Learning By Doing vs. On The Job Training:
Using Variation Induced By The EITC to Test Between Models of Skill Formation

Ricardo Cossa
James Heckman
Lance Lochner

November 1999
Outline of Talk

- Motivation
- Theoretical Models of Skill Formation, Earnings, and Labor Supply
- Description of EITC
- Empirical Determination of Two Skill Formation Processes
- Simulating the Effects of the EITC on Skills
- Summary of Current Findings/Results
Motivation

Many public policy debates hinge on magnitudes of labor supply effects. Except for the work on education, little attention has been paid to impacts of public policy on skill formation. Even the work on education is partial equilibrium in character and not well integrated with economics.

Goal: To develop economically-interpretable and empirically-grounded frameworks for analyzing skill policies.
Talk Today

Focus on post-school learning and integration of labor supply and post-school learning. Four main issues in the literature.

1. Is learning rivalrous with or complementary with working? Rivalrous with or complementary with earning?

2. Do people pay for their learning? What is the form of the payment? Foregone earnings? Foregone leisure or both?

3. What is the correct price of time to include in a labor supply equation? Is the measured average wage the correct price of time?

4. What is the correct interpretation of empirical Mincer earnings equations? What do we learn from cross-section estimates?
Plan: Synthesize models; Test among competing Hypotheses using variation in EITC; Show empirical relevance of theoretical issues. Scope: Will focus on partial equilibrium results today and partially complete empirical analysis.
Point of Departure
Mincer Model of Earnings

Widely used and widely misinterpreted in the empirical literature
At least two observationally equivalent interpretations
\[ \ln W = \alpha_0 + \alpha_1 S + \alpha_2 e + \alpha_3 e^2 \]
\( S = \) schooling
\( e = \) work experience
\( \alpha_1 = \) average rate of return to schooling
\( \alpha_2, \alpha_3 = \) related to “returns to experience”
Mincer’s Justification: OJT model
Appeals to Becker-Ben Porath model
In experience class $e$, $k(e)$ earnings foregone as % of potential earnings.
Assume
1. Constant rates of return (or if heterogeneous assume independent of level of investment)
2. $k(e) = 1 - \frac{e}{E}$
   
   $E$ = maximum experience span
3. Effect of OJT (in logs) additively separable from schooling
4. $E$ independent of $S$ (functionally)
5. $r(e)$ same for all $e$

(1), (2), (3), (4) and (5) $\Rightarrow$ Mincer model
\[ \alpha_1 = r_s; \text{ rate of return to schooling} \]
\[ \alpha_2, \alpha_3 \Rightarrow r_p; \text{ rate of return to post school investment.} \]

\[ \left( \alpha_2 = \left( r_p + \frac{r_p}{2E} \right); \alpha_3 = -\frac{r_p}{2E} \right) \]

Second model empirically indistinguishable but a different economics.

\[ e = \text{cumulated work experience} \]
\[ \ln H = \alpha_2 S + \alpha_3 e + \alpha_4 e^2 \]

Huge industry devoting attention to measurement of \( e \).

Models Indistinguishable

Pricing Relationships Unclear
Goal of This Line of Work
1. Produce Economically Interpretable Earnings Equations
2. Produce Sharp Econometric Identification Theorems
General Model and Special Cases

2 Period Analyses

Worker Problem

\[
\text{MAX} \quad U(C_0, L_0) + \frac{1}{1+\rho} U(C_1, L_1)
\]

\[
C_0 + C_1 = W(H_0, 1 - L_0, \theta_0) + W(H_1, 1 - L_1, \theta_1)
\]

\[
H_1 = H_0 + F(\theta, H_0, 1 - L_0)
\]

\[\theta = \text{“quality” (investment content) of job}\]
\[(\theta_1 \equiv 0; \text{no investment in second period})\]

\[L_0 = \text{leisure in period 0}; L_1 = \text{leisure in period 1}.\]

\[H_0 = \text{initial human capital}\]

\[H_1 = \text{final human capital}\]
Spot market view of pricing of human capital services $U$ in final output. No hours premium.

$$W(H_0, 1 - L_0, \theta) = RH_0(1 - L_0) - P(\theta, 1 - L_0, H_0)$$

$$W(H_1, 1 - L_1) = RH_1(1 - L_1)$$

$P(\theta, 1 - L_0, H_0)$ is price of a job.

$R = $ rental rate on efficiency units.
Pure Becker-Ben Porath Model:

1. Leisure fixed, $L_0 = L_1 = \overline{L}$; Jobs priced out.

\[ P(\theta, 1 - L_0, H_0) = P(\theta) \]

\[ H_0 = F(\theta, H_0) + H_0 \]

Common to write $\theta = I$

(Time Spent Investing) \[ P(\theta) = RH_0 I \]

\[ W(H_0, 1 - L_0, \theta) = RH_0(1 - \overline{L}) - RH_0 I \]

Can add leisure (Heckman, 1976; Blinder-Weiss, 1976)

No change in implications of model provided

\[ P(\theta, 1 - L_0, h_0) = P(\theta, 1 - L_0) \]

\[ h_0 = 1 - L_0 - I \]

No reason $\theta$ has to be explicitly $= I$.

(Implicit prices for Job)
2. Pure LBD model in literature

\[
\frac{\partial P}{\partial (1 - L_0)} \frac{\partial P}{\partial \theta} = 0 \quad \frac{\partial F}{\partial (1 - L_0)} > 0, \quad \frac{\partial F}{\partial \theta} = 0
\]


Free lunch. Only costs of learning are leisure.

3. Many intermediate cases
Firm Side of the Problem

Two types of firms: skill producers or skill consumers

\[ \Pi = K((1 - L_0), H_0) + P(\theta, (1 - L_0), H_0) - WRH_0(1 - L_0) \]

Can get hedonic equilibrium among firms and workers

\[ D(\theta, 1 - L_0; \nu, P(\theta, 1 - L_0, H_0, R))d(\theta, 1 - L_0) = S(\theta, 1 - L_0; \eta, P(\theta, 1 - L_0, H_0, R))d(\theta, 1 - L_0) \]

Determines equilibrium pricing function.
Model 1: OJT (Becker-Ben Porath),
Skills, and Policy

Individuals maximize $u(c_0, L_0) + u(c_1, L_1)$ subject to
\[ c_0 + c_1 = (1 + \tau_0)H_0(1 - I - L_0) + (1 + \tau_1)H_1(1 - L_1) \]
\[ H_1 = H_0 + F(I) \]
\[ \text{FOC: } (1 + \tau_0)H_0 \leq (1 + \tau_1)(1 - L_1)F''(I) \]

Compensating for income effects,

• $\tau_0 = \tau_1 > 0$: Flat subsidy increases
  $h_1 = 1 - L_1$ and raises MR of $I$ ($\uparrow I, H_1$)

• $\tau_0 > \tau_1 = 0$: Period 0 subsidy raises MC
  of $I$ ($\downarrow I, H_1$)

• $\tau_1 > \tau_0 = 0$: Period 1 subsidy raises MR
  of $I$ ($\uparrow I, H_1$)

Wealth & income effects discourage work
and reduce investment
Model 2: LBD, Skills, and Policy

Individuals maximize $u(c_0, L_0) + u(c_1, L_1)$ subject to

$$c_0 + c_1 = (1 + \tau_0)H_0(1 - L_0) + (1 + \tau_1)H_1(1 - L_1)$$

$$H_1 = H_0 + \phi(1 - L_0)$$

FOCs:

$$u_2(c_0, L_0) = \lambda[H_0(1 + \tau_0) + \phi'(1 - L_0)(1 - L_1)(1 + \tau_1)]$$

$$u_2(c_1, L_1) = \lambda[H_0 + \phi(1 - L_0)](1 + \tau_1)$$

Compensating for income effects ($\lambda$ constant),

- $\tau_0 = \tau_1 > 0$: Flat subsidy increases current and future return to $h_0 = 1 - L_0$ ($\uparrow H_1$)
- $\tau_0 > \tau_1 = 0$: Period 0 subsidy raises current return to $h_0$ ($\uparrow H_1$)
- $\tau_1 > \tau_0 = 0$: Period 1 subsidy raises future return to $h_0$ ($\uparrow H_1$)

Wealth & income effects discourage work and reduce learning
Model 2′: LBD with a Market for Learning Opportunities

- Firms may offer different learning opportunities indexed by $\theta \in (\theta, \bar{\theta})$, so $\phi(1 - L_0, \theta)$ where $\frac{\partial^2 \phi}{\partial (1 - L_0) \partial \theta} > 0$.

- With fixed distribution of firm types, a market for learning will emerge.

- All old workers and young workers who expect low $L_1$ have little value for learning, $\theta$.

- Pricing function $P(\theta)$ may arise with $P'(\theta) > 0$.

- Wage earnings: $W(H_0, \theta) = H_0(1 - L_0) - P(\theta)$
Individuals choose firm type ($\theta$) according to:

$$(1 + \tau_0)P'(\theta) = (1 + \tau_1)(1 - L_1)\frac{\partial \phi(1 - L_0, \theta)}{\partial \theta}$$

- $\tau_0 = \tau_1 > 0$: Flat subsidy increases current and future return to $h_0$ and raises return to $\theta$ by increasing $h_0$ and $h_1$ ($\uparrow H_1$)
- $\tau_0 > \tau_1 = 0$ Period 0 subsidy raises current return to $h_0$ and the MC of $\theta$
- $\tau_1 > \tau_0 = 0$ Period 1 subsidy raises future return to $h_0$ and return to $\theta$ ($\uparrow H_1$)

Can equate this with OJT model if $\theta$ can be priced according to both $L_0$ and $L_1$. Otherwise, LBD and OJT are distinct! (Adding leisure breaks the equivalence result of Rosen.)
Earned Income Tax Credit

- Introduced in 1975
- In 1994, EITC outlays equaled $21.6 billion and covered about 19.1 million workers
- From 1990-94, outlays grew by 150% and number of recipients grew by 50%
- Schedule depends on number of dependent children and wage earnings
Effects of the EITC on Skills
The Intensive Margin

• OJT: Reduces investment for all but the most skilled
• LBD: Reduces learning for all but the least skilled

The Extensive Margin
• Encourages employment and, therefore, skills in both models
Distribution of Women over the EITC Schedule

• Most qualifying women did not attend college

• Most qualifying mothers are in the phase-in or phase-out regions

• Many mothers with high school diplomas do not qualify for the EITC (especially at later ages)

• Single mothers are substantially more likely to be in the phase-in region

• Women are most likely to be in the phase-in region while young
Parameterizing the Model

- Individuals live for 10 periods (5 years each corresponding to ages 18-67)
- Perfect credit markets with interest rate $r$
- Preferences:
  \[
  V(H, K) = \max_{c,L} \left\{ \frac{c^{\gamma+1}}{\gamma + 1} + \psi \frac{L^{\sigma+1}}{\sigma + 1} + \delta V'(H', K') \right\}
  \]
- OJT technology: $H_{t+1} = H_t + B(I_tH_t)^{\alpha}$
- LBD technology: $H_{t+1} = H_0 + \beta_0 X + \beta_1 X^2$ where $X = \sum_{s=1}^{t-1} (1 - L_s)$ represents total experience
- Estimate leisure preference and human capital production parameters, $\Theta$, using synthetic cohorts from CPS in 1980 (pre-EITC) assuming $r = 0.61$, $\gamma = -0.9$, and $\delta = 0.62$
- For each type of worker, choose $\Theta$ to
minimize \[ \sum_{i=1}^{n} \sum_{t=1}^{10} \left[ W_t^w (w_{i,t} - w_t(\Theta))^2 + W_t^h (h_{i,t} - h_t(\Theta))^2 \right], \]
Effects at the Intensive Margin

OJT Model:

- Large declines in $I$
- Small initial hours effects, but greater long-term declines
- Wage profiles flatten considerably
- Sizeable increases in net lifetime earnings from EITC supplement

LBD Model:

- Large declines in hours for HS grads, but small increases for non-white dropouts
- Large decline in skills among HS grads, but negligible changes for dropouts
- Wage profiles flatten for HS grads
- Smaller (than with OJT) but sizeable increases in net lifetime earnings from EITC supplement
Balancing Intensive and Extensive Margin
• Generally observe declines at intensive margin
• Increase in skills at extensive margin
• OJT predicts net declines in potential ($H$) & utilized skills ($H(1 - I - L)$)
• LBD predicts net increases in potential ($H$) & declines in utilized skills ($H(1 - L)$)
Difficulties in Empirical Estimation

• Child requirements: individuals typically covered for only 20-30 years. Alters marginal returns depending on whether individuals are on phase-out or phase-in region of the schedule when children become too old to qualify.

• Consider tax schedule, TANF, and food stamps and changes over time

• Full schedule can be regressive in some regions (non-convex budget set)

• More recent data on earnings and hours worked must account for these schedules
Summary

• Standard models of skill formation yield similar lifecycle patterns for wages and hours

• Those models yield quite different predictions of individual responses to wage subsidy policies among workers

• Responses differ based on worker skill levels and age—small average effects can mask greater individual effects

• Both models predict increases in skills from increased employment

• Effects on skills at intensive and extensive margin are of the same order of magnitude, but on net, reductions at intensive margin tend to dominate
Determining the True Skill Formation Process

In steady state, cannot identify true model from lifecycle wage and hours worked profiles.

Can we use individual responses to changes in the EITC to determine the dominant method of skill formation?

Consider a difference in differences approach comparing women with and without children before and after an EITC expansion:

- Similar trends?
- Interaction of child constraints and schedule
- Heterogeneous responses expected depending on skill level and age
- Other tax/welfare changes?
- Changes are relatively recent–have responses kicked in?
- Changes at extensive margin need to be accounted for (heterogeneity)