On-the-job Training and On-the-job Search: Wage-Training Contracts in a Frictional Labor market

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Motivation

- Human Capital Accumulation (post schooling)
  - the major contributor individual wage growth and economic growth
  - the first best outcome: Workers should pay for the cost of general training.
  - In reality,
    - only firms can provide general training in many cases and
    - workers cannot commit to staying with the training firms

  - This paper studies the coexistence of On-the-job Training and Search
    - Do productive firms provide more training?
    - Do firms provide the efficient level of training?
    - Do firms provide more training, as search friction is mitigated?

Illustrative Examples

	period 1	period 2
worker:	w_1	w_2
firm:	$y - x - w_1$	$y + f(x) - w_2$

- Becker (1964): Perfect Competition

$$x^B \in \arg\max -x + f(x)$$

$$w_2 = y + f(x^B) \qquad w_1 = y - x^B$$

$$\pi_2 = 0 \qquad \pi_1 = 0$$

- Under perfect competition, the firm provides the efficient level of training, and the worker pays the training cost through lower wage during training.

Illustrative Examples

	period 1	period 2
worker:	w_1	w_2
firm:	$y - x - w_1$	$y + f(x) - w_2$

- Acemoglu (1997): exogenous job-turnover shock

$$x^A \in \arg\max -x + (1-\alpha) f(x)$$

$$w_2 = \phi(y + f(x^A)) \qquad w_1 = \phi(y - x^A)$$

$$\pi_2 = (1-\alpha)(1-\phi)(y + f(x^A)) \qquad \pi_1 = (1-\phi)(y - x^A)$$

$$\pi^p = \alpha(1-\phi)(y + f(x^A))$$

  - positive externality for subsequent poaching firms (free rider problem)

Previous Literature

- Moen and Rosen (2004)
  - no on-the-job search by unskilled workers
  - no skilled unemployed workers
  - no productivity differential

- Fu (2011)
  - incorporates the piece rate sharing rule into Burdett and Mortensen (1998)
  - ends up with inefficient level of training

- Sanders and Taber (2012)
  - over-investment on job specific human capital
  - under-investment on general human capital

The Basic Model

- Burdett and Mortensen (1998) with productivity differentials
- a unit measure of risk neutral (lifetime income maximizing) workers
  - A newly born worker enters the labor market as unskilled and unemployed.
  - The unemployed worker gets employed at rate λ^0.
  - The employed worker finds another job at rate λ^1 and gets laid off at rate δ.
  - The employed worker acquires (general) skills at rate μx through training.
  - All workers retire at rate ρ and they are replaced with newly born workers.
- a unit measure of heterogenous firms ($p \sim H(p)$)
  - Each firm maintains one vacancy at every instant.
  - The recruiting firm with p posts $(E_u(p), E_s(p)) = ((w_u(p), x(p), E_s^t(p)), (w_s(p)))$.
  - It meets an employed searcher at rate λ^1 and unemployed searcher at rate λ^0.
- ε-measure of noise firms
  - They offer only skilled wages from $\hat{F}_n : [\underline{p} + s, \overline{p} + s] \to [0, 1]$.

The Basic Model

- Unemployed Workers
  - retire at rate ρ, and get employed at rate λ^0.

$$rU_i = b - \rho U_i + \lambda^0 \int \max\{z - U_i, 0\} dF_i(z), \quad \text{for each} \quad i \in \{u, s\}$$

- Skilled Employed Workers
  - retire at rate ρ, get laid off at rate δ, and find offers at rate λ^1.

$$rE_s(p) = w_s - \rho E_s(p) + \delta(U_s - E_s(p)) + \lambda^1 \int \max\{z - E_s(p), 0\} dF_s(z)$$

- Unskilled Employed Workers
  - retire at rate ρ, get laid off at rate δ, find offers at rate λ^1, and
  - acquire (general) skills at rate μx.

$$\begin{aligned} rE_u(p) = {} & w_u - \rho E_u(p) + \delta(U_u - E_u(p)) + \lambda^1 \int \max\{z - E_u(p), 0\} dF_u(z) \\ & + \mu x(E_s^t - E_u(p)) \end{aligned}$$

The Basic Model

- Operating Firms with Skilled Matches
  - deliver the committed values through ...

$$rJ_s(p) = p + s - w_s(p) - [\rho + \delta + \lambda^1(1 - F_s(E_s(p)))]J_s(p)$$

- Operating Firms with Unskilled Matches
  - deliver the committed values through ...

$$rJ_u(p) = \max_{w_u,\, x,\, E_s^t} \; p - w_u - c(x) - [\rho + \delta + \lambda^1(1 - F_u(E_u(p)))]J_u(p) + \mu x(J_s(p) - J_u(p))$$

subject to the promise-keeping constraint on $E_u(p)$.

  - F.O.C.
    - $w_s^t(p) = p + s$
    - $c'(x) = \mu(E_s^t(p) - E_u(p) - J_u(p))$
    - The promise keeping constraint determines unskilled wages.

The Basic Model

- Recruiting Firms
  - post $(E_u(p), E_s(p))$ to maximize

$$[\lambda^0 u_s + \lambda^1 G_s(E_s)] J_s(E_s, p) + [\lambda^0 u_u + \lambda^1 G_u(E_u)] J_u(E_u, p)$$

The Basic Model

Given firms' productivity distribution $H(p)$, a steady state equilibrium with on-the-job training and on-the-job search consists of value equations $\{U_i, E_i, J_i\}$ compensation packages $\{(w_u(p), x(p), E_s^t(p)), (w_s(p))\}$ and steady state measures $\{F_i, G_i, u_i\}$ that jointly satisfy the following conditions.

(i) Given F_i, workers make optimal job turnover decision.

(ii) Given $\{F_i, E_i\}$, operating firms optimally deliver the committed values.

(iii) Given $\{G_i, u_i\}$, recruiting firms post their contract to maximize their profit.

(iv) $\{F_i, G_i, u_i\}$ are stationary and consistent with the behavior of each agents.

Steady State Equilibrium

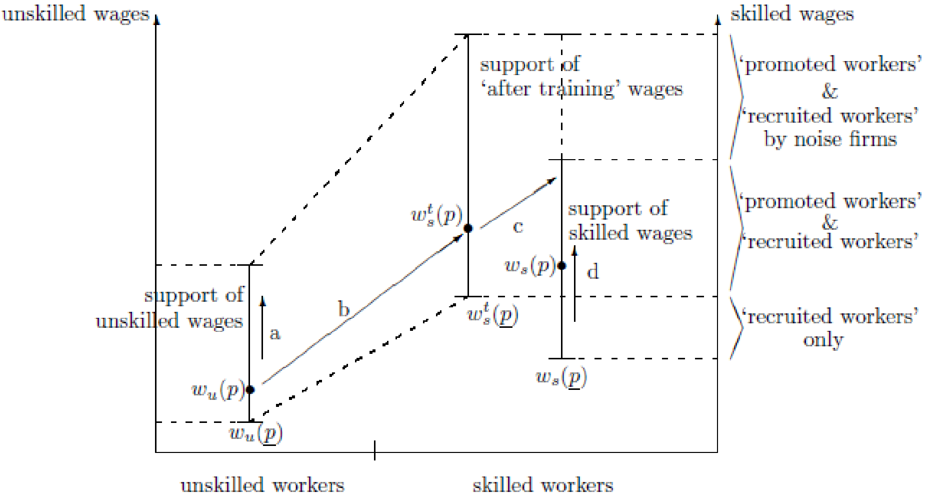


Figure 1: Equilibrium Support of Wages

Steady State Equilibrium

- Proposition 1 The optimal training intensity is characterized by

$$c'(x(p))(r+\rho+\delta)/\mu + x(p)c'(x(p)) - c(x(p)) = s + \delta(U_s - U_u)$$
$$+\lambda^1 \int_{E_s^t(p)}^{\overline{E}_s} [z - E_s^t(p)]dF_s(z) - \lambda^1 \int_{E_u(p)}^{\overline{E}_u} [z - E_u(p) - J_u(p)]dF_u(z)$$

- In particular, $x(\overline{p}) < x(p)$ for any $p \in [\underline{p}, \overline{p})$ if and only if

$$\int_{E_s^t(p)}^{\overline{E}_s} [z - E_s^t(p)]dF_s(z) > \int_{E_u(p)}^{\overline{E}_u} [z - E_u(p) - J_u(p)]dF_u(z)$$

Efficiency Benchmarks

- Constrained Social Planner
  - maximizes the present value of the expected output flow throughout the life of a newly born worker in the steady state equilibrium.

$$(r+\rho)S_s^*(p) = p + s + \delta(U_s^* - S_s^*) + \lambda^1 \int_p^{\overline{p}} [S_s^*(p') - S_s^*(p)] dH(p')$$

$$(r+\rho)S_u^*(p) = p - c(x^*(p)) + \delta(U_u^* - S_u^*) + \mu x^*(p)(S_s^*(p) - S_u^*(p))$$

$$+\lambda^1 \int_p^{\overline{p}} [S_u^*(p') - S_u^*(p)] dH(p')$$

$$(r+\rho)U_i^*(p) = b + \lambda^0 \int_p^{\overline{p}} [S_i^*(p') - U_i^*(p)] dH(p')$$

  - chooses the training intensity such that $c'(x^*(p)) = \mu(S_s^*(p) - S_u^*(p))$
    $(vs \quad c'(x(p)) = \mu(E_s^t(p) - E_u(p) - J_u(p)))$

Efficiency Benchmarks

- Proposition 2 The training intensity in the social planner's problem is characterized by

$$c'(x^*(p))(r+\rho+\delta)/\mu + x^*(p)c'(x^*(p)) - c(x^*(p)) = s + \delta(U_s^* - U_u^*)$$

- In particular, $dx^*/dp = 0$, $dx^*/d\lambda^1 = 0$, and $dx^*/d\lambda^0 > 0$

Efficiency Benchmarks

- In the market equilibrium,

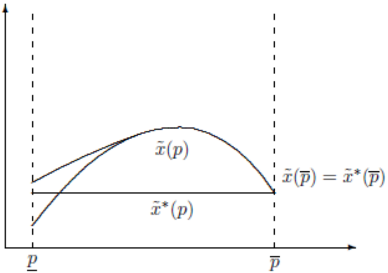
$$c'(x(p))(r+\rho+\delta)/\mu + x(p)c'(x(p)) - c(x(p)) = s + \delta(U_s - U_u)$$

$$+\lambda^1 \int_{E_s^t(p)}^{\overline{E}_s} [z - E_s^t(p)] dF_s(z) - \lambda^1 \int_{E_u(p)}^{\overline{E}_u} [z - E_u(p) - J_u(p)] dF_u(z)$$

- In the social planner's problem,

$$c'(x^*(p))(r+\rho+\delta)/\mu + x^*(p)c'(x^*(p)) - c(x^*(p)) = s + \delta(U_s^* - U_u^*)$$

Efficiency Benchmarks



(a) Without Separation Shocks ($\delta = 0$) (b) With Separation Shocks ($\delta > 0$)

Figure 2: Training Intensity

Baseline Simulation

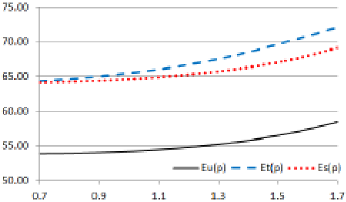
Table 1: Parameter Values

$[\underline{p}, \overline{p}] = [0.75, 1.75]$	the productivity support
$\eta = 1.0$	the shape parameter of $H(p)$
$s = 0.25$	productivity improvement through training
$\gamma = 2.0$	cost function parameter
$r = 0.012$	interest rate
$\rho = 0.008$	retirement rate
$\delta = 0.064$	separation rate
$\lambda^0 = 1.35$	job finding rate by unemployed workers
$\lambda^1 = 0.45$	job finding rate by employed workers

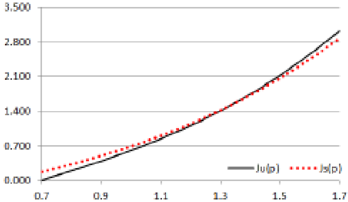
$$\text{Productivity Distribution: } H(p) = \frac{1 - (\underline{p}/p)^{\eta}}{1 - (\underline{p}/\overline{p})^{\eta}}$$

$$\text{cost function: } c(x) = x^{\gamma}$$

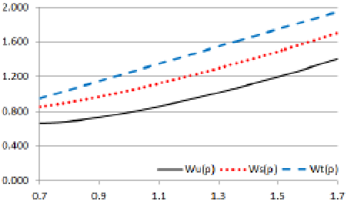
Baseline Simulation



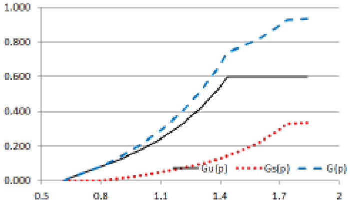
(a) Workers' Values



(b) Firms' Values



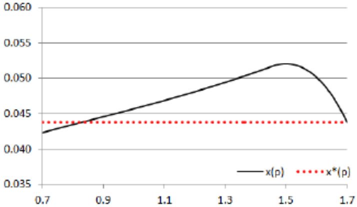
(c) Wages



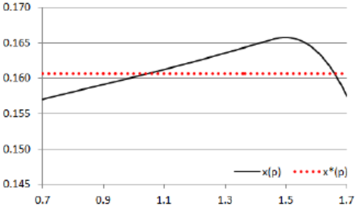
(d) The Value-earning Distribution

Figure 3: The Baseline Simulation Result I

Baseline Simulation



(a) In the Alternative Benchmark Setting



(b) In the Baseline Simulation

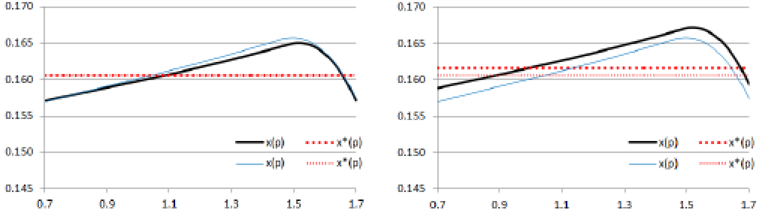
Figure 4: Training Intensity

	unskilled workers	skilled workers	training cost	total output	Net output
ME	0.6001	0.3492	0.0159	1.3859	1.3700
PP	0.6027	0.3467	0.0156	1.3862	1.3707
ME/PP	0.9958	1.0073	1.0191	0.9997	0.9995

ME: the market equilibrium outcome PP: the planner's solution ME/PP: the ratio of ME to PP

Table 2: The Outcome of the Baseline Simulation

Comparative Statics

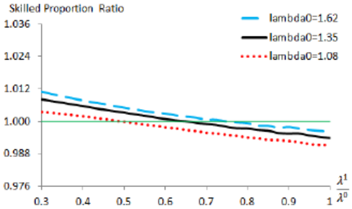


(a) Training Intensity with different λ^1

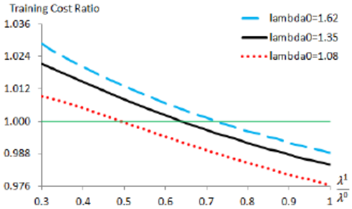
(b) Training Intensity with different (λ^0, λ^1)

Figure 5: Training Intensity

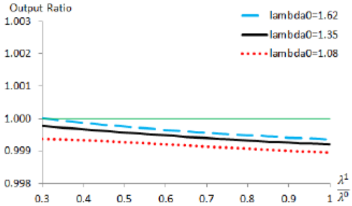
Comparative Statics



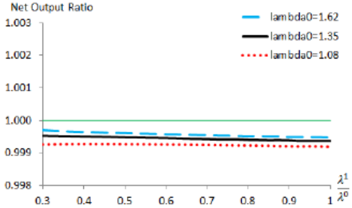
(a) The Ratio of the Skilled Proportions



(b) The Ratio of the Aggregate Training Cost



(c) The Ratio of the Aggregate Output



(d) The Ratio of the Aggregate Net Output

Figure 6: Training Intensity

Conclusion

- Human Capital Accumulation (post schooling)
  - the major contributor individual wage growth and economic growth
  - the first best outcome: Workers should pay for the cost of general training.
  - In reality,
    - only firms can provide general training in many cases and
    - workers cannot commit to staying with the training firms

  - This paper studies the coexistence of On-the-job Training and Search
    - Hump-shaped training intensity
    - over-intensified general training
    - Mitigating search friction intensifies training but improves net output.

Thanks for listening!

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