Macro II

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Announcements

- Today: frictional labor markets:
  1. summarize regularities about labor markets;
  2. give simple partial equilibrium model of labor market
- Next Tuesday (4/22): please be here on time.
- Having class eval for my tenure case.

Why are Similar Workers Paid Differently?

- Posed by Dale Mortensen in his book "Wage Dispersion"
- Abowd, Kramarz, and Margolis (1999): "That... observably equivalent individuals earn markedly different compensation and have markedly different employment histories–is one of the enduring features of empirical analyses of labor markets..."
- What are some possible reasons?
  1. Ability
  2. Selectivity

Residual Wage Dispersion

- We will look to theory to understand *residual wage dispersion*: wage/income dispersion left over after we condition on observables.
- There's a lot:
    1. Mortensen (2005): 70% of wage dispersion is unexplained.
- Understanding where this comes from is (one of) the goal of labor economics.

Unconditional Wage Dispersion across Industries

Table 1.1
Average hourly earnings (in USD) by industry, sex, and firm size (May 1983 CPS)

Industry and sex	No. of workers	In firms with an employment of 1–24	1000+	Ratio
Male		4.388	6.436	1.467
Agriculture	4,667	8.316	13.487	1.622
Mining	12,369	7.995	13.679	1.711
Construction	9,380	7.344	11.705	1.594
Manufacturing	10,300	7.761	13.096	1.687
Trans./comm.	11,541	6.253	8.438	1.349
Trade	7,433	8.437	12.588	1.492
Finance	11,696	7.526	10.020	1.331
Services	8,677			
Women		4.556	5.013	1.100
Agriculture	4,696	9.917	9.706	0.979
Mining	9,606	6.344	8.262	1.302
Construction	6,687	6.032	7.714	1.279
Manufacturing	6,880	5.722	9.787	1.710
Trans./comm.	8,697	4.403	5.269	1.197
Trade	4,858	6.193	7.538	1.217
Finance	6,902	5.955	7.759	1.303
Services	6,656			

Source: Oi and Idson (1999), Table 6.

Unexplained Variation

Wage equation coefficients by sex, May 1983 CPS[a]

Variable	Male employees			Female employees		
	Mean	β	*t*-value	Mean	β	*t*-value
Firm/plant						
Size dummies[b]						
F2SP	0.030	0.110	3.96	0.032	0.088	3.06
F3SP	0.025	0.092	3.04	0.27	0.127	4.06
F4SP	0.008	0.147	2.76	0.007	0.048	0.83
F5SP	0.051	0.117	5.17	0.040	0.131	4.96
F2LP	0.115	0.087	5.32	0.116	0.075	4.41
F3LP	0.109	0.142	8.38	0.124	0.127	7.50
F4LP	0.043	0.134	5.53	0.055	0.160	7.00
F5LP	0.353	0.245	17.90	0.316	0.232	17.00
Industry						
Agriculture	0.025	−0.351	−11.28	0.005	−0.170	−2.40
Mining	0.024	0.193	6.31	0.005	0.326	4.69
Construction	0.084	0.186	9.91	0.012	0.079	1.70
Trans./comm.	0.094	0.103	6.08	0.055	0.161	6.86
Trade	0.216	−0.129	−9.53	0.240	−0.190	−12.44
Finance	0.055	0.031	1.43	0.119	−0.006	−0.35
Service	0.162	−0.112	−7.49	0.350	−0.026	−1.84
Statistics						
R^2	0.4064			0.3352		
N	7,833			5,973		

Abowd, Kramarz, and Margolis (1999)

- Famous paper for estimating the size of worker and firm effects on residual wage dispersion.
- Longitudinal panel of matched employer-employee observations in France.
- Empirical specification:

$$
\begin{aligned}
ln(y_{it}) &= \mu_y + \theta_i + \psi_{j,t} + (x_{it} - \mu_x)\beta + \epsilon_{it} && (1) \\
y_{it} &: income && (2) \\
\mu_y &: average\ income\ in\ year\ t && (3) \\
\theta_i &: individual\ FEs && (4) \\
\psi_{j,t} &: firm\ FEs && (5)
\end{aligned}
$$

- Key findings:
  1. Individual FEs explain more than Firm FEs.
  2. Ind. FEs: 90% of inter-industry wage differentials.
  3. 75% of the firm-size wage differentials.

Abowd, Kramarz, and Margolis (1999)

- Ind. FEs strongly correlated with income, Firm FEs not as much.

Order-Independent Estimation Variable Description	Mean	Std. Dev.	Simple Correlation with: y	$x\beta$	θ	α	$u\eta$	ψ	ϕ	$s\gamma$	γ
y, Log (Real Annual Compensation, 1980 FF)	4.2575	0.5189	1.0000	0.2614	0.8962	0.8015	0.4011	0.2604	0.1603	0.2729	0.0333
$x\beta$, Predicted Effect of x Variables	0.3523	0.1464	0.2614	1.0000	−0.0445	−0.1243	0.1509	0.0697	0.0824	−0.0279	0.0300
θ, Individual Effect Including Education[a]	3.9052	0.4335	0.8962	−0.0445	1.0000	0.8964	0.4433	0.2965	0.1717	0.3384	0.0387
α, Individual Effect (Unobserved Factors)[a]	0.0000	0.3955	0.8015	−0.1243	0.8964	1.0000	0.0000	0.2640	0.1465	0.3178	0.0372
$u\eta$, Individual Effect of Education	3.9052	0.1776	0.4011	0.1509	0.4433	0.0000	1.0000	0.1349	0.0910	0.1209	0.0122
ψ, Firm Effect (Intercept and Slope)	0.0000	0.4839	0.2604	0.0697	0.2965	0.2640	0.1349	1.0000	0.9259	0.2537	0.0860
ϕ, Firm Effect Intercept	−0.0968	0.4721	0.1603	0.0824	0.1717	0.1465	0.0910	0.9259	1.0000	−0.1305	−0.0718
$s\gamma$, Firm Effect of Seniority	0.0968	0.1844	0.2729	−0.0279	0.3384	0.3178	0.1209	0.2537	−0.1305	1.0000	0.4094
γ, Firm Effect Slope	0.0157	0.0513	0.0333	0.0300	0.0387	0.0372	0.0122	0.0860	−0.0718	0.4094	1.0000

Abowd, Kramarz, and Margolis (1999)

- These are estimates of the size of firm and worker effects.
- But they are still *reduced-form*.
- We haven't identified the underlying causes of the size of each.
- What are some possible heterogeneities among workers?
- What are some possible heterogeneities among firms and industries?

Other Interesting Regularities

- Davis and Haltiwanger (1991, 1996) on the level and growth in wage-size effects and wage dispersion between plants:
  1. Plants with $> 5,000$ employees: \$3.14/hour more than plants with 25-49 in 1967.
  2. Between 1967 and 1986, real wage grew by \$1.00, but differential grew to \$6.31.
  3. Explains 40% of the between-plant wage dispersion.
  4. between-plant accounts for 59% of the total variance; within-plant accounts for 2%.
  5. Mean wage grows as plant size grows; wage dispersion falls!
- So is there wage dispersion in the economy?
- Why?

Perfectly Competitive Labor Markets

- We typically think of markets as being perfectly competitive/walrasian, etc.
- Prices are determined by the point where supply = demand, and there is no excess.
- Implications for labor market:
  1. Workers are paid $w = F_L(K, L)$, i.e., their marginal product.
  2. Zero profits in equilibrium.
- Wage dispersion *can* exist:
  1. Dispersion directly proportional to dispersion in productivity/ability/human capital, etc.

Frictional Labor Market

- But perfect competition is an approximation, both for analytical and computational simplicity.
- Things we observe:
  1. Price dispersion among identical workers/goods.
  2. Failure of markets to clear: unemployment.
  3. Profits.
- Market imperfections (frictions): agents are profit maximizing, but lack of information and randomness prevent markets from perfectly clearing.
- $w \neq F_L(K, L)$.
- Here: explore job search as explanation for (some) wage dispersion.

Outline: Frictional Labor Markets

- We'll explore the following:
  1. Partial equilibrium job search models: there is some wage distribution and workers optimize by specifying a reservation threshold.
  2. General equilibrium job search: introduce an entry decision on the firm's side and endogenize the matching rate.
  3. Efficiency and Directed search.
- Failings of the search framework:
  1. Shimer (2005): can't account for business cycle regularities.
  2. Hornstein, Krusell, Violante (2011): can't account for wage dispersion.

A Model of Sequential Search

- The first model we'll look at is called the "McCall Model" (McCall, 1970).
- Basic idea:
  1. Workers can be in one of two states: employed or unemployed, with value functions V, U.
  2. Receive job offers at exogenous rate α, no information about meeting prior.
  3. Once employed, workers remain at current job until unexogenously separated (no OTJS) at rate δ.
  4. Exogenous distribution of wages, $w \in [\underline{w}, \bar{w}], w \sim F(.)$.
  5. Linear utility: $u(c) = b$ or $u(c) = w$.
- Optimal policy is a "reservation strategy," i.e., a lower bound on the wages a worker will accept out of unemployment.
- Why is $w_R > \underline{w}$?
- What is the source of wage dispersion?

Discrete Time Formulation

- Each agent wants to maximize his discounted present value of consumption:

$$\max \sum_{t=0}^{\infty} \beta^t c_t \tag{6}$$

$$\tag{7}$$

- Some simplifying assumptions: $\alpha = 1, \delta = 0$.
- Unemployed Bellman:

$$U = b + \beta E[\max\{V, U\}] \tag{8}$$

$$U = b + \beta \int_{\underline{w}}^{\bar{w}} \max\{V, U\} dF(w) \tag{9}$$

- Employed Bellman:

$$V(w) = w + \beta V(w) \tag{10}$$

$$V(w) = \frac{w}{1 - \beta} \tag{11}$$

Reservation Strategy

- The reservation strategy is the lowest wage a worker will accept to leave unemployment.
- i.e., $V(w_R) = U$.
- Unemployed Bellman:

$$\rightarrow V(w_R) = U = \frac{w_R}{1-\beta} \tag{12}$$

$$\rightarrow \frac{w_R}{1-\beta} = b + \beta \int_{\underline{w}}^{\bar{w}} \max\{V, U\} dF(w) \tag{13}$$

$$\rightarrow \frac{w_R}{1-\beta} = b + \beta \int_{\underline{w}}^{\bar{w}} \max\{\frac{w}{1-\beta}, \frac{w_R}{1-\beta}\} dF(w) \tag{14}$$

$$\rightarrow (1-\beta) w_R = (1-\beta) b + \beta \int_{\underline{w}}^{\bar{w}} \max\{w - w_R, 0\} dF(w) \tag{15}$$

$$\rightarrow w_R = b + \frac{\beta}{1-\beta} \int_{\underline{w}}^{\bar{w}} \max\{w - w_R, 0\} dF(w) \tag{16}$$

Reservation Strategy

- Reservation strategy:

$$w_R = b + \frac{\beta}{1-\beta} \int_{\underline{w}}^{\bar{w}} \max\{w - w_R, 0\} dF(w) \qquad (17)$$

- Integrate by parts:

$$\int u dv = uv - \int v du.$$

$$\int_{w_R}^{\overline{w}} (w - w_R) dF(w) \quad \Longrightarrow \quad \begin{array}{ll} u = w - w_R & v = F(w) \\ du = dw & dv = dF(w) \end{array}$$

$$\int_{w_R}^{\overline{w}} (w - w_R) dF(w) = (w - w_R) F(w) \Big|_{w_R}^{\overline{w}} - \int_{w_R}^{\overline{w}} F(w) dw$$

$$= \int_{w_R}^{\overline{w}} [1 - F(w)] dw$$

Reservation Strategy

- Reservation strategy:

$$w_R = b + \frac{\beta}{1-\beta}\int_{w_R}^{\overline{w}}[1-F(w)]dw \tag{18}$$

- How would we solve for this?
- Assume a functional form for the distribution.
- Use root-finding algorithm to find w_R st:

$$w_R - b + \frac{\beta}{1-\beta}\int_{w_R}^{\overline{w}}[1-F(w)]dw = 0 \tag{19}$$

- Sounds like a good homework assignment!

Discrete Time Formulation

- Search models typically written in continuous time.
- Easier to work with analytically.
- Discrete time Bellman equation for Unemployment:

$$(1 + rdt)U = bdt + \alpha dtE[\max\{V, U\}] + (1 - \alpha dt)U \quad (20)$$

$$(r + \alpha)dtU = bdt + \alpha dtE[\max\{V, U\}] \quad (21)$$

$$U = \frac{bdt + \alpha dtE[\max V, U]}{(r + \alpha)dt} \quad (22)$$

- Taking limit as $dt \rightarrow 0$:

$$\frac{\partial Num.}{\partial dt} = b + \alpha E[\max\{V, U\}] \quad (23)$$

$$\frac{\partial Denom.}{\partial dt} = (r + \alpha) \quad (24)$$

$$\Rightarrow U = \frac{b + \alpha E[\max\{V, U\}]}{r + \alpha} \quad (25)$$

Existence and Uniqueness

- For simplicity, assume $V = \frac{w}{r}$, i.e. $\delta = 0$. Then,

$$U = \frac{b}{r+\alpha} + \frac{\alpha}{r+\alpha} E[\max\{\frac{w}{r}, U\}] \tag{26}$$

- $U = T(U)$ is a contraction:
  1. Discounting: $(\frac{\alpha}{r+\alpha} < 1)$.
  2. Monotonicity: $T(U)$ is nondecreasing in U.
- By Blackwell's Sufficient Conditions, this is a contraction with a unique fixed-point.

Continuous Time Formulation

- Generally, we will use the continuous time Bellman in its "asset value" formulation:

$$U = \frac{b + \alpha E[\max\{V, U\}]}{r + \alpha} \tag{27}$$

$$(r + \alpha)U = b + \alpha E[\max\{V, U\}] \tag{28}$$

$$rU = b + \alpha E[\max\{V - U, 0\}] \tag{29}$$

$$rU = b + \alpha \int_{\underline{w}}^{\bar{w}} \max\{V - U, 0\} dF(w) \tag{30}$$

- Employment:

$$rV(w) = w - \delta(V(w) - U) \tag{31}$$

- Jobs lost at rate δ.

Reservation Strategy

- Reservation wage: $V(w_R) = U$:

$$rV(w_R) = w_R - \delta(V(w_R) - U) \tag{32}$$

$$V(w_R) = U = \frac{w_R}{r} \tag{33}$$

$$\Rightarrow w_R = b + \alpha \int_{\underline{w}}^{\bar{w}} \max\{V - U, 0\} dF(w) \tag{34}$$

$$= b + \alpha \int_{\underline{w}}^{\bar{w}} \max\{\frac{w + \delta U}{r + \delta} - \frac{w_R}{r}, 0\} dF(w) \tag{35}$$

$$= b + \alpha \int_{\underline{w}}^{\bar{w}} \max\{\frac{w + \delta \frac{w_R}{r}}{r + \delta} - \frac{w_R}{r}, 0\} dF(w) \tag{36}$$

$$= b + \frac{\alpha}{r + \delta} \int_{\underline{w}}^{\bar{w}} \max\{w - w_R, 0\} dF(w) \tag{37}$$

- Note: if $\delta = 0$, identical to discrete time formulation.

Reservation Strategy II

- Truncating and integrating by parts:

$$w_R = b + \frac{\alpha}{r+\delta}\int_{\underline{w}}^{\bar{w}} \max\{w - w_R, 0\} dF(w) \tag{38}$$

$$w_R = b + \frac{\alpha}{r+\delta}\int_{w_R}^{\bar{w}} (w - w_R) dF(w) \tag{39}$$

$$\int_{w_R}^{\bar{w}} (w - w_R) dF(w) = (w - w_R)F(w)|_{w_R}^{\bar{w}} - \int_{w_R}^{\bar{w}} F(w) dw \tag{40}$$

$$= (\bar{w} - w_R)F(\bar{w}) - \cancel{(w_R - w_R)}F(w_R) \tag{41}$$

$$- \int_{w_R}^{\bar{w}} F(w) dw \tag{42}$$

$$\rightarrow w_R = b + \frac{\alpha}{r+\delta}\int_{w_R}^{\bar{w}} [1 - F(w)] dw \tag{43}$$

Hazard Rate

- What is the hazard rate of unemployment?
- Rate of leaving unemployment at time t.

$$H_u(t) = \alpha \int_{w_R}^{\bar{W}} dF(w) \tag{44}$$

$$= \alpha(F(\bar{w}) - F(w_R)) \tag{45}$$

$$= \underbrace{\alpha}_{MeetingRate} \underbrace{(1 - F(w_R))}_{Selectivity} \tag{46}$$

- Note, almost every search model generates a hazard composed of the product of a meeting probability and worker selectivity.
- This is important to remember.
- Hazard rate of employment (leaving employment for unemployment)?

$$H_e(t) = \delta \tag{47}$$

- Because separations are independent of state.

Dynamics of Unemployment

- Use hazard rates to understand dynamics and steady-state.
- What does the model predict about employment and unemployment?

$$\dot{u} = \delta(1-u) - \alpha(1-F(w_R))u \quad (48)$$

$$\dot{e} = \alpha(1-F(w_R))(1-e) - \delta e \quad (49)$$

- Steady-state: $\dot{u} = 0$, $\dot{e} = 0$:

$$0 = \delta(1-u) - \alpha(1-F(w_R))u \quad (50)$$

$$\rightarrow u = \frac{\delta}{\delta + \alpha(1-F(w_R))} \quad (51)$$

$$0 = \alpha(1-F(w_R))(1-e) - \delta e \quad (52)$$

$$\rightarrow e = \frac{\alpha(1-F(w_R))}{\alpha(1-F(w_R)) + \delta} \quad (53)$$

Next Time

- General equilibrium search model.
- Next Tuesday (4/22): please be here on time.
- Having class eval for my tenure case.