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Abstract

The literature on firm-financed general training after Becker tried to explain the firms' incentive to invest in general training by looking at labour market frictions. These friction were not only taken to explain the existence of firm-financed general training but were -- besides the workers' credit constraints -- made responsible for part of the inefficiency in the investment into general training. Although firms pay for general training, this paper confirms Becker's result that inefficient investment into general training can only arise if workers are credit constrained.

Keywords: General training, credit constraints, matching.

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1. Introduction

Becker (1964) shows that in a competitive labour market workers should pay for general training since they receive the full return to training. The observation that firms also finance general training lead to a paradox, which was solved by realizing that the training firms' superior information about a trainees productivity[1] and search frictions[2] give the training firm ex-post some market power over their trainees, which provides sufficient incentives for the firm to finance general training. Especially, search frictions were not only taken to explain the existence of firm-financed general training but were – besides the workers' credit constraints – made responsible for part of the inefficiency in the investment into general training (see Acemoglu 1997, Acemoglu and Pischke 1999a and Stevens 2001)[3].

In a model with search frictions and bargaining, this paper confirms Becker's result that inefficient investment into general training can only arise if workers are credit constrained. The firm can always use a low trainee wage and the difference in recruitment costs between skilled and unskilled workers to pay for general training. The low trainee wage will, however, induces trainees to search. In order to prevent trainees from quitting the firm need to pay them the outside wage. This is only profitable for the firm, if the trainee can pay a lump-sum transfer equivalent to the promotion up-front. Thus, training will only be inefficient if workers are credit constrained.

This is in contradiction to Acemoglu (1997), Acemoglu and Pischke (1999a) and Stevens (2001), who claim that in the absence of capital market imperfections labour

[1] See Katz and Ziderman (1990), Chang and Wang (1996), and Acemoglu and Pischke (1998).

[2] See Stevens (1994, 2001), Acemoglu (1997), and Acemoglu and Pischke (1999a, 1999b).

[3] Acemoglu and Pischke (1998) show in a framework with adverse selection that training will be efficient if workers are not credit constraint.

market frictions reduce training below the first best. Acemoglu (1997) and Acemoglu and Pischke (1999a) obtain this result because they do not endogenise the probability with which a worker leaves his current employer. Thus, due to a constant separation rate future employers profit from training because of the wage compression. Stevens' (2001) result is driven by the assumption that labour market frictions and the number of trainees trained in equilibrium influence only the recruitment cost for skilled labour but not for unskilled labour. By allowing the difference in recruitment costs between skilled and unskilled labour to adjust to the return of skilled and unskilled labour, I can show that search frictions per se do not cause underinvestment.

When deciding whether to train an unskilled worker or not, the firm faces the trade off between training an unskilled worker at its own expense or recruiting a skilled worker from the market. Thus, the firm is only willing to train, if it is more expensive to recruit a skilled worker than an unskilled worker. The difference in recruitment costs can be used to pay for the general training of some unskilled workers; this point was already mentioned by Oatey (1970) and Stevens (1994, 2001) and is endogenised in this paper. Furthermore, the local monopsony power of the firm, when offering a training contract to an unskilled worker, allows the firm to extract all rent from a trainee. This rent can be extracted by setting the trainee wage so low that the worker is indifferent between remaining unskilled or being trained provided the trainee wage does not become negative. (equivalent to Becker 1964, Acemoglu and Pischke 1999b, Stevens 2001, Malcomson et al. 2003). The problem remaining is that trainees will search for a better paid job at another firm. This search externality can be reduced by increasing the wage such that the trainee's incentive to search is lessened. If workers are not credit constrained, the training firm can offer the trainee the wage a skilled worker would get at an outside firm. In turn the trainee will have to pay the firm a lump-sum payment equivalent to the discounted value of this promotion. The result is that trainees will not search and move to other firms and training will be efficient.

If workers are credit constrained, then the rent the training firm can extract form its workers depends on the trainees probability to find an outside job. The cause of the externality is that outside firms do not take into account that by training they increase the pool of people searching for skilled job vacancies and that by doing so it becomes harder for other trainees to find a job. This lower separation rate increases the firm's return to general training, which sustains a high training level and a low market tightness for skilled labour. On the other side, a low training equilibrium can exist where the probability for trainees to find a job at another firm is high. This decreases the return to general training such that firms train less. Thus, the poaching externality can lead to multiple equilibria.

If there is on-the-job search, not only by trainees but by all workers, and if search is costly, then promotion in exchange for an equivalent lump-sum payment, which includes the forgone search cost of the worker, decreases the poaching externality and might – depending on the search cost function – lead to an efficient investment in general training. On-the-job search further implies that only unskilled workers, who just entered the labour market, are trained. The reason being that they accept the lowest trainee-wage or equivalently pay the highest lump-sum in turn for the promotion, since they have the lowest reservation utility. Thus, the training firm can extract from these unskilled workers the highest rent in order to pay for general training.

If specific training together with general training implies that the trainee's marginal product at the training firm is higher than at an outside firm – as modelled in Booth and Chatterji (1998) – then the training firm has some additional monopsony power over the trainee ex post. This enables the firm to counter the poaching externality even in the presence of on-the-job search, since it can offer a promotion wage below the workers marginal product in order to prevent quits.

The plan of the paper is as follows. Section 2 presents the framework. Section 3 analyses the workers' behaviour followed by the analysis of labour turnover in the steady state in Section 4. Section 5 derives the firms' vacancy-creation decision, and the general training condition, and explains the effect of promotion and credit constraints on efficiency. Section 6 establishes the labour market equilibrium and Section 7 investigates the extensions: On-the-job search, search intensity, and the combination of specific and general training.

2. Framework

2.1 Bargaining

Wages are negotiated by unions and an employers' association. The unions' bargaining power is given by $,$. Thus, for each skill level $ª \; R \; \{´[¶\}$ the agreed wage is given by:

$$¸_{ª}^{t} = \; , \; f_{ª}^{0} + (1 \quad ,)£, \qquad (1)$$

where $£$ is the workers unemployment income.

In order to guarantee a gain of trade, I assume that the unemployment income is sufficiently small (i.e. $f_{ª}^{0} \; \wedge \; £$). Firms and workers take these wages as given when they make their decisions. In Section 6, I allow for individual bargaining.

2.2 Firms

The model considers an infinite-horizon, stationary labour market in continuous time. There is a large and fixed number of identical firms with mass normalised to unity. Firms are assumed to be risk neutral and to discount future payments by the rate of interest ³. All firms are infinitely lived. Firms search for workers by creating vacancies ·ª for the respective labour markets, where ª R {´[¶}. ´ stands for the labour market of skilled workers and ¶ for the labour market of unskilled workers. The advertising cost for a vacancy per time unit is given by ¢¥µ.

The bargaining wages for skilled and unskilled workers are taken as given by the firm when it chooses the training - and the promotion rate :. The firm o;ers with probability -¥µ an employed, unskilled workers a training contract specifying a trainee-wage ¸µ and the commitment by the firm to pay the education cost ¤. The general training contract is a take-it-or-leave-it o;er by the firm. The large number of unskilled workers per firm implies that the firm has e;ectively all market power and can therefore o;er a contract that makes an unskilled worker exactly indi;erent between accepting and rejecting the o;er.

Firms produce according to a constant return to scale production function. The output produced over the period ¥µ is given by an strictly increasing, concave and twice continuously di;erentiable function.

º¥µ = f (-¶[-´ + -µ) ¥µ

Since training is instantaneous, trainees are able to work as skilled labour. Therefore, the skilled labour force (-´ + -µ) is given by the sum of skilled workers and trainees.

The unskilled labour force is given by $-_{¶}$.

Firms promote trainees to a full skilled job with a respective market wage at rate :¥µ. Furthermore, I assume that the firm is able to commit to its promotion promise by building up an organisation structure that ensures that the number of skilled positions cannot be filled by solely recruiting from outside but requires that the firm promotes its own trainees according to its promise.

2.3 Workers

There is a large and fixed number $¯_{¶}$ of skilled and $¯_{\prime}$ of unskilled workers with ® = $¯_{¶} + ¯_{\prime}$. Workers are assumed to be risk neutral and to discount future payments at rate ³. A worker's stay in the labour market is exponentially distributed with parameter . ^ 0. If a worker exits the labour market, he is replaced by a new individual. A skilled worker paid education cost ¤ before entering the labour market. Due to their uncertain life span, workers pay the e;ective interest rate (³ + .) on ¤. The initial level of human capital in the economy is assumed to be ine>cient, i.e. (³ + .)¤ \ $f^{0}_{-\prime}$ $f^{0}_{-¶}$.

All workers start searching as unemployed in their respective labour market. During that period they receive unemployment income, denoted by £¥µ. Individuals only search if the expected gain is strictly positive. For simplicity, I assume that employed workers cannot become unemployed. Employment ends with a positive probability per period (here .¥µ) because of workers exiting the labour market.

2.4 Matching

Define $´_{a}$ as the measure of workers searching in a particular labour market. The labour market tightness is defined as the ratio of vacancies to searching workers, 2ₐ 1 ·ₐ]´ₐ. Define m(·ₐ[´ₐ) as a Pissarides-type matching function, where m(0[´ₐ) = m(·ₐ[0) = 0 . It is assumed to be increasing, twice continuously di;erentiable, concave and linearly homogenous. It hence has constant returns to matching and can be written in terms of the labour market tightness m(·ₐ[´ₐ) 1 ´ₐ²(2ₐ). The properties of m(·ₐ[´ₐ) imply that ²(2ₐ) satisfies the Inada conditions:

i) ²(0) = 0[ii) lim 2Y+0 ²(2ₐ)' = Q[iii) lim 2Y+? ²(2ₐ)' = 0.

A searching worker meets a vacancy at the Poisson rate m(·ₐ[´ₐ)]´ₐ = ²(2ₐ). A vacancy is in turn contacted by a worker at the Poisson rate m(·ₐ[´ₐ)]·ₐ = ²(2ₐ)]2ₐ. For notational reasons I define:

5ₐ 1 ²(2ₐ)[and 1ₐ 1 ²(2ₐ)]2ₐ.

3. Individuals' Behaviour

3.1 Skilled Workers

Each skilled worker can be in one of two states, unemployment or employment. Denote the value of being unemployed by u´. While unemployed the worker receives utility £¥µ per time period. With a positive probability per time period 5´¥µ he meets a firm and bargains over the wage ¸´. The worker joins the firm if and only if the value of being employed v´(¸´) is greater than the value of being unemployed u´. In any case he has to pay the interest on his education loan. The corresponding Bellman equation is therefore given by:

(³ + .) u´ = £ + 5´ max[v´(¸´) u´[0] ¤(³ + .). (2)

The employed worker receives the wage ¸´¥µ per time period and pays the interest for his education cost:

$$(³ + .)\, v_´(¸_´) = ¸_´ \quad ¤(³ + .)\,. \tag{3}$$

¸´ ^ £ guarantees that skilled workers search, as can be shown by subtracting (2) from (3).

3.2 Unskilled Workers

An unskilled worker can be in four states. He can be unemployed or employed as unskilled worker. Once employed he can be o;ered training and become a trainee. This enables him to search for a skilled job afterwards if he is not promoted by his current employer.

Let us start with the value of being unemployed $u_¶$ as unskilled worker. Again as unemployed he gets utility £¥µ per time period. At the rate $5_¶$ he meets an unskilled job vacancy.

$$(³ + .)\, u_¶ = £ + 5_¶ \max[v_¶(¸_¶) \quad u_¶[0] \tag{4}$$

The value of being employed as unskilled worker at wage $¸_¶$ is given by $v_¶(¸_¶)$,

$$(³ + .)\, v_¶(¸_¶) = ¸_¶ + - \max[v_µ(¸_µ) \quad v_¶(¸_¶)[0] \tag{5}$$

where the current employer o;ers the worker a training contract at rate -. A trainee is promoted with probability : by the current employer. At the same time he can search for a skilled job vacancy at another firm (and matches with probability $5_´$). The implicit assumption that the firm matches the outside wage when promoting its trainee is without loss of generality. Promoting and paying a wage less than $¸_´$ cannot be optimal since the trainees would still search and leave at the same rate $5_´$ as before.

Paying a higher wage would reduce the firms profit. The value of being employed as trainee at wage $¸_µ$ is thus given by:

$$(³ + .)\, v_µ(¸_µ) = ¸_µ + (5_´ + :) \max [v_{µ´}(¸_´) \quad v_µ(¸_µ)[0] \qquad (6)$$

The value for a former trainee to be employed as skilled worker at wage $¸_´$ is given by:

$$(³ + .)\, v_{µ´}(¸_´) = ¸_´. \qquad (7)$$

There is no guarantee that it is always profitable to change the status (i.e. max [old status-new status[0] ^ 0). The four Bellman equations (4), (5), (6), and (7) can be used to derive the conditions under which it is profitable for a worker to change status and hence to start actively searching for a vacancy in the corresponding labour market.

For a trainee to search for a skilled job vacancy, it has to be true that the wage for a skilled worker has to exceed the wage earned as trainee:

$$v_{µ´}(¸_´) \wedge v_µ(¸_µ) \quad L \quad ¸_´ \wedge ¸_µ. \qquad (8)$$

For an employed unskilled worker to accept the training contract, the value of being employed as trainee $v_µ(¸_µ)$ must be at least as great as the value of being employed as unskilled worker $v_¶(¸_¶)$[4]

$$v_µ(¸_µ)\ 5\ v_¶(¸_¶) \quad L \quad \frac{(³ + .)\, ¸_µ + (5_´ + :)\, ¸_´}{³ + . + 5_´ + :}\ 5\ ¸_¶. \qquad (9)$$

In other words, the expected wage income from starting as a trainee and later being employed (with probability $5_´ + :$) as skilled worker has to exceed or be equal to the current wage earned as an unskilled worker.

[4] This condition does not require a strict inequality, since workers are o;ered training contracts without the necessity to participate in search.

Since it will be optimal for the firm to o;er a wage ¸µ such that the worker is indi;erent between accepting and rejecting condition (9) will hold with equality in equilibrium. Furthermore, the firm can choose its promotion strategy :, which allows the firm to determine the expected wage of becoming a trainee. By increasing the promotion rate the firm is thus able to lower the wage ¸µ acceptable to a trainee.

Returning to the individuals' behaviour, it follows from condition (9) that condition (8) is satisfied as long as ¸´ ^ ¸¶. Again, ¸¶ ^ £ guarantees an active economy as can be seen from equations (4) and (5).

4. Steady State Turnover

This section analyses the turnover for any given matching 5ª, training - and promotion : rate with the aim to find out how these influence the size of the labour forces of skilled and unskilled workers as well as trainees of the representative firm and the size of the pool of searching workers. The optimal matching, training and promotion rates are derived in section 5.

4.1 Unemployment Measures

For every individual who leaves the labour market a new individual enters unemployment. The measure .¯¶ of individuals enter the unemployment pool as unskilled workers and the measure .¯´ as skilled workers. The measure 5ª¶ª of unemployed exit into employment. In addition, there are .¶ª individuals that exit the labour market altogether. The steady state unemployment measures of the respective labour markets are:

$$\P_a = \frac{.}{5_a + .}\bar{}_a \quad \text{for } {}^a \mathrm{R} \{'[\P\}. \tag{10}$$

4.2 Employment Measures

Since only one wage prevails in each labour market, workers cannot improve their situation by searching for an identical job. Consequently, only unemployed and trainees search.

The measure of individuals flowing from unemployment into employment is given by $5_a\P_a$. Workers of every type exit employment at the rate $..$ $--_\P$ unskilled workers become trainees, so that the measure of employed unskilled workers is given by:

$$-_\P = \frac{5_\P}{- + .}\P_\P = \frac{5_\P}{5_\P + .}\frac{.}{- + .}\bar{}\P. \tag{11}$$

The inflow into apprenticeship equals $--_\P$. The sum of individuals, who exit the labour market altogether (i.e. $.-_\mu$), who find a skilled job vacancy at another firm or who are promoted by their current firm (i.e. $(5_' + :)-_\mu$) are flowing out of the apprenticeship. The measure of trainees is hence given by:

$$-_\mu = \frac{-}{. + 5_' + :}-_\P = \frac{.}{. + 5_' + :}\frac{5_\P}{5_\P + .}\frac{-}{- + .}\bar{}\P. \tag{12}$$

Skilled workers are recruited internally and externally. From the pool of unemployed $5_'\P_'$ are recruited and form the pool of trainees $5_'-_\mu$ are recruited externally and $:-_\mu$ internally. Given that $.-_'$ skilled workers flow out, the total measure of skilled labour is:

$$-_' = \frac{5_'}{.}\P_' + \frac{5_' + :}{.}-_\mu = \frac{5_'}{. + 5_'}\bar{}_' + \frac{5_' + :}{. + 5_' + :}\frac{5_\P}{5_\P + .}\frac{-}{- + .}\bar{}\P. \tag{13}$$

Note, that the sum of trainees and skilled workers is independent of :, since promotion only alters the status of the workers but not their role in production

$$-_{µ} + -_{´} = \frac{5_{´}}{. + 5_{´}} \,\_{}_{´} + \frac{5_{¶}}{5_{¶} + .} \frac{-}{- + .} \,\_{}_{¶}. \qquad (14)$$

For later analysis, let us briefly focus on the ratio of skilled to unskilled labour, which determines the marginal product of the respective labour forces and hence their wages in equilibrium

$$\frac{-_{µ} + -_{´}}{-_{¶}} = \frac{5_{´}}{5_{´} + .} \frac{5_{¶} + .}{5_{¶}} \frac{- + .}{.} \frac{\_{}_{´}}{\_{}_{¶}} + \frac{-}{.}. \qquad (15)$$

The ratio increases with -, the rate at which unskilled workers are recruited as trainees, but is independent of the promotion rate :. The assumption that the initial level of human capital is ine>cient implies that the gap of the marginal products between skilled and unskilled labour will be greater than in a competitive market, i.e. $(^{3} + .) ¤ \backslash$ $f^{0}_{-´}$ $f^{0}_{-¶}$. By increasing the general training rate - the firm can decrease this gap and narrows the gap of skilled and unskilled workers. At the same time, the firm can use the promotion rate : to squeeze the trainee-wage $¸_{µ}$ without a;ecting the marginal products of the labour forces.

4.3 Measure of Searching Individuals

The measure of individuals searching for unskilled job vacancies are the unskilled unemployed, i.e. $´_{¶} = ¶_{¶}$. Employed unskilled workers have no incentive to search, since they would get the same wage at each employer.

The measure of workers searching for skilled job vacancies are the skilled unemployed plus trainees

$$´_{´} = ¶_{´} + -_{µ} = \frac{.}{5_{´} + .} \,\_{}_{´} + \frac{.}{. + 5_{´} + :} \frac{5_{¶}}{5_{¶} + .} \frac{-}{- + .} \,\_{}_{¶}. \qquad (16)$$

Firms influence ´› through - and : without taking it into account. By granting more unskilled workers general training, firms increase the pool of people searching for skilled job vacancies. This makes it easier for other firms to recruit skilled labour. The resulting externality implies a rent for future employers of trainees.

5. Firms’ Behaviour

5.1 Vacancy creation conditions

A firm maximise its present value. The instruments at hand are to create vacancies ·ª for unskilled and skilled workers, to o;er unskilled workers general training contracts at rate -, to determine the trainee-wage ¸µ and to decide how many trainees : are promoted and given a full skilled worker’s contract. Since the trainee-wage depends on the promotion rate (i.e. ¸µ(:) = ¸¶ (5› + :) (¸´ ¸¶)/(3 + .) from condition (9)), determining the optimal promotion rate is equivalent to choosing the optimal trainee-wage. The firm takes the wages for skilled and unskilled workers as given. Formally:

max·ª[-[: 9 = Z? 0 P ` f (-¶[-› + -µ) X ªj{´[¶} [¸ª-ª + ¢·ª] ¸µ(:)-µ --¶¤ a ¦ P³µ¥µ Q (17)

s.t. -¶ = 1¶·¶ (- + .)-¶

-µ = --¶ (. + 5› + :)-µ

-› = 1›·› + :-µ .-›.

The total training costs for a firm is --¶¤, which equals the inflow of new trainees multiplied by the cost of education. The firm contacts a worker with probability 1ª per vacancy, so that the inflow out of unemployment into the skilled and unskilled labour force is given by $1_{a} \cdot _{a}$.

Note that the marginal product of a trainee is the same as the marginal product of a skilled worker, since I assume that training is instantaneous. Denote $^{1}{}_{a}$ as the co-state variable associated with (17). Then the resulting Euler-conditions are:

$$
\begin{array}{llll}
\frac{`h}{`\cdot_{¶}} : \; ¢ = {}^{1}{}_{¶} 1_{¶} & & \frac{`h}{`:} : \; {}^{1}{}_{µ} = {}^{1}{}_{´} + \frac{¸´ \quad ¸¶}{{}^{3} + .} \\
\frac{`h}{`\cdot_{´}} : \; ¢ = {}^{1}{}_{´} 1_{´} & & \frac{`h}{`-} : \; ¤ = {}^{1}{}_{µ} \quad {}^{1}{}_{¶} \\
\frac{¥^{1}{}_{¶}}{¥µ} = {}^{1}{}_{¶}{}^{3} \quad f^{0}_{-_{¶}} (-_{¶}[-_{´} + -_{µ}) + \; ¸_{¶} + ¤- + {}^{1}{}_{¶} (. + -) \quad {}^{1}{}_{µ} - \\
\frac{¥^{1}{}_{µ}}{¥µ} = {}^{1}{}_{µ}{}^{3} \quad f^{0}_{-_{´}} (-_{¶}[-_{´} + -_{µ}) + \; ¸_{µ} + {}^{1}{}_{µ} (. + 5_{´} + :) \quad {}^{1}{}_{´} : \\
\frac{¥^{1}{}_{´}}{¥µ} = {}^{1}{}_{´}{}^{3} \quad f^{0}_{-_{´}} (-_{¶}[-_{´} + -_{µ}) + \; ¸_{´} + {}^{1}{}_{´} . .
\end{array}
$$

The steady state solution to this problem gives the vacancy creation condition for each labour market:

$$
¢ = 1^{t}_{a} \frac{f^{0}_{-_{a}} \quad ¸^{a}}{{}^{3} + .} \quad \text{for } {}^{a} R \{´[¶\}, \tag{18}
$$

The vacancy creation condition requires that the cost of creating a vacancy ¢ equals the expected return of a match. In the simple Pissarides model the vacancy creation condition determines together with the zero profit condition the number of firms (vacancies) in equilibrium. Here, the measure of firms is fixed to unity, so that the vacancy creation condition determines the size of a firm. This also guarantees that the value of creating a vacancy is equal to zero.

Proposition 1 The recruitment cost for skilled labour is higher than for unskilled labour.

Proof: See appendix.

Rearranging equation (18) shows that the recruitment cost per match equals the discounted marginal revenue of a matched worker.

$$\frac{¢ \cdot_a}{m(\cdot_a [\, ´_a)} = \frac{f^0_{-a} \quad ¸^a}{^3 + .}$$

In equilibrium the cash flow (i.e. $f^0_{-a} \quad ¸_a$) of a skilled worker is greater than the cash flow of an unskilled worker. The firm will therefore pay more for the recruitment of a skilled worker than for an unskilled worker. This di;erence in recruitment costs is used to pay for the general training of some unskilled workers.

From a firm it is harder for to find skilled workers than unskilled workers (i.e. $1^t_{´} \setminus 1^t_{¶}$). The market tightness for skilled labour is therefore higher than for unskilled labour (i.e. $2^t_{´} \wedge 2^t_{¶}$). This implies that it is easier for searching skilled individuals to find a vacancy than for unskilled individuals (i.e. $5^t_{´} \wedge 5^t_{¶}$).

5.2 Promotion, E>ciency and Credit Constraints

There are always two sources for the firm to finance general training. The first source is the di;erence in recruitment cost, i.e. $\left(f^0_{-´} \quad ¸_{´} \right) \quad \left(f^0_{-¶} \quad ¸_{¶} \right)$. The second source is the low trainee wage. The di;erence between the wage of a skilled worker and of a trainee is going to the training firm as long as the trainee stays with the firm. Since trainees leave the training firm because of the low trainee wage, it follows that the extracted rent is not enough for the training firm to pay for the e>cient amount of general training. This can be seen by looking at the Euler equation, which implies that the di;erence in the shadow value of a trainee and the shadow value of employing an unskilled worker has to equal the cost of training (i.e. $¤ = {}^1_{µ} \quad {}^1_{¶}$). In other words, the general training condition without promotion (i.e. $: = 0$) requires that the cost of general training has to equal the discounted cash flows between trainees and unskilled workers. Using condition (9) to substitute the trainee-wage gives:

$$(^3 + .)¤ = \frac{(^3 + .)\, f^0_{-´} + 5´\, ¸´}{^3 + . + 5´} \quad f^0_{-¶}. \tag{19}$$

General training is still ine>cient as long as $5´ \wedge 0$. The reason for this ine>ciency is that future employers of skilled workers benefit from trainees quitting their training firm. By training unskilled workers the training firm increases the number of searching people in the skilled labour market without taking into account that this makes it easier for other firms to recruit skilled workers. The severance of this ine>ciency depends on the degree of the search frictions. The higher the search frictions, i.e. $5´\ \mathrm{A}\ 0$, the lower is the lost return for the training firm and the higher is the investment in general training. Thus, if no trainee searches on the skilled labour market, i.e. $5´ = 0$, there is no rent going to future employers and the rent extracted via the trainee wage plus the return from the di;erence in recruitment cost gives the current firm the whole return on the investment (i.e. $f^0_{-´} \quad f^0_{-¶}$) and the firm will invest e>ciently in general training.

The firm can use promotion to prevent trainees from searching for a skilled job vacancy at another employer. This comes at the higher cost of paying the promoted trainees the market wage of a skilled worker. This additional cost can, however, be retrieved from the trainee by decreasing the trainee-wage to such an extent that an unskilled worker is indi;erent between accepting and rejecting the training contract. The value of a trainee is therefore given by

$$^1{}_{\mu} = \frac{f^0_{-´} \quad ¸¶ + (5´ + :)\,\frac{¸´ \quad ¸¶}{^3 + .} + :\,\frac{f^0_{-´} \quad ¸´}{^3 + .}}{^3 + . + 5´ + :}. \tag{20}$$

The promotion condition requires that the shadow value of a trainee equals the shadow value of a skilled worker plus the discounted value of the promotion, which equals the discounted wage di;erence between a skilled and an unskilled worker:

$$ {}^{1}{}_{\mu} = {}^{1}{}_{\prime} + \frac{¸_{\prime} \quad ¸_{¶}}{{}^{3} + .} = \frac{f^{0}_{-\prime} \quad ¸_{¶}}{{}^{3} + .}. \tag{21} $$

Only if the promotion rate goes to infinity, then (20) equals (21).

Proposition 2 If trainees are not credit constrained, then the training firm promotes all trainees immediately and in turn trainees pay the discounted value of their promotion as a lump-sum transfer back to the training firm.

Proof: See the argument above.

Trainees are paid the wage of a skilled worker immediately. In turn the firm demands a lump-sum transfer of the worker that is equivalent to the value of the promotion (i.e. $(¸_{\prime} \quad ¸_{¶})\,]\,({}^{3} + .)$), since the firm can extract all rent from an unskilled worker when posting the training contract. This lump-sum transfer, however, requires that workers are not credit constrained. Is this the case, the firm keeps its trainees of the skilled labour market and thereby eliminates the externality as no trainee changes his employer.

Proposition 3 If workers are not credit constrained, firms will train the e>cient number of unskilled workers.

Proof: The rent extracted from the di;erence in recruitment cost is:

$$ ¤ = \frac{f^{0}_{-\prime} \quad ¸_{\prime}}{{}^{3} + .} \quad \frac{f^{0}_{-¶} \quad ¸_{¶}}{{}^{3} + .}. $$

The lump-sum payment equivalent to the value of the promotion is given by:

$$ \frac{¸_{\prime} \quad ¸_{¶}}{{}^{3} + .}. $$

Adding up gives the general training condition

$$(³ + .)¤ = f^{0}_{-´} \quad f^{0}_{-¶}. \tag{22}$$

QED.

The rent extracted by the difference in recruitment cost together with the trainee's lump-sum payment equivalent to the value of the promotion ensures that the general training condition with promotion results in an efficient investment in general training. The firm supplements the initially inefficient level of human capital up to the first best level, since it is able to extract all rent from general training from its trainees and thus leaves no rent to future employers.

This result changes only slightly if I introduce an exogenous separation rate like Acemoglu (1997). The return to general training is now more heavily discounted, i.e. $³ + . + ´¦±¢³¢µ^{ª º}¯ \; ³¢µ¦$, but still does not depend on the matching rate $5_{´}$ and is hence independent of the labour market frictions. Proposition 3 therefore shows that assuming an exogenous difference in recruitment costs as Stevens (2001) does lead to the misleading policy-relevant conclusion that search frictions on their own, i.e. without credit constraints, would lead to underinvestment in general training. Becker's statement that underinvestment in general training is due to workers being credit constrained is therefore right. But his claim that workers bear all training cost does not apply to a labour market with search frictions, because firms use besides the lump-sum payment $\frac{¸_{´} \quad ¸_{¶}}{³ + .}$ the difference in recruitment costs between skilled and unskilled workers to finance general training. However, if search frictions vanish, i.e. $5_{´} \; A \; Q$, and the markets become competitive such that the workers are paid their marginal product, i.e. $, \; A \; 1$, then this model replicates Becker's result that workers would invest the first best amount in general training, given they are not credit constrained.

6. Labour Market Equilibrium

The aim of this section is to show that in an economy with credit constrained workers there may be multiple training equilibria. If workers are not credit constrained, promotion in turn for an equivalent lump-sum payment from the trainee to the training firm prevents trainees from quitting and leads to a unique labour market equilibrium.

Definition: Labour Market Equilibrium

In a labour market equilibrium, firms create vacancies according to (18), o;er general training at rate - satisfying (19) if workers are credit constrained and (22) if workers are not credit constrained and are promoted immediately. Workers follow an optimal search strategy according to (2) - (7) and bargaining wages are formed according to (1).

Proposition 4 If workers are credit constrained, there exists a unique labour market equilibrium as defined above.

If workers are credit constrained, there can be multiple equilibria with ine>cient training where a high training equilibrium is sustained by a low matching rate for trainees, i.e. for any two equilibria ¢ and £, we have $2^{¢}_{´} \setminus 2^{£}_{´}$ and $-^{t} \wedge -^{¢} \wedge -^{£}$.

Proof: See appendix.

If workers are credit constrained, firms are deprived of the promotion instrument, and general training generates a positive externality for future employers. In other words, firms do not take into account that by training they increase the pool ´ of people searching for skilled job vacancies – compare equation (16) – and that by doing so it becomes harder for other trainees to find a job. This lower separation rate increases the firm's return to general training, which sustains a high training level and a low market tightness for skilled labour. On the other side, a low training equilibrium can exist where the probability for trainees to find a job at another firm is high. This decreases the return to general training such that firms train less, which sustains a high matching rate for trainees.

Only if unskilled workers are not credit constrained, then the current firm can extract the whole rent from general training and prevent its trainees from searching. This eliminates this externality and leads to the unique first best investment in general training.

7. Extensions

7.1 Individual Bargaining

Assume that wages are negotiated after a worker contacted a firm. Firms take these wages as given then they choose the number of vacancies, the training rate and the promotion rate. Nature chooses with probability , the worker to make an offer and with probability 1 , the firm. Workers and firms are assumed to have some bargaining power (i.e. 0 ^ , ^ 1). If the other party accepts the offer, a wage contract is written and production starts immediately thereafter. If the offer is rejected, the respondent can leave the negotiation table and continue searching (both parties), or he can wait for the bargaining game to start again next period.

During this period the worker receives the flow-utility of leisure £¥µ, since an employed worker cannot work and earn a wage while bargaining with a different firm. The firm makes no loss nor gain, since it does not advertise the job vacancy during negotiations.

At the same time there is a positive probability .¥µ that the worker exits the labour market. This could result in a breakdown of the negotiations, where the worker receives a flow utility of zero and the firm continues searching with the unfilled vacancy, which has a value of zero due to free entry. The firm's payoff while negotiations are postponed is also zero, as mentioned above.

The outside options of the workers are to remain unemployed and receive £ for ever. Thus the wage has to be greater than £, which will be the case due to the worker's inside option. Thus, this outside option constraint will not bind. The outside option for a firm is to walk away and to search for another worker. Since the value of a vacancy (i.e. searching) is zero in equilibrium, the outside option of the firm has a value of zero.

In case of a breakdown, payoffs are zero. The outside options are not binding so that the bargaining model simplifies to a random proposer Rubinstein model with inside options. Furthermore, the fact that the discount rates for firms and workers are identical implies that the bargaining power is equivalent to the probability of being chosen by nature to make an offer. Muthoo (1999, ch. 6.2 and 7.2.4) shows that the solution to the bargaining scenario - as ¥µ A 0 - is given by:

$$¸_a^t = , f_{-a}^0 + (1 \quad ,)£.$$

The assumption that an employed worker receives only the value of leisure and not his wage while negotiations are postponed ensures a single wage for each type of labour. This implies that employed workers do not gain by searching for an identical job at another firm. Therefore, only the unemployed and trainees will search. This assumption is relaxed below.

7.2 On-the-job Search and Search Intensity

In the preceding analysis the bargaining game was chosen such that only unemployed and trainees searched but not the skilled and unskilled workers. If one assumes that the inside option of a worker is his current wage and not the value of leisure, then on-the-job search will arise since workers can increase their wage every time they meet a new employer, i.e.

$$w^{e}_{i} = (1-\beta)\, w^{e}_{i-1} + \beta f'_{e}, \tag{23}$$

where i is an index for the number of employers the worker was/is employed with and w^{e}_{i-1} indicates the wage at the last employer or in the case of the first employer the value of leisure £. Thus, employed workers will continue searching as long as they earn less than their marginal product.

Although promotion would keep trainees away from the skilled labour market, it does not lead to efficient investment in general training. This can be seen by noting that in the basic model promotion implied not only an intertemporal transfer but additionally increased the firms' return of a promoted trainee by withdrawing his incentive to search. With on-the-job search, workers only stop searching if they are promoted and paid their marginal product. The return of a promoted trainee is therefore zero. The firms' return therefore does not increase if the worker stops searching. This result only changes if the search intensity is no longer fixed and costless.

To introduce search intensity I follow Pissarides (2000). The matching rate depends not only on the market tightness 2_a, but also on a worker's search intensity $;_{a[¦}$, which will vary with his wage and thus with the number of jobs he already occupied, and it will depend on the average search intensity $;_a$ of all workers from his skill group. The transition rate for a worker is therefore given by

$$;_{a[¦}>_a \; 1 \;\; ;_{a[¦}\frac{^2(;_a[2_a)}{;_a} = \; ;_{a[¦}\frac{m(\cdot_a[\; ;_a\acute{}_a)}{;_a\acute{}_a}.$$

Assume that the search cost function $\neg(;_{a[¦})$ is convex and $\neg(0) = 0$, then the Bellman equation for a trainee is given by:

$$(^3 + .)\,v\,(¸_{µ[¦}) = \max_{;_{µ[¦}}[¸_{µ[¦} \quad \neg(;_{µ[¦}) + \; ;_{µ[¦}>_µ(v\,(¸_{µ[¦+1}) \quad v\,(¸_{µ[¦}))]\,.$$

It follows that the optimal search intensity equates the marginal cost of searching with the marginal expected gain from being employed at the new employer at wage $¸_{µ[¦+1}$, i.e.

$$\frac{`\neg(;_{µ[¦})}{`\;;_{µ[¦}} = >_µ(v\,(¸_{µ[¦+1}) \quad v\,(¸_{µ[¦}))\,.$$

The convex search cost function and the fact that the expected utility gain of changing employer, i.e. $v\,(¸_{µ[¦+1}) \quad v\,(¸_{µ[¦})$, decreases[5] with a higher current wage guarantees that each trainee will search less if his current wage is higher. However, trainees will continue to search as long as they earn less than their marginal product. Nevertheless, firms are able to extract some rent from their trainees by promoting them since the promotion saves the trainee search costs and reduces his incentive to search intensively. In other words, firms can reduce the search intensity of their workers by promoting them and extract a rent which equals the search cost workers saved. They can do that by

[5] This can easily be seen from equation (23) and the fact that $v\,(¸_{µ[¦})$ is bounded above by the discounted sum of the workers marginal product.

demanding a lump-sum transfer at the beginning of the training. This additional rent can be used to finance general training. Whether this rent together with the di;erence in recruitment cost between skilled and unskilled workers is enough for an e>cient amount of general training depends on the functional form of the search cost function.

Another consequence following from on-the-job search is that the value of being employed increases each time the worker changes his employer, i.e. $v(¸_{ª[¦})$ increases with ¦. Since the firm has to match the value of an unskilled worker when o;ering a trainee contract, i.e. $v(¸_{¶[¦}) = v(¸_{µ[¦})$, it follows that it is optimal for the firm to o;er trainee contracts only to unskilled workers who just entered the labour market. The reason for this is that it allows the firm to o;er the trainee the lowest trainee-wage when o;ering him a training contract or respectively to demand the highest lump-sum transfer when promoting him at the same time when o;ering him the training contract.

7.3 Combined Specific and General Training

Introducing specific together with general training makes it easier for the training firm to extract the whole return on the investment in training. Following Booth and Chatterji (1998), the combination of specific and general training can most easily be modelled by assuming that the outside productivity of a skilled worker $-_{µ´}$ is strictly less than the trainee's productivity $-_{µ}$ at the training firm, i.e. $f^{0}_{-´}(\cdot[-_{µ´}) \setminus f^{0}_{-´}(\cdot[-_{µ})$. Regardless, of whether this relationship is stochastic or deterministic it gives the training firm – even in the presence of on-the-job search – the opportunity to promote its trainee and pay him less than his marginal product while achieving the aim of keeping him away from the skilled labour market. It follows that in the absence of credit constrained workers investment in training will be efficient since workers are able to pay for the value of the promotion in a lump-sum transfer up front. If workers are credit constrained than the training firm would still promote to some extent in order to reduce the quitting rate of its trainees. Booth and Chatterji focus on the role of unions that help the training firm to overcome the assumed inability to commit to long term contracts that would allow the firm to use its ex post monopsony power over its trainees for an efficient investment in training ex ante. The focus of this paper was to show that no other institution than government secured loans for trainees are needed to ensure efficient investment in training.

8. Conclusion

The literature on firm-financed general training after Becker tried to explain the firm's incentive to invest in general training by looking at labour market frictions. These friction were not only taken to explain the existence of firm-financed general training but were – besides the workers' credit constraints – made responsible for part of the inefficiency in the investment into general training. This paper confirms Becker (1964) and establishes, in a search and bargaining environment, that the mere fact that workers are credit constrained can lead to inefficient investment into general training. The contractual arrangements are, however, totally different from Becker's.

A firm is willing to train if it is more expensive to recruit a skilled worker than an unskilled worker. This difference in recruitment costs is used to pay for the general training of some unskilled workers. Furthermore, the local monopsony power of the firm when offering a training contract to an unskilled worker allows the firm to extract all rent from a trainee. This rent can be extracted by setting a low trainee-wage. The problem remaining is that trainees will search for a better paid job at another firm. If workers are not credit constrained, this search externality can be eliminated by paying the trainee the market wage of a skilled worker. In turn for this promotion the trainee will have to pay the firm a lump-sum payment equivalent to the discounted value of this promotion. The result is that trainees will not move to other firms and training will be efficient.

If workers are credit constrained, firms will extract some rent by paying a low trainee-wage that makes the unskilled worker indifferent between being trained and remaining unskilled. This low wage, however, induces trainees to search and generates an externality that benefits future employers and leads to underinvestment. This also generates multiple equilibria where a high training level can be sustained by the fact that the high number of searching trainees leads to a lower matching rate for all trainees. Since this implies a relatively high return to the training firm, it can invest more in general training.

Even in an environment with costly on-the-job search by all workers, promotion in exchange for an equivalent lump-sum payment can lead to an efficient investment into general training. On-the-job search further implies that only unskilled workers, who just entered the labour market, are trained.

Appendix

Proof of Proposition 1:

Part 1: Shows, that given $2^t_{«}$, 2^t_{a} is unique and strictly positive.

Define ¶(2_a) 1 ¢2_a]$^2(2_a)$. Given the properties of the matching function, it follows that

$$¶^0(2_a) \wedge 0, \quad ¶^{00}(2_a) \setminus 0, \quad \lim_{2_a Y +0} ¶(2_a) = 0 \text{ and } \lim_{2_a Y + ?} ¶(2_a) = Q$$

Hence, ¶(2_a) is a strictly increasing and concave function of 2_a, with domain [0[Q) and range [0[Q).

From (15) and the properties of the production function follows that the marginal product of a specific labour force decreases with 2_a, i.e. $f^0_{-a}(-_{¶}[-_{µ} + -_{\prime})$ 1 ₽$^0_{-a}(2_a[2_{«})$ has the following properties

$$₽^0_{-a}(2_a[2_{«}) \wedge 0, \quad `₽^0_{-a}(2_a[2_{«})]`2_a \setminus 0, \quad \lim_{2_a Y + ?} ₽^0_{-a}(2_a[2_{«}) = 0, \text{ and } \lim_{2_a Y +0} ₽^0_{-a}(2_a[2_{«}) = Q,$$

Hence, ₽$^0_{-a}(2_a[2_{«})$ is a strictly decreasing and convex function of 2_a, with domain (0[Q) and range (0[Q). It follows that there exists a 2^t_a R ¶(2_a) and ₽$^0_{-a}(2_a[2_{«})$ that is strictly positive and unique.

Part 2: Shows, that there exists a unique pair $(2^t_{¶}[2^t_{\prime})$ that satisfies (18).

Take an arbitrary solution to (18) and denote it by $^{i}2^1_{¶}[2^1_{\prime}{}^{¢}$. Suppose, there exists a second solution with $2^2_{\prime} \wedge 2^1_{\prime}$ and $2^2_{¶} \setminus 2^1_{¶}$. According to the properties of the production function and (15) it follows that $`₽^0_{-\prime}(2_{¶}[2_{\prime})]`2_{¶} \wedge 0$ and $`₽^0_{-\prime}(2_{¶}[2_{\prime})]`2_{\prime} \setminus 0$. Given these properties the marginal product of skilled labour decreases and the marginal product of unskilled labour increases as the economy switches from 1 to 2. However, according to (18) $2^t_{\prime}$ has to decrease as the marginal product of skilled labour decreases.

This contradicts the assumption that $2^2_{\prime} \wedge 2^1_{\prime}$. A similar argument applies for $2^2_{\prime} \setminus 2^1_{\prime}$ and $2^2_{¶} \wedge 2^1_{¶}$.

Now suppose, there exists a second solution $(2^2_{¶}[2^2_{\prime})$ with $2^2_{\prime} \wedge 2^1_{\prime}$ and $2^2_{¶} \wedge 2^1_{¶}$. According to (18) this implies that both marginal product have to increase. At the same time imply the properties of the production function and (15) that it is impossible for both marginal products to increase, since the marginal products react to changes in the ratio of the labour forces di;erently. Thus a second solution for $(2^t_{¶}[2^t_{\prime})$ does not exist.

Part 3: Shows, that the recruitment cost for skilled labour is higher than for unskilled labour.

The wage equation (1) together with the vacancy creation condition (18) implies

$$1^t_{\prime} \,\mathrm{i}\, f^0_{-\prime} \quad £^{¢} = 1^t_{¶} \,\mathrm{i}\, f^0_{-¶} \quad £^{¢}.$$

The marginal product of skilled workers is higher than for unskilled workers for any $- \mathrm{R}\ [0[-^t]$ as can be seen from the proof of Proposition 3 below. Thus,

$$1^t_{\prime} \setminus 1^t_{¶}\ \mathrm{H\ I}\ \frac{¢\cdot_{\prime}}{m(\cdot_{\prime}[\,\acute{}_{\prime})} \wedge \frac{¢\cdot_{¶}}{m(\cdot_{¶}[\,\acute{}_{¶})}.$$

QED

Proof of Proposition 3:

Unskilled labour decreases with -, and skilled labour force increases with -, as can be seen from (11) and (14), respectively. Define $f^0_{-a}(-_{¶}[-_{\mu} + -_{\prime})\ 1\ \text{Þ}^0_{-a}(-)$. From the properties of the production function it follows that the marginal product of unskilled labour increases with -,

$$þ^0_{-¶}(-) \wedge 0, \quad ` þ^0_{-¶}(-) ]`- \wedge 0 \ \text{ and } \lim_{-Y+?} þ^0_{-¶}(-) = Q$$

and that the marginal product of skilled labour decreases with -,

$$þ^0_{-´}(-) \wedge 0, \quad ` þ^0_{-´}(-) ]`- \setminus 0, \ \text{ and } \lim_{-Y+?} þ^0_{-´}(-) = 0$$

Hence $h(-)$ 1 $þ^0_{-´}(-)$ $þ^0_{-¶}(-)$ is a continuous and strictly decreasing function of - with domain [0[Q) and range [h(0)[Q), where h(0) = $þ^0_{-´}$(- = 0) $þ^0_{-¶}$(- = 0).

Eliminating $1_µ$ from the training condition ¤ = $1_µ$ $1_¶$ by using the promotion condition $1_µ = 1_´ + \frac{¸´ \quad ¸¶}{3 + .}$ and substituting the Euler Conditions for $1_´$ and $1_¶$ gives (3 + .)¤ = $þ^0_{-´}(-)$ $þ^0_{-¶}(-)$. Since $h(-)$ is monotone, there exists a unique $-^t \wedge 0$, if (3 + .)¤ \ h(0), which is assumed. QED

Proof of Proposition 4:

Part 1: Existence and Uniqueness with promotion

The variables $:^t[¸^t_¶[¸^t_´$ are functions of $2^t_¶[2^t_´[-^t$ but not vice versa. Thus it is su>cient to show the existence of the vector $1^t = (2^t_¶[2^t_´[-^t)$. 1^t is defined by (22) and (18) for ª R {´[¶}. Define $f^0_{-ª}(-_¶[-_µ + -_´)$ 1 $\overline{f}^0_{-ª}(r)$ and note, that (22) fixes a unique r^t 1 $(-_µ + -_´)]-_¶$. This in turn fixes a unique pair $(2^t_¶[2^t_´)$ according to Lemma 1. There exists now a $-^t \wedge 0$ such that $(2^t_¶[2^t_´[-^t)$ ensures that r^t is fixed. To ensure that $-^t \wedge 0$ note that ¯´]¯¶ in

$$r^t = \frac{5_´}{5_´ + .} \frac{5_¶ + .}{5_¶} \frac{-^t + .}{.} \frac{¯_´}{¯_¶} + \frac{-^t}{.}$$

is assumed to be su>ciently small. This is just another way of saying that the initial human capital level is ine>cient. Thus, r^t is unique and hence the equilibrium as well.

Part 2: Multiplicity without promotion

It is su>cient to show that there might exist multiple $(2^t_{¶}[2^t_{›}[-^t)$ or equivalently r^t that satisfy (18). The general training condition without promotion is given by:

$$(^3 + .)¤ = \frac{(^3 + .)\overline{f}^0_{-‚}(r^t) + 5‚\,¸‚}{^3 + . + 5‚} \quad \overline{f}^0_{-¶}(r^t)$$

The marginal product depends on the ratio of skilled to unskilled labour (i.e. r 1 $(-_µ + -‚)\,]-_¶$), where $`\overline{f}^0_{-‚}]`r \ 0$, $`\overline{f}^0_{-¶}]`r$ ^ 0. In contrast to the arguments above, does a change in r not imply that the general training condition is not satisfied, since an increase in r, which decreases $f^0_{-‚}$ and increases $f^0_{-¶}$ could be o;set by a decrease in $5‚$. This proves that there can exist multiple equilibria.

Multiple equilibria can only exist if r increases while $2^t_{›}$ decreases (or vice versa). According to the properties of the matching function a decrease in $2^t_{›}$, causes at the same time r to decrease (see 15). In order to have r increasing, either $-^t$ must increases or $2^t_{¶}$ decreases (or both) and o;set the decrease caused by $2^t_{›}$. However, since $f^0_{-¶}$ increases, $2^t_{¶}$ has to increase according to the vacancy creation condition (18). Thus, the only way r can increase is if $-^t$ increases, QED.

References

Acemoglu D., (1997), 'Training and innovation in an imperfect labour market', Review of Economic Studies vol. 64 (July), pp. 445-464.

Acemoglu D. and J.-S. Pischke, (1998), 'Why do firms train? Theory and evidence', Quarterly Journal of Economics 113 (February), 79-119.

Acemoglu D. and J.-S. Pischke, (1999a), 'Beyond Becker: Training in imperfect labour markets', The Economic Journal vol. 109 (February), pp. 112-142.

Acemoglu D. and J.-S. Pischke, (1999b), 'The Structure of Wages and Investment in General Training', Journal of Political Economy vol. 107, pp. 539-572.

Becker G., (1993), Human Capital - A theoretical and empirical analysis, with special reference to education, 3rd edition, University of Chicago Press, Chicago (1st edition 1964).

Booth A. and M. Chatterji, (1998), 'Unions and E>cient Training', The Economic Journal vol. 108 (March), pp. 328-343.

Chang C. and Y Wang, (1996), 'Human capital investment under asymmetric infromation: The pigovian conjecture revisited', Journal of Labor Economics 14, 505-519.

Katz E. and A. Ziderman, (1990), 'Investment in general training: The role of information and labor mobility', The Economic Journal 100 (December), 1147-1158.

Malcomson J.M., J. Maw and B. McCormick, (2003), 'General training by firms, apprenticeship contracts, and public policy', European Economic Review vol. 47 (2), pp. 197-227.

Muthoo A., (1999), Bargaining Theory with Applications, Cambridge University Press, Cambridge.

Oatey M., (1970), 'The Economics of Training with Respect to the Firm', British Journal of Industrial Relations vol. 8, pp. 1-21.

Pissarides C., (2000), Equilibrium Unemployment Theory, MIT Press, Cambridge.

Stevens M., (1994), 'An Investment Model for the Supply of Training by Employers', The Economic Journal vol. 104 (May), pp. 556-570.

Stevens M., (2001), 'Should Firms be required to pay for general training?', The Economic Journal vol. 111 (July), pp. 485-505.

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