Intersectoral Labor Mobility and the Growth of the Service Sector

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2006

- Estimate an equilibrium model of dynamic occupational choice.
- Include macro shocks of productivity.
- Try to explain a large shift in occupation from manufacturing sector to service sector without a sizeable difference in wage between the two sectors.
- Explains the above shift even though the mobility cost is large.

Technology

Production Function:

$$
\begin{aligned}
Y_t^j &= \zeta_t^j F^j(S_t^{jW}, S_t^{jP}, S_t^{jB}, K_t^j) \\
&= \zeta_t^j \Big\{ \alpha_{1t}^j (S_t^{jP})^{\sigma^j} + \alpha_{2t}^j (S_t^{jB})^{\sigma^j} \\
&\quad + (1 - \alpha_{1t}^j - \alpha_{2t}^j) \left[\lambda_t^j (S_t^{jW})^{\nu^j} + (1 - \lambda_t^j)(K_t^j)^{\nu^j} \right]^{(\sigma^j/\nu^j)} \Big\}^{1/\sigma^j} \\
&\quad j = G, R
\end{aligned}
$$

G: goods (manufacturing), S: service.
Skill categories for skill units S:
W: white collar
P: pink collar
B: blue collar

K: homogenous capital

ζ: productivity shock

Elasticity of Substitution

$1/(1-\nu)$: between capital and white collar skill.

$1/(1-\sigma^{j})$ between capital-white-collar input and other skills.

Productivity Dynamics

Sector specific real productivity $Z^j = p^j \zeta^j$
AR(1) type process

$$logz^j_{t+1} - logz^j_t = \phi^j_0 + \sum_{k=G,R} \phi^j_k (logz^k_t - logz^k_{t-1}) + \epsilon^j_{t+1}$$

ϵ^j_t: jointly normal.

Choice Set

- work: GB (1) , GW (2), GP (3), RB (4), RW (5), RP (6)
  Sector: goods sector (G), service sector (R)
  Occupation: blue collar (B), white collar (W), pink collar (P)
- school (7)
- leisure (8)

Preference

$$
\begin{aligned}
U_a^h \quad = \quad & \sum_{work:k=1}^{6} \gamma_k d_a^k + \gamma_{7ah} d_a^{sch} \\
& +(\gamma_{80ah} + \gamma_{81} n_{05,a}) d_a^{leis} + \gamma_9 d_a^{leis} d_{a-1}^{leis} \\
& +\gamma_{10} d_a^{sch} (1 - D_{a-1}^{sch}) I(E_a < 12) \\
& +\gamma_{11} d_a^{sch} (1 - D_{a-1}^{sch}) I(E_a \geq 12) + u(c_a^G, c_a^R)
\end{aligned}
$$

school and home utility coefficients: vary by unobserved type h.
home utility depends on number of children n_{05} under age six
γ_{10} : cost of reentering highschool.
γ_{11} : cost of reentering college.

$$\gamma_{kha} = \gamma_{kh} + \epsilon_{ka}, k = 7, 80$$

ϵ_{ka}: joint normal.

Budget Constraint

$$
\begin{aligned}
\sum_{j=G,R} p_t^j c_a^j &= \sum_{k=1}^{6} w_{at}^k d_a^k - \left[\beta_1 I(E_a \geq 12) + \beta_2 I(E_a \geq 16)\right] d_a^{sch} \\
&\quad - \sum_{k=1}^{8} \sum_{j=1}^{6} \delta_{jk} d_a^j d_{a-1}^k
\end{aligned}
$$

Income: labor income minus schooling cost minus switching cost. ($\delta_{jk} = 0$ if $j = k$)

Wage Equation

$$
\begin{aligned}
logw^j_{hat} &= logr^j_t + logs^j_{ha} \\
&= logr^j_t + \omega^j_{0h} + \omega^j_{1h} E_a + \left(\sum_{k=1}^{6} \omega^{jk}_2 X^k_a \right)^{\omega^j_3} \\
&\quad -\omega^j_4 I(a > 40)(a - 40) + \eta^j_a
\end{aligned}
$$

Transition process

Years of education: $E_a = E_{a-1} + d^{schl}_{a-1}$

Work experience: $X^j_a = X^j_{a-1} + d^j_{a-1}$

Market Clearing

Aggregate Supply and Demand

Aggregate skill supply: Individual optimal choice:

$$V_a(\Omega_{at}) = max_{d^j_{at}} \sum_{\tau=a}^{A} E\left[\rho^{\tau-a} U_\tau | \Omega_{at}\right]$$

subject to the budget constraint.
S^j_t, K^l_t satisfying
Aggregate skill demand:

$$\frac{\partial p^G_t Y^G_t(\xi^j_t, S^1_t, S^2_t, S^3_t, K^G_t)}{\partial S^j_t} = r^j_t, \ j = 1, 2, 3$$

$$\frac{\partial p^R_t Y^R_t(\xi^j_t, S^4_t, S^5_t, S^6_t, K^R_t)}{\partial S^j_t} = r^j_t \ j = 4, 5, 6$$

Aggregate capital demand:

$$\frac{\partial p_t^G Y_t^G(\xi_t^j, S_t^1, S_t^2, S_t^3, K_t^G)}{\partial K_t^G} = \frac{\partial p_t^R Y_t^R(\xi_t^j, S_t^4, S_t^5, S_t^6, K_t^R)}{\partial K_t^R} = r_t^K$$

Equilibrium

skill demand equals skill supply.

$$S_t^j = \sum_{a=16}^{65} \sum_{n=1}^{N_{at}} s_{nat}^j d_{nat}^j (r_t^1, ..., r_t^6)$$

$$j = 1, ..., 6$$

capital demand equals capital supply.

$$K_t^G + K_t^R = \overline{K_t}$$

Assume that the equilibrium skill rental rate has the following law of motion:

$$\begin{aligned} logr_{t+1}^{j} - logr_{t}^{j} &= \eta_0^j + \sum_{k=1}^{6} \eta_k^j \left[logr_t^j - logr_{t-1}^j \right] \\ &+ \eta_7^j \left[logz_{t+1}^{G} - logz_t^{G} \right] + \eta_8^j \left[logz_{t+1}^{R} - logz_t^{R} \right] \end{aligned}$$

Solve the equilibrium by estimating the parameter of the above equation.

A Simple Example

Utility function of a two period lived ($a = 1, a = 2$) consumer choosing occupation $j = G, R$ and buying goods or services:

$$U_{at}(C^G, C^R) = \delta lnC_G + (1 - \delta)lnC_R + \epsilon_j$$

subject to the budget constraint

$$p_G C_G + p_R C_R = W_j$$

Then, we know the optimal consumption to be

$$\frac{p_G C_G}{W} = \delta, \ \frac{p_R C_R}{W} = 1 - \delta$$

and the per period indirect utility to be

$$\begin{aligned} V_{at}(p_{1t}, p_{2t}) &= \delta ln\delta + (1-\delta)ln(1-\delta) + lnW_{jt} \\ &\quad -\delta lnp_G - (1-\delta)lnp_R + \epsilon_{jt} \end{aligned}$$

Hence, we can safely assume that individuals choose occupations to maximize the log wage plus the occupational specific utility shock.

That is, for the occupational choice, we can say the individual chooses occupations to maximize in period 2, i.e. $t = 2$

$$\begin{aligned} & V_2(I, r_{G,t+1}, r_{R,t+1}, v_{t+1}, \epsilon_{t+1}) \\ = \quad & Max\left\{lnW_{G2,t+1} + \epsilon_{G2,t+1}, lnW_{R2,t+1} + \epsilon_{R2,t+1}\right\} \end{aligned}$$

where

$$W_{G2,t+1} = r_{G,t+1}\left[a_G I(S_t = G) + a_R I(S_t = R)\right] + v_{G,t+1}$$

$$W_{R2,t+1} = r_{R,t+1}\left[a_G I(S_t = G) + a_R I(S_t = R)\right] + v_{R,t+1}$$

$$\begin{aligned} V \quad = \quad & Max\left\{lnW_{G1t} + \epsilon_{G1} + \beta EV_2(I, r_{G,t+1}, r_{R,t+1}, v_{t+1}, \epsilon_{t+1}),\right. \\ & \left. lnW_{R1t} + \epsilon_{R1} + \beta EV_2(I, r_{G,t+1}, r_{R,t+1}, v_{t+1}, \epsilon_{t+1})\right\} \end{aligned}$$

where

$$W_{G1t} = v_{Gt}, W_{R1t} = v_{Rt}$$

Output:Assume population is 1 in each period.

$$Y_{Gt} = z_{Gt} L_{Gt}^{\alpha_G}, \;\; Y_{Rt} = z_{Rt} L_{Rt}^{\alpha_R}$$

$$L_{Gt} = P(S_{1t} = G | r_t, r_{t+1}) + P(S_{2t} = G | r_{t-1}, r_t)$$

$$L_{Rt} = P(S_{1t} = R | r_t, r_{t+1}) + P(S_{2t} = R | r_{t-1}, r_t)$$

equilibrium price of labor:

$$r_{Gt} = \alpha_G z_{Gt} L_{Gt}^{\alpha_G - 1}, \;\; r_{Rt} = \alpha_R z_{Rt} L_{Rt}^{\alpha_R - 1}$$

Assume that equilibrium price of labor follow the below linear process

$$r_{t+1} = A r_t + B_1 z_t + B_2 z_{t+1}$$

Computing the Simple Model for T periods

1. Guess r_{1G}, r_{1R}, Draw z_1, z_2.
2. Individuals expect r_2 to be

$$r_2 = Ar_1 + B_1 z_1 + B_2 z_2$$

and the occupational choice probability is

$$P(S_{1t} = G|r_t, r_{t+1}), P(S_{2t} = G|r_{t-1}, r_t)$$

$$P(S_{1t} = R|r_t, r_{t+1}), P(S_{2t} = R|r_{t-1}, r_t)$$

where $t = 1$

3 Update the rental rate r^*_{1G}, r^*_{1R} satisfying

$$r^*_{1G} = \alpha_G z_{G1} L_{G1}^{\alpha_G - 1}, \; r^*_{1R} = \alpha_R z_{R1} L_{R1}^{\alpha_R - 1}$$

$$L_{Gt} = P(S_{1t} = G | r_t, r_{t+1}) + P(S_{2t} = G | r_{t-1}, r_t), \; t = 1$$

$$L_{Rt} = P(S_{1t} = R | r_t, r_{t+1}) + P(S_{2t} = R | r_{t-1}, r_t), \; t = 1$$

4 Set $r_1 = r^*_1$ and repeat 2,3 until convergence, i.e. r_1 and r^*_1 are close.

5 Repeat 2,3,4 for $t = 1, ..., T$. Get the labor input price sequence $r_1, r_2, ..., r_T$ given $s_1, ..., s_T$

6 Run the regression to reset the coefficient A, B_1, B_2. That is,

$$r_{t+1} = \hat{A} r_t + \hat{B}_1 z_t + \hat{B}_2 z_{t+1} + v_t$$

Computing the equilibrium

0) Set the initial skill distribution and age distribution of individuals at year 1860.
1) Set the parameters of the productivity VAR equation and the skill rental rate law of motion.

$$logz^j_{t+1} - logz^j_t = \phi^j_0 + \sum_{k=G,R} \phi^j_k (logz^k_t - logz^k_{t-1}) + \epsilon^j_{t+1}$$

$$logr_{t+1} - logr_t = f(logr_t - logr_{t-1}, \eta)$$

2) Solve for the individual dynamic choice problem.
Calculate the occupational choice probability function.

$$Pr(d_{at}|r_t, z_t, w_t, X_t, d_{a-1t})$$

3) Get the guess of the period $t = 1$ rental price r_t, productivity z_t
Calculate the skill supply for each period.
Derive the idiosyncratic wage shock to derive the wage

$$w^j_{hat} = w(r^j_t, s^j_{ha}, E_a, X_a) + \eta^j_a$$

Simulate the choices in period t, using

$$Pr(d_{at} | r_t, z_t, w_{at}, E_{at}, X_{at}, d_{a-1t}, h)$$

then aggregate them to derive the aggregate occupational labor supply.

4) Derive the new sets of equilibrium skill rental prices r_t^{j*} and productivity (ξ_t^{j*} and capital using the market clearing conditions and production function, where output is known from the data.

$$r_t^{G*} = \frac{\partial z_t^{G*} Y_t^G(S_t^1, S_t^2, S_t^3, K_t^G)}{\partial S_t^j}$$

$$r_t^{R*} = \frac{\partial z_t^{R*} Y_t^R(S_t^4, S_t^5, S_t^6, K_t^R)}{\partial S_t^j}$$

$$\frac{\partial z_t^{G*} Y_t^G(S_t^1, S_t^2, S_t^3, K_t^G)}{\partial K_t^G} = \frac{\partial z_t^{R*} Y_t^R(S_t^4, S_t^5, S_t^6, K_t^R)}{\partial K_t^R} = r_t^K$$

rental price of capital r_t^K comes from the macro data.

$$p_t^j Y_t^j = z_t^j F^j(S_t^{jW}, S_t^{jP}, S_t^{jB}, K_t^j)$$

5) Repeat 3), 4) until r_t, z_t converge, i.e. $r_t = r_t^*$, $z_t = z_t^*$. 6) Repeat 3) to 5) using $t = 2$. Repeat until $t = T$. 7) Given the sequence of r_t, z_t, $t = 1, \ldots T$, update the parameters of the rental price dynamics and productivity dynamics.

Estimation: Simulated Method of Moments

- Use both CPS (Current Population Survey), 1968-2001 and the NLSY (National Longitudinal Survey of Youth) 79. 1979-1993 for schooling, sector-occupational choice and wages.
- Use Bureau of Economic Analysis (BEA) data for output and sectoral capital stock, rental rate of capital.

Moments

Choose parameters to match the following moments from the data and model simulation.

Moments from the CPS data

CPS: Repeated cross section data.

- Career Decisions: Proportions of occupational choices by year, age, sex, schooling level, whether preschool child is present.
- The mean log hourly real wage by schooling, occupational category, year, sex, highest grade completed
- The mean 1 year difference in the log hourly real wage by occupation, sex , age.
- Variance of hourly wages by education, sector-occupation, experience and sex.

- Distribution of highest grade completed by year, age, sex.
- One period transition of occupation, school and home by year, age and sex.

Moments from the NLSY data

NLSY79: 1979-93, Panel data.

- Proportions of occupational choices by year, age, sex, initial schooling level, past occupational experience.
- The mean log hourly real wage by experience, occupation and sex.
- distribution of experience of all choices for ages 29-31, and years 1990-93

Service-manufacturing relative growth rate

	68-00	68-80	81-00
Output	2.01	1.26	2.51
Capital	0.65	-0.67	1.51
All			
Employment	2.23	2.45	2.09
Hourly wage	0.23	-0.17	0.50
White collar			
Employment	1.69	1.31	1.94
Hourly wage	0.19	0.26	0.14
Pink collar			
Employment	2.20	2.07	2.28
Hourly wage	-0.10	0.09	-0.22
Blue collar			
Employment	1.95	2.13	1.83
Hourly wage	0.08	-0.07	0.17

- High relative growth of the service sector, in terms of output and employment. Especially rapid relative growth after 1981.
- It is not accompanied by a substantial increase in hourly wage.
- Occupational Structure:
  manufacturing sector is more blue collar intensive.
  White collar worker share has increased in both sectors.
  Ratio of females among workers are higher in the service sector. In both sectors female ratio is increasing over time.