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Wage Profiles and Layoffs in the Theory of Specific Training

by

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ABSTRACT

This paper develops a theory of wage structure and layoff policy in the presence of firm-specific training. The drived conclusion on the layoff policy is that, when workers expect the firm's layoff policy rationally, it is potimal for the firm not to lay off the skilled employees even if their marginal productivity is lower than wages. This provides an economic rationale for seniority rules.

In imperfect capital market workers can not tolerate extremely steep wage profiles since their financial ability for consumptions are limited, so that the firm must decide its wage profile taking account of the consumption pattern of workers. In such a framework this paper discusses the nature and determinants of wage profile.

1. Introduction

The life-cycle models of human capital, developed by Ben-Porath (1967), Sheshinski(1968), Rosen(1972, 1973), Blinder and Weiss(1976), Heckman(1974, 1976) and others, assume that the skills which workers acquire from formal schooling or on-the-job training are general, that is, of value equally to all firms in the labor market. This assumption is very important because general skills assure workers of free mobility among different kinds of jobs and free choice of human investments by themselves. In such a world, as is well known[1], firms do not have any incentive to bear the cost of human investments, nor do they want to differentiate between the internal workers and the external ones. They only offer a wide variety of learning opportunities in the form of different conbinations of work-learning activities and wages, while workers choose the best one of them at each stage of age, according to the dynamic optimal policy of capital accumulation[2].

Within the above framework the life-cycle models of general skill analysed the optimal time profile of investments in human capital for a worker, and provided a penetrating interpretation for the existing wages structures in the real world. However, if we admit the exsistence of firm-specific skills there , the drastic change of analytical framework will be required. For, since skills aquired through on-the-job training are valuable only for a specific firm, workers must take into consideration not only the wage profile but also the possilibity of quit or being laid off in the future. On the other hand, the firm, which is now in a monopsonistic position, must decide its layoff policy and wage profile in consideration of their effects on the quit rate and the total wage costs which the firm must bear in order to maintain the optimal level of employment. The most important thing to note here is that these considerations by individuals make the wage profile diverge from workers' productivity, and the lifetime wage structure becomes unable to be explained only by the accumulation of human capital.

Because of such complexity the models of specific human capital have not yet been fully developed in spite of the important efforts by Oi(1962), Parsons(1972), Pencavel(1972), Donaldson and Eaton(1976), and Mortensen(1978). These works concentrated on the implications of firm-specific human capital for labor turnover, but it seems to me that the optimal properties of wage profile and layoff policy which firms adopt in the presence of specific skills have not been discussed satisfactorily compared to the models of general human capital. Therefore, this paper will attempt to develop a theory of wage profile and layoff policy in the presence of specific skills further.

There are two major points which I want to emphasize in this paper. One is concerned with the role of expectations of workers in the determination of the firm's layoff policy. In the economy where workers can expect the firm's layoff policy rationally and correctly, it is optimal for the firm not to lay off the skilled employees even if their marginal productivity is lower than the wages. This employment policy strengthens the character of labor as a quasi-fixed factor and gives the economic basis to the seniority rule.

The other point to put stress on is the following. In a two-period model, if the labor supply constraint is that over the two periods the expected present value of earnings in occupations with general skills must equal the expected present value of earnings in occupations with specific skills, then employers hiring employees in whom they intend to create specific skills have an incentive to pay the lowest wage possible in period one and the highest in period two in order to lower the quit probability of the specific-skilled. This result was obtained by Donaldson and Eaton(1976). Suppose, however, that capital markets are imperfect and workers do not have enough mortgages to finance their consumptions. Then this results does not necessarily hold. Since workers can not endure extremely low wages in period one, firms have to determine wage profiles taking account of the life-cycle consumption pattern of workers as well as their effect on the quit probability of the skilled. Thus, wage profiles diverge from productivity, and get closely related to consumptions which workers plan at each stage of life-cycles, based on their lifetime incomes. In this framework this paper will conduct comparative statics on the wage profile with respect to the variables which are very important in the empirical studies of wage structures, that is, the level of formal schooling, concentration in the industry and workers' ability to borrow against future earnings, and consequently derive realistic results.

The close relation between wage and consumption pattern provides an alternative interpretation for the existing wage profiles. In Japan many labor economists affected by Marx insist that Japanese wage profiles, what is called nenkō-wages, correspond to the living expenses which workers need at each stage of life-cycles to reproduce their own labor forces. But this hypothesis is always exposed to the criticism that paying higher wages to senior workers is not consistent with profit maximization of competitive firms unless thier skills are well worth it. In a sense the discussion in this paper will give an economic foundation to the living expense hypothesis in the framework of human capital theory.

In Section 2 the labor supply constraint which the firm face in the labor market is presented. Section 3 discusses what factors prevent the firm from paying the lowest wage possible in the initial period and how it determines its wage profile. In Section 4 the optimal properties of the firm's layoff policy are investigated focusing on the role of expectations of workers. In Section 5 we interpret the nature of wage profile in the presence of specific skills and conduct comparative statics with respect to the empirically important variables. Section 6 summarizes and concludes the paper.

2. Firm-specific Training and the Labor Market

In the labor market there exist many different kinds of jobs which workers can choose after formal schooling. One gives workers a lot of specific skills, specifically through on-the-job training, and another a lot of general skills. All these jobs must satisfy a certain condition on their wages if the labor market of the unskilled, that is, workers who are going to work after formal schooling, is perfectly competitive. Let us assume, for the time being, that capital markets are perfect and workers are risk-neutral in this economy. Then, the market condition requires that the discounted present values of wages must be equal in all jobs.

In this paper we consider two-period model for simplicity. That is, workers who can work for two periods acquire skills from on-the-job training in period one and possibly realize them in period two. If the acquired skills are all general, workers can move freely among jobs for a higher wage in period two. Therefore, firms do not have any incentive to bear the cost of human investments in general skills, while workers do not care about the possibility of being laid off by the firm or quitting it. Thus, the discounted present value of wages, W_g, which workers with the level of formal schooling, K, can look forward to by choosing the general skill job g, is given by

$$W_g = aK - C_g + \frac{1}{1+r} a^*(H_g+K) \tag{1}$$

where a, a^*, C_g, r and H_g are the market value per unit of general skill in period one, the expected market value per unit of general skill in period two, the cost of human investment, the rate of interest, and general skills produced through on-the-job training in job g, respectively. In this economy they are assumed to be given exogenously. It is also assumed that the nature of the skills acquired through formal schooling is general.

When job g is always available for the unskilled, a representative firm, which creates specific skills and utilizes them together with general skills, must pay them as high the present value of wages as they could obtain by choosing job g in peirod one. Ohterwise, no one wants to be employed by that firm. Thus, the labor supply constraint for the representative firm is given by

$$W_g = w_1 + \frac{1}{1+r} \{(1-ly)(1-q)w_2 + [1-(1-ly)(1-q)]a^*(H+K)\} \tag{2}$$

where w_1 and w_2 are the firm's wage profile, ly is the probability of being laid off which workers suppose on the firm, q is the probability of quit in period two, and H is the general skills which workers aquire from the on-the-job training in the firm. Here it is assumed that layoffs and quits occur independently in period two, and workers can earn the wage which equals the value of thier general skills in the other firms when they are separated from a specific firm.

The probability of quit in period two is given by

$$q = q(\ e\ ) \tag{3}$$

$$e = w_2 - a^*(H+K) \tag{4}$$

where $q' < 0$ and $q'' > 0$.[3] This means that quits depend on the differential between the current wage and the alternative wage, which workers can earn elsewhere through their general skills.

In this model it is assumed that workers are perfectly informed of the wage distribution across firms, but the contents of jobs and/or human relations in firms are not perfectly known to them. That is, workers do not know exactly what kind of job it will be, or what characters their supervisors and colleague have. Therefore, it is possible that after having obtained skills they find their jobs uninteresting and boring, or come into collision with the others in the firm. In addition, there are private reasons for workers to quit. For example, their families might migrate to other regions, or they might be forced to change the jobs for the sake of marriage or bad health. In any way it does not appear unrealistic to assume that these motives to quit can be partially compensated by the wage differential between the current and the alternative, as expressed by (3).[4]

3. Firm's Optimal Policy and the Imperfect Capital Market

We consider the firm which produces a single product for selling in the product market and maximizes the expected present value of profit. Labor, which embodies general skills and/or specific skills, is the only factor of production for the firm. Let F_k be the marginal value productivity of untrained workers whose level of schooling is K. Since the firm creates specific human capital and general human capital in them through on-the-job training in period one, their marginal productively increases. Let M_k be the marginal value productivity of the trained workers in period two.

M_k is a random variable because it depends mainly on the uncertain condition of the product market in period two. We represent its subjective density function by $f(M_k)$. If M_k turns out to be low in period two by the decline of product demand for the industry, the firm might lay off the skilled workers. Suppose that M_k° is the critical point below which the skilled are laid off. Then the possibility of layoff is given by

$$ly = \int_{-\infty}^{M_k^\circ} f(M_k)\ dM_k$$

where M_k° is determined by the firm's employment policy.

Considering the market value per unit of general skill and M_k are random variable, and assuming that they are independent, the expected present value of the firm's profit, R, from hiring an untrained worker is given by

$$R = F_k - C - w_1 + \frac{1}{1+r}\ [(1-q)M_k^* - (1-q)(1-ly)w_2] \tag{5}$$

$$M_k^* = \int_{M_k^\circ}^{\infty} M_k f(M_k)\ dM_k$$

where the cost of human investment, C, is given exogenously. Thus, the firm determines its wage profile(w_1, w_2) and layoff policy(M_k°) by maximizing R subject to the labor supply constraint (2).

But our problem is not so simple. After substituting (2) into (5), we get the partial derivative of R with respect to w_2,

$$\frac{\partial R}{\partial w_2} = -\frac{1}{1+r}\ q'[M_k^* + (1-ly)a^*(H+K)] > 0$$

which is always positive. Therefore, it is rational for the firm to reduce its period one wage to the lowest possible level and raise its period two wage to the highest level. The firm can benefit from decreasing the quit probability of the skilled because it retains more specific skills within the firm and reduces the wage cost to bear.[5]

Clearly this result is not realistic in the sense that, if this policy is taken by the firm, the period one wage should become negative, constary to the fact that most of initial wages which workers start with are really positive. Then, what makes firms refrain from reducing initial wages to the negative in the real economy? We can imagine three possible factors to do so, that is, the minimum wage law, the workers'risk-avertion to the uncertainties, and imperfection in the capital market.

If the minimum wage law dominates as a lowest level, all the initial wages of firms which create specific skills must be equal to the minimum wage. However, this contradicts the fact that initial wages differ widely and appear to depend on the expected lifetime incomes. As many empirical studies on wage profiles show,[6] the more the future income is expected from the job, the higher is its initial wage.

If workers are risk-averters, the uncertainty of being laid off or quit in period two makes them concerned about not only the present value of wages but also the wage profile. This means that the low wage in period one can not attract workers in the competitive labor market unless it is compensated by the extremely high wage in period two. Therefore, firms which minimize wage costs as far as their circumstances permit avoid such steep wage profiles.

When workers can not borrow money enough to finance their consumptions because of imperfection in capital market, steep wage profiles mean that they are forced to consume a small amount in period one and a large amount in period two, no matter how their desirable consumption patterns are. It is, however, possible that workers prefer to consume more in period one and less in period two even if the total amount of wages which they can receive becomes smaller. In such a case, firms can save wage costs by making wage profiles flatter. In fact, this situation is very likely to occur because the properties to mortgage and/or the opportunities to borrow against future earnings are severly limited for the workers who have just finished their academic careers. It should, however, be stressed here that imperfection in capital markets is asymmetric in general, that is, workers can not borrow sufficiently, but can lend money at the proper interest rate as mush as they want.

Taking account of risk-aversion and imperfection in the capital market, we can represent the worker's utility, U, like this,

$$U = u(w_1) + (1-q)(1-1y)v(w_2) + [1 - (1-q)(1-1y)]v(a^*(H+K))$$

where u and v are the utility function in period one and in period two, which are assumed to be monotone increasing and concave. It is also assumed, for the time being, that the worker can not borrow in the capital market at all.

If the earnings of job g in period one, $aK - C_g$ is relatively high and not binding against the worker's optimal plan of consumption, then his consumption profile(c_1, c_2) is such that

$$\frac{1}{1+r} = \frac{v'(c_2)}{u'(c_1)}$$

$$W_g = c_1 + \frac{1}{1+r} c_2$$

and he obtains the maximum utility, U_g. Therefore, the labor supply condition requires

$$U_g = u(w_1) + (1-q)(1-ly)w_2 + [1 - (1-q)(1-ly)]v(a^*(H+K)) \tag{6}$$

Thus, the firm determines M_k°, w_1 and w_2 by maximizing the expected present value of profit, R, under the condition of (6). Letting L and λ be the Lagrandian function and the multiplier, we have the first-order necessary conditions,

$$\frac{\partial L}{\partial M_k^\circ} = (1-q)f(M_k^\circ)\{-\frac{1}{1+r}(M_k^\circ - w_2) + \lambda[v(a^*(H+K)) - v(w_2)]\} = 0 \tag{7}$$

$$\frac{\partial L}{\partial w_1} = -1 + \lambda u'(w_1) = 0 \tag{8}$$

$$\frac{\partial L}{\partial w_2} = -\frac{1}{1+r} q'M_k^* + \frac{1}{1+r}(1-ly)q'w_2 - (1-q)(1-ly)[\frac{1}{1+r} - \lambda v'(w_2)]$$
$$+ \lambda(1-ly)q'[v(a^*(H+K)) - v(w_2)] = 0 \tag{9}$$

$$\frac{\partial L}{\partial \lambda} = u(w_1) + (1-q)(1-ly)v(w_2) + [1 - (1-q)(1-ly)]v(a^*(H+K))$$
$$= 0. \tag{10}$$

4. <u>Layoff Policy and Rational Expectations</u>

Before exploring some properties of the optimal layoff policy, we specify the density function of M_k as

$$f(M_k) > 0 \qquad \text{if} \quad M_k > \underline{M}_k$$

$$f(M_k) = 0 \qquad \text{if} \quad M_k \leq \underline{M}_k$$

where $\underline{M}_k$ is constant. This specification is only to exclude the case of multiple optimal solutions.

Using (8), we can rewrite the optimality condition (7) in a form which is readily interpretable,

$$M_k^\circ - w_2 = -(1+r)\frac{1}{u'}[v(w_2) - v(a^*(H+K))] < 0 \qquad \text{if} \quad M_k^\circ > \underline{M}_k$$

$$ly = 0 \quad (f(M_k^\circ) = 0) \qquad \text{if} \quad M_k^\circ \leq \underline{M}_k$$

Here it is interesting to note that the firm does not lay off the skilled even if their wages are higher than their marginal productivity. Clearly this is different from Oi's condition on layoffs.[7] In his pioneering paper(1962) Oi considered that under the existence of specific skills workers are laid off when their marginal productivity falls below their wages. Needless to say, this is the same as the condition of the traditional wage theory, represented by Hicks(1932), in spite of the existence of specific skills.

The difference between this model and Oi's is due to the different assumption on workers' expectations. Here the workers are assumed to be able to expect rationally and know correctly the layoff policy of the firm. This is the reason why the identical probability of layoff appears both in the equation (5) and (6). But, if the workers assume another layoff policy, ly*, which is determined independently of the firm's policy, because of their misconception or inability to expect the firm's behavior correctly in the short run, then the optimality condition for the firm is such that

$$M_k^\circ - w_2 = 0 \qquad \text{if} \quad M_k^\circ > \underline{M}_k$$

$$ly = 0 \qquad \text{if} \quad M_k^\circ \leq \underline{M}_k$$

which are essentially the same as Oi's condition.

This analytical result appears to have some implications for explanation of a different pattern of layoffs between the United States of America and Japan. In the U.S., when firms suffer from losses in business and are forced to cut down their wage costs, they first lay off the junior workers, the unskilled, according to the seniority rules. This implys that the case of workers' rational expectations is applicable to the U.S.. The American workers, who have often experienced business fluctuations and large scales of layoffs in their long history of capitalism, are very sensitive to firms' layoff policies. Therefore, if firms lay off the senior workers, the skilled, they will immediately have a bad reputation and be retaliated in the form of rising wage costs under the pressure of the unskilled labor market. In such a circumstance it is rational for firms to avoid the layoffs of the senior workers as much as possible. Thus, after World War II the American firms have widely become to respect the seniority rules in compliance with the demand of the trade unions.[8]

Special attention must be paid to that, as is clear from our setup on the time span, layoffs dealt with here mean the permanent termination of employment of the skilled. In other words, this model does not deny the existence of the temporary layoffs discussed by Feldstein(1976) and Baily(1977), or rather supports their basic assumption, that is, "the relatively permanent attachment of workers to individual firms" with the frequent spells of temporary unemployment.

In contrast, Oi's condition seems to be applicable to Japan, where people are possessed with the stereotyped idea that permanent employment strongly characterizes the Japanese industrial relations.[9] Owing to the rapid rate of economic growth and the intense demands for the skilled at least since Taishō era(1912-1926), the Japanese workers have seldom experienced large scales of layoffs and have had no chance to know how the firms' layoff policies are in the severe times. On the other hand, the mobility of workers has been limited by nenkō-wage, the reward system according to age and length of service, which functions skillfully to entrap workers within firms. Hence, the Japanese people easily adopt the permanent employment characterization by Abegglen(1958).

In this situation, as our model shows, it is rational for the firms to reduce their wage costs by firing the senior workers, whose wages are relatively high. In fact, this behavior has been oocasionally taken at the recent recessions specifically since 1973, what is called the year of oil shock, against our image of lifetime employment in Japan, and as a consequence difficulties facing the senior workers in finding jobs have become a serious problem. Some labor economists conjecture from this fact that the system of lifetime employment is now giving way in Japan.[10]

5. On the Determinants of Wage Profile and Quit Rate

In the case of general skills wages are equal to workers' productivity since workers can move freely among jobs and bear all the costs of human investments. But in the presence of firm-specific skills wages diverge from productivity. According to our model this can be shown by substituting (8) into (9) and conducting Taylor expansion on $v(w_2)$[11],

$$-\frac{1}{1+r}\,q'[M_k{*} - (1-1y)a{*}(H+K)] = \left(\frac{1}{1+r} - \frac{v'(w_2)}{u'(w_1)}\right)(1-1y)(1-q)$$
$$- q'e\left(\frac{1}{1+r} - \frac{v'(a{*}(H+K))}{u'(w_1)}\right)(1-1y)$$
$$+ \frac{1}{2}\,q'\,\frac{v'}{u'}\,\frac{v''}{v'}\,e^2(1-1y) \tag{11}$$

Equation (11) clearly shows us that, besides the productivity, the possibility of layoff, the workers' marginal propensity to quit, the degree of workers' absolute risk-aversion$(-\frac{v''}{v'})$ and the distortion of consumption plan $(\frac{1}{1+r} - \frac{v'}{u'})$ have effects on wage rationing by the firm. Here in this paper we focus on the role of consumption pattern of workers in the determination of wage profile.

As for the sign of the consumption distortion, specifically $(\frac{1}{1+r} - \frac{v'(w_2)}{u'(w_1)})$, we can not say anything desicively from (11). The left-hand side of (11) is positive since $M_k{}^* > a{*}(H+K)$ by the nature of specific skills, and the third term on the right-hand side is always positive. Therefore, it can be negative if the workers' absolute risk-aversion is sufficiently large. But our setup in Section 3 discards this negative case implicitly by the assumption of asymmetric imperfection in the capital market. If it is negative, the workers will cut down their consumptions in period one, lend money at the rate of interest r, and consume more in period two up to the point at which equality is attained. In this case, imperfection in the capital market becomes irrelevant to the wage profile since the firm takes into consideration only the workers' risk-aversion on determining it.

We consider the case where the workers' risk-aversion is very small and can be assumed, for simplicity, to be approximately zero. That is, in this paper we are not concerned with issue of risk in order to focus on imperfection in the capital market. The bitterness of this treatment is mitigated by the nature of our model. As we saw it in the last section, the firm makes the possibility of layoff for the skilled very low according to its optimal employment policy, so that uncertainty is relatively small in this economy.

Thus, neglecting risk-aversion(letting v' be constant), we have

$$\frac{1}{1+r} - \frac{v'}{u'} > 0 \tag{12}$$

(12) means that in period one the workers consume less than they would do in perfect capital markets or under unbinding wage profiles. This distortion of consumption plan must be compensated by the relatively high wage in period two because the wage profile of job g is assumed to be

unbinding. If the firm reduces the period one wage more, the distortion increases disproportionately by the concavity of the workers' utility function in period one. This is the reason why the firm refrains from reducing the period one wage infinitely.

There is the other important point to put stress upon here. Compared with his marginal productivity in a particular firm, a worker's consumption pattern is likely to be relatively stable because it is determined on the bases of his expected permanent income and "life style." Therefore, the close relation between wage and consumption pattern under the existence of specific skills, which work as a buffer absorbing short-run variations in workers' productivity, can be considered to make wage profiles stable in the course of business fluctuations.[12] This discussion gives a theoretical foundation to the living expense hypothesis in Japan.

In U.S., using the personnel records of two major corporations, Medoff and Abraham(1978) found the facts that, concerning managerial and professional employees within grade levels, there is either no association or a negative association between experience and relative performance while there is a strong positive association between experience and relative earnings. These findings imply that wage profiles are rising independently of changes in productivity and the human capital models assuming only the existence of general skills can not explain its phenomenon. If is clear that the model in this paper provides an explanation for their findings by paying attention to the relation between wage profile and consumption pattern in the presence of specific skills.

We now turn to comparative statics an the wage profile. In particular we examine the effects of a) the level of formal schooling, b) the change of specific skill value, c) workers' ability to borrow against future earnings.

For simplicity, we confine our analysis to the case of rational expectations on layoffs and assume the probability of layoff for the skilled workers to be zero. This assumption can be justified by the discussion in the last section. Thus, neglecting risk-aversion and the possibility of layoff, we can rewrite (11) and (10) as follows.

$$-\frac{1}{1+r}\,q'[M_k{}^* - a^*(H+K)] = \left(\frac{1}{1+r} - \frac{v'}{u'}\right)(1-q-q'e) \tag{13}$$

$$U_g = u(w_1) + v(a^*(H+K)) + (1-q)v'e \tag{14}$$

First, we examine the effects of formal schooling, which is assumed to create general skills in workers before they participate in the labor market. To begin with, we will show that as for general skills which are obtained through formal schooling and productive as well as specific skills in this firm, the following relations must hold in equilibrium,

$$\frac{dF_k}{dK} = a \qquad\qquad \frac{dM_k{}^*}{dK} = a^*$$

If $\frac{dM_k{}^*}{dK}$ $\left(\frac{dF_k}{dK}\right)$ is larger than $a^*(a)$, the firm will plan to hire more workers with general skills in period two (in period one) by paying the wage equal to value of $a^*(a)$ per unit of general skill, and consequently the expected marginal productivity of general skill will decrease to the point at which equality is restored. Thus, we have

$$\frac{dF_k}{dK} \leq a \quad \text{and} \quad \frac{dM_k^*}{dK} \leq a^*.$$

If inequality holds in both or either, the firm has no incentive to employ untrained workers with higher education since their productivity is relatively small in return for the wage cost, compared to workers with lower education. Note that the firm must pay at least $(a + \frac{1}{1+r} a^*)$ extra wage for an additional unit of K.

The analysis in the appendix demonstrates that

$$\frac{\partial w_1}{\partial K} > 0, \qquad \frac{\partial e}{\partial K} > 0, \qquad \frac{\partial w_2}{\partial K} > 0 .$$

These results mean that the increase in workers' productivity by higher formal schooling raises both wages in period one and in period two, and suppress the quits of the skilled by increasing e. It is interesting to note that the higher the level of formal schooling is, the higher is its initial wage. We can reason this result as follows. Since the marginal gain from increasing the period two wage decreases by the convexity of quit function, the firm can benefit by dividing into two periods the increment of wage payment due to the increase in the workers' productivity.

In the life-cycle models of general skill an initial wage depends on the amount of human investment which a worker decides by himself at that time. If he chooses a job which gives him a lot of opportunities to acquire general skills, his initial wage will be low. Therefore, the effect of formal schooling on an initial wage is not determined a'pri·o'ri unless it is made clear how the investment behavior of a worker is affected by his level of formal education. In contrast, in the current model the amount of human investment the cost of which the firm bears does not have an effect on the determination of wage profile.

Consider second the effects of the specific value of a worker in a particular firm. If the worker accumulates more specific skills instead of general ones through on-the-job training, his gap of productivity between the firm and others will become large. Therefore, his specific value is measured by

$$S \equiv M_k^* - a^*(H+K)$$

The appendix shows that

$$\frac{\partial w_1}{\partial S} < 0, \qquad \frac{\partial e}{\partial S} > 0, \qquad \frac{\partial w_2}{\partial S} > 0$$

Thus, when S increases, the firm steepens its wage profile by reducing the period one wage and raising the period two wage in order to refrain the skilled, who now became more valuable for the firm, from quitting even if this policy requires the more wage costs in total.

The specific value of a worker depends on many factors, such as the supply-demand condition of the industry, the firm's technology, the degree of monopoly, and so on. In the long run it seems that concentration in the industry is the key variable which determines S. The standard microeconomic textbook tells us that a monopolistic firm underutilizes production factors to capture a monopoly rent, so that their marginal productivity is higher than that of a competitive firm. In addition, the more monopolistic the firm is in the industry, the more likely is its technology to be particular and the more specific are skills which the worker acquires through on-the-job training in that firm. Thus, S is large in workers who work at monopolistic firms. If this assertion is correct, we can conclude that monopolistic firms offer steeper wage profiles and higher average wages, which function to reduce the quits of the skilled.

Consider finally how the improvement of workers' financial ability affects the wage profile. It has been assumed that the workers can not borrow against future earnings at all. But, we now relax this assumption as follows. Let D be the amount which the workers can borrow at the interest rate, r, in period one. Then, instead of (14), the labor market condition will be such that

$$U_g = u(w_1+D) + v(a^*(H+K) - (1+r)D) + (1-q)v^*e \tag{15}$$

where it is assumed that the workers pay their debts in period two.

From the appendix we can know that

$$\frac{\partial w_1}{\partial D} < 0, \qquad \frac{\partial e}{\partial D} > 0, \qquad \frac{\partial w_2}{\partial D} > 0$$

Thus, the improvement of consumption loan market makes the wage profile steeper because the workers become able to tolerate the lower wage in period one.

It is interesting to note that since the total utility is fixed at U_g in the competitive labor market of the unskilled, the workers can not benefit by their improved ability to borrow, but the firm can in the form of the decrease in the quit rate. This result makes it clear that the firm functions as a lender in imperfect capital markets, and the improvement of capital markets takes over its function and gives the firm some discretion in manipulating its wage policy.

In the above discussion it was implicitly assumed that workers are identical in their financial ability. But if there are variations in their financial positions, they will obtain the different levels of utility from a given wage pofile since those who are in preferable situations can realize the comsuption profiles which have small distortions from their optimal plans. In other words, workers evaluate each wage profile differently according to their financial ability. For example, workers facing large difficulties in financing their consumptions urge for a flatter wage profile more than those who are in preferable positions. In such situation it is rational for firms to offer a variety of wage profiles to reduce their wage costs or to lower quit rate. This is the reason why the percentage of the black, who are relatively at a disadvantage, is an important variable in explaining the differences in wage profiles among firms or industries.[13]

6. Summary and Some Further Extensions

This paper attempted to develop a theory of wage profile and layoff policy in the presence of firm-specific training, The derived conclusion on the optimal properties of layoff policy is that, in the economy where workers are very sensitive to firms' layoff Policies and expect them rationally, it is optimal for firms not to lay off the skilled employees even if their marginal productivity is lower than wages. This provides an economic rationale for seniority rules.

It was also discussed how wage profiles diverge from productivity under the existence of specific skills and get related to the consumption pattern of workers in imperfect capital markets. Workers can not tolerate the extremely steep wage profiles since thier financial ability for consumption are limited in imperfect capital markets, so that firms must take account of the consumption pattern of workers in the determination of wage profiles. In this framework we examined the effects on wage profiles of formal schooling, concentration in the industry, and workers' financial ability.

Two important problems remain for further extentions in this paper. First, the amount of human capital and investment were assumed to be given exogenously here. But it appears more realistic to assume that human capital depends on the investment which firms determine. In the current paper we ignored this phenomenon to focus on the particular problems of wage profile and layoff policy. The discussion on the determination of human investment is rather interesting from the point of view of income distribution in the sense that in such a economy inequality among workers is generated by firm-maximizing behaviors.

Second, workers will have some monopoly power once the specific investment has been completed, because firms can not hire the specific-skilled elsewhere. Then, the skilled can raise wages by negotiating with firms collectively if their specific value turn out to be high sufficiently. In this paper, however, there exists no firm-worker collective bargaining, so that firms unilaterally ration wages to each period under the constraint of market condition. If we admit collective bargaining, we need another approach instead of our rationing one. In his book(1964, 22) Becker developed the view that firms and employees share the costs of investment in specific training and the returns on it in order to reduce the likelihood of quit and to longer the recouping period. This sharing approach appears promising as a framework to deal with the case where collective bargaining is introduced.

FOOTNOTES

[1] See Becker(1964) for example.

[2] Rosen(1972b) discussed the logical structure in the life-cycle models of general skill.

[3] A dash means a derivative hereafter.

[4] This justification for the responsiveness of quits to e requires an amendment in equation (2) as follows. Let us assume that the dis-

utility of job attributes can be measured in terms of money and represented by x. Since the attributes are not known to workers upon becoming employed by a firm, x is a random variable. If $x > e$ in period two, workers will attempt to solve their problem by quitting the firm with the loss, e. When they remain in the firm in period two, the expected disutility which workers must tolerate is

$$\frac{\int_0^e x\, g(x)\, dx}{\int_0^e g(x)\, dx}$$

where $g(x)$ is the density function of x. When all acquired skills are general, workers can lessen disutility by exit without suffering any loss. Therefore, the wage in period two must be discounted by the amount of the expected conditional disutility in the above. But, this amendment is neglected here for the reasons that [1] since x is supposed to be widely distributed by its nature, the expected conditional disutility is very small compared to the other terms in equation(2), and [2] essentially the amendment does not change our conclusions.

5 Donaldson and Eaton(1976) obtained the same conclusion as this paper, only when quit probability is taken into consideration in the labor supply constraint. In contrast, when layoff probability is introduced instead, the opposite conclusion that the firm offers a declining wage profile as an optimal policy was derived.

6 See Hanock(1967) or Mincer(1974) as a representative.

7 Parsons also showed that "before layoffs will be undertaken in the first period, the worker's net marginal product in that period must be negative to the point that it offsets the direct layoff costs as well as expected future production losses, since some laid-off workers will not be available for rehire. If all laid-off workers could be rehired, only first-period net productivity would enter the decision,

..."(1972, p.1126). The time span assumed in Parsons's model is shorter than in this model in the calendar time, since the period two in this model means the rest of working-life of the worker after he obtained skills. Therefore, if we can ignore the direct layoff costs as negligible in the long run, this model says that layoffs will not be undertaken even if the current value of marginal product less wages is negative and the expected future production losses by layoffs are positive.

8 See Seniority in Promotion and Transfer Provisions.

9 It is generally agreed that permanent employment applies to regular employees in large-scale enterprises(1000 or more employees) and some medium-scale firms(100-999 employees) in the private sector and regular employees in the public sector.

10 See Galenson and Odaka(1976).

11 Neglecting terms of order higher than second, we used the following approximation:

$$v(w_2) = v(a^*(H+K)) + [w_2 - a^*(H+K)]v' + \frac{1}{2}[w_2 - a^*(H+K)]^2 v''$$

12 Parsons(1972) analysed how the firm manipulates its wage profile to deal with the different market situations, that is, a time of declining product demand and a period of prosperity. This means that the firm utilizes the wage profile to adjust employment in response to the demand fluctuations. In contrast, the wage profile in this model is determined from the point of view of supporting workers' consumptions, so that it is not responsive to the short run fluctuations.

13 See Hanoch(1967) for example.

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Appendix

To begin with, we explicitly present the second-order condition of the maximizing problem ignoring the workers' risk-aversion and the possibility of layoffs.

$$Z \equiv q'' \frac{1}{1+r}[M_k^* - a^*(H+K)] - \left(\frac{1}{1+r} - \frac{v'}{u'}\right)(2q'+q''e) - (1-q-q'e)^2\left(\frac{v'}{u'}\right)^2\frac{u''}{u'} > 0$$

a) The effects of formal schooling

$$\begin{bmatrix} -(1-q-q'e)\frac{v'}{u'}\frac{u''}{u} & -q''\frac{1}{1+r}[M_k^* - a^*(H+K)] + \left(\frac{1}{1+r} - \frac{v'}{u'}\right)(2q'+q''e) \\ 1 & (1-q-q'e)\frac{v'}{u'} \end{bmatrix} \begin{bmatrix} \frac{\partial w_1}{\partial K} \\ \frac{\partial e}{\partial K} \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ (1+r)a\frac{v'}{u'} \end{bmatrix}$$

In reducing this linear system, we used the following relation

$$\frac{\partial U_g}{\partial K} = \frac{\partial U_g}{\partial W_g}\frac{\partial W_g}{\partial K} = [(1+r)a + a^*]v'$$

$$\frac{dM_k^*}{dK} - a^* = 0$$

The former holds from equation (1) and the assumption of unbinding wage structure of job g. Solving the system, we have the effects of K as follows

$$\frac{\partial w_1}{\partial K} = \frac{a(1+r)\frac{v'}{u'}\left[q''\frac{1}{1+r}[M_k^* - a^*(H+K)] - \left(\frac{1}{1+r} - \frac{v'}{u'}\right)(2q'+q''e)\right]}{Z}$$

$$= \frac{-a(1+r)[(1-q)q''+2(q')^2](\frac{1}{1+r} - \frac{v'}{u'})\frac{v'}{u'}\frac{1}{q'}}{Z} > 0$$

where the first-order condition (13) was used in the second equality.

$$\frac{\partial e}{\partial K} = \frac{-a(1+r)(1-q-q'e)(\frac{v'}{u'})^2 \frac{u''}{u'}}{Z} > 0$$

$$\frac{\partial w_2}{\partial k} = \frac{\partial e}{\partial k} + a* > 0$$

b) <u>The effects of workers' specific value</u>

$$\frac{\partial w_1}{\partial S} = \frac{q(1-q-q'e)\frac{1}{1+r}\frac{v'}{u'}}{Z} < 0$$

$$\frac{\partial e}{\partial S} = \frac{-q'\frac{1}{1+r}}{Z} > 0$$

$$\frac{\partial w_2}{\partial S} = \frac{\partial e}{\partial S} > 0$$

c) <u>The effects of workers' financial ability</u>

$$\begin{bmatrix} -(1-q-q'e)\frac{v'}{u'}\frac{u''}{u'} & -q''\frac{1}{1+r}[M_k* - a*(H+K)] + (\frac{1}{1+r} - \frac{v'}{u'})(2q'+q''e) \\ 1 & (1-q-q'e)\frac{v'}{u'} \end{bmatrix} \begin{bmatrix} \frac{\partial w_1}{\partial D} \\ \frac{\partial e}{\partial D} \end{bmatrix}$$

$$= \begin{bmatrix} (1-q-q'e)\frac{v'}{u'}\frac{u''}{u'} \\ -(1+r)(\frac{1}{1+r} - \frac{v'}{u'}) \end{bmatrix}$$

we can easily show that

$$\frac{\partial w_1}{\partial D} < 0$$

$$\frac{\partial e}{\partial D} > 0$$

$$\frac{\partial w_2}{\partial D} = \frac{\partial e}{\partial D} > 0$$