Personnel Economics
Edward P. Lazear

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1 Introduction

This is a report on the lectures on personnel economics given by professor Edward P. Lazear at the NAKE Workshop in Tilburg, June 1999.

The subfield of personnel economics is a relatively young research area, founded about fifteen years ago by professor Lazear. It applies economic analysis to personnel, that is, it uses an economic approach to investigate topics like human resources, compensation methods, hiring and firing, and motivating of employees. Personnel economics should not be confused with agency theory. The main characteristic of the specific role of personnel economics is that it attempts to add structure and a level of detail to economic theories (e.g. agency theory) in such a way that the theories and their predictions can be applied to business situations. Thus, it adds economic theory to the psychological and sociological theories of personnel.

This report summarizes the variety of topics that was discussed by professor Lazear during the workshop in order to present an overview of the area of personnel economics. First, human capital theory is examined in Section 2. This theory provides an introduction into the relationship between firm and employee as well as a basis for other models. Then, Section 3 discusses the issues of sorting, i.e. self-selection of employees, and incentives in the context of choosing an (absolute) compensation method. Section 4 presents the theory of relative compensations, or tournament theory. Section 5 introduces work-life incentive schemes, and discusses topics like buy-outs and pensions. In Section 6, empowerment theory is outlined. Section 7 summarizes some main issues in international firms. Section 8 concludes.

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2 Human Capital

Human capital of an employee can be either general or firm-specific. General human capital is valuable at at least one other firm than the firm where the employee is currently employed. That is, general human capital is subject to competition. Firm-specific human capital, however, can be described as skills that make one more productive only in the current firm. How do these types of human capital affect wages and turnover rates?

First consider general human capital. Let A be the productivity, i.e. the value of the general human capital at the current firm, of a non-investor, and let V be the productivity of an investor. Both A and V are functions of age (which runs from some positive number to T). General human capital can be described by four characteristics. First, for low age we have $V < A$, that is, some income is foregone in order to invest. Observe that this foregone income will have to be paid by the worker, because it is invested in *general* human capital. Because of this investment, for high age, $V > A$. Second, A is horizontal, whereas V is upward sloping. Productivity rises over time with age for an investor. Third, V is concave. There are two reasons that explain this fact: because of finite life, investment at old age pays less, and the first things that a person learns are the most important (e.g. reading). Finally, the area between A and V for $V < A$ (low age) is smaller than the area between V and A for $V > A$ (high age): with any reasonable interest rate, the investment pays off.

Now turn to firm-specific human capital, denoted by V'. With investment, V' is an increasing and concave function of age. In this case, the firm will pay some of the investment. However, it will not pay everything, since the worker may leave the firm. How can this result be obtained? Consider a firm that promised to pay a certain wage when it first hired the worker, but now wants to lower wages. The firm may propose to pay a wage equal to A, the productivity level without investment which is again independent of age. However, in this case, the worker may threat to leave, and a bargaining problem arises. Both the firm and the worker know that this problem will occur *ex ante*. The usual solution to this problem is a wage profile W that uses a sharing rule: the firm pays some of the investment, and the worker in turn accepts a wage that is lower than V' whenever $V' > A$. That is, for low age we have $V' < W < A$, and for high age we have $A < W < V'$.

In order to examine how the wage profile W is determined, consider a bargaining problem with only two periods. Let indices to the variables denote the period, such that in period 1 we have $V_1' < A_1$, and in period 2, $V_2' > A_2$. First, note that the equilibrium requires the worker to remain employed by the firm in period 2, that is, the worker will not quit and will not be fired. This implies $A_2 \leq W_2 \leq V_2'$. Second, in equilibrium, both the firm and the worker cannot loose money on the deal, so $V_1' - W_1 + V_2' - W_2$ and $W_1 - A_1 + W_2 - A_2$ are nonnegative. Third, competition on the labor market implies that a firm cannot make profits on workers: $W_1 + W_2 = V_1' + V_2'$. Solving the model, we see that the equilibrium exists if and only if the condition $V_1' + V_2' \geq A_1 + A_2$ is satisfied. Observe that this is the condition for efficiency. If this condition were violated, the firm would not even *want* to produce. Therefore, we can conclude that the equilibrium always exists.

3 Sorting and Incentives

The optimal compensation scheme for a risk-neutral worker must be efficient on two aspects (Lazear (1986)). First, it must induce the right type of worker to come to work for the firm. That is, it should imply self-selection, or *sorting*, of workers. Second, it must provide the workers employed by the firm with an *incentive* to put forth the optimal level of effort. The optimal compensation method therefore can be derived in two steps. In the first step, the labor supply of the worker is determined for a given compensation structure. In the second step, the firm chooses the compensation scheme that maximizes its profits, given the worker's labor supply behavior. In this section, we first discuss sorting. Then, we turn to the analysis of incentives, and finally, we return to the issue of sorting by discussing a model of probation.

Sorting

As a first introduction on sorting, consider a simple model of probation in the situation in which there are both skilled and unskilled workers that can be hired by the firm. The production level of skilled workers is higher than that of unskilled workers, but the wages they require, i.e. their alternative wages, are also higher (say, \$20 for skilled workers and only \$10 for unskilled workers). It can be shown that the more capital-intensive the firm (i.e. the higher the fixed cost of production), the more likely it is that skilled workers are relatively cheaper and therefore preferred. A real-world example of this phenomenon is a Chief Executive Officer (CEO), who can be held responsible for the entire stock of capital of the firm, and who is usually preferred to be skilled. Assume that it is the case that the skilled workers are preferred, but the firm cannot distinguish *ex ante* whether a worker is skilled or unskilled. That is, an unskilled worker may pretend to be a skilled worker in order to be paid the higher wage. With respect to hiring and firing of workers, there are two types of errors. The first is that of firing a 'good guy' (a skilled worker) and the second that of retaining a 'bad guy' (an unskilled worker). Assume here that the first type of error does not occur, and concentrate on the second type of error. There are two periods, the first of which is the probation period. In order to attract the skilled workers to come to work for the firm, the sum of the wages of the two periods, $W_1 + W_2$, should be greater than or equal to \$40. Assume that equality holds here, because the firm maximizes its profits. Further, in order to induce unskilled workers to stay away, the payment scheme offered by the firm should satisfy $W_1 + pW_2 + (1-p)10 < 20$, where p is the probability to make it past probation. If we assume $p = 0.9$, these conditions imply $W_2 > 210$ and $W_1 < -170$. This means that even a skilled worker (a 'good guy') should put up over *four* times his lifetime productivity of \$40 in the first period! In this example, probation clearly will not work. This shows that in order for probation to work, the alternatives of the two groups (the wages that they can earn somewhere else) should not be very different, and screening should work very well (i.e. p is close to zero, or the probability of retaining a good worker is larger than the probability of retaining a bad worker).

Now consider a more general model of compensation methods (discussed in more detail in Lazear (1995, Ch. 2)), in which there exists a separating equilibrium in which some workers are paid a piece rate, and others are paid a fixed rate or salary. Let q denote the productivity of a worker (which will also be used to identify the worker), with density $f(q)$ and $q \in [q_{\min}, q_{\max}]$, and let θ denote the cost to a worker of his productivity being measured. With a piece rate, the worker will earn $q - \theta$, so if there is any worker that wants to be measured, it will be $q_{\max}$. Let q^* denote the worker who is indifferent between a piece rate and a salary. Then, all workers for which $q < q^*$ will go to the salary firm, and the salary will be equal to $E[q|q < q^*]$. The condition for q^* to be indifferent is $q^* - \theta = E[q|q < q^*]$. To show that the equilibrium mentioned above exists, this equation has to be solved. Observe that

$$E[q|q < q^*] = \frac{1}{F(q^*)} \int_{q_{\min}}^{q^*} q f(q) dq$$

Consider a numerical example with uniform density $f(q) = 1$, which implies $q^* = 2\theta$, and let $\theta = 0.25$. In this case, a separating equilibrium exists. For $q > 0.5$, the piece rate wage of $q - 0.25$ is greater than the salary (which equals 0.25) and the worker prefers the piece rate. Similarly, for $q < 0.5$, the salary is preferred. Evidently, in extreme cases, the separating equilibrium does not exist. For very high θ, $q^* > 1$ and all workers prefer the salary firm, and similarly, for very low θ, all firms will be piece rate firms.

The model of salary firms versus piece rate firms is essentially a signaling model. Workers can purchase a signal at a cost of θ. However, in this type of model, the signal is not efficient, since everybody at the piece rate firm 'throws away' θ. That is, signaling is wasteful. For this reason, the model shows that even if average output is higher in piece rate firms, average output may *increase* by introducing a legislation that forces all firms to pay a salary. This result is counterintuitive, because people mainly think about piece rates as incentives, which were ignored here but will be discussed below.

Incentives

Consider the standard principal-agent problem. How to determine the optimal commission level for a salesman? As will be derived formally below, the optimal commission rate is 100 % if risk-neutrality is assumed. How can this high rate be possible? First, the commission rate should be a percentage of profits, not of sales. Second, the firm should be allowed to charge the salesman for the job. An example of such a compensation method is that of taxi drivers, who rent their cab and pay for their license, and then take home everything they earn. The reasons for having a commission rate of 100 % are to solve the problem of monitoring quantity (which in the case of taxi drivers is quite difficult), to provide incentives for the worker, and to sort out more ambitious workers (i.e. to avoid adverse selection in hiring). In this subsection, we will discuss incentives, returning to the sorting effect later.

The formal argument for having a commission rate of 100 % can be derived from the following simple model (Lazear, 1995, Ch. 2). Consider the linear compensation scheme $a+bq-C(q)$, where $C(q)$ is an increasing and strictly convex cost function, describing labor supply. The worker (e.g. the taxi driver) maximizes this compensation by determining the output level q. The first-order condition is given by $C'(q) = b$, which is intuitively clear. The firm maximizes profits, $q - (a + bq)$ by determining a and b, subject to the worker's first-order condition and $a+bq \geq C(q)$. The second condition is required because otherwise, no workers will show up. Assume that this condition holds with equality (because the firm does not want to pay more than necessary). The first-order condition for the firm can then be written as $[1 - C'(q)]\frac{\partial q}{\partial b} = 0$, implying $C'(q) = 1$. Combining this with the first-order condition of the worker results in $b = 1$: a commission rate of 100 %. In competitive equilibrium, the rental price $-a$ will be the maximum rental price which supports attracting enough workers.

What about the empirical evidence on commission rates? In general, commission rates are lower than 100 %. However, these rates are usually a percentage of sales, not of profits, and therefore, they may be equivalent to a 100 %-rate on profits. The reason why commission rates are usually a percentage of sales is that sales are verifiable, and profits usually are not. Further, in the real world, in general you do not see firms selling jobs. The typical payment schedule consists of two parts. For high output, say $q \geq q^*$, the empirical schedule observed corresponds with the theoretical schedule. 'Implicitly', the worker pays the rental price. However, for low output ($q < q^*$), the firm pays a fixed salary equal to the theoretical compensation at $q = q^*$, which is below the market wage. That is, in the empirical schedule, payments to the worker cannot fall below a certain level. However, if the worker often has a low output $q < q^*$, he will be fired. Finally, the rental price $-a$ depends on the amount of capital the worker works with. For example, driver-owned taxicabs usually are in better shape than rented cabs. Using a commission rate of 100 % evidently does not solve all problems. The driver does not have appropriate incentives to care for the cab (capital) he uses. For stock brokers, a similar result holds. The implicit rental price $-a$ is larger for firms with better reputation (Elton (1991)). This result is intuitive, since it is easier to sell stock when working for a firm with better reputation. Similar reasoning can be applied to American football players, for whom the possibility of negotiating on their own behalf has resulted in more injuries, and to the treatment of slaves (Fogel and Engerman (1989)).

Again consider the salary scheme versus the piece rate scheme. The salary scheme consists of a fixed salary W, which is paid to the worker if and only if his effort e is above a minimum effort level e_0. That is, if $e < e_0$, the worker earns nothing, and if $e \geq e_0$, he earns W. Because workers like money and dislike effort, every worker will find it optimal to put forth an effort level of e_0. In the piece rate scheme, above a certain effort level e^*, say $e^* > e_0$, the worker is paid a piece rate in such a way that the piece rate wage is increasing in effort and higher than the salary (at e^*, the piece rate wage equals the salary). Now assume that the firm used to have a salary system, but changes toward the piece rate scheme. In this case, for some utility-maximizing workers, it may be optimal to increase effort to a level above e^*. This is the incentive effect of the piece rate scheme. However, observe that the change also has an important effect on *sorting*. The new system attracts more ambitious workers, who are willing to set their effort level above e^*, which also increases output. Piece rates deal a lot better with heterogeneous labor force. Thus, in many cases, this effect is even more important then the incentive effect. Finally, observe that in the salary system, there is also a strong incentive effect. If the effort level falls below e_0, the worker is fired, which provides an incentive to put forth an effort level of at least e_0. However, this compensation scheme is discontinuous.

For a formal analysis of incentives and the preference for a piece rate system, let the utility of a worker be described by his income W minus the pain of his effort (in dollars), $C(e)/A$. Here, $C(\cdot)$ is again an increasing, strictly convex function; e represents effort (in dollars worth of output); and A is the worker's ability level, which is also used to identify the worker. For the minimum required level of effort e_0, let A_0 be the ability level for which $W = C(e_0)/A$. Every worker with $A \geq A_0$ can do the job; every worker with $A > A_0$ can do the job with less pain than A_0 can. Let $R(A)$ denote the utility of the best alternative for an individual with utility level A. Both $W - C(e_0)/A$ and $R(A)$ are increasing and concave functions of A. Assume that $R(A_0)$ is negative. Let A_h denote the value of A for which the two curves intersect. Then all workers with $A \in [A_0, A_h]$ will work at the firm. Let the firm's objective be

$$\max_{e_o,W} \int_{A_0}^{A_h} (e_0 - W) g(A) dA = \max_{e_0,W} \left[e_0 - \frac{C(e_0)}{A_0} \right] [G(A_h) - G(A_0)]$$

This corresponds with a search model with upward sloping labor supply. The objective function of the firm can be interpreted as the profit per worker times the number (proportion) of workers attracted by the firm. The first-order condition with respect to e_0 implies that $C'(e_0)/A_0 > 1$. Compared to the optimal compensation scheme derived above, this shows that the minimum ability worker in the firm is forced to work too hard, and the maximum ability worker in the firm is forced to work too slow. Even though the schedule does provide incentives, the (single) schedule does not allow for heterogeneity among workers.

A Model of Probation

Now let us return to the issue of probation, and start with a numerical example. Suppose again that there are two types of workers, risky workers and safe workers. A safe worker produces an output of $200,000 per year, and costs $100,000 per year. A risky worker also costs $100,000, but he will either turn out to be a good worker, with production equal to $500,000, with probability 0.5 or a bad worker, with production -$100,000, with probability 0.5. After 35 years, what is the value (net of costs) of each worker to the firm? The value of the safe worker is $3.5 million, and the expected value of the risky worker is $6.9 million ($14 million if he turns out to be good, and -$200,000 if he turns out to be bad, in which case he is fired after one year). This argument shows that it may be profitable to hire a risky worker, because the risky worker has an option value, which increases with the variance of the option.

In equilibrium, the marginal firm has to be indifferent between the risky and the safe worker. We will now use a more formal approach, prove that the equilibrium exists, and derive the equilibrium wage. Denote the output of the safe worker by $\overline{M}$, and the output of the risky worker by $M + S_j$, where M is random with $E(M) = \overline{M}$ and S_j is a firm-specific component for firm j with $E(S) = 0$. The probation period lasts until time τ, at which moment the firm has to decide whether or not to keep the worker. Let W_T denote the wage after passing the probationary period, that is, from time τ until time T. Consider the firm at which the worker is initially hired, say firm 1. In order for the firm to want to keep a risky worker, the constraint $M + S_1 > W_T$ should be satisfied. Because of competition on the labor market, W_T should also be the wage an outside firm, say firm j, $j \neq 1$, would be willing to pay after time τ. That is, suppose firm j makes a job offer to firm 1's worker. The wage offered is given by

$$W_T = E[M + S_j | M + S_1 \geq W_T]$$

where the conditional part follows from the fact that firm j knows that the worker has been promoted. To prove that an equilibrium exists, we need to show that a fixed point exists. First consider $W_T = \min(M)$. In that case, the left-hand side is smaller than the right-hand side. Similarly, for $W_T = \max(M)$, the left-hand side is greater than the right-hand side. Making use of the fixed-point theorem, this shows that there exists a value of W_T such that equality holds, and the equilibrium exists.

The equilibrium condition for hiring risky workers is given by zero profits for the firm over lifetime, that is, wages paid should equal output produced. After rearranging, this gives

$$W_1 = \overline{M} + \frac{e^{-r\tau} - e^{-rT}}{1 - e^{-r\tau}} p_R \left[E[M + S_1 | M + S_1 \geq W_T] - W_T\right]$$

where p_R denotes the probability of retaining a risky worker. Since wages for safe workers equal $\overline{M}$, this shows that wages for risky workers (paid during the probation period) equal the wage for safe workers plus the present value of the probability of being retained times the premium of good workers.

With respect to the size of τ and T, the model shows that younger workers are preferred. There is more time to exploit good younger workers, since for them $T - \tau$ is larger. The option value of a younger worker is larger than that of an older worker. This is exactly what is observed in the real world: for a given wage, younger workers are preferred over old workers. A similar reasoning holds with respect to young versus old industries. A young industry has a longer time horizon T, and will prefer risky workers more, since there is more time to exploit them.

4 Tournament Theory

It can be argued that in many cases motivation of employees is not caused by *absolute* compensation, such as the salaries or piece rates of Section 3, but by *relative* comparisons. Therefore, when considering how large a raise to give a worker at promotion, or when determining whether or not CEO's are overpaid, one should model the entire compensation structure of the firm instead of using the static approach of considering the absolute wage level only. The argument used here is the fact that in general, a worker does not get promoted because he is good, but because he is better than his colleagues. Relative comparisons rather than absolute comparisons matter in promotions.

The theory of relative compensation, or tournament theory, was introduced by Lazear and Rosen (1981). The way competition between workers is modelled in this theory resembles the competition in, for example, a tennis tournament. The winner receives a prize that is greater than the prize received by the loser. Both prizes are independent of the amount by which the winner beats the loser. With a constant sum of prize money, the larger the spread between the prizes, the larger the effort of the players. There exists an optimal level of spread, above which one would not want to increase the spread further. The reason is that increasing the spread does not only increase effort, but also leads to a recruitment problem. If the 'prize' of the loser becomes negative and very large, nobody may be willing to participate in the tournament. This intuition, as well as the formal model presented below, is discussed in more detail in Lazear (1995, Ch. 3).

The formal tournament analysis resembles the standard principal-agent problem. First, the worker's decision has to be analyzed, and then, the firm's decision can be determined, given the worker's behavior. The worker receives a prize (wage) W_1 if he wins, which happens with probability p, and receives a prize W_2 if he loses. Evidently, $W_1 > W_2$. Let μ_j denote the effort level of worker j, and let $C(\mu)$ be the cost of effort. $C(\cdot)$ is again assumed to be increasing and strictly convex. Then the worker chooses μ_j so as to maximize $W_1 p + W_2(1-p) - C(\mu_j)$, where p is his probability of winning. The corresponding first-order condition is $(W_1 - W_2)\frac{\partial p}{\partial \mu_j} - C'(\mu_j) = 0$, which says that the marginal return to effort should equal the marginal cost of effort. Let the outputs q_j and q_k of workers j and k, respectively, be determined by $q_j = \mu_j + \varepsilon_j$ and $q_k = \mu_k + \varepsilon_k$, respectively, where ε is a random variable which represents luck. Then the probability of winning can be rewritten as

$$p = \Pr\{q_j > q_k\} = \Pr\{\mu_j + \varepsilon_j > \mu_k + \varepsilon_k\} = \Pr\{\mu_j - \mu_k > \varepsilon_j - \varepsilon_k\} = G(\mu_j - \mu_k)$$

where $G(\cdot)$ is the cumulative distribution function of the variable $\xi \equiv \varepsilon_j - \varepsilon_k$, with corresponding distribution function $g(\cdot)$. Ex ante, individuals j and k are identical, and therefore $\mu_j = \mu_k$. The partial derivative of p with respect to μ_j (or μ_k) is therefore given by $g(0)$. Using this result, worker j's first-order condition can be rewritten to give

$$(W_1 - W_2)g(0) = C'(\mu_j) \tag{1}$$

This result has two important implications. First, if the wage spread $(W_1 - W_2)$ increases, effort increases, as was mentioned above. Second, for given wages, the level of effort depends on luck, even though workers are assumed to be risk-neutral. If luck is very important, for example because measures of effort are noisy, effort does not help much, and workers tend to give up. More formally, in terms of the density $g(\cdot)$, if luck is very important, $g(\cdot)$ has fat tails and $g(0)$ is small, which implies that μ_j and μ_k are small, i.e. the level of effort put forth by the workers is low.

The firm maximizes profits (per worker) $\mu - (W_1 + W_2)/2$ by choosing W_1 and W_2, subject to the labor supply constraints (i.e. the workers' first-order conditions), and subject to the condition that it is able to induce the workers to apply for the job, i.e. $(W_1+W_2)/2 \geq C(\mu)$. The last condition will again be assumed to hold with equality, and can thus be substituted in the firm's objective function to obtain $\mu - C(\mu)$. The first-order conditions corresponding to this objective function are

$$[1 - C'(\mu)] \frac{\partial \mu}{\partial W_i} = 0 \quad \text{for } i = 1, 2 \tag{2}$$

This shows that wages W_1 and W_2 will be chosen such that $C'(\mu) = 1$, that is, $C'(\mu)$ is set equal to the value of one unit of output. This efficiency condition corresponds to that of the piece rate firm in Section 3, and determines the optimal level of effort, μ^*. Combining the first-order conditions of the firm with those of the workers shows that the wage spread satisfies $(W_1 - W_2) = 1/g(0)$, and it can be concluded that the wage spread depends on the level of luck, whereas the optimal effort level μ^* does not. The effect of luck will be fully offset by an increase in the wage spread.

To come back to the issue of CEO salaries, American CEO salaries are relatively high compared to worker's salaries. Also, CEO salaries in the US are very high compared to those Japan. Tournament theory can be used to analyze whether or not American CEO salaries are *too* high. Since wages or, more specifically, the wage spread, is determined by the amount of noise present in the production environment, we should examine the amount of uncertainty instead of the absolute output. Japanese firms typically operate in less risky environments than US firms. Therefore, according to tournament theory, the high observed wage spread in the US is rational.

A corollary of tournament theory is that it provides a model of *industrial politics*, that describes competition between workers. In this model, the issue of personality plays an important role, which is unusual in economics in general. From tournament theory, competition between workers is optimal from the worker's point of view. However, from the firm's point of view, it is not optimal, because workers should cooperate in order to achieve high output or profits. The implications of relative compensation methods on interaction of workers have been examined by Lazear (1989). The model is similar to the tournament model, but adds the effect of noncooperation (i.e. competition or sabotage) between workers. Again assume linear production (although the model works with nonlinear production as well), but let production of worker j now be described by $q_j = \mu_j - \theta_k + \varepsilon_j$. A similar production function holds for worker k. The variable θ_i represents the effect on output of worker i not cooperating with the other worker, $i = j, k$. Also, the cost function $C(\cdot)$ is now a function of both μ and θ. In this adjusted version of the tournament model, if the wage spread increases, not only does effort go up, but also competition between workers increases. Evidently, a trade-off occurs between these two effects on output, the first of which is positive, and the second of which is negative. The first-order conditions for the firm (2) are now given by

$$[1 - C_1(\mu, \theta)] \frac{\partial \mu}{\partial W_i} = [1 + C_2(\mu, \theta)] \frac{\partial \theta}{\partial W_i} \quad \text{for } i = 1, 2 \tag{3}$$

where $C_1(\cdot)$ and $C_2(\cdot)$ denote the partial derivatives of $C(\cdot)$ with respect to μ and θ, respectively. Since the right-hand side of (3) is positive, the left-hand side also has to be positive, implying $\mu < \mu^*$. This shows that in the industrial-politics version of the model wages have to be compressed in order to limit sabotage. That is, in this model, wage compression occurs because of efficiency reasons, not because of risk-aversion. In practice, the problem in avoiding sabotage by compression of the wage spread is that in general, the sabotage variable θ is unobservable.

Individuals may be different with respect to their attitude towards sabotage. Refer to the type of individuals that cannot engage in sabotage as doves, and refer to the type of individuals that have no problem with sabotage as hawks. As will be shown below, it is optimal to have segregated firms with either doves only or hawks only, instead of integrated firms. The intuition behind this result is that hawks require a compressed wage structure whereas doves have no need for compression. In an integrated firm, the payment scheme would have to be in between these two optimal schemes, implying that the resulting scheme is not optimal for either group.

For a formal analysis, observe that the first-order conditions of matching types, i.e. segregated firms, can be adjusted from (1) to give

$$(W_1^A - W_2^A) g(0) = C_i^A(\mu^A, \theta^A) \quad \text{for } A = D, H \text{ and } i = 1, 2$$

where A denotes the attitude of the workers, i.e. D for doves and H for hawks. For the integrated firm, the first-order conditions (1) should be rewritten as

$$\left.\begin{array}{l} (W_1 - W_2) g(\mu^H - \mu^D + \theta^H - \theta^D) = C_i^H(\mu^H, \theta^H) \\ (W_1 - W_2) g(\mu^D - \mu^H + \theta^D - \theta^H) = C_i^D(\mu^D, \theta^D) \end{array}\right\} \quad \text{for } i = 1, 2$$

Because the degrees of freedom are four in case of segregated firms (i.e. W_i^A for $A = D, H$ and $i = 1, 2$) and only two in the integrated form (i.e. W_1 and W_2), the integrated firm can never do better than the segregated firms. Segregation therefore is optimal.

What can be said about sorting in this industrial-politics model? For hawkish firms, self-selection occurs. A dove would never voluntarily join a hawkish firm, because sabotage implies that equilibrium output is lower for hawks. Therefore, average compensation is lower for hawks. Furthermore, a dove would be subject to sabotage in a hawkish firm and would find it difficult to be promoted to a higher position. On the other hand, for the same reasons, hawks do want to join dovish firms. A separating equilibrium does not exist, and dovish firms have to screen the workers they hire.

At higher levels of the hierarchy, hawks will be selected out. Workers can be promoted either because they are good workers or because they are good at making other workers look bad. As one gets to the top of the firm, therefore, the good and aggressive (hawkish) workers remain. The formal proof of this claim uses the fact that, letting W denote the event of 'winning' a promotion,

$$\begin{aligned}\Pr\{W|H\} &= \Pr\{W|H \text{ plays } D\}\Pr\{H \text{ plays } D\} \\ &\quad + \Pr\{W|H \text{ plays } H\}\Pr\{H \text{ plays } H\}\end{aligned}$$

Let $\Pr\{H \text{ plays } D\}$, the probability that a hawk pretends to be a dove, be equal to α and $\Pr\{H \text{ plays } H\}$ be equal to $1-\alpha$. Since $G^* \equiv \Pr\{W|H \text{ plays } D\}$ is strictly greater than $1/2$, and $\Pr\{W|H \text{ plays } H\}$ =1/2, we obtain that the probability of being a hawk given that you won can be written as

$$\Pr\{H|W\} = \frac{\Pr\{W|H\}\Pr\{H\}}{\Pr\{W\}} = 2\alpha\left[G^*(1-\alpha\} + \frac{1}{2}\alpha\right]$$

The probability $\Pr\{H|W\}$ is equal to $1/2$ if $G^* = 1/2$, and is strictly increasing in G^*. Therefore, the probability of being a hawk given that you have been promoted to a higher position is strictly greater than $1/2$, implying that hawks will dominate the top levels of the hierarchy. In these levels of the hierarchy, relative rewards are therefore very important, in order to avoid all cooperation being lost.

5 Work-Life Incentive Schemes

In Section 2, the life-cycle productivity profile of a worker and the optimal compensation scheme were discussed. In this section, we discuss the incentive effects of this compensation scheme, buy-outs and layoffs.

Assuming that the worker's productivity V (in terms of general human capital) increases when young, and (possibly) decreases later, when old, it will be argued below that the compensation scheme W should be such that W is below V for low age, and above V for high age. Let A denote the value of leisure, which is an increasing function of age and is below V for low age, and let T denote the age at which $V = A$. For self-employed workers, who earn V, voluntary retirement will take place at age T. However, for a firm that would pay a wage equal to V, a problem occurs when a worker's age is close to T. Consider the day before T. The worker will decide whether to work or to shirk this day. In case he shirks, the worst thing that can happen to him is that he gets fired, but since he will retire tomorrow anyway, he is indifferent and will decide to shirk. That is, when a worker is close to retirement age, he will 'take it easy'. How can the firm prevent this, and keep the worker motivated? The profile W described above solves the problem, by paying higher wages close to retirement age T. W is chosen such that the present value of W from 0 to T is equal to the present value of V from 0 to T. This mechanism to motivate workers by using an upward-sloping experience-earnings profile was first discussed in Lazear (1979) and (1981). Note that in order to be able to use the compensation scheme W, the firm needs reputation, since it will pay a wage that is lower than productivity for young workers, and will pay a wage above productivity only later. An important observation from this analysis is that mandatory retirement is needed. After T, $V < A$, and retirement is efficient. However, there is no incentive for the worker to retire since wage is above the alternative 'salary' (the value of leisure) at least for some period after time T.

Now consider the possibility of a buy-out at time $t_1 < T$, which increases the value of the alternative. If the alternative wage W_A is above V, it is efficient to leave the firm. However, the firm still owes you the present value of the difference between W and V from time t_1 to T, and a buy-out is needed. The worker will accept the buy-out B if B plus the present value of the alternative is greater than the present value of W. The firm will offer a buy-out which satisfies the constraint that B is smaller than the present value of W minus the present value of V. Combining these two constraints, it follows that a buy-out will occur if and only if the present value of the 'remaining' productivity is smaller than the present value of the alternative use of time.

For empirical evidence on this result, consider pensions, which can sometimes act as a buy-out, as discussed in more detail in Lazear (1995, Ch. 4). Standard pensions usually have an implicit incentive to induce workers to retire around a specific age (Lazear (1983)). The expected present value of a pension is very low for low retirement age, because young workers have not accumulated pension benefits yet. Also, for very high retirement age, the expected present value is low, because retiring at very old age implies dying soon after retirement. At some intermediate retirement age, the expected present value of pension benefits will be higher. This is an alternative, implicit way to lower 'wages' for older workers, which will induce them to leave voluntarily. A structure similar to that of pensions can be seen in layoffs. With layoffs, the middle-aged use most rent. The efficient policy is therefore to concentrate layoffs at young and old age. This result is support by empirical evidence, even though it may seem counterintuitive since in general firms are not supposed to fire old, experienced workers.

6 Empowerment

According to industrial psychologists, the main reason to use empowerment is to give workers the feeling that they are 'part of the family'. Personnel economics provides a more formal and statistical analysis of empowerment, which will be discussed below.

Let the term 'false negative error' refer to the error of rejecting a good proposal or project. Similarly, a 'false positive error' is the error of accepting a bad proposal. In general, there will be a trade-off between the two types of errors: if the probability of a false negative error increases, the probability of a false positive error decreases, and the other way around. Evidently, various decision rules on the acceptance of projects are characterized by different trade-offs.

Consider the following decision rules or structures: the hierarchy, the second opinion structure, and the flat structure. In the hierarchical structure, a project has to pass two decision levels before being accepted. If a project is rejected in the first level, it will not be examined at the second level. In the second opinion structure, there are also two persons who have to examine the project, but there is no hierarchy. If the two persons agree on whether or not to accept a project, the result is evident. However, if they do not agree, a decision rule is needed. This results in an outcome that is a convex combination of the opinions of the two decision makers. In the flat structure, every worker is assumed to make his own decisions. This can be interpreted as the ultimate level of empowerment.

How can the structures described above be ordered in terms of the trade-off between false negative errors and false positive errors? And how should a firm choose an appropriate decision rule? Let us first turn to the ordering of the three decision rules. Assume that N projects are proposed per person per period, and there are two workers. With the flat structure, if p is the probability of accepting a project, $2Np$ projects will be accepted each period. In the hierarchical structure, since each project has to be considered twice, there is only time to examine half of the projects. Only Np projects pass on to the second level and, letting p_{YY} denote the probability that a project is accepted in the second decision level given that it was accepted in the first, Npp_{YY} projects will be accepted in the hierarchical structure. Since $Npp_{YY} < 2Np$, the hierarchical structure is more stringent (i.e. accepts less projects) that the flat structure. The main reason for this result is the fact that in the hierarchical structure, because of a time constraint, half of the projects is rejected beforehand. But even if this were not the case, the (reasonable) assumption $p_{YY} < 1$ would lead to the same conclusion.

For the second opinion structure, letting λ describe the acceptance rate in case of disagreement, the number of projects accepted is given by

$$N\left[pp_{YY} + \lambda p(1 - p_{YY}) + \lambda(1 - p)p_{YN}\right]$$

where p_{YN} denotes the probability that a project is accepted in the second level, given that it was rejected in the first level. Using the facts that the number of projects accepted with the second opinion structure reaches a maximum for $\lambda = 1$, and the assumption that $p_{YN} \leq p$, the second opinion structure can be shown to be more stringent than the flat structure. Finally, for $\lambda = 0$ the number of projects accepted in the second opinion structure can be shown to equal Npp_{YY}, the number of projects accepted in the hierarchical structure. Since an increase in λ will increase the number of projects accepted in the second opinion structure, this shows that the hierarchical structure is more stringent than the second opinion structure. Summarizing, this shows that the hierarchical structure is more stringent than the second opinion structure, which is more stringent than the flat structure.

How should a firm choose between the three structures? The projects of a firm can be described by a probability distribution over the dollar value per project. If this distribution is very skewed, there will be a preference for one of the two extremes, either the hierarchical structure or the flat structure. Suppose that the left tail of the distribution is relatively fat. This implies that the cost of a false positive error (accepting a bad project) is relatively high. In this case, the firm will prefer the hierarchical decision structure. On the other hand, if the right tail of the distribution is relatively fat, some projects earn extremely high revenues and the cost of a false negative decision (rejecting a good project) is relatively high. This type of firm will in general prefer a flat structure. Examples of this situation can be found in firms that depend heavily on R&D. Firms that are in the middle, with a relatively symmetric probability distribution, will prefer to use a second opinion structure.

Now let us turn to the issue of the works council. As will be shown below, an adviser to the firm would always advice the firm to give workers less power than is socially optimal. Let X denote the amount of power given to the workers, and let $R(X)$ describe the total surplus or rent associated with X. $R(X)$ is increasing for low values of X, decreasing for high values of X, and it attains its maximum at $X = X^*$. However, increasing the amount of power of the workers does not only affect the total surplus, but also the workers' share of the pie $\tau(X)$: the higher X, the larger $\tau(X)$. The firm's optimization problem is to maximize over X its rent $R(X)[1 - \tau(X)]$. The first order condition can be written as $R'(X) = \tau'(X)R(X)/[1 - \tau(X)]$. Since the right-hand side of this equation is positive, the level of power X chosen by the firm satisfies $R'(X) > 0$, which implies $X < X^*$. The firm decides to give workers less power than optimal because giving workers more power increases their share of the pie. Could the government solve this problem by changing legislation and letting each firm have a works council? The answer is no, because letting the workers decide on their level of power leads to a symmetric problem: the workers will choose a level of power that is *above* the socially optimal level X^*. The level chosen by the workers is not necessarily better than that chosen by the firm.

When is it the case that a firm wants to have a works council? That is, in which situation is it most likely that the firm has a works council? Assume that there are two states of the world, that can be observed only by the firm, not by the workers. In the good state, the firm will survive anyway. In the bad state the firm will only survive if the workers work very hard. However, workers are afraid of being exploited. A works council can solve this problem by 'opening the books', i.e. informing the workers about the state of the world.

Let a worker's utility be described by U_N if he works at normal speed, by U_F if he works at fast speed, and by U_0 if he is fired (i.e. if the firm does not survive). Assume that $U_N > U_F > U_0$. The firm's profits in the good state are given by π_F if workers work at fast speed and by π_N if workers work at normal speed. In the bad state, if the firm survives (i.e. workers work hard), the firm's profits are π_B. Assume that $\pi_F > \pi_N > \pi_B > 0$. Although workers cannot observe the state of the world, they know that the good state occurs with probability p. The workers will be indifferent between working at normal speed and working at fast speed if the expected utility of working at normal speed equals the utility of working at fast speed, that is, if p equals

$$p^* = \frac{U_F - U_0}{U_N - U_0}$$

The workers will work fast if and only if $p < p^*$. If workers have very good alternatives, U_0 will be relatively high, p^* will be low, and workers will generally work at normal speed.

If workers are uninformed, that is, if there is no works council, they will either choose to work at normal speed, implying an expected profit to the firm of $p\pi_N$, or choose to work at fast speed, in which case the firm's profits will be $p\pi_F + (1-p)\pi_B$. If there is a works council, the workers will always work at normal speed in good states and at fast speed in bad states. The expected profits to the firm when there is a works council are $p\pi_N + (1-p)\pi_B$. When does the firm benefit from having a works council? If the workers would have chosen to work at normal speed, the firm benefits, since by having a works council its expected profits increase by an amount of $(1-p)\pi_B$. On the other hand, if the workers would have chosen to work fast, introducing a works council reduces the firm's expected profits by an amount of $p(\pi_F - \pi_N)$. That is, the problem of having a works council is that it slows down speed in good states. The firm's decision on whether or not to have a works council will depend on whether the workforce is aggressive or docile. In Europe, for example, workers have good fallback positions, so p^* is low in Europe, and in general, workers will work at normal speed. In Europe, firms therefore are less opposed to works councils than in, for example, the US, where fallback positions are not that good, and workers work fast in general.

7 International Firms

In domestic firms, workers (or teammates) have the same culture and background. In international firms, however, this is not the case. Three aspects that are particularly important in international firms are disjointness, communication, and relevance. Disjointness refers to workers having disjoint sets of knowledge. In this sense, the more disjoint the workers in a team are, the better, since workers can learn from each other. Communication evidently refers to the fact that workers should be able to communicate with each other. That is, workers with disjoint sets of knowledge form a good team with respect to the first aspect, but if they cannot communicate properly, it may be better to have a team of workers whose sets of knowledge are less disjoint, but who are at least able to communicate. The third aspect, relevance, refers to the skills that are relevant to doing the task. Relating the aspect of relevance to the other two aspects, if a firm has to choose a team out of several workers, whose knowledge sets are all disjoint, and who are all able to communicate fluently with each other, it should choose those workers that have the most relevant skills. In forming a team of workers in an international firm, all three aspects should be taken into account in order to form a good team.

Another issue that is important in international firms is that of best practices. Consider an international firm that owns several factories or departments that perform the same tasks in different countries. 'Best practices' means that the firm wants every factory to perform every task in the way that it is done by the factory that does it best. This sounds reasonable, and intuitively, one would expect the introduction of best practices to increase profits. However, an order statistics problem occurs here. Let η and ε be random variables that describe the profits of two different ways of performing the same task. Let ρ be the corresponding correlation coefficient, such that $\eta = \rho\varepsilon + (1-\rho)\nu$, where ν is an error term. It can be shown that

$$\frac{\partial E\left[\max\left(\eta, \varepsilon\right)\right]}{\partial \rho} < 0$$

The expected value of the highest order statistic is decreasing in the correlation coefficient of the two random variables. That is, if the two ways of performing the same task become more correlated, the expected profits of the best way to perform the task will decrease.

8 Conclusion

The discussion of the topics of human capital, sorting, incentives, absolute and relative compensation methods, work-life incentive schemes, empowerment, and aspects of international firms has presented an interesting overview of the relatively young subfield of personnel economics. It has become clear that economists use a more general approach to personnel than do psychologists and sociologists. Although it is largely a normative analysis, personnel economics does not only provide qualitative results but quantitative results as well, by adding more structure to the analysis. Also, this overview shows that a personnel system should be considered as an entire structure. Specific parts of it cannot be analyzed separately, without referring to other parts. For example, when considering retirement issues, not only should one consider wages, but also the worker's (pecuniary equivalent of) leisure (see Section 5). A related point is that relative comparisons are more important in personnel economics than absolute comparisons. Individual workers are compared to each other rather than to an absolute standard (Section 4). Finally, personnel economics has revealed that some simple and intuitive predictions on personnel issues are misleading or wrong, and it has been shown to offer an important contribution to psychological and sociological approaches of personnel.

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