# Perceived Income Risks and Subjective Attribution

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# Outline

# This paper's agenda

1. **Theory**: a subjective heterogeneous-agent model
   - imperfect understanding of income risks
     - the size: experienced volatility → perceived risks
     - the nature: i.e. aggregate v.s. idiosyncratic → different perceptions
   - life-cycle agents with uninsured idioyncratic (and aggregate) risks
2. **Empirics:** subjective risk perceptions from density surveys
   - Cross-sectional difference across age, generation and income
   - Correlation structure with current labor market outcomes: counter-cylical

# Literature

- experience-based learning: Malmendier and Nagel (2015)
- subjective survey, especially on probabilistic surveys: Manski (2004), Delavande et al. (2011), Manski (2018), Bertrand and Mullainathan (2001), Armantier et al. (2017)
- "insurance or information": Kaufmann and Pistaferri (2009), Meghir and Pistaferri (2011), Pistaferri (2001), New York Fed Blog (2019), Flavin (1988)
- consumption/saving and portfolio choice under imperfect perception/understanding: Rozsypal and Schlafmann (2017), Carroll et al. (2018), Lian (2019)
- macroeconomic expectation formation: Coibion and Gorodnichenko (2012), Fuhrer (2018), etc
- counter-cyclical labor income risks: Storesletten et al. (2004), Guvenen et al. (2014), Catherine (2019)

# Preview of the theory

- Learning: learns about the parameters of income process from a small sample
- Experience: past experience of volatility $\rightarrow$ future risk perceptions
- Attribution: subjectively determine whether shocks are aggregate or idiosyncratic $\rightarrow$ different parameter uncertainty
- Attribution errors: positive (negative) shocks $\rightarrow$ internal (external) attribution $\rightarrow$ zero (positive) subjective correlation $\rightarrow$ low (high) perceived risks
- Countercylical perceived risks: positive (negative) news $\rightarrow$ low (high) aggregate uncertainty

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1. Motivation
2. Model
   - Learning and attribution
3. Empirical facts
   - Cross-sectional patterns
   - Coutercylical perceived risks
4. Conclusion

# Income process

$$y_{i,c,t} = \rho y_{i,c,t-1} + \epsilon_{i,c,t}$$
$$\epsilon_{i,c,t} \sim N(0, \sigma^2) \tag{1}$$

- individual $i$ at time $t$
- cohort $c$: year of entering the job market
- $\rho$: persistence parameter
- $\epsilon_{i,c,t}$: income shock
  - Identical: constant income risks across people and time
  - Independence: purely idiosyncratic risk
  - Both can be relaxed, i.e. cross-sectional correlation for aggregate shocks

# Perceived risk

- Perfect understanding

$$\begin{aligned} Var^*_{i,t}(\Delta y_{i,t+1}) &= Var^*_{i,t}(\epsilon_{i,t+1}) \\ &= \sigma^2 \end{aligned} \tag{2}$$

- Imperfect understanding

$$\widehat{V}ar_{i,t}(\Delta y_{i,t+1}) = y^2_{i,t} \underbrace{\widehat{Var}^{\rho}_{i,t}}_{\text{Persistence uncertainty}} + \underbrace{\hat{\sigma}^2_{i,t}}_{\text{Shock uncertainty}} \tag{3}$$

# Learning

$$\underbrace{\hat{\rho}_{i,t}}_{\text{estimated parameter}} = (\sum_{k=0}^{t-c}\sum_{j=1}^{n} y^2_{j,t-k-1})^{-1}(\sum_{k=0}^{t-c}\sum_{j=1}^{n} y_{j,t-k-1}y_{j,t-k}) \tag{4}$$

- sample: past experience of both $i$'s own and others' income
- size: $N_{i,t} = n_i(t - c_i)$
  - $n_i$, an arbitrarily small $n$ is sufficient
  - $t - c_i$, the duration of career (approximate for age)
- learning rule: ordinary least square (OLS) (Evans and Honkapohja (2012), Malmendier and Nagel (2015))

# Shock uncertainty

$$\underbrace{\tilde{\sigma}^2_{i,t}}_{\text{estimated shock uncertainty}} = \underbrace{s^2_{i,t}}_{\text{experienced volatility}} = \underbrace{\frac{1}{N_{i,t}-1}\sum_{j=1}^{n}\sum_{k=0}^{t-c}\hat{e}^2_{j,t-k}}_{\text{variance of residuals}} \quad (5)$$

- $\hat{e}_{i,t}$: unexpected income shocks

# Persistence uncertainty

$$\tilde{Var}^{\rho}_{i,t} = (\sum_{k=0}^{t-c}\sum_{j=1}^{n} y^2_{j,t-k-1})^{-1}(\sum_{k=0}^{t-c}\tilde{\Omega}_{i,t-k})(\sum_{k=0}^{t-c}\sum_{j=1}^{n} y^2_{j,t-k-1})^{-1} \tag{6}$$

$$\begin{aligned} \tilde{\Omega}_{i,t} &= \underbrace{\tilde{E}_{i,t}(Y'_{t-1}e_t e'_t Y_{t-1})}_{\text{attribution matrix}} \\ Y'_{t-1} &= [y_{1,t-1}, y_{2,t-1} ... y_{n,t-1}]' \end{aligned} \tag{7}$$

- **Attribution**: how $i$ thinks about the correlation between her own income and others

# Attribution

- Under constant risk across people and time (homoscedasticity)

$$\tilde{\Omega}_{i,t} \approx \sum_{j=1}^{n} y_{j,t}^{2}\tilde{(}1 + \underbrace{\tilde{\delta}_{i,t}}_{\equiv \tilde{\delta}_{y,i,t}\tilde{\delta}_{\epsilon,i,t}}(n-1))\tilde{\sigma}_{t}^{2} \tag{8}$$

- $\tilde{\delta}_{i,t} \in \mathbf{[0,1]}$: attribution parameter - perceived correlation of individual outcome with others
- $\tilde{\delta}_{\epsilon,i,t}$: short-run attribution - perceived correlation in income shocks
- $\tilde{\delta}_{y,i,t}$: long-run attribution -perceived correlation in income

# Perceived risk under internal v.s. external attribution

- External: $\tilde{\delta}_{i,t} > 0$, i.e. "something common affects all of us"

$$\begin{aligned} \tilde{Var}_{i,t}(\Delta y_{i,t+1}) &= y^2_{i,t-1}\tilde{Var}^{\rho}_{i,t} + \tilde{\sigma}^2_{i,t} \\ &= [(\sum_{k=0}^{t-c}\sum_{j=1}^{n} y^2_{j,t-k-1})^{-1}(1+\tilde{\delta}_{i,t}(n-1))y^2_{i,t} + 1]s^2_{i,t} \end{aligned} \tag{9}$$

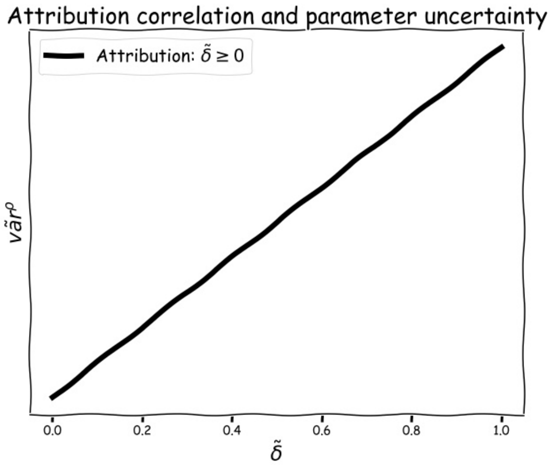
- Internal: $\tilde{\delta}_{i,t} = 0$, i.e. "my income has nothing to do with others"

$$\widehat{Var}_{i,t}(\Delta y_{i,t+1}) = [(\sum_{k=0}^{t-c}\sum_{j=1}^{n} y^2_{j,t-k-1})^{-1} y^2_{i,t} + 1]s^2_{i,t} \tag{10}$$

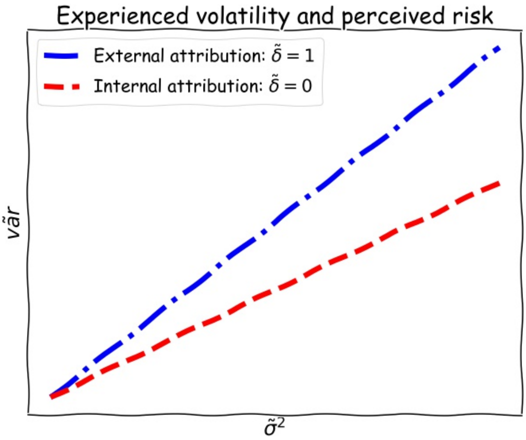
- Comparison

$$\tilde{Var}_{i,t}(\Delta y_{i,t+1}) > \widehat{Var}_{i,t}(\Delta y_{i,t+1}) \tag{11}$$

# Prediction 1. higher degree of external attribution leads to higher perceived risks



# Prediction 2. extrapolation of experienced volatility into perceived risks

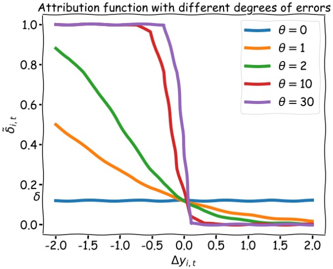


# Attribution errors

- positive (negative) shock → internal (external) attribution

$$\text{Attribution function:} \quad \tilde{\delta}(\Delta y_{i,t}) = 1 - \frac{1}{(1 + e^{\alpha - \theta \Delta y_{i,t}})} \tag{12}$$

- $\theta$: degree of attribution error
- $\alpha$: unbiasedness of attribution



# Prediction 3. Counter-cylical perceived risks under aggregate risk and attribution error

$$\tilde{Var}_t(\Delta y_{i,t+1}) = \underbrace{\lambda_t}_{\text{lucky fraction}} \tilde{Var}_t^{internal} + (1-\lambda_t)\tilde{Var}_t^{external} \tag{13}$$

- Aggregate versus idionsyncratic risks
  - Aggregate: $\lambda_t$ is procyclical.
  - Idionsyncratic: $\lambda_t \approx 0.5$
- With and without attribution errors
  - Attribution error: $\tilde{Var}_t^{external} > \tilde{Var}_t^{internal}$
  - No error: $\tilde{Var}_t^{external} = \tilde{Var}_t^{internal}$

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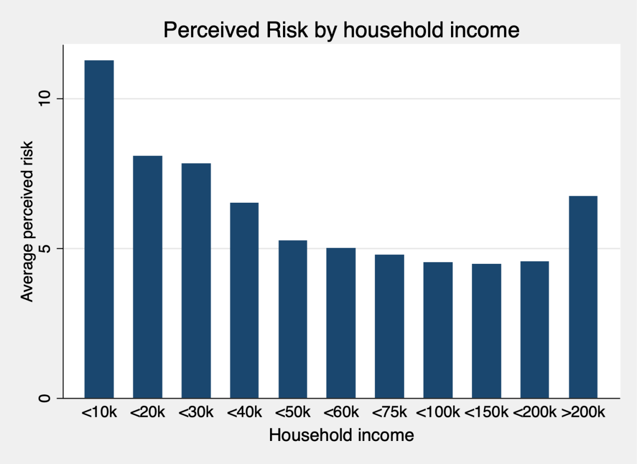
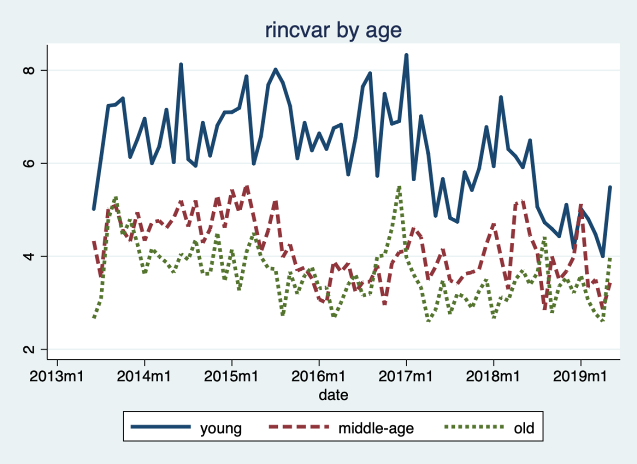
# Perceived risks by household income

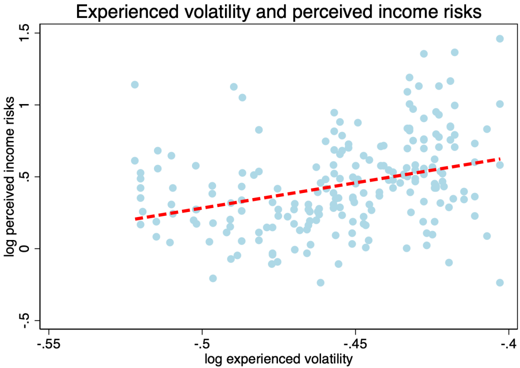


# Perceived risks by age



# Perceived risks and experience

- Approximated experienced volatility: $s^2_{c,t}$, MSE of the income regression for the PSID sample between $c$ and $t$
- Perceived risk: $\overline{var_{c,t}}$: average across individuals within cohort $c$ at time $t$



# Perceived risks and experienced volatility

$$\underbrace{log(\overline{\text{var}}_{i,c,t})}_{\text{log perceived risk}} = a + \zeta \underbrace{log(\hat{s}^2_{c,t})}_{\text{log experienced volatility}} + Z \underbrace{\Gamma_{i,t}}_{\text{individual controls}} + \xi_{i,t}$$

| | Perceived risk | Perceived risk | Perceived risk | Perceived iqr | Perceived iqr | Perceived iqr |
|---|---|---|---|---|---|---|
| log experienced volatility | 1.291** | 1.265** | 1.208** | 0.690** | 0.713** | 0.650** |
| | (3.08) | (3.02) | (2.61) | (3.05) | (3.16) | (2.62) |
| R-squre | 0.0170 | 0.0222 | 0.0243 | 0.0118 | 0.0168 | 0.0269 |
| N | 40158 | 40158 | 33485 | 44454 | 44454 | 37058 |
| Control age | Yes | Yes | Yes | Yes | Yes | Yes |
| Control educ | No | Yes | Yes | No | Yes | Yes |
| Control income | No | No | Yes | No | No | Yes |

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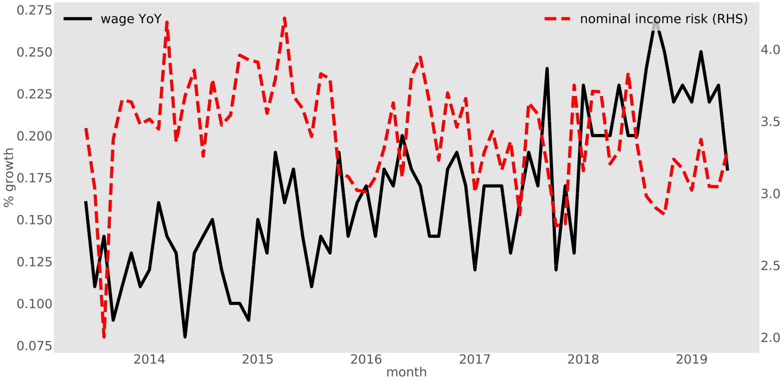
# Perceived risks and recent (past) wage growth

- $\overline{\text{var}_t}$: average perceived risk across individuals
- $log(\text{wage}_t) - log(\text{wage}_{t-3})$: quarterly growth in average hourly wage



# Perceived risks and current labor market condition

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

$$\forall k = 1...6$$

| k | varMean | iqrMean | rvarMean | varMed | iqrMed | rvarMed |
|---|---|---|---|---|---|---|
| 1 | -2.046** | -0.801*** | -10.437*** | -0.269 | -0.191 | -5.121*** |
| 2 | -3.823*** | -1.193*** | -12.287*** | -0.021 | 0.009 | -5.292*** |
| 3 | -2.942*** | -0.938*** | -9.642*** | -0.147 | -0.077 | -4.445*** |
| 4 | -3.261*** | -0.994*** | -9.021*** | -0.142 | -0.094 | -4.467*** |
| 5 | -2.312** | -0.892*** | -6.792** | -0.441** | -0.252* | -4.718*** |
| 6 | -3.419*** | -1.207*** | -10.791*** | -0.412** | -0.274** | -5.466*** |

# Perceived risks and current labor market condition

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

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

# Conclusion

- Experience + Learning + Attribution $\rightarrow$ Perception (Expectation)
- Attribution is important because of
    - imperfect understanding in both the size and the nature
    - forming perceptions about second moments, i.e. income risks
    - certain attribution errors $\rightarrow$ aggregate patterns, i.e. counter-cyclical subjective risk

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