Lecture 6: On the Job Training

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1. General human capital theory.

2. Under which conditions would firms pay for general training?


4. Specific human capital theory.

Becker (1964) was the first to think carefully about on-the-job training and distinguished two types of skills that may be valuable to employers:

1. **General skills** - Skills useful to many employers.
2. **Specific skills** - Skills useful to only one employer.

This distinction is important because it affects who will be willing to pay for training.
Who Will Pay for General Training?

- Formalizing the Becker idea. Consider two periods:
  1. $t = 1$: *Training and production*:
     Workers produce output $y$.
     Workers receive training $\tau$ at cost $c(\tau)$.
  2. $t = 1.5$: *Workers may leave the firm*.
  3. $t = 2$: *Production*:
     Workers produce output $y + f(\tau)$ at any firm (because they received general training)

- We assume the following about the $f(\tau)$ and $c(\tau)$ functions:
  $f'(\tau) > 0$
  $c(0) = c'(0) = 0$; $c''(\tau) > 0$; $c'(\tau) \to \infty$ as $\tau \to \infty$

  (convex training cost function).
The social optimum for training is given when: \( c'(\tau^*) = f'(\tau^*) \).

Suppose the firm pays for training. Can it offer the following wage schedule?

1. \( w_1 = y \)
2. \( w_2 = y + f(\tau) - c(\tau) \)

In a competitive labour market other firms would offer the worker \( w_{2,\text{Other}} = y + f(\tau) \). Therefore the incumbent firm would have to pay the same or lose the worker.

The incumbent firm would therefore not be willing to pay for general training in a competitive labour market.
Can We Achieve the Socially Optimal Level of General Training?

- Since employers are not willing to pay for general training will nobody get general training?
- Two solutions of how to achieve the socially optimal level of training:
  1. Workers pay for general training directly (School, university, etc.).
  2. Workers pay indirectly to employer by accepting a lower training wage.

  The wage schedule will be:
  1. $w_1 = y - c(\tau^*)$
  2. $w_2 = y + f(\tau^*)$

- Does higher turnover affect training incentives? No, because the wage in the second period is $y + f(\tau^*)$ anyway.
- How do credit constraints for workers impact the model?
  - workers cannot borrow against the future stock of human capital (except from government: e.g. student loans).
  - wages in the first period may not go low enough (e.g. negative) to cover efficient training expenditures.
Graphical Analysis
Marginal Products

- MP with training
- MP without training

(time)
Graphical Analysis

Firms Paying a Training Wage in the First Period

Wage with training

MP without training

Time
We observe that a lot of general training is paid for by workers. They pay for attending school, university and so on. This is in line with Becker’s insight.

In practice, however, we also see that firms pay considerable amounts for general training or their workers:

- Autor (2001) for example shows that temporary help firms offer a lot of general training (e.g. IT skills) to their workers. By definition this must be general training as the workers are used by other firms.
- In Germany, firms train a large number of apprentices (about 1/3 of a cohort) during 3 year apprenticeships. A large fraction of that training is in general skills.

How can we explain that firms pay for general training?
Firms would only pay for general training if wages were lower than the MP.

Suppose wages are always lower than MP by a constant wedge for every level of training:
Firms always get $\Delta$ as a rent. They would not invest in general training because $\Delta$ is constant and the costs of training are increasing.

Showing this mathematically:

With a constant wedge we have $f'(\tau) = v'(\tau)$ and $f''(\tau) = v''(\tau)$ where $v(\tau)$ is the outside wage paid to a person with training $\tau$.

The firm maximizes profits:

\[
\max \pi(\tau) = f(\tau) - v(\tau) - c(\tau)
\]

FOC: $f'(\tau) - v'(\tau) = c'(\tau)$

which is satisfied at $\tau = 0$. (Like in the Becker model firms would not pay for general training).
Firms would only invest in training if $\Delta$ increases with training.
When Would Firms Pay for General Training?
Increasing Wedge

- Showing mathematically that with an increasing wedge firms would pay for general training.
- The FOC is the same as above: \( f'(\tau) - v'(\tau) = c'(\tau) \)
- But now there will be an interior solution at \( \tau^* > 0 \). Because \( \Delta'(\tau) > 0 \) and therefore \( f'(\tau) - v'(\tau) > 0 \) and thus \( c'(\tau) > 0 \) in the optimum. This occurs at positive training levels.
- Is this solution socially efficient?
- No, it will be too low. The socially optimal level of training would be where \( f'(\tau) = c'(\tau) \) but the firm only maximizes \( f'(\tau) - v'(\tau) = c'(\tau) \).
- Thus the firm would only choose the social optimum if \( v'(\tau) = 0 \); i.e. the wage is invariant to the training level.
Why Could the Outside Wage be Lower Than Productivity?

- Firms would only pay for general training if the wedge increases with the level of training. Why could that be the case?
  1. Adverse selection.
  2. Outside firms don’t know $\tau$. (In that case $v'(\tau) = 0$ and the firm can pay everybody the untrained wage; see above)
  3. Search:
     If there is a possibility that workers are unemployed for a period the discounted present value of the outside wage is lower than productivity. Therefore firms can pay below marginal product.
  4. Complementaries between specific and general training.
Adverse Selection Can Make Employers Pay For General Training

- The Acemoglu and Pischke (1999) model shows how adverse selection can lead firms to pay for general training.

- The basic insight is that incumbent firms have an informational advantage in knowing the ability of their workers compared to outside firms. They will therefore get rid of bad workers which reduces the quality of workers for outside firms. Outside firms will thus pay lower wages.

- This insight is analogous to the Akerlof (1970) "Market for Lemons" paper.

- Here we are going to look at a slightly simplified version of their model: instead of using a distribution of abilities workers are either high or low productivity. All the insights of the model stay the same.
t = 1:
- Firm hires worker and decides whether to train the worker.
- The firm observes the worker’s ability $\eta$ (this does not depend on whether it trains the worker or not).
- In the first period there is no production (a normalization).

$\ t = 1.5:$
- Market offers outside wage $v(\tau)$. They do not observe ability.
- Firm makes counter offer $w(\tau, \eta)$
- Worker decides whether he wants to leave or whether he has to move for exogeneous reasons (this will occur with probability $q$).

$t = 2:$
- Production takes place.
Acemoglu & Pischke Model - Model Details:

- Production:
  The production function is \( f(\tau, \eta) = \tau \eta \)
  where \( \tau \) is the level of training and \( \eta \) is the worker’s ability.

- The worker’s ability is: \( \eta = \begin{cases} 0 \text{ with probability } p \\ 1 \text{ with probability } (1-p) \end{cases} \)

- Probability that a worker quits = \( \begin{cases} 1 \text{ if } w(\tau, \eta) < v(\tau) \\ q \text{ if } w(\tau, \eta) \geq v(\tau) \end{cases} \)
  where \( q \) is the exogeneous turnover probability.
To obtain equilibrium wages and training we solve the model by backward induction:

In period 2:
Market offers $v(\tau)$.

Firms best response:

- offer $w(\tau, \eta) = v(\tau)$ if $v(\tau) \leq \tau\eta$ (good worker) they don’t have to pay more because that would not make him more likely to stay.
- offer $w(\tau, \eta) = 0$ if $v(\tau) > \tau\eta$ (bad worker)

The firm lets low $\eta$ workers go.
The Movers

What is the overall probability that a worker moves?

\[
\text{prob. of move} = P(τη < ν) + qP(τη ≥ ν) = "lemons" + \text{exogenous movers}
\]

The probability that \((τη < ν) = p\) (see above)

\[
⇒ \text{prob. of move} = p + q(1 − p)
\]

Expected productivity of movers:

\[
E(τη \mid move) = \frac{p}{p + q(1−p)}0 + \frac{q(1−p)}{p + q(1−p)}τ = \frac{q(1−p)}{p + q(1−p)}τ
\]

Outside firms pay workers according to their expected productivity:

\[
ν(τ) = \frac{q(1−p)}{p + q(1−p)}τ
\]
Acemoglu & Pischke Model - Equilibrium
First Period Subgame - Optimal Amount of Training

- Training firm will only have good workers in period 2. \((\eta = 1)\). Its profits are therefore:
  \[
  \pi = (1 - q)(1 - p)[f(\tau, \eta) - w(\tau, \eta)] - c(\tau)
  \]
  the firm pays the training cost for everybody because it does not know who the good guys are.
  \[
  = (1 - q)(1 - p)[\tau - v(\tau)] - c(\tau)
  \]
- FOC: \(\pi' = (1 - q)(1 - p)[1 - v'(\tau)] - c'(\tau) = 0\)
  \( (1 - q)(1 - p)[1 - v'(\tau)] = c'(\tau) \)
- This has a solution with \(\tau^* > 0\) because \(v'(\tau) = \frac{q(1-p)}{p+q(1-p)} < 1\) (see last slide).
- Thus \(v(\tau)\) has a slope smaller than 1.
- What is the slope of \(f(\tau, \eta) = \tau\eta?\)
  Only the high productivity types are left with the firm \(\Rightarrow\)
  \(f(\tau, \eta) = \tau \Rightarrow f'(\tau, \eta) = 1\)
We are in a situation where there is an increasing wedge between the MP and the wage due to adverse selection and therefore the firm pays for general training:
Acemoglu & Pischke investigate whether they can find evidence for adverse selection in the German apprenticeship market.

German apprentices leave the training firm for 3 possible reasons:

1. Employer does not offer a permanent contract ("lemons").
2. Worker quits voluntarily (exogeneous movers).
3. To do compulsory military service.

What does the model predict for the earnings of these 3 groups of leavers?
What Does the Model Predict For the Different Groups of Stayers and Leavers?

1. **Stayers** earn at least as much as the movers: \( w(\tau) \geq v(\tau) \).
   (In the model \( w(\tau) = v(\tau) \) because firms get all the rents from the adverse selection problem)

2. **Military Quitters** earn more than other movers: \( v^m(\tau) > v(\tau) \)
   Because military quitters have only a random fraction of lemons.

3. **Military Quitters** may earn more than stayers: \( v^m(\tau) \geq w(\tau) \)
   Military quitters are freed from the adverse selection problems even though military quitters have lower ability than stayers (unlike stayers they have a random fraction of lemons).
Column (2) adds dummies for firm size and firm's sector.
Specific Skills

As we have seen before Becker distinguished between 2 types of skills:

1. General skills
2. Specific skills

Who is going to pay for training in firm-specific skills?

Rewriting the productivity and outside wage functions to include specific human capital we get:

\[ y = f(g, s) \text{ with } f_1(g, s) > 0 \text{ and } f_2(g, s) > 0 \]

\[ w = v(g, s) \text{ with } v_1(g, s) > 0 \text{ and } v_2(g, s) = 0 \]

(the outside wage cannot increase with specific human capital).
Suppose the firm pays for specific training.

The worker would get his MP which only depends on general training in the outside market and therefore at the training firm as well.

Because the inside and the outside wage are exactly the same the worker has no incentive to stay at the firm.

He can threaten to leave but then the firm would lose out and so the firm would be willing to pay a higher wage than the outside wage to keep the worker.
Specific Skills - Would Workers Pay for Specific Training?

- Suppose the worker pays for specific training and get all the rents.
- In that case the firm does not gain from employing the trained worker.
- So it may just employ another worker.
- If the firm fires the worker before returns = costs the worker would lose out.
- The worker therefore has an incentive to give the firm some of his rents to be able to stay in the firm.
This is a typical case where some form of Nash bargaining seems plausible.

The wage schedule would therefore look as follows:
One way to estimate whether specific human capital matters is to estimate the following regression:

\[ \ln(w) = \beta_1 + \beta_2 S + \beta_3 \text{EXP} + \beta_4 \text{TENURE} + \epsilon \]

This is, however, problematic because workers with more tenure may be different to other workers due to the following reasons:

1. Because they are very good the firm will always try to keep the worker.
2. Because their search has helped them to find a particularly good firm they do not want to leave.

Because of these reasons the coefficient on tenure is likely to be upward biased if one estimates this model in a cross-sectional sample of workers.
Estimating the Returns to Specific Human Capital

\[\ln(w)\]

- \(w(0,0)\) - 0 years of experience
- 0 years of tenure

- \(w(1,0)\) - 1 year of experience
- 0 years of tenure

- \(w(1,1)\) - 1 year of experience
- 1 year of tenure

Experience
The problem is that we never observe all 3 wages for the same person.
The cross-sectional estimates of returns to job tenure and experience would be:

- experience: \( w(1, 0) - w(0, 0) \)
- tenure: \( w(1, 1) - w(1, 0) \)

This will be biased. Illustrating this with a stark example:

- Suppose everybody with a bad job quits and everybody in a good job stays.
Estimating the Returns to Specific Human Capital

\[ \ln(w) \]

- \( w^{good}(0,0) \)
- \( w^{avg}(0,0) \)
- \( w^{bad}(0,0) \)

Estimated Return to Tenure

- \( w(1,1) \)

Estimated Return to Experience

- \( w(1,0) \)

Experience
Cross sectional estimates of tenure would therefore be upward biased. During the 1980s, researchers have started to estimate returns to tenure using panel data. This allows to include individual specific effects which addresses part of the problem. A particularly careful and revolutionary study is the study on earnings losses of displaced workers by Jacobson, LaLonde, and Sullivan (1993).
Jacobson, LaLonde, and Sullivan (1993) investigate returns to specific human capital by looking at displaced workers. There are two important reasons why displaced workers may have lower earnings:

1. Because they lose *firm specific human capital*. (They would initially lose this job-specific HC but their earnings may recover if they work in the new jobs for long enough).

2. *Search*: Workers may have searched for higher paying jobs for some time before ending up in their old job. Now they have to start again.

They focus on high-tenure workers because they are more likely to have accumulated substantial amounts of firm specific human capital or "match" capital prior to their job loss.

They use data from administrative records covering 5 percent of the workforce in Pennsylvania for the years 1974 to 1986.
What happens to Earnings After Job Separation?

Earnings of separators fall sharply after separation and then rise quickly for the first quarters after separation. They stay, however, about 20 percent below their pre-separation level. Already before the separation wages of separators are slightly lower than wages of stayers. It will therefore be important to control for the heterogeneity of workers.

Figure 1. Quarterly Earnings (1987 Dollars) of High-Attachment Workers Separating in Quarter 1982:1 and Workers Staying Through Quarter 1986:4

- Earnings of separators fall sharply after separation and then rise quickly for the first quarters after separation. They stay, however, about 20 percent below their pre-separation level.
- Already before the separation wages of separators are slightly lower than wages of stayers. It will therefore be important to control for the heterogeneity of workers.
Defining Earnings Losses

Previous studies had often measured the losses of displaced workers by subtracting their post-displacement earnings from their pre-displacement earnings. This is problematic due to a number of reasons:

1. This does not control for macroeconomic factors that cause changes in workers’ earnings regardless of the displacement.
2. This does not account for the earnings growth that would have occurred in the absence of the job loss.
3. Firm’s declining fortunes may adversely affect workers’ earnings several years prior to the displacement.

They define displaced workers’ earnings losses to be the difference between their actual and expected earnings had the events that led to their job losses not occurred.
Econometric Model

- They estimate the following regression:
  \[ y_{it} = \alpha_i + \gamma_t + x_{it} \beta + \sum D_{it}^{k} \delta_k + \varepsilon_{it} \]

  - \( y_{i} \) is income of individual \( i \) in quarter \( t \).
  - \( \alpha_{i} \) is an individual FE. (controlling for heterogeneity across workers).
  - \( \gamma_{t} \) is a quarter FE. (controls for macroeconomic effects affecting all workers).
  - \( x_{it} \) consists of observed time varying characteristics of the worker (such as age).
  - \( D_{it}^{k} \) is a full set of dummies covering 20 quarters prior and many quarters after separation interacted with whether a worker is displaced.

- This is essentially a differences-in-differences estimator but they estimate the separation effect for several pre and post-separation quarters.

- They estimate their results for a mass layoff sample (more than 30 percent of the workforce dismissed) and other layoffs.
As with any differences-in-differences type strategy we have to be careful that treatment and control group would evolve similarly in the absence of treatment.

They address this concern by including linear worker-specific time trends. (a separate time trend for each worker).

An alternative way to measure the earnings loss due to displacement is to compare workers within a same firm where some have been displaced and others have not.

- Advantage: we avoid potential bias if particular firms make workers with a certain skill set especially productive.
- Disadvantage: we may underestimate (or overestimate) the effect of dismissal as the struggling firm may reduce wage of remaining workers because it is struggling (or overestimate if the firm keeps only those workers with a particularly good firm-worker skill match).
Mass Layoff Results

As the key parameters of interest is the large set of quarterly dummies interacted with whether you are dismissed they plot the estimated regression coefficients:

![Graph showing earnings losses for separators in Mass-Layoff Sample](image)

**Figure 2. Earnings Losses for Separators in Mass-Layoff Sample**
Mass Layoff Results

- As we can see, displaced workers have falling earnings already about 3 years before the displacement.
- In the displacement year, earnings drop sharply.
- Earnings recover somewhat in the first 3 years after displacement but are flat and about 25 percent lower than pre-displacement earnings for a long time after displacement.
- If one controls for worker-specific time trends, the estimated losses are even larger in the long run. (This suggests that firms are not displacing workers with more slowly growing earnings).
Now they compare displaced workers’ earnings to earnings of workers in the same firm:

**Figure 4. Sensitivity of Earnings-Loss Estimates for Mass-Layoff Sample to Different Comparison Groups**
The authors now use workers who were not displaced but who are employed by firms who have mass layoffs as the comparison group. The estimated earnings losses are smaller in this case.
Non-Mass Layoff Results

- They also investigate the evolution of earnings for separators in a non-mass layoff sample.

![Graph showing earnings losses for separators in a non-mass layoff sample](image)

**Figure 3. Earnings Losses for Separators in Non-Mass-Layoff Sample**
The evolution of earnings for separators in the non-mass layoff sample look very different:

- They do not decline before separation.
- In the quarter of separation they decline sharply but by less than those in the mass layoff sample and after that earnings recover.
- This is not surprising as the sample includes a larger fraction of workers who quit their jobs or who had fewer firm-specific skills.
The study is extremely careful and thoughtful. It does, however, not fully inform us whether these earnings losses are due to the loss of firm-specific human capital or the loss of "search" capital.

Job loss may also affect worker’s health, marriage, and so on. All these factors will affect the wage profile after job losses.

It is very difficult to obtain empirical evidence on the importance of specific human capital!