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Abstract

The paper demonstrates that in a two-period model with imperfect capital markets firms will share the costs and returns of general training if human capital depreciates over time. Analyzing the firm's choice of the level of investment and the sharing-rule, it is shown that in spite of cost-sharing there will be an inefficient provision of general training: firms will economize on training in order to reduce workers' expected gain from quitting. If training is both general and firm-specific, overinvestment in firm-specific training will result.

I. Introduction

Traditional human capital theory defines general training as increasing the worker's marginal product in many firms by the same amount (Becker 1975). Thus no firm providing it will be ready to share the expenses of this training since it cannot capture any of the returns to this investment. Only if training is firm-specific and thus reducing the worker's mobility as his marginal product is higher in the firm providing it than elsewhere, the firm will be ready to bear part of the costs of training. Hashimoto (1981) suggested that the parties should agree to share the costs and returns to firm-specific human capital in a manner to minimize the loss from a possible separation for both parties, the exact sharing rule depending on the existence of transaction costs in evaluating and agreeing on the worker's productivities inside and outside the firm.

In a recent paper, Barron, Black, and Loewenstein, (1989) estimated the effect of on-the-job-training on wage growth and productivity growth. They found that approximately half of the returns to training are received by workers, i.e. a 10% increase in training leads to a 3% increase in productivity but only to a 1.5% increase in wage growth (Barron et al., p.10). Human capital theory would suggest two interpretations for this observation: first, all on-the-job-training is firm-specific and the two parties share the costs of training equally. Second, approximately one half of all training is job-specific and workers may bear the entire costs of general training but no share of the costs of specific training (Barron et al., p.11). Thus, if only workers pay for general training, the above mentionned results are only consistent with a share of firm-specific training of at least a half. Yet several recent studies have shown (Topel 1986, Abraham and Farber, Altonji and Shakotko 1987) that the coefficient of tenure is reduced dramatically after controlling for the quality of the employment match, which suggests little on-the-job-training is firm-specific. Following Becker, workers should get significantly more than half of the productivity growth in this case.

Empirical findings of workers getting only a half of the returns of training when the share of firm-specific human capital is low can be made plausible if arguments can be put forward in favor of cost-sharing of general training. Indeed, in a recent paper Katz and Ziderman (1990) provided a rationale that firms will frequently share the costs of general training: If potential employers do not possess costless information on the extent and the type of worker's on-the-job-training, a recruiting firm will place a lower value on a recruited worker with general training than the firm that trained him. If the employer anticipates that the worker will not get his full marginal product at another firm, this informational asymmetry enables the training firm to finance part or even the whole costs of general training. Under certain cirumstances, even only the firm and not the worker will be prepared to invest in general training.

This paper presents another argument why firms should accept to share the costs and returns of general training even if the worker's marginal product is commonly known to be identical across firms. If in a two-period model returns to training are declining over time due to human capital depreciation or due to technical progress, an employee will prefer to stay with a firm paying less than his current marginal product but continuously providing new training than to quit and join a new firm paying a higher wage for his current level of human capital but not offering additional training. If it is assumed that capital markets are imperfect so that workers prefer to join firms offering the highest share of training costs, and if in addition some plausible fair-wage requirements are met, it can be shown that a stable equilibrium will emerge in which the worker gets less than the returns to his general training and nevertheless has no incentive to quit even if his productivity is identical across firms. This effect will be the more pronounced the higher the rate of depreciation of human capital. In a next step the firm's choice of the level of investment as well as of the sharing-rule is analyzed. In the course of this the firm is supposed to anticipate a rational worker's quit decision. We demonstrate that the firm's readiness to pay part of the training is not sufficient to eliminate the well known market failure of underinvestment in general training with imperfect capital markets. Instead the firm will control the speed of offering general training in order to bind the workers and the firm to each other: by reducing the supply of training, workers' expected gain from quitting is decreased and the firm's risk of forfeiting the returns to training is eliminated. If firm-specific training is involved, too, it is shown that employers will choose too high a level of investment from a social point of view in order to reduce the worker's mobility.

The paper proceeds as follows: Section II presents the worker's mobility decision. In section III the choice of investment and the sharing-rule by the firm is analyzed.

II. The Worker's Mobility Decision

The model can be thought of as a three-stage game: in the first stage (at the beginning of the first period) workers choose training firms offering the best sharing-rule. Next firms decide on the amount and type of training as well as on the sharing-rule for the costs and returns of training. In the third stage (at the beginning of the second period) workers resolve either to quit or to stay with the training firm. Thus, by backward induction we first investigate the mobility decision of a worker who has been staying with a firm for one period during which he got both general and firm-specific on-the-job-training.

Contrary to the literature, in this model it is the firm and not the worker who decides on how much to invest in on-the-job-training and how to share the costs and returns of training, leaving the choice of separation with the worker[1]. In this section the employee's mobility decision is analyzed. The next section deals with the firm's decisions on investment and the sharing-rule which are made prior to the worker's mobility decision. At this stage it will be assumed that in the course of this the firm anticipates a rational worker's behavior concerning both mobility and the choice of a training firm.

In each period (t=1,2) investment in general (G_1,G_2) and firm-specific (S_1, S_2) training takes place at costs $c_i=c_i(S_i,G_i)$, i=1,2. Costs are raising at increasing rates (i.e. $c'>0, c''>0$). Investment in the second period only yields returns in period 2, $R_2=R_2(S_2,G_2)$, whereas training in the first period raises income in both periods. The crucial assumption refers to decreasing returns to training: due to human capital depreciation, technical progress, or shifts in market demand, returns are declining over time. They are given by $R_1=R_1(S_1,G_1)$ in the first and by $kR_1=kR_1(S_1,G_1)$, $0<k<1$, in the second period. Marginal returns of training are decreasing ($R'>0$, $R''<0$) with respect to investment. In addition, we require that training is productive within the given time horizon, i.e. there exists a level of investment S_i,G_i, i=1,2 such that

(1a) $R(S_2) - c(S_2) > 0, \qquad R(G_2) - c(G_2) > 0,$

(1b) $R(S_1)(1+\delta k) - c(G_1) > 0, \; R(G_1)(1+\delta k) - c(G_1) > 0.$

is met. However, costs of first-period investment will in

[1] Of course, a worker has a certain amount of scope at the beginning of the first period to join a firm offering a bundle of general and specific training and its sharing-rule. This decision is modelled in the first stage of the game.

general exceed returns in this period: $R_1(S,G)-c_1(S,G)<0$. The length of the time period has to be looked at more closely: If due to legal constraints the firm cannot force the worker not to quit until all returns to investment are yielded, it is given by the minimum period the employer expects the worker not to separate from the firm. Therefore, the length of the period may be given institutionally (i.e. by laws of firing or quitting). In reality, however, it will be substantially longer because workers need time both to learn the characteristics of the present job before making a mobility decision as well as to find a new job after having chosen to quit. It is reasonable to suppose that this time period will be influenced by the quality of the job which is dependent on the amount and type of training and the sharing-rule as well. For simplicity it is given exogeneously in this model.

When the worker's quit-decision is to be made, the level of investment (S,G) as well as the sharing-rule α have been decided upon in the previous stage. α refers to the firm's share of costs and returns to investment, $(1-\alpha)$ is the worker's share $(0<\alpha<1)$. We assume that α is constant during the two periods of the model. It is to be noted that although the sharing-rule is identical for both kinds of training in this model, this will not affect results qualitatively as will be shown later on. The intuition behind is is that as soon as the firm is ready to share the costs of general training, it will forfeit some returns to general and firm-specific training in case of separation. Therefore, even if a lower sharing-rule for general training could be applied, the possibility of worker's mobility would nevertheless distort investment in both types of training.

Making the mobility decision, the worker compares his wage inside and outside the training firm. If he takes a job at another firm, only his general skills can be transferred as his firm-specific skills do not yield returns outside the training firm. Having been paid

$$(2) \quad w_1 = (1-\alpha)\cdot[R_1(S_1,G_1) - c_1(\cdot)]$$

in the first period (for simplicity, compensation of unskilled labor is neglected, so the first-period wage will in general be negative) the worker gets an inside wage

$$(3) \quad w_2 = (1-\alpha)\cdot[R_2(S_2,G_2) + kR_1(S_1,G_1) - c_2(\cdot)]$$

in period 2 if he does not quit and an outside wage

$$(4) \quad \underline{w}_2 = kR_1(0,G_1)$$

in case of mobility as he has to give up his firm-specific training at a new firm. Obviously, the worker will not separate from the firm if $\underline{w}_2 < w_2$, i.e. if

$$(5) \quad (1-\alpha)\cdot(R_2 - c_2) > k[R_1(0,G_1) - (1-\alpha)R_1(S_1,G_1)].$$

The l.h.s. of (5) refers to the gain from staying with the firm, whereas the r.h.s. gives the wage differential in case of separation. If $G=0$, so that skills are completely firm-specific, the worker will not quit for any level of $(1-\alpha)>0$ and will be indifferent if $\alpha=1$. On the contrary, if $S=0$ education is fully general. Even in this case (5) may continue to hold if the worker's share of additional training in the second period outweighs the losses from being paid the full marginal product of first-period training at another firm. Thus as $R_2 - c_2 > 0$ it is possible that the costs and returns of general training are shared by the training firm and yet the worker has no incentive to quit even if the opportunity wage for his initial level of training is higher than at his present firm. This will happen if investment in the second period is sufficiently productive or if the difference between inside and outside productivity of first-period training is sufficiently small. Of course, a high rate of technical progress will render the l.h.s. of (5) larger, whereas a high rate of human capital depreciation will decrease the difference on the r.h.s. of (5) since the value of training is low irrespective of mobility. This result reflects the basic insight that there will be a trade-off between getting and paying for the most recent know-how on the one hand and being no more trained but receiving a wage equal to the full marginal product, on the other hand.

It has been assumed that workers always choose training firms offering the highest α, i.e. bearing the largest part of the training costs. Yet when the quit decision is to be made, a high level of α becomes a disadvantage for the firm: rearranging (5), we get

$$(6) \quad \alpha < 1 - \frac{k[R_1(0,G_1)}{kR_1(S_1,G_1) + R_2 - c_2}$$

as a necessary condition for no separation, indicating that a high share of returns for the firm will render a separation more profitable for the employee. Since a contract forcing the worker to stay with the training firm cannot be accomplished, yet nonetheless both the firm and the worker have to stick to the rules of the sharing rule in case of no separation, (6) will provide a upper limit for the firm's share on investment. It will be referred to as the "non-mobility constraint" in this paper.

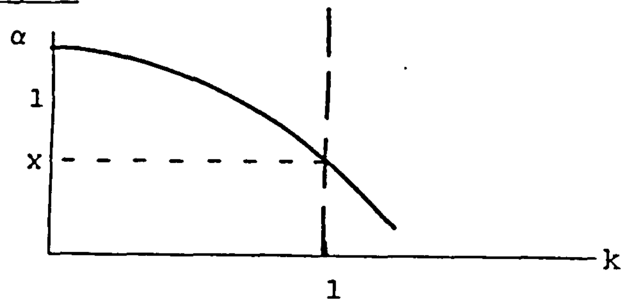
It is useful to look more closely at the link between α, k and the returns to general and firm-specific skills. Obviously, a higher rate of human capital depreciation (a lower value of k) will raise the critical value of α, enabling the firm to bear a larger part of investment. Thus if returns to training are decreasing quickly, the tie between the firm and the worker gets closer. This is the main explanation why firms are ready to share investment in general training with workers in this model. If k=1 returns to training would not decline over time. In this case workers could only be tied to the training firm if marginal rates of returns would be increasing, which is not a plausible assumption. If on-the-job training gets more firm-specific, the non-mobility condition will be fulfilled for a wider range of values α as inside productivity is increased stronger. Again cost-sharing becomes more attractive to the firm. This corresponds to the well-known negative relationship between mobility and the amount of firm-specific skills.

Furthermore, for general training results are dependent on whether the returns to general training increase or decrease in firm-specific skills. If $R_{SG}=0$ holds, so that returns to both kinds of training are independent, (6) reduces to

$$\alpha < \frac{kR_1(S_1) + R_2 - c_2}{kR_1(S_1,G_1) + R_2 - c_2},$$

stating that a higher G will unambiguously reduce the firm's willingness to pay for general training. If $R_{SG} < 0$ holds, the above result is reinforced. It will be mitigated if there are economies of scope between general and firm-specific skills yet continues to hold. Fig. 1 shows the relationship between α and k of returns to investment are separable in general and firm-specific training.

Fig.1:



$x=[R_1(S)+R_2-c_2]/[R_1(S,G)+R_2-c_2]$

It is easy to recognize that this result crucially hinges on the absence of firms paying the full marginal product of training acquired elsewhere and offering additional training at the same time. Yet two plausible assumptions can rule out this possibility: The firm would have to pay higher wages to new entrants with the same level of general training than to employess which have been trained within the firm before. Obvious fairness-considerations can prevent a firm from persuing such a policy: working morale would be destroyed and labor productivity would go down as analyzed by Assar and Lindbeck (1988) and Akerlof and Yellen (1990). Nevertheless it is possible that firms offering training without a sharing rule pay higher wages to workers who were trained elsewhere. Yet in the absence of perfect capital markets no worker would join such a type of firm so that it could not survive as a training firm in the market. Even if some workers would be able to pay for training by themselves, they would always choose firms offering the highest sharing rule (i.e. paying most for training) at the beginning of the first period since they are free to quit and join another firm in the second period.

III. The Firm's Choice of the Sharing Rule and the Level of Investment

At this stage the firm's choice of the sharing-rule as well as of the level of investment for both types of training is investigated. We assume that the firm is not naive but anticipates the worker's mobility decision in the next stage, choosing S,G and α in order to maximize profits π which are given by:

$$\pi = \alpha(-c_1(\cdot) + R_1(S_1,G_1)(1+\delta k) + \delta[R_2(\cdot) - c_2(\cdot)]).$$

The following nonnegativity constraints have to be added:

$$\alpha \geq 0, \quad 1-\alpha \geq 0;$$
$$S_i \geq 0, \quad G_i \geq 0, \quad i=1,2.$$

Furthermore, the non-separation condition (6) has to be met:

$$\alpha < 1 - \frac{kR_1(O,G_1)}{kR_1(S_1,G_1) + R_2 - c_2}$$

The Lagrangian of this problem is given by:

$$(7) \quad L = \alpha\{-c_1(\cdot) + R_1(S_1,G_1)(1+\delta k) + \delta[R_2(\cdot) - c_2(\cdot)]\} -$$

$$- \mu\{(\alpha-1)(R_2-c_2) + kR_1(0,G_1) - k(1-\alpha)R_1(S_1,G_1)\}.$$

The following first-order conditions can be derived:

$$(8) \quad S_1{*}: \quad S_1{*}\geq 0; \quad L_{S1*}\leq 0; \quad S_1{*}\cdot L_{S1*}=0;$$

$$L_{S1*}: \alpha[-c_1'+R_1'(1+\delta k)] + (1-\alpha)\mu kR_1'(S_1,G_1) \leq 0;$$

$$(9) \quad G_1{*}: \quad G_1{*}\geq 0; \quad L_{G1*}\leq 0; \quad G_1{*}\cdot L_{G1*}=0;$$

$$L_{G1*}: \alpha[-c_1'+R_1'(1+\delta k)] + (1-\alpha)\mu kR_1'(S_1,G_1) - \mu kR_1'(0,G_1) \leq 0.$$

$$(10) \quad S_{2*}: R_2'(\cdot) = c_2'(\cdot)$$

$$(11) \quad G_{2*}: R_2'(\cdot) = c_2'(\cdot)$$

$$(12) \quad \alpha{*}: \quad \alpha{*}\geq 0; \quad L_{\alpha*}\leq 0; \quad \alpha{*}\cdot L_{\alpha*}=0;$$

$$L_{\alpha*}: -c_1 + R_1 + (\delta-\mu)(kR_1 + R_2 - c_2) \leq 0$$

$$(13) \quad 1-\alpha{*}: \quad 1-\alpha{*}\geq 0; \quad L_{\alpha*}\geq 0; \quad (1-\alpha{*})\cdot L_{\alpha*}=0;$$

$$L_{\alpha*}: -c_1 + R_1 + (\delta-\mu)(kR_1 + R_2 - c_2) \geq 0$$

$$(14) \quad \mu: \quad \mu\geq 0; \quad L_\mu\leq 0; \quad L_\mu\cdot\mu = 0;$$

$$L_\mu: \quad \alpha < 1 - \frac{k[R_1(0,G_1)}{kR_1(S_1,G_1) + R_2 - c_2}$$

There are different possible types of outcomes. However, (10) and (11) state that investment in both S_2 and G_2 will be efficient in any case: as the risk of mobility is irrelevant at this stage, efficiency will hold irrespective of the chosen sharing rule. Furthermore, from our assumption concerning the pay-off period of investment in the second period we know that S_2 as well as G_2 will be strictly positive.

It is interesting to investigate two special cases at first. If first-period training is fully firm-specific, G_1=0 and the non-mobility constraint is not binding. Thus, μ=0 holds by condition (14). Necessary conditions for an optimum are reduced to:

(15) $S_1*: \ c_1' = R_1'(1+\delta k);$

(17) $L_{\alpha*}: \ \geq 0; \quad (1-\alpha*)\cdot L_{\alpha*} = 0;$

(18) $L_{\alpha*}: \ -c_1 + R_1(1+\delta k) + (R_2-c_2) > 0,$

thus $\alpha* = 1$. Investment is only dependent on the costs and returns to training. The firm chooses an efficient level of firm-specific training for the worker. Moreover, as (18) will be strictly positive in this case, it follows from (11) that the firm will offer the worker a sharing-rule α=1: It is ready to pay the entire firm-specific training. In other words, if there is no risk of separation, the firm is interested to get all the net benefits from training. Of course, it is possible to suggest that in this case workers would be better off by having a sharing-rule $\alpha<1$. This could be dealt with in a possible extension of the model where workers are rejecting to choose training firms offering a sharing rule with $\alpha \geq \alpha*$. Yet this paper is primarily concerned with the case where the workers want the firm to increase, not to decrease the its share on costs and returns to training as there are no perfect capital markets.

The second special case is concerned with training that is fully general, S_1=0. In this case the non-negativity condition $(1-\alpha)\geq 0$ will be of no relevance since α will be restricted by the non-mobility constraint. Comparing (12), we recognize that the firm will share investment (α>0) if

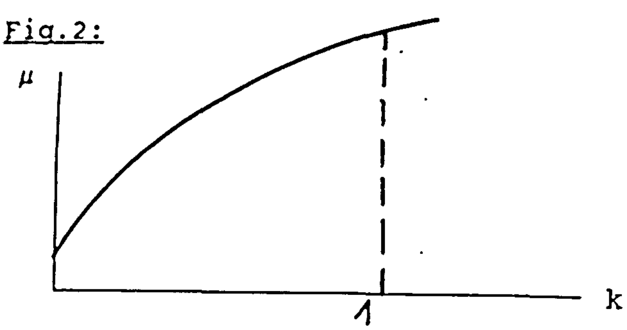
(19) $(R_1 - c_1) = (\mu-\delta)(R_2 - c_2 + kR_1)$

or if

(20) $$\mu = \delta - \frac{(c_1 - R_1)}{(R_2 - c_2 + kR_1)} \geq 0$$

holds[2]. μ is the shadow-price of the non-mobility constraint, measuring the marginal increase of profits if the non-mobility constraint is relaxed. It must not be too high in order to motivate the firm's investment. Obviously, this shadow price decreases if k goes down, indicating that a higher rate of obsolence of first period investment will render the worker's outside opportunities less attractive (fig.2). Similarily, a lower return to first-period investment in general training will work in the same direction. Finally, if second period investment is very productive (i.e. R_2-c_2 is high), the non-mobility constraint will be mitigated because this provides an incentive for the worker not to quit the training firm.

Fig.2:



It is to be noted that if the rate of human capital depreciation goes up (k decreases), the r.h.s. of (20) is reduced as $R_1-c_1<0$. Regarding next the first-order conditions for general training, for $\mu>0$ we get:

(21) $\alpha[-c_1'+R_1'(1+\delta k)] = \alpha\mu kR_1'(S_1,G_1)$ or

$R_1'(1+\delta k) > c_1'$. Marginal returns exceeding marginal costs of

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[2] $\mu>0$ in this case if $\delta>[c_1-R_1]/[kR_1 -c_2+R_2]$, which will always hold as $R_1(1+\delta k)+\delta(R_2-c_2)>0$ per assumption.

general training, the firm will choose too low an amount of investment from a social point of view. Thus, the well known result of underprovision of general training in the absence of perfect capital markets if only workers pay for training is not eliminated if firms are ready to pay part of the costs of general training. In order to tie the workers to the firm, it economizes on training expenditures by controlling the speed of providing general training. In the course of this lowering the workers' opportunity wages at another firm, the incentive to quit after the first period is diminished. The higher the shadow-price of the non-mobility constraint, the more investment will be hampered. Once again we recognize that a high rate of human capital depreciation will mitigate the inefficiency of investment.

In general, training will be neither fully general nor fully firm-specific. As long as training is primarily specific so that $\mu=0$, both S and G will be provided at an efficient level from the viewpoint of a social planner. However, if the non-mobility constraint becomes binding as the share of general training goes up, there will be a distortion of investment in both general and firm-specific skills. Using (8) and (9) and assuming $R_{SG}=0$ yields:

(22) $S_1{*}$: $[-c_1'+R_1'(1+\delta k)] = -[(1-\alpha)/\alpha]\mu k R_1'(S_1,G_1)$

(23) $G_1{*}$: $[-c_1'+R_1'(1+\delta k)] = \mu k R_1'(S_1,G_1)$.

Obviously, the r.h.s. of (23) is negative so that the firm is investing too high an amount in firm-specific training in order to induce the worker not to quit. At the same time, investment in general training will continue to be at too low a level from a social point of view. If $R_{SG}>0$, general training will be more productive at the margin within the training firm than outside, so that the inefficiency will be mitigated. If $R_{SG}<0$, on the other hand, it will be reinforded.

The inefficient level of firm-specific training in this model arises as the firm does not explicitly distinguish between general and specific training but is only concerned with the nonmobility constraint. This seems to be very plausible since it may be impossible to distinguish between the two types of training in contracts explicitly. Yet even if different sharing-rules α_S and α_G could be accomplished, the results would not be affected qualitatively. In this case firm's profits are given by:

$$\pi = \alpha_S\{-c_1(S_1) + R_1(S_1)(1+\delta k) + \delta[R_2(S_2) - c_2(S_2)]\} +$$

$$\alpha_G\{-c_1(G_1) + R_1(G_1)(1+\delta k) + \delta[R_2(G_2) - c_2(G_2)]\}$$

Nonnegativity conditions now are present for S_i, G_i, $i=1,2$, and α_S, α_G, $1-\alpha_S$, $1-\alpha_G$. The non-mobility constraint is changed to:

$$(1-\alpha_S)[-c_1(S) + R_1(S) + \delta(-c_2(S) + R_2(S) + kR_1(S))] +$$

$$+ (1-\alpha_G)[-c_1(G) + R_1(G) + \delta(-c_2(G) + R_2(G) + kR_1(G))] > kR_1(G_1)$$

First-order conditions for investment yield:

$$S_1{*}: \quad \alpha_S[-c_1'(S) + R_1'(S)(1+\delta k)] + (1-\alpha_S)\mu k R_1'(S_1) \le 0;$$

$$G_{1*}: \quad \alpha_G[-c_1'(G) + R_1'(G)(1+\delta k)] + (1-\alpha_G)\mu k R_1'(S_1) - \mu k R_1'(0,G_1) \le 0.$$

As long as the non-mobility constraint is binding, there will be a distortion of both types of training: In order not to give the worker an inventive to quit, the firm will restrict both the amount and the share of general training. However, it will offer the worker too high a level of firm-specific training from a social point of view at the same time.

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