

ON-THE-JOB TRAINING AND ON-THE-JOB
SEARCH: WAGE-TRAINING-PROMOTION IN A
FRICTIONAL LABOR MARKET

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INTRODUCTION

MOTIVATION

THE MODEL

PRIMITIVES

STEADY STATE EQUILIBRIUM

NUMERICAL ANALYSIS

STEADY STATE

COMPARATIVE STATICS

CONCLUSION

MOTIVATION

- Human Capital Accumulation (post schooling)
 - the major contributor of 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.
- Research Questions:
 - Does the ME provide the efficient level of training?
 - Does the ME provide more (or less) training, as search friction is mitigated?

PREVIOUS LITERATURE

- Becker (1964): perfectly competitive labor market
 - Under perfect competition, firms provide the efficient level of training, and workers pay the training cost through low wages during training.
- Acemoglu (1997): frictional labor market
 - incorporates job-to-job transition into an ex-post bargaining model
 - positive externality for subsequent poaching firms (free rider problem)
- Sanders and Taber (2012)
 - under-investment on general human capital
 - over-investment on job specific human capital
- This paper
 - As the offer arrival rate increases, ...
 - first mover advantage? (general training but specific asset?)

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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 unskilled 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 $((w_s(p)), (w_u(p), x(p), w_s^t(p)))$.

THE BASIC MODEL

- Unemployed Workers

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

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

- Skilled Employed Workers

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

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

- 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 $\mu x(p)$.

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

THE BASIC MODEL

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

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

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

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

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 $H(\rho)$, 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 $\{(w_u(\rho), x(\rho), E_s^t(\rho)), (w_s(\rho))\}$ 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

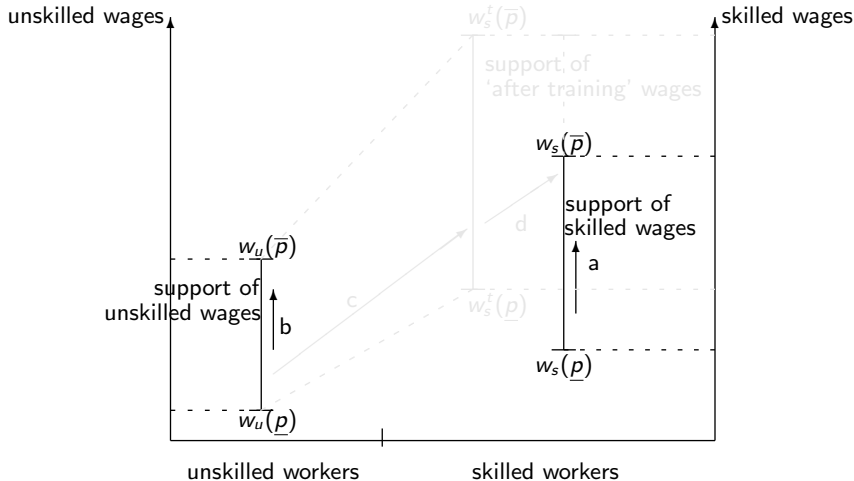


FIGURE: Equilibrium Support of Wages

STEADY STATE EQUILIBRIUM

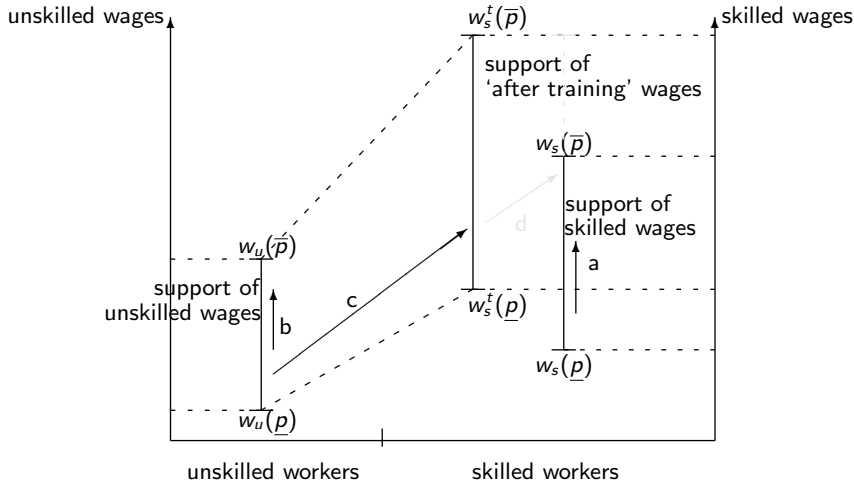


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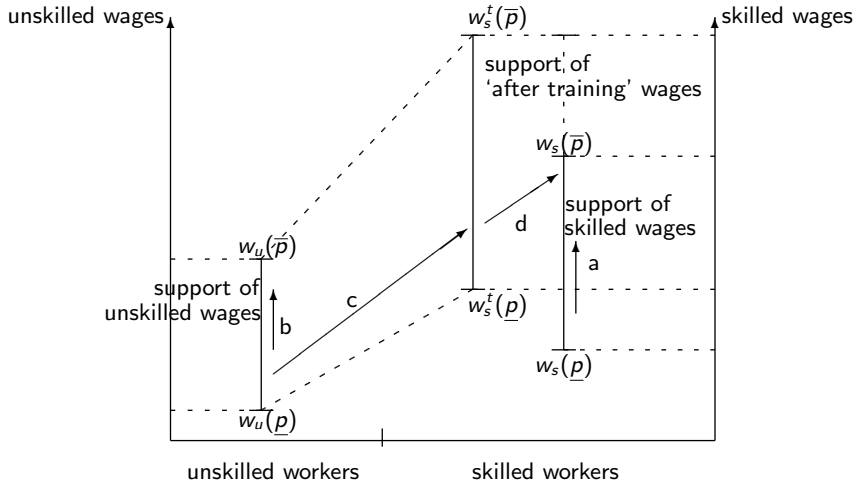


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STEADY STATE EQUILIBRIUM



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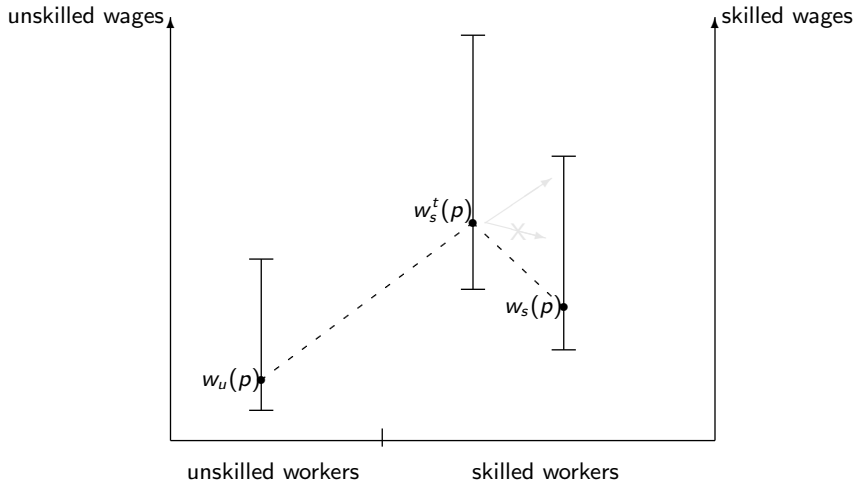


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STEADY STATE EQUILIBRIUM

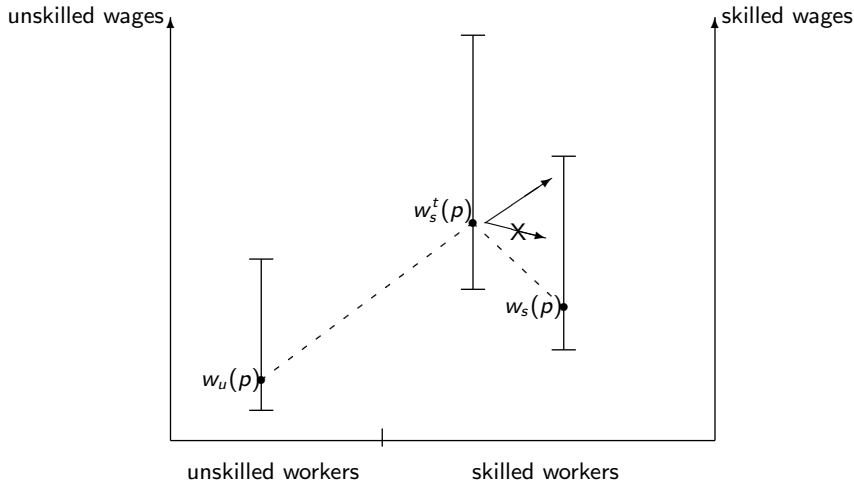


FIGURE: Equilibrium Support of Wages

STEADY STATE EQUILIBRIUM

- Proposition 1 The optimal training intensity is characterized by

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

- Training intensity $x(p)$ is well-defined.
- The right hand side is (more likely to be) positive.

STEADY STATE EQUILIBRIUM

- 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.

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

$$(r + \rho)S_u^*(p) = p - c(x^*(p)) + \delta(U_u^* - S_u^*) + \mu x^*(p)(S_s^*(p) - S_u^*(p)) \\ + \lambda^1 \int_p^{\bar{p}} [S_u^*(p') - S_u^*(p)] dH(p')$$

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

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

STEADY STATE EQUILIBRIUM

- Proposition 2 The efficiency benchmark implies that for each $p \in [\underline{p}, \bar{p}]$

$$c'(x^*(p))(r + \rho + \delta)/\mu + x^*(p)c'(x^*(p)) - c(x^*(p)) = s + \delta(U_s^* - U_u^*)$$
 - (i) $dx^*(p)/dp = 0$
 - (ii) $dx^*(p)/d\lambda^1 = 0$ and $dx^*(p)/d\lambda^0 > 0$

STEADY STATE EQUILIBRIUM

- In the market equilibrium,

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

- In the social planner's problem,

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

STEADY STATE EQUILIBRIUM

- Consider an alternative environment for a while.
 - Workers retire at rate δ and all retirees due to δ -shock are replaced with newly born unemployed workers possessing the same skills.
 - Simply, subtract δU_i from all value equations.
 - Designate by overhead $\tilde{\cdot}$ all endogenous variables associated with the alternative environment.

STEADY STATE EQUILIBRIUM

- In the market equilibrium,

$$c'(\tilde{x}(p))(r + \rho + \delta)/\mu + \tilde{x}(p)c'(\tilde{x}(p)) - c(\tilde{x}(p)) = s$$

$$+ \lambda^1 \int_{\tilde{E}_s^t(p)}^{\bar{E}_s} [z - \tilde{E}_s^t(p)] d\tilde{F}_s(z) - \lambda^1 \int_{\tilde{E}_u(p)}^{\bar{E}_u} [z - \tilde{E}_u(p) - \tilde{J}_u(p)] d\tilde{F}_u(z)$$

- In the social planner's problem,

$$c'(\tilde{x}^*(p))(r + \rho + \delta)/\mu + \tilde{x}^*(p)c'(\tilde{x}^*(p)) - c(\tilde{x}^*(p)) = s$$

- No distortion at the top (without separation shocks)
- Allocation inefficiency: deterring socially efficient job-to-job transition
- Training inefficiency: over-investment by firms with higher productivity

STEADY STATE EQUILIBRIUM



FIGURE: Equilibrium Support of Wages

STEADY STATE EQUILIBRIUM

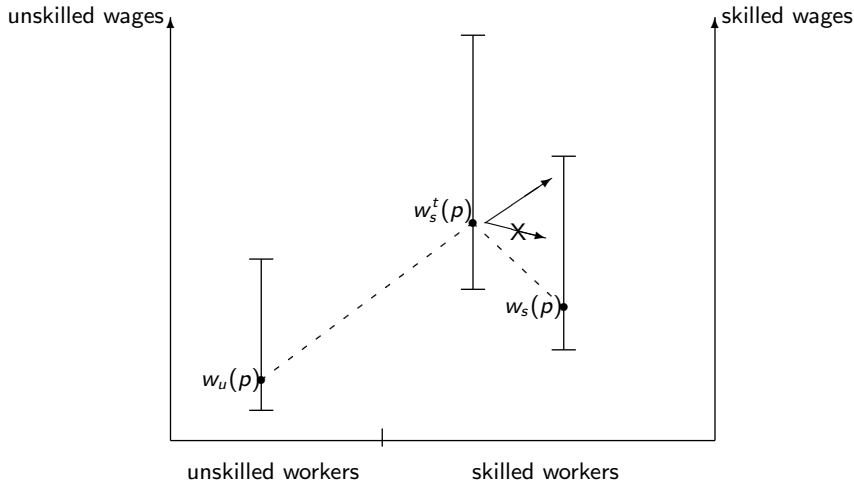


FIGURE: Equilibrium Support of Wages

STEADY STATE EQUILIBRIUM

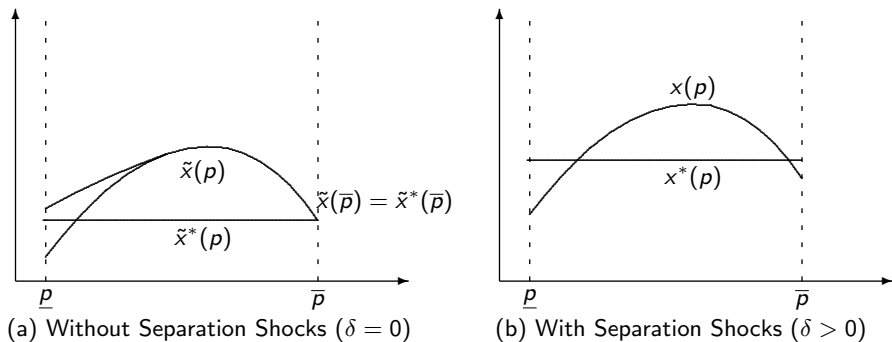


FIGURE: Training Intensity

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BASELINE SIMULATION

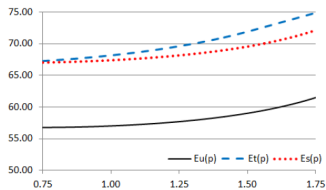
Table 1: Parameter Values

$[\underline{p} + s, \bar{p} + s] = [1.0, 2.0]$	the productivity support
$s = 0.25$	productivity improvement through training
$\eta = 1.0$	the shape parameter of $H(p)$
$\gamma = 2.0$	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
$b = 0.16$	unemployment benefit

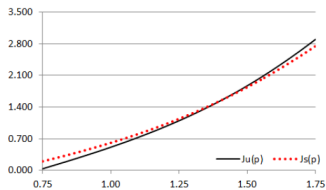
Productivity Distribution:
$$H(p) = \frac{1 - (\underline{p}/p)^\eta}{1 - (\underline{p}/\bar{p})^\eta}$$

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

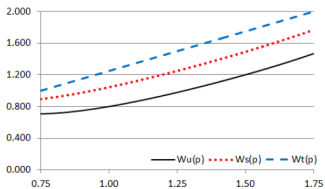
BASELINE SIMULATION



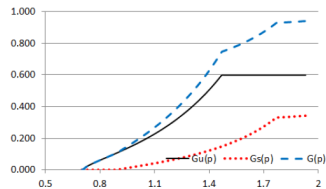
(a) Workers' Values



(b) Firms' Values



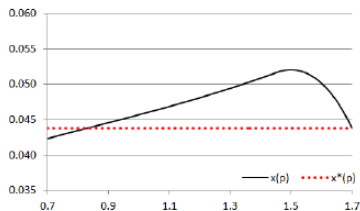
(c) Wages



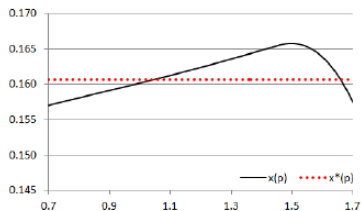
(d) The Value-earning Distribution

Figure 3: The Baseline Simulation Result

BASELINE SIMULATION



(a) In the Alternative Benchmark Setting



(b) In the Baseline Simulation

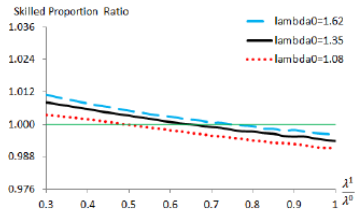
Figure 4: Training Intensity

	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

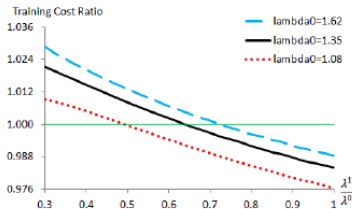
ME: the market equilibrium outcome PP: the planner's solution ME/PP: the ratio of ME to PP

Table 2: The Outcome of the Baseline Simulation

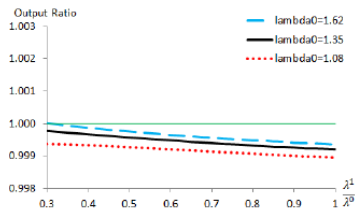
COMPARATIVE STATICS



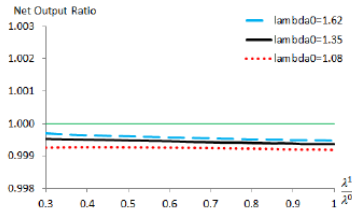
(a) The Ratio of the Skilled Proportions



(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

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- This paper studies the coexistence of on-the-job training and search.
 - Key Innovation
 - including on-the-job search by unskilled workers
 - allowing (initial) skill-dependent back-loading contracts
 - Key Channel:
 - The back-loaded compensation works, as if it were relationship-specific asset.
 - Key Implication:
 - The market equilibrium outcome, relative to the planner's outcome, get more skilled workers (training inefficiency) but less output (allocation inefficiency).
 - The aggregate efficiency loss is moderate (offsetting the positive externality).
 - The efficiency loss can be resolved, as search friction is mitigated.

Thanks for listening!

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