How Important is Health Inequality for Lifetime Earnings Inequality?

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*The views expressed do not necessarily reflect the position of the Federal Reserve Bank of Atlanta or the Federal Reserve System.

Introduction

- Poor health impacts individuals through several channels:
  - reduces labor productivity
  - increases costs of working, mortality risk, medical expenses
  - increases chance of access to social insurance programs (SSDI/SSI)

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graph

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  reduces labor productivity

  increases costs of working, mortality risk, medical expenses

  increases chance of access to social insurance programs (SSDI/SSI)

- Individuals in poor health have lower earnings and labor supply ▸ graph

- **Question:** How important is health inequality for lifetime earnings inequality?

- What are key channels?

  availability/generosity of Soc Ins – vs – higher costs/lower productivity of work

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2. **Empirical Analysis:** dynamic panel estimation using PSID data
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3. **Quantitative Analysis:** structural model consistent with empirical findings
   - agents in the model have heterogeneous and risky health profiles
   - use model to assess

     impact of health inequality on lifetime earnings inequality

     relative importance of each channel through which health operates

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3. **Quantitative Analysis:** structural model consistent with empirical findings
   - Find:
     - health inequality accounts for 30% of lifetime earnings inequality at age 65
     - 2/3 of which is due to the SSDI/SSI programs
     - yet, SSDI/SSI is ex-ante welfare improving

Related Literature

- Impact of health on labor supply/earnings: Bound et al. (1999), Blundell et al. (2017), French (2005), Garcia-Gomez et al. (2013), Lenhart (2019).
- SSDI and disability: Aizawa et al. (2020), French and Song (2014), Kitao (2014), Low and Pistaferri (2015), Meyer and Mok (2019), Michaud and Wiczer (2017).
- Health and inequality and income distribution: Capatina (2015), Capatina et al. (2020), Kim and Rhee (2020), O'Donnell et al. (2015), Prados (2017).
- Frailty index: Dalgaard and Strulik (2014), Hosseini et al. (2021), Schunemann et al. (2017a, 2017b), Searle et al. (2008).
- Impact of income/employment/wealth on health: Adda et al. (2009), Cutler et al. (2011) , Junna et al. (2020), Smith (1999, 2004, 2007), Schaller and Stevens (2015).
- Dynamic panel estimation: Blundell and Bond (1998), Blundell and Bond (2000), Arellano and Bond (1991), Arellano and Bover (1995), Al-Sadoon et al. (2019), Bond (2002), Roodman (2009).
- Health and savings: De Nardi et al. (2010), Kopecky and Koreskhova (2014), Porterba et al. (2017), Scholz and Seshadri (2013).
- Welfare costs of bad health: Cole et al. (2018), De Nardi et al. (2017), Rios-Rull and Pijoan-Mas (2019).

Plan of the Talk

How we measure health

Empirical Analysis

Structural Model

Calibration Highlights

Quantitative Exercise

How we measure health

- **Frailty index**: cumulative sum of all adverse health events (*deficits*)
  - Proposed and widely used in gerontology literature.

▸ gerontology literature

- Type of deficit variables used to construct frailty index in PSID:
  - Difficulties with ADL and IADL (eating, dressing, using phone, etc)
  - Diagnosis (ever had heart disease, psychological problems, loss of memory, etc)
  - Body measurements (BMI over 30, etc)
- Assign value of 1 whenever one of these conditions exists, and value of 0 o/w.
- Add them up and normalize to a number between 0 and 1.

▸ Why frailty?

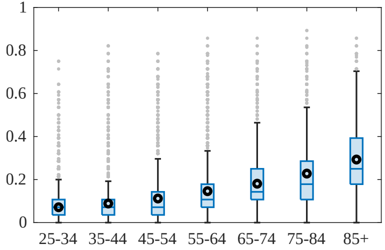
Why use frailty index?

1. Need objective measure of health to study health-contingent policies.
2. Easy to construct, univariate, and highly predictive of health-related outcomes:
   mortality, nursing home stay, DI recipiency, medical expenditures. ▸ tables
3. Better than self-reported health at predicting decline in health with age. ▸ illustration
4. Cardinal and measures health on a fine scale $\rightarrow$ we can observe variation in the unhealthy tail and its effects. ▸ graph
5. Can be treated as continuous variable $\rightarrow$ useful for estimating marginal effects.
6. Consistent measure of health across multiple datasets: PSID, MEPS, HRS.

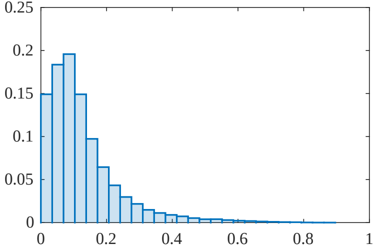
Summary Stats for Frailty

Sample: 2003–2017 PSID household heads + spouses, ages 25–94

Boxplots of frailty by age



Cross-sectional distribution



Mean	0.11	Median	0.07
by gender:		Standard deviation	0.11
male	0.11	*Wave-to-wave:*	
female	0.12	$+\Delta$ frailty	0.29
by education:		$-\Delta$ frailty	0.13
HS dropouts	0.16		
HS grads	0.12	Effect of 1 additional deficit	+0.037
college grads	0.08		

- Mean frailty increases with age and decreases with education.

all summary stats

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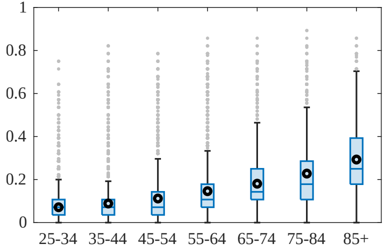

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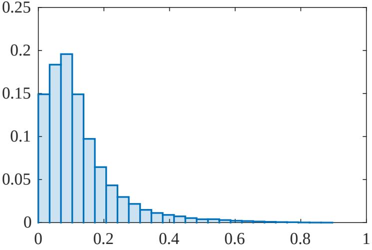

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- Cross-sectional distribution is right-skewed both overall and by age.

▸ all summary stats

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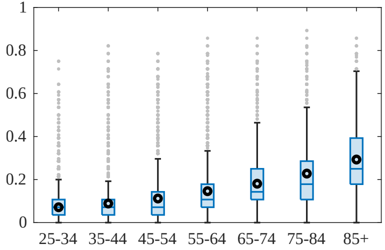

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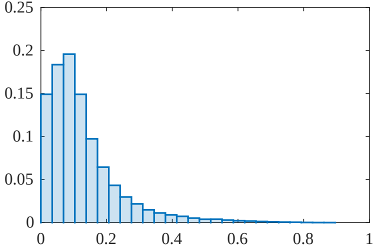

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- Both positive and negative changes in frailty from wave to wave.

all summary stats

Plan of the Talk

Empirical Analysis: Question

- What is the effect of health — measured by frailty — on earnings/hours/wages?
- We estimate the following regression

$$y_{i,t} = b_i + \gamma f_{i,t} + \alpha_1 y_{i,t-1} + \alpha_2 y_{i,t-2} + \delta \boldsymbol{Z}_{i,t} + \varepsilon_{i,t}$$

using Blundell-Bond System GMM estimator and PSID sample (ages 25-64)

$y_{i,t}$ is log of earnings (or hours, or wages)

$\boldsymbol{Z}_{i,t}$ is vector of exogenous controls: marital status, marital status×gender, # of kids, # of kids×gender, cubic in age, and year dummies

▸ Details

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- Why dynamic panel?
  - Want fixed effects to control for unobserved heterogeneity.
  - Earnings and frailty are both highly persistent variables.
  - Concerns of endogeneity/simultaneity.

▸ Details

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- Report $\gamma/27$: response of earnings/hours to one more deficit.

▸ Details

Effect of Frailty on Earnings

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{earnings}_{t-1})$	0.283					
	(0.364)					
$\log(\text{earnings}_{t-2})$	0.396					
	(0.298)					
frailty_t	-0.199^{***}					
	(0.061)					
AR(1) test (p-value)	0.455					
AR(2) test (p-value)	0.380					
Hansen test (p-value)	0.796					
Diff-in-Hansen test (p-value)	0.652					

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

frailty $\uparrow$ by 1 deficit
$\Downarrow$
earnings $\downarrow$ **19.9%**

Effect of Frailty on Earnings

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
log(earnings$_{t-1}$)	0.283	0.370	0.220			
	(0.364)	(0.319)	(0.362)			
log(earnings$_{t-2}$)	0.396	0.318	0.444			
	(0.298)	(0.259)	(0.297)			
frailty$_t$	-0.199^{***}					
	(0.061)					
frailty$_t$ × HSD		-0.232^{**}				
		(0.066)				
frailty$_t$ × HSG		-0.207^{***}				
		(0.058)				
frailty$_t$ × CG		-0.093^{*}				
		(0.052)				
frailty$_t$ × Bad Health			-0.193^{***}			
			(0.065)			
frailty$_t$ × Good Health			-0.071			
			(0.178)			
AR(1) test (p-value)	0.455	0.319	0.497			
AR(2) test (p-value)	0.380	0.474	0.298			
Hansen test (p-value)	0.796	0.132	0.826			
Diff-in-Hansen test (p-value)	0.652	0.360	0.827			

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Concentrated in less educated and those in bad health

▸ Age

Effect of Frailty on Earnings

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{earnings}_{t-1})$	0.283	0.370	0.220	1.474***	1.371***	1.293***
	(0.364)	(0.319)	(0.362)	(0.509)	(0.400)	(0.410)
$\log(\text{earnings}_{t-2})$	0.396	0.318	0.444	− 0.640	−0.569	−0.498
	(0.298)	(0.259)	(0.297)	(0.454)	(0.356)	(0.377)
frailty_t	−0.199***			− 0.036**		
	(0.061)			(0.017)		
frailty_t × HSD		−0.232**			− 0.068**	
		(0.066)			(0.030)	
frailty_t × HSG		−0.207***			− 0.046***	
		(0.058)			(0.002)	
frailty_t × CG		−0.093*			− 0.021	
		(0.052)			(0.018)	
frailty_t × Bad Health			−0.193***			− 0.036**
			(0.065)			(0.017)
frailty_t × Good Health			−0.071			− 0.065
			(0.178)			(0.066)
AR(1) test (*p*-value)	0.455	0.319	0.497	0.030	0.010	0.021
AR(2) test (*p*-value)	0.380	0.474	0.298	0.130	0.082	0.138
Hansen test (*p*-value)	0.796	0.132	0.826	0.434	0.826	0.543
Diff-in-Hansen test (*p*-value)	0.652	0.360	0.827	0.255	0.484	0.259

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Primarily due to extensive margin

Age

Effect of Frailty on Hours

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{hours}_{t-1})$	0.399	0.383	0.386	0.003	0.074	0.040
	(0.322)	(0.319)	(0.317)	(0.345)	(0.313)	(0.311)
$\log(\text{hours}_{t-2})$	0.263	0.269	0.272	0.304	0.168	0.282
	(0.257)	(0.253)	(0.253)	(0.218)	(0.221)	(0.219)
frailty_t	-0.144^{***}			0.003		
	(0.044)			(0.009)		
$\text{frailty}_t \times$ HSD		-0.177^{***}			-0.001	
		(0.049)			(0.013)	
$\text{frailty}_t \times$ HSG		-0.159^{***}			0.001	
		(0.045)			(0.010)	
$\text{frailty}_t \times$ CG		-0.082^{**}			0.009	
		(0.041)			(0.009)	
$\text{frailty}_t \times$ Bad Health			-0.137^{***}			0.001
			(0.046)			(0.010)
$\text{frailty}_t \times$ Good Health			-0.082			-0.002
			(0.128)			(0.034)
AR(1) test (p-value)	0.287	0.290	0.289	0.409	0.286	0.335
AR(2) test (p-value)	0.596	0.569	0.565	0.273	0.572	0.312
Hansen test (p-value)	0.971	0.317	0.838	0.060	0.166	0.174
Diff-in-Hansen test (p-value)	0.944	0.597	0.713	0.080	0.062	0.108

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Similar findings for hours

▸ Other Results

Effect of Frailty on Wages of Workers

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{wage}_{t-1})$				0.212	0.122	0.303
				(0.541)	(0.368)	(0.449)
$\log(\text{wage}_{t-2})$				0.532	0.600*	0.461
				(0.489)	(0.328)	(0.419)
frailty_t				−0.023**		
				(0.010)		
$\text{frailty}_t \times$ HSD					−0.069***	
					(0.023)	
$\text{frailty}_t \times$ HSG					−0.033***	
					(0.011)	
$\text{frailty}_t \times$ CG					−0.008	
					(0.011)	
$\text{frailty}_t \times$ Bad Health						−0.022*
						(0.012)
$\text{frailty}_t \times$ Good Health						0.013
						(0.062)
AR(1) test (p-value)	0.651	0.518	0.552			
AR(2) test (p-value)	0.454	0.189	0.474			
Hansen test (p-value)	0.085	0.374	0.207			
Diff-in-Hansen test (p-value)	0.044	0.145	0.082			
Note:	$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$					

Average effect of frailty on wages is small

Significant negative effect for less educated workers

Other Results

Effect of Earnings on Frailty

	Everyone			
	(1)	(2)	(3)	(4)
frailty_{t-1}	0.445	0.334	-0.152	-0.456
	(0.463)	(0.435)	(0.528)	(0.400)
frailty_{t-2}	0.602	0.661	1.124^{**}	1.446^{***}
	(0.447)	(0.443)	(0.495)	(0.404)
$\log(\text{earnings}_t)$	0.004*			
	(0.002)			
$\log(\text{earnings}_t) \times$ HSD		0.003		
		(0.002)		
$\log(\text{earnings}_t) \times$ HS		-0.008		
		(0.039)		
$\log(\text{earnings}_t) \times$ CL		0.000		
		(0.001)		
$\log(\text{earnings}_t) \times$ Bad Health			0.002	
			(0.002)	
$\log(\text{earnings}_t) \times$ Good Health			0.000	
			(0.003)	
$\log(\text{earnings}_t) \times$ Young				-0.000
				(0.001)
$\log(\text{earnings}_t) \times$ Old				-0.000
				(0.002)
AR(1) test (p-value)	0.531	0.573	0.501	0.001
AR(2) test (p-value)	0.333	0.260	0.061	0.002
Hansen test (p-value)	0.269	0.842	0.621	0.129
Diff-in-Hansen test (p-value)	0.450	0.852	0.894	0.132

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

No statistically significant effect of changes in earnings on frailty

Consistent with empirical literature

▸ empirical literature

Empirical Findings — Summary

- Increases in frailty reduce earnings and hours.
- The effect is
  - primarily driven by employment margin.
  - concentrated in less educated and less healthy individuals.
- These findings suggest that
  - health inequality may be an important source of lifetime earnings inequality.
  - social insurance may play an important role.
- Next: Quantify the impact of health inequality on lifetime earnings inequality (and importance of various channels).

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How we measure health

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Structural Model

Calibration Highlights

Quantitative Exercise

Quantitative Model Overview

- J period, OLG, GE model.
- Individuals are subject to exogenous shocks:
  - frailty, productivity, and job separation.
- If separated, can choose to pay a one-time wage cost and go back to work.
- Frailty impacts an individual's
  - Labor productivity
  - Mortality
  - OOP medical expenditures
  - Disutility of working
  - Probability of becoming DI beneficiary.

Quantitative Model Overview

- Individuals:
  - **Employed:**
    - If young: can choose to switch to non-employment.
    - If old: can choose to retire.
  - **Non-employed:**
    - Become a DI beneficiary with some probability.
    - Can choose to go to employed state.
  - **DI beneficiaries:**
    - Collect SSDI/SSI benefits until retirement at age R.
  - **Retirees:**
    - Collect social security benefits and do not work.
- Government: collects taxes (capital, income, payroll)
  - Pays out SS, SSDI, SSI, and means-tested transfers + exogenous government purchases.

Problem of Young Employed Individual

Employed individual with $j < R - 1$ solves

$$V^E(x, i_s) = \max_{c, a' \geq 0} u(c, v(f)) + \sigma \beta p(j, f, s) E\left[\max\left\{V^E(x', 1), V^N(x', 0)\right\}\right]$$
$$+ (1 - \sigma) \beta p(j, f, s) E\left[\max\left\{V^E(x', 0), V^N(x', 0)\right\}\right]$$

subject to ...

- individual state variable $x = (j, a, s, f, \epsilon, \bar{e})$

  j: age

  a: assets

  s: education

  f: frailty $\equiv \psi(j, s, \varepsilon_f)$ where ε_f is frailty shocks and fixed effect

  ϵ: productivity shock and fixed effect

  $\bar{e}$: average past earnings

Problem of Young Employed Individual

Employed individual with $j < R - 1$ solves

$$V^E(x, i_s) = \max_{c,a' \geq 0} u(c, v(f)) + \sigma \beta p(j, f, s) E\left[\max\left\{V^E(x', 1), V^N(x', 0)\right\}\right]$$
$$+ (1 - \sigma)\beta p(j, f, s) E\left[\max\left\{V^E(x', 0), V^N(x', 0)\right\}\right]$$

subject to

$$\frac{a'}{1+r} + c + m^E(j, f, s) = a + w\eta(j, f, s, \epsilon) - T(w\eta) - \chi(w\eta) i_s + Tr(x, i_s),$$

$$\bar{e}' = [(j-1)\bar{e} + w\eta]/j$$

- i_s: indicates the worker is coming from separation

Problem of Young Employed Individual

Employed individual with $j < R - 1$ solves

$$V^E(x, i_s) = \max_{c, a' \geq 0} u(c, v(f)) + \sigma \beta p(j, f, s) E\left[\max\left\{V^E(x', 1), V^N(x', 0)\right\}\right] + (1 - \sigma) \beta p(j, f, s) E\left[\max\left\{V^E(x', 0), V^N(x', 0)\right\}\right]$$

subject to ...

- Utility function is

$$u(c, v(f)) = \frac{\left(c^{\mu}(1 - v(f))^{1-\mu}\right)^{1-\gamma}}{1 - \gamma},$$

where $v(f) = \phi_0 + \phi_1 f^{\phi_2}, \quad \phi_0 \geq 0,\ \phi_1 \geq 0,$ and $\phi_2 \geq 0.$

Problem of Old Employed Individual

Employed individual with $j > R - 1$ solves

$$V^E(x, i_s) = \max_{c, a' \geq 0} u(c, v(f)) + \sigma p(j, f, s) E\left[\max\left\{V^E(x', 1), V^R(x')\right\}\right]$$
$$+ (1 - \sigma)\beta p(j, f, s) E\left[\max\left\{V^E(x', 0), V^R(x')\right\}\right]$$

subject to

$$\frac{a'}{1 + r} + c + m^R(j, f, s) = a + w\eta(j, f, s, \epsilon) + SS(\bar{e}) - T(w\eta)$$
$$-\chi(w\eta)i_s + Tr(x, i_s),$$

$$\bar{e}' = \bar{e}$$

Problem of Young Non-employed Individual

Non-employed individual with $j < R - 1$ solves

$$V^N(x, n_a) = \max_{c,a' \geq 0} u(c) + \theta(f, n_a)\beta p(j, f, s) E\left[V^D(x', 0)\right]$$
$$+ \left[1 - \theta(f, n_a)\right]\beta p(j, f, s) E\left[\max\left\{V^E(x', 1), V^N(x', n_a + 1)\right\}\right]$$

subject to

$$\frac{a'}{1 + r} + c + m^N(j, f, s) = a + Tr(x).$$

- n_a: number of periods in non-employment.
- Probability of successful DI application: $\theta(f, n_a) = \min\left\{1, \kappa_0 f^{\kappa_1} {n_a}^{\kappa_2}\right\}$

R-1

Problem of a DI Beneficiary

- DI beneficiary with $j < R - 1$ solves

$$V^D(x, n_d) = \max_{c, a' \geq 0} u(c) + \beta p(j, f, s) E\left[V^D(x', n_d + 1)\right]$$

subject to

$$\frac{a'}{1+r} + c + m^D(j, f, s, n_d) = a + SS(\bar{e}) + Tr(x, n_d).$$

- n_d: number of periods on DI.

R-1 Retiree Equilibrium Govt

Plan of the Talk

Calibration Strategy Overview

- Model period is 1 year.
- Agents live from $j = 1$ (age 25) to a maximum $J = 70$ (age 94).
- Frailty affects earnings through five channels:

1. Survival rate
2. Out of pocket medical expenditures
3. Labor productivity – proxied by hourly wages

} estimated outside model

4. Probability of successful DI application
5. Preferences – disutility of work

} calibrated using model

Details 1 Details 2

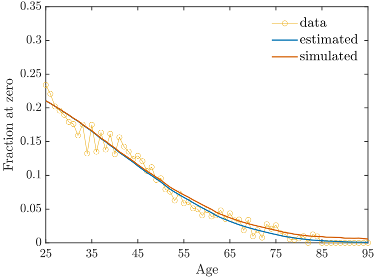
Stochastic process for frailty

- Assume positive fraction of people with zero frailty at age 25.
- Each period, frailty remains zero with probability $P(age)$ and becomes positive with probability $1 - P(age)$.
- If positive, log frailty is sum of
  - deterministic component: age poly
  - stochastic component: fixed effect, transitory shock, and AR(1) shock
- Estimate separately for each education group.
- To account for selection due to mortality, estimation uses
  - auxiliary simulation model
  - simulated method of moments

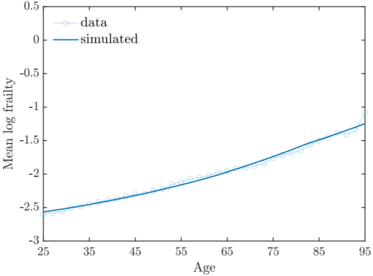
▸ Details ▸ Illustration

Stochastic frailty process for high school graduates

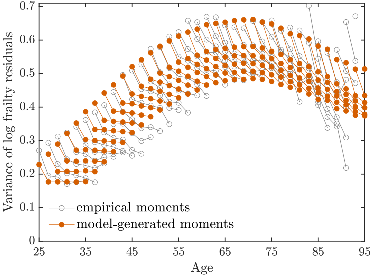
Fraction w/zero frailty



Mean log frailty age-profile (deterministic component targets)



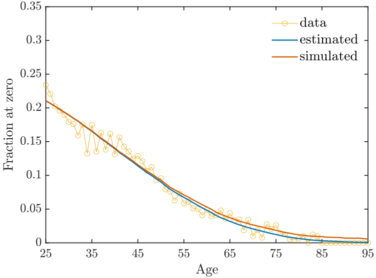
Variance-covariance moments (stochastic component targets)



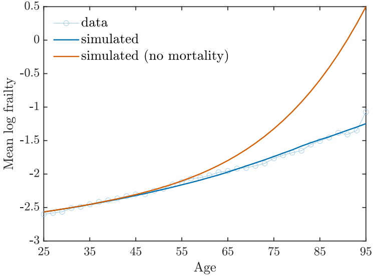
HSD COL

Stochastic frailty process for high school graduates

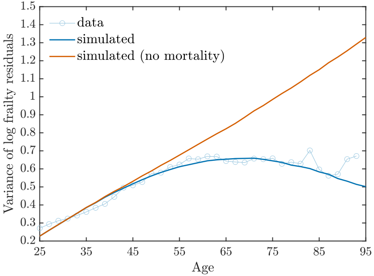
Fraction w/zero frailty



Mean log frailty age-profile (deterministic component targets)



Variance-covariance moments (stochastic component targets)



- **Important to account for selection:** effects of mortality on mean and variance of log frailty are large at older ages.

▸ HSD ▸ COL

Stochastic process for productivity

- By education, log productivity (wage) is sum of
  - deterministic component: age poly and quadratic frailty effect
  - stochastic component: fixed effect and AR(1) shock
- Frailty effects are estimated using dynamic panel system GMM estimator.
  - Correct for selection bias using a procedure recommended by Al-Saddoon et al. (2019).
- Effect of an additional deficit on wage:

	HSD	HSG	COL (frailty $<$ 76th prctile)	COL (frailty $=$ 95th prctile)
Before correction	-4.2%	-2.5%	0%	-2.6%
After correction	-4.4%	-2.7%	0%	-2.8%

▸ Details ▸ Compare ▸ Severe disability

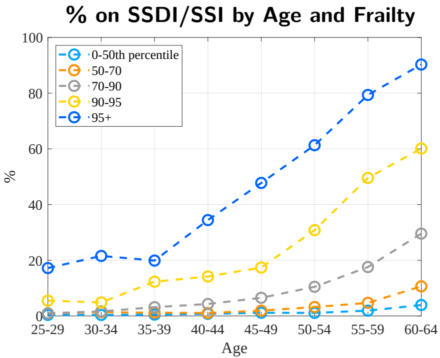
Disutility of Work vs DI Probabilities

Identification Strategy

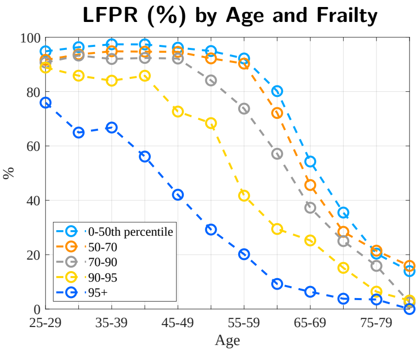
- DI probability and disutility of work parameters calibrated using the model.
- Calibration targets:
  - DI recipiency rates by age and frailty for ages 25 to 64.
  - Labor force participation by age and frailty for ages 25 to 74.
  - Relative DI acceptance rate by number of years tried.
- Effect of frailty on disutility of work is identified by

  dispersion in LFPR's by frailty for 65-74 year-olds.
- **Idea:** DI process does not directly affect labor supply after age 65.

DI and LFP by Age and Frailty: Model vs Data



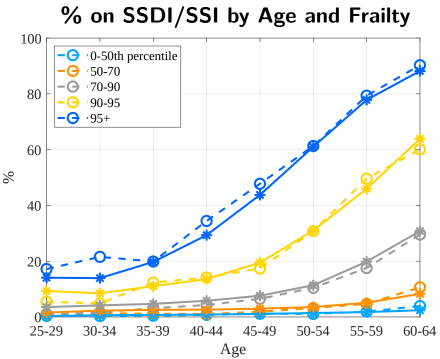
Data source: MEPS 2000–2016 and SSA.

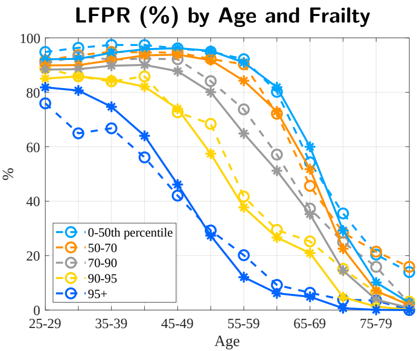


Data source: 2003–2015 PSID men ages 25-84.

- Target more moments in the unhealthy tail of frailty distribution.

DI and LFP by Age and Frailty: Model vs Data

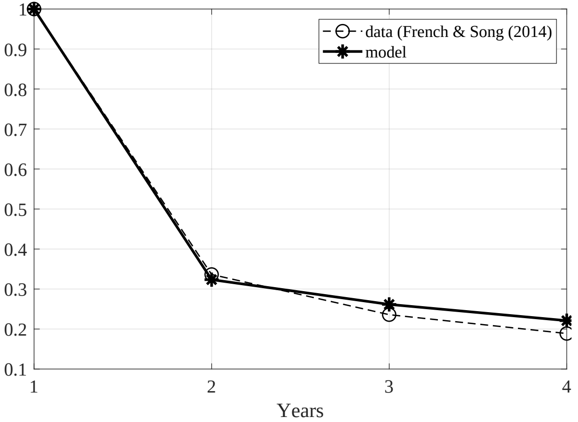




- Target more moments in the unhealthy tail of frailty distribution.
- Model matches moments well including the dispersion in LFPR's by frailty for 65-74 year-olds.
- DI probability and disutility from working are increasing and convex in frailty.

Values

DI acceptance rate: Model vs. Data



Data source: French and Song (2014)

- Model also matches rate of decline in DI acceptance by year since initial application
- DI probability increases in numbers of years since initially applied.

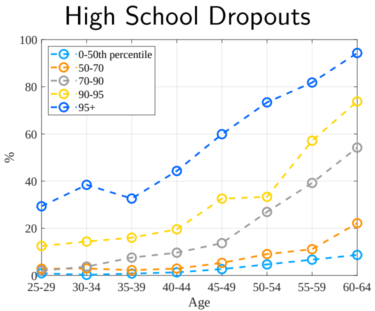
Calibrated Values

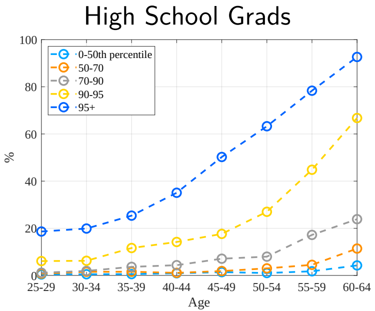
Table: DI Probability and Disutility Parameter Values

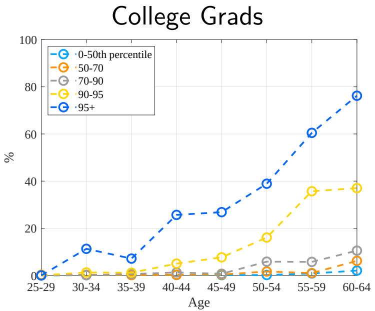
Parameter	Description	Value
κ_0	level	179
κ_1	elasticity w.r.t. frailty	5.9
κ_2	elasticity w.r.t. 'number of attempts'	0.6
ϕ_0	level	0.64
ϕ_1	frailty level effect	2.8
ϕ_2	elasticity w.r.t frailty	5.5

- DI probability $\theta(f, n_a) = \min\{1, \kappa_0 f^{\kappa_1} n_a^{\kappa_2}\}$ increases in frailty and number of years since initially applied.
- Disutility from working $v(f) = \phi_0 + \phi_1 f^{\phi_2}$ is increasing and convex in frailty.

Assessment: % on DI by frailty, age, and education

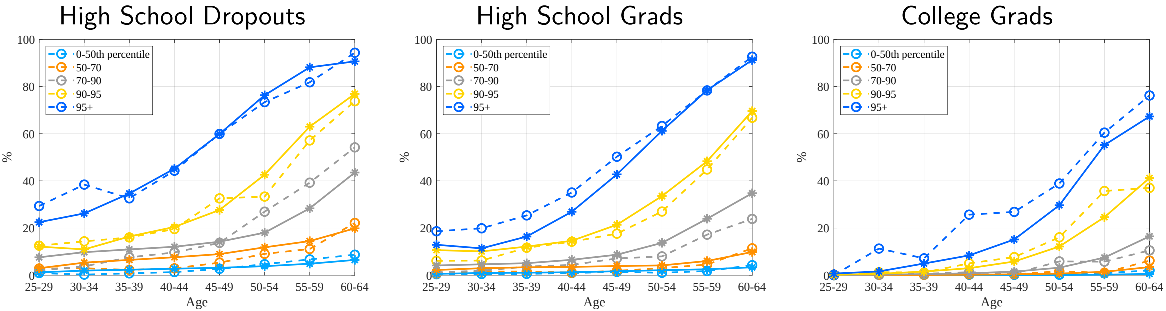






Larger Aggregate Go Back

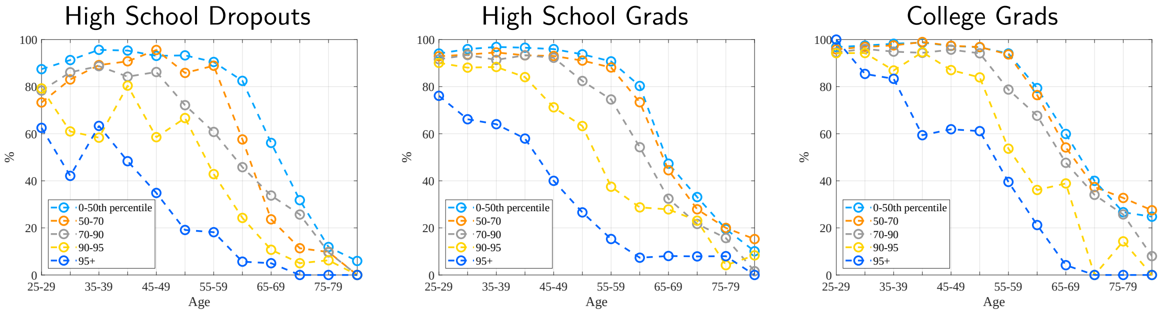
Assessment: % on DI by frailty, age, and education



- The model matches levels and patterns of DI recipiency education.

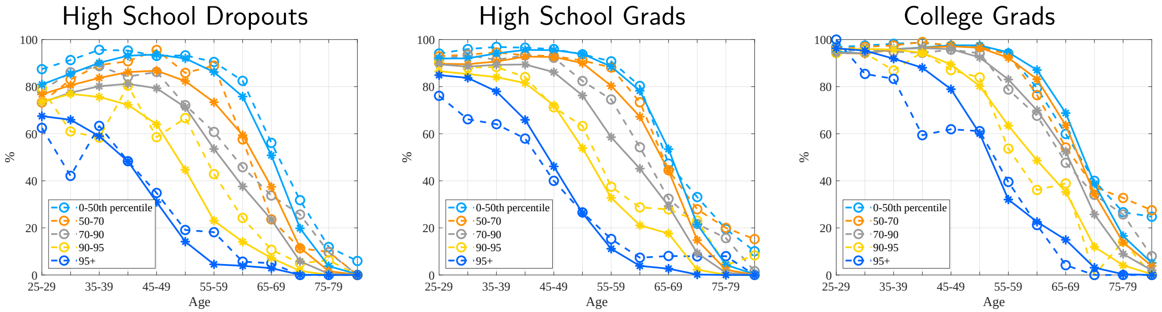
Larger Aggregate Go Back

Assessment: LFP by frailty, age, and education



▸ Larger ▸ Aggregate ▸ Go Back

Assessment: LFP by frailty, age, and education



- The model matches levels and patterns of LFP by education.

▸ Larger ▸ Aggregate ▸ Go Back

Assessment: Impact of DI benefit denial on labor force participation

Table: Individuals denied benefits in first year of application: fraction working 3 years later

Ages	Period	25–64	35–64	45–64
Model		31%	28%	26%
Empirical estimates				
French & Song (2014)	1990's		26%	
Maestas et al. (2013)	early 2000's	27%		
Von Wachter et al. (2011)	1982			31%
Von Wachter et al. (2011)	1997			35%
Bound (1989)	1977			32%

French & Song (2014) is for individuals denied benefits 2 years after application. Maestas et al. (2013) is for 18 to 64 year-olds.

- Labor force participation of those denied DI benefits are consistent with empirical estimates.

Details

Plan of the Talk

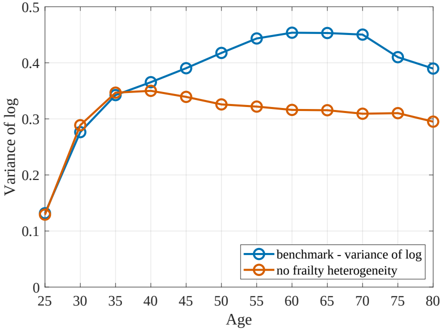
Quantitative Exercise

- To understand the impact of health inequality on lifetime earnings inequality:
  - Consider a counterfactual economy where everyone has the same (average) frailty profile.
  - What is the impact on inequality in lifetime earnings at each age?

lifetime earnings at age j = sum of all earnings up to age j

inequality = variance of log

Lifetime earnings inequality by age: Variance of log



	Age 45	Age 55	Age 65	Age 75
Benchmark	0.390	0.443	0.453	0.410
No frailty heterogeneity	0.339	0.322	0.315	0.310
$\triangle \downarrow$	13.1%	27.4%	30.4%	24.3%

▸ Zeros ▸ Ratios ▸ Gini ▸ Decomp

Quantitative Model Results: Decomposition

- How important are each of the 5 channels through which health affects individuals?
  1. Probability of getting DI
  2. Labor productivity
  3. Disutility
  4. Medical expenses
  5. Survival probability
- To assess the importance of each channel:
  - Run 5 counterfactuals
  - Counterfactual 1: Equivalent to baseline except probability of DI is determined by average frailty profile.
  - And so on...

Computational Experiments: Decomposition

Table: Effect of removing frailty variation in each channel on the variance of log lifetime earnings

	age 45	age 55	age 65	age 75
1. DI channel	$\downarrow$ 0.6%	$\downarrow$ 14.2%	$\downarrow$ 21.0%	$\downarrow$ 19.9%
2. Labor prod channel	$\downarrow$ 2.3%	$\downarrow$ 3.7%	$\downarrow$ 4.1%	$\downarrow$ 4.3%
3. Disutility channel	$\downarrow$ 0.4%	$\downarrow$ 0.8%	$\downarrow$ 1.0%	$\downarrow$ 0.9%
4. Med exp channel	$\downarrow$ 0.1%	$\downarrow$ 0.2%	$\downarrow$ 0.0%	$\uparrow$ 0.0%
5. Surv prob channel	$\downarrow$ 0.9%	$\uparrow$ 0.3%	$\uparrow$ 8.3%	$\uparrow$ 5.9%

- These three channels are least important.

Computational Experiments: Decomposition

Table: Effect of removing frailty variation in each channel on the variance of log lifetime earnings

	age 45	age 55	age 65	age 75
1. DI channel	$\downarrow$ 0.6%	$\downarrow$ 14.2%	$\downarrow$ 21.0%	$\downarrow$ 19.9%
2. Labor prod channel	$\downarrow$ 2.3%	$\downarrow$ 3.7%	$\downarrow$ 4.1%	$\downarrow$ 4.3%
3. Disutility channel	$\downarrow$ 0.4%	$\downarrow$ 0.8%	$\downarrow$ 1.0%	$\downarrow$ 0.9%
4. Med exp channel	$\downarrow$ 0.1%	$\downarrow$ 0.2%	$\downarrow$ 0.0%	$\uparrow$ 0.0%
5. Surv prob channel	$\downarrow$ 0.9%	$\uparrow$ 0.3%	$\uparrow$ 8.3%	$\uparrow$ 5.9%

- Removing DI channel $\uparrow$ inequality at younger ages and $\downarrow$ it at older ages.

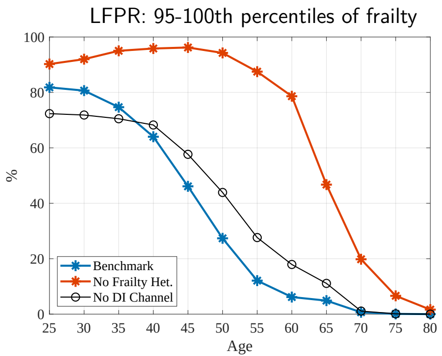
Computational Experiments: Decomposition

Table: Effect of removing frailty variation in each channel on the variance of log lifetime earnings

	age 45	age 55	age 65	age 75
1. DI channel	↓ 0.6%	↓ 14.2%	↓ 21.0%	↓ 19.9%
2. Labor prod channel	↓ 2.3%	↓ 3.7%	↓ 4.1%	↓ 4.3%
3. Disutility channel	↓ 0.4%	↓ 0.8%	↓ 1.0%	↓ 0.9%
4. Med exp channel	↓ 0.1%	↓ 0.2%	↓ 0.0%	↑ 0.0%
5. Surv prob channel	↓ 0.9%	↑ 0.3%	↑ 8.3%	↑ 5.9%

- Removing DI channel ↑ inequality at younger ages and ↓ it at older ages.
- Removing productivity channel ↓ lifetime earnings inequality at all ages.

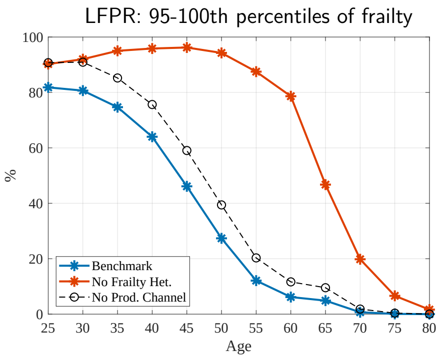
LFP of Highly Frail in Counterfactural Economies



- Without DI channel:
  - Frail individuals no longer qualify for DI w/ high probability $\Rightarrow$ Highly frail old's LFP $\uparrow$
  - Less incentive to work to accumulate SSDI earnings credits $\Rightarrow$ Highly frail young's LFP $\downarrow$.

▸ Details ▸ Income ▸ Consumption ▸ Aggregate Effects

LFP of Highly Frail in Counterfactural Economies



- Without productivity channel:
  - Wages of frail individuals ↑ ⇒ Highly frail LFP ↑ at all ages.

▸ Details ▸ Income ▸ Consumption ▸ Aggregate Effects

Welfare effects of eliminating the DI program

- SSDI/SSI is primary channel through which health inequality leads to $\uparrow$ lifetime earnings inequality. Should we eliminate it?

Welfare effects of eliminating the DI program

- SSDI/SSI is primary channel through which health inequality leads to ↑ lifetime earnings inequality. Should we eliminate it?

- No, removing DI program reduces ex-ante welfare.

Ex-ante welfare changes (% of lifetime consumption)

	Average	HSD	HSG	COL
No DI program (PE) no benefits or DI payroll taxes	-1.16%	-3.14%	-1.81%	0.74%
No DI program (GE), prop. increase in income taxes	-1.80%	-3.70%	-2.45%	0.05%
No DI program (GE), reduction of consumption floor	-2.50%	-5.81%	-3.22%	0.09%

Understanding the welfare value of DI: insurance v. redistribution

- Ex ante welfare losses are due to a loss of both insurance and redistribution.

- To understand their relative importance, consider a DI program with no redistribution across education: DI is self-financed within each education group.

Understanding the welfare value of DI: insurance v. redistribution

Ex-ante welfare changes (% of lifetime consumption)

	Average	HSD	HSG	COL
No DI program (PE) no benefits or DI payroll taxes	-1.16%	-3.14%	-1.81%	0.74%
No DI redistribution (PE), benefits financed by education-specific payroll taxes	-0.20%	-1.99%	-0.54%	1.08%
No DI redistribution (GE), income taxes adjust to clear govt budget				

- About two-thirds (one-third) of welfare benefit of DI for HSD (HSG) comes from redistribution.

Understanding the welfare value of DI: insurance v. redistribution

Ex-ante welfare changes (% of lifetime consumption)

	Average	HSD	HSG	COL
No DI program (PE) no benefits or DI payroll taxes	-1.16%	-3.14%	-1.81%	0.74%
No DI redistribution (PE), benefits financed by education-specific payroll taxes	-0.20%	-1.99%	-0.54%	1.08%
No DI redistribution (GE), income taxes adjust to clear govt budget	-1.61%	-3.21%	-1.93%	-0.42%

- In PE, college value DI program with no redistribution.
- But, they are worse off in GE because increased reliance on means-tested programs leads to higher income taxes.

Conclusion

- Document empirically:
  - Large response of earnings to incremental changes in frailty: mostly driven by participation.
  - Wage effects for less educated workers.
- Results from structural model:
  - Health inequality accounts for a substantial fraction (30%) of lifetime earnings inequality at age 65.
  - Reduced participation due to increased access to SSDI/SSI when health is poor plays an important role.
  - Yet, SSDI/SSI is ex-ante welfare improving.

The End

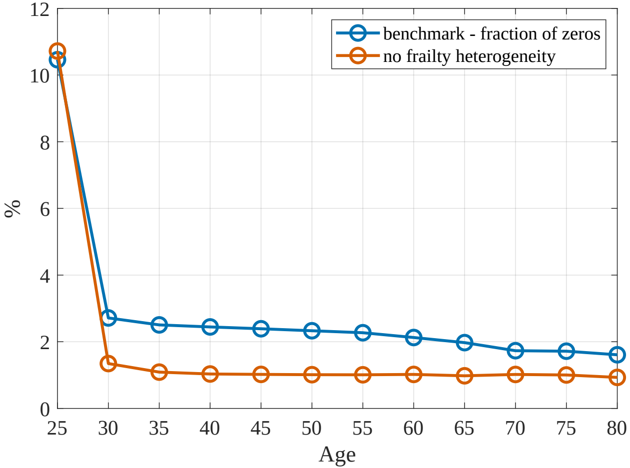
Thank You!

Plan of the Talk

back up

Back Up Slides

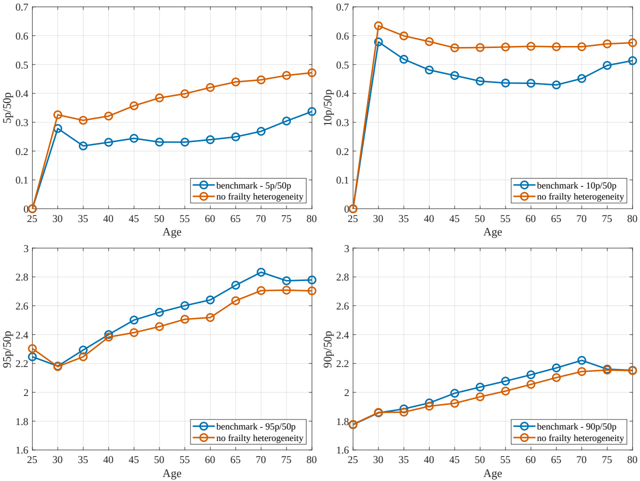
Fraction at zero: Model vs Data



- Removing frailty heterogeneity also reduces the fraction with zero lifetime earnings.

Go Back

Lifetime earnings inequality by age: Ratios

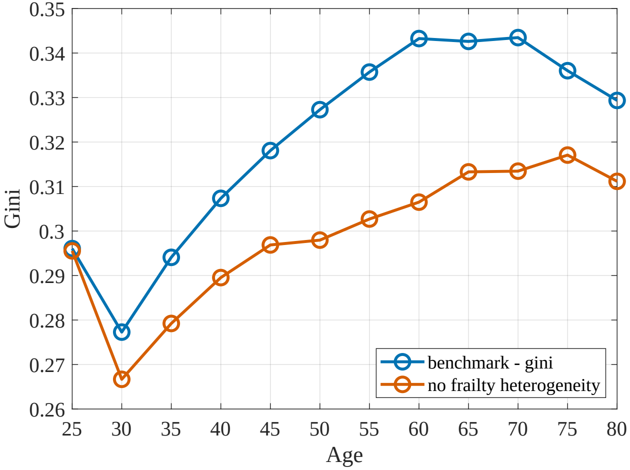


- Impact is concentrated in the bottom of the lifetime earnings distribution.

Go Back

Quantitative Model Results

Lifetime earnings inequality by age: Gini



- Removing frailty heterogeneity reduces the Gini of lifetime earnings at age 65 by 8.5%.

Go back

Lifetime earnings inequality by age: Variance decomposition

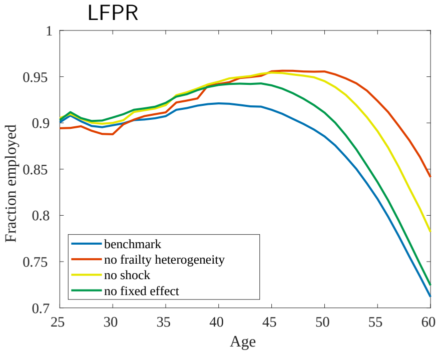
Contribution of Ex-ante Heterogeneity vs. Frailty Shocks

	Age 45	Age 55	Age 65	Age 75
Benchmark	0.390	0.443	0.453	0.410
No frailty heterogeneity	0.339	0.322	0.315	0.310
$\triangle \downarrow$	13.1%	27.4%	30.4%	24.3%
No frailty fixed effect	0.349	0.388	0.392	0.367
$\triangle \downarrow$	10.5%	12.4%	13.5%	10.6%
No frailty shock	0.338	0.337	0.349	0.346
$\triangle \downarrow$	13.5%	24.0%	22.9%	15.7%

- Health shocks account for $\approx 2/3$'s of the impact of health inequality on lifetime earnings inequality.
- Removing heterogeneity vs risk vs both impacts both amount and timing of lifecycle labor supply.

Details Go back

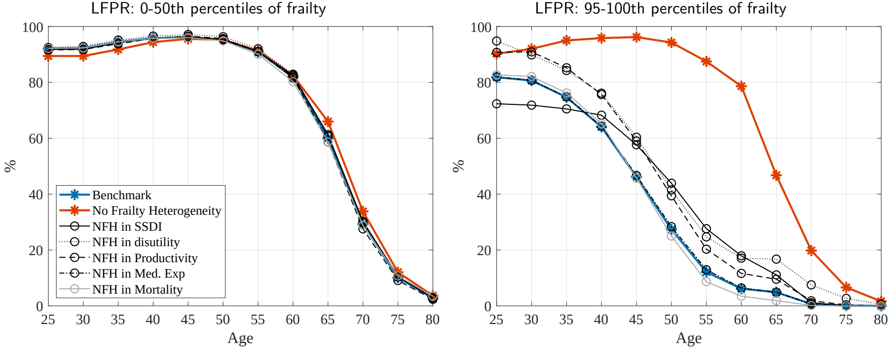
Removing heterogeneity vs shocks vs both: Fraction employed



- No fixed effect, shocks, or both: lifetime labor supply ↑ ⇒ lifetime earnings inequality ↓
- No fixed effects **and** no shocks: labor supply of young ↓ ⇒ lifetime earnings inequality ↑
- No fixed effects **or** no shocks: labor supply of young ↑ ⇒ lifetime earnings inequality ↓

▸ Go back

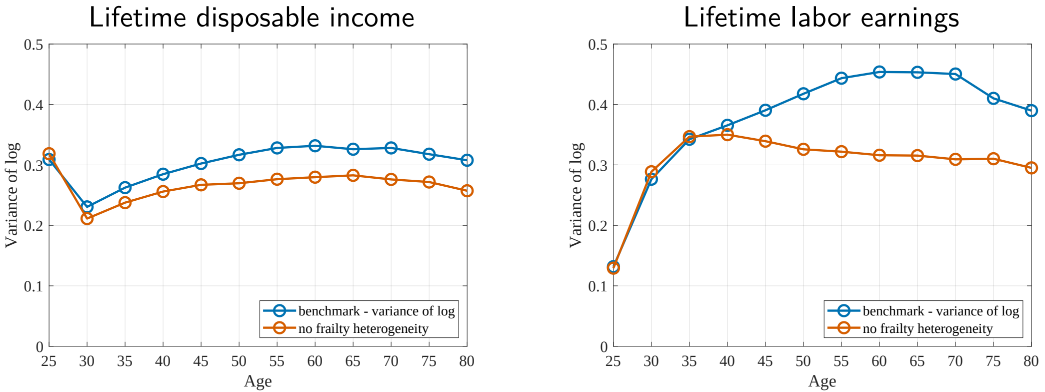
LFP in Counterfactural Economies



- LFP effects of removing frailty inequality are very small in healthy half of distribution.
- Without DI channel: LFP is lower at young ages and higher at older ages.
- Without productivity channel: LFP of highly frail is higher at all ages.

Go Back

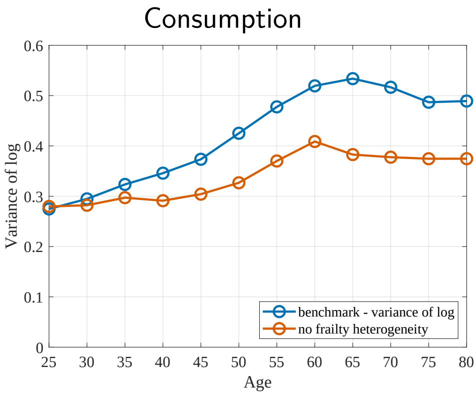
Alternative measures of inequality: Variance of log

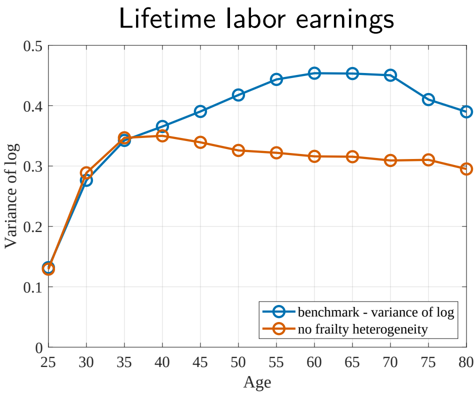


	Age 45	Age 55	Age 65	Age 75
Benchmark	0.302	0.328	0.326	0.318
No frailty heterogeneity	0.267	0.276	0.283	0.272
$\triangle\downarrow$	11.7%	15.8 %	13.3%	14.5%

▸ Details
▸ Go back

Consumption inequality: Variance of log





	Age 45	Age 55	Age 65	Age 75
Benchmark	0.373	0.478	0.534	0.487
No frailty heterogeneity	0.304	0.370	0.383	0.375
$\triangle \downarrow$	18.5%	22.5 %	28.3%	23.1%

Go back

Aggregate effects of frailty heterogeneity

	NFH in model	NFH in DI	NFH in Disutility	NFH in Labor prod.	NFH in Med. Exp.	NFH in Mortality
	% change relative to benchmark					
GDP	2.15	1.35	2.25	1.75	0.13	−0.72
Consumption	0.92	0.61	1.68	1.14	0.09	−1.54
Capital	2.15	1.35	2.25	1.75	0.13	−0.72
Labor input	2.15	1.35	2.25	1.75	0.13	−0.72
Hours	3.48	1.35	2.95	2.23	0.17	−0.50
GDP per Hour	−1.29	0.01	−0.67	−0.46	−0.04	−0.23

Note: NFH: no frailty heterogeneity.

- Removing frailty heterogeneity increases GDP per capita.
- Effects of higher LFP larger than effect of lower mortality.

Go Back

Alternative Inequality Measure

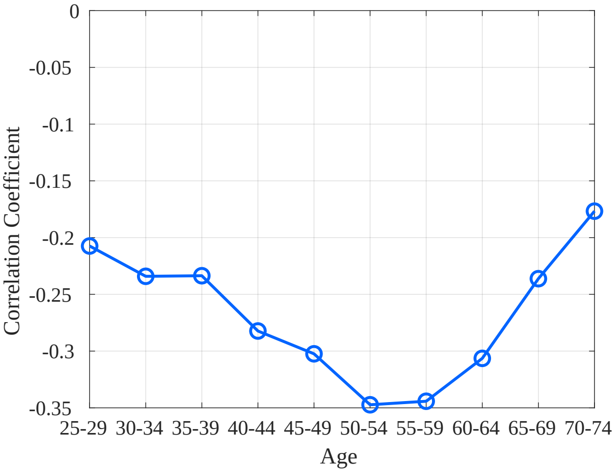
Inequality in lifetime disposable income by age: Variance of Log

	Age 45	Age 55	Age 65	Age 75
Benchmark	0.302	0.328	0.326	0.318
No frailty heterogeneity	0.267	0.276	0.283	0.272
$\triangle \downarrow$	11.7%	15.8 %	13.3%	14.5%
No frailty shock	0.261	0.277	0.286	0.275
$\triangle \downarrow$	13.5%	15.7%	12.4%	13.4%
No frailty fixed effect	0.265	0.287	0.286	0.274
$\triangle \downarrow$	12.4%	12.5%	12.2%	13.7%

- Both shocks and fixed effect have a large effect on disposable income inequality.

Go Back

Frailty-Earnings Correlation by Age



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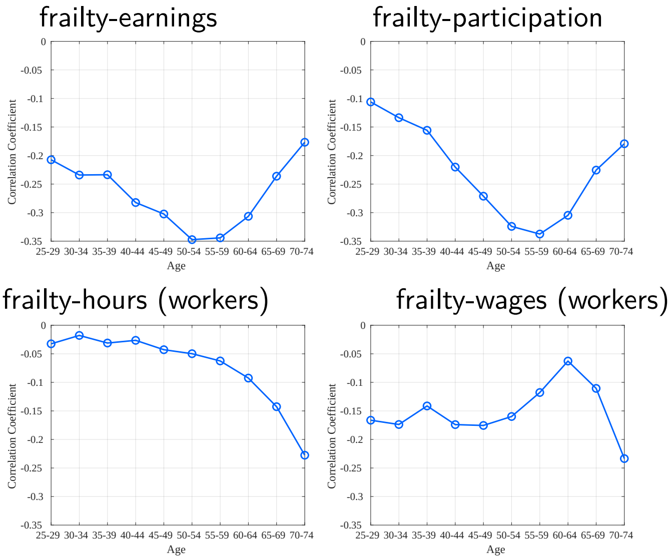
Frailty Correlations by Age



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Gerontology Literature

- Mitnitski et al. (2001); Mitnitski et al. (2002)
- Mitnitski et al. (2005); Goggins et al. (2005)
- Searle et al. (2008); Yang and Lee (2010)
- Woo et al. (2005); Rockwood and Mitnitski (2007)
- Rockwood et al. (2007); Mitnitski et al. (2004)
- Kulminski et al. (2007a); Kulminksi et al. (2007b)

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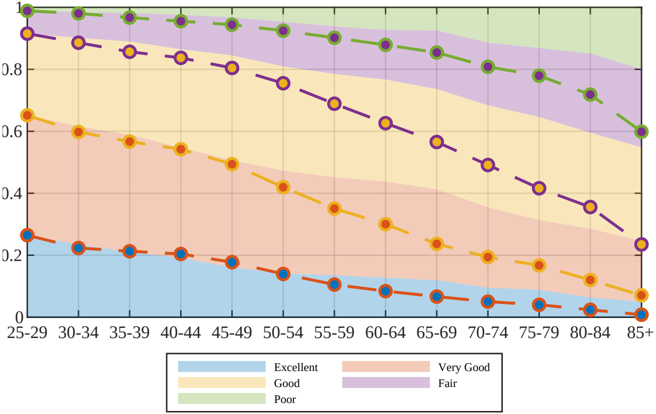
Frailty and SRHS over the Life Cycle

Data: Household heads and spouses in 2003–2015 PSID



- Area shows share reporting each SRHS at each age.
- We partition frailty distribution at each age.
- Choose cutoffs to match dist. of SRHS at 25-29.
- Hold cutoffs fixed.

  Health declines faster after age 50 when measured by frailty.

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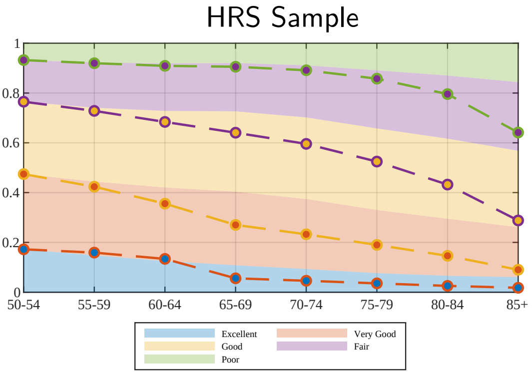
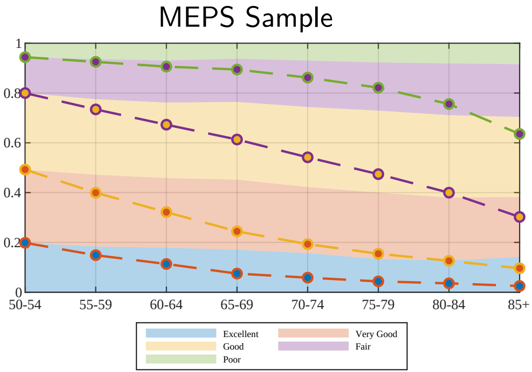
Frailty and SRHS over the Life Cycle





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Probit: Becoming a DI recipient (HRS)

	Panel A: everyone			Panel B: by SRHS health at $t-1$				
				'Excellent	'Very good'	'Good'	'Fair'	'Poor'
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
very good$_{t-1}$	0.070		-0.085					
	(0.049)		(0.053)					
good$_{t-1}$	0.418***		0.015					
	(0.046)		(0.051)					
fair$_{t-1}$	0.984***		0.306***					
	(0.046)		(0.053)					
poor$_{t-1}$	1.597***		0.555***					
	(0.049)		(0.058)					
frailty$_{t-1}$		7.275***	6.098***	6.572***	4.310***	4.676***	5.381***	4.806***
		(0.253)	(0.273)	(1.256)	(0.879)	(0.613)	(0.518)	(0.725)
frailty$^2_{t-1}$		-4.929***	-4.387***	-3.297	-0.388	-0.792	-3.438***	-3.550***
		(0.368)	(0.384)	(2.478)	(1.806)	(1.036)	(0.735)	(0.833)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	76,513	76,513	76,513	12,478	25,409	23,486	11,679	3,461
Pseudo R^2	0.178	0.239	0.252	0.211	0.116	0.161	0.111	0.064

Data: HRS respondents under age 66. Panel A are results from the full sample while Panel B are results obtained using sub-samples based on SRHS in wave $t-1$. Controls are gender, education, marital status and quadratic in age. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors in parentheses.

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Probit: Becoming a DI recipient (PSID)

	Panel A: younger than 66			Panel B: by SRHS health at $t-1$				
				'Excellent	'Very good'	'Good'	'Fair'	'Poor'
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
very good$_{t-1}$	0.080		-0.054					
	(0.073)		(0.077)					
good$_{t-1}$	0.487***		0.208***					
	(0.067)		(0.072)					
fair$_{t-1}$	1.013***		0.484***					
	(0.069)		(0.076)					
poor$_{t-1}$	1.622***		0.745***					
	(0.078)		(0.089)					
frailty$_{t-1}$		7.380***	5.992***	6.061***	5.595***	5.361***	5.672***	4.232***
		(0.385)	(0.408)	(2.310)	(1.300)	(0.879)	(0.830)	(1.212)
frailty$^2_{t-1}$		-5.558***	-4.879***	-7.942	-3.237	-2.366	-4.030***	-3.262**
		(0.654)	(0.676)	(7.899)	(3.188)	(1.928)	(1.352)	(1.572)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	45,906	45,906	45,906	9,240	16,816	14,271	4,542	1,037
Pseudo R^2	0.187	0.232	0.251	0.145	0.118	0.151	0.111	0.077

Data: PSID respondents under age 66. Panel A are results from the full sample while Panel B are results obtained using sub-samples based on SRHS in wave $t-1$. Controls are gender, education, marital status and quadratic in age. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors in parentheses.

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Probit: Becoming a DI recipient - under 45 only (PSID)

	Panel A: younger than 45			**Panel B:** by SRHS health at $t-1$				
				'Excellent	'Very good'	'Good'	'Fair'	'Poor'
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
very good$_{t-1}$	0.113		-0.024					
	(0.100)		(0.105)					
good$_{t-1}$	0.330***		0.055					
	(0.097)		(0.104)					
fair$_{t-1}$	0.999***		0.479***					
	(0.099)		(0.110)					
poor$_{t-1}$	1.550***		0.627***					
	(0.125)		(0.146)					
frailty$_{t-1}$		6.964***	5.838***	4.036	5.788***	4.022***	6.242***	9.881***
		(0.651)	(0.687)	(2.863)	(1.803)	(1.407)	(1.381)	(3.044)
frailty$^2_{t-1}$		-4.370***	-3.910***	-5.259	-0.602	0.691	-4.022*	-9.945**
		(1.175)	(1.209)	(9.696)	(4.266)	(2.964)	(2.243)	(4.085)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	23,475	23,475	23,475	5,693	9,062	6,650	1,775	295
Pseudo R^2	0.153	0.218	0.237	0.097	0.158	0.149	0.152	0.149

Data: PSID respondents under age 66. Panel A are results from the full sample while Panel B are results obtained using sub-samples based on SRHS in wave $t-1$. Controls are gender, education, marital status and quadratic in age. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors in parentheses.

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Probit: Mortality

	Panel A: everyone			Panel B: by SRHS health at $t-1$				
				'Excellent	'Very good'	'Good'	'Fair'	'Poor'
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
very good$_{t-1}$	0.053**		-0.007					
	(0.024)		(0.025)					
good$_{t-1}$	0.293***		0.120***					
	(0.023)		(0.024)					
fair$_{t-1}$	0.649***		0.300***					
	(0.023)		(0.025)					
poor$_{t-1}$	1.186***		0.570***					
	(0.024)		(0.027)					
frailty$_{t-1}$		2.970***	1.886***	2.595***	2.377***	2.456***	1.345***	0.499
		(0.098)	(0.107)	(0.452)	(0.267)	(0.215)	(0.233)	(0.350)
frailty$^2_{t-1}$		-0.490***	0.105	0.295	0.463	0.164	1.000***	1.406***
		(0.120)	(0.126)	(0.651)	(0.368)	(0.275)	(0.265)	(0.350)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	212,978	212,978	212,978	23,689	53,552	57,117	34,890	14,109
Pseudo R^2	0.217	0.241	0.251	0.259	0.233	0.220	0.188	0.148

Data: HRS. Panel A are results from the full sample while Panel B are results obtained using sub-samples based on SRHS in wave $t-1$. Controls are gender, education, marital status and quadratic in age. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors in parentheses.

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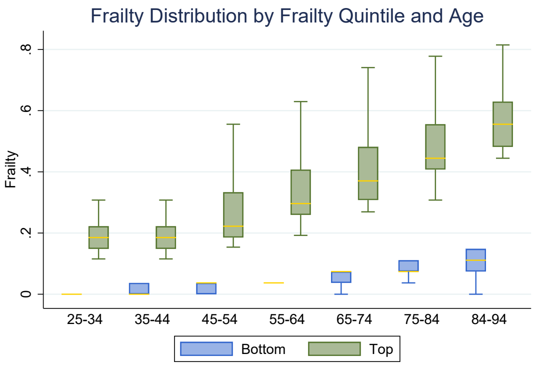
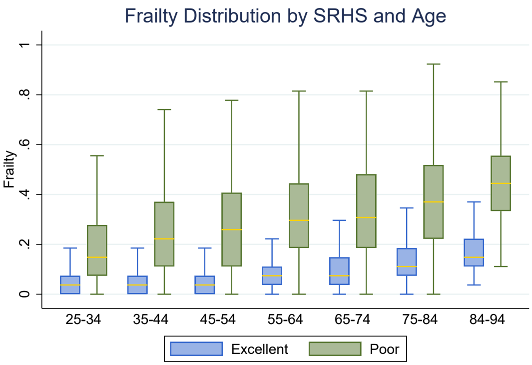
Probit: Entering Nursing Home

	Panel A: everyone			**Panel B:** by SRHS health at $t-1$				
				'Excellent	'Very good'	'Good'	'Fair'	'Poor'
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)
very good_{t-1}	0.008		-0.064					
	(0.044)		(0.046)					
good_{t-1}	0.139***		-0.044					
	(0.042)		(0.045)					
fair_{t-1}	0.360***		0.012					
	(0.043)		(0.047)					
poor_{t-1}	0.700***		0.125**					
	(0.045)		(0.052)					
frailty_{t-1}		1.975***	1.798***	2.580**	1.445**	2.089***	0.574	-0.437
		(0.211)	(0.227)	(1.010)	(0.577)	(0.470)	(0.469)	(0.667)
frailty^2_{t-1}		0.160	0.160	-0.791	1.449	-0.113	1.437**	2.212***
		(0.269)	(0.279)	(1.641)	(0.908)	(0.661)	(0.562)	(0.683)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	168,412	168,412	168,412	19,602	49,875	53,616	33,040	12,279
Pseudo R^2	0.231	0.261	0.263	0.369	0.288	0.256	0.218	0.166

Data: HRS. Panel A are results from the full sample while Panel B are results obtained using sub-samples based on SRHS in wave $t-1$. Controls are gender, education, marital status and quadratic in age. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors in parentheses.

Why use frailty index?





Lots of action in the tails: need for finer grid.

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Summary Statistics for PSID Sample

	2002	2004	2006	2008	2010	2012	2014	2016	Pooled 2002-2016
Panel A: Mean (median) [standard deviation] of sample characteristics									
Age	44.33	44.28	44.34	44.58	44.74	45.02	45.4	45.54	44.65
	(43)	(43)	(43)	(43)	(43)	(43)	(43)	(42)	(43)
	[15.24]	[15.53]	[15.67]	[15.8]	[16.01]	[16.08]	[16.04]	[15.99]	[15.71]
Frailty	0.1	0.1	0.11	0.11	0.12	0.12	0.12	0.12	0.11
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.1)	(0.07)	(0.07)
	[0.1]	[0.11]	[0.11]	[0.11]	[0.12]	[0.12]	[0.12]	[0.12]	[0.12]
Annual Earnings	$35,623.31	$35,992.43	$36,313.91	$36,712.28	$33,658.89	$34,072.19	$33,635.38	$35,303.67	$35,095.34
	(27,231.43)	(27,247.63)	(27,474.38)	(26,544.91)	(22,987.3)	(23,000)	(23,339.49)	(24,978.14)	(25,564.01)
	[68,179.23]	[63,875.82]	[62,243.45]	[74,320.19]	[57,064.71]	[87,518.92]	[65,135.22]	[51,803.91]	[64,377.99]
Annual Hours	1,531.6	1,528.01	1,517.57	1,448.99	1,377.42	1,411.74	1,434.46	1,471.19	1,476.92
	(1,888)	(1,880)	(1,880)	(1,813.5)	(1,700)	(1,783)	(1,814)	(1,872)	(1,840.5)
	[1,035.63]	[1,049.47]	[1,042.58]	[991.18]	[1,033.49]	[1,045.86]	[1,057.89]	[1,059.13]	[1,037.86]
Hourly Wage	$23.43	$24.31	$24.35	$24.76	$24.14	$23.59	$23.11	$24.03	$23.78
	(17.67)	(17.77)	(17.67)	(18.74)	(17.76)	(17)	(17.23)	(18)	(17.68)
	[37.64]	[57.69]	[61.27]	[36.63]	[29.94]	[40.69]	[31.39]	[28.38]	[40.52]
Panel B: Fraction of sample by characteristics									
Male	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
$+\Delta$ Frailty	-	0.3	0.33	0.32	0.3	0.29	0.28	0.29	0.3
$-\Delta$ Frailty	-	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14
Observations (N)	11,777	12,210	12,727	13,177	13,473	13,524	13,294	14,092	104,274
# of Individuals (n)									21,024
Average # of Years Observed (T)									4.86

Note: The summary statistics are for ages 25 to 94 of household heads and spouses. Annual earnings is an individual's labor earnings for the year (in 2012$). Annual hours is the sum of reported working hours for the year. Hourly wage is annual earnings divided by annual hours for labor force participants. Means are reported; median values are reported in parentheses; standard deviations are reported in brackets.

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Summary Statistics for PSID Sample

	2002	2004	2006	2008	2010	2012	2014	2016	Pooled 2002-2016
Panel A: Mean (median) [standard deviation] of sample characteristics									
Age	44.33	44.28	44.34	44.58	44.74	45.02	45.4	45.54	44.65
	[15.24]	[15.53]	[15.67]	[15.8]	[16.01]	[16.08]	[16.04]	[15.99]	[15.71]
Frailty	0.1	0.1	0.11	0.11	0.12	0.12	0.12	0.12	0.11
	[0.1]	[0.11]	[0.11]	[0.11]	[0.12]	[0.12]	[0.12]	[0.12]	[0.12]
Annual Earnings	$35,623.31	$35,992.43	$36,313.91	$36,712.28	$33,658.89	$34,072.19	$33,635.38	$35,303.67	$35,095.34
	[68,179.23]	[63,875.82]	[62,243.45]	[74,320.19]	[57,064.71]	[87,518.92]	[65,135.22]	[51,803.91]	[64,377.99]
Annual Hours	1,531.6	1,528.01	1,517.57	1,448.99	1,377.42	1,411.74	1,434.46	1,471.19	1,476.92
	[1,035.63]	[1,049.47]	[1,042.58]	[991.18]	[1,033.49]	[1,045.86]	[1,057.89]	[1,059.13]	[1,037.86]
Hourly Wage	$23.43	$24.31	$24.35	$24.76	$24.14	$23.59	$23.11	$24.03	$23.78
	[37.64]	[57.69]	[61.27]	[36.63]	[29.94]	[40.69]	[31.39]	[28.38]	[40.52]
Panel B: Fraction of sample by characteristics									
Male	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
High School Dropouts (HSD)	15.16	14.92	14.28	13.96	13.9	13.91	13.61	13.89	14.58
High School Graduates (HS)	55.76	55.19	55.04	54.89	54.43	54.09	54.32	53.7	54.88
College Graduates (CL)	29.08	29.89	30.68	31.15	31.67	32	32.07	32.41	30.55
$+\Delta$ Frailty	-	0.3	0.33	0.32	0.3	0.29	0.28	0.29	0.3
$-\Delta$ Frailty	-	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14
Observations (N)	11,777	12,210	12,727	13,177	13,473	13,524	13,294	14,092	104,274
# of Individuals (n)									21,024
Average # of Years Observed (T)									4.86

Note: The summary statistics are for ages 25 to 94 of household heads and spouses. Individuals included in the sample are in at least 2 consecutive waves in PSID. Annual earnings is an individual's labor earnings for the year (in 2012$). Annual hours is the sum of reported working hours for the year. Hourly wage is annual earnings divided by annual hours for labor force participants. Means are reported; median values are reported in parentheses; standard deviations are reported in brackets.

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Summary Statistics for Dynamic Panel Sample

	2002	2004	2006	2008	2010	2012	2014	2016	Pooled 2002-2016
Panel A: Mean (median) [standard deviation] of sample characteristics									
Age	40.75	41.2	41.73	42.36	42.97	43.77	45.64	47.53	42.65
	(41)	(42)	(42)	(42)	(42)	(42)	(44)	(46)	(42)
	[11.11]	[11.77]	[12.33]	[12.85]	[13.34]	[13.7]	[13.7]	[13.69]	[12.72]
Frailty	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.11
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)	(0.07)
	[0.09]	[0.09]	[0.1]	[0.1]	[0.11]	[0.11]	[0.12]	[0.12]	[0.11]
Annual Earnings	$39,913.5	$39,951.17	$39,779.58	$39,670.04	$36,294.58	$36,659.7	$36,554.79	$38,088.25	$38,526.71
	(30,944.81)	(30,446.27)	(30,277.88)	(29,730.3)	(26,121.94)	(25,100)	(26,256.93)	(27,860.24)	(29,174.36)
	[73,161.16]	[68,148.32]	[65,088.35]	[77,401.9]	[58,809.46]	[92,687.86]	[70,310.25]	[56,168.13]	[68,482.15]
Annual Hours	1,698.71	1,675.51	1,647.33	1,550.34	1,466.27	1,492.25	1,495.81	1,482.53	1,590.6
	(1,960)	(1,960)	(1,944)	(1,880)	(1,820)	(1,856)	(1,872)	(1,888)	(1,920)
	[965.19]	[990.17]	[989.62]	[949.76]	[1,011.75]	[1,030.75]	[1,051.32]	[1,064.97]	[999.24]
Hourly Wage	$22.84	$23.27	$23.03	$24.38	$24.01	$23.27	$23.67	$25.27	$23.50
	(17.84)	(17.94)	(17.74)	(18.96)	(18.09)	(17.56)	(18.04)	(18.89)	(18.06)
	[25.85]	[28.3]	[23.46]	[27.15]	[26.59]	[25.73]	[23.07]	[26.81]	[25.37]
Panel B: Fraction of sample by characteristics									
Male	0.45	0.45	0.45	0.45	0.45	0.45	0.44	0.44	0.45
High School Dropouts (HSD)	13.47	13.31	13.06	13.02	13.04	13.04	13.12	12.86	13.21
High School Graduates (HS)	55.62	55.06	54.56	54.33	53.97	53.47	53.49	53.42	54.51
College Graduates (CL)	30.91	31.63	32.39	32.66	32.99	33.48	33.39	33.72	32.28
$+\Delta$ Frailty	-	0.28	0.32	0.3	0.28	0.28	0.27	0.27	0.29
$-\Delta$ Frailty	-	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.13
Observations (N)	9,665	10,100	10,647	11,174	11,536	11,663	10,809	10,206	85,800
# of Individuals (n)									14,269
Average # of Years Observed (T)									6.01

Note: The summary statistics are for ages 25 to 64 of household heads and spouses. Individuals included in the sample are in at least 2 consecutive waves in PSID. Annual earnings is an individual's labor earnings for the year (in 2012$). Annual hours is the sum of reported working hours for the year. Hourly wage is annual earnings divided by annual hours for labor force participants. Means are reported; median values are reported in parentheses; standard deviations are reported in brackets.

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Summary Statistics for Dynamic Panel Sample, Workers

	2002	2004	2006	2008	2010	2012	2014	2016	Pooled 2002-2016
Panel A: Mean (median) [standard deviation] of sample characteristics									
Age	38.69	38.95	39.39	39.77	40.14	40.66	42.42	44.34	40.10
	(39)	(39)	(39)	(39)	(39)	(39)	(40)	(42)	(39)
	[9.61]	[10.26]	[10.79]	[11.33]	[11.83]	[12.13]	[12.1]	[12.14]	[11.19]
Frailty	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.08
	(0.04)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
	[0.06]	[0.06]	[0.06]	[0.07]	[0.07]	[0.07]	[0.08]	[0.08]	[0.07]
Annual Earnings	51,857.65	53,167	53876.26	54,826.77	52,899.68	54,881.27	55,503.18	58,201.99	53,757.76
	(39609.35)	(41,463.79)	(41,491.91)	(42,471.86)	(41,585.08)	(40,000)	(42,789.07)	(45,152.8)	(41,463.79)
	[84,044.28]	[64,951.95]	[59,016.86]	[63,531.05]	[64,581.51]	[120,948.31]	[87,450.06]	[64,377.8]	[75,912]
Annual Hours	2124.32	2140.36	2122.89	2034.56	2037.7	2081.94	2106.28	2096.56	2095.49
	(2065.5)	(2080)	(2064)	(2000)	(2024)	(2040)	(2050)	(2056)	(2040)
	[654.65]	[671.24]	[649.82]	[593.82]	[637.21]	[642.07]	[634.54]	[645.84]	[639.66]
Hourly Wage	23.9	24.72	24.72	26.35	25.57	25.31	26.02	27.78	25.29
	(19.06)	(19.35)	(19.42)	(20.42)	(19.8)	(19.32)	(19.98)	(21.52)	(19.67)
	[22.37]	[27.64]	[22.21]	[27.6]	[25.85]	[27.99]	[24.33]	[26.21]	[25.09]
Panel B: Fraction of sample by characteristics									
Male	0.54	0.54	0.54	0.54	0.54	0.54	0.53	0.53	0.54
High School Dropouts (HSD)	8.82	8.02	7.28	6.84	6.68	6.59	6.64	6.5	7.4
High School Graduates (HS)	50.35	49.77	49.47	49.27	49.46	48.99	48.89	48.87	49.61
College Graduates (CL)	40.82	42.21	43.25	43.89	43.86	44.42	44.48	44.63	42.99
$+\Delta$ Frailty	-	0.24	0.28	0.26	0.23	0.24	0.23	0.23	0.24
$-\Delta$ Frailty	-	0.11	0.10	0.10	0.11	0.11	0.10	0.11	0.10
Observations (N)	4794	4937	5237	5557	5869	6119	5742	5355	43610
# of Individuals (n)									7,539
Average # of Years Observed (T)									5.78

Note: The summary statistics are for ages 25 to 64 of household heads and spouses. Individuals included in the sample are in at least 2 consecutive waves in PSID. Annual earnings is an individual's labor earnings for the year (in 2012$). Annual hours is the sum of reported working hours for the year. Hourly wage is annual earnings divided by annual hours for labor force participants. Means are reported; median values are reported in parentheses; standard deviations are reported in brackets.

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Blundell-Bond System GMM Estimation

- In short panels, fixed effect estimator biases can be severe (Nickell (1981 ECTA)).
- Following Blundell-Bond (1998,JoEtrics), we estimate the following using GMM

$$\begin{bmatrix} y_{i,t} \\ \Delta y_{i,t} \end{bmatrix} = \gamma \begin{bmatrix} f_{i,t} \\ \Delta f_{i,t} \end{bmatrix} + \alpha_1 \begin{bmatrix} y_{i,t-1} \\ \Delta y_{i,t-1} \end{bmatrix} + \alpha_2 \begin{bmatrix} y_{i,t-2} \\ \Delta y_{i,t-2} \end{bmatrix} + \delta \begin{bmatrix} \boldsymbol{Z}_{i,t} \\ \Delta \boldsymbol{Z}_{i,t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,t} \\ \Delta \varepsilon_{i,t} \end{bmatrix}$$

- Full sample:
  - Use $f_{i,t-k}$, $y_{i,t-k}$, $k = 4, 5$ as instruments for differences
  - Use $\Delta f_{i,t-k}$, $\Delta y_{i,t-k}$, $k = 4, 5$ as instruments for levels
- Workers $k = 5, 6$ and frailty (reverse causality) $k = 6, 7, 8$.
- Use system estimator because earnings and frailty are close to random walk.

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Blundell-Bond System GMM Estimation

- For our instruments to be valid is must be that:
  - lagged levels are uncorrelated with current error term.
  - correlation between endogenous variables and the unobserved (fixed) effect is constant over time.
- To check these assumptions we run the following tests:
  - AR(1) test for no ser corr in error terms (of diff eqn): this should be rejected (by construction)
  - AR(2) test for no second-order ser corr in error terms (of diff eqn): this should not be rejected
  - Hansen test for validity of level instruments: this should not be rejected
  - Diff-in-Hansen test for validity of diff instruments: this should not be rejected
- Also do additional robustness checks.

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Dynamic Panel Additional Robustness Checks

- **Perform Diff-in-Hansen test on y-lag set only.**
- Check that estimates lie in expected range based on OLS and FE.
- Run F-tests of instrument power.
- Conduct robustness tests to instrument set.

Go Back

Effect of Frailty on Earnings

Full Set of Diagnostic Tests

	Everyone				Workers			
	(1)	(2) By Educ	(3) By Health	(4) By Age	(5)	(6) By Educ	(7) By Health	(8) By Age
AR(1) test (p-value)	0.455	0.319	0.497	0.104	0.030	0.010	0.021	0.008
AR(2) test (p-value)	0.380	0.474	0.298	0.949	0.130	0.082	0.138	0.160
Hansen test (p-value)	0.796	0.132	0.826	0.752	0.434	0.826	0.543	0.465
Diff-in-Hansen test (p-value)	0.652	0.360	0.827	0.464	0.255	0.484	0.259	0.214
Diff-in-Hansen test (p-value), Y-lag set	0.796	0.516	0.960	0.479	0.434	0.388	0.283	0.249
Starting IV Lag t-k (k=)	4	4	4	4	5	5	5	5
Ending IV Lag t-k (k=)	5	5	5	5	6	6	6	6

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Dynamic Panel Additional Robustness Checks

- Perform Diff-in-Hansen test on y-lag set only.
- **Check that estimates lie in expected range based on OLS and FE.**
- Run F-tests of instrument power.
- Conduct robustness tests to instrument set.

Go Back

Effect of Frailty on Earnings

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{earnings}_{t-1})$	0.564***	0.206***	0.283	0.555***	0.098***	1.474***
	(0.006)	(0.004)	(0.364)	(0.013)	(0.006)	(0.509)
$\log(\text{earnings}_{t-2})$	0.188***	-0.021***	0.396	0.240***	-0.031***	-0.640
	(0.006)	(0.005)	(0.298)	(0.012)	(0.006)	(0.454)
frailty_t	-4.973***	-8.818***	-5.374***	-0.519***	-0.471***	-0.978**
	(0.138)	(0.235)	(1.653)	(0.044)	(0.084)	(0.447)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.432		0.601	0.080	

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Effect of Frailty on Earnings – Young vs Old

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{earnings}_{t-1})$	0.564***	0.206***	0.628**	0.555***	0.098***	1.127***
	(0.006)	(0.004)	(0.291)	(0.013)	(0.006)	(0.302)
$\log(\text{earnings}_{t-2})$	0.188***	-0.021***	0.115	0.241***	-0.031***	-0.308
	(0.006)	(0.005)	(0.239)	(0.012)	(0.006)	(0.273)
$\text{frailty}_t \times$ Young	-4.870***	-8.547***	-4.992***	-0.660***	-0.483***	-1.650**
	(0.202)	(0.297)	(1.784)	(0.061)	(0.099)	(0.673)
$\text{frailty}_t \times$ Old	-5.034***	-8.943***	-4.030***	-0.376***	-0.463***	-0.293
	(0.161)	(0.249)	(1.317)	(0.054)	(0.091)	(0.365)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.433		0.601	0.080	

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Effect of Frailty on Earnings – Education

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{earnings}_{t-1})$	0.560***	0.206***	0.370	0.544***	0.097***	1.371***
	(0.006)	(0.004)	(0.319)	(0.013)	(0.006)	(0.400)
$\log(\text{earnings}_{t-2})$	0.183***	-0.022***	0.318	0.233***	-0.031***	-0.569
	(0.006)	(0.005)	(0.259)	(0.011)	(0.006)	(0.356)
$\text{frailty}_t \times$ HSD	-6.143***	-8.533***	-6.269***	-1.340***	-0.742***	-1.846**
	(0.213)	(0.526)	(1.777)	(0.111)	(0.254)	(0.807)
$\text{frailty}_t \times$ HS	-5.215***	-9.586***	-5.591***	-0.762***	-0.712***	-1.239***
	(0.155)	(0.289)	(1.574)	(0.052)	(0.107)	(0.460)
$\text{frailty}_t \times$ CL	-3.003***	-6.900***	-2.519*	0.053	-0.014	-0.558
	(0.209)	(0.457)	(1.402)	(0.053)	(0.132)	(0.484)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.581	0.435		0.605	0.089	

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Effect of Frailty on Earnings – Good Health vs Bad Health

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
log(earnings$_{t-1}$)	0.564***	0.206***	0.220	0.555***	0.097***	1.293***
	(0.006)	(0.004)	(0.362)	(0.013)	(0.006)	(0.410)
log(earnings$_{t-2}$)	0.188***	-0.021***	0.444	0.240***	-0.031***	-0.498
	(0.006)	(0.005)	(0.297)	(0.012)	(0.006)	(0.377)
frailty$_t$ $\times$ Good Health	-3.076***	-6.816***	-1.930	-0.610***	-0.230*	-1.765
	(0.305)	(0.499)	(4.816)	(0.082)	(0.135)	(1.775)
frailty$_t$ $\times$ Bad Health	-4.818***	-8.607***	-5.207***	-0.522***	-0.446***	-0.963**
	(0.137)	(0.239)	(1.745)	(0.044)	(0.085)	(0.469)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.433		0.601	0.079	

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Effect of Frailty on Hours

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{hours}_{t-1})$	0.554***	0.200***	0.399	0.332***	-0.027***	0.003
	(0.006)	(0.004)	(0.322)	(0.008)	(0.006)	(0.345)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.263	0.157***	-0.090***	0.304
	(0.006)	(0.004)	(0.257)	(0.007)	(0.006)	(0.218)
frailty_t	-3.626***	-6.655***	-3.887***	-0.175***	-0.442***	0.070
	(0.100)	(0.172)	(1.188)	(0.028)	(0.056)	(0.246)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.400		0.234	0.001	

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Effect of Frailty on Hours – Young vs Old

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{hours}_{t-1})$	0.554***	0.200***	0.669***	0.332***	-0.027***	0.382
	(0.006)	(0.004)	(0.257)	(0.008)	(0.006)	(0.318)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.048	0.157***	-0.090***	0.254
	(0.006)	(0.004)	(0.206)	(0.007)	(0.006)	(0.246)
$\text{frailty}_t \times$ Young	-3.457***	-6.411***	-3.564***	-0.200***	-0.484***	-0.286
	(0.149)	(0.217)	(1.325)	(0.039)	(0.066)	(0.387)
$\text{frailty}_t \times$ Old	-3.726***	-6.767***	-3.131***	-0.151***	-0.414***	0.144
	(0.116)	(0.182)	(0.936)	(0.036)	(0.060)	(0.259)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.401		0.234	0.001	

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Effect of Frailty on Hours – Education

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{hours}_{t-1})$	0.550***	0.200***	0.383	0.331***	-0.027***	0.074
	(0.006)	(0.004)	(0.319)	(0.008)	(0.006)	(0.313)
$\log(\text{hours}_{t-2})$	0.176***	-0.028***	0.269	0.156***	-0.091***	0.168
	(0.006)	(0.004)	(0.253)	(0.007)	(0.006)	(0.221)
$\text{frailty}_t \times$ HSD	-4.433***	-6.526***	-4.770***	-0.403***	-0.942***	-0.533
	(0.157)	(0.385)	(1.320)	(0.078)	(0.169)	(0.356)
$\text{frailty}_t \times$ HS	-3.732***	-7.241***	-4.303***	-0.189***	-0.440***	-0.033
	(0.112)	(0.211)	(1.224)	(0.032)	(0.071)	(0.281)
$\text{frailty}_t \times$ CL	-2.380***	-5.119***	-2.219**	-0.092***	-0.311***	0.248
	(0.150)	(0.334)	(1.118)	(0.035)	(0.088)	(0.254)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.557	0.402		0.234	0.001	

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Effect of Frailty on Hours – Good Health vs Bad Health

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{hours}_{t-1})$	0.553***	0.200***	0.386	0.332***	-0.027***	0.040
	(0.006)	(0.004)	(0.317)	(0.008)	(0.006)	(0.311)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.272	0.157***	-0.091***	0.282
	(0.006)	(0.004)	(0.253)	(0.007)	(0.006)	(0.219)
$\text{frailty}_t \times$ Good Health	-1.957***	-5.137***	-2.216	-0.046	-0.292***	-0.060
	(0.222)	(0.365)	(3.455)	(0.049)	(0.090)	(0.910)
$\text{frailty}_t \times$ Bad Health	-3.491***	-6.494***	-3.707***	-0.171***	-0.426***	0.026
	(0.099)	(0.175)	(1.242)	(0.028)	(0.056)	(0.258)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.402		0.234	0.001	

▸ Go Back

Wage regression

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.212
				(0.010)	(0.006)	(0.541)
$\log(\text{wage}_{t-2})$				0.288***	-0.028***	0.532
				(0.009)	(0.006)	(0.489)
frailty_t				-0.378***	-0.028	-0.623**
				(0.037)	(0.073)	(0.263)
Observations				34,170	34,170	34,170
R^2*				0.592	0.056	

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Wage regression – Young vs Old

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.511
				(0.010)	(0.006)	(0.399)
$\log(\text{wage}_{t-2})$				0.289***	-0.029***	0.272
				(0.009)	(0.006)	(0.359)
$\text{frailty}_t \times$ Young				-0.481***	0.028	-1.106**
				(0.050)	(0.086)	(0.463)
$\text{frailty}_t \times$ Old				-0.274***	-0.064	-0.414
				(0.045)	(0.079)	(0.295)
Observations				34,170	34,170	34,170
R^2*				0.592	0.055	

▸ Go Back

Wage regression – Education

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{wage}_{t-1})$				0.514***	0.067***	0.122
				(0.010)	(0.006)	(0.368)
$\log(\text{wage}_{t-2})$				0.279***	-0.029***	0.600*
				(0.009)	(0.006)	(0.328)
$\text{frailty}_t \times$ HSD				-1.040***	0.191	-1.854***
				(0.102)	(0.222)	(0.616)
$\text{frailty}_t \times$ HS				-0.602***	-0.268***	-0.889***
				(0.043)	(0.094)	(0.307)
$\text{frailty}_t \times$ CL				0.123***	0.298***	-0.216
				(0.046)	(0.116)	(0.309)
Observations				34,170	34,170	34,170
R^2*				0.596	0.063	

▸ Go Back

Wage regression – Good Health vs Bad Health

Comparison of OLS, FE, and BB

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.303
				(0.010)	(0.006)	(0.449)
$\log(\text{wage}_{t-2})$				0.288***	-0.028***	0.461
				(0.009)	(0.006)	(0.419)
$\text{frailty}_t \times$ Good Health				-0.561***	0.061	0.348
				(0.071)	(0.118)	(1.685)
$\text{frailty}_t \times$ Bad Health				-0.384***	-0.019	-0.581*
				(0.037)	(0.074)	(0.332)
Observations				34,170	34,170	34,170
R^2*				0.592	0.055	

▸ Go Back

Dynamic Panel Additional Robustness Checks

- Check that estimates lie in expected range based on OLS and FE.
- **Run F-tests of instrument power.**
- Conduct robustness tests to instrument set.

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Dynamic Panel Additional Robustness Checks

F-tests instrument power results

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Dynamic Panel Additional Robustness Checks

- Check that estimates lie in expected range based on OLS and FE.
- Run F-tests of instrument power.
- **Conduct robustness tests to instrument set.**

▸ Go Back

Effect of Frailty on Earnings – Education

Robustness to instrument set

	Everyone	Everyone	Everyone
$\log(\text{earnings}_{t-1})$	0.676***	0.370	0.055
	(0.110)	(0.319)	(0.264)
$\log(\text{earnings}_{t-2})$	0.050	0.318	0.632***
	(0.046)	(0.259)	(0.210)
$\text{frailty}_t \times$ HSD	-5.133***	-6.269***	-5.772***
	(1.809)	(1.777)	(2.050)
$\text{frailty}_t \times$ HS	-5.009***	-5.591***	-6.532***
	(1.610)	(1.574)	(1.876)
$\text{frailty}_t \times$ CL	-3.237**	-2.519*	-3.125*
	(1.313)	(1.402)	(1.743)
AR(2) test (p-value)	0.156	0.474	0.024
Hansen test (p-value)	0.022	0.132	0.116
Diff-in-Hansen test (p-value)	0.015	0.360	0.151
Diff-in-Hansen test (p-value), Y-lag set	0.053	0.516	0.516
Starting IV Lag t-k (k=)	3	4	5
Ending IV Lag t-k (k=)	4	5	6

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Effect of Frailty on Earnings

	Everyone			Workers		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\text{earnings}_{t-1})$	0.283	0.628**				
	(0.364)	(0.291)				
$\log(\text{earnings}_{t-2})$	0.396	0.115				
	(0.298)	(0.239)				
frailty_t	−0.199***					
	(0.061)					
$\text{frailty}_t \times$ Young (age ≤ 45)		−0.185***				
		(0.066)				
$\text{frailty}_t \times$ Old (age > 45)		−0.149***				
		(0.049)				
AR(1) test (p-value)	0.455	0.104				
AR(2) test (p-value)	0.380	0.949	0.057			
Hansen test (p-value)	0.796	0.752	0.352			
Diff-in-Hansen test (p-value)	0.652	0.464	0.192			

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Similar effect for young and old

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Effect of Frailty on Hours - Young v. Old

	Everyone		Workers	
	(1)	(2)	(3)	(4)
$\log(\text{hours}_{t-1})$	0.399	0.669^{***}	0.003	0.382
	(0.322)	(0.257)	(0.345)	(0.318)
$\log(\text{hours}_{t-2})$	0.263	0.048	0.304	0.254
	(0.257)	(0.206)	(0.218)	(0.246)
frailty_t	-0.144^{***}		0.003	
	(0.044)		(0.009)	
$\text{frailty}_t \times$ Young (age ≤ 45)		-0.132^{***}		-0.011
		(0.049)		(0.014)
$\text{frailty}_t \times$ Old (age > 45)		-0.116^{***}		0.005
		(0.035)		(0.010)
AR(1) test (p-value)	0.287	0.043	0.409	0.180
AR(2) test (p-value)	0.596	0.706	0.273	0.642
Hansen test (p-value)	0.971	0.811	0.060	0.051
Diff-in-Hansen test (p-value)	0.944	0.545	0.080	0.037

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

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Effect of Frailty on Wages of Workers - Young v. Old

	Workers	
	(1)	(2)
$\log(\text{wages}_{t-1})$	0.212	0.511
	(0.541)	(0.399)
$\log(\text{wages}_{t-2})$	0.532	0.272
	(0.489)	(0.359)
frailty_t	-0.023^{**}	
	(0.010)	
$\text{frailty}_t \times$ Young		-0.041^{**}
		(0.017)
$\text{frailty}_t \times$ Old		-0.015
		(0.011)
AR(1) test (p-value)	0.651	0.362
AR(2) test (p-value)	0.454	0.734
Hansen test (p-value)	0.085	0.170
Diff-in-Hansen test (p-value)	0.044	0.104
Note:	$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$	

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Empirical literature on earnings/wealth/job loss impacts on health

- **Overview:** No evidence that changes in income/wealth/employment impact objective measures of health. Mixed evidence of impacts on mortality/mental health/risky behavior.

  "[A] preponderance of evidence suggests that in developed countries today, income does not have a large causal effect on adult health,...Once childhood health is set, the effect of economic resources on health diminishes. In most of adulthood, income and wealth no longer appear to have a large effect on health. Education continues to be a powerful determinant of health, but to a great extent because of its impact on behaviors rather than its association with resources. Exactly why education affects health behaviors remains unclear, but much of the story seems to hinge on the ability to process new information and to take advantage of new technologies." (Cutler et al., 2011 survey paper)

- **Papers:** Adams et al. (2003), Adda et al. (2009), Apouey and Clack (2015), Black et al. (2015), Cesarini et al. (2016), Eliason and Storrie (2009), Evans and Moore (2011), Evans and Snyder (2006), Gathmann et al. (2021), Junna et al. (2020), Meer et al. (2003), Michaud and Soest (2008), Ostling et al. (2020), Raschke (2019), Schaller and Stevens (2015), Schwandt (2018), Smith (1999, 2004, 2007), Sullivan and Von Wachter (2009)

▸ Go back

Problem of Young Nonemployed Individual at $R-1$

- Nonemployed individual with $j = R - 1$ solves

$$V^N(x, n_a) = \max_{c, a' \geq 0} u(c) + \beta p(j, f) E\left[\max\left\{V^E(x', 1), V^R(x')\right\}\right]$$

subject to

$$\frac{a'}{1+r} + c + m^N(j, f, s) = a + Tr(x, n_a)$$

Go back

Problem of a DI Beneficiary at $R-1$

- DI beneficiary with $j = R-1$ solves

$$V^D(x, n_d) = \max_{c,a' \geq 0} u(c) + \beta p(j, f, s) E\left[V^R(x')\right]$$

subject to

$$\frac{a'}{1+r} + c + m^D(j, f, s, n_d) = a + SS(\bar{e}) + Tr(x, n_d).$$

- n_d: number of periods on DI.

Go back

Problem of a Retiree

- Retiree solves

$$V^R(x) = \max_{c,a' \geq 0} u(c) + \beta p(j,f) E\left[V^R(x')\right]$$

subject to

$$\frac{a'}{1+r} + c + m^R(j,f,s) = a + SS(\bar{e}) + Tr(x)$$

▸ Go Back

Equilibrium

- Return on assets, r, is exogenously given (small open economy)
- There is an aggregate production function

$$Y = AK^{\alpha}L^{1-\alpha}$$

  where L is aggregate labor input $=$ sum of hours$\times$productivity
- Wage per efficient unit of labor $=$ marginal product
- Consolidated government budget holds – with exog. purchases g
- All measures are stationary – usual definition

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Parametrization: Tax and Transfers

- Taxes includes
  - Proportional capital tax τ_K paid by firm
  - Federal income tax – HSV tax function
  - SS retirement & disability payroll tax – statutory tax formula
  - Medicare payroll tax

$$T(e) = e - \lambda e^{1-\tau} + \tau_{ss} \min\{e, 2.47\bar{e}_a\} + \tau_{med} e$$

- Transfers include
  - SS retirement & disability benefit – statutory benefit formula
  - SSI benefits to guarantee minimum DI payment $\underline{b}$
  - Welfare programs to guarantee minimum consumption floor $\underline{c}$

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Estimation of Frailty Process: Deterministic Component

$$Prob(f_{ij} = 0) = \Phi(quad(age) + \nu_{ij})$$

$$\begin{aligned} \ln f_{ij} &= quartic(age) + R_{ij}, \\ R_{ij} &= \alpha_i + z_{ij} + u_{ij}, \\ z_{ij} &= \rho z_{ij-1} + \varepsilon_{ij}, \end{aligned}$$

- Run OLS to remove time/sample duration effects
- Estimate zero frailty probit
- Estimate deterministic component of log frailty via SMM
- Calculate cohort-adjusted vars/covars of $R_{i,j}$
- Estimate process for $R_{i,j}$ using SMM
- Separate estimation for each educ group

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Estimation of Frailty Process: Deterministic Component

	HS Dropout	HS Graduates	Col Graduates
age	1.26	0.988	0.999
	(0.095)	(0.030)	(0.064)
age^2	2.19	1.40	2.04
	(0.492)	(0.146)	(0.305)
age^3	-0.607	-1.39	-0.838
	(0.951)	(0.380)	(0.585)
age^4	3.03	8.77	3.05
	(0.636)	(0.307)	(0.403)
const.	-2.50	-2.57	-2.83
	(0.006)	(0.003)	(0.004)

Note: age is scaled so that age $=$ (age-25)/100.

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Estimation of Frailty Process: Stochastic Component

results of estimating the shock process

	HS Dropout	HS Graduates	Col Graduates
ρ	0.979	1.001	0.9690
	(0.002)	(0.001)	(0.002)
σ_α^2	0.2232	0.1542	0.1270
	(0.0107)	(0.005)	(0.0050)
σ_u^2	0.0368	0.0506	0.0357
	(0.0039)	(0.002)	(0.0023)
σ_ε^2	0.0286	0.0162	0.0250
	(0.0018)	(0.001)	(0.0012)

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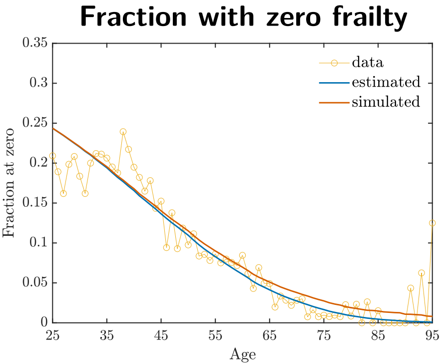
Stochastic frailty process for high school dropouts



- Mortality has little impact on the fraction at zero by age.

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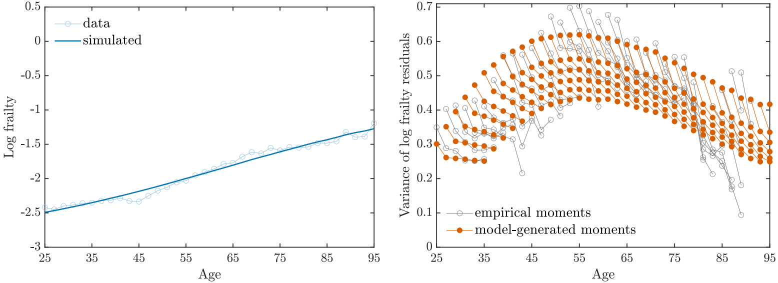
Stochastic frailty process for high school dropouts

Targeted Moments: Model versus Data



- Deterministic age polynomial targets mean frailty by age in data.
- Stochastic component targets variance-covariance profile of frailty residuals.

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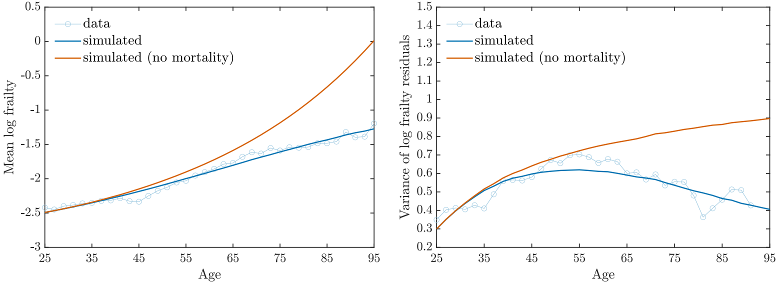
Stochastic frailty process for high school dropouts

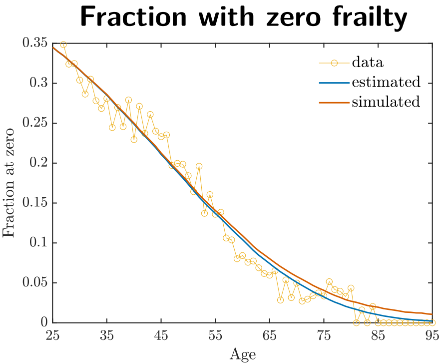
Targeted Moments: Model versus Data



- Effects of mortality on mean and variance of frailty are large at older age.

▸ Go Back

Stochastic frailty process for college graduates



- Mortality has little impact on the fraction at zero by age.

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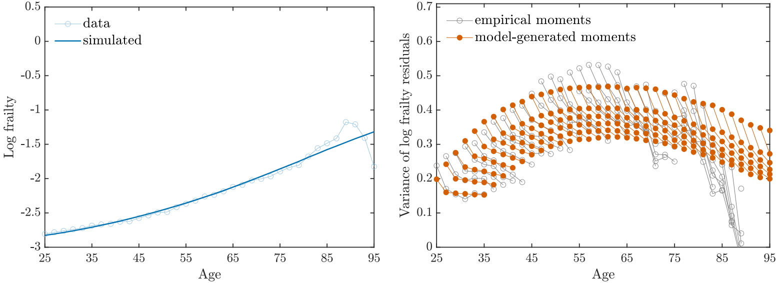
Stochastic frailty process for college graduates

Targeted Moments: Model versus Data



- Deterministic age polynomial targets mean frailty by age in data.
- Stochastic component targets variance-covariance profile of frailty residuals.

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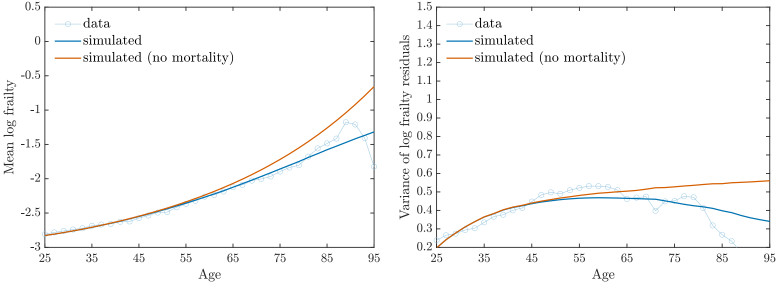
Stochastic frailty process for college graduates

Targeted Moments: Model versus Data



- Effects of mortality on mean and variance of frailty are large at older ages.

▸ Go Back

Calibration: What is done outside the model

- Utility parameters : γ and μ
- Technology parameters: capital share α, depreciation δ
- Job separation rate σ, return on asset r, pop. growth ν
- Tax progressivity τ, payroll tax rates (τ_{ss}, τ_{med}), capital tax τ_K
- SS, SSDI, and SSI benefits, and minimum consumption $\underline{c}$

▸ Ex-ante parameters

- The following processes
  - Stochastic processes for frailty and labor productivity
  - Out of pocket medical expenditures
  - Survival rates

▸ Med exps and survival

▸ Go Back

Calibration: Predetermined Parameters

Parameter	Description	Values/source
Demographics		
J	maximum age	70 (94 y/o)
R	retirement age	41 (66 y/o)
ν	population growth rate	0.02
Preferences		
γ	curvature of utility function	2
μ	weight on consumption	0.5
	(implies CRRA of 1.5)	
Job Separation		
σ	annual layoffs/separations in JOLTS	0.15
Technology		
α, δ, r	capital share, depreciation, return on assets	0.33, 0.07, 0.04
Government policies		
τ	tax progressivity (Guner et al (2014))	0.036
τ_K	captial tax (Gomme and Rupert (2007)	0.3
τ_{ss}, τ_{med}	payroll tax rates	0.124, 0.029
$\underline{b}$	SSI payment (% of ave. earning)	13
$\underline{c}$	minimum consumption (% of ave. earning)	11
G	government purchases (% of GDP)	17.5

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Parametrization: Survival and OOP Med. Expenditure

- For survival: estimate (probit)

$$s_{ij} = \text{quad. poly. on age} + \text{quad. poly. on frailty} + \text{edu} + \text{gender}$$

  Dataset: HRS

- For out of pocket medical expenditures: estimate

$$\text{oop}_{ij} = \text{cubic poly. on age} + \text{cubic poly. on frailty}$$

  separate for each edu. & labor market status.
  Dataset: MEPS

- Education: HSD, HSG, CG

- Labor market status: employed, non-employed and on Medicare, non-employed and not on Medicare

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Estimating Productivity Profiles

Step 1: exclusion restriction

- Following Low & Pistaferri (2014) assume “potential” government transfers have different work disincentives for people w/ different health levels.
  - These effects are captured by interactions
- We regress participation on
  - log wage (1 and 2 lags), lag of frailty interacted educ., poly. on age, year dummies
  - interaction term: state $\times$ # of kids $\times$ marital status $\times$ frailty
  - fixed effect
- We use estimated fixed effects in step 2

Estimating Productivity Profiles

Step 2: bias correction

- Follow: Al-Saddoon, Jimenez-Martin, & Labeaga (2019)
- Run log wage on
  - 2 lags of log wage
  - edu. interacted w/quad. of lag of frailty (treated exogenous – given our earlier findings)
  - age poly. + year dummies
  - fixed effects estimated in step 1

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Estimating Productivity Profiles

Estimation of frailty effect

	Linear		Quadratic	
	w/o correction	w/ correction	w/o correction	w/ correction
$\log(\text{wage\_}t-1)$	1.044***	1.034***	1.039***	1.024***
	(0.298)	(0.295)	(0.298)	(0.295)
$\log(\text{wage\_}t-2)$	-0.263	-0.262	-0.265	-0.259
	(0.270)	(0.262)	(0.268)	(0.260)
$\text{frailty}_t \times \text{HSD}$	-1.128**	-1.201**	-1.952**	-2.078**
	(0.453)	(0.469)	(0.900)	(0.929)
$\text{frailty}_t^2 \times \text{HSD}$			3.477*	3.595*
			(1.999)	(2.027)
$\text{frailty}_t \times \text{HSG}$	-0.662***	-0.741***	-1.048**	-1.169**
	(0.235)	(0.251)	(0.441)	(0.466)
$\text{frailty}_t^2 \times \text{HSG}$			1.658	1.804*
			(1.015)	(1.036)
$\text{frailty}_t \times \text{COL}$	0.052	0.025	0.397*	0.392*
	(0.119)	(0.119)	(0.223)	(0.221)
$\text{frailty}_t^2 \times \text{COL}$			-2.058**	-2.146**
			(0.843)	(0.845)
selection term		0.076**		0.090**
		(0.035)		(0.038)
Observations	23,874	23,755	23,874	23,755
AR(2) test (*p*-value)	0.182	0.163	0.182	0.165
Hansen test (*p*-value)	0.107	0.096	0.107	0.096
Diff-in-Hansen test (*p*-value)	0.307	0.417	0.307	0.434

Go Back Exog Robust

Estimating Productivity Profiles

Steps 3 and 4: estimating shock process

- Using results in step 2, remove effect of frailty
- Run the remainder (separate for college and non-college) on
  - quadratic in age
  - year dummies
- Estimate age profile for 25-49 using PSID and 50+ using HRS
- Back out residuals
- Estimate a RIP process for residuals using GMM and PSID

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Estimating Productivity Profiles

Step 3: Deterministic component estimates

	Ages 25-49 Non-college	Ages 25-59 College	Ages 50+ Non-college	Ages 60+ College
age	0.050	0.092	0.080	0.006
	(0.003)	(0.005)	(0.018)	(0.029)
age^2	-0.0005	-0.0009	-0.0008	-0.0002
	(0.0004)	(5.2e-6)	(0.0001)	(0.0002)
constant	1.878	1.196	1.224	3.932
	(0.075)	(0.108)	(0.574)	(0.924)
year fixed effects	yes	yes	yes	yes
Observations	13,448	9,838	13,286	6,144
R^2	0.042	0.060	0.030	0.019

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Estimating Productivity Profiles

Step 4: Shock process estimates

	Non-college	Col Graduates
var. of transitory shock	0.0824	0.0985
	(0.0115)	(0.0122)
var. of permanent shock	0.0165	0.0181
	(0.0049)	(0.0059)
var. of fixed effect	0.0920	0.1254
	(0.0145)	(0.0234)
persistence	0.9218	0.9730
	(0.0231)	(0.0114)

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Comparison with Low & Pistaferri (2014)

- Low & Pistaferri (2014) estimate the effect of disability on wages
- They have three disability groups $d = 0, 1, 2$
  - $d = 0$: those with no work limitation
  - $d = 2$: those with severe work limitation
  - $d = 1$: the rest
- We calculate mean frailty for each of these categories in our sample
  - $d = 0$ has mean frailty of 0.07
  - $d = 1$ has mean frailty of 0.18
  - $d = 2$ has mean frailty of 0.28
- Using these values and our estimated coefficients, we can compute effects that are comparable to Low & Pistaferri (2014)

Comparison with Low & Pistaferri (2014)

Table: Effect of work limitation on wages (% decline in wages relative to no limitation)

	mean frailty	Low & Pistaferri (2014)	Our estimation			
		non-college	non-college	HSD	HSG	College
No limitation	0.07					
Moderate limitation	0.18	-5.7	-9.0	-13.1	-8.1	-5.7
Severe limitation	0.28	-17.7	-18.0	-26.1	-16.1	-13.8

- Note Low and Pistaferri's estimates are based on non-college sample only.

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Robustness to Exogenous Frailty

Estimation of linear frailty effect (men only)

	ENDOGENOUS No Correction	ENDOGENOUS stateXkidsXmar	ENDOGENOUS +Xfrail	EXOGENOUS No Correction	EXOGENOUS stateXkidsXmar	EXOGENOUS +Xfrail
log(wage_$t-1$)	0.863***	0.859***	0.853***	1.044***	1.043***	1.034***
	(0.172)	(0.170)	(0.170)	(0.298)	(0.296)	(0.295)
log(wage_$t-2$)	-0.093	-0.091	-0.088	-0.263	-0.274	-0.262
	(0.158)	(0.161)	(0.159)	(0.270)	(0.264)	(0.262)
frail_hsd (one add. deficit)	-0.037	-0.039	-0.039	-0.042**	-0.044**	-0.044**
	(0.024)	(0.024)	(0.024)	(0.017)	(0.017)	(0.017)
frail_hsgp (one add. deficit)	-0.019	-0.026	-0.026	-0.025***	-0.027***	-0.027***
	(0.018)	(0.020)	(0.019)	(0.009)	(0.009)	(0.009)
frail_col (one add. deficit)	0.000	-0.003	-0.002	0.002	0.001	0.001
	(0.021)	(0.022)	(0.021)	(0.004)	(0.005)	(0.004)
eta		0.038	0.059		0.046	0.076**
		(0.152)	(0.141)		(0.032)	(0.035)
Controls	YES	YES	YES	YES	YES	YES
Observations	23,874	23,755	23,755	23,874	23,755	23,755
AR(1) test (p-value)	0.000	0.000	0.000	0.010	0.008	0.009
AR(2) test (p-value)	0.195	0.183	0.189	0.182	0.152	0.163
Hansen test (p-value)	0.228	0.169	0.172	0.107	0.096	0.096
Diff-in-Hansen test (p-value)	0.370	0.324	0.356	0.307	0.385	0.417
Diff-in-Hansen test (p-value), Y-lag set	0.122	0.070	0.079	.	.	.
Starting IV Lag t-k (k=)	5	5	5	5	5	5
Ending IV Lag t-k (k=)	7	7	7	7	7	7

* $p < .1$, ** $p < .05$, *** $p < .01$

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Robustness to Exogenous Frailty

Estimation of quadratic frailty effect (men only)

	ENDOGENOUS No Correction	ENDOGENOUS stateXkidsXmar	ENDOGENOUS +Xfrail	EXOGENOUS No Correction	EXOGENOUS stateXkidsXmar	EXOGENOUS +Xfrail
log(wage_$t-1$)	0.749***	0.733***	0.728***	1.039***	1.033***	1.024***
	(0.157)	(0.156)	(0.156)	(0.298)	(0.295)	(0.295)
log(wage_$t-2$)	0.007	0.021	0.023	-0.265	-0.271	-0.259
	(0.141)	(0.141)	(0.140)	(0.268)	(0.261)	(0.260)
frail_hsd	-1.923	-2.785	-2.753	-1.952**	-2.062**	-2.078**
	(2.617)	(2.377)	(2.357)	(0.900)	(0.933)	(0.929)
frail_hsd_sq	3.631	5.195	5.085	3.477*	3.597*	3.595*
	(6.762)	(5.999)	(5.935)	(1.999)	(2.053)	(2.027)
frail_hsgp	-1.101	-1.908	-1.870	-1.048**	-1.149**	-1.169**
	(1.428)	(1.367)	(1.365)	(0.441)	(0.461)	(0.466)
frail_hsgp_sq	2.891	4.594	4.499	1.658	1.779*	1.804*
	(4.364)	(4.095)	(4.120)	(1.015)	(1.037)	(1.036)
frail_col	0.902	0.535	0.580	0.397*	0.403*	0.392*
	(1.198)	(1.168)	(1.173)	(0.223)	(0.229)	(0.221)
frail_col_sq	-4.486	-4.059	-4.115	-2.058**	-2.152**	-2.146**
	(3.189)	(3.102)	(3.159)	(0.843)	(0.858)	(0.845)
eta		0.115	0.136		0.061*	0.090**
		(0.158)	(0.151)		(0.033)	(0.038)
Controls	YES	YES	YES	YES	YES	YES
Observations	23,874	23,755	23,755	23,874	23,758	23,755
AR(1) test (p-value)	0.000	0.001	0.001	0.010	0.008	0.009
AR(2) test (p-value)	0.452	0.478	0.488	0.178	0.154	0.165
Hansen test (p-value)	0.347	0.334	0.341	0.107	0.096	0.096
Diff-in-Hansen test (p-value)	0.200	0.235	0.259	0.309	0.401	0.434
Diff-in-Hansen test (p-value), Y-lag set	0.051	0.038	0.040	.	.	.
Starting IV Lag t-k (k=)	5	5	5	5	5	5
Ending IV Lag t-k (k=)	7	7	7	7	7	7

* $p < .1$, ** $p < .05$, *** $p < .01$

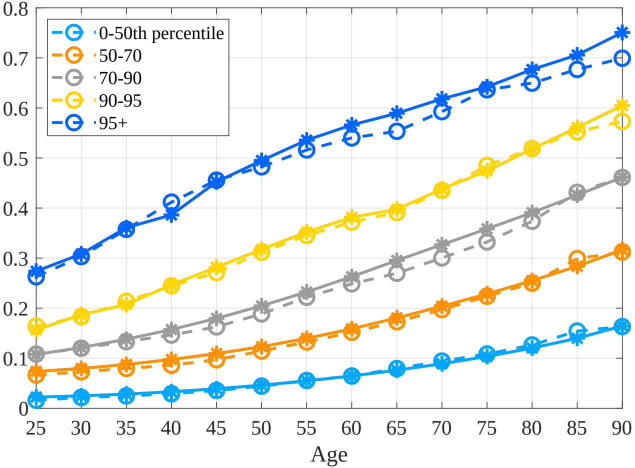
Go Back

Capturing severe disability

- Productivity process doesn't capture the effects of severe lifelong disability.
- To capture these effects we assume:
  - individuals face small probability of being born severely disabled (having zero productivity)
  - probability depends on frailty and education
  - pinned down by the fractions of 25 year-olds on SSI/SSDI in the data (2.3% overall)

▸ Go back

Frailty: Model vs Data



- Frailty process in model generates mean frailty levels by age and percentile groups that align closely with those in the data.

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Assessment: DI and LFP by Education Groups

DI recipiency rate (%), ages 25–64

	HS Dropout	HS Graduates	Col Graduates
Data	11.8	6.6	2.7
Model	12.3	7.4	2.6

LFPR (%), ages 25–64

	HS Dropout	HS Graduates	Col Graduates
Data	78	87	94
Model	76	86	94

- The model matches levels and patterns of DI recipiency and LFP by education.

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Calibration: What is Chosen to Match Targets

- Prob. of DI acceptance parameters: $\theta(f, n_a) = \min\{1, \kappa_0 f^{\kappa_1} n_a^{\kappa_2}\}$
  - Targets:
    - DI enrollment by frailty percentiles and 5-year age group (ages 25–64)
    - Rate of decline in DI acceptance by year since initial application (French and Song, 2014)
- Disutility of work parameters: $v(f) = \phi_0 + \phi_1 f^{\phi_2}$
  - Targets: LFP by frailty percentiles for age group 25 to 74.
- Discount factor β
  - Target: wealth to output ratio of 3.2.
- Average tax parameter λ
  - Target: federal income tax as % of GDP = 8%.

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Calibration: Parameters Chosen using the Model

Table: Additional Parameters and Targets: Values

Parameter	Description		Value
β	discount factor		0.982
λ	HSV tax parameter		0.908
Moment		**Target**	**Model**
Wealth-output ratio		3.2	3.2
Federal Inc. Tax (% of GDP)		8.0	8.0

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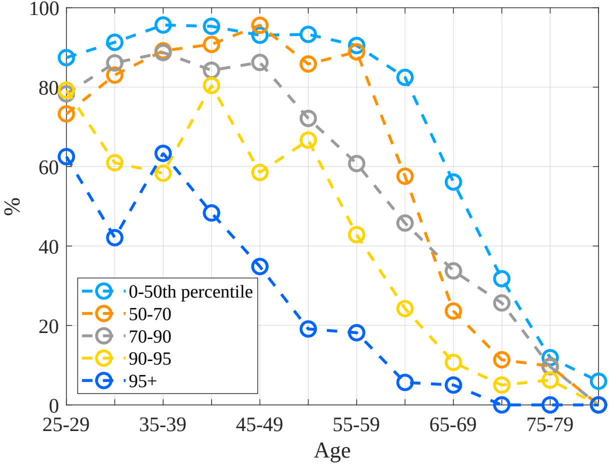
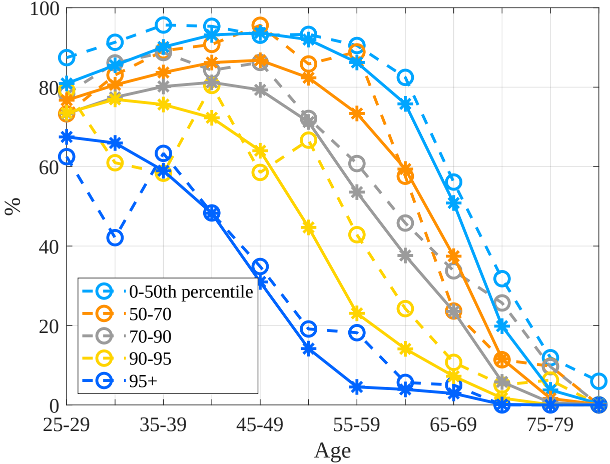
Assessment: LFP by Frailty and Age

High School Dropouts: Model vs Data



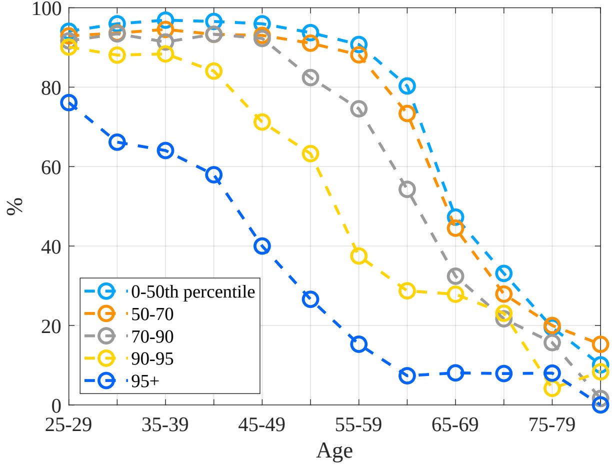
Assessment: LFP by Frailty and Age

High School Dropouts: Model vs Data



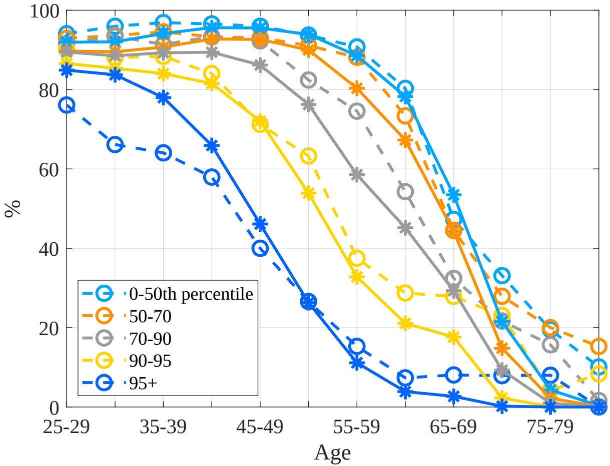
Assessment: LFP by Frailty and Age

High School Graduates: Model vs Data



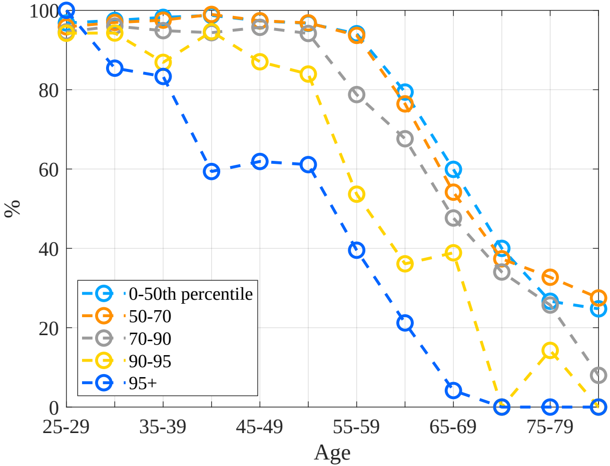
Assessment: LFP by Frailty and Age

High School Graduates: Model vs Data



Assessment: LFP by Frailty and Age

College Graduates: Model vs Data



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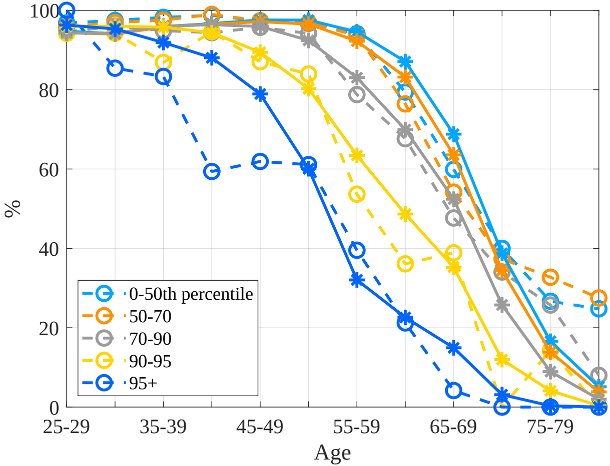
Assessment: LFP by Frailty and Age

College Graduates: Model vs Data



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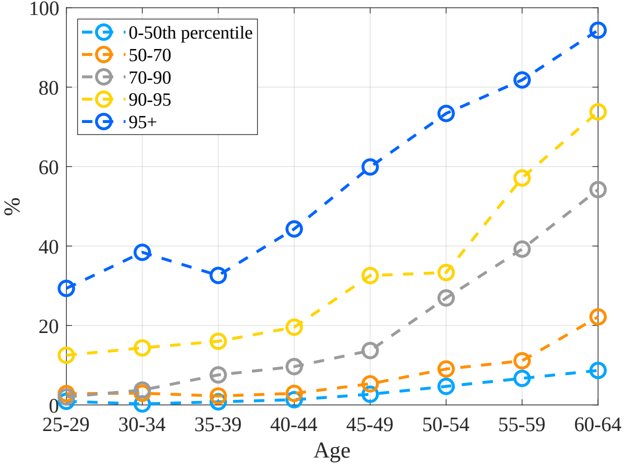
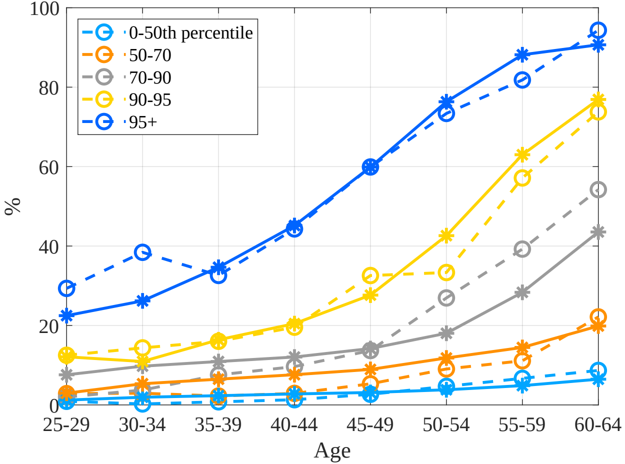
Assessment:% on DI by Frailty and Age

High School Dropouts: Model vs Data



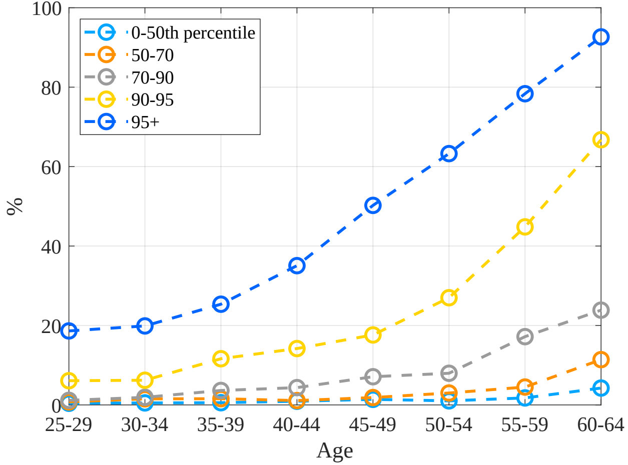
Assessment:% on DI by Frailty and Age

High School Dropouts: Model vs Data



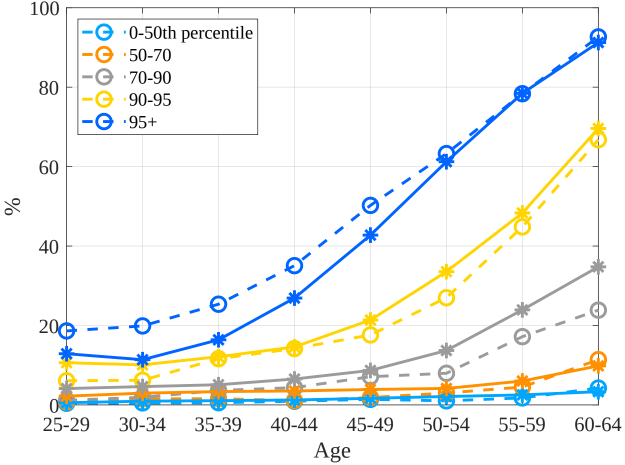
Assessment:% on DI by Frailty and Age

High School Graduates: Model vs Data



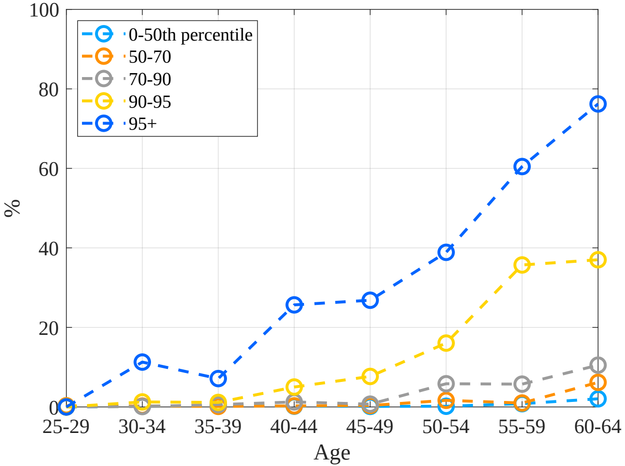
Assessment:% on DI by Frailty and Age

High School Graduates: Model vs Data



Assessment:% on DI by Frailty and Age

College Graduates: Model vs Data



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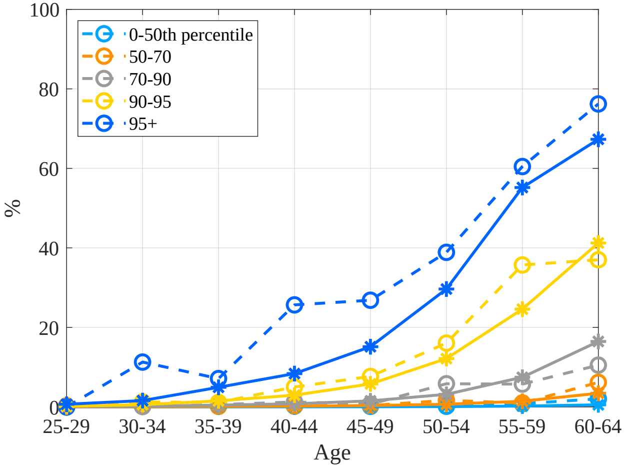
Assessment:% on DI by Frailty and Age

College Graduates: Model vs Data



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Sample Details

- Use PSID 2003–2017 (years 2002–2016)
  - Cannot construct frailty index in earlier waves.
- Sample consists of household heads and spouses aged 25–64 with non-missing labor earnings.
- Workers are defined as follows:
  - $LF_t = 1$ if hours ≥ 260 AND wages $> \$3/\text{hour}$
  - Worker $= 1$ if $LF_t = 1$ for all time periods observed
  - Wages $=$ Annual labor earnings/Annual hours worked
  - Annual hours worked $= (52 -$ weeks unemployed$) \times$ average weekly hours
- Good/Bad health: frailty below/above 75th percentile

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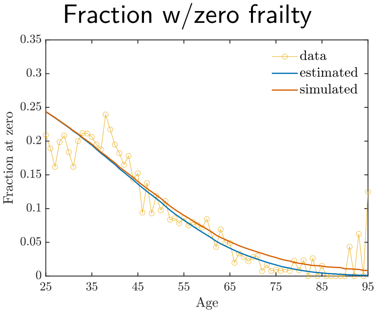
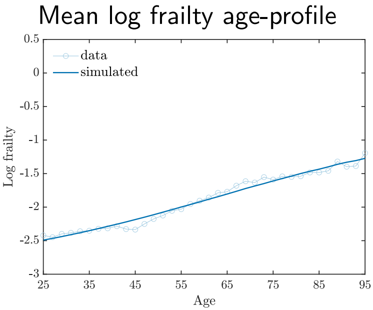
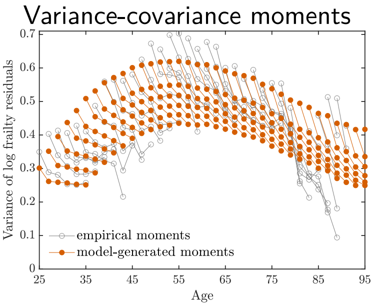
Stochastic frailty process for high school dropouts







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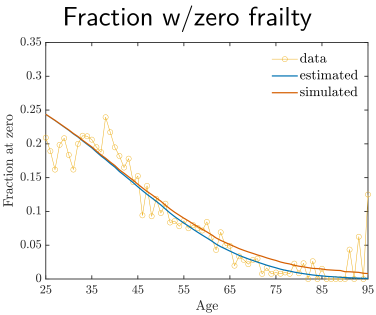
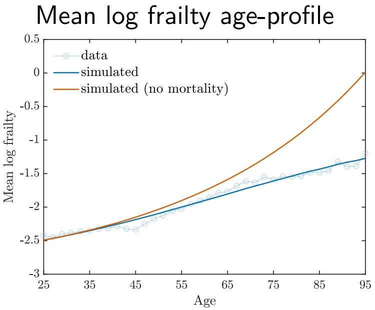
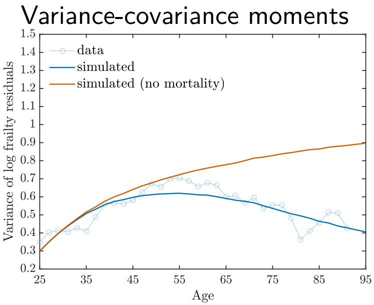
Stochastic frailty process for high school dropouts







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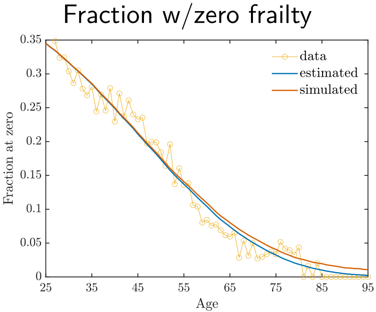
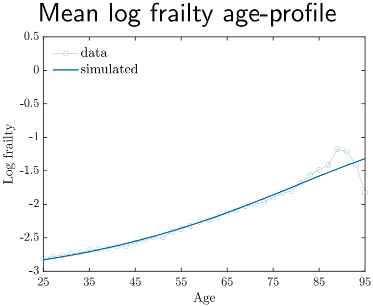
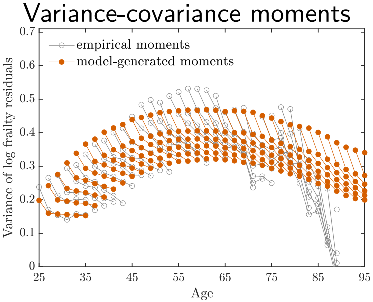
Stochastic frailty process for college graduates







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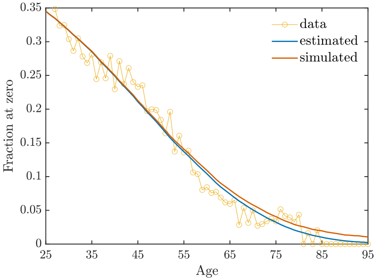
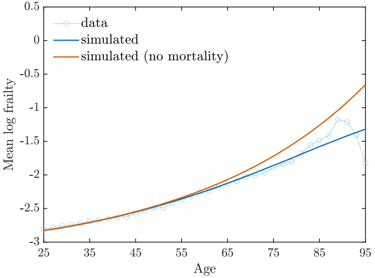
Stochastic frailty process for college graduates

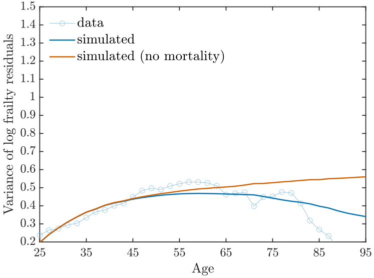
Fraction w/zero frailty



Mean log frailty age-profile



Variance-covariance moments



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DI Applicants in the Model

Table: Fraction of individuals non-employed for 1 year who are working 3 years later in the benchmark economy

	All	By frailty level		
Age		frailty > 0.1	frailty > 0.2	frailty > 0.3
25–65	31.9	30.8	27.7	24.6
35–64	28.5	27.8	26.3	23.2
45–64	26.2	25.9	24.7	21.2

- We assume those with frailty > 0.1 are DI applicants:
  - probability of getting DI is less than 0.1% if frailty below 0.1
  - under this assumption 50% of applicants successfully obtain DI one year after application consistent with estimated fraction in data (French & Song, 2014).
- Assumption doesn't have that big an impact on labor force participation rates.

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