The Price of Experience

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Motivation

Observation: Market return to experience highly correlated with average labor market experience.

Question: To what extent do demographic trends (supply-side changes) drive changes in the market price of experience?

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Correlations:

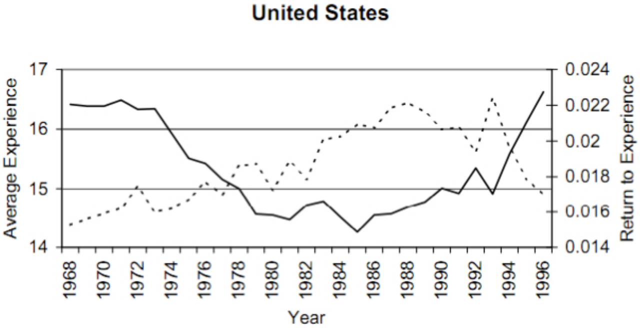
- U.S. PSID, 1968-1996: $\rho = -0.75$
- Swedish SAF, 1975-1995: $\rho = -0.97$
- Danish data, 1980-2003: $\rho = -0.80$

Market return to experience measured as β_t from Mincer wage regression in repeated cross-sections:

$$\log(w_{it}) = \beta_t \text{Experience}_{it} + \gamma_t C_{it} + \varepsilon,$$

C_{it} a vector of control variables.

Motivation, cont.



Approach

- Assume workers are endowed with two distinct and complimentary production inputs: labor and experience.
- Efficiency units of labor and experience are only inputs to production.
- Competitive market pricing: factor prices determined by marginal products.
- Relative price of experience determined by relative stock of experience to labor.
- CRS production technology: output, effective labor, and effective experience across workers consistently aggregate.
- Estimate parameters of production technology, efficiency experience/labor schedules from individual wage equation.

Evaluation

- Do model estimated parameters support hypothesis of complementarity between experience and labor?
- If so, how does "experience premium" derived from the aggregate production technology compare with that estimated from the data?

Workers

- Time is discrete
- Worker is endowed with one unit of labor each year.
- Worker of age j accumulates experience e for each year she works more than threshold $\underline{h}$:

$$e = \sum_{k=0}^{j} I(h_k > \underline{h})$$

- Effective factor inputs of agent determined by "life-efficiency schedules" that depend on age (j) and education (e)
- Labor input: $\lambda_L(j, s)$
- Experience input: $\lambda_E(j, s) \cdot e$

Workers, cont.

- Let R_{E_t} and R_{L_t} denote the market prices of experience and labor.
- Individual productivity term z_{it}
- Earnings:

$$y_{it} = [R_{L_t}\lambda_L(j_{it}, s_{it}) + R_{E_t}\lambda_E(j_{it}, s_{it})e_{it}]h_{it}z_{it}$$
$$= R_{L_t}(j_{it}, s_{it}) \left[1 + \frac{R_{E_t}}{R_{L_t}} \frac{\lambda_E(j_{it}, s_{it})}{\lambda_L(j_{it}, s_{it})} e_{it}\right] h_{it}z_{it}$$

- Experience premium: $\Pi_{E_t} \equiv \frac{R_{E_t}}{R_{L_t}}$.
- Relative life-cycle efficiency schedule of experience:

$$\lambda_{E/L}(j_{it}, s_{it}) \equiv \frac{\lambda_E(j_{it}, s_{it})}{\lambda_L(j_{it}, s_{it})}$$

Technology

- CRS production technology mapping aggregate stock of labor L_t and aggregate stock of experience E_t into aggregate earnings Y_t:

$$Y_t = A_t G(L_t, E_t)$$

  where A_t represents the aggregate productivity of the composite labor/experience input.
- Euler's theorem:

$$Y_t = A_t (G_{L_t} L_t + G_{E_t} E_t),$$

  where $G_{E_t} = \frac{\partial G}{\partial E_t}$ and $G_{L_t} = \frac{\partial G}{\partial L_t}$
- Competitive factor prices:

$$\begin{aligned} R_{L_t} &= A_t G_{L_t} \\ R_{E_t} &= A_t G_{E_t} \end{aligned}$$

Aggregation

Sum individual earnings equation over individuals i for a given t:

$$\begin{aligned}\sum_i y_{it} &= R_{L_t} \sum_i \lambda_L(j_{it}, s_{it}) z_{it} h_{it} + R_E \sum_i \lambda_E(j_{it}, s_{it}) z_{it} h_{it} e_{it} \\ &= A_t G_{L_t} L_t + A_t G_{E_t} E_t \\ &= Y_t\end{aligned}$$

where

$$\begin{aligned}L_t &= \sum_i \lambda_L(j_{it}, s_{it}) z_{it} h_{it} \\ E_t &= \sum_i \lambda_E(j_{it}, s_{it}) e_{it} z_{it} h_{it}\end{aligned}$$

Complementarity

- Assume G is CES:

$$Y_t = A_t \left(L_t^{\mu} + \delta E_t^{\mu} \right)^{\frac{1}{\mu}}$$

- $\mu \leq 1 \Rightarrow$: necessary condition for relative factor supply to determine relative factor prices.

Log wage equation

Combine aggregate production function with individual earnings equation:

$$\ln w_{it} = \ln A_t + \ln G_{L_t} + \ln \lambda_L(j_{it}, s_{it}) + \ln \left[1 + \Pi_{E_t} \lambda_{E/L}(j_{it}, s_{it}) e_{it}\right] + \ln z_{it}$$

where

$$\begin{aligned} w_t &= \frac{y_{it}}{h_{it}} \\ G_{L_t} &= \left(1 + \delta \left(\frac{E_t}{L_t}\right)^{\mu}\right)^{\frac{1}{\mu}-1} \\ \Pi_{E_t} &= \delta \left(\frac{E_t}{L_t}\right)^{\mu-1} \end{aligned}$$

Life-cycle efficiency schedules

- Life-cycle efficiency schedules for labor and experience:

$$\begin{aligned} \lambda_L(j,s) &= \exp(\lambda_{L,1}(s)j + \lambda_{L,2}(s)j^2) \\ \lambda_E(j,s) &= \exp(\lambda_{E,1}(s)j + \lambda_{E,2}(s)j^2) \end{aligned}$$

- Relative life-cycle efficiency schedule of experience:

$$\lambda_{E/L}(j,s) = \exp\left(\lambda_{E/L,1}(s)j - \lambda_{E/L,2}(s)j^2\right)$$

where

$$\begin{aligned} \lambda_{E/L,1}(s) &= \lambda_{E,1}(s) - \lambda_{L,1}(s) \\ \lambda_{E/L,2}(s) &= \lambda_{E,2}(s) - \lambda_{L,2}(s) \end{aligned}$$

- Individual productivity:

$$\ln z_{it} = \alpha_t \chi_{it}$$

where χ_{it} is a vector of observables.

Fully parametrized log wage equation

Substitute efficiency schedules into log wage equation:

$$
\begin{aligned}
\ln w_{it} = & \ln A_t + \ln G_{L_t} + \left(\lambda_{L,1}(s_{it}) j_{it} + \lambda_{L,2}(s_{it}) j_{it}^2\right) \\
& + \ln\left[1 + \delta \left(\frac{E_t}{L_t}\right)^{\mu-1} \exp\left(\lambda_{E/L,1}(s_{it}) j_{it} + \lambda_{E/L,2}(s_{it}) j_{it}^2\right) e_{it}\right] \\
& + \alpha_t \chi_{it} + \varepsilon_{it}
\end{aligned}
$$

Identification of aggregate parameters

- Given the measurement of E_t and L_t, variation of experience premium Π_{E_t} in relation to relative factor endowment $\frac{E_t}{L_t}$.
- Correlation between Π_{E_t} and $\frac{E_t}{L_t}$ identifies μ.
- Average magnitude of Π_{E_t} relative to $\frac{E_t}{L_t}$ identifies δ, subject to scale factor.
- Normalize $\lambda_E(0, s) = \lambda_L(0, s) = 1$.

Two-step estimation

First stage:
Estimate life-cycle efficiency parameters and time-varying coefficients ($\hat{\alpha}_t$, $\hat{D}_t$, and $\hat{\Pi}_{E_t}$) from the following equation:

$$\begin{aligned}\ln w_{it} = D_t &+ \left(\lambda_{L,1}(s_{it})j_{it} + \lambda_{L,2}(s_{it})j_{it}^2\right) \\ &+ \ln\left[1 + \Pi_E \exp\left(\lambda_{E/L,1}(s_{it})j_{it} + \lambda_{E/L,2}(s_{it)}j_{it}^2\right) e_{it}\right] \\ &+ \alpha_t \chi_{it} + \varepsilon_{it}\end{aligned}$$

where $D_t \equiv \ln A_t + \ln G_{L_t}$ and $\Pi_{E_t} \equiv \delta \left(\frac{E_t}{L_t}\right)^{\mu-1}$

From first-stage estimates:

- Obtain $\hat{\lambda}_E(j, s)$ from

$$\hat{\lambda}_E(j, s) = \hat{\lambda}_{E/L}(j, s)\hat{\lambda}_L(j, s)$$

- Then

$$\hat{L}_t = \sum_i \hat{\lambda}_L(j_{it}, s_{it})\hat{z}_{it}h_{it}, \quad \hat{E}_t = \sum_i \hat{\lambda}_E(j_{it}, s_{it})\hat{z}_{it}h_{it}e_{it}$$

Two-stage estimation, cont.

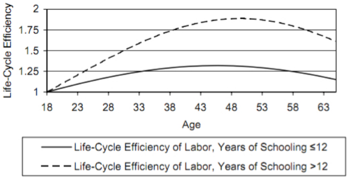
Second stage: Use first-stage estimates to estimate μ and δ from the following equation:

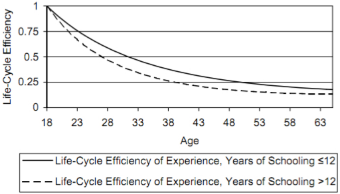
$$\ln w_{it} = \hat{D}_t + \left(\hat{\lambda}_{L,1}(s_{it})j_{it} + \hat{\lambda}_{L,2}(s_{it})j_{it}^2\right)$$
$$+ \ln\left[1 + \delta\left(\frac{\hat{E}_t}{\hat{L}_t}\right)^{\mu-1}\exp\left(\hat{\lambda}_{E/L,1}(s_{it})j_{it} + \hat{\lambda}_{E/L,2}(s_{it})j_{it}^2\right)e_{it}\right]$$
$$+ \hat{\alpha}_t\chi_{it} + \varepsilon_{it}$$

Data

- Benchmark: PSID over 1968-1996 sample period.
- Use actual experience rather than potential experience: important for separately identifying the returns to experience.
- Variation in experience premium and experience-labor ratio comes from across time.
- Robustness: U.S. census
- Impute actual experience from PSID estimates.
- Variation in experience premium and experience-labor ratio comes from across states.

Life Cycle Efficiency Schedules





Technology parameters

Table 1: PSID estimates of technology parameters.

Parameter	Second Stage		Full Estimation	
	Estimate	St. Error	Estimate	St. Error
μ	-2.352	0.061	-2.367	0.175
δ	6.931	0.447	7.028	1.354
R^2	0.926		0.926	
$RMSE$	0.596		0.596	

Correlation between experience premium $\hat{\Pi}_{E_t}$ and experience-labor ratio $\hat{E}_t/\hat{L}_t$ estimated from first stage: -0.96

Actual vs. Predicted Experience Premium

- Actual experience premium: $\hat{\Pi}_{E_t}$ estimated in the first stage.
- Predicted experience premium: Analytic expression for Π_{E_t} evaluated at estimated technology parameters $\hat{\mu}$ and $\hat{\delta}$, and estimated aggregate experience/labor ratio, $\hat{E}_t/\hat{L}_t$.
- Correlation is 0.97