Investment in Firm-Specific and General Human Capital

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Abstract

In this paper, we extend the analysis of specific schooling by Hashimoto (1981), by introducing non-specific or general schooling. Human capital investment is analysed within a two-period framework. In the first period, the employer and the employee not only have to choose the level of investment in human capital and the division of costs and benefits, but also have to decide on the specificity of the training. In the second period, (private) information on the productivity of schooling comes available, whereafter the employee may decide to quit and the employer can dismiss the employee. Also, the consequences of subsidies or taxes on schooling are analysed.

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1 Introduction

At the moment there is a lively popular debate in the Netherlands about 'employability'. The discussion is focused on the benefits of permanent schooling for workers. Employees have to update their knowledge continuously in order to maintain or increase their value inside and/or outside their current employment. The benefits of schooling to workers is obvious, the higher their value of human capital is, the more they can earn or the easier it is to find another job. Firms also benefit from schooling of their workers since their productivity increases, but seem reluctant to pay for the schooling. Since a higher rate of job finding reduces unemployment, the benefits for the government are also fairly obvious (*cf.* Layard et al. 1994.). A good indication is that the ministry of economic affairs is elaborating on (partial) tax deductibility of costs of schooling for workers (*cf.* NRC Handelsblad, 8-10-1997). In order to shed some (academic) light on the current discussion, we develop a model to analyse the effects of schooling for the worker and the firm. We also elaborate on the optimal sharing conditions for the costs and benefits of investment and introduce a (benevolent) government to see if and how it can alter the privately optimal decisions.

The model we develop is an extension of the model developed by Hashimoto (1981), and related to the more restrictive analysis by Kato (1989). The model by Hashimoto explores the effect of the optimal sharing arrangement on the costs and benefits of an investment in purely firm-specific human capital accumulation. It is a two-period model. At the beginning of the first period, the firm and the worker decide how much to invest in human capital accumulation and how the benefits and the costs are divided. At the beginning of the second period, the worker and the firm decide whether to continue the arrangement or not. The worker quits if he can earn more elsewhere, which depends on the realization of a random variable, and the firm dismisses the worker if his realized productivity is too low compared to the wage. Renegotiations are not possible due to high transaction costs. The optimal arrangement for both parties is to share both the costs and the benefits of the investment.

We extend this analysis by assuming that part of the investment in human capital accumulation is also productive outside the firm. We explore the consequences of this additional externality for the optimal sharing arrangement of the costs and benefits of the investment. Furthermore we endogenize the choice of this degree of generality. Moreover we check the consequences of policy interventions by the government.

The remainder of this paper is organized as follows. The next section displays the model and shows the differences with the original model. The third section solves the model and shows the main results. In the fourth section, some policy interventions are shown. The last section concludes.

2 The Model

We study a two-period model of the interaction between a worker and an employer. The model is an extension of the formalization of the Becker (1962) model by Hashimoto (1981). The worker and the firm interact on a perfect labour market, backed by a perfect capital market. Both actors are risk neutral. The worker is assumed to endow a level H of completely general human capital, to which no uncertainty or variance is attached. At the beginning of the first period, the firm and the worker decide upon the non-zero amount of investment in human capital and on their respective share in the costs, β for the worker and $1-\beta$ for the firm, and benefits, α for the worker and $1-\alpha$ for the firm, of the investment. In the first period the (net) wage of the worker is lower than without schooling, because he pays for some part of the costs of the investment, whereas in the second period, the wage is higher than alternatively because his productivity is increased by the investment. At the beginning of the second period, the worker and the firm decide unilaterally whether to continue the 'contract' or not. The worker quits if he can earn more elsewhere. The firm dismisses the worker if his actual productivity is too low compared to the wage. The productivity might be influenced by, e.g., real shocks to the economy.

Given a production function and input prices, the cost function (C) for human capital investment (h) is assumed to be convex and increasing. In formal notation

$$C(h) > 0,\ C'(h) > 0,\ C''(h) > 0. \tag{1}$$

The worker's original level of human capital is H. We assume that $C(h)$ and H are independent. The value to the firm of a unit of h is m, and dm to any other firm (where $0 \leq d \leq 1$). In other words a fraction $1-d$ of the investment is completely specific to the firm whereas a fraction d is completely general. Thus, our paper is a generalization of Hashimoto (1981), where $d = 0$, or schooling is completely firm-specific.

The return to the investment for the firm is uncertain. This uncertainty might reflect errors in predicting market conditions facing the firm, errors in predicting the productivity of the worker, etcetera.

The value of an extra unit of human capital in the firm is $m + \eta$, where η is a random component with expectation zero, $E(\eta) = 0$, and density function $\phi(\eta)$. The worker does not observe the value of η.

The alternative wage of the worker is also uncertain. This uncertainty reflects *e.g.* errors in predicting market conditions in the alternative employment, or changes in the valuation of leisure. The value of an extra unit of human capital to the worker in the alternative employment is $dmh + \varepsilon h$, where ε is a random component with expectation zero, $E(\varepsilon) = 0$, and has a density function $\psi(\varepsilon)$. The employer does not observe the value of ε. For simplicity it is assumed that ε and η are uncorrelated, *i.e.* $\text{cov}(\varepsilon, \eta) = 0$, so that factors that influence the value of the worker in its alternative employment are unrelated to factors that influence his value in his current employment.

The worker and the firm are supposed to transact costlessly on the values of m and H, but transacting on the realized values of η and ε is assumed to be very costly.

The actual value $\widehat{v}$ of the worker to the firm is

$$\widehat{v} = H + (m + \eta)\, h. \tag{2}$$

The worker does not observe η and receives αmh of the rent. So, the wage of the worker in the second period is

$$w = H + \alpha mh. \tag{3}$$

The actual value $\widehat{y}$ to the worker of the alternative employment is

$$\widehat{y} = H + dmh + \varepsilon h. \tag{4}$$

where d reflects the generality of the schooling. The worker will quit if $w < \widehat{y}$ or

$$\varepsilon \geq (\alpha - d)\, m \equiv \varepsilon^*. \tag{5}$$

The part of the rent the employer receives equals $(1 - \alpha)mh$. Given η the actual rent is

$$\widehat{r} = (1 - \alpha)\, mh + \eta h. \tag{6}$$

The employer will dismiss the worker if $\widehat{r} \leq 0$ or

$$\eta \leq -\,(1 - \alpha)\, m \equiv \eta^*. \tag{7}$$

Note that the jointly optimal separation rule is $\widehat{v} - \widehat{y} \leq 0$ or

$$(1 - d)\, m \leq \varepsilon - \eta. \tag{8}$$

3 The Solution

Due to the presence of ε and η, or uncertainty on realized values in the second period of the model, disoptimal splitting solutions can occur. If η and ε are low, the firm has an incentive to dismiss the worker whereas the worker does not want to quit. Stated differently, the firms impose an externality upon the worker. An equivalent problem arises if the realized values of η and ε are high, the worker wants to quit, whereas the firm does not want to let him go. In both cases either party would like to compensate the other party not to breach the contract. In that case their joint gain would be higher.

It would of course be optimal to renegotiate the contract in the second period, but this is not possible due to the high transaction costs associated with the renegotiation process. Realized values of η and ε can be the result of *e.g.* an increased valuation of leisure by the worker or adverse market circumstances. These realizations are very costly to transact about. Furthermore, mistrust may prevent both parties to start renegotiating. Moreover, possibilities for cheating are also present.

The problem can be somewhat avoided if parties, in setting up the contract, partly internalize some of the associated externalities. The way to do this is to maximize their joint utility subject to the choice variable α, the parameter that divides the (ex ante) returns of the investment between the worker and the firm. In this case the costs of disoptimal dismissal is minimized and spread between both parties. This is an application of the theorem due to Coase (1960).

The worker's expected gross gain is

$$M_w = (1-L)(1-Q)E(w) + (1-L)QE(\widehat{y} \mid \varepsilon > \varepsilon^*) + LE(\widehat{y}) - H, \tag{9}$$

where L and Q are the probabilities of dismissal and quit. The first term is the wage if the worker does not leave the firm and is not fired, the second term is the alternative wage if the worker decides to quit, and the last term is the alternative wage if the worker is laid off. The objective of the worker is to maximize his expected net gain,

$$G_w = M_w/(1+i) - \beta C(h), \tag{10}$$

where i is the interest rate and β the worker's share in the cost of investment. The expected gross gain for the employer is

$$M_e = (1-L)(1-Q)\, E(\widehat{r} \mid \eta > \eta^*)\,. \tag{11}$$

The expected gross gain for the employer is the part of the rent that the firm receives if the worker does not quit and if the worker is not laid off. Expected net gain is

$$G_e = M_e/(1+i) - (1-\beta)\, C(h)\,. \tag{12}$$

By maximizing their joint gain and *dividing* it, both parties are better off than by maximizing their individual gain.[1] Their mutual gain can be represented by

$$G = M/(1+i) - C(h). \tag{13}$$

The first order conditions for the problem are

$$\begin{aligned} G_\alpha &= -\frac{L_\alpha}{1+i}(1-Q)[\varepsilon^* - E(\varepsilon \mid \varepsilon < \varepsilon^*)]h \\ &\quad + \frac{Q_\alpha}{1+i}(1-L)[\eta^* - E(\eta \mid \eta > \eta^*)]h = 0, \end{aligned} \tag{14}$$

$$\begin{aligned} G_h &= \frac{1}{1+i}\{(1-L)(1-Q)[m + E(\eta \mid \eta > \eta^*)] \\ &\quad + (1-L)QE(\varepsilon \mid \varepsilon > \varepsilon^*)\} - C'(h) = 0, \end{aligned} \tag{15}$$

$$\begin{aligned} G_d &= \frac{1}{1+i}[-L_d(1-Q)E(\widehat{v} \mid \eta > \eta^*) - (1-L)Q_d E(\widehat{v} \mid \eta > \eta^*) \\ &\quad - L_d Q E(\widehat{y} \mid \varepsilon > \varepsilon^*) + (1-L)Q_d E(\widehat{y} \mid \varepsilon > \varepsilon^*) \\ &\quad + (1-L)Q\frac{\partial E(\widehat{y} \mid \varepsilon > \varepsilon^*)}{\partial d} + L_d E(\widehat{y}) + L\frac{\partial E(\widehat{y})}{\partial d}\Bigg] = 0. \end{aligned} \tag{16}$$

From the equations above, the optimal values of α, h, and d are derived. In general α will lie between 0 and 1, *i.e.* the benefits from the investment will be shared. Now we have to derive the 'sharing arrangement' of the costs. The long-run competitive equilibrium requires that the present value of the benefits exactly equals the costs for both parties. Stated differently, the net gain (G) to the worker and to the employer, and therefore to both parties, has to equal zero. In formal notation

$$G_w = M_w/(1+i) - \beta C = 0,$$

[1] See Carmichael (1985) and Hashimoto (1985) for a proof of this result.

and

$$G_e = M_e/(1+i) - (1-\beta)C = 0,$$

where $0 \le \beta \le 1$, so

$$G = (M_w + M_e)/(1+i) - C = 0.$$

It follows that

$$\beta = M_w/M,$$

or, the costs of the investment are shared between the actors proportional to their gain of the investment.

Intuitively, the value of β is higher than that of α. As long as d is nonzero, the worker gains from the investment irrespective of his employer. If the contract is broken up, the worker still reaps the benefits of the investment, namely a higher alternative wage. His share in the costs of the investment will therefore have to be higher than his share in the benefits.

Suppose $\varepsilon = 0$. In this case, there is no uncertainty for the worker about the value of his alternative employment in the second period. It follows from equation (6) that $Q = Q' = 0$, the worker will not quit, although the employer can still dismiss the worker. The FOC (14) then becomes

$$-L'\,(\alpha - d)\,m = 0. \tag{17}$$

The optimal arrangement is $\alpha = d$, This condition implies that the worker is indifferent between the current and the alternative employment, the wage he receives is $H + \alpha mh = H + \alpha dh$.

Suppose now $\eta = 0$. In this case, there is no uncertainty for the employer about the productivity of the schooling in the second period, and it follows from equation (7) that the employer will not dismiss the worker, or $L = L' = 0$. The FOC (14) then becomes

$$-Q'\,(1 - \alpha)\,m = 0. \tag{18}$$

The optimal arrangement is $\alpha = 1$, the worker receives the returns, and has to pay for it. Note that the worker is indifferent with respect to the degree of specificity of the training.

4 Policy Interventions

The government can influence the choices made by the actors by subsidizing or taxing their activities. Let us assume that the government wants to stimulate investment in human capital, for the moment we abstract for their desire to increase d, the degree of generality of the investment. An appropriate instrument is a subsidy to the costs of the investment. The subsidy can be general, or aimed at the worker only. Furthermore, we extend the subsidy to be aimed at d as well. These cases are displayed below. Another instrument, as proposed in the public debate in the Netherlands, is to give a tax credit to the worker. The worker can deduct (part of) the expenses on schooling from his tax liabilities. We also analyse the effects of this instrument below.

4.1 General Subsidy

4.1.1 Subsidizing Both Agents

The subsidy can be used to lower the effective marginal cost of investment. The subsidy can be incorporated by changing the entry for the cost function to $(1-s)C(h)$, where s is the proportional rate of the subsidy.[2] In the original model the only variable that is affected by the cost function is h. The FOC for the actors changes from (15) to

$$\begin{aligned} G_h &= \frac{1}{1+i}\{(1-L)(1-Q)[m+E(\eta \mid \eta > \eta^*)] \\ &\quad + (1-L)QE(\varepsilon \mid \varepsilon > \varepsilon^*)\} - (1-s)C'(h) = 0 \end{aligned} \tag{19}$$

The effect of this subsidy is an increase in the amount invested in schooling. No other choice variables are affected.

4.1.2 Subsidizing the Worker Only

Another possibility for the government is to only subsidise the worker. The subsidy can be instrumented by lowering the costs of investment to $(1-\beta s)C(h)$. In this case equation (15) changes to

$$\begin{aligned} G_h &= \frac{1}{1+i}\{(1-L)(1-Q)[m+E(\eta \mid \eta > \eta^*)] \\ &\quad + (1-L)QE(\varepsilon \mid \varepsilon > \varepsilon^*)\} - (1-\beta s)C'(h) = 0. \end{aligned} \tag{20}$$

The effect of the subsidy on the level of h now depends on the sharing arrangement between both actors. In general the worker pays for at least some part of the costs of the investment,

[2] This might alternatively be thought of as a discount on the tax burden that is proportional to the marginal tax rate.

i.e.. the term βs will be larger than zero so that the amount of h increases. Due to the zero profit condition in equilibrium, the sharing arrangement also changes. The resulting β can be derived from the following expression

$$\frac{M_w}{M} = \frac{\beta(1-s)}{1-\beta s},$$

that is, the worker is likely to bear a larger (gross) share of the costs.

4.2 Subsidizing d

The benevolence of the government could also strive further to it wanting to increase the level of d, the degree of generality of the investment. This improves the position of the worker on the labour market. The increase in d could be achieved by tailoring the subsidy to the degree of generality. In formal terms the effective cost schedule now looks like $(1 - sd)C(h)$ or $(1 - \beta sd)C(h)$ if only the worker is subsidized.

Again, two situations can be distinguished. One in which both actors are subsidized and one in which only the worker is subsidized.

4.2.1 Subsidizing Both Agents

By subsidizing both agents in the way expressed above two FOCs change. One is the condition on h and the other the condition on d. Formally, equation (15) changes to

$$\begin{aligned} G_h &= \frac{1}{1+i}\{(1-L)(1-Q)[m + E(\eta \mid \eta > \eta^*)] \\ &\quad + (1-L)QE(\varepsilon \mid \varepsilon > \varepsilon^*)\} - (1-sd)C'(h) = 0 \end{aligned} \tag{21}$$

Again, this modifies the optimal amount of h, it increases. The condition on d, equation (16), changes to

$$\begin{aligned} G_d &= \frac{1}{1+i}[-L_d(1-Q)E(\widehat{v} \mid \eta > \eta^*) - (1-L)Q_d E(\widehat{v} \mid \eta > \eta^*) \\ &\quad - L_d Q E(\widehat{y} \mid \varepsilon > \varepsilon^*) + (1-L)Q_d E(\widehat{y} \mid \varepsilon > \varepsilon^*) \\ &\quad + (1-L)Q\frac{\partial E(\widehat{y} \mid \varepsilon > \varepsilon^*)}{\partial d} + L_d E(\widehat{y}) + L\frac{\partial E(\widehat{y})}{\partial d}\Bigg] + sC(h) = 0 \end{aligned} \tag{22}$$

Adding the last term on the LHS ensures that d increases. So, in the new equilibrium both h and d have increased. Since the gain from the subsidy is distributed equivalently between the worker and the firm, the value of β does not change.

4.2.2 Subsidizing the Worker Only

A subsidy only targeted at the worker also changes both conditions. Equation (15) now changes to

$$
\begin{aligned}
G_h &= \frac{1}{1+i}\{(1-L)(1-Q)[m+E(\eta \mid \eta > \eta^*)] \\
&\quad + (1-L)QE(\varepsilon \mid \varepsilon > \varepsilon^*)\} - (1-\beta sd)C'(h) = 0. \qquad (23)
\end{aligned}
$$

Again this tends to increase the optimal level of investment h. The effects for the optimal value of d can be shown by modifying equation (16) to

$$
\begin{aligned}
G_d &= \frac{1}{1+i}[-L_d(1-Q)E(\widehat{v} \mid \eta > \eta^*) - (1-L)Q_dE(\widehat{v} \mid \eta > \eta^*) \\
&\quad - L_dQE(\widehat{y} \mid \varepsilon > \varepsilon^*) + (1-L)Q_dE(\widehat{y} \mid \varepsilon > \varepsilon^*) \\
&\quad + (1-L)Q\frac{\partial E(\widehat{y} \mid \varepsilon > \varepsilon^*)}{\partial d} + L_dE(\widehat{y}) + L\frac{\partial E(\widehat{y})}{\partial d}\Bigg] + \beta sC(h) = 0 \qquad (24)
\end{aligned}
$$

The value of d increases. Due to the presence of the factor β in the expression for the joint value function M, the value of β also changes. The new expression from which β can be derived now becomes

$$
\frac{M_w}{M} = \frac{\beta(1-s)}{1-\beta sd},
$$

so the value of β is likely to increase. The worker again pays a larger (gross) fraction of the investment.

4.3 A Tax Credit

A tax credit can also be used to influence the decisions made by the actors. Let us assume that the governments allows the worker to deduct his expenses on schooling up to an amount c.[3] In this case the effective tax burden of the worker changes from τY to $\tau(Y-c)$, where Y is the taxable income of the worker and τ the marginal tax rate, that is assumed to be constant. The cost schedule of investment in schooling changes to

$$
C^*(h) = \begin{cases} C(h) - \tau c & \text{if } \beta C(h) \geq \tau c \\ (1-\beta\tau)C(h) & \text{otherwise} \end{cases}. \qquad (25)
$$

This affects the optimal choice of h by modifying the term $C'(h)$ in equation (15) to $(1-\tau)C'(h)$, as long as $\beta C(h) \leq \tau c$. So, as long as $\beta C(h) < \tau c$ the value of h is increased.

[3]We abstract from the effects of the loss of tax revenue by the government. Alternatively, the costs could be reclaimed from both agents lump sum.

In this case the value of β will be higher than in the original framework. If the original value of h was high enough to ensure that $\beta C(h) \geq \tau c$, nothing is changed in the amount of h by introducing the tax credit. The value of β increases again.

5 Concluding Remarks

In this paper we have extended the analysis by Hashimoto (1981), by introducing a degree of generality of investment in human capital. This tends to change the distribution of costs and benefits related to the investment in schooling. In general the share in the benefits of the investment of the worker increases. A benevolent government can influence the choices made by the agents by subsidising schooling or by giving a tax credit. The degree of generality can also be influenced.

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