The Macro-dynamics of Sorting between Workers and Firms

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Barcelona GSE Summer Forum
Sorting: Theory and Estimation
12-13 June, 2014

Contribution

- We develop an equilibrium random on-the-job search model of the Labor market, with ex-ante heterogeneous workers and firms, and aggregate productivity shocks
- We calibrate the model to US time-series data 1951-2007 and assess the model predictions for patterns during 2008-12 recession
- We use the model to asses the cyclicality of sorting/mismatch between workers and jobs, both for those hired from unemployment and those who were employed the period before

Contribution

- The model delivers rich dynamics in terms of the cyclical composition of
  - unemployed workers
  - vacancies
  - productive matches
  - transition rates
  - measured labor productivity
- The model has a recursive structure that implies that:
  - knowledge of the current aggregate shock (and the stochastic process) is a sufficient statistic for decisions regarding which worker-firm matches to form or dissolve, and who change jobs
  - the decision of which types of vacancies to create depends on the current distribution of worker-types among the unemployed and the current distribution of worker-types across job-types

Related Literature

Models of aggregate shocks with heterogeneity

- Directed search: Menzio & Shi (2010a,b, 2011), Kaas & Kircher (2011), Schaal (2011); Wage posting: Moscarini & Postel-Vinay (2011a,b), Coles & Mortensen (2011);

Cyclical behavior of labor productivity and labor market variables

- Shimer (2005), Hall (2005), Hagedorn & Manovskii (2008), Gertler & Trigari (2009), Hagedorn & Manovskii (2010), ...

Sorting between workers and firms (or unemployed and vacancies)

- Shimer & Smith (2001), Eekhout & Kircher (2011), Lise, Meghir, Robin (2012), Melo (2009), Bagger & Lentz (2012), Barlevey (2002), Sahin, Song, Topa & Violante (2012), Hagedorn, Law & Manovskii (2012), Mueller (2012), ...

As far as we know, there is still very little work with double-sided worker-firm heterogeneity. Yet there is a lot of interest in understanding the evolution of match quality in recessions and booms.

Agents and Technology

- Time is discrete and indexed by t.
- The planning horizon for workers and firms is infinite
- All agents are risk neutral and discount the future at rate r
- Let x, y, and z index worker type, firm type and the aggregate productivity level

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- There is a continuum of workers indexed by type $x \in [0, 1]$
  - with distribution $\ell(x)$ and home production $b(x, z)$
  - workers search both when unemployed and employed
- There is a continuum of profit maximizing firms $y \in [0, 1]$
  - type is defined by their technology $p(x, y, z)$
  - recruit by posting vacancies $v(y)$ at increasing convex cost $c[v(y)]$
  - retain workers by responding to outside offers

Aggregate States

- $u_t(x)$: the distribution of unemployed workers at the beginning of period t (prior to realization of z_t)
- $h_t(x, y)$: the distribution of worker-firm matches at the beginning of period t (prior to realization of z_t)
- z_t is updated from z_{t-1} according to $\pi(z, z')$
- The state at the beginning of period t is defined by $\{u_t(x), h_t(x, y), z_t\}$

Three Key Modeling Assumptions

1. Transferable Utility
   - Workers and firms value a wage change the same way.
2. Firms make state-contingent offers and counter-offers to workers
   - When firms contact unemployed workers, they offer them their reservation value.
   - When firms contact employed workers, they engage in Bertrand competition with current employer.
3. Firms operate constant returns to scale production and pay flow costs to recruit new workers
   - Hiring a new worker does not affect the productivity of existing matches, or the ability to hire more workers in the future.

Values and Match Surplus

- Let $W_t(w, x, y)$ be the present value to a worker of type x of receiving a wage w when employed by a firm of type y.
  - The subscript t indicates that the function depends, in general, on the aggregate state at time t : $\{u_t(x), h_t(x, y), z_t\}$

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  - The subscript t indicates that the function depends, in general, on the aggregate state at time t : $\{u_t(x), h_t(x, y), z_t\}$
- Let $B_t(x)$ be the value of unemployment
- Let $\Pi_t(w, x, y)$ be the present value to a firm of type y employing a worker of type x, paying a wage w
- The match surplus is given by

$$W_t(w, x, y) - B_t(x) + \Pi_t(w, x, y) = S_t(x, y)$$

Timing

- Within a period
  1. The aggregate shock z_t is realized, endogenous and exogenous separations occur
  2. Firms post vacancies and new meetings occur
  3. Production takes place

Separations (Layoffs)

- The aggregate state changes from $z_{t-1} = z$ to $z_t = z'$.
- All jobs such that $S_t(x,y) \leq 0$ are immediately destroyed,
- A fraction δ of the viable ones are also destroyed.
- Hence the stock of unemployed workers of type x immediately after the realization of z_t (at time $t+$) is

$$u_{t+}(x) = u_t(x) + \int \left[\mathbf{1}\{S_t(x,y) \leq 0\} + \delta \mathbf{1}\{S_t(x,y) > 0\}\right] h_t(x,y)\,\mathrm{d}y.$$

- The stock of matches of type (x,y) is

$$h_{t+}(x,y) = (1-\delta)\mathbf{1}\{S_t(x,y) > 0\} h_t(x,y).$$

Meeting Function

- The total measure of meeting at time t is given by

$$M_t = M(L_t, V_t) = \min\{\alpha\sqrt{L_t V_t}, L_t, V_t\},$$

  where $M(L_t, V_t)$ in strictly increasing in L_t and V_t and constant returns to scale.
- For the purposes of new meetings, the Labor force is defined by:

$$L_t = f(u_{t+}, h_{t+}) = s_0 \int u_{t+}(x)\,\mathrm{d}x + s_1 \iint h_{t+}(x,y)\,\mathrm{d}x\,\mathrm{d}y$$

- Firms observe the new aggregate state and choose visibility $v_t(y)$, with aggregator:

$$V_t = g(v_t) = \int v_t(y)\,\mathrm{d}y$$

Laws of Motion

For unemployment:

$$u_{t+1}(x) \quad = \quad u_{t+}(x)\left[1 - \int \lambda_{0,t}\frac{q_t v_t(y)}{M_t}\mathbf{1}\{S_t(x,y) > 0\}\,\mathrm{d}y\right]$$

For employment:

$$\begin{aligned} h_{t+1}(x,y) = h_{t+}(x,y) &+ u_{t+}(x)\lambda_{0,t}\frac{q_t v_t(y)}{M_t}\mathbf{1}\{S_t(x,y) > 0\} \\ &+ \int h_{t+}(x,y')\lambda_{1,t}\frac{q_t v_t(y)}{M_t}\mathbf{1}\{S_t(x,y) > S_t(x,y')\}\,\mathrm{d}y' \\ &- h_{t+}(x,y)\int \lambda_{1,t}\frac{q_t(y')v_t(y')}{M_t}\mathbf{1}\{S_t(x,y') > S_t(x,y)\}\,\mathrm{d}y' \end{aligned}$$

where $\lambda_{0,t}$, $\lambda_{1,t}$ and q_t are the equilibrium meeting probabilities for unemployed workers, employed workers and vacancies

Contracting and Re-contracting

Postel-Vinay & Robin (2001) and Postel-Vinay & Turon (2010)

- An unemployed worker is offered her reservation wage:

$$W_t(\phi_{0,t}(x,y),x,y) - B_t(x) = 0$$

- An employed worker is offered the minimum to outbid current (or poaching) firm,

$$W_t(\phi_{1,t}(x,y,y'),x,y) - B_t(x) = S_t(x,y'),$$

  where $S_t(x,y) > S_t(x,y')$

- After an aggregate shock the current wage w may not be viable. We assume that $w' = \phi_{2,t}(w,x,y)$ with
    - $\phi_{2,t}(w,x,y) = \phi_{0,t}(x,y)$ if $W_t(w,x,y) - B_t(x) < 0$ (Worker PC binds)
    - $\phi_{2,t}(w,x,y) = \phi_{1,t}(x,y,y)$ if $\Pi_t(w,x,y) < 0$ (Firm PC binds)
    - $\phi_{2,t}(w,x,y) = w$ otherwise (status quo)

The Match Surplus and the Aggregate State

- The *value* to the worker and the value to the firm depend on x, y, aggregate productivity z_t, and on the distributions $v_t(y)$, $u_t(x)$, and $h_t(x, y)$ (they affect the expectations of outside offers available to the worker)

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- However, the *match surplus* depends on time only through z
    - Outside offers trigger a change to the transfer between firm and worker (the wage) but leave the size of the surplus unchanged
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- We can write the surplus as

$$S(x, y, z) = s(x, y, z) + \frac{1-\delta}{1+r} \int \max\{S(x, y, z'), 0\} \pi(z, z') \, \mathrm{d}z'$$

with $s(x, y, z) = p(x, y, z) - b(x, z)$.

▸ $B_t(x)$ ▸ $W_t(w, x, y)$ ▸ $\Pi_t(w, x, y)$

Vacancy Creation and the Aggregate State

Firms choose $v_t(y)$ to maximize the return to recruiting:

$$\max_{v_t(y)} \Big\{ -c[v_t(y)] + q_t v_t(y) J_t(y) \Big\}$$

where $J_t(y)$ is the expected value of a new match

$$J_t(y) = \int \frac{s_0 u_{t+}(x)}{L_t} S(x,y,z)^+ \, \mathrm{d}x + \iint \frac{s_1 h_{t+}(x,y')}{L_t} [S(x,y,z) - S(x,y',z)]^+ \, \mathrm{d}x \, \mathrm{d}y'$$

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For cost function $c_0\left[v(y)\right] = \frac{c_0}{1+c_1} v_t(y)^{1+c_1}$ and CD meeting technology: $q_t = \alpha \theta_t^{-\omega}$ we have a closed form for vacancy creation:

$$\theta_t \equiv \frac{V_t}{L_t} = \left(\frac{\alpha}{c_0}\right)^{\frac{1}{c_1+\omega}} \left(\frac{J_t}{L_t}\right)^{\frac{c_1}{c_1+\omega}},$$

$$v_t(y) = \left(\frac{q_t J_t(y)}{c_0}\right)^{\frac{1}{c_1}}.$$

Computation of the Stochastic Search Equilibrium

1. Solve for the fixed point in $S(x, y, z)$ independently of the actual realization of aggregate productivity shocks
2. Given an initial distribution of workers across jobs and employment states, $u_0(x)$, $h_0(x, y)$ and a realized sequence of aggregate productivity shocks $\{z_0, z_1, ...\}$ we can solve for the sequence of distributions of unemployed worker types, worker-firm matches, and vacancies $\{u_{t+1}(x), h_{t+1}(x, y), v_t(y)\}_{t=0}^{T}$.

Parametric Specification

- Meeting function

$$M_t = M(L_t, V_t) = \min\left\{\alpha\sqrt{L_t V_t}, L_t, V_t\right\}, \quad \alpha > 0$$

- Vacancy costs

$$c[v_t(y)] = \frac{c_0 v_t(y)^{1+c_1}}{1+c_1}, \quad c_0 > 0, \quad c_1 > 0$$

- Value added

$$p(x, y, z) = z \times \left(p_1 + p_2 x + p_3 y + p_4 x^2 + p_5 y^2 + p_6 xy\right)$$

- Home production

$$b(x, z) = b_0 + z \times \left(b_1 x + b_2 x^2\right)$$

- Worker type distribution

$$x \sim \mathrm{Beta}(\beta_1, \beta_2)$$

Calibration

- We calibrate the model parameters by method of simulated moments
- The model is solved at a weekly frequency and the simulated data is then aggregated (exactly as the BLS and BEA data) to form quarterly moments
- From the data we remove a quadratic trend from log transformed data (1951-2007)

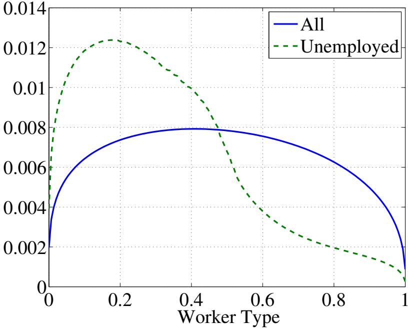
Some Comments on Identification

- α, s_1, and δ (mobility) identified by the average transition rates between unemployment and employment, between jobs, and from employment to unemployment
- σ and ρ (process for z) identified by standard deviation and auto-correlation of output
- c_0 and c_1 (vacancy costs) identified by the standard deviation of vacancies and the correlation of vacancies with output
- β_i, b_i, and p_i (heterogeneity and match production)
  - The distribution of worker types is identified by the pattern in the number of workers unemployed 5, 15 and 27 or more weeks
  - The contribution of firm type to value added is identified by the cross-sectional variation in value added per job, and its correlation with output

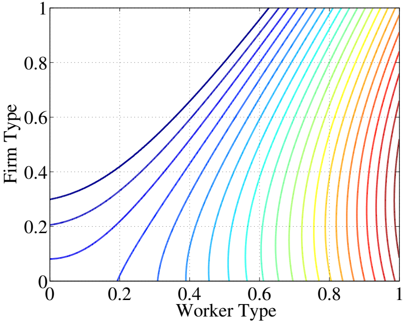
Model Fit to Moments

Moments	Data	Model	Moments	Data	Model
$\mathbb{E}[U]$	0.0562	0.0568	sd$[U]$	0.2140	0.2063
$\mathbb{E}[U^{5p}]$	0.0324	0.0339	sd$[U^{5p}]$	0.3138	0.2670
$\mathbb{E}[U^{15p}]$	0.0153	0.0148	sd$[U^{15p}]$	0.4435	0.3699
$\mathbb{E}[U^{27p}]$	0.0078	0.0064	sd$[U^{27p}]$	0.5388	0.4740
$\mathbb{E}[U2E]$	0.4376	0.4188	sd$[U2E]$	0.1257	0.1509
$\mathbb{E}[E2U]$	0.0254	0.0244	sd$[E2U]$	0.1291	0.1267
$\mathbb{E}[J2J]$	0.0273	0.0260	sd$[J2J]$	0.0924	0.1069
$\mathbb{E}$[prod. disp.]	0.7478	0.6623	sd[prod. disp.]	0.0166	0.0082
sd$[V]$	0.2291	0.1860	corr$[U, VA]$	-0.7742	-0.9406
sd$[V/U]$	0.4162	0.3722	corr$[V, VA]$	0.6372	0.9159
sd$[VA]$	0.0363	0.0379	corr$[U2E, VA]$	0.8143	0.9010
autocorr$[VA]$	0.9427	0.9553	corr$[E2U, VA]$	-0.5984	-0.5169
corr$[V, U]$	-0.7642	-0.8005	corr[prod.disp, VA]	-0.3902	-0.4552
corr$[U2E, J2J]$	0.6333	0.5526			

Parameter Estimates



Distribution of worker types

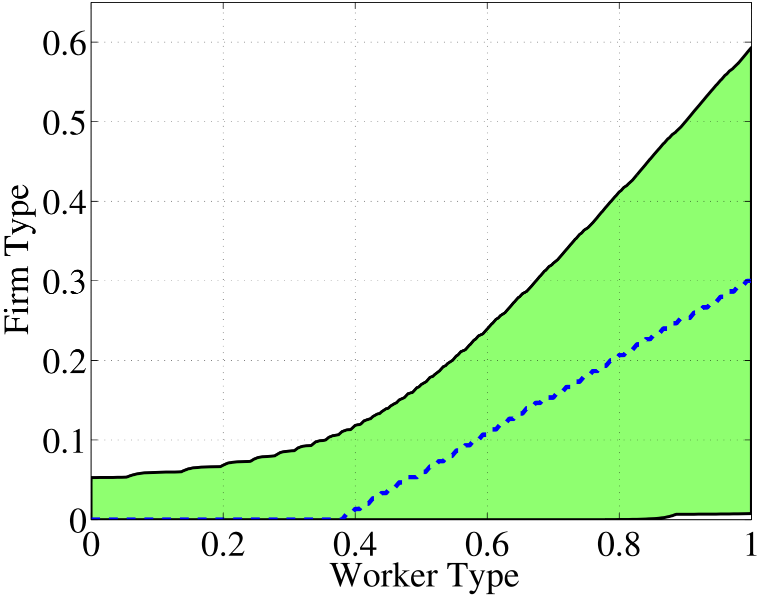


Production function

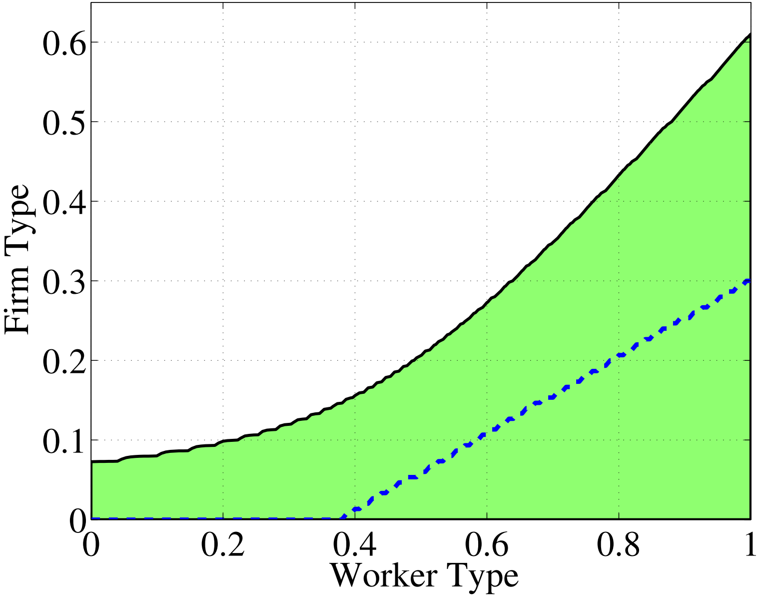
$M(L,V) = 1.89\sqrt{LV}$			$c[v(y)] = 0.03v(y)^{2.12}$		
Search intensity	s_1/s_0	0.022	$b(x,z) = 0.5 + e^z\left(-0.1x + 4.7x^2\right)$		
Exogenous separation	δ	0.007	Productivity shocks	σ	0.049
			Gaussian copula (σ,ρ)	ρ	0.999

▸ Complete Parameter Estimates   ▸ Effect of Heterogeneity Specification on Moments

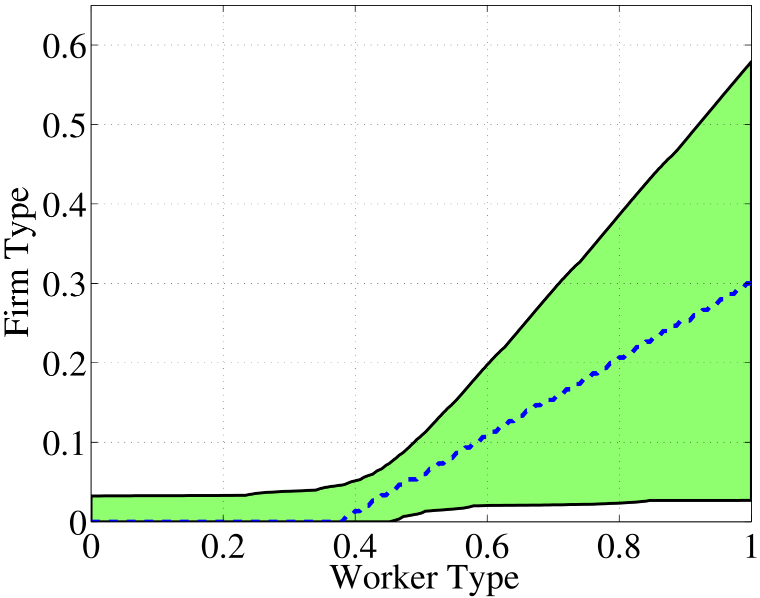
Feasible matches with aggregate shock at median



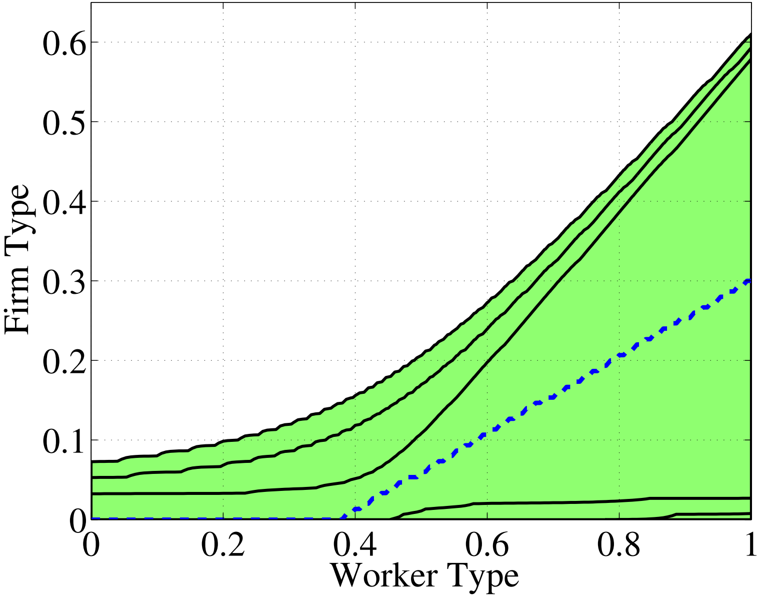
Feasible matches with aggregate shock at 90th percentile



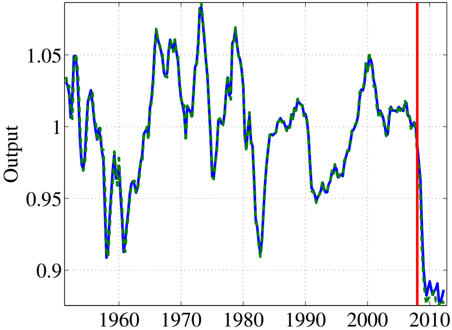
Feasible matches with aggregate shock at 10th percentile

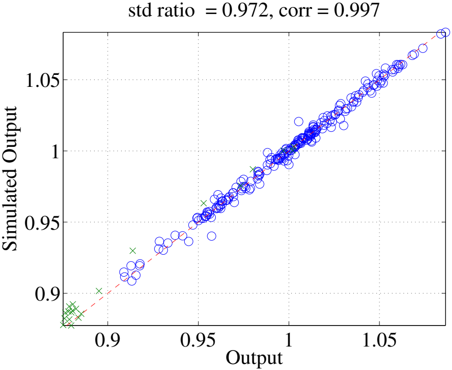


Feasible matches

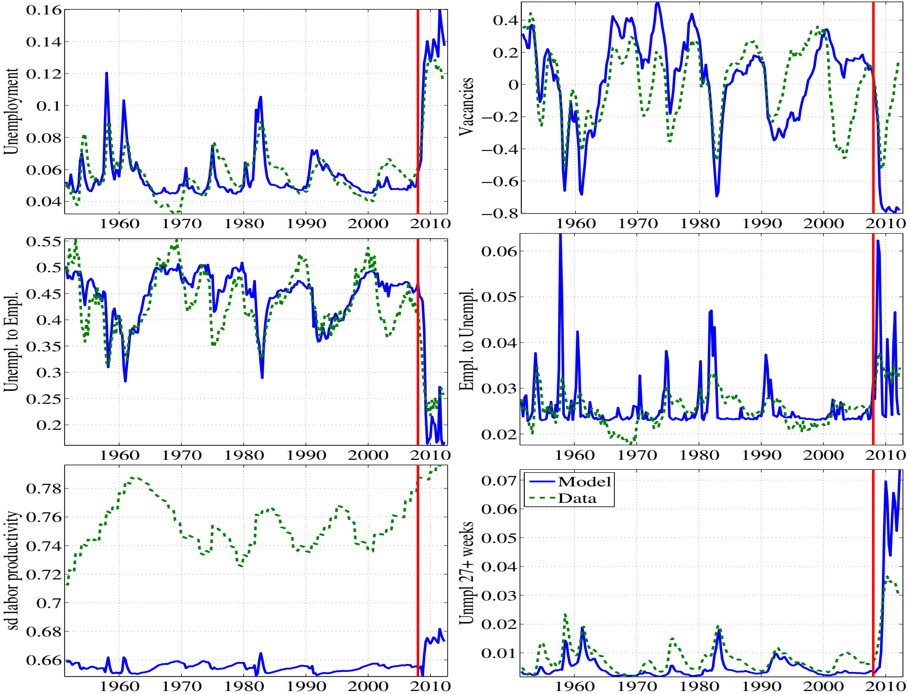


Recovering the realized shock process z_t

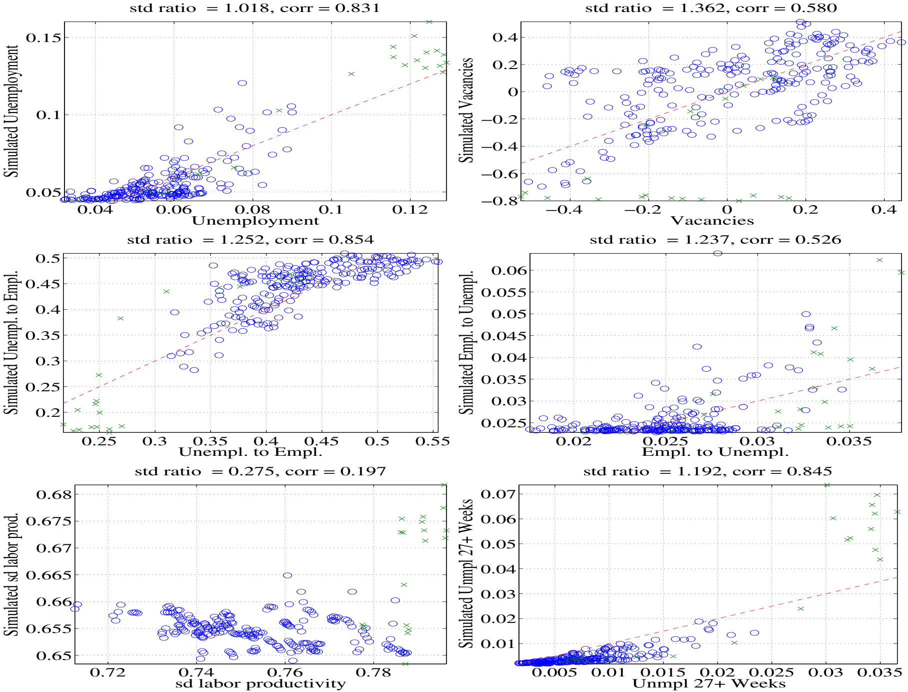




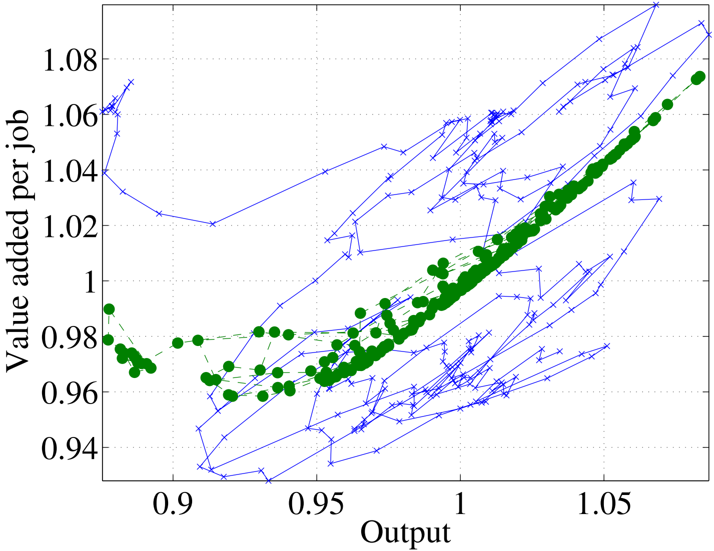
We filter out the series for z_t that best matches the output series 1951q1 to 2012q4.



Unemployment
Vacancies
Unempl. to Empl.
Empl. to Unempl.
sd labor productivity
Unmpl 27+ weeks
Model
Data

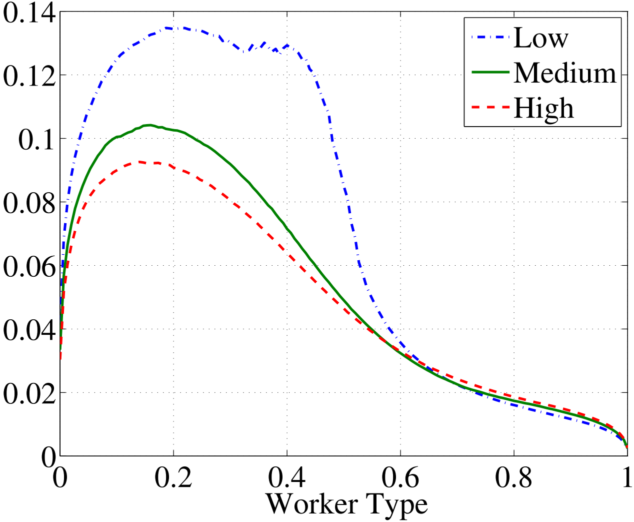

std ratio = 1.018, corr = 0.831
Simulated Unemployment
Unemployment
std ratio = 1.362, corr = 0.580
Simulated Vacancies
Vacancies
std ratio = 1.252, corr = 0.854
Simulated Unempl. to Empl.
Unempl. to Empl.
std ratio = 1.237, corr = 0.526
Simulated Empl. to Unempl.
Empl. to Unempl.
std ratio = 0.275, corr = 0.197
Simulated sd labor prod.
sd labor productivity
std ratio = 1.192, corr = 0.845
Simulated Unmpl 27+ Weeks
Unmpl 27+ Weeks

Labor Productivity and Output



Data - blue; Model prediction - green

Cyclical composition of unemployed workers



Cyclicality: low skilled 0.84, high skilled 1.23 (from regression of log unemployment rate by skill on log unemployment rate)

Relative productivity, sorting and Firms' surplus share

		Baseline	constant b	No heterogeneity
$\frac{b(x,\overline{z})}{p(x,y(x),\overline{z})}$	mean	0.9564	0.8350	0.9631
	min	0.9040	0.1780	0.9631
	max	0.9803	0.9585	0.9631
corr(x, y)		0.736	0.709	na
Firm share of surplus at matching		0.274	0.372	0.558

Mismatch (Sorting)

- Let $y(x) = \arg\max_y S_t(x,y)$

$$\begin{aligned} \text{absolute mismatch}_t &= \frac{1}{H_t^j} \int \left[S_t(x,y(x)) - S_t(x,y) \right] h_t^j(x,y)\, \mathrm{d}x\, \mathrm{d}y \\ \text{relative mismatch}_t &= \frac{1}{H_t^j} \int \left[\frac{S_t(x,y(x)) - S_t(x,y)}{S_t(x,y(x))} \right] h_t^j(x,y)\, \mathrm{d}x\, \mathrm{d}y \end{aligned}$$

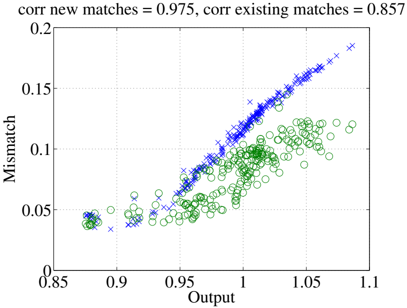
- Distribution of matches with workers hired out of unemployment

$$h_t^0(x,y) = u_{t+}(x)\lambda_{0,t} \frac{q_t v_t(y)}{M_t} \mathbf{1}\{S_t(x,y) \geq 0\}$$

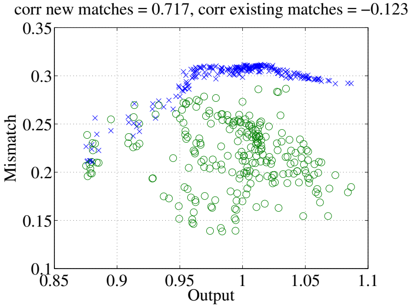
- Distribution of matches where the worker was employed last period

$$\begin{aligned} h_t^1(x,y) = h_{t+}(x,y) &\left[1 - \int \lambda_{1,t} \frac{q_t v_t(y')}{M_t} \mathbf{1}\{S_t(x,y') > S_t(x,y)\}\, \mathrm{d}y' \right] \\ &+ \int h_{t+}(x,y')\lambda_{1,t} \frac{q_t v_t(y)}{M_t} \mathbf{1}\{S_t(x,y) > S_t(x,y')\}\, \mathrm{d}y'. \end{aligned}$$

Cyclical Mismatch



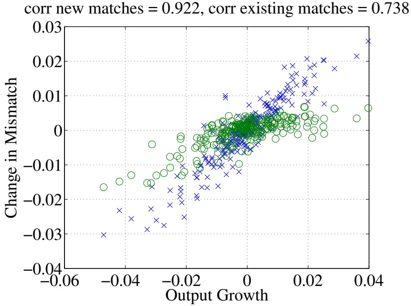
Absolute Mismatch



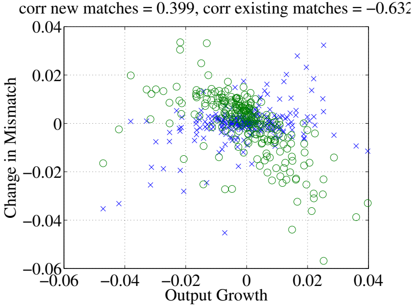
Relative Mismatch

- $\times$ - worker-job pairs where the worker was hired out of unemployment.
- $\circ$ - worker-job pairs in which the worker was employed in the previous period.

Cyclical Mismatch



Absolute Mismatch



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Summary

- We develop an equilibrium random on-the-job search model of the Labor market, with ex-ante heterogeneous workers and firms, and aggregate productivity shocks
- The model fits the US time-series data 1951-2007 and does quite well predicting the patterns over 2008-12
- In booms, workers initially accept worse matches on average than in recessions. At the same time, once employed they move more quickly to better matches in booms than in recessions

The Value of Unemployment

Consider a worker of type x who is unemployed for the whole period t.

$$B_t(x) = b(x,z) + \frac{1}{1+r}\mathbb{E}_t\Bigg[\left(1-\lambda_{0,t+1}\right)B_{t+1}\left(x\right)$$

$$+\lambda_{0,t+1}\int \max\left\{W_{t+1}(\phi_{0,t+1}(x,y),x,y),B_{t+1}\left(x\right)\right\}\frac{q_{t+1}(y)v_{t+1}(y)}{M_{t+1}}\,\mathrm{d}y\Bigg]$$

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Consider a worker of type x who is unemployed for the whole period t.

$$B_t(x) = b(x,z) + \frac{1}{1+r}\mathbb{E}_t\Bigg[\left(1-\lambda_{0,t+1}\right)B_{t+1}(x)$$
$$+\lambda_{0,t+1}\int \max\left\{W_{t+1}(\phi_{0,t+1}(x,y),x,y), B_{t+1}(x)\right\}\frac{q_{t+1}(y)v_{t+1}(y)}{M_{t+1}}\,\mathrm{d}y\Bigg]$$

Since any firm the worker contacts will offer her reservation value this simplifies to

$$B_t(x) = b(x,z) + \frac{1}{1+r}\mathbb{E}_t B_{t+1}(x).$$

Match Surplus

The Value of Employment

$$
\begin{aligned}
W_t(w,x,y) = w + \frac{1}{1+r}\mathbb{E}_t \Bigg[& \left[\mathbf{1}\{S_{t+1}(x,y) < 0\} + \delta \mathbf{1}\{S_{t+1}(x,y) \geq 0\}\right] B_{t+1}(x) \\
& + (1-\delta)\mathbf{1}\{S_{t+1}(x,y) \geq 0\} \\
\times \Bigg[\lambda_{1,t+1} \int_{y' \in \mathcal{M}_{1,t+1}(x,y)} & W_{t+1}(\phi_{1,t+1}(x,y',y),x,y') \frac{q_{t+1}(y')v_{t+1}(y')}{M_{t+1}} \,\mathrm{d}y' \\
+ \lambda_{1,t+1} \int_{y' \in \mathcal{M}_{2,t+1}(w,x,y)} & W_{t+1}(\phi_{1,t+1}(x,y,y'),x,y) \frac{q_{t+1}(y')v_{t+1}(y')}{M_{t+1}} \,\mathrm{d}y' \\
& + \left[1 - \lambda_{1,t+1} \int_{y' \in \mathcal{M}_{3,t+1}(w,x,y)} \frac{q_{t+1}(y')v_{t+1}(y')}{M_{t+1}} \,\mathrm{d}y' \right] \\
& \times \min\{W_{t+1}(w,x,y), \max\{S_{t+1}(x,y) + B_{t+1}(x), B_{t+1}(x)\}\} \Bigg]\Bigg].
\end{aligned}
$$

$\mathcal{M}_{1,t}(x,y) \equiv \{y' | S_t(x,y') > S_t(x,y)\}$,

$\mathcal{M}_{2,t}(w,x,y) \equiv \{y' | W_t(w,x,y) - B_t(x) < S_t(x,y') < S_t(x,y)$,

$\mathcal{M}_{3,t}(w,x,y) \equiv \{y' | S_t(x,y') < W_t(w,x,y) - B_t(x)\}$. Match Surplus

Firm Value

$$\Pi_t(w,x,y) = p(x,y,z) - w + \frac{1}{1+r}\mathbb{E}_t\Bigg[(1-\delta)\mathbf{1}\{S_{t+1}(x,y) \geq 0\}$$
$$\times \Bigg[\lambda_{1,t+1}\int_{y' \in \mathcal{M}_{2,t+1}(w,x,y)} \Pi_{t+1}(\phi_{1,t+1}(x,y,y'),x,y)\frac{q_{t+1}(y')v_{t+1}(y')}{M_{t+1}}\,\mathrm{d}y'$$
$$+ \Bigg[1 - \lambda_{1,t+1}\int_{y' \in \mathcal{M}_{3,t+1}(w,x,y)} \frac{q_{t+1}(y')v_{t+1}(y')}{M_{t+1}}\,\mathrm{d}y'\Bigg]$$
$$\times \min\{\Pi_{t+1}(w,x,y), S_{t+1}(x,y)^+\}\Bigg]\Bigg].$$

▸ Match Surplus

Estimated Parameters

Matching $M=\alpha\sqrt{LV}$	α	1.894	Home production	b_0	0.553
Interest rate	r	0.05	$b(x,z)=b_0+e^z$	b_1	-0.095
Search intensity	s_1/s_0	0.022	$\times\left(b_1x+b_2x^2\right)$	b_2	4.688
Vacancy posting costs	c_0	0.055	Value added	p_1	0.612
$c[v(y)]=\frac{c_0}{1+c_1}v(y)^{1+c_1}$	c_1	1.120	$p(x,y,z)=e^z$	p_2	-0.171
Exogenous separation	δ	0.007	$\times(p_1+p_2x$	p_3	-1.024
Productivity shocks	σ	0.049	$+p_3y+p_4x^2$	p_4	4.650
Gaussian copula (σ,ρ)	ρ	0.999	$+p_5y^2+p_6xy)$	p_5	-2.995
Worker heterogeneity	β_1	1.105		p_6	3.093
Beta(β_1,β_2)	β_2	1.407			

Note: r is fixed at 0.05 annually. Moments

Fitted Moments	Data	I	II	III	IV	V	VI
$\mathbb{E}[U]$	0.0562	0.0568	0.0573	0.0541	0.0549	0.0614	0.0615
$\mathbb{E}[U^{5p}]$	0.0324	0.0339	0.0348	0.0294	0.0309	0.0320	0.0312
$\mathbb{E}[U^{15p}]$	0.0153	0.0148	0.0155	0.0090	0.0103	0.0091	0.0089
$\mathbb{E}[U^{27p}]$	0.0078	0.0064	0.0067	0.0023	0.0032	0.0024	0.0029
$\mathbb{E}[U2E]$	0.4376	0.4188	0.4090	0.4680	0.4465	0.4881	0.5109
$\mathbb{E}[E2U]$	0.0254	0.0244	0.0240	0.0262	0.0254	0.0314	0.0323
$\mathbb{E}[J2J]$	0.0273	0.0260	0.0311	0.0277	0.0276	0.0382	0.0231
$\mathbb{E}$[sd labor prod]	0.7478	0.6623	0.3537	na	0.0683	0.1856	0.0953
sd$[U]$	0.2140	0.2063	0.2126	0.1731	0.1633	0.1678	0.2098
sd$[U^{5p}]$	0.3138	0.2670	0.2791	0.2728	0.2197	0.2238	0.2898
sd$[U^{15p}]$	0.4435	0.3699	0.3979	0.4647	0.3615	0.3344	0.4435
sd$[U^{27p}]$	0.5388	0.4740	0.5332	0.6823	0.5429	0.4601	0.6356
sd$[U2E]$	0.1257	0.1509	0.1599	0.1400	0.1228	0.1130	0.1655
sd$[E2U]$	0.1291	0.1267	0.1300	0.0573	0.1033	0.1335	0.1374
sd$[J2J]$	0.0924	0.1069	0.1037	0.1899	0.1285	0.1984	0.1288
sd[sd labor prod]	0.0166	0.0082	0.0063	na	0.0042	0.0009	0.0087
sd$[V]$	0.2291	0.1860	0.1163	0.2349	0.2384	0.2260	0.1777
sd$[V/U]$	0.4162	0.3722	0.3157	0.3964	0.3223	0.3147	0.3185
sd[VA]	0.0363	0.0379	0.0389	0.0384	0.0379	0.0344	0.0354
autocorr[VA]	0.9427	0.9553	0.9557	0.8804	0.9254	0.7976	0.8754
corr$[V, U]$	-0.7642	-0.8005	-0.8272	-0.8846	-0.2614	-0.2608	-0.3463
corr$[U$, VA]	-0.7742	-0.9406	-0.9528	-0.9778	-0.3586	-0.7664	-0.7380
corr$[V$, VA]	0.6372	0.9159	0.8881	0.9477	0.9315	0.7690	0.8604
corr$[U2E$, VA]	0.8143	0.9010	0.9360	0.9416	0.2102	0.4501	0.6420
corr$[E2U$, VA]	-0.5984	-0.5169	-0.4455	-0.9226	-0.2932	-0.3915	-0.3132
corr$[U2E, J2J]$	0.6333	0.5526	0.5494	0.9974	0.2857	0.5842	0.4270
corr[sd labor prod, VA]	-0.3902	-0.4552	-0.3910	na	0.7465	-0.2184	-0.2690

▸ Moments

Model (I) baseline model; (II) home production is independent of worker type and aggregate state $b(x, z) = b$; (III) no worker or firm heterogeneity; (IV) only worker heterogeneity; (V) has no production complementarities: $p_{xy} = 0$; (VI) has production of the form $p(x, y, z) = xyz$.