original investment level I, $x^I = x^I(w^i, S^i, I)$. Higher investment expenses increase the effort level chosen by employers since for given wages and severance payments future profits increase in the investment level,

$$\frac{\partial x^I}{\partial I} = \frac{p'(I)\lambda_x(x^I, \bar{e})^2}{(r + \lambda(x^I, \bar{e}))\lambda_{xx}(x^I, \bar{e})} = -p'(I)\frac{\partial x^I}{\partial w^i} > 0, \tag{21}$$

while $\frac{\partial x^I}{\partial w^i}$ and $\frac{\partial x^I}{\partial S^i}$ are still given by equation (6) with x^I replacing x^*.

As employees are not directly affected by the investment decisions by their employers, the no-shirking condition derived in section 2.2 applies further on.

Concerning the employment contract employers now maximize

$$J(x^I(w^i, S^i, I), w^i, S^i, I) - I$$

[11]Additional effects concerning employer's effort level x have not to be taken into account due to the Envelope theorem.

[12]This assumption is equivalent to modeling firing restrictions as costs due at the time of a layoff. Again, firing costs are not due if a worker is dismissed due to shirking.

with respect to wages w^i, severance payments S^i and investment $I \geq 0$, taking into consideration the requirement to induce worker effort $\bar{e}$. With μ as the Lagrange multiplier, the first order conditions are now given by equations (13), (14), (15) and

$$\begin{aligned} I\frac{\partial \mathscr{L}}{\partial I} &= I\left(\frac{p'(I)}{r+\lambda(x^I,\bar{e})} - 1 \right. \\ &\left. +\mu\left[-\frac{\lambda_x(x^I,\bar{e})}{r+\lambda(x^I,\bar{e})}(E^{NS} - U - S^i)\frac{\partial x^I}{\partial I} - \frac{\partial R}{\partial x^I}\frac{\partial x^I}{\partial I}\right]\right) = 0 \end{aligned} \tag{22}$$

As equations (13), (14) and (15) are still valid, μ and the optimal severance payments are still given by equations (16) and (17) with x^* replaced by x^I. The remaining question is, whether investment I is positive and whether the optimal effort level of the employer has changed. In the latter case, severance payments would also be adjusted according to the new equilibrium level of $x^I \neq x^*$.

There are two possible solutions. First, an interior solution may exist, so that $I > 0$ and $\partial\mathscr{L}/\partial I = 0$ holds. Otherwise, optimal investment costs are zero and $\partial\mathscr{L}/\partial I$ has a negative sign at $I = 0$.

Using equation (17), we derive

$$\frac{\partial \mathscr{L}}{\partial I} = \frac{p'(I)}{r+\lambda(x^I,\bar{e})}\frac{q+\lambda(x^I,0)-\lambda(x^I,\bar{e})}{q} - 1. \tag{23}$$

Optimal investment I equals zero if

$$p'(0) < \frac{q(r+\lambda(x^I,\bar{e}))}{q+\lambda(x^I,0)-\lambda(x^I,\bar{e})} \tag{24}$$

holds, where $x^I = x^*$. Otherwise, optimal investment I is given by

$$p'(I) = \frac{q(r+\lambda(x^I,\bar{e}))}{q+\lambda(x^I,0)-\lambda(x^I,\bar{e})} \tag{25}$$

That is, given a interior solution, optimal investment is determined by a rate of return of less than $r+\lambda(x^I,\bar{e})$ in case employee's effort also affects the rate of firm-specific shocks λ. On the other hand, if this rate is independent of effort exerted by the employee, the rate of return of marginal investment coincides with the adjusted interest rate $r+\lambda(x^I,\bar{e})$, that is the employer pursues a neutral investment strategy since the expected present value of marginal investment equals investment costs. In this case optimal self-commitment is reached by using severance payments alone. Otherwise, the employer chooses a higher investment level as it allows him to credibly commit to higher effort levels without raising the rent of the employee. But over-investment will only be used if severance payments are imperfect concerning their use as a self-commitment device.

In case of firm-specific investments, the interpretation of this result is straightforward. Concerning firing costs the rate of return equals $p'(I) = r$. Therefore, with 25 it follows that additional firing restrictions are only optimal if

$$q < r\frac{\lambda(x^*, 0) - \lambda(x^*, \bar{e})}{\lambda(x^*, \bar{e})} \tag{26}$$

holds. That is firing costs are only applied if the rate with which a shirking worker is detected is relatively small compared to the influence of the employee's effort decision on the rate of firm-specific shocks. In this case, the rent of the employee increases sharply in severance payments.

Remark 3: *Instruments for self-commitment which are not a transfer to the employee are only used as far as optimal self-commitment cannot be achieved by severance payments alone. In case the employee's effort decision does not influence the rate of idiosyncratic shocks, employers rely on severance payments alone.*

4 Conclusion

The model illustrates not only the possible use of severance payments as a component of employment contracts in an efficiency wage framework, but also their limitations. The employer uses severance payments to self-commit to provide a high effort level, thereby he reduces necessary efficiency wages and increases total surplus of the employer-employee pair. But if worker effort also influences the probability of a lay-off, severance payments reduce incentives for employees to provide effort. Therefore, the rent necessary to induce employees to provide effort increases in severance payments, diminishing the profit of employers. Employment contracts the increase in the rent of workers and the loss in joint surplus due to reduced incentives for employers.

Other possibilities for self-commitment are firm-specific investments and the incorporation of pure firing costs. In contrast to severance payments, these instruments cause direct costs, but prevent an increase in the rent of the employee. In case severance payments are not associated with an increasing rent for the employee, neither over-investment in firm-specific capital nor additional pure firing costs will be optimal. In addition, the application of pure firing costs depends on the specific parameters of the model. They will be optimal if the probability of a shirking worker being caught idle is relatively low compared to the influence of the employee's effort decision on the layoff rate, that is, the rent necessary to induce workers to provide effort increases sharply in severance payments. Concerning pure firing costs additional problems of time-inconsistence may arise, since when a layoff occurs neither party benefits from these payments. It is therefore possible that employers appreciate state-mandated dismissal regulations.

Appendix

A Derivation of equation (6)

Totally differentiating equation (5) with respect to x^*, w^i and S^i we get

$$\left(-\lambda_{xx}(x^*,\bar{e})\frac{p-w^i-x^*+rS^i}{r+\lambda(x^*,\bar{e})}-\lambda_x(x^*,\bar{e})\left[\frac{-(r+\lambda(x^*,\bar{e}))-\lambda_x(x^*,\bar{e})(p-w^i-x^*+rS^i)}{(r+\lambda(x^*,\bar{e}))^2}\right]\right)dx^*$$
$$-\lambda_x(x^*,\bar{e})\left(-\frac{1}{r+\lambda(x^*,\bar{e})}dw^i+\frac{r}{r+\lambda(x^*,\bar{e})}dS^i\right)=0.$$

Using equation (5) to replace $p-w^i-x^*+rS^i$ with $-\frac{r+\lambda(x^*,\bar{e})}{\lambda_x(x^*,\bar{e})}$ the last equation can be transformed to

$$\frac{\lambda_{xx}(x^*,\bar{e})}{\lambda_x(x^*,\bar{e})}dx^*=\lambda_x(x^*,\bar{e})\left(-\frac{1}{r+\lambda(x^*,\bar{e})}dw^i+\frac{r}{r+\lambda(x^*,\bar{e})}dS^i\right) \tag{27}$$

which yields equation (6).

B Derivation of the first order conditions equations (13) and (14)

Differentiating the Lagrangian, equation (12), with respect to wages w^i yields

$$\frac{\partial \mathscr{L}}{\partial w^i} = \frac{-1}{r+\lambda(x^*,\bar{e})} + \mu \left[\frac{1}{r+\lambda(x^*,\bar{e})} \right.$$

$$\left. + \frac{\lambda_x(x^*,\bar{e})S^i(r+\lambda(x^*,\bar{e})) - \lambda_x(x^*,\bar{e})(w^i - \bar{e} + \lambda(x^*,\bar{e})S^i)}{[r+\lambda(x^*,\bar{e})]^2} \frac{\partial x^*}{\partial w^i} - \frac{\partial R}{\partial x^*}\frac{\partial x^*}{\partial w^i} \right] = 0.$$

Making use of $E^{NS} - U = \frac{w^i - \bar{e} + \lambda(x^*,\bar{e})S^i}{r+\lambda(x^*,\bar{e})}$ the second term in brackets can be transformed to $-\frac{\lambda_x(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})}(E^{NS} - U - S^i)$, which yields equation (13). Equation (14), is derived by similar calculations.

C Derivation of equation (16)

Using $\frac{\partial x^*}{\partial S^i} = -r\frac{\partial x^*}{\partial w^i}$, equation (6), equation (14) can be rearranged to

$$-\mu\lambda_x(x^*,\bar{e})\frac{E^{NS} - U - S^i}{r+\lambda(x^*,\bar{e})}\frac{\partial x^*}{\partial w^i} - \frac{1}{r}\frac{\partial R}{\partial x^*}\frac{\partial x^*}{\partial w^i} = -(1-\mu)\frac{\lambda(x^*,\bar{e})}{r(r+\lambda(x^*,\bar{e}))} - \mu\frac{\partial R}{\partial S^i}.$$

Inserting the result into equation (13) we get

$$-(1-\mu)\frac{1}{r+\lambda(x^*,\bar{e})} - (1-\mu)\frac{\lambda(x^*,\bar{e})}{r(r+\lambda(x^*,\bar{e}))} - \mu\frac{1}{r}\frac{\partial R}{\partial S^i} = 0.$$

Solving for the Lagrange multiplier μ yields

$$\mu = \frac{1}{1 - \frac{\partial R}{\partial S^i}},$$

the first part of equation (16).

The partial derivative of the rent R with respect to severance payments is given by equation (8), as $\frac{\lambda(x^*,0) - \lambda(x^*,\bar{e})}{q + \lambda(x^*,0) - \lambda(x^*,\bar{e})}$, which yields the second part of equation (16).

D Derivation of equation (17)

In equilibrium $E^{NS} - U - S^i = R - S^i$ holds. Using equations (7) and (16) to replace $E^{NS} - U - S^i$ and μ, equation (13) can be rewritten as

$$\underbrace{-\frac{1}{r+\lambda(x^*,\bar{e})} + \frac{q+\lambda(x^*,0)-\lambda(x^*,\bar{e})}{q(r+\lambda(x^*,\bar{e}))}}_{\frac{\lambda(x^*,0)-\lambda(x^*,\bar{e})}{q(r+\lambda(x^*,\bar{e}))}}$$

$$-\frac{\lambda_x(x^*,\bar{e})}{r+\lambda(x^*,\bar{e})}\left(\frac{\bar{e}}{q} - S^i\right)\frac{\partial x^*}{\partial w^i} - \frac{\lambda_x(x^*,0)-\lambda_x(x^*,\bar{e})}{q+\lambda(x^*,0)-\lambda(x^*,\bar{e})}\left(S^i - \frac{\bar{e}}{q}\right)\frac{\partial x^*}{\partial w^i} = 0,$$

which yields equation (17).

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