Job Specialization and Labor Market Turnover

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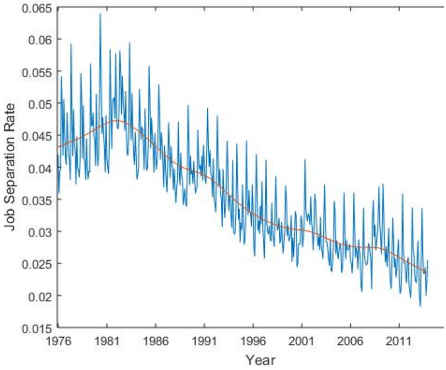
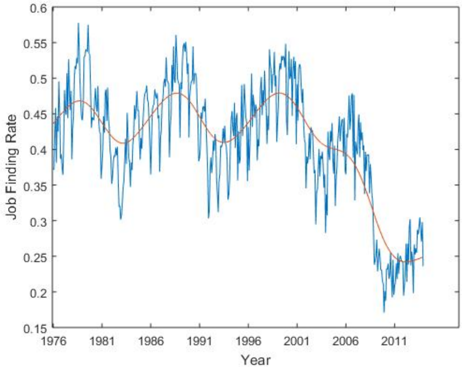
Labor Market Turnover



(a) Separation Rate



(b) Job Finding Rate

Figure: Labor Market Turnover

Firm Flows

Job Specialization

- Specialization of a job:
  - Impact of mismatch on match productivity.
  - Productivity cost of mismatch.

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  - Mismatch has no effect on productivity

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  - Productivity cost of mismatch.

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- If a job has zero specialization ($\gamma = 0$),
  - Any worker is suitable for the job
  - Mismatch has no effect on productivity
- If a job is highly specialized (high γ)
  - Mismatch has large negative effect on match productivity.
  - Mismatch is costly

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- This increase in specialization can explain more than 50% of the fall in labor market turnover.
- Decline in labor market turnover has a negative impact on aggregate labor productivity.

Mechanism

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- Cost of mismatch $\uparrow$
- Greater selectivity in match formation
- **Separation rate:** Better matches on average $\Rightarrow$ separation rate $\downarrow$
- **Job finding rate:** Takes longer to find an acceptable match $\Rightarrow$ job finding rate $\downarrow$
- **Aggregate Labor Productivity:** Mismatch $\downarrow$, but productivity cost of mismatch $\Big\uparrow$ $\Rightarrow$ Aggregate Productivity $\downarrow$

Literature

- **Worker Flows (CPS, LEHD, JOLTS)**
  - Davis et al. (2006), Fallick and Fleischman (2004), Hyatt and McEntarfer (2012), Hyatt and Spletzer (2013), Shimer (2012), Davis et al. (2010), Fujita (2015).
- **Job Flows (BED, LEHD, JOLTS)**
  - Davis et al. (2006), Faberman (2008), Hyatt and Spletzer (2013), Davis (2008), Davis et al. (2010), Davis et al. (2012), Davis and Haltiwanger (2014), Decker et al. (2014a),Decker et al. (2014b), Cairo (2013).
- **Search with Mismatch**
  - Marimon and Zilibotti (1999), Gautier et al. (2010)

Existing Theories

- **Davis et al. (2010)**
  - Decrease in job destruction rate associated with decrease in unemployment inflows
- **Fujita (2015)**
  - Increased turbulence - increased risk of skill obsolescence during unemployment.
- **Cairo (2013)**
  - Increased job specific training requirement.

Roadmap

Empirical Framework

- Empirical work involves generating two objects from the data:
  - Estimate of job specialization.
  - Distribution of employment over mismatch.

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- Empirical work involves generating two objects from the data:
  - Estimate of job specialization.
  - Distribution of employment over mismatch.
- Both involves obtaining an estimate of mismatch from the data.

Mismatch

- Distance between a worker's skills and job's skill requirements
- To estimate, need skill endowments and skill requirements
- I adopt Guvenen et al. (2016), Lise and Postel-Vinay (2016)

Mismatch

Data Sources

- Individual worker data: NLSY79
- Worker's skills: ASVAB (Armed Services Vocational Aptitude Battery)
- Job's skill requirement: O*NET (Occupation Information Network)
- 3 skill dimensions: Math, Verbal, Social

▸ ASVAB ▸ ONET

Mismatch

Definition

- Mismatch $x_{i,c}$ is given by the distance measure

$$x_{i,c} = \sum_{j=1}^{3} [\omega_j \times |\hat{a}_{i,j} - \hat{r}_{c,j}|] \tag{2}$$

- $\hat{a}_{i,j}$: endowment of worker i in skill dimension j.
- $\hat{r}_{c,j}$: requirement of skill dimension j in occupation c
- ω_j: relative importance skill dimension j

▸ Properties

Job Specialization

- For a worker i, in occupation c at time t,

$$lnw_{i,c,t} = Z'_{i,t}\chi + \phi x_{i,c,t} + \alpha_1 T_{i,c,t} + \alpha_2 E_{i,t} + \epsilon_{i,c,t} \quad (3)$$

- ϕ: estimate of job specialization
- $Z_{i,t}$: characteristics of worker i at time t
- $x_{i,c,t}$: mismatch of worker i in occupation c at time t
- $T_{i,c,t}$: tenure of worker i in occupation c at time t
- $E_{i,t}$: labor market experience of worker i at time t

Job Specialization

Benchmark

log wage	Coefficients
Mismatch	-0.3809^{***}
Skill	0.6188^{***}
Requirement	0.3432^{***}
Skill*Tenure	0.0004^{***}
Requirement*Tenure	0.0003^{***}

- Other regressors: tenure(cubic), experience(cubic), race, education, industry(1-digit), occupation(1-digit).

Cross-section

Education vs Specialization

Education ↑, Specialization ↑

- Looking at the specialization of jobs performed by workers having different education.

Workers	Specialization
High school graduate	-0.1155^{***}
College dropout	-0.1971^{***}
College graduate	-0.7292^{***}
More than college	-1.3921^{***}

Job Specialization

Specialization increased over time

- How has the specialization of jobs changed over time?

Period	Specialization
Pre – 1995	-0.2857^{***}
Post – 1995	-0.4380^{***}

- The wage loss between the best and the worst match has increased by 15pp.

Time Variation

Turnover and Specialization

Turnover ↓, Specialization ↑

Classification	Δf	Δs	$\Delta\phi$
Aggregate	-14.41	-32.06	15.23
High school graduate	-13.95	-21.36	7.18
College dropout	-14.48	-23.95	38.11
College graduate	-11.96	-19.05	63.29
More than college	-8.46	-12.12	19.55

[1] f is job finding rate, s is separation rate, ϕ is my estimate of specialization.

[2] Δf and Δs is percent change while $\Delta\phi$ is percentage point change pre and post 1995.

▸ Details

Employment Distribution

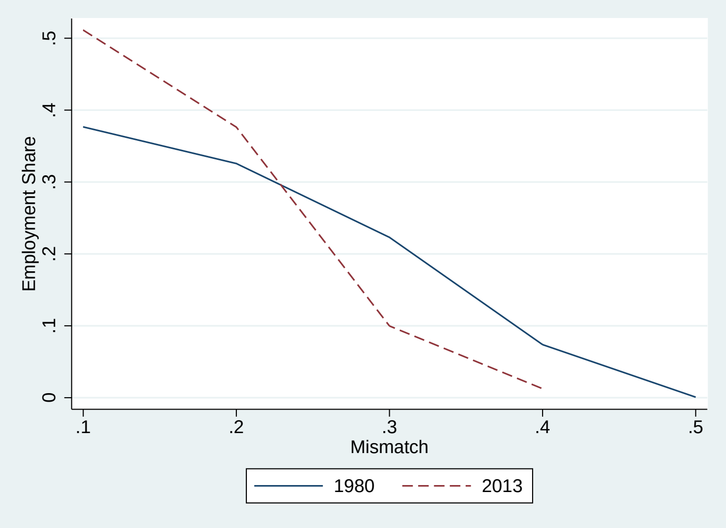
- Distribution of employment over mismatch and its evolution
- But, NLSY follows same cohort of individuals
- Control for demographic transition (cohort effects vs. time effects)

Demographic Correction

Controlling Cohort Effects

- A linear probability model for employment shares
- Regressors
  - year dummies (time effect)
  - age dummies (cohort effect)
- Time effects isolated by fixing age controls at their sample means.

Employment Distribution: 1980 vs. 2013



Construction

Roadmap

1 Empirical Framework

2 Model

3 Quantitative Analysis

4 Conclusion

Model Setup

- An equilibrium labor search model.
- Marimon and Zilibotti (1999), Gautier et al. (2010) + Match specific productivity ($\Rightarrow$ Endogenous turnover)
  - Ex-ante heterogeneous workers and firms
  - Productivity of match falls with mismatch
  - Time-varying idiosyncratic productivity shocks

Match Productivity

- A worker be located at $w \in [0, 2\pi]$ and a firm at $f \in [0, 2\pi]$.
- Mismatch x - the distance between worker and firm in the match.

$$x = \widehat{f, w} \tag{4}$$

- The productivity η of a match with mismatch x is

$$\eta(x) = 1 - \gamma x \tag{5}$$

γ - job specialization.

Labor Market Matching

- Density of vacancies at location f: $v(f)$
- Density of unemployed at location w: $u(w)$
- Random search.
- Labor Market tightness: $\theta(f, w) = v(f)/u(w)$
- Flow of interviews: $m(v(f), u(w))$
- Probability that a firm f meets a worker w: $q(f, w) = m(v(f), u(w))/v(f)$

Continuation Values

- Value of a vacant firm at the location f.

$$rV(f) = -c + \frac{1}{2\pi}\int_{f}^{f+2\pi} q(\theta(f,\tau))\ max\{J(f,\tau,\bar{\epsilon}), V(f)\}d\tau \tag{6}$$

- Value of an unemployed worker at the location w.

$$rU(w) = b + \frac{1}{2\pi}\int_{w}^{w+2\pi} \theta(\tau,w)q(\theta(\tau,w))\ [max\{W(\tau,w,\bar{\epsilon}), U(w)\} - U(w)]d\tau \tag{7}$$

Continuation Values

- Value of a filled firm

$$rJ(f,w,\epsilon) = \eta(x)\epsilon - \omega(f,w,\epsilon) + \lambda \int_0^{\bar{\epsilon}} [max\{J(f,w,z), V(f)\} - J(f,w,\epsilon)] dF(z) \tag{8}$$

- Value of an employed worker

$$rW(f,w,\epsilon) = \omega(f,w,\epsilon) + \lambda \int_0^{\bar{\epsilon}} [max\{W(f,w,z), U(w)\} - W(f,w,\epsilon)] dF(z) \tag{9}$$

Wage Determination

- Nash bargaining
- Wages of a worker $\omega(f, w, \epsilon)$ having bargaining power β satisfy

$$(1-\beta)[W(f, w, \epsilon) - U(w)] = \beta J(f, w, \epsilon) \tag{10}$$

Equilibrium

Uniform distribution of u and v

- Symmetric Equilibrium (Marimon and Zilibotti(1999), Gautier et al. (2010))
- labor market tightness: $\theta(f, w) = \theta$, $\forall f, w \in [0, 2\pi]$.
- Continuation values depend only on the mismatch

$$J(f, w, \epsilon) = J(x, \epsilon), \; W(f, w, \epsilon) = W(x, \epsilon), \; \omega(f, w, \epsilon) = \omega(x, \epsilon) \tag{11}$$

Continuation Values

Equilibrium

Equilibrium of this model is characterized by $\{\theta, \bar{x}, \epsilon^*(x)\}$

- θ: market tightness.
- $\bar{x}$: cutoff mismatch, above which firms and workers choose to walk away from their interviews.
- $\epsilon^*(x)$: cutoff productivity below which firms and workers mutually choose to separate from an existing match.

Equilibrium Equations

Labor Market Flows

- $e_x(\epsilon)$: CDF of employment with mismatch x.
- $e_x(\bar{\epsilon})$: Total employment at mismatch level x
- Aggregate employment

$$e = 2\int_0^{\bar{x}} e_x(\bar{\epsilon})dx \tag{12}$$

- Separation Rate

$$s = \frac{2\lambda \int_0^{\bar{x}} F(\epsilon^*(x))e_x(\bar{\epsilon})dx}{e} \tag{13}$$

- Job finding rate

$$f = 2\bar{x}\theta q(\theta) \tag{14}$$

▸ Labor Market Flows

Roadmap

Calibration

- The model has 10 parameters to calibrate.
- 3 parameters are chosen outside the model while the rest 7 are chosen internally.

Parameter	Value	Definition
r	0.004	Interest rate (Time period = 1 Month)
β	0.5	Worker's bargaining power
α	0.5	Elasticity of matching function

Calibration Targets

Initial Steady State

Parameter	Definition	Value	Target
c	Vacancy posting cost	0.8106	Market tightness (θ)
b	Value of leisure	0.6460	60% of aggregate output
μ	Efficiency of matching function	0.6583	Job finding rate (f)
λ	Frequency of shocks	0.0996	Separation rate (s)
σ_ϵ	Std. dev. of shocks	0.3891	Emp. share at $x = 0.1$
$\bar{\epsilon}$	Maximum shock realization	1.6033	Maximum mismatch ($\bar{x}$)
γ	Importance of mismatch	0.5135	Job specialization (ϕ)

Matching Targets

Initial Steady State

Target	Data	Model	Source
Market tightness (θ)	0.72	0.80	Pissarides (2009)
Job finding rate (f)	0.44	0.4425	CPS
Separation rate (s)	0.0418	0.0426	CPS
Emp. share at $x = 0.1$	0.3767	0.3479	NLSY
Maximum mismatch ($\bar{x}$)	0.4	0.3758	NLSY
Job specialization (ϕ)	-0.2857	-0.2849	NLSY

Increase in Specialization

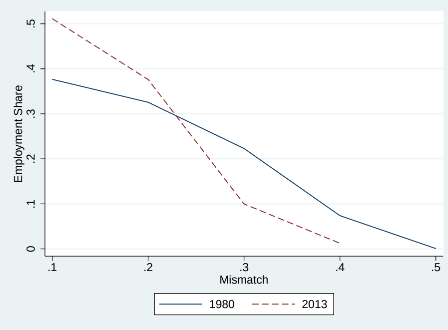
Final Steady State

- Increase job specialization by increasing the mismatch parameter γ to match the regression coefficient.

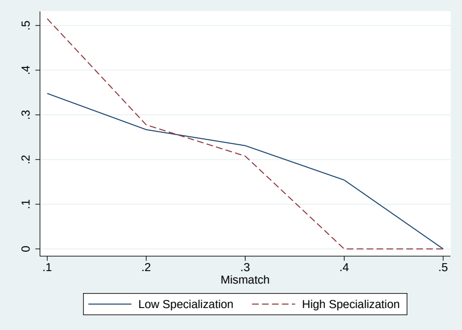
γ	Data	Model	Source
0.5137	-0.2857	-0.2849	NLSY (1980-1995)
0.773	-0.4380	-0.4380	NLSY (1996-2013)

[1] Data and Model moments are the regression coefficients of log wages on mismatch.

Employment Distribution



(a) Data



(b) Model

Figure: Employment Distribution

Details

Result

	High Turnover	Low Turnover
Data	*CPS (1980-1995)*	*CPS (1996-2013)*
f	**0.44**	**0.30**
s	0.0418	0.0284
$\bar{x}$	0.40	0.37
u	0.07	0.06
Model	$\gamma = 0.5135$	$\gamma = 0.773$
f	**0.44**	**0.33**
s	0.0426	0.0345
$\bar{x}$	0.38	0.29
u	0.088	0.095

Table: Increase in Job Specialization

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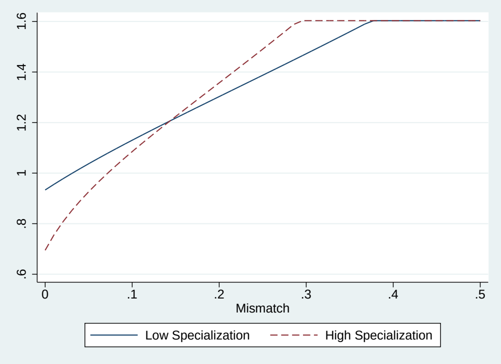
Table: Increase in Job Specialization

Mechanism

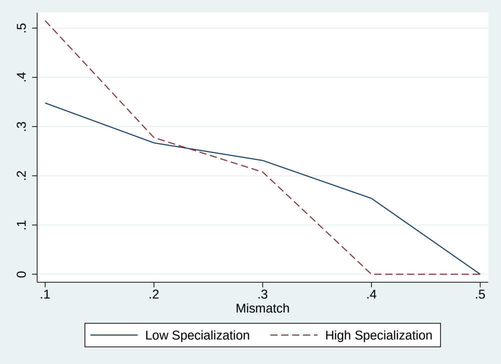
Separation Rate: Cutoff Productivity



- Separation rate of good matches fall - more difficult to get a better match in the future.
- Separation rate of bad matches rise - the cost of mismatch has increased.

Mechanism

Separation Rate: Employment Distribution



- More firms and workers move to better matches.
- Majority - lower separation rate, Minority - higher separation rate
- Aggregate separation rate falls.

Mechanism

Job finding rate

- Increased selectivity in match formation
- More difficult to find an acceptable match
- Job finding rate falls.

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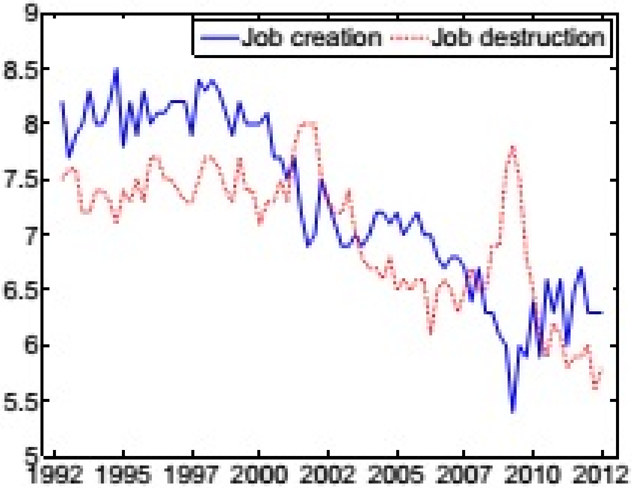
Aggregate Labor Productivity

- Negative impact on aggregate labor productivity.
- As the specialization increases,
  - mismatch $\downarrow$
  - productivity cost of mismatch $\uparrow$
  - Aggregate Productivity $\downarrow$

Conclusion

- Specialization of jobs has increased by 15 percentage points over time
- Explains more than 50% of the fall in labor market turnover
- Turnover decline - negative impact on aggregate labor productivity
- Increased sorting - need not be productivity enhancing

Firm Flows



Turnover

ASVAB Components

- arithmetic reasoning, mathematics knowledge, numerical operations
- paragraph comprehension, word knowledge
- general science, coding speed, automotive and shop information, mechanical comprehension, electronics information,

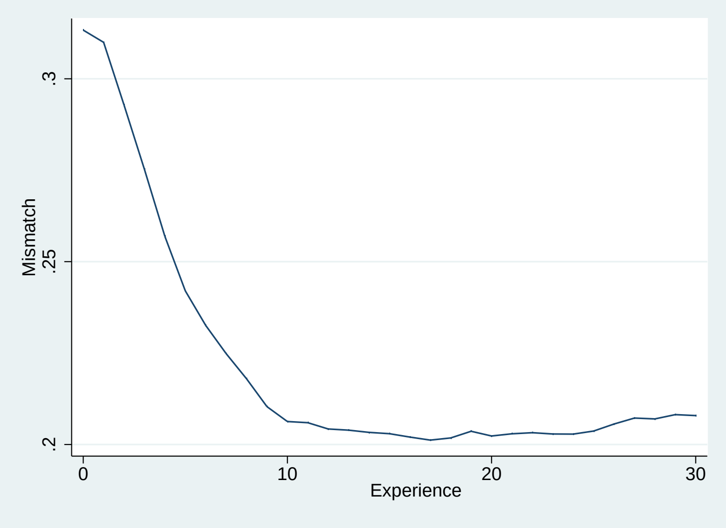
Mismatch

O*NET Descriptors

Verbal and Math Skills			
1.	Oral Comprehension	2.	Written Comprehension
3.	Deductive Reasoning	4.	Inductive Reasoning
5.	Information Ordering	6.	Mathematical Reasoning
7.	Number Facility	8.	Reading Comprehension
9.	Mathematics Skill	10.	Science
11.	Technology Design	12.	Equipment Selection
13.	Installation	14.	Operation and Control
15.	Equipment Maintenance	16.	Troubleshooting
17.	Repairing	18.	Computers and Electronics
19.	Engineering and Technology	20.	Building and Construction
21.	Mechanical	22.	Mathematics Knowledge
23.	Physics	24.	Chemistry
25.	Biology	26.	English Language
Social Skills			
1.	Social Perceptiveness	2.	Coordination
3.	Persuasion	4.	Negotiation
5.	Instructing	6.	Service Orientation

Mismatch

Mismatch Over Lifetime



▸ Mismatch

Skills vs Specialization

- Looking at the specialization of jobs performed by workers having different education.

Workers	Specialization
High school graduate	-0.1155^{***}
College dropout	-0.1971^{***}
College graduate	-0.7292^{***}
More than college	-1.3921^{***}

Table: Job Specialization: Education

Occupation vs. Specialization

Jobs	Specialization
Cognitive	-0.4022^{***}
Manual	-0.2811^{***}

Table: Cognitive vs. Manual

Jobs	Specialization
Non-Routine	-0.3813^{***}
Routine	-0.2893^{***}

Table: Non-Routine vs. Routine

Estimates

Job Specialization: Across Decades

Period	Specialization
1980 – 1989	-0.2524^{***}
1990 – 2000	-0.3325^{***}
2001 – 2013	-0.4506^{***}

Table: Job Specialization: Across Decades

Across Time

Job Specialization: No Occupational Change

Period	Specialization
1990 – 2000	-0.4334^{***}
2001 – 2013	-0.5151^{***}

Table: Job Specialization: No Occupational Change

Across Time

Job Finding Rate

Education	Full Sample	Pre 1995	Post 1995	% Change
Aggregate	0.4106	0.4407	0.3772	-14.4089
Less than high school	0.4422	0.4707	0.4106	-12.7682
High school	0.3915	0.4217	0.3579	-15.1292
Less than college	0.4233	0.4545	0.3887	-14.4774
College graduate	0.3713	0.3937	0.3466	-11.9634
More than college	0.3324	0.3463	0.317	-8.4609

Separation Rate

Education	Full Sample	Pre 1995	Post 1995	% Change
Aggregate	0.0355	0.0418	0.0284	-32.0574
Less than high school	0.0812	0.0894	0.0721	-19.3512
High school	0.0354	0.0398	0.0305	-23.3668
Less than college	0.0296	0.0334	0.0254	-23.9521
College graduate	0.0153	0.0168	0.0136	-19.0476
More than college	0.0093	0.0099	0.0087	-12.1212

Job Specialization

Education	Full Sample	Pre 1995	Post 1995	% Change
Aggregate	-0.3809	-0.2857	-0.438	15.23
High school graduate	-0.2320	-0.1795	-0.2513	7.18
Less than college	-0.1972	0	-0.427	42.7
College graduate	-0.7292	-0.3671	-1	63.29
More than college	-1.3921	-1.253	-1.4485	19.55

Back

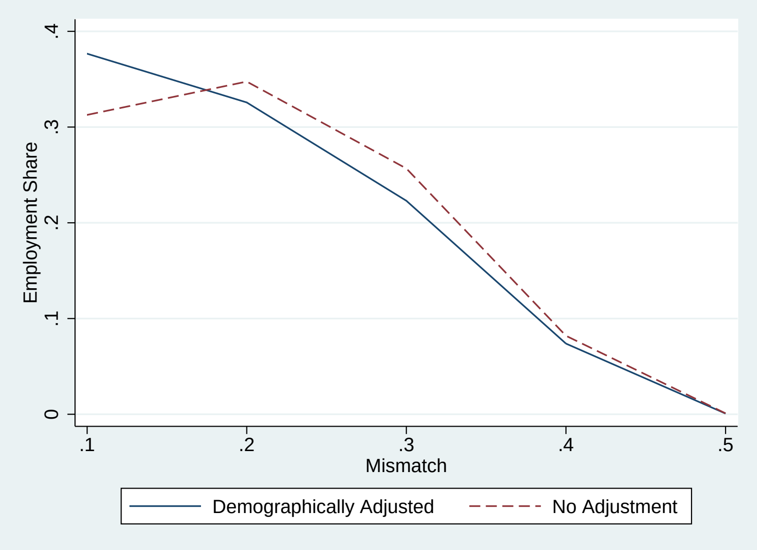
Employment Distribution

- Armed with the estimate of mismatch, we can construct the employment distribution and how it changes over time.
- But, comparison of distributions over time would be misleading as the average age and labor market experience of the NLSY sample increases over time.
- So, we have to control for the demographic transition before we can make such a comparison.

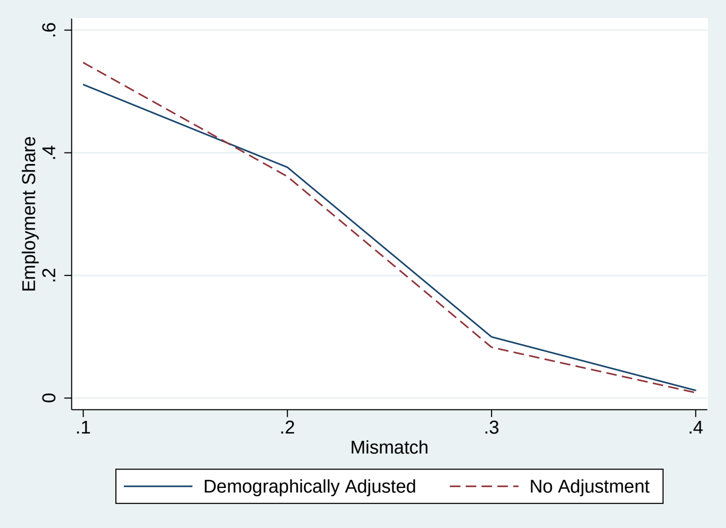
Demographic Correction

- I estimate a linear probability model for the employment shares at different levels of mismatch.
- To obtain employment share for mismatch $x \in [x_l, x_u]$, dependent variable has a value of 1 if a match has a mismatch value in that interval, 0 otherwise.
- Regressors include year dummies (time effect) and demographic controls (dummies that distinguish between young (16-24), middle-aged (25-54) and old(55-) workers).
- After estimation, the time effects can be isolated by fixing demographic controls at their sample means.

Employment Distribution: 1980



Employment Distribution: 2013



▸ Empirics ▸ Model

Other Findings

- Workers with more education earn higher wages.
- Wages follow an increasing and concave profile with labor market experience and job tenure.
- Tenure effect is higher for workers with higher skills or jobs with higher skill requirements.

▸ Findings

Continuation Values

- $$rV = -c + 2q(\theta) \int_0^{\bar{x}} J^0(\tau) d\tau \tag{15}$$

- $$rU = b + 2\theta q(\theta) \int_0^{\bar{x}} [W^0(\tau) - U] d\tau \tag{16}$$

- $$rJ^0(x) = \eta(x)\bar{\epsilon} - \omega_0(x) + \lambda \int_0^{\bar{\epsilon}} [max\{J(x,z), V\} - J^0(x)] dF(z) \tag{17}$$

- $$rW^0(x) = \omega_0(x) + \lambda \int_0^{\bar{\epsilon}} [max\{W(x,z), U\} - W^0(x)] dF(z) \tag{18}$$

Continuation Values

- $$rJ(x,\epsilon) = \eta(x)\epsilon - \omega(x,\epsilon) + \lambda \int_0^{\bar{\epsilon}} [max\{J(x,z), V\} - J(x,\epsilon)]dF(z) \quad (19)$$

- $$rW(x,\epsilon) = \omega(x,\epsilon) + \lambda \int_0^{\bar{\epsilon}} [max\{W(x,z), U\} - W(x,\epsilon)]dF(z) \quad (20)$$

- $$\omega_0(x) = \beta[\eta(x)\bar{\epsilon} + c\theta] + (1-\beta)b \quad (21)$$

- $$\omega(x,\epsilon) = \beta[\eta(x)\epsilon + c\theta] + (1-\beta)b \quad (22)$$

▸ Equilibrium

Equilibrium Conditions

- **Free Entry Condition**

$$rV = 0 \tag{23}$$

- **Cutoff Distance**

$$W^0(\bar{x}) - U = J^0(\bar{x}) = 0 \tag{24}$$

- **Cutoff Productivity**

$$W(x, \epsilon^*(x)) - U = J(x, \epsilon^*(x)) = 0 \tag{25}$$

Equilibrium Conditions

- **Free Entry Condition**

$$rV = 0 \tag{26}$$

Using the definition of V,

$$c = 2q(\theta)\int_0^{\bar{x}} J^0(\tau)d\tau \tag{27}$$

Substituting the wages and the continuation values

$$c = \frac{2q(\theta)(1-\beta)}{r+\lambda}\Bigg[\bar{\epsilon}\bar{x}\bar{\eta}(\bar{x}) - b\bar{x} - \frac{\beta c\theta\bar{x}}{1-\beta} + \frac{\lambda}{r+\lambda}\int_0^{\bar{x}}\int_{\epsilon^*(\tau)}^{\bar{\epsilon}} \eta(\tau)(z-\epsilon^*(\tau))dF(z)d\tau\Bigg] \tag{28}$$

Equilibrium Conditions

- **Cutoff Mismatch**

$$W^0(\bar{x}) - U = J^0(\bar{x}) = 0 \tag{29}$$

Substituting the continuation values

$$\bar{\epsilon} + \frac{\lambda}{r+\lambda}\int_{\epsilon^*(\bar{x})}^{\bar{\epsilon}}(z - \epsilon^*(\bar{x}))dF(z) = \frac{b}{\eta(\bar{x})} + \frac{\beta c\theta}{(1-\beta)\eta(\bar{x})} \tag{30}$$

Equilibrium Conditions

- **Cutoff Productivity**

$$W(x, \epsilon^*(x)) - U = J(x, \epsilon * (x)) = 0 \tag{31}$$

Substituting the continuation values

$$\epsilon^*(x) + \frac{\lambda}{r+\lambda}\int_{\epsilon^*(x)}^{\bar{\epsilon}} (z - \epsilon^*(x))dF(z) = \frac{b}{\eta(x)} + \frac{\beta c\theta}{(1-\beta)\eta(x)} \tag{32}$$

Equilibrium

Labor Market Flows

- Let $e_x(\epsilon)$ represent the CDF of the employment with mismatch x. The total employment at mismatch level x is $e_x(\bar{\epsilon})$.
- Aggregate employment

$$e = 2 \int_0^{\bar{x}} e_x(\bar{\epsilon}) dx \tag{33}$$

- Separation Rate

$$s = \frac{\lambda \int_0^{\bar{x}} F(\epsilon^*(x)) e_x(\bar{\epsilon}) dx}{\int_0^{\bar{x}} e_x(\bar{\epsilon}) dx} \tag{34}$$

- Job finding rate

$$f = 2\theta q(\theta) \bar{x} \tag{35}$$

Labor Market Flows

- Inflow into unemployment from x

$$\lambda F(\epsilon^*(x))e_x(\bar{\epsilon}) \tag{36}$$

- Outflow from unemployment to x

$$\theta q(\theta)u \tag{37}$$

- Equating inflow and outflow

$$e_x(\bar{\epsilon}) = \frac{\theta q(\theta)[1 - 2\int_0^{\bar{x}} e_x(\bar{\epsilon})dx]}{\lambda F(\epsilon^*(x))} \tag{38}$$

Labor Market Flows

- Distribution of employment over $\{x, \epsilon\}$

$$e_x(\epsilon) = \begin{cases} [F(\epsilon) - F(\epsilon^*(x))]e_x(\bar{\epsilon}) & \text{if } \epsilon^*(x) \leq \epsilon < \bar{\epsilon} \\ 0 & \text{if } \epsilon < \epsilon^*(x) \\ \frac{\theta q(\theta)[1-2\int_0^{\bar{x}} e_x(\bar{\epsilon})dx]}{\lambda F(\epsilon^*(x))} & \text{if } \epsilon = \bar{\epsilon} \end{cases}$$

- Separation Rate

$$s = \frac{\lambda \int_0^{\bar{x}} F(\epsilon^*(x))e_x(\bar{\epsilon})dx}{\int_0^{\bar{x}} e_x(\bar{\epsilon})dx} \tag{39}$$

- Job finding rate

$$f = 2\theta q(\theta)\bar{x} \tag{40}$$

▸ Flows