Lifecycle mental health and earnings inequality

Ben Boyajian

Vanderbilt University

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Roadmap

Introduction & Data

Lifecycle model

Model estimation and validation

Counterfactuals

Motivation

Why mental health (MH)?

- Prevalent and costly (Direct costs, Indirect costs)
- US: 20% adults experience mental illness each year (NSDUH) (NIMH)
- UK: 65% of adults in the UK have experienced some mental health problem (UKMHF)
  - 40% of adults have experienced depression, 25% a panic attack
  - Notably 85% of adults out of work have experienced a mental health problem,
    - 65% of the in work, 50% of the retired

Why MH and labor?

- Policy makers care but difficult to evaluate (WHO, 2023), (OECD)
- Evaluate policy by health and labor outomces
  - mean levels and spread or inequality.
- Large (mostly physical) health and lifecycle labor literature

Health and labor literature

- Physical health and labor: empirical
  - Health effects labor, justify single index: Bound et al. (1999), Blundell et al. (2023)
  - Labor effects PH somewhat (mostly risky behavior & MH) Schaller and Stevens (2015)
- Large physical health and the lifecycle
  - Health, wealth and retirement: French (2005)
  - Continuous PH: Hosseini et al. (2021), Dal Bianco and Moro (2022)
  - Unobserved types: De Nardi et al. (2021)
- Mental health and labor: empirical
  - MH effects employment, maybe in NLSY79: Germinario et al. (2022)
  - MH effects career trajectory: Biasi et al. (2021)
  - Work autonomy effects MH: Spearing (2024)
- Newer mental health and labor: structural
  - Macro of mental health: Abramson et al. (2024)
  - MH treatment: Cronin et al. (2023)
  - Job search, stress and MH: Jolivet and Postel-Vinay (2020)

Questions and methods

How much does mental health (MH) inequality matter for lifetime earnings inequality?

- Estimate a life-cycle model of consumption, labor, wealth with heterogeneous MH
- Run counterfactuals with no MH inequality, compare earnings inequality

Eventually:

- How much does lifetime earnings inequality matter for mental health inequality?
  - Run counterfactuals with no lifetime earnings/labor inequality, compare mental health inequality
- How does physical health fit in?

Note:

$$Earnings = Employed * Hours * Wage$$

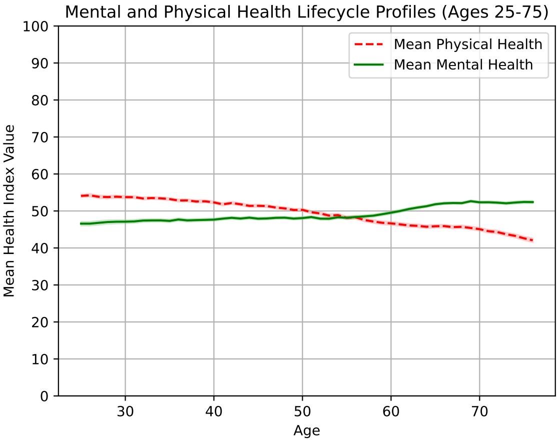
SF12 and UKHLS Panel

Table 12: SF-12 Questionnaire

1	How is your health in general?	7	Did your mental health mean you work less carefully?
2	Does your health limit moderate activities?	8	Did the pain interfere with your work?
3	Does your health limit walking up flights of stairs?	9	Did you feel calm and peaceful?
4	Did your physical health limit the amount of work you do?	10	Did you have a lot of energy?
5	Did your physical health limit the kind of work you do?	11	Did you feel downhearted and depressed?
6	Did your mental health mean you accomplish less?	12	Did you health interfere with your social life?

- UKHLS: United Kingdom Household Longitudinal Survey
- Nationally representative panel survey with health, income, employment, hours, demographics, time use etc.
- Sample is individuals aged 25-75 in the UK between 2009 and 2021
- SF-12 constructs mental health and physical health indices using principal component analysis
  - shown to be predictive of diagnosis and other health outcomes: Yu et al. (2015),Ohrnberger et al. (2020), Soh et al. (2021).

Mean Health Over the Lifecycle



- Index is standardized to a 50 pt. mean and 10 pt. standard deviation
- MH increases by about 1 std. dev., while PH decreases by about 1.5 std. dev. from 25-75

MH affects labor outcomes

Mental and Physical Health Indices and Labor Outcomes

	Year FE				Individ and Year FE			
	Employment	ln(Earnings)	ln(Wage)	ln(Hours)	Employment	ln(Earnings)	ln(Wage)	ln(Hours)
Mental Health	0.01677***	0.00212	0.00263**	-0.00050	0.00338***	-0.00090	0.00111	-0.00201***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Physical Health	0.01923***	0.00630***	0.00584***	0.00046	0.00387***	-0.00080	0.00094	-0.00175**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
MH × PH	-0.00023***	0.00001	-0.00001	0.00002	-0.00004***	0.00001	-0.00001	0.00003**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
female	-0.08798***	-0.41398***	-0.14776***	-0.26622***	0.00214	0.20999*	0.10675*	0.10324
	(0.002)	(0.004)	(0.003)	(0.002)	(0.050)	(0.082)	(0.052)	(0.062)
College	0.06733***	0.36049***	0.30941***	0.05108***	0.09178***	0.06414**	0.01899	0.04514**
	(0.002)	(0.004)	(0.003)	(0.002)	(0.019)	(0.021)	(0.018)	(0.015)
Observations	142,051	76,849	76,849	76,849	136,648	73,068	73,068	73,068
R-Square	0.40755	0.31907	0.26407	0.19929	0.80956	0.88147	0.82475	0.79041
Adj. R-Square	0.40737	0.31869	0.26366	0.19884	0.77397	0.85690	0.78843	0.74698

All models control for race, marital status, urban location, and an age cubic.

- PH and MH deferentially effect labor market outcomes
- Individual FE: unobserved fixed heterogeneity seems important

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Model in one slide: words

- Households (HH) live J periods and derive utility from consumption and leisure
- Continuous choices in labor n (switch to discrete), consumption c, and future assets a'
- Constrained by expendable income and time endowment
- Exogenous wage and health process
- Wage is quadratic in age and linear in health
- Two health states $H \in \{Bad, Good\}$: effects wage w_H
- Permanent labor productivity type γ effects the wage process

Utility and time endowment

Individuals derive period utility from consumption and leisure

$$u\left(c_j, l_j\right) = \frac{\left(c_j^{\alpha} l_j^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}$$

where the time endowment is s.t.

$$l_j = 1 - \phi_n n_j$$

ϕ_n the time cost of work > 1 to account for commuting etc, ϕ_H is the time cost of bad health.

Consumption constraints

Choices must be s.t.

$$c + a' = z(\gamma, j, H) \cdot n + a(1 + r)\, ; \forall j$$

$$a_0 = a_{J+1} = 0;$$

and

$$a_j > -\kappa, \text{ and } c_j, n_j \geq 0; \forall j.$$

With $\ln z(\gamma, j, H) = w_{0\gamma_i} + w_1 j + w_2 j^2 + w_H 1_{H=Good}$ where the linear coefficient depends on productivity type γ_i.

Model in one slide: math

$$V_j\left(a,\gamma,H\right)=\max_{c,n,a'}\left\{u\left(c,1-\phi_n n\right)+\beta\,\mathbb{E}_{H'}\,V_{j+1}\left(a',\gamma,H'\right)\right\}$$

$$\text{s.t. }\; c+a'=z\left(\gamma,j,H\right)\cdot n+a\left(1+r\right);\forall j$$

$$\ln z\left(\gamma_i,j,H_{ij}\right)=w_{0\gamma_i}+w_1 j+w_2 j^2+w_H 1_{H_{ij}=Good} \tag{1}$$

$$H'\sim\Pi^H \tag{2}$$

$w_{0\gamma_i}$ depends on productivity type γ_i.

Standard: $a_0=a_{J+1}=0$ and $a_j>-\kappa,;c_j,n_j\geq 0;\forall j$.

Establishing and good and bad mental health

Table 1: Mental and Physical Health Quintile Effects and Labor Outcomes

	Year FE				Individ and Year FE			
	Employment	ln(Earnings)	ln(Wage)	ln(Hours)	Employment	ln(Earnings)	ln(Wage)	ln(Hours)
Fair Mental Health	0.198***	0.006	0.012	-0.006	0.033***	-0.001	0.013	-0.014
	(0.008)	(0.018)	(0.013)	(0.013)	(0.005)	(0.010)	(0.009)	(0.008)
Good Mental Health	0.269***	0.034	0.032*	0.002	0.046***	-0.003	0.016	-0.018*
	(0.009)	(0.020)	(0.014)	(0.014)	(0.006)	(0.010)	(0.009)	(0.008)
Very Good MH	0.305***	0.087***	0.076***	0.011	0.060***	0.002	0.023*	-0.021*
	(0.010)	(0.022)	(0.016)	(0.015)	(0.007)	(0.012)	(0.010)	(0.009)
Excellent Mental Health	0.320***	0.059***	0.060***	-0.001	0.051***	0.002	0.016	-0.014
	(0.007)	(0.017)	(0.013)	(0.012)	(0.006)	(0.010)	(0.009)	(0.008)
Fair Physical Health	0.243***	0.056**	0.047***	0.010	0.044***	0.014	0.017*	-0.003
	(0.009)	(0.017)	(0.013)	(0.012)	(0.007)	(0.009)	(0.008)	(0.008)
Good Physical Health	0.344***	0.073***	0.064***	0.009	0.062***	0.012	0.022*	-0.010
	(0.011)	(0.017)	(0.013)	(0.013)	(0.008)	(0.010)	(0.009)	(0.008)
Very Good PH	0.351***	0.098***	0.080***	0.018	0.038***	0.017	0.024*	-0.008
	(0.013)	(0.019)	(0.015)	(0.014)	(0.010)	(0.011)	(0.010)	(0.009)
Excellent Physical Health	0.398***	0.166***	0.140***	0.026*	0.060***	-0.001	0.019*	-0.020**
	(0.008)	(0.015)	(0.011)	(0.011)	(0.007)	(0.009)	(0.008)	(0.007)
female	-0.090***	-0.416***	-0.150***	-0.266***	0.002	0.210*	0.107*	0.104
	(0.002)	(0.004)	(0.003)	(0.002)	(0.050)	(0.082)	(0.052)	(0.061)
College	0.070***	0.359***	0.308***	0.051***	0.086***	0.066**	0.021	0.045**
	(0.003)	(0.004)	(0.003)	(0.002)	(0.019)	(0.021)	(0.018)	(0.015)
Observations	142055.000	76858.000	76858.000	76858.000	136652.000	73078.000	73078.000	73078.000
R-Square	0.403	0.320	0.266	0.199	0.810	0.881	0.825	0.790
Adj. R-Square	0.402	0.319	0.265	0.198	0.774	0.857	0.788	0.746

All models control for race, marital status, urban location, and an age cubic.

Define good and bad

- For simplicity and congruence with the literature I assume two health states $H \in \{Bad, Good\}$
- Use regression and Wald tests to inform cutoffs.
- Quantile regressions suggests bottom 40% *Bad*, top 60% *Good*
- Other quantile specifications yield low action relative to the increased complexity
    - Might think there are 3 health states G,A,B

Health states and process

Health evolves according to the transition matrix

$$\Pi_j^H = \begin{bmatrix} \pi_j^{BB}, & \pi_j^{BG} \\ \pi_j^{GB}, & \pi_j^{GG} \end{bmatrix}$$

where entry $\pi_{B,G}$ is the probability of transitioning from health state $H = Bad$ to $H = Good$.

- $H = Bad$ if below the 40th percentile of the mental health index. $H = Good$ otherwise.
- I estimate the transition probabilities as the fraction of individuals that make the relevant transition.
    - E.g. $\hat{\pi}_j^{BG}$ is the fraction of people who transition from bad to good health at age j

Unconditional transitions by age

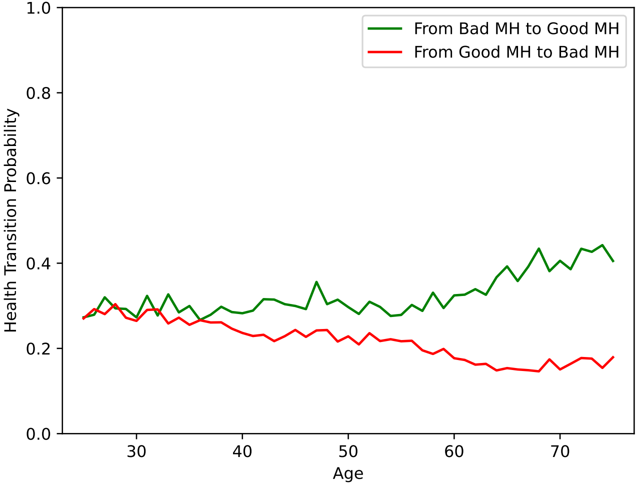


Figure: 1-Year Mental Health Transitions

Roadmap

Exogenous parameters

Parameter	Description	Value	Source
R	Gross interest rate	1.02	Benchmark
β	Patience	0.9804	$1/R$
σ	CRRA	0.9999	Benchmark
ϕ_n	Labor time-cost	1.125	Benchmark

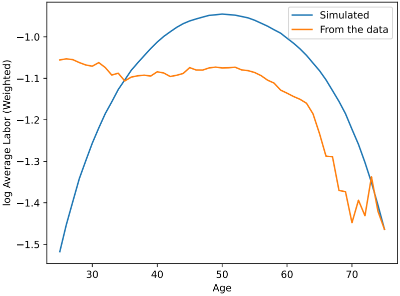
Table: Exogenous parameters

Calibrated parameters

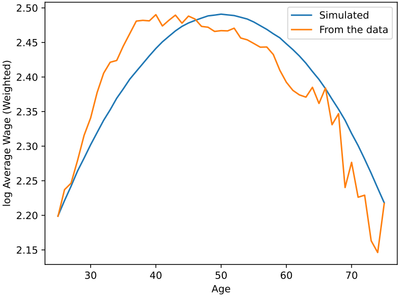
Parameter	Description	Par. Value	Target Moment	Target Value	Model Value
α	c utility weight	0.3789	Mean hours worked	33.5	33.48
$\mu_{w_{0,\gamma}}$	Lab. FE mean	2.1423	Mean wage, $j = 0$	2.1986	2.1992
$\sigma_{w_{0,\gamma}}$	Lab. FE SD	0.3288	SD wage, $j = 0$	0.2996	0.299
w_1	Linear wage coeff.	0.0229	Wage growth	29.16%	29.17%
w_2	Quad. wage coeff.	-0.0005	Wage decay	27.32%	27.28%
w_H	Health wage coeff.	0.0562	Healthy wage premium	5.13%	5.11%

Table: Calibrated parameters 1

Targeted hours and wage fit



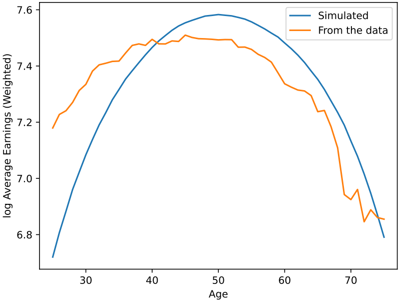
(a) Mean log hours worked (labor)



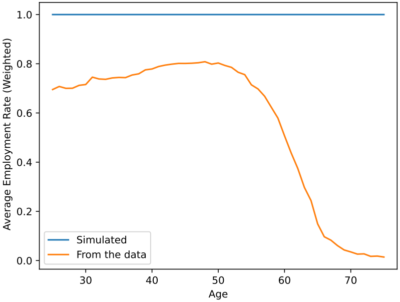
(b) Mean log wage

- Unsurprisingly targeted moments fit pretty well.

Labor earnings and employment



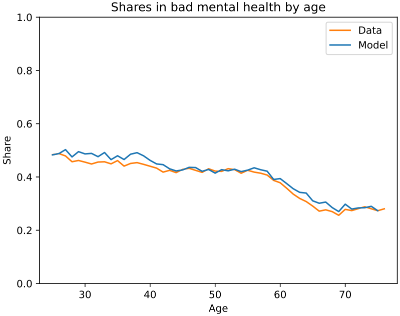
(c) Monthly mean earnings



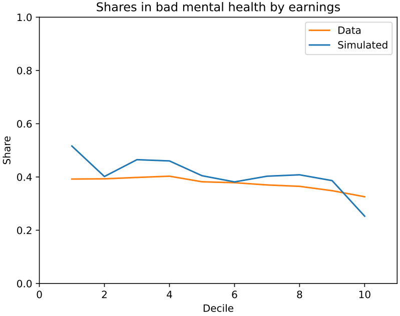
(d) Employment rate

- Earning fit is not great since I entirely miss the extensive margin.

Shares in bad mental health



(e) Bad MH by age



(f) Bad MH by earnings

Earnings by health

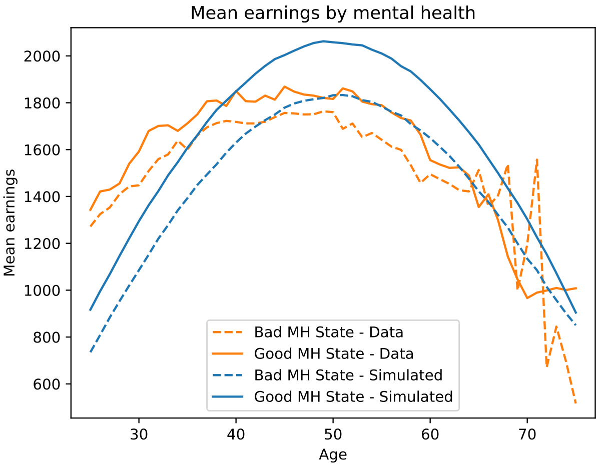
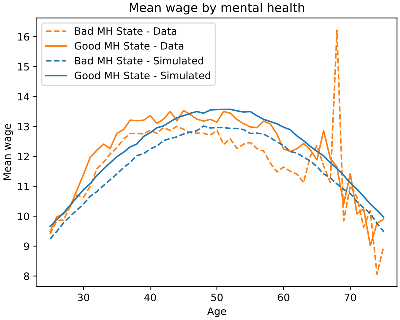
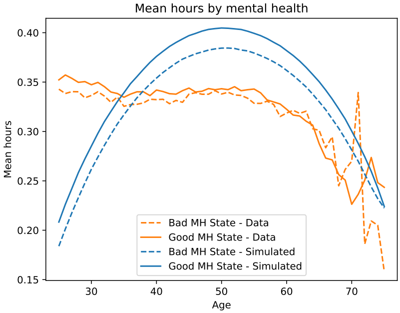


Figure: Mean earnings by mental health

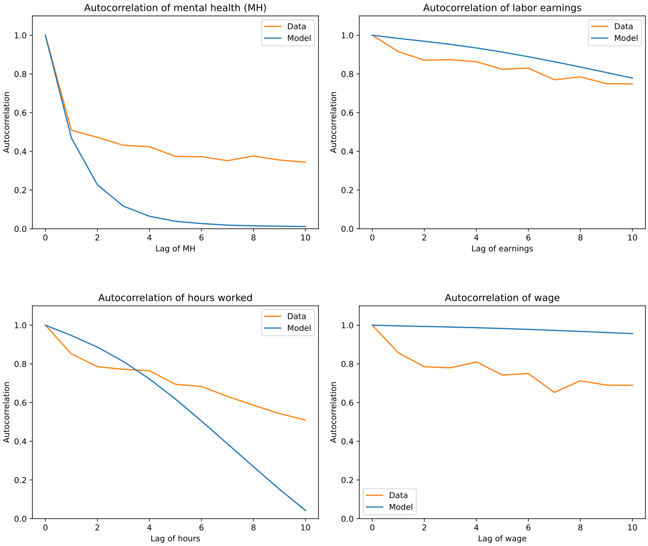
- My health states are more different than the data conditional on employment

Wages and hours by health

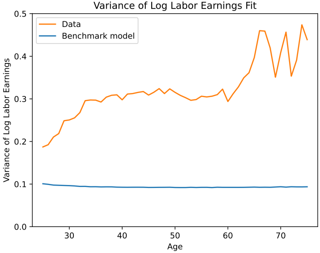


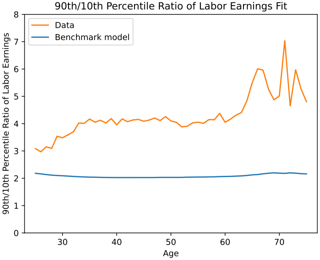


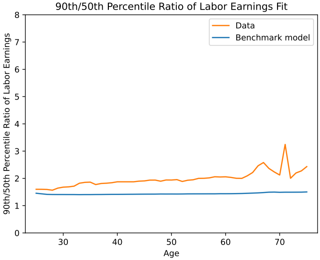
Fit persistence

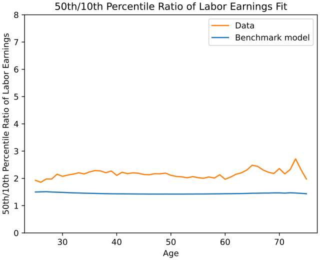


Fit inequality in log earnings









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Counterfactuals

Consider a counter factual where we turn off the mental health channel

- Set $w_H = 0$. Since MH only effects wages, all mental health channels are turned off.

Variance of log earnings current counterfactuals

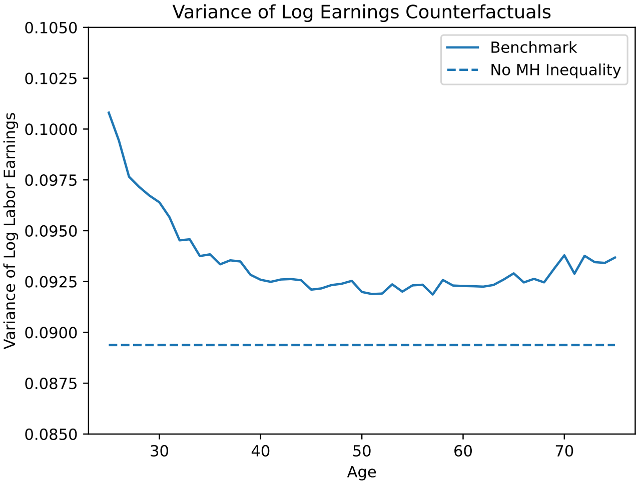
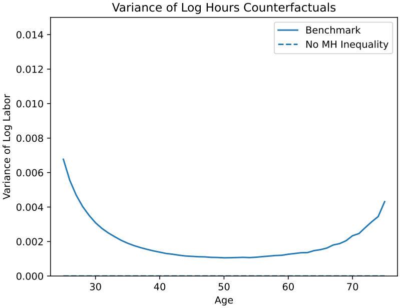
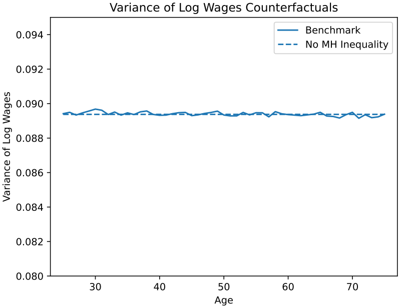


Figure: Variance of log earnings counterfactuals

Decomposing the variance of log earnings





Lifetime earnings

Define annualized lifetime earnings in the model as in Guvenen et al. (2022)

$$\bar{Y}^i \equiv \frac{1}{31} \times \sum_{j=25}^{55} Y_j^i = \frac{1}{31} \times \sum_{j=25}^{55} n_j * z_j$$

Lifetime Earnings Comparison

	Summary		Percentiles					Ratios		
Source	Mean	Std. Dev.	P10	P25	P50	P75	P90	P90/P10	P90/P50	P50/P10
Baseline Model	19.35	5.94	13.25	17.61	17.77	35.22	40.24	3.04	2.26	1.34
No MH Inequality	19.37	5.94	13.34	17.11	17.11	34.22	37.98	2.85	2.22	1.28

Table: Lifetime earnings statistics

Lifetime earnings in the data

Define annualized lifetime earnings in the data as

$$\bar{Y} \equiv \frac{1}{31} \times \sum_{j=25}^{55} \bar{Y}_j$$

where $\bar{Y}_j = \sum_{i=1}^{I} Y_j^i$. Similarly we could define an annualized X percentile as

$$P^x \equiv \frac{1}{31} \times \sum_{j=25}^{55} P_j^x$$

where P_j^x is the percentile at that age. And could do the same thing in the model... this would give comparable statistics for both.

Conclusion and next steps

- Developed a simple lifecycle model with mental health
- Matches some important moments,misses others
- Previewed some results
- Mechanical next steps
  - Match the extensive margin employment and retirement
- More interesting but later..
  - Endogenize mental health (e.g. treatment decisions)
  - Add physical health. How does it effect mental health and vice versa?
  - Are my symptoms caused by stress?

Thank You!

Thank you!

Any questions? I appreciate your feedback!

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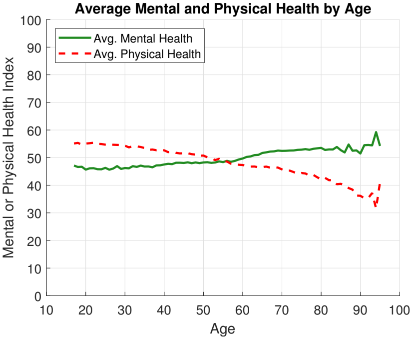

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References

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