Lecture Note: Theories of the Provision and Payment of General Skills Training

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1 Goal of this lecture

- Review basic Becker story
- Consider stylized model of general skills training in a competitive labor market.
- Add various labor market perfections to the model to consider how they alter firms' training decisions:
  - Search costs and other wedges
  - Search costs that differ by worker skill level
  - Exogenous turnover
  - Nash bargaining
  - Minimum wages
  - Asymmetric information→Adverse selection
- Goal is to understand who pays for general skills training, and what are the efficiency consequences. As it turns out, market structure and training provision are tightly linked, an insight originally due to Becker. Deviating from either the perfectly competitive or pure monopsony cases studied by Becker gives rise to interesting and general insights about wage structure, market institutions, private information, and training provision.
- An interesting feature of the modern literature is its implicit focus on the limitations of contracting. Becker considered one specific contracting problem – holdup of firm by workers. It turns out, this problem is richer than Becker may have seen at that time.

1.1 Basic model

Definition 1 *Generals skills – Skills useful to many employers ("many buyers").*

Definition 2 *Specific skills – Skills with exactly one buyer.*

- Timeline

1. $t = 1$. Training and production (human capital investments sunk). Workers produce output y and receive training τ at cost $c(\tau)$.
2. $t = 1.5$. Workers face option to leave firm.
3. $t = 2$. Production takes place again. Worker produces output $y + f(\tau)$ at any firm (general training).

- Assume: $f'(\tau) > 0, c(0) = c'(0) = 0$ and $c'(\tau) > 0, c''(\tau) > 0, \underset{\tau \to \infty}{c'(\tau)} \to \infty$.

1.2 Basic Becker insight: Holdup

- FOC social optimum for training? $c'(\tau^*) = f'(\tau^*)$.
- How do we know that $\tau^* > 0$?
- Can firm pay worker $w_1 = y$, $w_2 = y + f(\tau) - c(\tau)$?
- Basic insight of Becker model: In a competitive labor market, employers will not pay for general human capital. The problem is "holdup." Since the worker's opportunity (outside) wage rises by $f(\tau)$ with training, firm must pay $w_2 = y + f(\tau)$ or lose employee to a competitor.
- Q: Since employers unwilling to fund socially productive training, is this a market failure? A: Worker is full residual claimant to returns from training investments $\Rightarrow$ Efficient incentive for worker to make the investments.
- Two canonical solutions to this problem:
  1. Direct investments by workers – School, training programs, etc.
  2. Indirect payment to employer: Training wage. Hence:
     $w_1 = y - c(\tau^*)$, $w_2 = y + f(\tau^*)$.
- Just to check intuition:

- How do high rates of labor turnover affect training investment incentives? Not at all.
- How do worker credit constraints impact this model? Quite a bit.
  * Cannot typically borrow against future stock of human capital (except from government, e.g., student loans).
  * Wages may not go low enough (e.g., negative) to cover efficient training expenditures.

- How relevant is this model?
  - Clearly, covers considerable territory: College education is paid for by families, society; Professional schools do not generally subsidize tuition: Law, medicine, business.
  - What about the case of military education? Military flight education costs multiple millions to provide. The skills are completely portable (to commercial aviation).

1.3 Is that all there is to it?

- A persistent suspicion that there is more going on – employers are paying for general skills training.
  - German apprenticeships: Acemoglu and Pischke QJE (1998) Table 1.
  - BLS 1994 study of employer training. Found that employers spent $3.4 billion in 1994 on direct tuition reimbursements and outside training funds (almost certainly general). Was all of this paid for by workers?
  - Example of Temporary Help Supply (THS) firms. Demonstrably clear that THS firms do pay up-front costs of training (about $150 per trainee) prior to job assignment, without any contractual obligation to perform work.

- These examples have spurred continued interest in the provision and payment of general skills training.

- There are 2 seminal papers that give rise to discussion of modern theories of training. One is Grout (1984) *Econometrica,* the second is Greenwald (1986), *Review of Economic Studies*. I'll touch on results from both of these papers later on.
- Continue with the setup from above with.
  - $f(\tau)$ is productivity with $f'(\tau) > 0$ and $f''(\tau) < 0$, and $c(\tau)$ is as above.
  - Denote $\nu(\tau)$ as the outside wage paid to a person with training τ.
  - Assume for now that for whatever reasons, workers do not obtain outside training. Hence $\tau = 0 < \tau^*$ initially.

1.3.1 Case 1: Constant wedge

- See Figure 1.
- Take a case initially where $f'(\tau) = \nu'(\tau)$ and $f''(\tau) = \nu''(\tau)$.
- Consider firm's maximization problem:

$$\max_{\tau} \pi(\tau) = f(\tau) - \nu(\tau) - c(\tau) \tag{1}$$

  Q: What does perfectly competitive market about relationship between $f(\tau)$ and $\nu(\tau)$?
  Q: Why $\nu(\tau)$ not $f(\tau)$ in the firm's maximization?

- FOC for (1) is

$$c'(\tau) = f'(\tau) - \nu'(\tau) \tag{2}$$

  which is satisfied at $\tau^* = 0$. This echoes the Becker model.

- Now instead assume that $f(\tau) - \nu(\tau) = \Delta(\tau) = \Delta > 0$. Can think of Δ as a search friction. How does this search affect τ^* in (2)? Why?

1.3.2 Case 2: Increasing wedge

- See Figure 2.

- Now consider a new search friction whereby

$$f(\tau) > \nu(\tau) \text{ and } f'(\tau) > \nu'(\tau).$$

  Continue to assume concavity of $f(\cdot)$ and $\nu(\cdot)$.

- Assume for now:

  - No exogenous turnover. All workers remain with the firm in period 2 if receive $v(\tau)$.
  - All bargaining power rests with the firm – that is, firm is the full residual claimant of any surplus $(f(\tau) - \nu(\tau) - c(\tau))$.

- First order condition is the same as (2), $f'(\tau) - \nu'(\tau) = c(\tau)$, but now there will be an interior solution at $\tau^* > 0$. This follows because $\Delta(\tau) > 0$ and $\Delta'(\tau) > 0$ (and recall that $c'(\cdot), c''(\cdot) > 0$).

- So notice that this search friction raises training, whereas the other does not. How does the assumption that $f'(\tau) > \nu'(\tau)$ change the holdup problem?

- Q: Is this solution socially efficient? A: No, inefficiently low.

- Social maximization is $f'(\tau) = c(\tau)$, whereas firm only maximizes $(f'(\tau) - \nu'(\tau)) = c(\tau)$. In other words, firm maximizes 'the wedge,' not output net of costs.

- So, firm would only choose the social optimum if $\nu'(\tau) = 0$, i.e., wage invariant to training level.

- This is something of a paradox: More 'inefficient' market structure – greater wedge between productivity and wages – encourages greater firm training. (Echoes Becker result on labor market monopsony, or firm specific capital also has the feature that $\nu'(\tau^{specific}) = 0$.)

- Let's look at two other wrinkles on this result: Nash bargaining and exogenous post-training turnover.

Nash bargaining and turnover

- Nash bargaining: A fraction of the surplus $\beta \in [0,1]$ goes to the worker.
- Nash bargaining corresponds to the absence of contracts. The assumption is that ex ante wage agreements are not feasible, so firms and workers bargain over the surplus ex post. Each demands at least its threat point: for workers, that's $\nu(\tau)$, for firms, that's also $\nu(\tau)$, since they could hire identical workers to produce $f(\tau)$ at wage $\nu(\tau)$ if these workers quit.
- So the maximization is now

$$c'(\tau^\beta) = (1-\beta)\left[f'(\tau^\beta) - \nu'(\tau^\beta)\right], \tag{3}$$

  with the worker's wage set by

$$w(\tau^\beta) = \nu(\tau^\beta) + \beta\left[f(\tau^\beta) - \nu(\tau^\beta)\right],$$

  and profits

$$\pi(\tau^\beta) = (1-\beta)\left[f(\tau^\beta) - \nu(\tau^\beta)\right] - c\left(\tau^\beta\right)$$

- Now, some important questions raised by the Grout article:

1. Why doesn't $c(\tau)$ enter (3) in parallel to $f(\tau)$ or $\nu(\tau)$?
   - Answer: Because $c(\tau)$ is sunk. And this bargain is set ex post.
   - That is, wages are determined by worker's outside opportunity $\nu(\tau)$ and her claim β on firm's quasi-rents, which are $f'(\tau^\beta) - \nu'(\tau^\beta)$.
   - Q: Why is $f'(\tau^\beta) - \nu'(\tau^\beta)$ a quasi rent?
2. Are workers necessarily better off with β large?
   - Notice that with τ constant, it is clearly the case that

$$\nu(\tau) + \beta\left[f(\tau) - \nu(\tau)\right] > \nu(\tau).$$

- But τ is not constant. As Grout's article demonstrates (not for this case), since since τ^β that satisfies $c'\left(\tau^\beta\right) = (1-\beta)\left[f'(\tau^\beta) - \nu'(\tau^\beta)\right]$is strictly less than τ^0 that satisfies $c'\left(\tau^0\right) = \left[f'(\tau^0) - \nu'(\tau^0)\right]$.This follows because in the $\beta > 0$ case, workers are expropriating part of the firm's quasi-rents from the sunk training investment. Anticipating this fact, the firm invests less in training.
- Note that this result also depends upon the convexity of the training cost function. By reducing scale of training, firm increases marginal returns.
- As β rises, workers get a larger share of a smaller pie. In the extreme case where $\beta = 1$, we have $\tau^\beta = 0$, no training occurs.
- This brings up a key point from Grout's article (Theorem 3.2):

$$-\frac{\partial \pi(\cdot)}{\partial \beta} > \frac{\partial w}{\partial \beta},$$

that is, the fall in profits for an increase in worker bargaining power is strictly less than the gain in worker wages – so the bargaining solution reduces social efficiency.

- How do we know this to be true? The change in profits for an increment to β is:

$$\frac{\partial \pi(\tau^\beta)}{\partial \beta} = -f(\tau^\beta) + \nu(\tau^\beta) + \left[(1-\beta)\left(f'(\tau^\beta) - \nu'(\tau^\beta)\right) - c'\left(\tau^\beta\right)\right]\partial\tau^\beta/\partial\beta,$$

whereas the increase in wages is

$$\frac{\partial w(\tau^\beta)}{\partial \beta} = f(\tau^\beta) - \nu(\tau^\beta) + \beta\left[f'(\tau^\beta) - \nu'(\tau^\beta)\right]\partial\tau^\beta/\partial\beta.$$

Putting these two together, the total social gain/loss is

$$\frac{\partial \pi(\tau^\beta)}{\partial \beta} + \frac{\partial w(\tau^\beta)}{\partial \beta} = \left[f'(\tau^\beta) - \nu'(\tau^\beta) - c'\left(\tau^\beta\right)\right]\partial\tau^\beta/\partial\beta < 0,$$

since $\partial\tau^\beta/\partial\beta < 0$ and $f'(\tau^\beta) - \nu'(\tau^\beta) - c'\left(\tau^\beta\right) > 0$ as long as t^β is below the social optimum, which will always be true here. Notice that the social loss here is exactly the contraction in the pie caused by the reduction in training $\partial\tau^\beta/\partial\beta$ (the rest is a transfer from firm to worker).

- So, as soon as we deviate into a case where contracts are not enforceable and costs are sunk, the 2nd welfare theorem no longer holds – there is a direct conflict between efficiency and distribution. This is a primary insight from Grout's article.

- Also briefly consider the case of exogenous worker turnover at rate q. From the firm's perspective, this works exactly like an increase in bargaining power. The FOC is

$$c'(\tau^q) = (1-q)\left[f'(\tau^q) - \nu'(\tau^q)\right].$$

  Training again drops with a rise in q. The reason is that there are fewer trainees around in the 2^{nd} period from whom the firm can capture the returns from training.

1.3.3 Summary so far

The discussion of training in the "increasing wedge" case gives rise to three perverse comparative statics. Training is increasing in:

1. The degree of distortion in the wage structure. The greater is $\Delta'(\tau)$, the more firms train.
2. The more bargaining power that rests with the firm. The smaller is β (worker's bargaining power), the more firm trains.
3. The lower is worker mobility. Less turnover $q \downarrow$, more training.

Hence, anything that increases firm's marginal share of returns to training also increases training in this setup. Yet, you should not think this is a complete accounting; a higher training economy is not necessarily globally more efficient:

- Training is closer to optimal
- But labor supply is sub-optimal due to inefficient wage incentives (workers paid below marginal product).
- The limited monopsony present when turnover is low may dampen efficient reallocation of workers to jobs (speaking loosely).

1.4 Structure of wages and investment in general training

- It is a commonplace belief that worker turnover is inimical to employer training. And indeed, industries with low turnover also have high training.

- Is it the simple duration of the attachment between workers and firms that gives rise to this pattern?

- Consider the constant wedge case, where $\Delta(\tau) > 0$ and $\Delta'(\tau) = 0$. The firm's FOC, as above, is

$$c'(\tau^q) = (1-q)\left[f'(\tau^q) - \nu'(\tau^q)\right],$$

  which is satisfied at $t^q = 0$.

- Hence, the commonplace assertion that "labor market frictions" are sufficient for firm investment in training is incorrect. A "frictional" labor market is not necessarily a high training labor market.

- Frictions must be of a specialized kind: The compression of the wage structure – that is, the gap between wages and marginal products – must be greater for more skilled/trained workers.

- If $f(\tau) - \nu(\tau) = \Delta$, then there is no firm-sponsored training, even with zero exogenous turnover and no worker bargaining power ($q = 0, \beta = 0$).

- This is a key insight because it directs your gaze towards features of the labor market that might give rise to a situation where $f(\tau) - \nu(\tau)$ is increasing in τ, that is $\Delta'(\tau) > 0$. This point is made in full generality by the Acemoglu-Pischke (1999) *JPE* paper.

- Now, we want to consider a two possible reasons why the wage structure might be compressed as needed to generate incentives for firm investment in general skills: 1) Minimum wages; 2) Adverse selection.

1.4.1 Minimum wages and investment in general training

- It is a standard view that minimum wages will reduce training. Why? Function like a credit constraint – reduce workers' ability to take a pay cut to pay for general training.
- This result has been "verified" in papers by Blackburn and Neumark among others – but this work does not exploit within-state variation in minimum wages, so it's hard to have great confidence in these papers.
- Consider a case as depicted in Figure 3. Here $\Delta'(\tau) = 0$ by assumption, so normally not an incentive for firm investment in worker training (however, we still assume that $\Delta(\tau) > 0$, which is not standard).
- Imposition of a binding minimum wage compresses wage distribution below the minimum, but leaves it unaffected above. If the following things are true:
  - Firms don't shut down
  - Positive profits are still made on these workers
  - $c(\tau_{\min}) < [f(\tau_{\min}) - \nu(\tau_{\min})] - (\tau_{\min}) < [f(0) - w_{\min})]$
    ...firms will want to increase training.
- A table from the Acemoglu-Pischke (1999) paper on minimum wages and general training provides some evidence that this might be going on.
- At a minimum, their paper does not support the contention that the impact of binding minimum wage on training provision is negative.

1.4.2 Adverse selection, monopsony, and training

- Greenwald's seminal 1986 *ReStud* paper offered the general observation that if workers are heterogeneous and potential employers cannot observe this heterogeneity perfectly, incumbent employers are likely to have an informational advantage over their employees relative to outside employers. This informational advantage can give rise to adverse selection.

- This insight is directly analogous to the Akerlof 1970 "Market for Lemons" paper applied to the labor market – where it could easily be more relevant. (Q: Unlike used cars, workers can tell you about their 'quality.' Why doesn't this solve the problem?)

- Let's embellish the current model to incorporate the case of worker heterogeneity and see how it gives rise to adverse selection. Assumptions:

  1. Two types of workers: $\eta \in \{H, L\}$. $\Pr(\eta = H) = \rho$.
  2. Type H produces $f(\tau)$, type L produces 0 (a normalization).
  3. Ability η is unknown to employers at time of hire. ρ and $f(\tau)$ are common knowledge.
  4. Ability for each employee is observed by incumbent employer in 1^{st} period
  5. There is *exogenous* turnover after end of 1^{st} turnover. A fraction q of all workers turns over immediately after training.
  6. In addition, there is *endogenous* turnover if $w < \nu(\tau)$.

- Time line is as above:

  1. $t = 0$: Training and production
  2. $t = 1.5$: Turnover
  3. $t = 2$: Production

- What are equilibrium wages and training in this model? Solve by backward induction.

  - Consider wages in 2^{nd} period *assuming* that $\tau^* > 0$.
  - The expected productivity of trained type H workers is $f(\tau^*)$
  - The expected productivity of trained type L workers is 0.

- How are wages set in the outside labor market? Our outside wage concept is $\nu(\tau^*)$. This is the opportunity wage for a trained worker (remember, we are assuming all workers are trained).

- Since outside firms cannot distinguish H from L workers, it must be the case that $\nu(\tau^*)$ is independent of η. So $\nu(\tau^*)$ must equal the *expected* productivity of workers available for hire at wage $\nu(\tau^*)$. (This is the Perfect Bayesian equilibrium concept that is normally applied to models with information uncertainty).

- It's easiest to think about the expected productivity of workers who have turned over, since they are in the market (but we can generalize to the case of 'raids' on firms). Expected productivity of departed workers is

$$E(f(\cdot)\,|\text{separate}) = \frac{(\#H \text{ separators})}{\#H \text{ separators} + \#L \text{ separators}} \cdot f(\tau^*)$$

- What is the composition of the outside pool:

  - Exogenous turnover q of H workers $\rightarrow q\rho$
  - Exogenous turnover q of L workers $\rightarrow q(1-\rho)$
  - All type L workers who don't turn over by themselves will be offered a wage of 0 by their incumbent employer after the 1^{st} period (this is the informational advantage). This fraction is $(1-q)(1-\rho)$. These group of endogenous separators will 'pool' with the exogenous separators. Hence, productivity of outside pool is

$$\nu(\tau^*) = \frac{q\rho}{q\rho + (1-\rho)} \cdot f(\tau^*) \tag{4}$$

- Consequently, the incumbent employer need only pay $\nu(\tau^*)$ to retain its type H workers. Incumbent employer benefits from "ex post monopsony" stemming from private information.

  Why? Because this is the wage that they would command if they quit the firm (in equilibrium, they do not, of course). Moreover, if an outside firm tried to bid them away, the incumbent employer could simply match wage offers up to $f(\tau^*)$ for its H workers while not matching this wage for its L workers. Hence, the outside firm would always overpay for workers it poached ('winner's curse').

- Now, return to firm's maximization for training in 1^{st} period,

$$\max_{\tau} \pi = (1-q)\,\rho\,[f(\tau) - \nu(\tau)] - c(\tau),$$

with FOC

$$c'(\tau^*) = (1-q)\,\rho\,[f'(\tau^*) - \nu'(\tau^*)]\,.$$

Since $\nu'(\tau) < f'(\tau)$, this maximization will have a solution with $\tau^* > 0$.

- In this example, adverse selection compresses the wage structure. Why does this work? Due to private information, the expected productivity of the pool of separators is below the expected productivity of the randomly drawn hire during the 1^{st} period. That's because good workers predominately stay with their own firm, while the bad ones turnover after their low productivity is discovered by incumbent employer. Although good workers would like to earn $f(\tau^*)$, their actual productivity, rather than $\nu(\tau)$, the opportunity wage, they would be cursed by adverse selection if they turned over. Hence, incumbent employer has limited monopsony power.

- Q: The model has a hidden assumption – unrelated to the information structure of the model – that made this result work. What is it? There is a complementarity between training and ability; specifically, $\partial^2 f(\cdot)/\partial\tau\partial\eta > 0$: H workers get $\partial f(\cdot)/\partial\tau > 0$ from training, whereas L workers get $\partial f(\cdot)/\partial\tau = 0$.

- Consider instead if we had assumed that $f(\tau) = \eta + \gamma(\tau)$. Then equation (4) becomes

$$\nu(\tau) = \frac{q\rho}{q\rho + (1-\rho)} + f(\tau), \tag{5}$$

and so $f'(\tau) - \nu(\tau) = 0$, and no general training is provided.

- So, this assumed complementarity between training and ability (positive cross-partial derivative) was necessary to generate the "increasing wedge" that makes it profitable for firms to fund general training. Whether this assumption is reasonable – in addition to being necessary – is a question that the model cannot answer.

- In fact, there is considerable evidence that better educated and better paid workers – in addition to more "able" workers within education cells – receive more training. Is this evidence convincing for existence of complementarity? If you believed in complementarity, how would you explain the fact that Instrumental Variables (IV) returns to education are

higher than OLS returns? IV returns, after all, are identified from behavior of less-educated workers.

1.4.3 Testing the adverse selection model

- For many economists, the adverse selection model has something of the ring of truth. That is, incumbent employers do have better information about their own employees than do other potential employers – this is hard to dispute. And this informational advantage might make it rational to invest in their general skills if it gave rose to some type of wedge between productivity and outside wages.

- Problem: A model that is inherently about unobservable information is difficult to test using standard data sources.

- One idea: Look for exogenous shocks to employment that break adverse selection equilibrium.

    1. Gibbons and Katz (1991) *Journal of Labor Economics* (not about training). Layoffs versus plant closings. It follows very generally from the adverse selection argument that workers who separate from a firm endogenously (layoffs) should be worse than workers who separate due to exogenous shocks (plant closings – not necessarily exogenous, but affect bad and good workers in the plant simultaneously).
       Hence, G&K compare these two groups, show that in fact the laid off workers do considerably worse (esp. for white collar workers). This is particularly striking because you might assume that workers losing jobs in plant closing would fare worse due to concentrated job loss in one geographic area.
    2. Acemoglu and Pischke (1999, *QJE*). They view "military quitters" as a group like those who experience plant closings. Exogenously separate, not cursed by adverse selection. So, even though military quitters are lower in ability than average workers, their post-military wages are higher. This is interesting, though perhaps not a strong est.

- Another idea: Study a labor market where...

- Lots of general training given.
- Essentially no firm-specific capital (since workers sent to multiple client sites), so training most likely "general."
- High turnover. (An outlier in the industry plot of training versus turnover.)
- Training provided up-front during unpaid, non-production hours and is not contracted. Hence, there is no opportunity for firms to pay a training wage that is below marginal product.
- Heterogeneity of policies – not all firms train (but the 'high quality' ones do).

- Autor, 2001 *QJE* attempts to understand why this training is profitable for THS firms. Motivations for training (interviews):

  1. 'Recruitment' – Attract skilled/motivated workers
  2. Testing – Training is a skill screen
  3. Skills development – Human capital acquisition, particularly in office software

- Insight of this model is that if training and ability are indeed complements, offering training should induce positive self-selection on unobserved ability – that is, high ability workers value training more than low ability workers since it is complementary with ability. (See Salop and Salop 1976 *QJE* for a similar structure applied to a different benefit.)

- Setup of model. Building on previous information model, but now giving workers some *ex ante* knowledge of own ability (necessary for self-selection to be relevant):

  1. Workers have some private information about own ability.
     - $\eta = \{H, L\} = \{1, 0\}$. $\Pr(\eta = H) = \rho$.
     - Workers have beliefs about their own ability ex ante: $b = \{H, L\}$
     - $\Pr(\eta = H|b = h) = \delta_h > \rho$. $\Pr(\eta = H|b = l) = \delta_l < (1 - \rho)$. So $1 > \delta_h > \rho > \delta_l > 0$. Beliefs are informative but not infallible.

2. Firms learn about ability by training. That is, training incorporates testing, but it is not only testing.
3. Ability and training are publicly observed in 3^{rd} period. So, period of monopsony is brief.
4. Production $f(\tau) = \eta(1+\tau)$. Training and ability are complements.

- Time line of this model:
  - $t = 1$: Workers select a firm (training versus non-training) and receive any training offered.
  - $t = 1.5$: Exogenous + endogenous turnover
  - $t = 2$: Deployed by THS firm to client site
  - $t = 3$: Hired into non-THS sector (monopsony ends)

- To find equilibrium, backward induction. Start at 3^{rd} period. Assume we are at separating equilibrium. H workers go to training firms, L workers do not.

- Third period:

$$w_3 = \eta(1+\tau).$$

  Since ability and training are publicly observed in 3^{rd} period, workers are paid their marginal product, which depends on η and where they worked in 1^{st} period and hence how much training they received.

- Second period:

$$w_2 = \left\{ \begin{array}{ll} \nu(0) = \delta_l & \text{if } b = l \\ \nu(\tau) = \frac{q\delta_h(1+\tau^*)}{q\delta_h+(1-\delta_h)} & \text{if } b = h \end{array} \right\}.$$

  Notice that there is no adverse selection for low ability workers (who go to non-training firms); since non-training firms don't train, don't get private information. So, wage of workers at non-training firms is simply the share who are in expectation high ability, which is δ_l.

  By contrast, wage of trainees $\nu(\tau)$ is set by adverse selection due to private information.

- Comparison of $\nu(0) \lesseqgtr \nu(\tau)$: Could easily be the case that $\nu(0) > \nu(\tau)$, even though ability, productivity higher at training firms (since high ability share is $\delta_h > \delta_l$). Why? Consider comparison with "military quitters."

- Now, we can get separating condition for low ability to choose non-training firms, high ability to choose training firms. Expected earnings are:

	ω_1	ω_2	ω_3
No train	0	$\nu(0)$	δ_l
Train	0	$\nu(\tau^*)$	$\delta_l(1+\tau^*)$

- For high ability, expected earnings are:

	ω_1	ω_2	ω_3
No train	0	$\nu(0)$	δ_h
Train	0	$\nu(\tau^*)$	$\delta_h(1+\tau^*)$

- So, the separating condition under which high ability workers choose training firms and low ability workers choose non-training firms is simply,

$$\delta_l \tau^* < \nu(0) - \nu(\tau^*) < \delta_h \tau^*.$$

  The expected gain to training for high ability workers exceeds short term wage costs in period 2, and vice versa for low ability workers.

- Testable empirical implication: Wages lower (post-training) at training establishments, despite up-front training. This is particularly surprising since wages of trainees should be higher ex post in Becker setup – and this is almost universally found in literature. This would be true in general even if workers were paying for training if ability and training are complements. (See tables from QJE 2001)

- So, in this model, training is not solely a human capital formation mechanism. It also elicits otherwise unobservable information about worker (beliefs about) ability, which firms can use profitably (for a short period) while they hold information privately.

- (A contribution of this paper: May help to understand the role that THS industry plays as an information broker in labor market, rather than as simply a provider of spot market labor services.)

1.5 Conclusions

- View of general training has come some ways since Becker, though its fair to say that these models are standing on Becker's shoulders rather than standing Becker on his head.
- View of training has to some extent caught up with what economists probably once believed but did not have tools to express: private information, poor contracting, distorts costs and benefits of training. It is neither wholly paid for by workers nor necessarily efficiently provided by firms.
- Does this literature have a future? It's possible to argue that training has been over-studied by labor economists. It's no longer interesting to ask what are the 'returns to training.' However, it is interesting to ask about how market structure affects training provision (the question implicitly raised by the A&P models on wage compression and training provision).
- Interesting example: training provision and AIDS in Africa. How would you expect AIDS to affect training investment? Overall? By age group? By geography?
- Next topic: Specific capital. The Becker view and some contemporary versions.

Figure 1

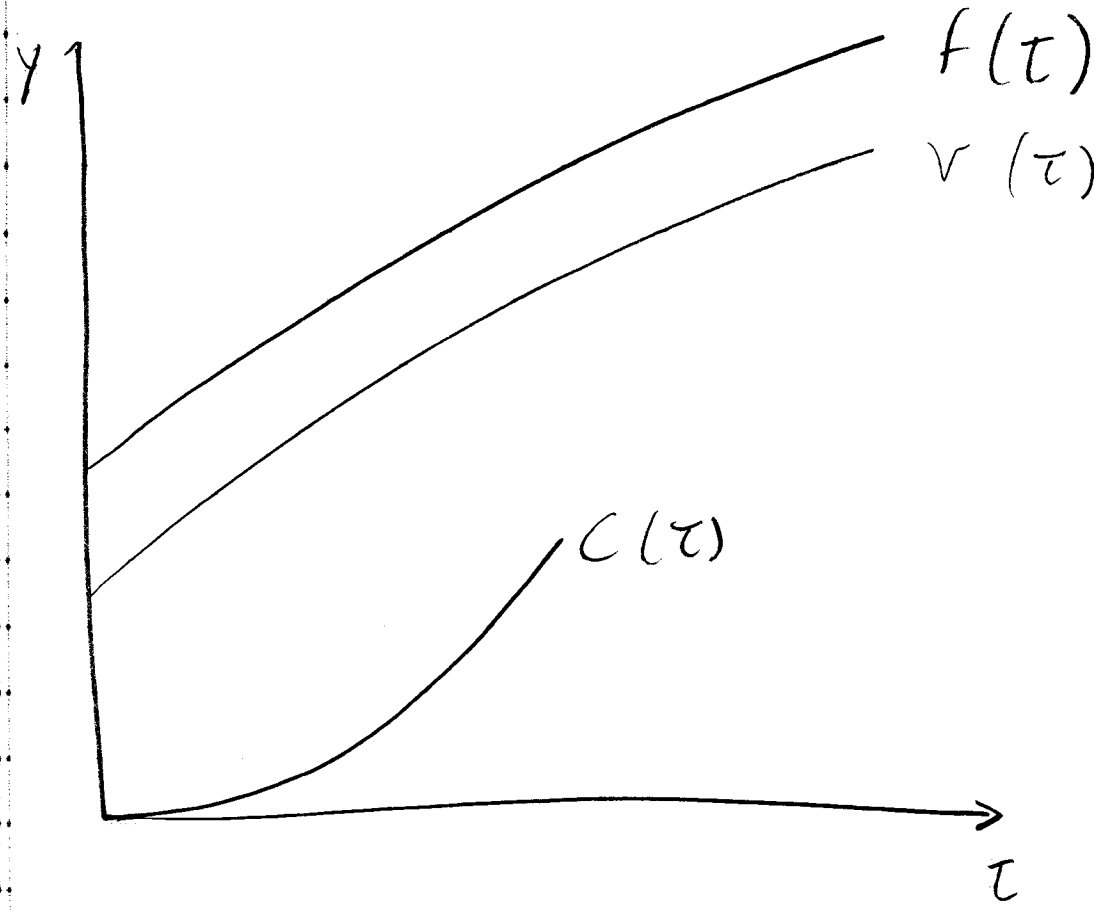


Figure 2

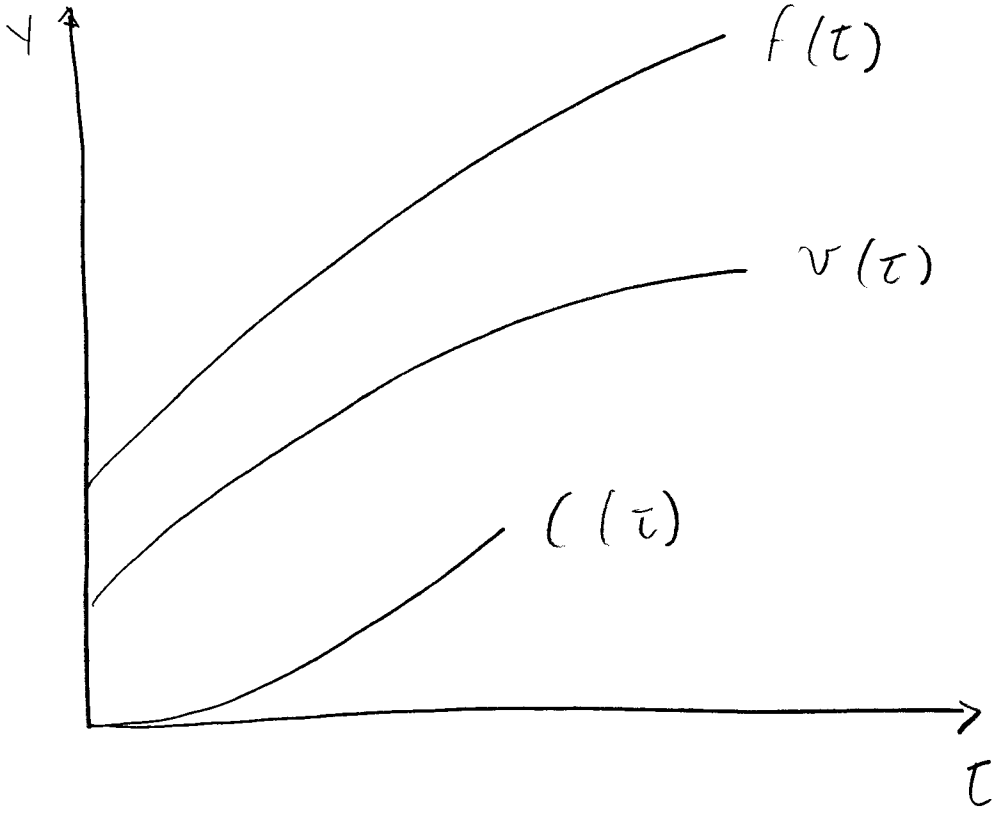
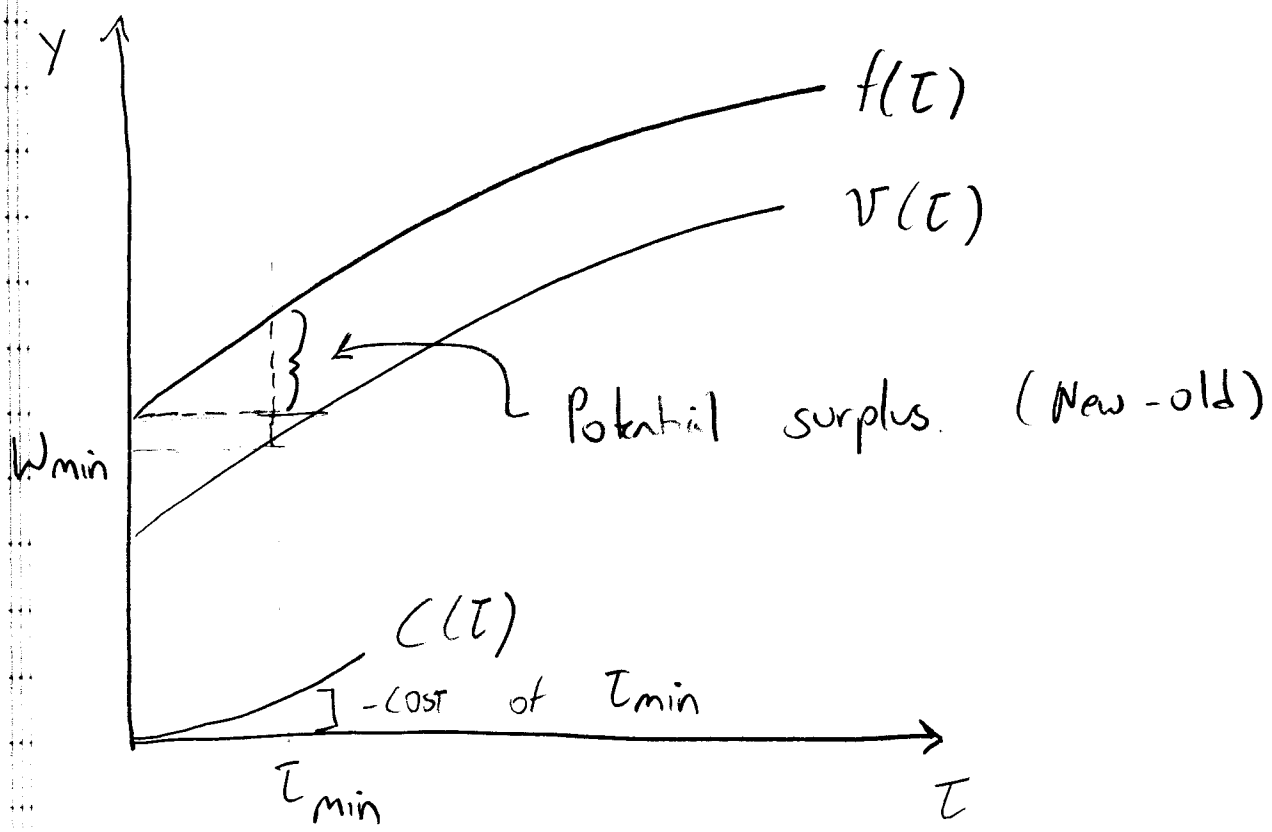


Figure 3



Acemoglu & Pischke, QJE 1998

TABLE I

COSTS OF APPRENTICESHIP TRAINING IN GERMANY 1991 (GERMAN MARKS PER YEAR)

	All firms	By firm size (number of employees)			
		0–9	10–49	50–499	500+
A) Total gross costs	29,573	27,473	28,176	30,344	35,692
B) Variable gross costs	18,051	13,867	15,074	20,283	28,197
C) Aprentice productivity	11,711	12,221	11,465	12,099	10,311
Perfect markets					
Total net costs (A − C)	17,862	15,252	16,711	18,245	25,381
Variable net cost (B − C)	6,340	1,646	3,609	8,184	17,886
Imperfect markets (50% markdown)					
Total net costs (A − 2 * C)	6,151	3,031	5,246	6,146	15,070
Variable net costs (B − 2 * C)	−5,371	−10,575	−7,856	−3,915	7,575

Source. von Bardeleben, Beicht, and Fehér [1995], Chart 27 and Table 12.

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CEP Working Paper
0527

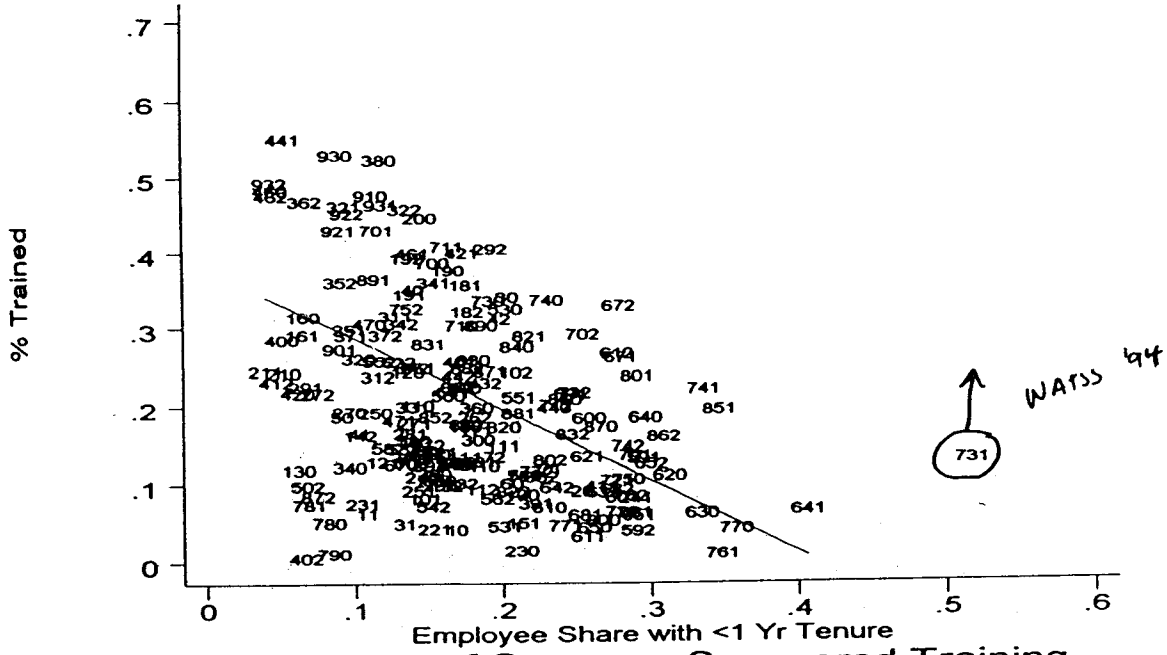
Table 4
The Effect of Minimum Wage Increases on Affected Workers

Comparison Group	*All*	*Affected States*	*Low Wage Workers*	*All*	*Affected States*	*Low Wage Workers*	*All*	*All*
Independent Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Minimum wage increased and wage in prior year is below the current minimum wage	0.009 (0.014)	0.011 (0.015)	0.003 (0.016)	--	--	--	--	--
Minimum increased and wage in prior year is below the current minimum and above prior year minimum	--	--	--	0.016 (0.019)	0.018 (0.020)	0.011 (0.021)	--	--
Minimum wage increased and wage in prior year is below 150 % of the current minimum wage	--	--	--	--	--	--	0.005 (0.008)	--
Minimum wage increased and wage in prior year is below 130 % of the current minimum wage	--	--	--	--	--	--	--	-0.003 (0.010)
Change in high school graduation status	0.070 (0.054)	0.091 (0.083)	0.040 (0.041)	0.070 (0.054)	0.090 (0.083)	0.040 (0.041)	0.070 (0.054)	0.071 (0.054)
Change in new job status	0.032 (0.008)	0.039 (0.012)	0.039 (0.011)	0.032 (0.008)	0.039 (0.012)	0.039 (0.011)	0.032 (0.008)	0.032 (0.008)
Number of Observations	17074	7552	5873	17074	7552	5873	17074	17074

Notes: Non-mover sample, consisting of all workers with a high school education or less, who do not move between states from one year to the next. The low wage comparison sample consists of all workers with wages in the prior year below 150 % of the current minimum wage. Dependent variable is the change in training incidence between two consecutive years. All regressions also include a constant and year dummies. Regressions are weighted by NSLY sampling weights. Standard errors are adjusted for the presence of individual effects in the error term, and therefore robust to the MA structure of the error.

AUTOR

Source: January 1991 CPS Training Supplement



Industry Frequency of Company Sponsored Training

Table 2
Descriptive Statistics by Broad Occupation from January 1984 and 1986 CPS Displaced Workers Surveys, Males Reemployed at Survey Data in Wage and Salary Employment

	Means			
	White Collar		Blue Collar	
Variable	Plant Closing	Layoff*	Plant Closing	Layoff*
Previous tenure in years	5.17	3.84	6.23	3.66
	(.28)	(.20)	(.22)	(.13)
Change in log real weekly earnings	−.068	−.125	−.208	−.191
	(.02)	(.02)	(.02)	(.02)
Log of previous weekly earnings	6.06	6.05	5.88	5.87
	(.02)	(.02)	(.01)	(.01)
Log of current weekly earnings	5.99	5.93	5.67	5.68
	(.02)	(.02)	(.02)	(.02)
Weeks of joblessness after displacement	13.96	18.36	22.54	25.29
	(.84)	(.85)	(.84)	(.81)
No unemployment after displacement = 1	.25	.11	.16	.09
	(.02)	(.01)	(.01)	(.01)
Advance notification of displacement = 1	.55	.41	.56	.51
	(.02)	(.02)	(.02)	(.01)
Years of schooling	13.87	14.21	11.65	12.07
	(.10)	(.09)	(.06)	(.06)
(Age − education − 6) at displacement	13.04	11.82	13.99	10.92
	(.44)	(.40)	(.34)	(.28)
Previous job in manufacturing = 1	.35	.39	.60	.62
N	552	627	1,062	1,186

NOTE.—Standard errors of the means are in parentheses. The white-collar sample consists of workers with predisplacement jobs as managers and administrators, professional and technical workers, clerical workers, or sales workers. The blue-collar sample consists of workers with predisplacement jobs as craft and kindred workers, operatives, laborers, transport operatives, or service workers. Weekly earnings figures are deflated by the GNP deflator.

* Reason for displacement was slack work or elimination of shift or position.

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Table 3
Coefficients on Layoff Dummy in Earnings Equations from January 1984 and 1986 CPS Displaced Workers Surveys, Males Reemployed at Survey Date

		Dependent Variable*		
Sample	*N*	Wage Change (1)	Predisplacement (2)	Postdisplacement (3)
Whole sample	3,427	−.040	.017	−.021
		(.017)	(.014)	(.017)
White collar	1,179	−.055	−.0094	−.064
		(.028)	(.024)	(.029)
Blue collar	2,248	−.024	.022	.0023
		(.022)	(.017)	(.021)
Low union	1,716	−.040	−.007	−.046
		(.023)	(.020)	(.024)
High union	1,711	−.031	.030	.002
		(.026)	(.020)	(.004)

NOTE.—The reported regressions include a spline function in previous tenure (with breaks at 1, 2, 3, and 6 years), education, a dummy for advance notification of displacement, year-of-displacement dummies, seven previous-industry dummies, eight previous-occupation dummies, experience (age − education − 6) and its square, a marriage dummy, a nonwhite dummy, and three region dummies. Columns 1 and 3 also include years since displacement. The white-collar sample consists of workers with predisplacement jobs as managers and administrators, professional and technical workers, clerical workers, or sales workers. The blue-collar sample consists of workers with predisplacement jobs as craft and kindred workers, operatives, laborers, transport operatives, or service workers. The low-union sample consists of workers in industry-occupation cells with unionization rates of less than 25.5% in 1983; all workers in industry-occupation cells with higher unionization rates are in the high-union sample. Earnings are deflated by the GNP deflator. The numbers in parentheses are standard errors.

* Dependent variable: col. 1 = log (current wage/previous wage); col. 2 = log (previous wage); col. 3 = log (current wage).

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TABLE III

BASIC WAGE REGRESSIONS (DEPENDENT VARIABLE: LOG AVERAGE HOURLY EARNINGS)

Independent variable	Qualification and career survey (1)	Qualification and career survey (2)	1984 SOEP (3)
Attended 10th grade	0.160	0.162	0.153
	(0.011)	(0.007)	(0.028)
Experience	0.123	0.108	0.028
	(0.024)	(0.017)	(0.098)
Experience^2/100	−0.694	−0.532	−0.086
	(0.182)	(0.126)	(0.848)
Experience^3/10,000	1.840	1.229	0.161
	(0.558)	(0.379)	(3.007)
Experience^4/1,000,000	−1.806	−1.063	−0.123
	(0.597)	(0.399)	(3.740)
Apprenticeship in manufacturing	0.024	—	—
	(0.013)		
Apprenticeship in trade	0.036	—	—
	(0.022)		
Apprenticeship in other sector	0.041	—	—
	(0.021)		
Apprenticeship firm had 100–499 employees	0.045	—	—
	(0.013)		
Apprenticeship firm had 500–999 employees	0.072	—	—
	(0.016)		
Apprenticeship firm had 1000+ employees	0.095	—	—
	(0.014)		
Stayer	0.012	0.027	—
	(0.015)	(0.008)	
Military quitter	0.045	0.011	—
	(0.025)	(0.014)	
Ever did military service	—	—	−0.022
			(0.024)
R^2	0.384	0.337	0.126

White standard errors are in parentheses. Samples in the first two columns are pooled from the 1979, 1985/86, and 1991/92 German Qualification and Career Surveys and consist of German males, age 23–59, with nine or ten years of schooling, who left secondary school in 1948 or later, completed private sector apprenticeship training without returning to school after the apprenticeship, were employed in the private sector outside construction, and were working full-time. Column (1) includes workers who did an apprenticeship in a firm with 50 employees or more; column (2) uses apprentices from firms of all sizes. Number of observations is 5,355 in column (1) and 13,051 in column (2). "Stayers" are those workers who continued in their apprenticeship firm after training; "military quitters" are those who left their training firm for military service. Sample in the last column is from the Socioeconomic Panel and consists of German males, age 23–59, with nine or ten years of schooling, who left secondary school in 1948 or later, were employed in the private sector outside construction, and were working full-time. Number of observations is 513. All regressions also include a constant, and the regressions in columns (1) and (2) include two additional dummies for the survey year.

TABLE I

SKILLS TRAINING: PREVALENCE AND POLICIES AT U. S. TEMPORARY HELP SUPPLY ESTABLISHMENTS, 1994

Training provided		Training policies	
All skills training		*(multiple policies possible)*	
Any	78%	"Up-front": All/Volunteers trained	66%
White-collar workers	56%	Establishment selects trainees	34%
Clerical/sales workers	81%	Client requests and pays	36%
Blue-collar workers	59%	No training	22%
Computer skills training			
Any	65%		
White-collar workers	27%	Training methods used (if training given)	
Clerical/sales workers	74%	*(multiple methods possible)*	
Blue-collar workers	14%	Computer-based tutorials	82%
"Soft" skills training		Classroom work, lectures	45%
Any	70%	Written self-study materials	52%
White-collar workers	52%	Audiovisual presentations	47%
Clerical/sales workers	70%	Other	14%
Blue-collar workers	58%		

Detailed training subject frequencies by major occupation group

	Any	White-collar	Clerical/sales	Blue-collar
Word processing	63%	23%	75%	13%
Data entry	58%	19%	69%	11%
Computer programming languages	22%	12%	23%	1%
Customer service	41%	27%	47%	12%
Workplace rules/on-job conduct	66%	55%	68%	60%
Interview and resume development skills	30%	31%	32%	13%
Communications skills	14%	15%	14%	10%

White-collar occupations are professional specialty, technical, and executive and managerial. Clerical/sales occupations are marketing, sales, and clerical and administrative support. Blue-collar occupations are precision production, craft and repair, machine operators, assemblers, and inspectors, transportation and material movement occupations, and handlers, equipment cleaners, and laborers. The sample includes 1002 temporary establishments supplying white-collar, clerical, or blue-collar temporary workers (establishments may supply more than one type of worker). Training statistics by collar include only the subsample of firms supplying workers in collar (n = 630, 859, and 755 for establishments supplying white-collar, clerical, and blue-collar workers, respectively). All frequencies are weighted by BLS national establishment sampling weights.

Autor 2001, QJE

TABLE II

COMPARISON OF LOG HOURLY WAGES OF THS WORKERS AT TRAINING AND NONTRAINING ESTABLISHMENTS BY MAJOR OCCUPATION

	Log hourly wages			Training	Nontraining
	Free training	No training	Difference	No. workers No. estabs	No. workers No. estabs
White-collar					
All	2.66	2.79	−0.13	10,497	13,034
	(0.04)	(0.05)	(0.06)	360	270
Professional specialty	3.05	3.17	−0.13	2,918	5,016
	(0.02)	(0.03)	(0.04)	200	170
Technical	2.41	2.45	−0.05	5,805	6,554
	(0.04)	(0.05)	(0.06)	274	213
Accountants and auditors	2.72	2.77	−0.06	1,774	1,464
	(0.04)	(0.06)	(0.07)	187	134
Clerical/sales					
All	2.01	2.09	−0.09	156,419	17,925
	(0.01)	(0.03)	(0.03)	693	166
Clerical and administrative support	2.02	2.10	−0.08	145,997	16,957
	(0.01)	(0.02)	(0.03)	690	164
Marketing and sales	1.84	1.97	−0.13	10,422	1,328
	(0.03)	(0.08)	(0.09)	435	42
Blue-collar					
All	1.76	1.78	−0.02	85,756	50,257
	(0.01)	(0.01)	(0.02)	461	294
Precision production, craft, and repair	1.89	1.97	−0.08	8,193	6,142
	(0.04)	(0.04)	(0.06)	216	162
Operators, assemblers, and inspectors	1.79	1.82	−0.03	19,867	12,851
	(0.02)	(0.02)	(0.03)	310	187
Transport, material movement	1.89	1.92	−0.03	1,884	1,809
	(0.06)	(0.05)	(0.08)	186	126
Handlers, equipment cleaners, and laborers	1.72	1.71	0.01	55,812	29,445
	(0.01)	(0.01)	(0.02)	445	252

All estimates are weighted by BLS national probability sampling weights. Standard errors in parentheses are corrected for clustering of observations at the establishment level. Sample includes 1002 establishments, which may employ workers in multiple occupations.

Autor 2001, QJE

TABLE III

OLS ESTIMATES OF THE RELATIONSHIP BETWEEN ESTABLISHMENT TRAINING POLICIES AND WORKER WAGES, POOLED AND FIXED EFFECTS MODELS DEPENDENT VARIABLE IS THE LOG HOURLY WAGE OF THS WORKERS

	A. Pooled estimates			*B. Fixed effect estimates*		
	(1)	(2)	(3)	(4)	(5)	(6)
Any training provided	−0.020	−0.019		−0.035	−0.034	
	(0.010)	(0.010)		(0.0179)	(0.0176)	
Up-front training provided			−0.025			−0.049
			(0.010)			(0.019)
Firm selects trainees			0.005			−0.026
			(0.013)			(0.040)
Client requests/pays for training			0.003			0.061
			(0.012)			(0.039)
Log of establishment size		−0.026	−0.025		−0.020	−0.022
		(0.004)	(0.004)		(0.007)	(0.007)
Log of THS employment in MSA-collar		0.051	0.050		0.023	0.024
		(0.012)	(0.011)		(0.013)	(0.013)
Firm fixed effects	No	No	No	Yes	Yes	Yes
R^2	0.62	0.62	0.62	0.54	0.54	0.54
n	333,888	333,888	333,888	201,314	201,314	201,314

All models are weighted by OCS national establishment probability weights and include 103 metropolitan statistical area (MSA) dummies and 8 major occupation dummies. Huber-White standard errors in parentheses are corrected for clustering at the establishment level (1002 establishments). Fixed effect models are limited to workers employed at multiregion firms (50 firms and 395 establishments). Training policies are not mutually exclusive.

Autor, Murnane, Levy 1999

Table 12. Hiring selectivity at THS firms by major occupation

Q: For an applicant to be hired for an assignment, how necessary is... ? Absolutely necessary, strongly preferred, mildly preferred or not at all.

	Percentage absolutely necessary or strongly preferred			
	Prof/ Tech	Clerical/ Sales	Blue Collar	Training/Non-Training Firm Difference
A high school diploma	95.2%	86.0%	47.9%	12.5% ***
	(2.4%)	(2.7%)	(3.7%)	(4.7%)
	83	164	188	435
A college diploma	77.1%	32.3%	0.5%	-3.4%
	(4.6%)	(3.7%)	(0.5%)	(4.1%)
	83	164	188	435
Previous experience in this line of work	94.0%	86.1%	51.9%	9.7% **
	(2.6%)	(2.7%)	(3.7%)	(4.7%)
	83	165	187	435
Some previous training or skill certification	74.7%	57.7%	36.2%	11.4% **
	(4.8%)	(3.9%)	(3.5%)	(5.6%)
	83	163	188	434
Good English/verbal skills	85.5%	97.0%	52.7%	10.2% **
	(3.9%)	(1.3%)	(3.7%)	(4.4%)
	83	165	188	436
Good attitude and/or motivation	97.7%	97.6%	97.9%	1.9%
	(1.7%)	(1.2%)	(1.1%)	(1.8%)
	83	166	188	437

Notes. Standard errors are in parentheses. Sample size for each cell appears below standard error. Technical/professional occupations are professional/managerial and technical workers. Clerical/sales occupations are clerical workers and sales and marketing workers. Blue collar includes industrial, other blue collar, and service occupations. Training/non-training differentials are regression adjusted for establishments' major occupation and MSA. *** p=.01, **p<.05

Autor, Murnane Levy 1999

Table 15. Permanent Placement Rates at THS Establishments

Q: Of the workers who worked at an assignment last month, about what percentage were hired by a customer last month?

	All Firms	Free training provided	No training provided	Difference (standard error)
Overall	12.5%	15.9%	10.5%	**5.3%** ***
	(1.2%)	(1.1%)	(1.0%)	**(1.5%)**
	375	197	178	**375**
Professional/technical	12.2%	15.0%	10.4%	**4.7%**
	(1.8%)	(3.2%)	(2.1%)	**(3.8%)**
	68	26	42	**68**
Clerical/Sales	14.9%	15.3%	11.4%	**3.9%**
	(1.2%)	(1.2%)	(4.3%)	**(4.4%)**
	144	127	17	**144**
Blue collar occupations	12.5%	18.0%	10.5%	**7.5%** ***
	(1.2%)	(2.7%)	(1.2%)	**(3.0%)**
	163	44	119	**163**

Panel B. Regression models: Percentage of workers placed last month

	(1)	(2)	(3)
Training provided		**6.07%** ***	**7.51%** ***
		(2.00%)	**(2.17%)**
Clerical/Sales	3.24% *	-0.49%	-1.01%
	(1.85%)	(2.21%)	(2.38%)
Professional/technical	-0.32%	-0.94%	-1.51%
	(2.33%)	(2.31%)	(2.49%)
Intercept	9.62% ***	8.34% ***	6.95% **
	(2.23%)	(2.24%)	(2.42%)
R-squared	0.025	0.481	.
n	381	381	381

Notes. Standard errors are in parentheses. Sample size for each cell appears below standard error. Outlying observations (percentage placed >70) are omitted. Columns (1) and (2) are estimated by Ordinary Least Squares. Column (3) is estimated by a maximum likelihood Tobit model with truncation points at 0 and 70 percent. Regression models also include MSA dummies. ***p<.01, **p<.05, *p<.10., ~p<.20