Income, Employment and Health Risks of Older Workers

Siqi Wei

CEMFI

22 Aug 2022

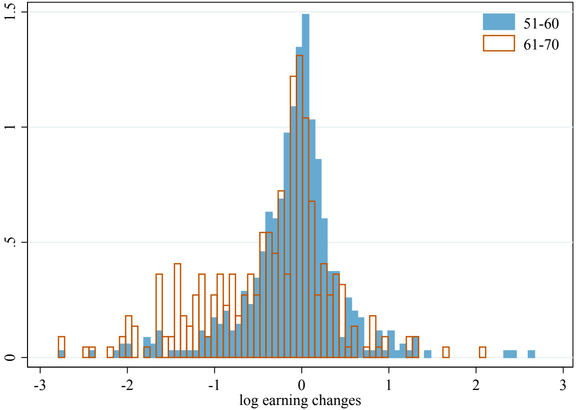
EEA-ESEM 2022

Motivation

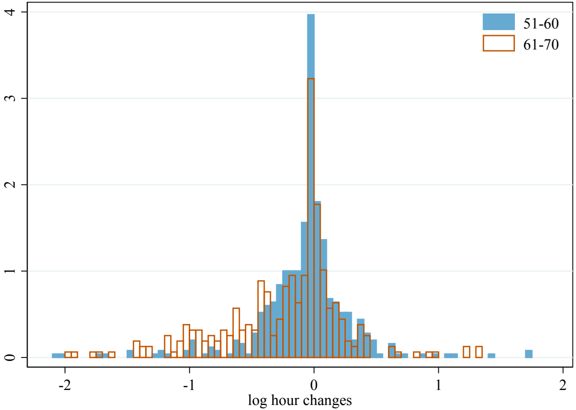
- Meet Dennis, a 58-year-old software engineer
  - He has a well-paying but stressful job in a high-tech company
  - He is considering moving to a worse-paying but less demanding job (e.g., part-time teacher in a school)
  - His plan is to work there a few more years before fully retiring
- For many older Americans, retirement is not a one-time withdrawal from the labor market, but a gradual process.
  - Around $30\% - 50\%$ of older workers in the United States experience post-retirement employment (loosely called bridge jobs) before exiting the labor force for good
- **Gradual transition** to full retirement often involves moving to jobs with
  - Less salary
  - Fewer working hours

Motivation

- Age ↑ ⟹ left-skewness of earning and hour changes for job movers ↑



(a) Log earning changes of job movers by age group



(b) Log hour changes of job movers by age group

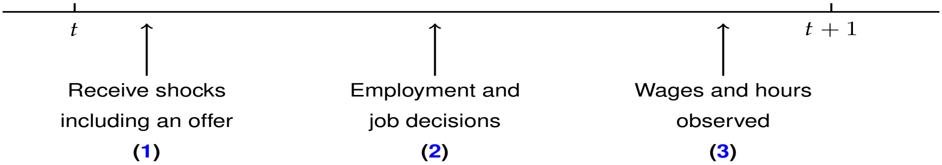
Note: HRS data, males

This Paper

1. Explain the gradual transition:
   - Propose a one-off, discrete shock associated with aging that mismatches workers with their jobs — *mismatch shock* (e.g., endurance decreases)
   - Build a flexible empirical model of employment transitions to separate mismatch shock (Low, Meghir and Pistaferri, 2010; Altonji, Smith and Vidangos, 2013)
   - Estimation: A modified stochastic EM algorithm studied in Wei (2021) for better algorithmic efficiency (Dempster, Laird and Rubin, 1977; Diebolt and Celeux, 1993; Liu, Rubin and Wu, 1998)
2. Conduct welfare analysis:
   - Calculate the welfare cost of mismatch risk and how much people value the gradual transition to full retirement in a utility-based structural model (French, 2005; French and Jones, 2011; Berkovec and Stern, 1991; Jacobs and Piyapromdee, 2016)
   - Policy-relevant: Heterogeneity across countries; Retirement age $\uparrow$
   - Estimation: Develop a new simulation-based method that takes advantage of the estimated empirical model under the premise: The empirical model is more flexible than the structural model (Keane and Smith, 2003)

The Empirical Model

For individual i at period t, his employment, job, wages and working hours are determined



(1). Dynamic processes of shocks
- Health shock; Job destruction shock; General productivity shock; Job offer; Mismatch shock

(2). Employment and job transitions
- For the employed: stay employed or not? if stay employed, new job or not?
- For the non-employed: new job or not?

(3). Stochastic wage and hour equations
- Demographics, latent health, unobserved heterogeneity, general productivity, firm-worker-level job fit, tenure

Mismatch Shock

- Mismatch shock: 0-1 discrete shock, capture non-marginal productivity decline associated to aging
- How does mismatch shock work in the model?
  1. Affect the fit of the existing job fit: staying $\Rightarrow$ lower wages
  2. Affect the outside offer (wages and hours): impaired skills might be required by other jobs too
  3. Force job leave: capture other elements lead to job leave other than productivity reason
- Why mismatch shock might incentivise gradual transition (left-skewness in hour and wage changes)?
  1. Worse outside offer
  2. More likely to accept worse-paying offer: reservation wage changes

Model Estimation by PX-SEM Algorithm

- Difficulty: latent components (e.g., health, productivity, fixed effect, mismatch)
- For latent-variable models, Stochastic EM (SEM) algorithm is a useful tool for estimation (Diebolt and Celeux, 1993).

  Iterate between an E step and an M step until convergence to stationary distribution

- Problem: Inefficient in computing time $\longrightarrow$ Infeasible to estimate complicated models

$\Longrightarrow$ Explore a modified (parameter-expanded) stochastic EM algorithm (PX-SEM) to speed up convergence, studied in Wei (2021).

Data

- The Health and Retirement Study (HRS) is a longitudinal panel study that surveys a representative sample of non-institutionalized individuals aged 50+ in US.
  - Male individuals aged 51 to 70 in RAND HRS from 1996 to 2016 (11 waves)
  - Never self-employed, and employed at least once during the sample periods
  - Number of consecutive waves: ≥ 3
  - No missing data
- Sample size: $N = 2,897$, $N \times T = 15,277$

Fit of Model

- Percentiles of log wage changes

	HE				LE			
	Stayers		Movers		Stayers		Movers	
	Data	Model	Data	Model	Data	Model	Data	Model
P10	-0.168	-0.187	-0.583	-0.622	-0.118	-0.139	-0.557	-0.606
P25	-0.055	-0.076	-0.266	-0.318	-0.044	-0.052	-0.237	-0.315
P50	0.005	0.007	-0.023	-0.042	0.001	0.022	-0.043	-0.062
P75	0.083	0.091	0.163	0.156	0.059	0.096	0.103	0.089
P90	0.203	0.201	0.373	0.377	0.15	0.181	0.254	0.234

Results — How Much Risks Explain?

- Simulate without 1) mismatch, 2) job destruction, and 3) offer shocks

	Δw, movers, 61-70				Δh, movers, 61-70			
	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	-0.2	0.19	-0.73	0.27	-0.22	0.23	-0.86	0.33
No mismatch shocks	58%	72%	77%	104%	29%	36%	51%	92%
No jd shocks	97%	96%	99%	102%	113%	107%	108%	93%
No offer shocks	75%	51%	79%	61%	76%	59%	77%	87%

Notes: In both panels, entries in the second row to the last display the ratios relative to the Baseline (first row).

Quantifying The Welfare Costs– Structural Model Set-up

- Agents start life at 51 and live at most up to 90
- Goal: Maximize expected discounted lifetime utility link
  1. Utility from consumption and leisure: $U(C_t, d_t)$
  2. Utility from leaving a bequest: $b(A_t)$
- Choices: He receives a job offer each period and decide
  1. Employment and job d_t
     (0 – nonemployed, 1 – stay in the existing job, 2 – work in a new job)
  2. Consumption C_t
- Risks: link
  1. Mortality: $E(s_t) = f_s(h_{t-1}, t)$, $s \in \{0, 1\}$
  2. Same risks as in the empirical model
- Welfare: government transfer, social security retirement benefits link optim

A New Simulation-based Method

- Connections between the empirical (E) and the structural (S) model:
  1. E and S model share wage equation and latent variable dynamics
  2. E employment $\&$ job transitions can be seen as an approximate reduced form of the S model.

$\Longrightarrow$ A new simulation-based estimation method that exploits E model results

- The estimator: choose S model that best approximates the estimated E model (Kullback-Leibler divergence)

$$\hat{\Omega} = \arg\max_{\Omega} \sum \sum_{\widetilde{Z}} \ln f_E(Y, \widetilde{Z}; \Theta(\Omega))$$

  where $\widetilde{Z} \sim f_E(Z|Y; \hat{\Theta})$: draws of latent variables Z from posterior distribution given all observables Y under E model estimates $\hat{\Theta}$

- Different from Indirect Inference: we use information on latent variables
- Allows us to bring the latent variable dynamics $\&$ wage equation to S model as primitive parameters

What is The Welfare Cost of Mismatch Risk?

- Counterfactual: Eliminate mismatch risk by imposing $Prob(m_{it} = 0) = 1$
- Two welfare measures: measures
  1. ΔA: the lump sum transfer of asset received at age $55/56$
  2. π: the proportion of consumption per period after age $55/56$

	$\Delta A(\times\$10,000)$		π	
	HE	LE	HE	LE
P10	3.98	1.45	5.9%	4.34%
P50	6.23	2.67	7.11%	5.33%
P90	8.62	4.57	7.99%	6.18%

conditional

What is The Welfare Cost of Inflexible Transitions?

- Counterfactual: Ban the job change and re-entry for people older than 65
- Two welfare measures: measures
  1. ΔA: the lump sum transfer of asset received at age $55/56$
  2. π: the proportion of consumption per period after age $55/56$

	$\Delta A(\times\$10,000)$		π	
	HE	LE	HE	LE
p10	-17.4	-13.4	-13.78%	-16.79%
p50	-10.73	-5.84	-12.65%	-13.53%
p90	-5.55	-2.98	-10.88%	-10.52%

conditional

Conclusion

- I study the risks and gradual transition to full retirement of older workers
- Empirical contribution: Propose an aging-related *mismatch shock* which could explain the job movements to worse-paying and less-demanding jobs
- Methodological contribution: Develop a new simulation-based estimation algorithm to combine empirical model (risks) and the structural model (welfare calculation)
- I find that
    - Mismatch shock can explain the job movements to worse-paying, less-demanding jobs
    - Mismatch risk causes non-negligible amount of welfare loss
    - People value the possibility of a smooth transition to retirement

Appendix — (1) Dynamic Processes: Health

Latent health:

$$h_{it} = f_h(h_{i,t-1}, age_{i,t-1}, \varepsilon_{it}^h) \tag{1}$$

Measurement equation:

$$srh_{it} = \sum_{k=1}^{5} 1(h_{it} > \tau_k^{sh}) \tag{2}$$

- h_{it} is an underlying continuous index not observed by researchers
- The self-reported health srh_{it}, containing information of h_{it}, is observed
- The value of srh_{it}: discrete, varying from 1 (Excellent) to 5 (Poor)

back

Appendix — (1) Dynamic Processes: Individual-specific Productivity

Productivity ω_{it} and productivity risk σ_{it}

$$\omega_{it} = \rho(\sigma_{it}, age_{i,t-1})\omega_{i,t-1} + \varepsilon^{\omega}_{it}\sigma_{it} \tag{3}$$

$$\sigma_{it} = f_{\sigma}(edu_i, age_{i,t-1}, h_{i,t-1}, \sigma_{i,t-1}, \varepsilon^{\sigma}_{it}) \tag{4}$$

- Heterogeneity in productivity risks and depreciation of productivity
- Non-linear persistence in income dynamics: e.g., negative health history causes non-marginal drop in productivity.

back

Appendix — (1) Dynamic Processes: Job Destruction

Job destruction shock

$$jd_{it} = 1\{f_{jd}(edu_i) + \varepsilon_{it}^{jd} > 0\} \tag{5}$$

- Only triggers a job leave
- No impact on productivity and offer

back

Appendix — (1) Dynamic Processes: The Existing Job

Dynamics of (v_{ijt}, ξ_{ijt}):

$$\begin{cases} v_{ijt} = v_{i,t-1}, \text{ if } m_{ijt} = 0 \\ v_{ijt} \ll v_{i,t-1}, \text{ if } m_{ijt} = 1 \end{cases} \tag{6}$$

$$\xi_{ijt} = \xi_{i,t-1} \tag{7}$$

- Hour component stays constant during a job tenure
- When mismatch happens, wage to be received from the existing job is reduced to a much smaller value that triggers a job leave

back

Appendix — (1) Dynamic Processes: The New Job

Dynamics of $(\nu_{ij't}, \xi_{ij't})$:

$$\nu_{ij't} = f_\nu(\nu_{ijt}, E_{i,t-1}, edu_i) + \varepsilon_{it}^{\nu} \tag{8}$$

$$\xi_{ij't} = f_\xi(\xi_{ijt}, E_{i,t-1}, edu_i, \nu_{ij't}) + \varepsilon_{it}^{\xi} \tag{9}$$

- When mismatch happens, offer is also affected through terms ν_{ijt} and ξ_{ijt}
- The wages of the mismatched are expected to be lower on average
  - Worse outside offer
  - More likely to accept worse-paying offer: either the offer or non-employment

back

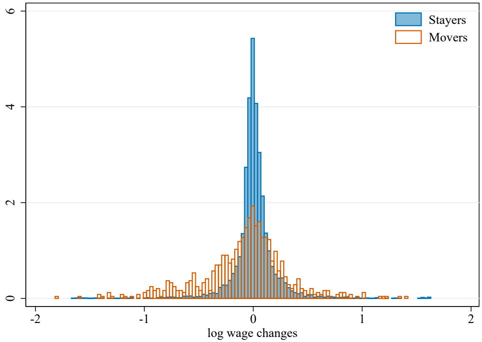
Appendix — Older Workers In HRS

- There is a non-negligible number of employment and job movements, and the movements do not concentrate on a narrow age group.

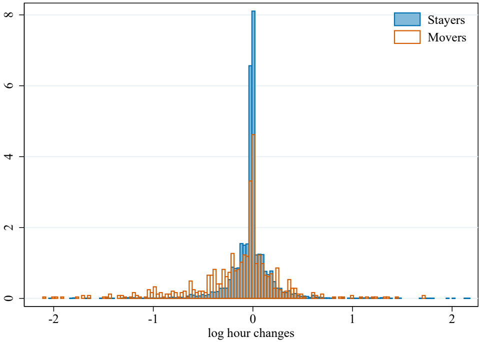
		Age group			
	All	≤ 55	$55 \sim 60$	$60 \sim 65$	> 65
Individual					
People who have started new jobs	0.32	0.16	0.21	0.17	0.13
job-to-job transition	0.21	0.12	0.15	0.10	0.05
re-entry	0.14	0.03	0.06	0.06	0.08
Individual-year					
Employment to Employment	0.60	0.87	0.78	0.54	0.30
Employment to Nonemployment	0.14	0.08	0.10	0.18	0.14
Nonemployment to Employment	0.04	0.03	0.04	0.03	0.04

Appendix — Older Workers In HRS

- There is heterogeneity between stayers and movers
  - The wage and hour changes among movers are more dispersive
  - The wage and hour changes of movers are more left-skewed



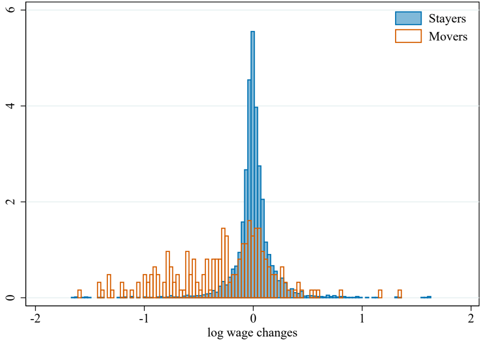
(a) Log wage changes



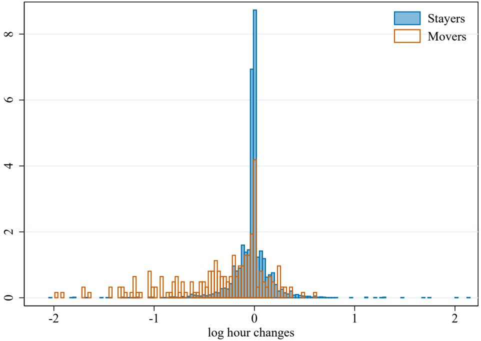
(b) Log hour changes

Appendix — Older Workers In HRS

- There is heterogeneity between stayers and movers
  - The wage and hour changes among movers are more dispersive
  - The wage and hour changes of movers are more left-skewed



(a) Log wage changes, Tenure $\geq 10yrs$



(b) Log hour changes, Tenure $\geq 10yrs$

Appendix — Model Specification

back

Dynamics of Assets:

$$E(1(A_{it} < \tau_k^A)) = \Phi(f_{A,k}(X_{it}, A_{i,t-1}, E_{it}, w^*_{it}, l_{it}, h_{it}, \omega_{it}, \nu_{it}, \mu_i)) \quad (10)$$

Empirical model assumptions:

- i.i.d. all error terms
- Normal distributions

Appendix — Fit of Empirical Model

Table: Percentiles of log hour changes

	HE				LE			
	Stayers		Movers		Stayers		Movers	
	Data	Model	Data	Model	Data	Model	Data	Model
P10	-0.218	-0.363	-0.601	-0.601	-0.207	-0.361	-0.634	-0.638
P25	-0.085	-0.208	-0.282	-0.302	-0.061	-0.207	-0.266	-0.339
P50	-0.012	-0.037	-0.051	-0.044	-0.008	-0.037	-0.015	-0.075
P75	0.036	0.135	0.052	0.188	0.016	0.134	0.043	0.16
P90	0.173	0.288	0.236	0.394	0.166	0.288	0.262	0.365

Appendix — Mismatch Shocks

- How likely for workers to receive mismatch shocks?
  - Per individual-period:

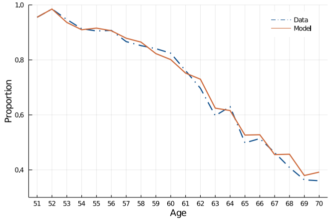
	$51 \sim 55$	$56 \sim 60$	$61 \sim 65$	$66 \sim 70$
HE	0.8%	2.5%	4.4%	4.2%
LE	0.4%	1.4%	2.7%	3.1%

  - Per individual: Probability of receiving at least one mismatch shock by age 65 and 70 are 10.3% and 13.5%, respectively.
- Among movers who switch to worse-paying jobs, how many received mismatch shocks?

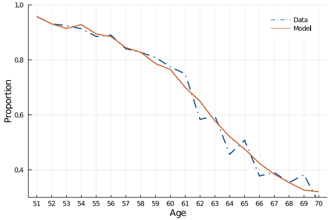
$\Delta w_t \leq$	$51 \sim 55$	$56 \sim 60$	$61 \sim 65$	$66 \sim 70$
-0.1	9.8%	30.8%	56.4%	63.2%
-0.3	13.5%	40.2%	64.8%	69.9%

Appendix — Fit of empirical model

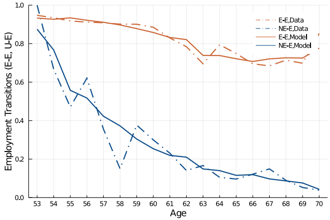
back



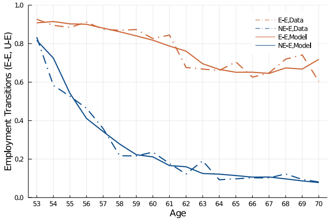
(a) LFP, HE



(b) LFP, LE



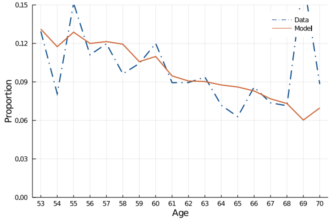
(c) Employment transitions, HE



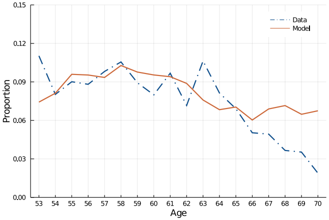
(d) Employment transitions, LE

Appendix — Fit of empirical model

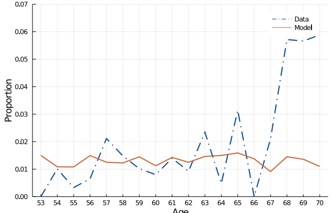
back

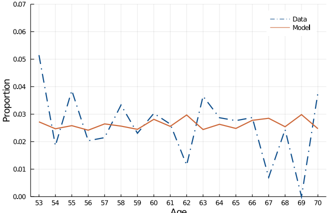


(a) Job-to-job move conditional on EE, HE



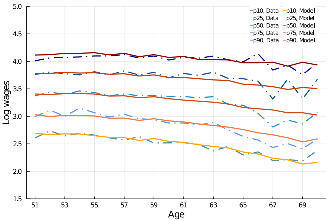
(b) Job-to-job move conditional on EE, LE



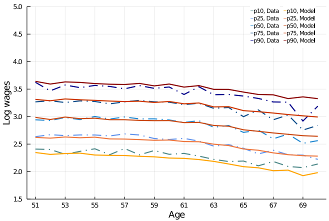


Appendix — Fit of empirical model

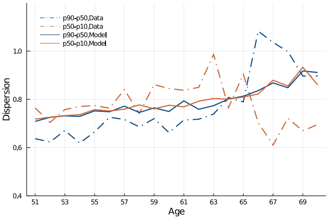
back



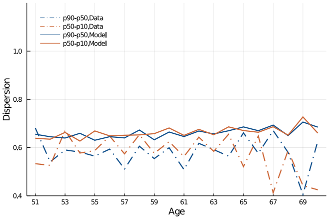
(a) Quantiles of wages (excluding zeros), HE



(b) Quantiles of wages (excluding zeros), LE



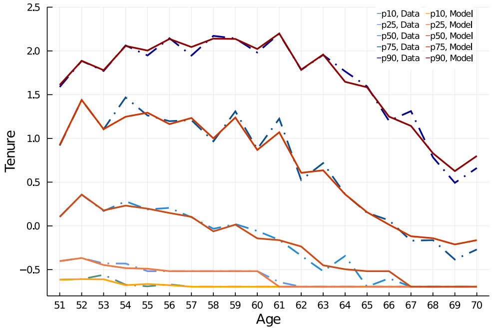
(c) $P90 - P50$ and $P50 - P10$ of log



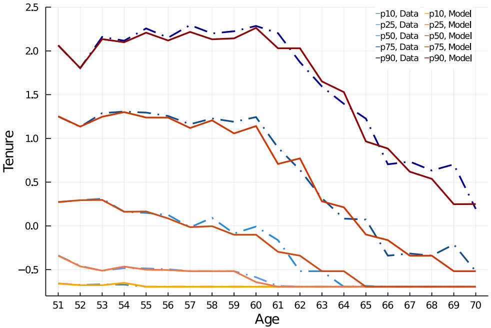
(d) $P90 - P50$ and $P50 - P10$ of log

Appendix — Fit of empirical model

back



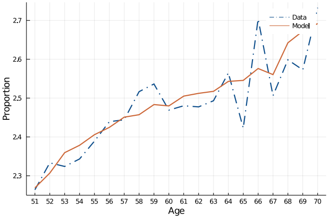
(a) Percentiles of tenures, HE



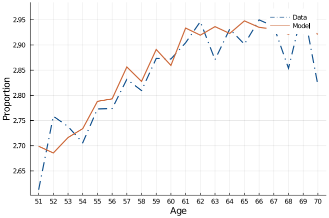
(b) Percentiles of tenures, LE

Appendix — Fit of empirical model

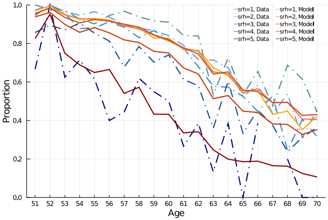
back



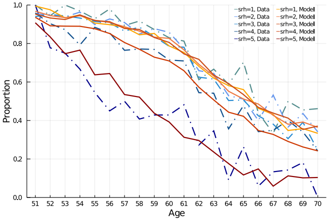
(c) Mean self-reported health, HE



(d) Mean self-reported health, LE



(e) LFP by health and age, HE

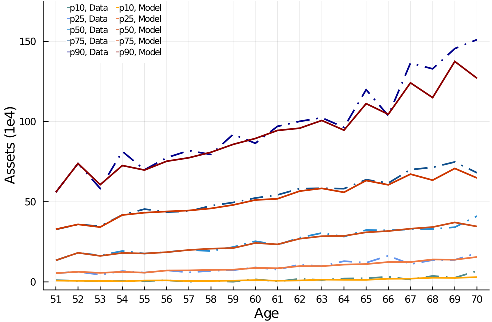


(f) LFP by health and age, LE

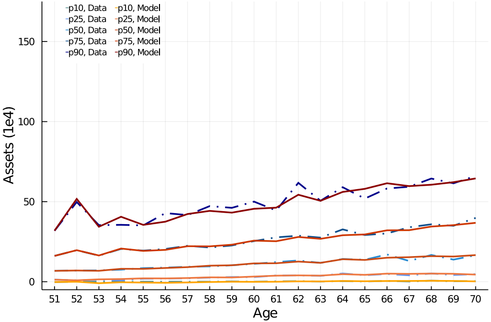
Appendix — Fit of empirical model

back

Figure: Percentiles of Assets



(a) Percentiles of assets, HE



(b) Percentiles of assets, LE

Appendix — Mismatch Shocks

- Among movers who switch to jobs with fewer working hours, how many received mismatch shocks?

$\Delta l_t \leq$	$51 \sim 55$	$56 \sim 60$	$61 \sim 65$	$66 \sim 70$
-0.1	11.9%	30.2%	56.9%	68%
-0.3	21.3%	44.4%	69.5%	79.4%
-0.5	35%	66.7%	84.6%	90%

back

Appendix — How Much Risks Explain?

- Simulate without 1) mismatch, 2) job destruction, and 3) offer shocks

	Δw, movers, 51-60				Δh, movers, 51-60			
	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	-0.09	0.15	-0.58	0.31	-0.06	0.16	-0.53	0.39
No mismatch shocks	55%	83%	83%	103%	-4%	58%	72%	99%
No jd shocks	82%	94%	93%	101%	106%	102%	104%	100%
No offer shocks	96%	52%	80%	61%	68%	68%	86%	92%

Notes: In both panels, entries in the second row to the last display the ratios relative to the Baseline (first row).

Appendix — How Much Risks Explain?

back

Table: Relative importance of different risks and initial conditions (continues)

	A. Age group 51 to 60															
	Employment				w, all		h, all		Δw, movers				Δh, movers			
	LFP	E-E	NE-E	JC	$Mean$	Var	$Mean$	Var	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	0.87	0.87	0.29	0.11	3.16	0.36	7.81	0.1	-0.09	0.15	-0.58	0.31	-0.06	0.16	-0.53	0.39
No mismatch shocks	1.0	1.0	1.32	0.87	1.0	0.98	1.0	0.84	0.55	0.83	0.83	1.03	-0.04	0.58	0.72	0.99
No jd shocks	1.01	1.01	1.2	0.89	1.0	1.0	1.0	1.0	0.82	0.94	0.93	1.01	1.06	1.02	1.04	1.0
No offer shocks	1.0	1.0	1.19	1.27	1.0	0.97	1.0	0.87	0.96	0.52	0.8	0.61	0.68	0.68	0.86	0.92
No productivity shocks	1.0	1.0	1.22	1.01	1.0	0.93	1.0	0.99	1.07	0.79	0.94	0.79	0.99	0.99	1.0	1.01
Median σ	1.0	1.0	1.22	1.0	1.0	0.95	1.0	1.0	1.03	0.86	0.95	0.87	1.0	1.0	0.99	1.01
No health shocks	1.02	1.03	1.35	1.04	1.0	1.0	1.0	1.0	1.01	0.96	0.99	0.98	0.88	0.97	0.98	1.01
No fix effect	1.0	1.0	1.23	0.99	1.0	0.85	1.0	0.99	1.01	1.18	1.06	1.2	1.01	0.98	0.99	1.0

Notes: In both panels, entries in the second row to the last display the ratios relative

Appendix — How Much Risks Explain?

back

Table: –Continued

	A. Age group 51 to 60							
	Δw, stayers				Δh, stayers			
	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	0.01	0.04	-0.16	0.19	-0.03	0.06	-0.35	0.3
No mismatch shocks	0.98	0.99	1.0	1.0	1.01	1.0	1.0	1.0
No jd shocks	0.97	1.0	1.0	1.0	1.01	1.0	1.0	1.0
No offer shocks	0.89	1.0	1.01	0.99	0.99	1.0	1.0	1.0
No productivity shocks	1.0	0.14	0.49	0.56	1.03	1.0	1.0	1.0
Median σ	1.0	0.34	0.8	0.83	1.01	1.0	1.0	1.0
No health shocks	1.0	1.01	1.0	1.0	1.01	1.0	1.0	1.0

Appendix — How Much Risks Explain?

back

Table: Relative importance of different risks and initial conditions (continues)

	B. Age group 61 to 70															
	Employment				w, all		h, all		Δw, movers				Δh, movers			
	LFP	E-E	NE-E	JC	$Mean$	Var	$Mean$	Var	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	0.56	0.69	0.11	0.08	3.0	0.39	7.57	0.17	-0.2	0.19	-0.73	0.27	-0.22	0.23	-0.86	0.33
No mismatch shocks	1.02	0.99	1.41	0.61	1.01	0.92	1.01	0.57	0.58	0.72	0.77	1.04	0.29	0.36	0.51	0.92
No jd shocks	1.01	1.01	1.12	0.9	1.0	1.0	1.0	0.99	0.97	0.96	0.99	1.02	1.13	1.07	1.08	0.93
No offer shocks	1.0	1.0	1.09	1.35	0.99	0.94	1.0	0.74	0.75	0.51	0.79	0.61	0.76	0.59	0.77	0.87
No productivity shocks	1.0	1.0	1.14	1.03	1.0	0.88	1.0	0.99	0.97	0.71	0.93	0.69	1.03	1.03	1.03	1.03
Median σ	1.0	1.0	1.15	1.02	1.0	0.91	1.0	1.0	0.93	0.81	0.91	0.8	1.07	1.03	1.07	0.98
No health shocks	1.1	1.06	1.32	1.08	1.0	0.99	1.0	0.98	0.96	0.94	0.99	0.95	0.98	1.01	1.0	1.01
No fix effect	1.0	1.0	1.14	1.01	1.0	0.83	1.0	0.99	0.93	1.04	1.0	1.15	1.06	1.0	1.03	0.95

Notes: In both panels, entries in the second row to the last display the ratios relative

Appendix — How Much Risks Explain?

back

Table: –Continued

	B. Age group 61 to 70							
	Δw, stayers				Δh, stayers			
	$Mean$	Var	$P10$	$P90$	$Mean$	Var	$P10$	$P90$
Baseline	0.01	0.05	-0.18	0.21	-0.09	0.06	-0.42	0.23
No mismatch shocks	0.94	1.0	1.01	1.0	1.0	1.0	1.0	1.0
No jd shocks	0.97	1.0	1.0	0.99	1.0	1.0	1.0	1.0
No offer shocks	0.96	1.0	1.0	0.99	1.0	1.0	1.0	1.0
No productivity shocks	1.05	0.11	0.41	0.51	0.99	1.0	1.0	1.01
Median σ	1.07	0.26	0.69	0.75	0.97	1.0	0.99	1.01
No health shocks	0.97	0.97	0.99	0.99	0.98	1.0	0.99	1.0

Results — Bridge Job

- In this exercise, I label any jobs after a job with ≥ 10yrs of tenure as a "bridge job"

	Bridge job (IDVI.)	$E(\Delta w)$	$Var(\Delta w)$	$E(\Delta h)$	$Var(\Delta h)$
Model	0.13	-0.49	0.25	-0.31	0.33
No mismatch shocks	88%	78%	66%	32%	35%
No jd shocks	89%	99%	103%	109%	104%
No offer shocks	91%	123%	56%	107%	54%

Notes: Entries in the second row to the last display the ratios relative to the Baseline (first row). Columns 2-5 computed for the first bridge job.

back

Appendix — Bridge Jobs

- Bridge jobs: those connect career employment with the full retirement
- In this exercises: define career employment as any job with ≥ 10yrs of tenure

Table: Job, mean and variance of wage change conditional on tenure larger than 10yrs

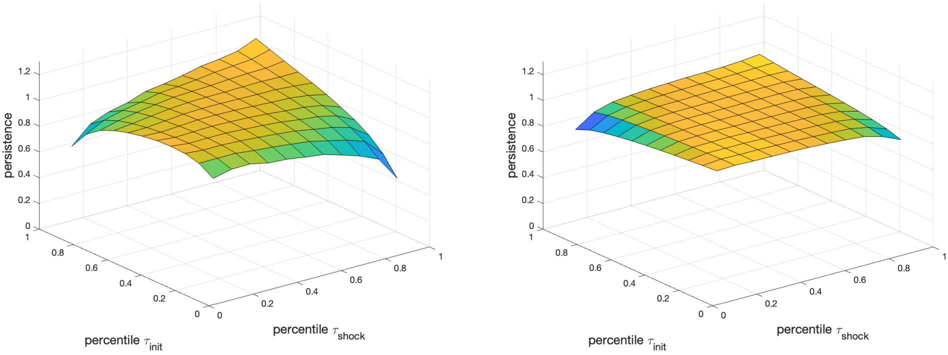
	Proportion of IDVI			$E(\Delta w)$			$Var(\Delta w)$			$E(\Delta h)$			$Var(\Delta h)$		
	Bridge	JC	NE-E	Bridge	JC	NE-E	Bridge	JC	NE-E	Bridge	JC	NE-E	Bridge	JC	NE-E
Model	0.13	0.08	0.06	-0.49	-0.35	-0.67	0.25	0.19	0.28	-0.31	-0.2	-0.45	0.33	0.23	0.42
No mismatch shocks	0.88	0.67	1.2	0.78	0.7	0.71	0.66	0.79	0.57	0.32	-0.01	0.38	0.35	0.41	0.28
No jd shocks	0.89	0.83	0.96	0.99	0.95	0.98	1.03	0.98	1.03	1.09	1.24	0.97	1.04	1.07	1.01
No offer shocks	0.91	0.91	0.98	1.23	1.31	1.14	0.56	0.39	0.61	1.07	1.21	0.96	0.54	0.64	0.45
No productivity shocks	1.01	1.03	1.0	1.02	1.0	1.03	0.83	0.78	0.81	0.99	1.01	0.99	0.97	0.98	0.97
Median σ	1.0	1.01	0.99	1.03	0.99	1.05	0.9	0.84	0.88	1.02	1.05	1.01	1.0	1.0	1.0
No health shocks	1.04	1.08	0.99	0.98	1.0	1.0	0.99	0.94	1.05	0.95	0.95	0.98	0.98	0.97	1.01
No fix effect	1.0	0.99	1.0	0.99	1.0	0.98	1.12	1.08	1.19	1.02	1.05	0.99	1.0	1.0	1.0

Notes: Entries in the second row to the last display the ratios relative

to the Baseline (first row). The variables w and h are log wages and log hours

Appendix — Empirical Model Implications

Figure: Wage Persistence



(a) Data

(b) Model

back

Appendix — U Model Utility

Utility from consumption and leisure: back

$$U(C_t, d_t, d_{t-1}, jd_t, h_t, \epsilon_t^d) = \frac{1}{1-\nu} C_t^{1-\nu} + L_t$$

where

$$\begin{aligned} L_t = & -(\theta_{e0} + \theta_{e1} t + \theta_{e2} 1(t > 6)(t-6) + \theta_{e3} h_t) E_t \\ & -(\theta_{r0} + \theta_{r1} t + \theta_{r2} 1(t > 6)(t-6) + \theta_{r3} h_t) RE_t \\ & -(\theta_{j0} + \theta_{j1} t + \theta_{j2} 1(t > 6)(t-6) + \theta_{j3} h_t) JC_t + \epsilon_t^d \end{aligned}$$

- E_t: Being employed, $E_t = 1\{d_t = 1$ or $d_t = 2\}$
- RE_t: Re-entry (NE-E movement), $RE_t = 1\{E_1 = 1, and(E_{t-1} = 0)$ or $jd_t = 1$ or $m_t = 1)\}$
- JC_t: Job changes (JC movement), $JC = 1\{E_{t-1} = 1, jd_t = 0, m_t = 0, E_t = 1\}$
- ϵ_t^d: idiosyncratic preference shocks, i.i.d. Type-I extreme Value distribution

Utility from leaving a bequest for people who die at period t:

$$b(A_t) = \kappa A_t 1(A_t \geq 0)$$

Appendix — U Model Risks

back

Risks:

- Survival: $E(s_t) = f_s(h_{t-1}, t)$, $s \in \{0, 1\}$
- Composite firm-specific component and offers:

$$\widetilde{v}_{j(t)} = \begin{cases} \rho_{v0} + \rho_v \widetilde{v}_{j(t-1)} & \text{if stay at the same job} \\ \widetilde{v}'_{j(t)} & \text{if move to new job} \end{cases}$$

$$\widetilde{v}'_{j(t)} \sim f_{v'}(\widetilde{v}_{j,t-1}, m_{jt}, jd_{it}, E_{t-1})$$

- Mismatch: $E(m_{jt}) = f_m(t, edu, \widetilde{v}_{t-1}, E_{t-1})$, $m_{jt} \in \{0, 1\}$
- Job destruction: $E(jd_t) = f_{jd}(t, edu, \widetilde{v}_{t-1}, m_{jt})$
- Other components, including health h_t, individual-specific wage component ω_t, and the productivity risks σ_t are the same as in the empirical model

Appendix— U Model Budget Constraint

back

Budget constraint:

$$A_{t+1} = (1+r)A_t + Y_t + ss_t \times B_t + tr_t - C_t$$

- Labor income: $Y_t = W_t \times N$,

  in which the log hourly wage rate:

  $$\ln W_t = X_t' \gamma_X + h_t \gamma_h + \omega_t + \widetilde{v}_t$$

  - Exclude measurement errors from the wage equation.
  - Reduce the dimensionality of state variables:
    * Fixed hour supply N
    * Define a a composite firm component $\widetilde{v} \equiv \mu + ten_t' \gamma_{ten}^w + \nu$
- Borrowing constraint: $A_{t+1} \geq A_{min}$,
- Government transfers tr_t: guarantees a minimum consumption C_{min}
- Social security income ss_t: everyone collects social security after 65: $B_t = 1\{t \geq 8\}$, with a fixed

Appendix — Optimzation Problem

back

Value function:

$$
\begin{aligned}
V_t(\Omega_t) \quad &= \quad \max_{C_t, d_t} \Big\{ U(C_t, d_t, d_{t-1}, jd_t, h_t, \epsilon_t^d) + \beta(1 - s_{t+1}) b(A_{t+1}) \\
&\qquad + \beta s_{t+1} E\Big(V_{t+1}(\Omega_{t+1}) \Big| \Omega_t, C_t, d_t \Big) \Big\} \\
s.t. \quad & \qquad A_{t+1} = (1+r)A_t + Y_t + ss_t \times B_t + tr_t - C_t \\
& \qquad A_{t+1} \geq A_{min}, C_t \geq C_{min}
\end{aligned}
$$

with state variables $\Omega_t = (A_{t-1}, \widetilde{v}_{t-1}, \widetilde{v}'_t, \omega_t, \sigma_t, h_t, m_t, t, d_{t-1}, jd_t, edu, \epsilon_t^d)$

Appendix — Structural Model Solution

back

- Model Solution
  - Backward induction
  - Discretization
  - Grouping individuals by age: $51 \sim 52$, $53 \sim 54$,...$89 \sim 90$
  - Type-I extreme value assumption of preference shocks

Appendix — Structural Model Solution

back

- Steps:

  1. Primitive parameters $\hat{\Omega}_1$: survival probability; approximation due to $\widetilde{\upsilon}$.
  2. Remaining parameters Ω_2 are estimated:

$$\hat{\Omega}_2 = \arg\max_{\Omega_2} \sum \sum_{\widetilde{Z}} \ln f_{NU}(Y, \widetilde{Z}; \Theta(\Omega_2, \hat{\Omega}_1))$$

- Details on step 2:

  - Start with an initial guess of Ω_2. Given $\hat{\Omega}_1$ and Ω_2, simulate M statistically independent data sets from the U model: $\{Y, Z\}^m$, $m = 1, ..., M$, where each data set consists of N_M individuals and T_M periods.
  - Then compute $\Theta(\Omega_2, \hat{\Omega}_1) = \frac{1}{M} \sum \hat{\Theta}^m(\Omega_2, \hat{\Omega}_1)$, where $\hat{\Theta}^m$ is the estimator for each of the M simulated data sets: $\hat{\Theta}^m(\Omega_2, \hat{\Omega}_1) = \arg\max_\Theta \ln f_{NU}(Y^m, Z^m; \Theta)$.
  - Evaluate the objective function $\sum \sum_{\widetilde{Z}} \ln f_{NU}(Y, \widetilde{Z}; \Theta(\Omega_2, \hat{\Omega}_1))$ (only ee, ne, jc, A_t).

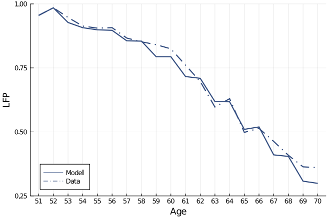
Choose Ω_2 that maximizes the objective function ($M = 50$, $N_M = 10,000$, $T_M = 6$).

Appendix — Structural Model Estimates

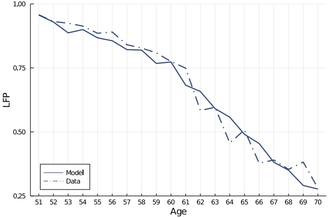
	Parameters	HE	LE		Parameters	HE	LE
θ_{e0} :	Cost of working	-0.347	-0.212	θ_{j0} :	Cost of job change	2.295	2.005
θ_{e1} :	Cost of working: age dependent ($\times t$)	0.106	0.04	θ_{j1} :	Cost of job change: age dependent ($\times t$)	-0.003	0.11
θ_{e2} :	Extra cost of working for 60+: age dependent ($\times t$)	0.009	0.061	θ_{j2} :	Extra cost of job change: for 60+: age dependent ($\times t$)	-0.044	0.002
θ_{e3} :	Cost of working: health dependent ($\times h$)	0.446	0.373	θ_{j3} :	Cost of job change: health dependent ($\times h$)	0.01	0.011
θ_{r0} :	Extra cost when reentering labor market	1.925	0.978				
θ_{r1} :	Reentry cost: age dependent ($\times t$)	0.147	0.328	ν :	Coef. risk aversion	1.666	1.896
θ_{r2} :	Extra Reentry cost for 60+: age dependent ($\times t$)	-0.188	-0.417	κ :	Bequest intensity	0.029	0.037

Appendix — Fit of structural model

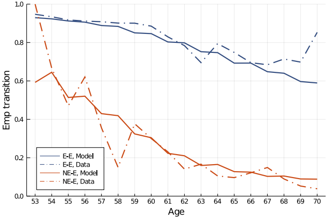
back



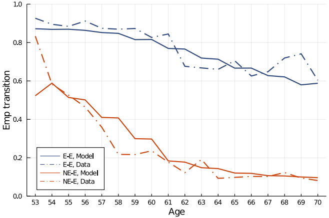
(a) LFP, HE



(b) LFP, LE



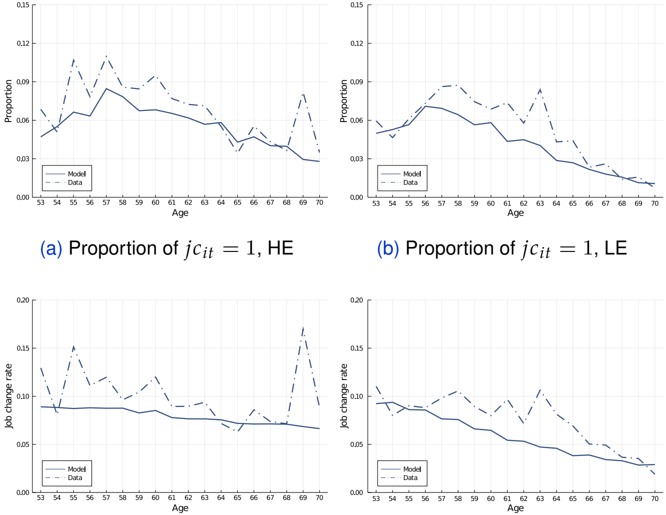
(c) Employment transitions, HE



(d) Employment transitions, LE

Appendix — Fit of structural model

back



(a) Proportion of $jc_{it} = 1$, HE

(b) Proportion of $jc_{it} = 1$, LE

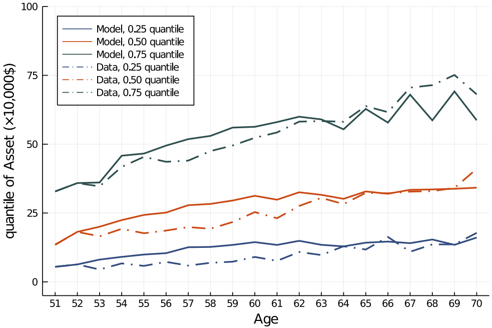
(c) Proportion of $jc_t = 1$ cond. on

(d) Proportion of $jc_t = 1$ cond. on

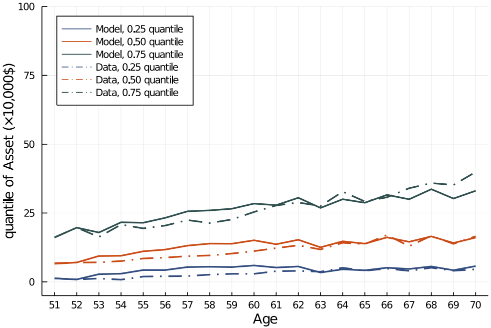
Appendix — Fit of structural model

back

Figure: Asset Accumulation



(a) Quantiles of asset by age, HE



(b) Quantiles of asset by age, LE

Appendix — Welfare Measures

back

- Measure of welfare gain or loss:
  - Lump sum transfer of asset ΔA, at age $55/56$, (t=3)

$$V_3(A_2 + \Delta A, \Omega_3 \backslash A_2) = \widetilde{V}_3(\Omega_3)$$

  - Proportion of consumption adjusted, π, in all ages since $55/56(t \geq 3)$

$$V_3(\Omega_3) + \sum_{t=3} \beta^{t-3} E_3 \left(s(t) \frac{1}{1-\nu} (\pi C_t^*)^{1-\nu} \right) = \widetilde{V}_3(\Omega_3)$$

Appendix — What is The Welfare Cost of Mismatch Risk?

back

	$\Delta A (\times \$10,000)$		$\pi (\times 100)$	
	HE	LE	HE	LE
By assets level				
$A_{t-1} \leq P33$	4.8	1.81	7.43	5.14
$P33 < A_{t-1} \leq P66$	6.2	2.61	6.91	5.18
$A_{t-1} > P66$	7.97	4.05	6.88	5.68
By employment status				
Non-employed	3.02	1.4	5.31	3.73
Employed, ten≥ 10 yrs	6.66	3.18	7.09	5.56
Employed, ten< 10 yrs	5.94	2.39	7.28	5.2
Employed, high wage ($\geq P50$)	7.2	3.53	7.04	5.77
Employed, low wage ($< P50$)	5.55	2.18	7.35	5.1

Appendix — What is The Welfare Cost of Inflexible Transitions?

back

	$\Delta A(\times\$10,000)$		$\pi(\times 100)$	
	HE	LE	HE	LE
By asset level				
$A_{t-1} \leq p30$	-6.87	-3.78	-11.38	-11.4
$p33 < A_{t-1} \leq p66$	-10.89	-5.78	-12.61	-13.23
$A_{t-1} > p66$	-15.74	-10.91	-13.51	-15.88
By employment status				
Non-employed	-4.99	-3.5	-10.99	-11.49
Employed, ten≥ 10	-12.0	-7.4	-12.88	-14.31
Employed, ten< 10	-9.1	-4.8	-12.29	-12.68
Employed, high wage ($\geq p50$)	-13.99	-8.95	-13.25	-15.08
Employed, low wage ($< p50$)	-8.34	-4.52	-11.93	-12.26
By health level				

*

Altonji, Joseph G, Anthony A Smith, and Ivan Vidangos. 2013. "modelling earnings dynamics." *Econometrica*, 81(4): 1395–1454.

Berkovec, James, and Steven Stern. 1991. "Job exit behavior of older men." *Econometrica: Journal of the Econometric Society*, 189–210.

Dempster, Arthur P, Nan M Laird, and Donald B Rubin. 1977. "Maximum likelihood from incomplete data via the EM algorithm." *Journal of the Royal Statistical Society: Series B (Methodological)*, 39(1): 1–22.

Diebolt, Jean, and Gilles Celeux. 1993. "Asymptotic properties of a stochastic EM algorithm for estimating mixing proportions." *Stochastic Models*, 9(4): 599–613.

French, Eric. 2005. "The effects of health, wealth, and wages on labour supply and retirement behaviour." *The Review of Economic Studies*, 72(2): 395–427.

French, Eric, and John Bailey Jones. 2011. "The effects of health insurance and self-insurance on retirement behavior." *Econometrica*, 79(3): 693–732.

Jacobs, Lindsay, and Suphanit Piyapromdee. 2016. "Labor Force Transitions at Older Ages: Burnout, Recovery, and Reverse Retirement."

Keane, Michael, and Anthony A Smith. 2003. "Generalized indirect inference for discrete choice models." *Yale University*.

Liu, Chuanhai, Donald B Rubin, and Ying Nian Wu. 1998. "Parameter expansion to accelerate EM: the PX-EM algorithm." *Biometrika*, 85(4): 755–770.

Low, Hamish, Costas Meghir, and Luigi Pistaferri. 2010. "Wage risk and employment risk over the life cycle." *American Economic Review*, 100(4): 1432–67.

Wei, Siqi. 2021. "Estimating Nonlinear Panel Data Models By Parameter-Expanded Stochastic EM Methods." Unpublished Manuscript.