Mismatch

Katarína Borovičková

New York University

April 28, 2016

Outline

1. Shimer (2007)
2. Sahin, Song, Topa, Violante (2014)
3. Herz, van Rens (2016)

Shimer (2007): Mismatch

Introduction

- why do vacancies and unemployed workers co-exist?
- what determines the job finding rate?
- idea
  - at any point in time, skills or location of unemployed are poorly matched with vacancies
  - former unemployed steel workers remaining around a plant which closed down in the hope it reopens
- unemployed workers are attached to an occupation, location

Model

Model

- M_a workers, many firms, L_a labor markets
- workers cannot freely move across markets
- workers are risk-neutral, infinitely-lived, discount rate r
- at any time t, each worker assigned to one of L_a labor markets
  - assignment independent across time and space
  - distribution of workers is multinomial random variable
- firms create jobs
  - assigned randomly to one of the labor markets
  - $N_a(t)$ total number of jobs
  - distribution of jobs across markets is multinomial random variable
- $M \equiv M_a/L_a$, $N(t) = N_a(t)/L_a$
  - study $L_a \to \infty$ with $M > 0$ (exogenous) constant ($N(t)$ is endogenous)
  - use Poisson distribution

Distributions

- fraction of markets with $i \in \{0,1,2,\ldots\}$ workers, $j \in \{0,1,2,\ldots\}$ jobs

$$
\begin{aligned}
\tilde{\pi}(i; M) &= \frac{e^{-M} M^i}{i!} \\
\tilde{\pi}(j; N(t)) &= \frac{e^{-N(t)} N(t)^j}{j!}
\end{aligned}
$$

- these are independent thus fraction of (i,j) workers and jobs is

$$
\pi(i,j; N(t)) = \tilde{\pi}(i; M)\,\tilde{\pi}(j; N(t)) = \frac{e^{-(M+N(t))} M^i N(t)^j}{i!j!}
$$

- properties of the distribution

$$
\begin{aligned}
\frac{\partial \pi(i,j;N)}{\partial M} &= \pi(i-1,j;N) - \pi(i,j;N) \\
\frac{\partial \pi(i,j;N)}{\partial N} &= \pi(i,j-1;N) - \pi(i,j;N)
\end{aligned}
$$

Matching

- production happens in worker-job pairs: $p(t)$ units of output
- unemployed produce $z < p(t)$, vacancy produces zero
- perfect competition within a labor market
- case 1: $i > j$
  - $i - j$ unemployed, wage $w = b$
- case 2: $i < j$
  - $j - i$ vacancies, wage $w = p(t)$
- case 3: $i = j$
  - no unemployment or vacancies
  - wage indeterminate, assume $w = z$

Aggregate variables

- unemployed, vacancies

$$\begin{aligned} U(N) &= \sum_{i=1}^{\infty} \sum_{j=0}^{i} (i-j)\, \pi(i,j;N) \\ V(N) &= \sum_{j=1}^{\infty} \sum_{i=0}^{j} (j-i)\, \pi(i,j;N) \end{aligned}$$

- unemployment rate $u(N) = U(N)/M$, vacancy rate $v(N) = V(N)/N$
- share of markets with unemployed workers

$$S(N) = \sum_{i=1}^{\infty} \sum_{j=0}^{i} \pi(i,j;N)$$

- these equations hold at any instant

Flows

- worker quits according to Poisson with arrival rate q (both employed and unemployed)
- after quit, worker leaves an island, moves to a different one chosen randomly
- jobs are destroyed at rate l (layoff), job disappears
- firm can create a new job by paying $k > 0$, location assigned at random
- these processes maintain Poisson distribution across islands
- this can be verified – see next slide

Flows

- law of motion for share of islands with i workers

$$\begin{aligned}\dot{\tilde{\pi}}(i; M) &= q(i+1)\tilde{\pi}(i+1, M) + qM\tilde{\pi}(i-1, M) \\ &\quad -q(i+M)\tilde{\pi}(i; M)\end{aligned}$$

- if you substitute out $\tilde{\pi}(i; M)$ from before, you get $\dot{\tilde{\pi}}(i; M) = 0$

Flows

- law of motion for share of islands with i workers

$$\begin{aligned}\dot{\tilde{\pi}}(i;M) &= q(i+1)\tilde{\pi}(i+1,M) + qM\tilde{\pi}(i-1,M) \\ &\quad -q(i+M)\tilde{\pi}(i;M)\end{aligned}$$

- if you substitute out $\tilde{\pi}(i;M)$ from before, you get $\dot{\tilde{\pi}}(i;M) = 0$
- $n(t)$ rate of job creation: $\dot{N}(t) = n(t) - lN(t)$
- job is randomly assigned to a labor market

$$\begin{aligned}\dot{\tilde{\pi}}(j;N(t)) &= l(j+1)\tilde{\pi}(j+1,N(t)) + n(t)\tilde{\pi}(i-1;N(t)) \\ &\quad -(lj+n(t))\tilde{\pi}(j;N(t)) \\ &= \left(\frac{j}{N(t)} - 1\right)\tilde{\pi}(j;N(t))\dot{N}(t)\end{aligned}$$

- you would get this equation by differentiating $\tilde{\pi}(j;N(t))$ directly
- Poisson distribution is preserved at any instant

Aggregate shocks

- assume

$$p(t) = e^{y(t)} + \left(1 - e^{y(t)}\right)(z + (r + l)k)$$

- $y(t)$ is a jump variable which lies on a grid

$$y(t) \in Y \equiv \{-\nu\Delta, -(\nu - 1)\Delta, \ldots, 0, \ldots, (\nu - 1)\Delta, \nu\Delta\}$$

- Δ is a step size, $2\nu + 1 > 3$ is the number of grid points
- a shock hits y according to Poisson with rate λ
- then

$$y' = \begin{cases} y + \Delta & \text{with prob. } \frac{1}{2}\left(1 - \frac{y}{\nu\Delta}\right) \\ y - \Delta & \text{with prob. } \frac{1}{2}\left(1 + \frac{y}{\nu\Delta}\right) \end{cases}$$

- step size is constant, probability is not
- representation $dy = -\gamma y dt + \sigma dx$
- $\gamma = \frac{\Delta}{\nu}, \sigma = \sqrt{\lambda}\Delta$
- by construction, $p > z + (r + l)k$

Equilibrium

- only decision: how many vacancies to create
- value function

$$
\begin{aligned}
rJ_p(N) &= (p-z)\,S(N) - lJ_p(N) + J_p'(N)\,\dot{N} \\
&\quad + \lambda\left(E_p J_{p'}(N) - J_p(N)\right)
\end{aligned}
$$

Equilibrium

- only decision: how many vacancies to create
- value function

$$
\begin{aligned}
rJ_p(N) &= (p-z)\,S(N) - lJ_p(N) + J_p'(N)\,\dot{N} \\
&\quad + \lambda\left(E_p J_{p'}(N) - J_p(N)\right)
\end{aligned}
$$

- if $J_p(N) < k$: no jobs created
- if $J_p(N) > k$, jobs are created so to equalize them
- N_p^* target
  - if $N(t) > N_p^*$, no new jobs created, $\dot{N}(t) = -lN(t)$
  - if $N(t) < N_p^*$, $N_p^* - N(t)$ jobs are created, $rJ_p(N) = rk$

Equilibrium

- only decision: how many vacancies to create
- value function

$$\begin{aligned} rJ_p(N) &= (p-z)\,S(N) - lJ_p(N) + J_p'(N)\,\dot{N} \\ &\quad + \lambda\left(E_p J_{p'}(N) - J_p(N)\right) \end{aligned}$$

- if $J_p(N) < k$: no jobs created
- if $J_p(N) > k$, jobs are created so to equalize them
- N_p^* target
  - if $N(t) > N_p^*$, no new jobs created, $\dot{N}(t) = -lN(t)$
  - if $N(t) < N_p^*$, $N_p^* - N(t)$ jobs are created, $rJ_p(N) = rk$
- equilibrium is efficient (important assumption: $w = z$ if $i = j$)

Predictions of the model

The Beveridge curve

- unemployment rate

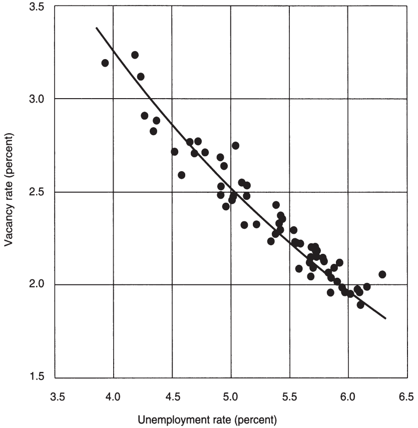
$$\frac{\partial u}{\partial \log M} = \frac{N}{M} \sum_{i=2}^{\infty} \sum_{j=0}^{i-2} \pi\left(i, j; N\right), \quad \frac{\partial u}{\partial \log N} = -\frac{N}{M} \sum_{i=1}^{\infty} \sum_{j=0}^{i-1} \pi\left(i, j; N\right)$$

- vacancy rate

$$\frac{\partial v}{\partial \log M} = -\frac{M}{N} \sum_{j=1}^{\infty} \sum_{j=0}^{i-1} \pi\left(i, j; N\right), \quad \frac{\partial v}{\partial \log N} = \frac{M}{N} \sum_{j=2}^{\infty} \sum_{i=0}^{j-2} \pi\left(i, j; N\right)$$

- p increases$\rightarrow$ N increases $\rightarrow$ $v \uparrow$ and $u \downarrow \Longrightarrow$ downward-sloping Beveridge curve
- proposition: (u, v) uniquely pin down (M, N)

The Beveridge curve



Elasticity of v-u

- elasticity of $v - u$ to p about 4.25 compared to 1.03 in Shimer(2005)
- here fixed of job creation, not flow
  - if flow costs, then vacancies would leave from markets with excess vacancies
- in search model, increase in p was absorbed by wages
  - here wage rises only in markets with vacancies
- some markets shift from having excess workers to having excess jobs, wage increases

Job finding and separation rates

- UE transition after a quit shock
  - quitting worker is employed on an island with unemployed workers
  - quitting worker is unemployed and moves to an island with vacant jobs

$$p_q^{UE}(N) \quad = \quad \frac{1}{M}\sum_{i=1}^{\infty}\sum_{j=0}^{i-1} j\pi(i,j;N) + u(N)\sum_{i=0}^{\infty}\sum_{j=i+1}^{\infty}\pi(i,j;N)$$

- EU transition after a layoff shock (only on an island with excess workers)

$$p_l^{EU}(N) = \frac{1}{N}\sum_{j=1}^{\infty}\sum_{i=1}^{\infty} j\pi(i,j;N)$$

- it holds: $p_q^{UE}(N) = p_q^{EU}(N)$, and $p_l^{UE}(N) = p_l^{EU}(N) = S(N)$

- job-finding probability, separation rate into unemployment

$$f(N) = \frac{qMp_q^{UE}(N) + lNp_l^{UE}(N)}{U(N)}, \quad s(N) = \frac{qMp_q^{EU}(N) + lNp_l^{EU}(N)}{M - U(N)}$$

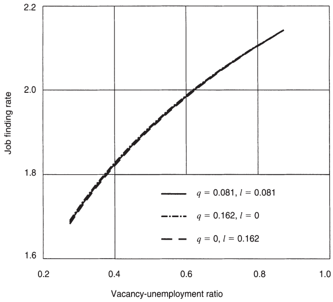
Matching function

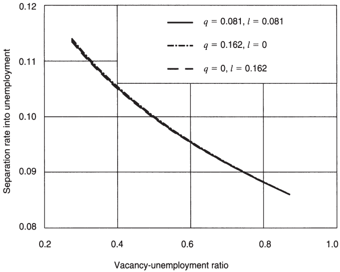
- parameters

$$\begin{aligned} M &= 244.2, \quad q = l = 0.081 \\ N &\in [233, 243] \end{aligned}$$

- findings:
  - split between q, l does not matter
  - nearly iso-elastic - will not be able to reject that the matching function is Cobb-Douglas
  - higher productivity is associated with a lower separation rate (even though q, l are constant)

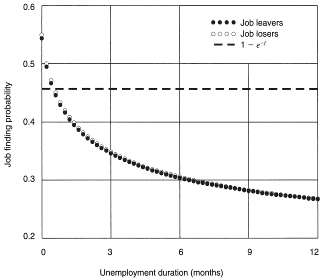
Matching function





Duration dependence

- job-finding rate of an individual depends on an island (i, j)
- longer unemployment spell – worker must be on an island with i large and j small
- short unemployment spell – worker must be on an island with i small and j large



Stochastic model

- aggregate productivity shocks, mean-reverting process
- larger volatility of $U, V, V - U, f, s$ larger than in search models
- U, V are persistent (V is a jump variable in search models)

Results

TABLE 1—SUMMARY STATISTICS, QUARTERLY US DATA, 1951 TO 2003

		U	V	V/U	f	s	p
Standard deviation		0.190	0.202	0.382	0.118	0.075	0.020
Quarterly autocorrelation		0.936	0.940	0.941	0.908	0.733	0.878
Correlation matrix	U	1	−0.894	−0.971	−0.949	0.709	−0.408
	V	—	1	0.975	0.897	−0.684	0.364
	V/U	—	—	1	0.948	−0.715	0.396
	f	—	—	—	1	−0.574	0.396
	s	—	—	—	—	1	−0.524
	p	—	—	—	—	—	1

TABLE 2—RESULTS FROM SIMULATIONS OF THE BENCHMARK MODEL[a]
(Model-generated data and standard errors)

		U	V	V/U	f	s	p
Standard deviation		0.059	0.084	0.143	0.031	0.032	0.020
		(0.008)	(0.011)	(0.019)	(0.004)	(0.004)	(0.003)
Quarterly autocorrelation		0.878	0.878	0.878	0.791	0.884	0.878
		(0.030)	(0.030)	(0.030)	(0.050)	(0.029)	(0.030)
Correlation matrix	U	1	−0.999	−1.000	−0.927	0.994	−0.999
			(0.001)	(0.000)	(0.019)	(0.001)	(0.000)
	V	—	1	1.000	0.927	−0.992	0.996
				(0.000)	(0.019)	(0.002)	(0.002)
	V/U	—	—	1	0.927	−0.993	0.997
					(0.019)	(0.001)	(0.001)
	f	—	—	—	1	−0.939	0.925
						(0.015)	(0.018)
	s	—	—	—	—	1	−0.995
							(0.001)
	p	—	—	—	—	—	1

Conclusion

- always a downward sloping Beveridge curve
- not affected by separation shocks
- micro foundation for a matching function
- duration dependence

Herz, van Rens (2016)

Introduction

- estimate mismatch unemployment in the U.S.
- evolution of the mismatch over time
- decompose into sources of mismatch
  - worker mobility costs
  - job mobility costs
  - wage setting frictions
  - heterogeneity in matching efficiency

Accounting framework

- segmented labor labor market, segments i
- matches can be created only within a submarket
- matching function within any submarket
- f_i^W, f_i^F - prob. of finding a job, and finding a worker
- S_i^W, S_i^F - surplus of a worker, and firm
- b_i^W, b_i^F - unemployment and vacancy benefits (can be negative)

Benchmark relations

- W's value of searching in submarket i

$$z_i^W = b_i^W + f_i^W S_i^W$$

- if workers can move across markets: $z_i^W = z^W$ for all i
- define deviations from mean $\bar{f}^W$:

$$\hat{f}_i^W = \frac{f_i^W - \bar{f}^W}{\bar{f}^W}$$

- rewrite the above equation in terms of deviations: worker mobility curve

$$\hat{f}_i^W + \hat{S}_i^W = -\frac{\bar{b}^W}{z^W - \bar{b}^W} \hat{b}_i^W$$

Worker mobility

- if $\hat{b}_i^W = 0$, then $\hat{f}_i^W = -\hat{S}_i^W$: jobs that are hard to get must have a high surplus
- introducing mobility costs
$$\hat{f}_i^W + \hat{S}_i^W = \alpha_i^{WM}$$
- α_i^{WM} captures mobility costs as well as dispersion in b_i^W

Job mobility

- value of a vacancy in submarket i

$$z_i^F = b_i^F + f_i^F S_i^F$$

- if no costs of reallocation of vacancies: $z_i^F = z^F$ for all i
- similar math as before

$$\hat{f}_i^F + \hat{S}_i^F = \alpha_i^{JM}$$

- α_i^{JM} captures mobility costs as well as dispersion in b_i^F

Wage determination

- benchmark: wage splits the surplus proportionately
- claim: this wage rule does not give rise to match
- Nash bargaining, with worker's bargaining power ϕ

$$S_i^W = \frac{\phi}{1-\phi} S_i^F$$

- in term of deviations

$$\hat{S}_i^W = \hat{S}_i^F + \alpha_i^{WD}$$

- α_i^{WD} captures dispersion in ϕ or a different wage setting rule

Matching technology

- Cobb-Douglas matching function

$$f_i^W = B_i \theta_i^{-\mu}, \quad f_i^F = B_i \theta_i^{1-\mu}$$

- in term of deviations

$$\hat{f}_i^F = \hat{f}_i^W + \alpha_i^{MT}$$

- α_i^{MT} captures dispersion in B, to the first order also μ

Mismatch unemployment

- combing all equations above

$$\hat{f}_i^W = (1-\mu)\left(\alpha_i^{WM} - \alpha_i^{JM} - \alpha_i^{WD} + \alpha_i^{MT}\right)$$

- terminology
  - $\hat{f}_i^W = 0$: all unemployment is search unemployment
  - $\hat{f}_i^W > 0$: some unemployment is mismatch unemployment
- how to measure contribution of $\hat{f}_i^W$ to unemployment?

Mismatch unemployment

- compute counterfactual job finding rate, $\hat{f}_i^{W,CF}$
- compute counterfactual distribution of market tightness: $\hat{\theta}_i^{CF} = \hat{f}_i^{W,CF}/(1-\mu)$
  - note: this assumes $f_i = \theta_i^{1-\mu}$, so no dispersion in B_i
- compute $\bar{\theta}$ from actual data, i.e. mean of $\theta_i = \left(f_i^W\right)^{1/(1-\mu)}$
  - impose the same mean in the actual data and in the counterfactual scenario
  - focus on effect of dispersion
- compute counterfactual distribution of $\theta_i^{CF} = \bar{\theta}(1+\hat{\theta}_i^{CF})$ and job-finding rates $f_i^{W,CF}$
- compute counterfactual average job finding rate $\bar{f}^{W,CF} = \sum_i \bar{f}_i^{W,CF}$ and unemployment rate $u^{CF} = \frac{\lambda}{\lambda+\bar{f}^{W,CF}}$
- fraction of unemployment due to mismatch is $\left(u - u^{CF}\right)/u$
- $u^{CF} < u$ iff θ_i^{CF} has a lower dispersion than θ_i (keeping the mean the same)

Mismatch accounting

- estimate all α from the data
- compute counterfactual $\hat{f}_i^{W,CF}$ if some of α is zero
- apply the above procedure

Discussion

- $\alpha_i^{WM}, \alpha_i^{JM}$ have a clear interpretation: no arbitrage condition
- $\alpha_i^{WD}, \alpha_i^{MT}$ less clear; is this mismatch?
- mismatch is estimated from dispersion in wages, profits and job finding rates

Data

- submarket: 50 states and 33 industries
- CPS data: wages, transition rates between E and U
  - for each state-year and industry-year
- data on firm profits from NIPA
- unemployment benefits: $b_{it}^{W}/w_{it} = 0.73$
- vacancy posting costs: $-b_{it}^{F}$ at 3 percent of profits
- $\mu = 0.6$, $r = 0.04$

Match surplus

- Bellman equation

$$
\begin{aligned}
(1+r)\, S_{it}^{k} &= y_{it}^{k} + E_t\left[\left(1-\tau_{it+1}^{k}\right) S_{it+1}^{k}\right] \\
\tau_{it+1}^{k} &= \lambda_{it} + f_{it}^{k} \\
y_{it}^{W} &: \quad \text{wages minus un. benefits} \\
y_{it}^{F} &: \quad \text{profits}
\end{aligned}
$$

- measure $y_{it}^{k}, \tau_{it}^{k}$ directly in the data
- assume that both follow an AR(1) process
- recursively solve the Bellman equation
- robustness checks with respect to values of AR(1)

Results

- see figures in the paper