

Perceived Income Risks

Tao Wang
Johns Hopkins University

September 13, 2022
Job Market Talk

Outline

- ① Motivation
- ② Empirical evidence
 - Framework
 - Cross-sectional patterns
 - Unemployment risks
 - Perceived risks and decisions
- ③ Model
 - Subjective model
- ④ Conclusion

Motivation

- Risks matter for individual decisions
 - precautionary saving
 - stock market participation
 - portfolio choice

Motivation

- Risks matter for **individual decisions**
 - precautionary saving
 - stock market participation
 - portfolio choice
- Risks matter for **macroeconomic outcomes**
 - since idiosyncratic risks are not perfectly insured
 - → income/wealth inequality
 - → heterogeneous $MPCs$
 - → distributional channel of macroeconomic policies
 - → business cycle fluctuations

Motivation

- Risks matter for **individual decisions**
 - precautionary saving
 - stock market participation
 - portfolio choice
- Risks matter for **macroeconomic outcomes**
 - since idiosyncratic risks are not perfectly insured
 - → income/wealth inequality
 - → heterogeneous $MPCs$
 - → distributional channel of macroeconomic policies
 - → business cycle fluctuations
- Income risks are central inputs of any incomplete-market model
 - Conventional approach: **estimated using panel data**
 - This paper: directly calibrating **perceived risks from a survey**

Some macro facts

- Wealth inequality and heterogeneity in MPC s
 - a standard incomplete market model generates **insufficient inequality compared to that seen in the data**
 - unless additional features such as **preference heterogeneity** or **illiquid assets** are introduced

Some macro facts

- Wealth inequality and heterogeneity in MPC s
 - a standard incomplete market model generates **insufficient inequality compared to that seen in the data**
 - unless additional features such as **preference heterogeneity** or **illiquid assets** are introduced
- Liquid assets holding
 - **too low** in data compared to a standard one-asset incomplete market model
- “Excessive sensitivity” to unanticipated transitory shocks
 - **higher MPC s** seen in the data than PIH model prediction

Preview of the findings

- ① **Empirics:** perceived income risks (PRs) from a **density survey**
 - **Heterogeneity:** sizable difference across/within groups
 - **Superior information/unobserved heterogeneity:** lower than standard estimates/ parameterizations
 - **Decisions:** spending plans react to risk perceptions

Preview of the findings

- ① **Empirics:** perceived income risks (PRs) from a **density survey**
 - **Heterogeneity:** sizable difference across/within groups
 - **Superior information/unobserved heterogeneity:** lower than standard estimates/ parameterizations
 - **Decisions:** spending plans react to risk perceptions
- ② **Model:**
 - survey-calibrated OLG / incomplete-market GE model
 - Lower PR \rightarrow lower buffer-stock savings
 - Heterogeneity in PR \rightarrow more wealth inequality
 - Heterogeneity in expected wage growth \rightarrow more wealth inequality

Literature

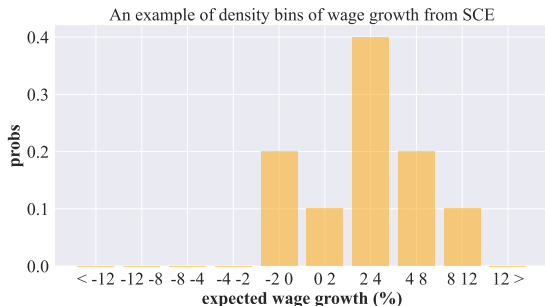
- income risks and partial insurance: [Gottschalk et al. \(1994\)](#), [Carroll and Samwick \(1997\)](#), [Meghir and Pistaferri \(2004\)](#), [Storesletten et al. \(2004\)](#), [Blundell et al. \(2008\)](#), [Moffitt and Gottschalk \(2002\)](#), [Guvenen et al. \(2014\)](#), [Arellano et al. \(2017\)](#), [Bloom et al. \(2018\)](#)
 - “insurance or information”: [Pistaferri \(2001\)](#), [Kaufmann and Pistaferri \(2009\)](#), [Meghir and Pistaferri \(2011\)](#), [Kaplan and Violante \(2010\)](#)
- subjective/probabilistic survey of beliefs: [Manski \(2004\)](#), [Delavande et al. \(2011\)](#), [Manski \(2018\)](#), [Bertrand and Mullainathan \(2001\)](#), [Armantier et al. \(2017\)](#)
- incomplete market macro: [Bewley \(1976\)](#), [Aiyagari \(1994\)](#), [Huggett \(1996\)](#), [Krusell and Smith \(1998\)](#), [Heathcote et al. \(2009\)](#), [Carroll et al. \(2017\)](#), [Krueger et al. \(2016\)](#), [Bayer et al. \(2019\)](#)
- consumption/saving under incomplete information/imperfect perception: [Pischke \(1995\)](#), [Wang \(2004\)](#), [Rozsypal and Schlafmann \(2017\)](#), [Carroll et al. \(2018\)](#), [Lian \(2019\)](#)

Data and sample

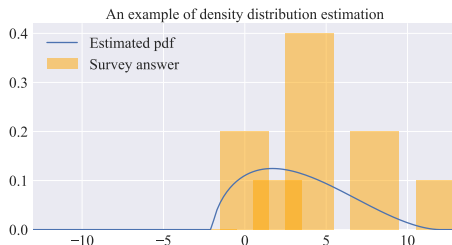
- Density survey: SCE
 - 2013M6-2020M4 (monthly)
 - 1300 households
 - 12-month panel
- Income panel: SIPP
 - 2014M1-2019M12 (monthly)
 - hourly wage
 - primary/full-time/non-self-employed job
 - 900-2700 respondents
 - CPI adjusted
 - age 30-65
 - only **job-stayers** with the same employer for ≥ 2 ([Low et al. \(2010\)](#))

The survey question

“Suppose that 12 months from now, you are working in the exact same [“main” if $Q11 > 1$] job at the same place you currently work and working the exact same number of hours. In your view, what would you say is the percentage chance that 12 months from now, your earnings on this job, before tax and deductions, will increase by $x\%$?”



An illustration of the density forecast estimation



- case 1. 3+ intervals with positive probs, a generalized beta dist
- case 2. exactly 2 adjacent intervals with positive probs: a triangle dist
- case 3. one interval only: a uniform dist

Survey questions (continued)

- Individual-specific bin-based forecast on $\Delta w_{i,t+1}$
 - wage growth of the same job/position/hours
 - exl. endogenous labor supply changes/promotion/demotion/separation
- Measurement of PR:
 - variance: $\overline{Var}_{i,t}(\Delta w_{i,t+1})$
 - computed from the density forecast
- density estimation following [Engelberg et al. \(2009\)](#)
- restricted to attentive/high numeracy score sample
- both nominal and real terms (adjusted by inflation uncertainty)

Log wage process

$$\underbrace{w_{i,t}}_{\text{log wage}} = \underbrace{z_{i,t}}_{\text{predictable by the agent}} + \underbrace{e_{i,t}}_{\text{stochastic component}}$$

- individual i at time t
- the time-series nature of $e_{i,t}$ to be specified later

Perceived risks (PR)

- Wage growth

$$\Delta w_{i,t+1} = \Delta z_{i,t+1} + \Delta e_{i,t+1}$$

Perceived risks (PR)

- Wage growth

$$\Delta w_{i,t+1} = \Delta z_{i,t+1} + \Delta e_{i,t+1}$$

- To the agent: **conditional** variance under FIRE

$$Var_{i,t}^*(\Delta w_{i,t+1}) = Var_{i,t}^*(\Delta e_{i,t+1})$$

Perceived risks (PR)

- Wage growth

$$\Delta w_{i,t+1} = \Delta z_{i,t+1} + \Delta e_{i,t+1}$$

- To the agent: **conditional** variance under FIRE

$$Var_{i,t}^*(\Delta w_{i,t+1}) = Var_{i,t}^*(\Delta e_{i,t+1})$$

- To econometricians: **approximated unconditional** variance

$$Var_c(\Delta \hat{e}_{i,c,t+1}) = Var_c(\Delta w_{i,t+1} - \Delta \hat{z}_{i,t+1})$$

- $\hat{e}_{i,c,t+1}$: the first-step regression residual controlling observable vars
- group c : **assumed** to share income process/risks
 - i.e. education/year of birth/gender/age

Time series structure of wage shocks

$$e_{i,t} = \underbrace{p_{i,t}}_{\text{permanent}} + \underbrace{\theta_{i,t}}_{\text{transitory}}$$

$$p_{i,t+1} = p_{i,t} + \psi_{i,t+1}$$

$$\psi_{i,t} \sim N(0, \sigma_{i,t,\psi}^2)$$

$$\theta_{i,t} \sim N(0, \sigma_{i,t,\theta}^2)$$

Time series structure of wage shocks

$$e_{i,t} = \underbrace{p_{i,t}}_{\text{permanent}} + \underbrace{\theta_{i,t}}_{\text{transitory}}$$

$$p_{i,t+1} = p_{i,t} + \psi_{i,t+1}$$

$$\psi_{i,t} \sim N(0, \sigma_{i,t,\psi}^2)$$

$$\theta_{i,t} \sim N(0, \sigma_{i,t,\theta}^2)$$

- The agent's PR

$$Var_{i,t}^*(\Delta w_{i,t+1}) = \sigma_{i,t+1,\psi}^2 + \sigma_{i,t+1,\theta}^2$$

Time series structure of wage shocks

$$e_{i,t} = \underbrace{p_{i,t}}_{\text{permanent}} + \underbrace{\theta_{i,t}}_{\text{transitory}}$$

$$p_{i,t+1} = p_{i,t} + \psi_{i,t+1}$$

$$\psi_{i,t} \sim N(0, \sigma_{i,t,\psi}^2)$$

$$\theta_{i,t} \sim N(0, \sigma_{i,t,\theta}^2)$$

- The agent's PR

$$Var_{i,t}^*(\Delta w_{i,t+1}) = \sigma_{i,t+1,\psi}^2 + \sigma_{i,t+1,\theta}^2$$

- Econometricians' approximated PR

$$\widehat{Var}_{c,t}(\Delta \hat{e}_{i,c,t+1}) = \hat{\sigma}_{c,t+1,\psi}^2 + \hat{\sigma}_{c,t+1,\theta}^2$$

Limitations with risk estimates from panel data

- Superior information/unobservable heterogeneity: $\hat{z}_{i,t} \neq z_{i,t}$
 - $\hat{z}_{i,t}$ unlikely capture all in the information set of i at t
 - ① Intrinsic heterogeneity of individual i not observable by economists
 - ② Foresight about individual circumstance not available to economists

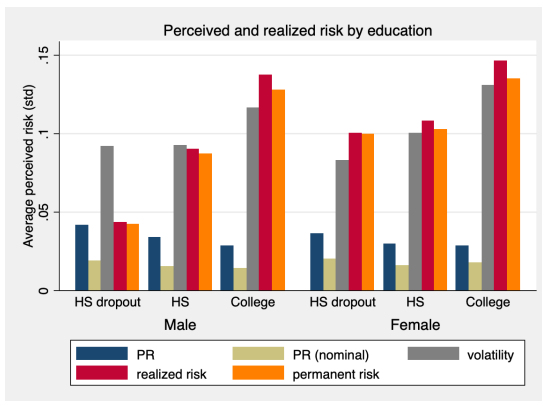
Limitations with risk estimates from panel data

- Superior information/unobservable heterogeneity: $\hat{z}_{i,t} \neq z_{i,t}$
 - $\hat{z}_{i,t}$ unlikely capture all in the information set of i at t
 - ① Intrinsic heterogeneity of individual i not observable by economists
 - ② Foresight about individual circumstance not available to economists
- Model misspecification
 - Risks may differ within group c , but economists have to estimate it at the group level.

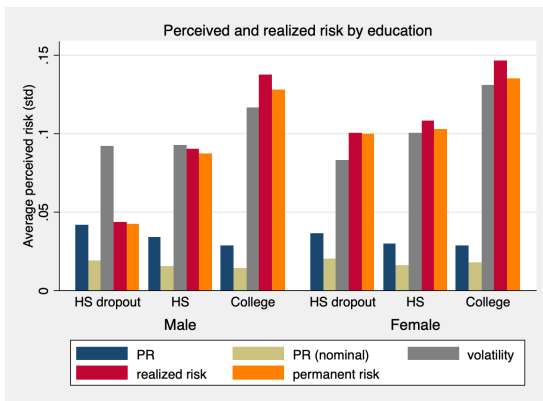
Limitations with risk estimates from panel data

- Superior information/unobservable heterogeneity: $\hat{z}_{i,t} \neq z_{i,t}$
 - $\hat{z}_{i,t}$ unlikely capture all in the information set of i at t
 - ① Intrinsic heterogeneity of individual i not observable by economists
 - ② Foresight about individual circumstance not available to economists
- Model misspecification
 - Risks may differ within group c , but economists have to estimate it at the group level.
- Surveyed PR can be a better alternative
 - Directly conditional on information set of each i at t
 - No need to restrict risk heterogeneity by group c
 - But need to be careful with measurement errors

Observable heterogeneity: by education and gender

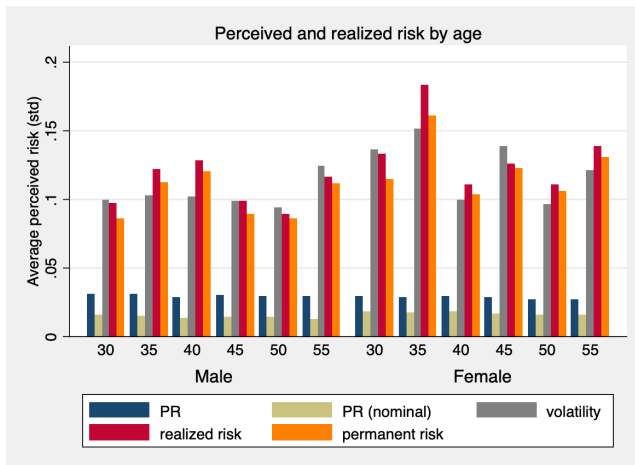


Observable heterogeneity: by education and gender

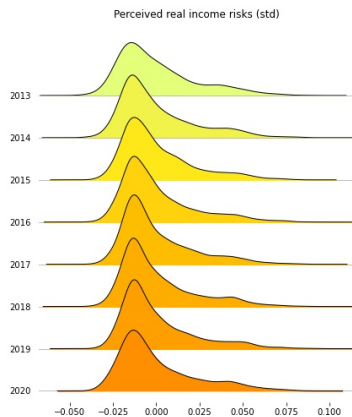


- The wage risk estimates by [Low et al. \(2010\)](#):
 - low education: permanent risk = 0.09, transitory risk = 0.08
 - high education: permanent risk = 0.106, transitory risk = 0.08

Observable heterogeneity: by age and gender



Unobservable heterogeneity

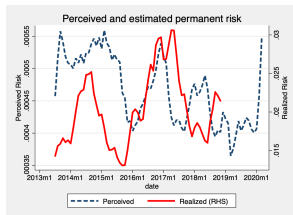


- residuals controlling for observables + time FE ($R^2 = 0.10$)
- average PR: 3.5% in std; 10/90 IQR: 5.2% in std

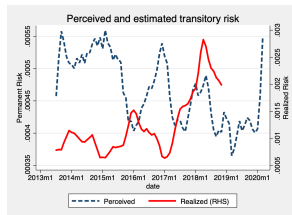
nominal

Permanent versus transitory risks

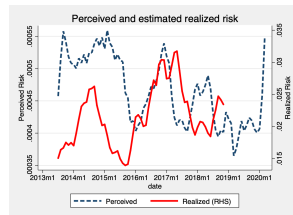
(a) permanent



(b) transitory



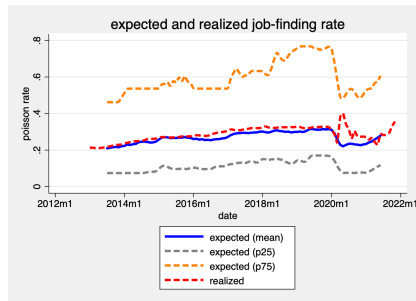
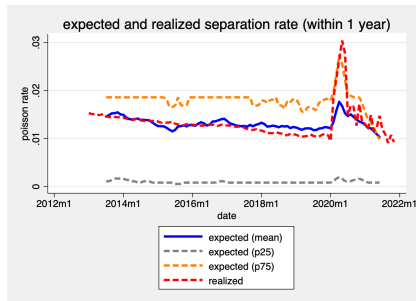
(c) volatility



- i.e. one-year-ahead perceived risk at 2014m1 v.s. realized risk over the same period
- wage rate for the same job/hours/position
- estimated monthly risks aggregated into annual frequency

More details

Perceived UE risks and realization



- the realization computed from CPS panel data of workers following [Fujita and Ramey \(2009\)](#)

Perceived risks and household spending

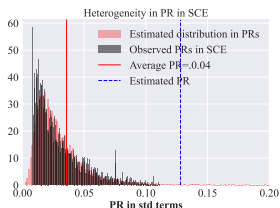
$$E_{i,t}(\Delta c_{i,t+1}) = u_0 + u_1 \text{Var}_{i,t}(\Delta w_{i,t+1}) + \xi_{i,t}$$

	(1)	(2)	(3)	(4)	(5)	(6)
perceived earning risk	8.394*** (1.175)	8.399*** (1.176)	3.642*** (0.533)	3.243*** (0.537)		
perceived earning risk (nominal)					3.656*** (0.990)	
perceived ue risk						0.353*** (0.0553)
R-squared	0.0010	0.00282	0.928	0.928	0.941	0.633
Sample Size	53178	53178	53178	53178	54584	6269
Time FE	No	Yes	No	Yes	Yes	No
Individual FE	No	No	Yes	Yes	Yes	Yes

- Higher perceived risks → higher expected spending growth.

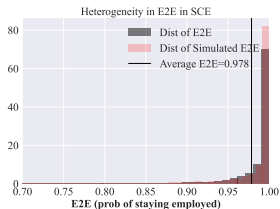
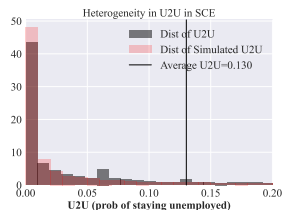
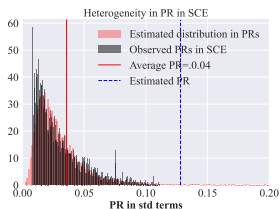
Calibrating heterogeneous PRs from SCE survey

- Fit a truncated log-normal dist over the cross-section of PRs
- Uncover unobserved heterogeneity in wage growth using the difference between reported PR and the estimated PR.



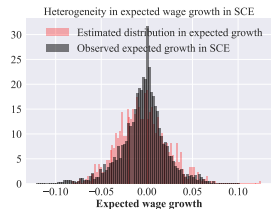
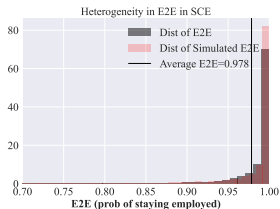
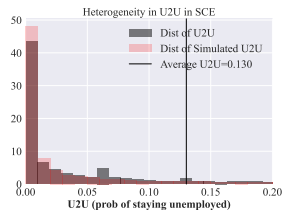
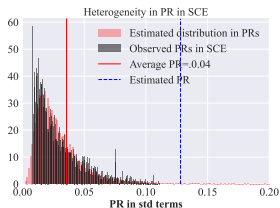
Calibrating heterogenous PRs from SCE survey

- Fit a truncated log-normal dist over the cross-section of PRs
- Uncover unobserved heterogeneity in wage growth using the difference between reported PR and the estimated PR.



Calibrating heterogenous PRs from SCE survey

- Fit a truncated log-normal dist over the cross-section of PRs
- Uncover unobserved heterogeneity in wage growth using the difference between reported PR and the estimated PR.



Implications for consumption/saving

- On **level** of savings
 - ① ↓ **lower PR**: lower precautionary saving motives → less liquid holding → higher MPC

Implications for consumption/saving

- On **level** of savings
 - ① ↓ **lower PR**: lower precautionary saving motives → less liquid holding → higher MPC

Implications for consumption/saving

- On **level** of savings
 - ① ↓ **lower PR**: lower precautionary saving motives → less liquid holding → higher MPC
- On **wealth inequality**
 - ↑ **heterogeneous PR** → heterogeneity in saving/wealth

Model overview

- Overlapping generation
- General equilibrium
- Uninsured idiosyncratic income risks
 - Permanent+ transitory idiosyncratic wage shock
 - Persistent unemployment spells
- No aggregate risk a la [Krusell and Smith \(1998\)](#)
- A blend of [Huggett \(1996\)](#) and [Carroll \(1997\)](#)
- Single one risk-free asset
- Calibrating income risks **using survey** versus **estimates from panel**
- Extension: subjective risk perceptions
 - Individuals swing between low/high risk perceptions

Benchmark model

$$\max \quad \mathbb{E} \left[\sum_{\tau=0}^{\tau=L-1} (1-D)^{\tau} \beta^{\tau} u(c_{i,\tau}) \right]$$

$$\underbrace{a_{i,\tau}}_{\text{Savings}} = \underbrace{m_{i,\tau}}_{\text{Cash in hand}} - c_{i,\tau}$$

$$b_{i,\tau+1} = a_{i,\tau} R$$

$$m_{i,\tau+1} = b_{i,\tau+1} + (1 - \underbrace{\lambda}_{\text{Income tax}})(1 - \underbrace{\lambda_{SS}}_{\text{SS tax}})y_{i,\tau+1}$$

$$a_{i,\tau} \geq 0$$

- CRRA: $u(c) = \frac{c^{1-\rho}}{1-\rho}$
- Work age: $\tau = 1, 2, \dots, T$ (since entering job market)
- Life length: $\tau = 1, 2, \dots, L$ (since entering job market)
- Survival probability: 1-D

Income process over the life-cycle

- income

$$y_{i,\tau} = n_{i,\tau}W$$

$$n_{i,\tau} = p_{i,\tau}\xi_{i,\tau}$$

- permanent component

$$p_{i,\tau} = G_\tau p_{i,\tau-1} \psi_{i,\tau}, \quad \log(\psi_{i,\tau}) \sim N(-\sigma_\psi^2/2, \sigma_\psi^2) \quad \forall \tau \leq T$$

- persistent/transitory component

$$\xi_{i,\tau} = \begin{cases} \theta_{i,\tau} & \text{if } \nu_{i,\tau} = e \quad \& \quad \tau \leq T, \quad \log(\theta_{i,\tau}) \sim N(-\frac{\sigma_\theta^2}{2}, \sigma_\theta^2) \\ \zeta & \text{if } \nu_{i,\tau} = u \quad \& \quad \tau \leq T \\ \mathbb{S} & \text{if } \tau > T \end{cases}$$

- transition probability between $\nu = u$ and $\nu = e$

$$\pi(\nu_{\tau+1}|\nu_\tau) = \begin{bmatrix} \mathfrak{U} & 1 - \mathfrak{U} \\ 1 - E & E \end{bmatrix}$$

Macroeconomic environment

- Technology

$$Y = ZK^{\alpha}N^{1-\alpha}$$

Macroeconomic environment

- Technology

$$Y = ZK^{\alpha}N^{1-\alpha}$$

- Government (balance budget)

$$\lambda \left[1 - \Pi^{\psi} + \zeta \Pi^{\psi} \right] = \zeta \Pi^{\psi}$$

$$\lambda_{SS} \sum_{\tau=1}^T G_{\tau} (1 - \Pi^{\psi}) = \mathbb{S} \sum_{\tau=T+1}^L G_{\tau}$$

Macroeconomic environment

- Technology

$$Y = ZK^{\alpha}N^{1-\alpha}$$

- Government (balance budget)

$$\lambda \left[1 - \Pi^{\bar{v}} + \zeta \Pi^{\bar{v}} \right] = \zeta \Pi^{\bar{v}}$$

$$\lambda_{SS} \sum_{\tau=1}^T G_{\tau} (1 - \Pi^{\bar{v}}) = \mathbb{S} \sum_{\tau=T+1}^L G_{\tau}$$

- Demographics

- Stable age distribution $\{\mu_{\tau}\}_{\tau=1,2,\dots,L}$

$$\mu_{\tau+1} = (1 - D)\mu_{\tau}, \quad \sum_{\tau=1}^L \mu_{\tau} = 1$$

Macroeconomic environment

- Technology

$$Y = ZK^{\alpha}N^{1-\alpha}$$

- Government (balance budget)

$$\lambda \left[1 - \Pi^{\bar{v}} + \zeta \Pi^{\bar{v}} \right] = \zeta \Pi^{\bar{v}}$$

$$\lambda_{SS} \sum_{\tau=1}^T G_{\tau} (1 - \Pi^{\bar{v}}) = \mathbb{S} \sum_{\tau=T+1}^L G_{\tau}$$

- Demographics

- Stable age distribution $\{\mu_{\tau}\}_{\mu=1,2,\dots,L}$

$$\mu_{\tau+1} = (1 - D)\mu_{\tau}, \quad \sum_{\tau=1}^L \mu_{\tau} = 1$$

- Zero or positive accidental bequests: lum-sum of a fraction of the deceased' wealth

Value function and transitions

- Value function

$$V_{\tau}(\underbrace{\nu_{i,\tau}, m_{i,\tau}, p_{i,\tau}}_{x_{i,\tau}}) = \max_{\{c_{i,\tau}, a_{i,\tau}\}} u(c_{i,\tau}) \\ + (1 - D)\beta \mathbb{E}_{\tau} [V_{\tau+1}((\nu_{i,\tau}, m_{i,\tau+1}, p_{i,\tau+1}))]$$

- Transitions

$$\psi_{\tau}(B) = \int_{x \in X} \underbrace{P(x, \tau - 1, B)}_{\text{transition funcs}} d\psi_{\tau-1} \quad \text{for all } B \in B(X)$$

Stationary equilibrium (StE)

- Optimal consumption and saving policies given W, R, λ
- Distribution evolution consistent with optimal c and a policies and income risks
- The factor markets clear

$$\sum_{\tau} \mu_{\tau} \int_X a(x, \tau) d\psi_{\tau} = K$$

$$\sum_{\tau=0}^{T-1} \mu_{\tau} \Pi_{\tau}^E = N$$

- Firm optimization under competitive factor markets.

$$W = Z(1 - \alpha)(K/N)^{\alpha}$$

$$R = 1 + Z\alpha(K/N)^{\alpha-1} - \delta$$

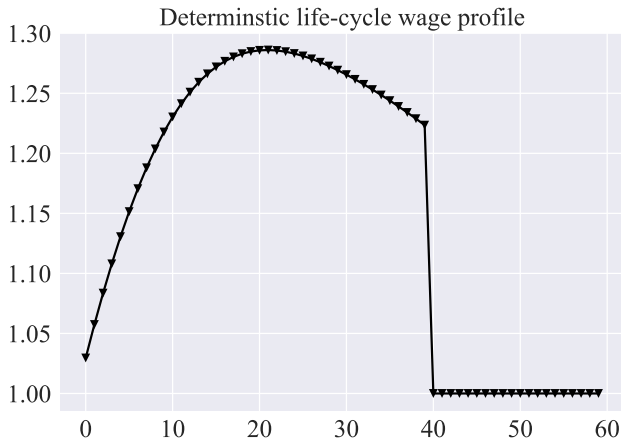
- Balanced government budget

Calibration of the benchmark model

Table: Model parameters

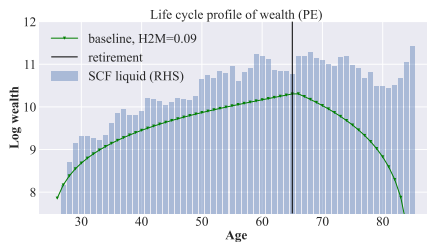
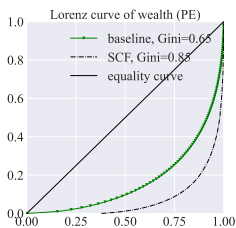
block	parameter name	values	source
risk	σ_ψ	0.15	Median estimates from the literature
risk	σ_θ	0.15	Median estimates from the literature
risk	$U2U$	0.18	Median estimates from the literature
risk	$E2E$	0.96	Median estimates from the literature
initial condition	$\sigma_\psi^{\text{init}}$	0.629	Estimated for age 25 in the 2016 SCF
initial condition	bequest ratio	0	assumption
life cycle	T	40	standard assumption
life cycle	L	60	standard assumption
life cycle	$1 - D$	0.994	standard assumption
preference	ρ	1	standard assumption
preference	β	0.98	standard assumption
policy	S	0.65	U.S. average
policy	λ	0	endogenously determined
policy	λ_{SS}	0	endogenously determined
policy	μ	0.15	U.S. average
production	W	1	target values in steady state
production	K2Y ratio	3	target values in steady state
production	α	0.33	standard assumption
production	δ	0.025	standard assumption

Deterministic wage profile over life cycle

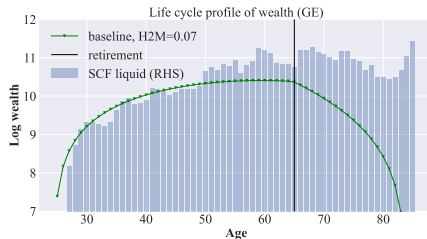
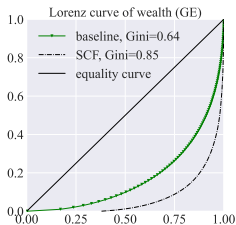
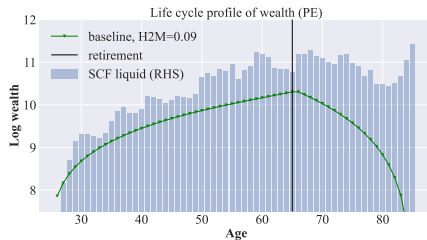
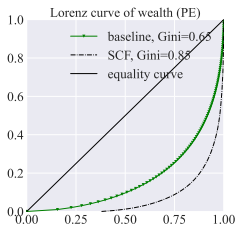


- Estimated from SIPP with a fourth-order age polynomial regression

StE Distribution in different models in PE and GE

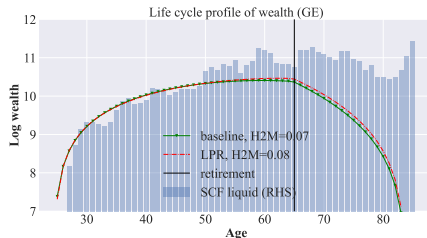
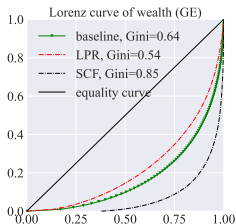
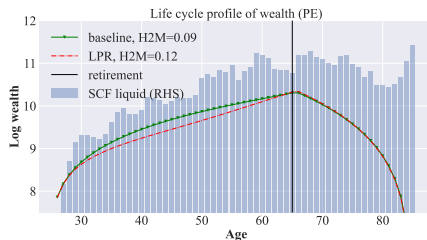
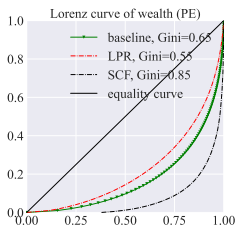


StE Distribution in different models in PE and GE



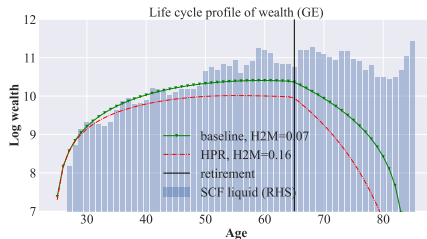
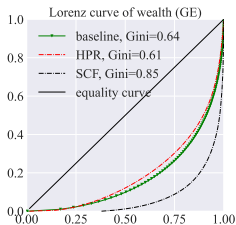
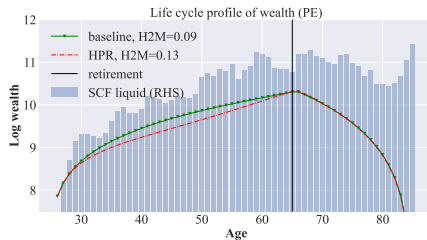
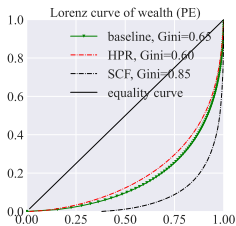
$$\sigma_{\psi} = 0.15, \sigma_{\theta} = 0.15, U2U = 0.18, E2E = 0.96 \quad \text{other parameters}$$

Lower perceived risks (LPR)



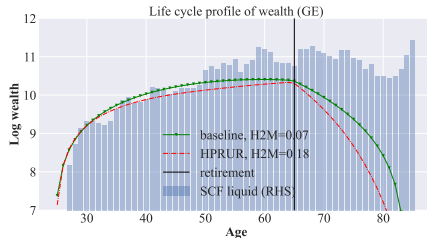
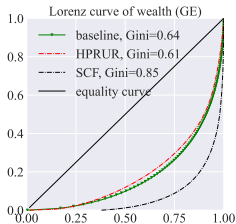
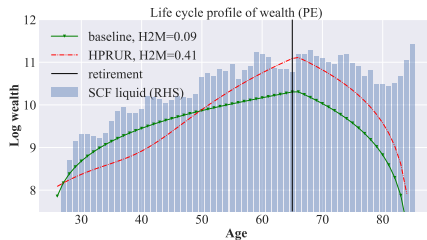
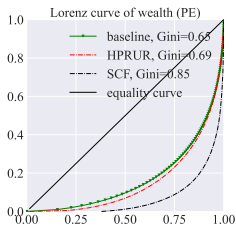
$$\sigma_{\psi} = 0.03, \sigma_{\theta} = 0.02, U2U = 0.18, E2E = 0.96 \quad \text{other parameters}$$

Heterogeneous perceived wage risks (HPR)



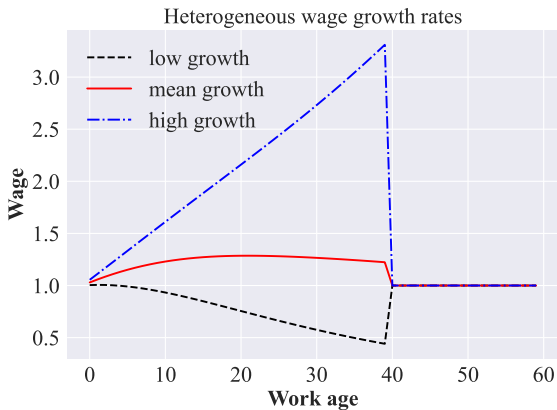
$$\sigma_\psi = \sigma_\theta = [0.01, 0.02, 0.04], U2U = 0.18, E2E = 0.96$$

Heterogeneous perceived wage /UE risks (HPRUR)

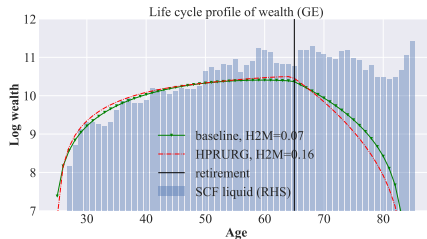
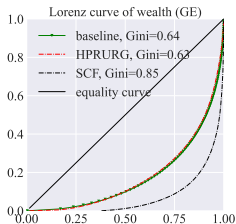
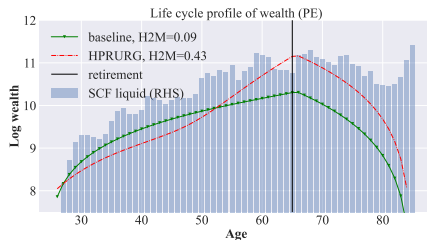
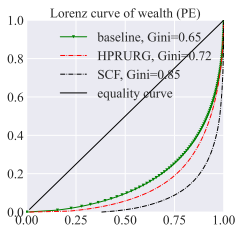


$$\sigma_\psi = \sigma_\theta = [0.01, 0.02, 0.04], U2U = [0, 0.02, 0.24], E2E = [0.96, 0.99, 1.0]$$

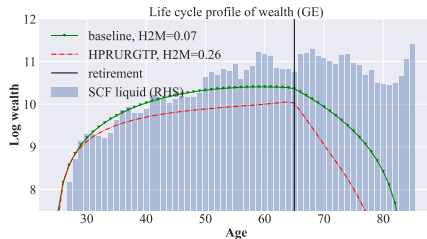
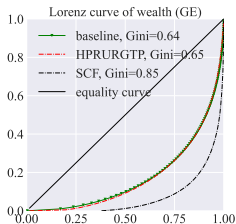
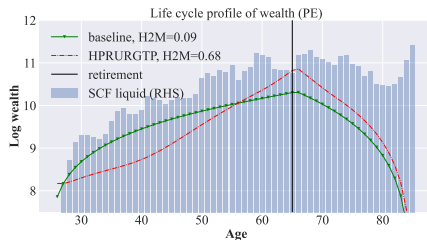
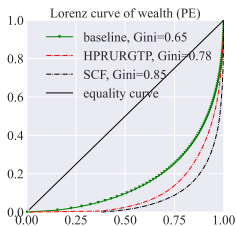
Hetero wage growth rates



Hetero perceived wage /UE risks/ growth rates (HPRURG)



Hetero perceived wage /UE risks/ growth rates/time preference (HPRURGTP)



Taking stock

Model/Data	Gini coeff	H2M share (0.1)	H2M share (0.3)	H2M share (0.5)
SCF (liquid)	0.85	0.18	0.26	0.31
baseline (PE)	0.65	0.02	0.04	0.09
LPR (PE)	0.55	0.02	0.06	0.12
HPR (PE)	0.60	0.03	0.07	0.13
HPRUR (PE)	0.69	0.17	0.28	0.41
HPRURG (PE)	0.72	0.17	0.29	0.43
HPRURGTP (PE)	0.78	0.36	0.58	0.68
baseline (GE)	0.64	0.02	0.05	0.07
LPR (GE)	0.54	0.02	0.05	0.08
HPR (GE)	0.61	0.08	0.13	0.16
HPRUR (GE)	0.61	0.07	0.13	0.18
HPRURG (GE)	0.63	0.08	0.13	0.16
HPRURGTP (GE)	0.65	0.15	0.20	0.26

Extension: subjective PR

Key assumption:

- Consumption/saving decisions made based on the **subjective** perceptions from the survey
- But income shocks drawn from the **objective** size of income risks
- Killing two birds with one stone
 - A robustness check against possible mis-perception by the agents
 - An breakdown of model implications into two channels
 - Ex-ante precautionary saving behaviors
 - Ex-post realized income inequality

Value functions under different profiles

- objective:

$$V_{\tau}(\underbrace{\nu_{i,\tau}, m_{i,\tau}, p_{i,\tau}}_{x_{i,\tau}}) = \max_{\{c_{i,\tau}, a_{i,\tau}\}} u(c_{i,\tau}) \\ + (1 - D)\beta \mathbb{E}_{\tau} [V_{\tau+1}((\nu_{i,\tau}, m_{i,\tau+1}, p_{i,\tau+1}))]$$

- subjective:

$$\tilde{V}_{\tau}(\underbrace{\tilde{\Gamma}_{\tau}, \nu_{\tau}, m_{\tau}, p_{\tau}}_{\tilde{x}_{i,\tau}}) = \max_{\{c_{\tau}\}} u(c_{\tau}) \\ + (1 - D)\beta \mathbb{E}_{\tau} [\tilde{V}_{\tau+1}(\tilde{\Gamma}_{\tau+1}, \nu_{\tau}, m_{\tau+1}, p_{\tau+1})]$$

Evolution of the distribution over state variables

- objective:

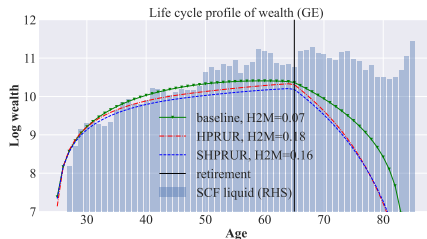
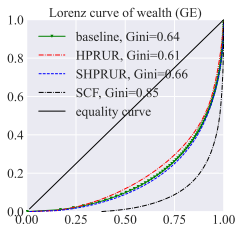
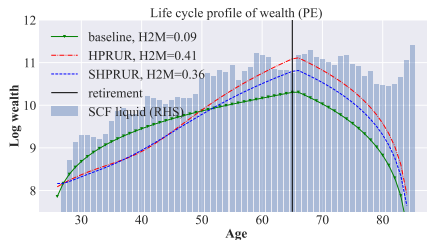
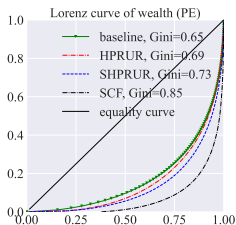
$$\psi_\tau(B) = \int_{x \in X} \underbrace{P(x, \tau - 1, B)}_{\text{transition funcs}} d\psi_{\tau-1} \quad \text{for all } B \in \mathcal{B}(X)$$

- $B(X)$: distribution measure on state space X
- ψ_τ : distribution over state variables x for agents in age τ
- ψ_1 depends on initial draws of income shocks

- subjective:

$$\tilde{\psi}_\tau(\tilde{B}) = \int_{\tilde{x} \in \tilde{X}} \tilde{P}(\tilde{x}, \tau - 1, \tilde{B}) d\tilde{\psi}_{\tau-1} \quad \text{for all } \tilde{B} \in \tilde{\mathcal{B}}(X)$$

Subjective HPRUR



Other results

- Other drivers of PR

- Macroeconomic conditions
- Experienced labor market outcomes
- Experienced income volatility

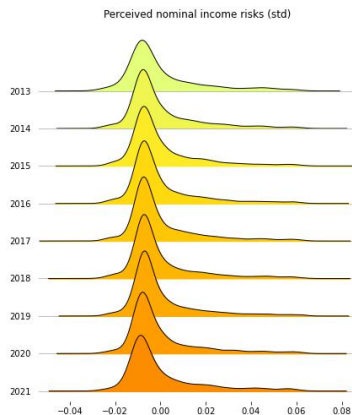
- State-dependent PR

- Individuals stochastically swing between low and high PR states
- Transition estimated from survey data [details](#)

Conclusion

- Survey data can inform incomplete-market macro models
 - Direct evidence for heterogeneity in perceptions that *matter*
 - Closer to agents' information set that truly affects their decisions
 - No need to make stringent assumptions on expectation formation
- More work needed on
 - heterogeneous beliefs in HM models
 - understanding risk perception formation

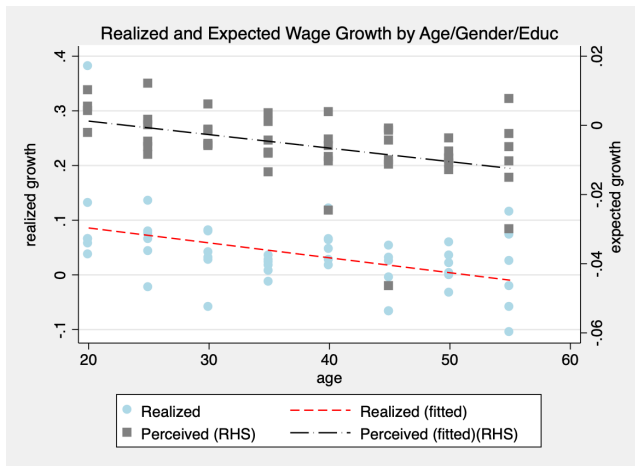
Within-group dispersion in nominal PR



- residuals controlling for observables /time fixed effects
- average PR: 2.1% in std; 10/90 IQR: 3.2% in std

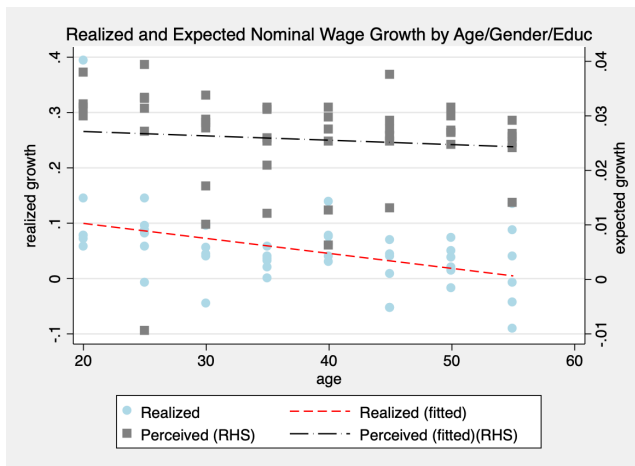
[Back](#)

Appendix: expected growth by age



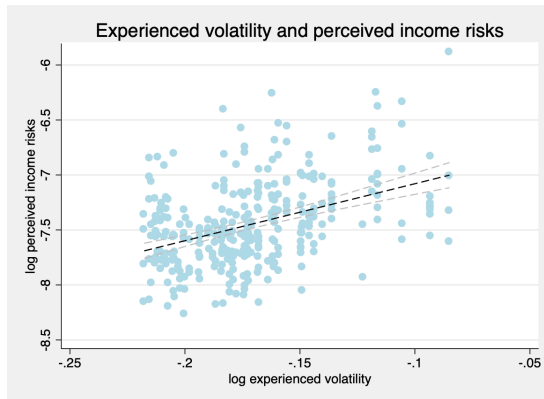
- e.g. a male high school graduate aged 30

Appendix: expected nominal growth by age



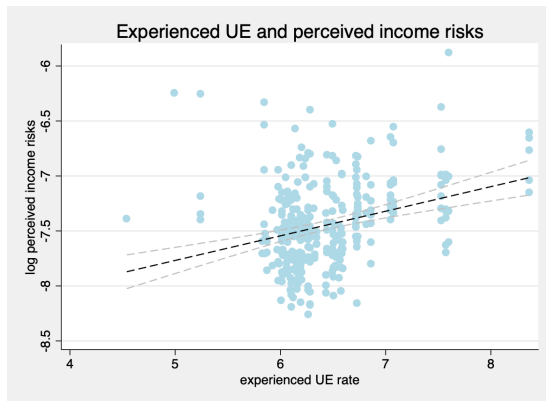
- e.g. a male high school graduate aged 30

Appendix: Experienced volatility and PR



- income volatility conditional on macroeconomic history
[Storesletten et al. \(2004\)](#)
- e.g. the experience by a 25-year old till 2015 is between 1990-2015

Experienced labor market and perceived risks



- e.g. experienced UE by a 25-year old in 2015 is between UE over 1990-2015

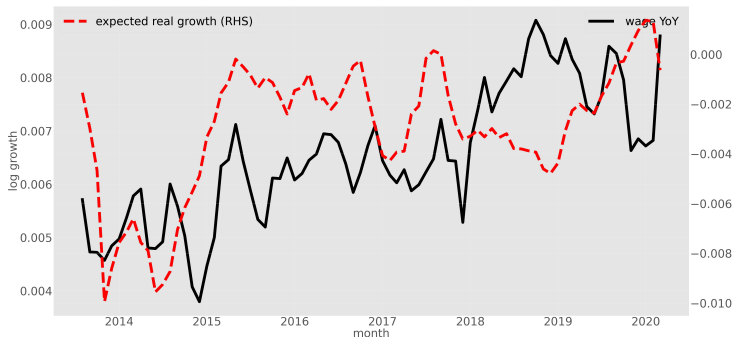
Appendix: Extrapolation from individual experiences

- higher experienced volatility \rightarrow higher PR
- recent unemployment experience \rightarrow higher PR

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
income shock squared	0.0225*** (0.00562)	0.0222*** (0.00570)	0.0217*** (0.00562)	0.0207*** (0.00564)	0.000773 (0.000743)	0.00205*** (0.000516)	0.000566 (0.000744)	0.00183*** (0.000515)	0.000614 (0.000745)	0.00184*** (0.000516)
recently unemployed				0.511* (0.260)	0.228*** (0.0330)	0.0895*** (0.0200)				
unemployed since m-8							0.161*** (0.0207)	0.0783*** (0.0121)		
unemployed since y-1									0.138*** (0.0193)	0.0701*** (0.0113)
Observations	3662	3662	3662	3662	3701	1871	3701	1871	3701	1871
R-squared	0.004	0.013	0.016	0.017	0.015	0.030	0.019	0.041	0.016	0.039

Appendix: expected income growth and recent (past) wage growth

- $\overline{\text{exp}}_t$: average expected growth across individuals
- quarterly growth in average hourly wage



Appendix: PR and current labor market condition

$$\underbrace{\overline{\text{risk}}_t}_{\text{average perceived risk}} = \alpha + \beta \underbrace{(\log(\text{wage}_{t-k/12}) - \log(\text{wage}_{t-(k-3)/12}))}_{\text{wage growth}} + \epsilon_{i,t}$$

$\forall k = 0 \dots 4$

	mean:var	mean:iqr	mean:rvar	mean:skew
0	-0.28**	-0.42***	-0.48***	-0.02
1	-0.42***	-0.53***	-0.51***	0.12
2	-0.43***	-0.48***	-0.44***	-0.01
3	-0.43***	-0.48***	-0.42***	-0.1
4	-0.31***	-0.41***	-0.32***	-0.21*

- Counter-cyclical income risks: [Storesletten et al. \(2004\)](#), [Guvenen et al. \(2014\)](#), [Bayer et al. \(2019\)](#)

Appendix: PR and current labor market condition

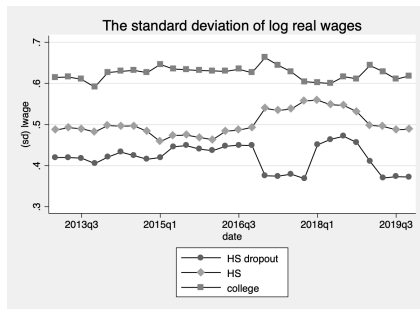
$$\underbrace{\overline{\text{risk}}_{s,t}}_{\text{median perceived risk in state } s} = r + \underbrace{\psi}_{\text{state labor market condition}} LM_{s,t} + \eta_{s,t}$$

	(1)	(2)	(3)	(4)
	log(var)	log(risk)	log(iqr)	log(iqr)
wage growth	-0.05*** (0.01)		-0.03*** (0.01)	
unemp rate		0.04* (0.02)		0.04*** (0.01)
Observations	3529	3529	3546	3546
R-squared	0.023	0.020	0.025	0.028

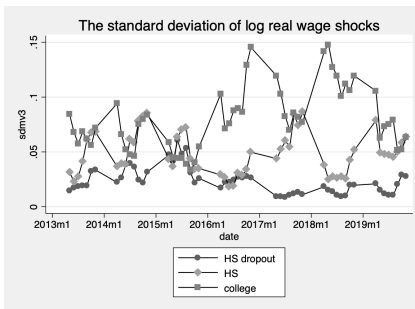
[Back](#)

Appendix: monthly earning inequality and volatility

(a) Inequality



(b) Volatility


[Back](#)

Appendix: estimating state-dependent PR using survey

$$\underbrace{\tilde{\Gamma}_{i,t}^s}_{\text{reported PR}} = \underbrace{\tilde{\Gamma}_l + \mathbb{1}(\overbrace{J_{i,t}}^{\text{Hidden state}} = 1)(\tilde{\Gamma}_h - \tilde{\Gamma}_l)}_{\tilde{\Gamma}_{i,t}} + \xi_t + \eta_i + \epsilon_{i,t}$$

$$\text{Prob}(J_{i,t+1}|J_{i,t}) = \Omega$$

- $J_{i,t} = 0$ for low and $= 1$ for high PR state
- a short time series of $\tilde{\Gamma}_{i,t}$ for many i s observed in the survey
- $\{\tilde{\Gamma}_l, \tilde{\Gamma}_h, \Omega\}$ can be estimated by *MLE*
- a modified [Hamilton \(1989\)](#) 2-regime-switching model
- $J_{i,t}$ can be also dependent upon business cycles

More details

Appendix: estimating state-dependent PR using survey

$$\log(\text{var}_{i,t}) = (12 + \frac{1}{12\kappa^2})\tilde{\sigma}_{i,t,\psi}^2 + \xi_t + \eta_i + \epsilon_{i,t}$$

- κ : externally assumed ratio of permanent and transitory risks $\frac{\tilde{\sigma}_{i,t,\psi}}{\tilde{\sigma}_{i,t,\theta}}$

[Back](#)

- Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics*, 109(3):659–684.
- Arellano, M., Blundell, R., and Bonhomme, S. (2017). Earnings and consumption dynamics: a nonlinear panel data framework. *Econometrica*, 85(3):693–734.
- Armantier, O., Topa, G., Van der Klaauw, W., and Zafar, B. (2017). An overview of the Survey of Consumer Expectations. *Economic Policy Review*, (23-2):51–72.
- Bayer, C., Lüttinge, R., Pham-Dao, L., and Tjaden, V. (2019). Precautionary savings, illiquid assets, and the aggregate consequences of shocks to household income risk. *Econometrica*, 87(1):255–290.
- Bertrand, M. and Mullainathan, S. (2001). Do people mean what they say? Implications for subjective survey data. *American Economic Review*, 91(2):67–72.
- Bewley, T. (1976). The permanent income hypothesis: A theoretical formulation. Technical report, HARVARD UNIV CAMBRIDGE MASS.

- Bloom, N., Guvenen, F., Pistaferri, L., Sabelhaus, J., Salgado, S., and Song, J. (2018). The great micro moderation. Working paper.
- Blundell, R., Pistaferri, L., and Preston, I. (2008). Consumption Inequality and Partial Insurance. *American Economic Review*, 98(5):1887–1921.
- Carroll, C., Slacalek, J., Tokuoka, K., and White, M. N. (2017). The distribution of wealth and the marginal propensity to consume. *Quantitative Economics*, 8(3):977–1020.
- Carroll, C. D. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *The Quarterly journal of economics*, 112(1):1–55.
- Carroll, C. D., Crawley, E., Slacalek, J., Tokuoka, K., and White, M. N. (2018). Sticky expectations and consumption dynamics. Technical report, National Bureau of Economic Research.
- Carroll, C. D. and Samwick, A. A. (1997). The nature of precautionary wealth. *Journal of monetary Economics*, 40(1):41–71.
- Delavande, A., Giné, X., and McKenzie, D. (2011). Measuring subjective expectations in developing countries: A critical review and new evidence. *Journal of development economics*, 94(2):151–163.

- Engelberg, J., Manski, C. F., and Williams, J. (2009). Comparing the point predictions and subjective probability distributions of professional forecasters. *Journal of Business & Economic Statistics*, 27(1):30–41.
- Fujita, S. and Ramey, G. (2009). The cyclicalities of separation and job finding rates. *International Economic Review*, 50(2):415–430.
- Gottschalk, P., Moffitt, R., Katz, L. F., and Dickens, W. T. (1994). The growth of earnings instability in the us labor market. *Brookings Papers on Economic Activity*, 1994(2):217–272.
- Guvenen, F., Ozkan, S., and Song, J. (2014). The nature of countercyclical income risk. *Journal of Political Economy*, 122(3):621–660.
- Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the econometric society*, pages 357–384.
- Heathcote, J., Storesletten, K., and Violante, G. L. (2009). Quantitative macroeconomics with heterogeneous households. *Annu. Rev. Econ.*, 1(1):319–354.

- Huggett, M. (1996). Wealth distribution in life-cycle economies. *Journal of Monetary Economics*, 38(3):469–494.
- Kaplan, G. and Violante, G. L. (2010). How much consumption insurance beyond self-insurance? *American Economic Journal: Macroeconomics*, 2(4):53–87.
- Kaufmann, K. and Pistaferri, L. (2009). Disentangling insurance and information in intertemporal consumption choices. *American Economic Review*, 99(2):387–92.
- Krueger, D., Mitman, K., and Perri, F. (2016). Macroeconomics and household heterogeneity. In *Handbook of Macroeconomics*, volume 2, pages 843–921. Elsevier.
- Krusell, P. and Smith, Jr, A. A. (1998). Income and wealth heterogeneity in the macroeconomy. *Journal of political Economy*, 106(5):867–896.
- Lian, C. (2019). Consumption with imperfect perception of wealth. Working paper.
- Low, H., Meghir, C., and Pistaferri, L. (2010). Wage risk and

- employment risk over the life cycle. *American Economic Review*, 100(4):1432–67.
- Manski, C. F. (2004). Measuring expectations. *Econometrica*, 72(5):1329–1376.
- Manski, C. F. (2018). Survey measurement of probabilistic macroeconomic expectations: progress and promise. *NBER Macroeconomics Annual*, 32(1):411–471.
- Meghir, C. and Pistaferri, L. (2004). Income variance dynamics and heterogeneity. *Econometrica*, 72(1):1–32.
- Meghir, C. and Pistaferri, L. (2011). Earnings, consumption and life cycle choices. In *Handbook of labor economics*, volume 4, pages 773–854. Elsevier.
- Moffitt, R. A. and Gottschalk, P. (2002). Trends in the transitory variance of earnings in the united states. *The Economic Journal*, 112(478):C68–C73.
- Pischke, J.-S. (1995). Individual income, incomplete information, and aggregate consumption. *Econometrica: Journal of the Econometric Society*, pages 805–840.

- Pistaferri, L. (2001). Superior information, income shocks, and the permanent income hypothesis. *Review of Economics and Statistics*, 83(3):465–476.
- Rozsypal, F. and Schlafmann, K. (2017). Overpersistence bias in individual income expectations and its aggregate implications.
- Storesletten, K., Telmer, C. I., and Yaron, A. (2004). Cyclical dynamics in idiosyncratic labor market risk. *Journal of political Economy*, 112(3):695–717.
- Wang, N. (2004). Precautionary saving and partially observed income. *Journal of Monetary Economics*, 51(8):1645–1681.