Severance Payments and Firm-specific Human Capital

Jens Suedekum – Peter Ruehmann

Abstract. What effect does employment protection through severance payments have on the behaviour of employed workers? We analyse this issue within a stochastic two-period framework where workers decide on human capital investments and find two competing effects: severance payments imply higher job security that fosters human capital formation. At the same time, a lay-off is perceived by the workers to be a weaker penalty if severance payments are provided. This incentive lowers their optimal amount of firm-specific investments. Which effect prevails on balance depends on the distribution of investment returns among firm and workers. For strong positive reactions, employment protection is also in the interests of the firm.

1. Introduction

There are probably few other issues that would produce such broad agreement among economists and policy commentators, but that European labour markets are highly inflexible and should undergo substantial reforms. One device for 'Eurosclerotic' inflexibility that is frequently critiqued is the high degree of employment protection legislation (EPL). The list of objections against EPL is long. Ultimately, it is often seen, among other

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things, as being 'at the root' of high continental unemployment (Siebert, 1997). Rigorous econometric testing only partly supports this perception as significant negative impacts on overall unemployment are difficult to identify in the data.[1] At the same time, one hardly ever hears convincing arguments that are in favour of some EPL. Often it is defended on vague justice or equity grounds, its existence seemingly due to mighty unions that manage to defend the rents of well-organized insiders.

Recently, however, a literature on severance payments (SP)[2] has emerged, arguing that EPL can also have efficiency-enhancing effects if the economy is subject to frictions and SP are suited to solving certain market or coordination failures, e.g. in insurance markets (Alvarez, Veracierto, 2001; Cahuc, Zylberberg, 1999; Kuhn, 1992; Levine, 1991; Pissarides, 2001). In this paper, we want to shed some light on the efficiency effects of employment protection from a different perspective. We do not focus on overall welfare or employment, as most authors do, but rather on the behaviour of *employed workers*. This is a largely unexplored issue. Still, at some points in the literature it is possible to find controversial viewpoints on this matter.

It is sometimes argued that SP increase the incentive for employed workers to invest in firm-specific human capital, or respectively to provide more effort at the workplace[3] (Buttler, Walwei, 1990; Houseman, 1990; Schmid, 1995). The reason is that workers perceive higher job security through EPL, they rely more heavily on the long-term validity of their labour contracts and are consequently willing to provide stronger commitment to a specific employer.[4] This enhancement of firm-specific skills is generally thought to benefit both sides — employees and employers. If this argument holds, which one might call the *incentive effect* of employment protection, there might be some neglected merits of continental European labour relations that counteract the widely acknowledged problematic aspects. But there are also different positions. Since a lay-off is cushioned by redundancy transfers, workers might perceive firing not to be such a strong penalty. Under this set of incentives, the motivation of incumbent workers to invest in specific human capital is reduced and a lower degree of 'firm-specific commitment' can follow as the consequence of employment protection. Such arguments, which one might label the *lethargy effect* of SP, are presented by Ichino and Riphahn (2001) and Goerke (2003), for example.

Which of the two scenarios is a better approximation of reality? In this paper we argue that really both mechanisms are at work in parallel and there is a trade-off between them. Our aim is to provide a systematic theoretical analysis that is capable of indicating under what circumstances either of the competing forces is likely to dominate the other. Our main finding is that this crucially depends on the conditions of the specific firm under consideration, in particular on whether workers have strong incentives to build up specific human capital to begin with.

However, even if the incentive effect of job security predominates, there might be no essential need for legislation if private parties recognize the side-effects of job security.[5] Some degree of SP can also be in the interests of the firm if the induced human capital formation is strong.

The remainder of the paper is organized as follows: Section 2 introduces the model structure, Section 3 presents the basic decision problem of a representative worker, and Section 4 analyses the impacts of a marginal increase in SP on the optimal human capital investment. Section 5 discusses the implications for the firm's profits and determines the optimal level of SP that the firm would provide. Section 6 concludes.

2. The model structure

We present a simple two-period partial equilibrium model where identical workers are employed at one particular firm and decide on firm-specific human capital investments. In order to analyse the impact of SP on optimal human capital formation, it is essential that not only workers expect returns from the specific investment in the form of higher earnings, but that the firm's expected profits are also an increasing function of the level of human capital embodied by the firm's employees. The second essential requirement is that the investment decisions are made in a stochastic environment, where exogenous shocks might induce the employer to lay off workers.

The firm in our model has a time horizon of two periods $t = \{1, 2\}$ and produces a particular commodity X_t in an imperfectly competitive market with some degree of market or monopoly power. Labour is used as the only variable input, and we assume that the marginal productivity of effective units of labour employed by the firm (L_t) is constant and given by $1/\beta$, i.e.

$L_t = \beta X_t$. Furthermore, production in each period requires that the firm pays a fixed sum F_t, which might be thought of as overhead costs or a required licence fee. The level of fixed cost in the second period, F_2, is assumed to be a random variable and unknown to the firm during $t = 1$. With these assumptions, the firm's profits at time t are given by:

$$\pi_t = p_t X_t - F_t - w_t L_t, \qquad [1]$$

where p_t is the sales price per output unit, and w_t is the wage rate for each effective labour unit employed by the firm. This (unit) wage rate is determined by the market and has to be taken as given by the firm. We suppose that this unit wage rate will not change over time, i.e. $w_1 = w_2 = w$. But its market power allows the firm to charge prices with a mark-up $(1/\mu)$ over marginal costs. For simplicity we assume that this mark-up $1/\mu$ is constant. The firm thus charges output prices:

$$p_t = \frac{1}{\mu}(\beta w), \qquad 0 < \mu < 1. \qquad [2]$$

Inserting the pricing rule and the production function $X_t = (1/\beta)L_t$ into [1], it is clear that profits under this linear technology increase proportionally with the variable input L_t:

$$\pi_t = -F_t + \left(\frac{1-\mu}{\mu}\right) w L_t. \qquad [3]$$

Thus, for any given (unit) wage rate, and provided the firm is active, it runs at some capacity level, which we impose to be given exogenously by $\overline{X}_t$. The firm's labour demand at $t = 1$ is given simply by the output constraint as $\overline{L}_1 = \beta \overline{X}_1$, which refers to the number of effective labour units employed by the firm. This number of labour units is equal to the number of identically employed people, which implies that in $t = 1$ each of the employees embodies exactly one effective labour unit. Let the level of fixed costs at $t = 1$ also be given at F_1, which grants the firm some level of profits $\pi_1 > 0$.

During the first period, workers can invest in firm-specific human capital and expand their embodied effective labour units. More specifically, given that all workers are identical and will reveal the same investment behaviour,[6] the representative

employee will choose some optimal number of labour units $h^* \geqslant 1$ that he/she will embody in $t = 2$. We make the simplifying assumption that the worker finances investments alone, i.e. he/she bares the learning costs necessary to obtain the optimal level of firm-specific human capital, h^*.[7] Through the firm-specific investment of the worker, the output capacity limit $\overline{X}_t$ is expanded for the second period $t = 2$ by the factor $h^* > 1$, i.e. $\overline{X}_2 = h^* \overline{X}_1$. The firm will run at this capacity level provided it is active during the second period, and hence benefits from the output expansion because variable profits increase $1/\mu$ times faster than payroll earnings $wh^* \overline{L}_1$.

However, the firm has no power to directly influence the optimal human capital choice of workers. Put differently, it is impossible for the firm to raise output through pure increases in scale by hiring more workers. But if incumbent workers invest in specific human capital, then output and variable profits increase. This might be so because an expansion of the technologically determined capacity constraint $\overline{X}_1$ is conditional on quality improvements which can be attained only by better training of the incumbent workforce.

At the time when human capital investment decisions have to be made, however, it is uncertain if the firm is actually going to be active in the second period. This depends on the realization of the random variable F_2, which is observed by the firm at the beginning of $t = 2$. As noted above, the fixed costs do not represent any sunk costs, but are required only if the firm remains active during the second period. We consider a uniform distribution of F_2 over the range $[F_1 - c;\ F_1 + c]$, where $c > 0$ is an exogenous parameter. Thus, the expected value of F_2 is equal to the known level F_1.

In a world without employment protection, the firm would choose to remain active in the market for good X if total profits π_2 are positive, given the information on F_2. If fixed costs outweigh variable profits at the capacity constraint $\overline{X}_2$, production is ceased and the plant is shut down. The introduction of SP alters the closure condition, since it makes exit costly for the firm. Production is maintained whenever total profits $\pi_2(\overline{X}_2)$ are greater than the sum of exit costs, which amount to $s\overline{L}_1$. The variable s indicates the mandatory transfer, the SP, to each of the single $\overline{L}_1$ employees in case of a lay-off.[8] Given the information on the distribution of F_2, we can calculate the probability ρ that the firm remains active during $t = 2$. It is

given by

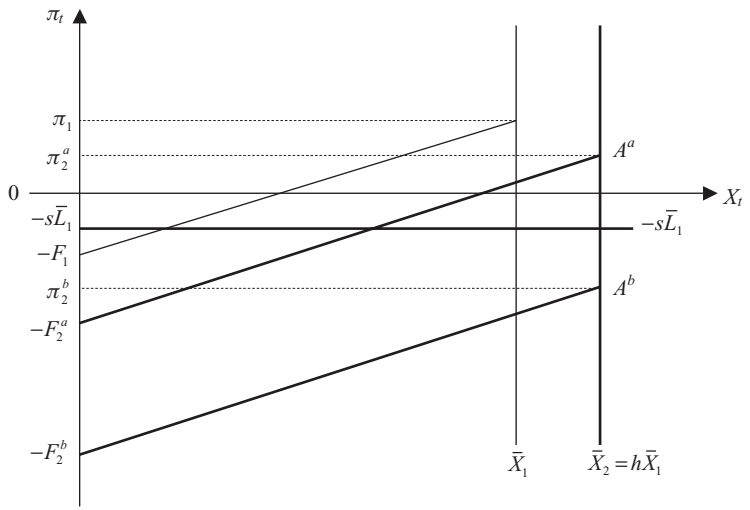
$$\rho = \Pr\left(F_2 < \frac{1-\mu}{\mu}\, wh\bar{L}_1 + s\bar{L}_1 \right)$$

$$= \frac{-(F_1 - c) + \frac{1-\mu}{\mu}\, wh\bar{L}_1 + s\bar{L}_1}{2c}; \qquad [4]$$

ρ is increasing in both s and h: it is *less likely* that the firm closes the higher the level of exit costs s, and the higher the stock of human capital.[9] The intuition for the positive sign of ρ_h is straightforward: the output level in $t = 2$ and thus the level of variable profits is exogenous to the firm, but (positively) depends on the workers' choice h^*. For any given realization of F_2 it is less likely that total profits are negative the higher the stock of specific capital.

The role of the firm in our model is admittedly quite passive. Effectively, apart from setting marked-up prices, it only decides whether to maintain production at the capacity level, or to cease

Figure 1. Profits π_t and the plant closure decision



production completely and shut down the plant.[10] The firm's 'all or nothing' decision is summarized in Figure 1. Profits are linearly increasing in the output level up to the capacity constraint $\bar{X}_t$, which is higher in period $t = 2$ the higher the level of specific capital h^*. Depending on the realization of F_2, profits $\pi_2(\bar{X}_2)$ might fall short of $-s\bar{L}_1$, given by the thick horizontal line, in which case (F_2^b) the firm will decide to close.

3. The worker's decision problem

Each of the $\bar{L}_1$ employed workers is identical, risk neutral, embodies one effective labour unit in period $t = 1$, and consequently earns w. As argued above, we abstract from strategic interactions in the human capital choice of single workers, and consequently focus on a representative employee whose investment decision will be replicated by all other workers. We assume that the costs of 'on the job' learning are imposed exclusively on workers, possibly through unpaid overtime devoted to training. Total learning costs are given by $\alpha(h)h$, where the cost function $\alpha(h)$ is assumed to rise in h at an increasing rate, i.e. $\partial\alpha/\partial h > 0$ and $\partial^2\alpha/\partial h^2 > 0$.

The investment payoff, however, is uncertain, since the firm only keeps on operating with probability ρ. Note that the worker has no incentive to quit him/herself, since he/she carries firm-specific human capital and does not receive any better job offer from another company. Thus, the worker would consider working for a different employer only if the particular firm closed down at the beginning of $t = 2$. This event occurs with probability $(1 - \rho)$, in which case the worker will receive a redundancy compensation s, loose his/her accumulated stock of specific human capital and make earnings w at some other enterprise. The worker's choice problem is to maximize the following inter-temporal value function ψ with respect to the level of specific capital h:

$$\underset{\{h\}}{\text{Max}}\ \psi = \{w - \alpha(h)h + \delta(\rho hw + (1 - \rho)(s + w))\}, \qquad [5]$$

where $0 < \delta < 1$ is a time discount factor. The first-order condition to this problem is given by:

$$-\alpha(h) - \frac{\mathrm{d}\alpha(h)}{\mathrm{d}h}\, h + \delta(\rho w + \rho_h wh - \rho_h(s + w)) = 0. \qquad [6]$$

Keeping in mind that $\rho_{hh} = 0$, we can write the second-order conditions as:

$$\underbrace{-2\,\frac{\mathrm{d}\alpha(h)}{\mathrm{d}h} - h\,\frac{\mathrm{d}^2 a(h)}{\mathrm{d}h^2}}_{\boxed{-}} + \underbrace{2\delta\rho_h w}_{\boxed{+}} \overset{!}{<} 0\,. \qquad [7]$$

The sign of [7] is theoretically ambiguous and the existence of a maximum hinges on functional forms. Yet if the existence of a maximum is warranted,[11] we can rewrite the first-order condition in the following intuitive form:

$$\frac{\alpha(h)}{\delta}\,(1 + \eta_{\alpha,\,h}) = \rho w + \rho_h(hw - (s + w)). \qquad [8]$$

This expression consists of three terms. On the left-hand side are the opportunity costs of human capital formation, where

$$\eta_{\alpha,\,h} = \frac{\mathrm{d}\alpha(h)}{\mathrm{d}h}\,\frac{h}{\alpha(h)}$$

is the elasticity of the function $\alpha(h)$ evaluated at the optimal level h^*. In equilibrium, this expression must equal the sum of two effects that we label the *direct wage effect* ρw and the *job security effect* $\rho_h(hw - (s + w))$. The straightforward intuition for the direct wage effect is that marginal investment costs must equal marginal revenue for the worker. The job security effect stems from the endogenous uncertainty. Since ρ_h is positive, any increase in h makes the job *ceteris paribus* more secure. The overall sign of the job security effect, however, depends on the difference between the attainable earnings with this specific firm and the earnings in the event of a lay-off.

The worker will choose some optimal h^* such that [8] is satisfied. The optimal choice h^* depends on the properties of $\alpha(h)$, on the exogenous variables w and δ, and — most importantly for our purposes — on s, the level of employment protection.

4. An increase in severance payments

We now ask what effect a marginal increase in s has on the optimal choice h^*. Total differentiation of [6] around the optimum

h^*, with all variables except s held constant, yields:

$$\left(-2\,\frac{\mathrm{d}\alpha(h)}{\mathrm{d}h} - h\,\frac{\mathrm{d}^2 a(h)}{\mathrm{d}h^2} + 2\delta\rho_h w \right)\,\mathrm{d}h^* + \delta(\rho_s w - \rho_h)\,\mathrm{d}s = 0. \quad [9]$$

Substituting in ρ_h and ρ_s, we can rewrite [9] to give:

$$\frac{\mathrm{d}h^*}{\mathrm{d}s} = -\,\frac{\dfrac{\delta w \bar{L}_1}{2c}\left(1 - \dfrac{1-\mu}{\mu}\right)}{\left(\dfrac{\partial^2 \psi}{\partial h^2}\,(h^*)\right)}. \quad [10]$$

The denominator is equal to the second-order condition at $h = h^*$, which is negative. Thus, at any maximum of ψ, the marginal effect $\mathrm{d}h^*/\mathrm{d}s$ is positive if and only if the following surprisingly simple condition holds:

$$\mu > \tfrac{1}{2}. \quad [11]$$

If the mark-up $(1/\mu)$ of the firm is too large, i.e. if $\mu < \frac{1}{2}$, an increase in SP leads to a lower optimal value h^*. An instructive way to think about condition [11] is as follows: one can show that firm-specific investments induce an increase in payroll earnings by $(h^* - 1)w\bar{L}_1$ units. The increase in variable profits makes up for $(1/\mu - 1)$ times this amount, and is thus smaller only if μ is greater than $\frac{1}{2}$. In other words, when faced with higher SP, workers are willing to invest more heavily in specific human capital only if the expected increase in payroll (which is shared equally among the $\bar{L}_1$ workers) exceeds the expected increase of variable profits that the firm takes out even though it had not contributed to the financing of the investments.

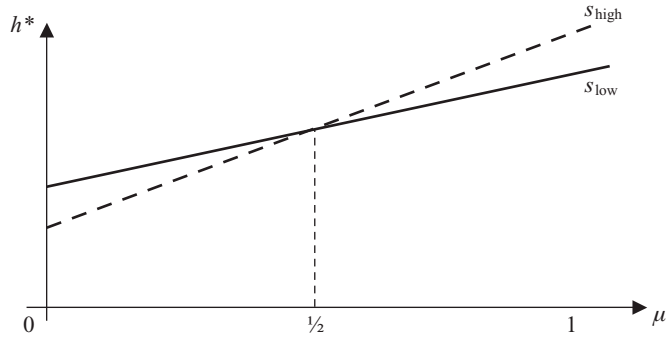
More intuition for this result can be grasped in terms of the direct wage and the job security effect. Upon an increase in s, the worker perceives two changes: firstly, the probability ρ (and thereby the direct wage effect) has increased. Secondly, the attractiveness of maintaining the job relative to receiving s, i.e. the job security effect, has decreased. Subsequently, the worker re-optimizes over h such that the sum of the two matches the (approximately) unchanged opportunity costs. It turns out that for

all cases with $\mu > \frac{1}{2}$ the direct wage effect reacts more strongly in the positive direction than the job security effect in the negative direction. Consequently, the worker will increase h^* in order for [8] to match. The opposite occurs if $\mu < \frac{1}{2}$. In this case, the return to human capital investments for the worker is low, and an increase in s induces the worker to invest less in human capital, since this negatively affects the probability ρ that the firm stays in business during $t = 2$.

The result is summarized in Figure 2, which is a stylized, linear representation of the optimal investments decision h^* as a function of s and μ. The optimal h^* is increasing in μ, and the influence of s is ambiguous. As long as $\mu > \frac{1}{2}$, h^* is higher with high SP than with low SP. At $\mu = \frac{1}{2}$ the choice h^* is independent of the level of s. With $\mu < \frac{1}{2}$, $h^*(s_{\text{low}})$ is higher than $h^*(s_{\text{high}})$.

In the introduction we outlined competing arguments, citing authors who attributed employment protection either with an exclusively positive impact on the level of firm-specific human capital, or with an exclusively negative one. Employment protection can work as an incentive to build up firm-specific skills, because workers perceive a lower default risk of their investments and rely on the long-term validity of their labour contracts. The main idea of this *incentive effect* has been put forward by authors such as Buttler and Walwei (1990), Schmid (1995) and Houseman (1990), and is consistent with our analysis. Yet it is also possible that more employment protection reduces the level of 'firm-specific commitment' since a lay-off is perceived not to be such a strong penalty. The transmission channel of this competing *lethargy effect*, which has been described, for example, by Ichino and

Figure 2. Optimal human capital formation $h^*(s, \mu)$



Riphahn (2001) and Goerke (2003), is also part of our model. And thus the basic message that follows from our analysis is that the influence of SP on the optimal amount of human capital formation is actually ambiguous, since there is a trade-off between two competing forces. Which one dominates crucially depends on the particular firm under consideration at which workers are employed, specifically on the measure of its market power $(1/\mu)$.

5. Implications for the firm's profits

So far we have treated s as an exogenous parameter, imposed on the firm by government policy. But since our analysis did not point to an essential reason for government intervention, we now want to analyse whether the firm would also provide some positive level of s if it could foresee the investment behaviour of the workers.

Intuitively, there are three effects of SP for the firm. The first two are negative: SP are exit costs that can force the firm to operate under loss in $t = 2$. And, in the event of a plant closure, the firm actually needs to pay s and thus realizes negative profits. The argument in favour of SP is that they can induce human capital formation (provided that $\mathrm{d}h^*/\mathrm{d}s > 0$) that also benefits the firm through higher variable profits. If it turns out that this latter effect is strong enough to compensate the two negative ones, we could expect the firm to provide some SP as of free will, without being obliged to do so as a result of public policy.

To demonstrate this, we need to derive a function of the firm's *realized profits* P_2 that needs to be distinguished sharply from π_2, since the firm responds to some realizations of F_2 with exit. Recall that the firm keeps on operating if total profits π_2 exceed the level of exit costs $-s\bar{L}_1$. This event occurs with probability ρ. If, however, the realization of F_2 is such that π_2 is negative and below the level of exit costs, an event occurring with probability $(1 - \rho)$, the firm exits and makes *realized profits* $P_2 = -s\bar{L}_1$, regardless of the value of π_2. Thus, realized profits P_2 are

$$P_2 = \begin{cases} \pi_2 & \text{if } \pi_2 \geqslant -s\bar{L} \\ -s\bar{L}_1 & \text{if } \pi_2 < -s\bar{L} \end{cases}. \qquad [12]$$

Given that the firm remains active during $t = 2$, the range of possible profits goes from $-s\bar{L}_1$ to $-(F_1 - c) + (1 - \mu/\mu)wh^*\bar{L}_1$.

Since F_2 is uniformly distributed, all cases between these two extremes are equally likely. Expected realized profits $E(P_2)$ can thus be written as:

$$E(P_2) = \rho \frac{-(F_1 - c) + \left(\frac{1-\mu}{\mu}\right) wh^* \bar{L}_1 - s\bar{L}_1}{2} - (1-\rho)s\bar{L}_1. \quad [13]$$

In [13], the two negative effects of SP for the firm can be seen directly: s enters twice with a negative sign. The positive effect operates through h^*, which must be increasing in s (i.e. $\mu > \frac{1}{2}$). Rewriting [13] under the use of [4] yields:

$$E(P_2) = c\rho^2 - s\bar{L}_1, \quad [14]$$

with $\rho = \rho(h^*(s), s)$. The firm aims to maximize expected realized profits, and would thus choose the level of s so as to maximize [14] for a given level of μ, taking into account the effects of SP on the optimal human capital formation $h^*(s)$. Suppose that initially, i.e. at the beginning of $t = 1$, a situation exists with $s = 0$. The question is then whether it is in the interests of the firm to set some strictly positive level of s in order to induce human capital investments, i.e. if there exists an interior maximum of $E(P_2)$ associated with some optimal level $s^* > 0$. In the Appendix we show that such a maximum can exist if human capital investments h^* are highly responsive to changes in s. Provided a maximum of $E(P_2)$ exists, the firm would set the following level of SP per worker (s^*):

$$s^* = \frac{2c/\bar{L}_1}{1 + w\left(\frac{1-\mu}{\mu}\right)\left(\frac{\mathrm{d}h^*}{\mathrm{d}s}\right)} + \frac{F_1 - c}{\bar{L}_1} - \frac{1-\mu}{\mu} wh^*. \quad [15]$$

Hence, the firm can also have an interest in providing some employment protection by means of SP if this has strong effects on the human capital formation of the worker(s). We should thus expect a profit-maximizing firm to provide s^* in its own interests, without being obliged to do so as a result of public policy.

6. Conclusion

We have seen that the effect of SP on the behaviour of employed workers, i.e. on the optimal human capital investment choice, is ambiguous. Whereas other authors have pointed either to an exclusively negative or positive impact, we have shown that there is actually a trade-off between two competing forces (that we have called the *incentive effect* and the *lethargy effect*). Which of the two forces predominates is determined in our model by the mark-up parameter μ, which can be interpreted as a measure of the firm's market power.

The optimal amount of firm-specific human capital investments for the representative worker is increasing in μ, because the firm extracts an ever smaller share of the additional output generated through the workers' learning effort.

If the mark-up of the firm is high ($\mu < \frac{1}{2}$), human capital formation is low, since any investment raises variable profits stronger than payroll earnings. If in such an environment the level of SP rises, it is optimal for workers to increase the chance of actually receiving the redundancy compensation by lowering the amount of firm-specific human capital investments.

If, however, the market power of the firm is low ($\mu > \frac{1}{2}$), investment returns induce stronger increases in payroll earnings than in variable profits. Human capital formation is more attractive to workers, because the additionally generated output remains largely in their pockets. In such case, a rise in SP induces an increase in the amount of optimal investment. The perception of higher job security in environments like this is stimulating, because the default risk is lowered, which effectively results in a more vital investment behaviour.

Our model thus suggests that the overall effect of more job security (through SP) depends on whether workers have high incentives to invest in specific human capital to begin with. In corporate environments where it is attractive for workers to commit to their employer anyway, because human capital investments are rewarded by sufficient payment increases, employment protection can act as a complementary motivation to invest. Contrariwise, if workers have a low motivation for 'firm-specific commitment', this may even decrease further if employment protection is provided.

If the effects of SP on human capital formation are strongly positive, firms can also have an interest in providing employment

protection. In this partial equilibrium model, a private provision of some employment protection is possible if parties recognize the positive side-effects of job security. But it would be precipitate to conclude on the basis of our model that public policy is obsolete in terms of providing employment protection legislation, given that our analysis consists only of a partial equilibrium framework and had to abstracted from several potentially important issues.

Probably the most restrictive part of our model is the very low degree of adaptability of the firm, which effectively can produce only at the capacity level or shut down the plant completely. However, our main objective was to analyse how workers' human capital formation is affected by employment protection. The basic insight that we have derived, the trade-off between *job security* and the *lethargy effect*, does not critically depend on the low degree of firm adaptability. Suppose the firm could adjust to adverse exogenous shocks by realigning prices and output while maintaining some production and employment. As long as any single worker faces a non-zero probability of getting laid off, the provision of more job security through SP would still imply two things: (a) a lower default risk of specific investments, and (b) a cushioning of lay-offs through redundancy compensations. Therefore, the overall effect of SP on the optimal choice of firm-specific human capital investments is ambiguous and presumably dependent, at least qualitatively, on similar considerations as in our simplified model.

Appendix: maximum condition $\partial E(P_2)/\partial s$

The first-order condition of [14] with respect to s is:

$$\frac{\partial E(P_2)}{\partial s} = 2c\rho\left(\rho_s + \rho_h \frac{\mathrm{d}h^*}{\mathrm{d}s}\right) - \bar{L}_1 = 0 \qquad [A1]$$

and the second-order condition is given by:

$$\frac{\partial^2 E(P_2)}{\partial s^2} = 2c\left(\overbrace{\rho_s\left(\rho_s + \rho_h \frac{\mathrm{d}h^*}{\mathrm{d}s}\right)}^{\boxed{+}} + \overbrace{\rho\rho_h \frac{\mathrm{d}^2 h^*}{\mathrm{d}s^2}}^{\boxed{-}}\right) \overset{!}{<} 0. \qquad [A2]$$

Since ρ, ρ_s, ρ_h and $(\mathrm{d}h^*/\mathrm{d}s)$ are positive, [A2] is negative only if the term $\rho\rho_h(\mathrm{d}^2h^*/\mathrm{d}s^2)$ is strongly negative. Thus, the existence of a maximum with respect to s requires that the optimal human capital choice h^* reacts very sensitively to a small change in s, and that h^* is increasing in s at a rapidly declining rate. In case a maximum exists, the optimality condition [A1] can be rewritten as:

$$\rho = \frac{1}{1 + w\,\dfrac{1-\mu}{\mu}\,\dfrac{\mathrm{d}h^*}{\mathrm{d}s}}. \qquad [A3]$$

Substituting in the definition of ρ and manipulating [A3] gives equation [15].

Notes

[1] Starting from Lazear (1990), who has argued both theoretically and empirically that EPL substantially lowers employment, the subsequent literature found little evidence for significant negative impacts of EPL (see Addison, Teixeira, 2001; Bentilola, Bertola, 1990; OECD, 1999; Pissarides, 2001).

[2] SP are government-mandated transfers from employers to workers in the event of a lay-off, not a quit. It is a common form of EPL in many OECD countries (see OECD, 1999), both de jure and de facto. Note that SP must not be interpreted as a pure firing tax, and therefore must be distinguished from other forms of EPL as discussed, for example, in Bentilola and Bertola (1990).

[3] The terms 'human capital investment' and work effort are used synonymously in the model.

[4] Some related evidence for the positive impact of employment protection on productivity is presented by Freeman and Medoff (1984). A result in the same spirit comes from Acemoglu and Pischke (2001) for the case of minimum wages.

[5] Pissarides (2001, p. 133) also makes this point: 'it is difficult to see why firms will need legislation to protect them from not wasting firm-specific skills'.

[6] Each worker has a private investment incentive, but might spend too little time on training and free ride on the job security externality induced by the human capital investments of others. But we do not consider this strategic interaction further, and pay attention only to cooperative behaviour among workers, because this seems to be more relevant in the context of one particular small firm with an intact system of social control.

[7] Since the human capital is firm specific, we would normally expect the firm to at least partially contribute to the financing. But including a firm's share in learning costs would only complicate the analysis, without affecting the central insights.

[8] Note that the level of SP does not depend on the human capital decision h^*, i.e. employment protection is provided for employed *people*, not labour units.

[9] From [4] we can compute that $\rho_s = (\bar{L}_1/2c) > 0$ and $\rho_h = (1 - \mu/2c\mu)w\bar{L}_1 > 0$.

[10] The construction of fixed mark-ups over linear marginal costs (which effectively results in production at capacity level) is, however, used also in other contexts, e.g. in the imperfect competition approach to macroeconomics (see Carlin, Soskice, 1990, Ch. 18). We discuss some of its limitations in the conclusion (Section 6).

[11] Our numerical simulations show that it is almost impossible to find functions $\alpha(h)$ that increase in h at an increasing rate for which a maximum of ψ does not exist.

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