

BELIEF HETEROGENEITY WITH UNINSURABLE RISKS

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The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

Household survey data on macroeconomic forecasts contain large systematic biases

- substantial belief dispersion in the cross section
- large variation in the time series

Introduce a model of subjective beliefs

- links subjective beliefs to risk exposure of the consumption process

Estimate risk exposures from consumption micro data

- study whether the model can rationalize observed belief dispersion

Interested in studying departures from rational expectations

- **parsimony**: model of subjective beliefs does not depend on details of the environment
- **discipline**: model-implied subjective forecasts can be compared to survey data

Hypothesis: agents' subjective beliefs have a quantitatively large impact on aggregate dynamics, wealth distribution and welfare

- **Bhandari, Borovička and Ho (2018)** show that common fluctuations in subjective beliefs play an important role in unemployment dynamics
- here we focus on cross-sectional evidence on belief heterogeneity

- Facts from expectational survey data
 - document cross-sectional and time series patterns using FRBNY Survey of Consumer Expectations and Michigan Survey of Consumers
- A framework for subjective beliefs
 - theoretically link agents' subjective beliefs to consumption risk exposures
- Empirical implementation using micro consumption data
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Study household survey evidence on forecasts of macroeconomic variables

- **Belief wedge**: difference between subjective and rational forecast

Document

- Large heterogeneity in forecasts across demographic groups
- Large and time-varying common biases in the time series

Data source

- New York Fed Survey of Consumer of Expectations
 - cross-sectional information (2013–2018)
- University of Michigan Survey of Consumers
 - aggregate time series (1982–2018)

Macroeconomic variables

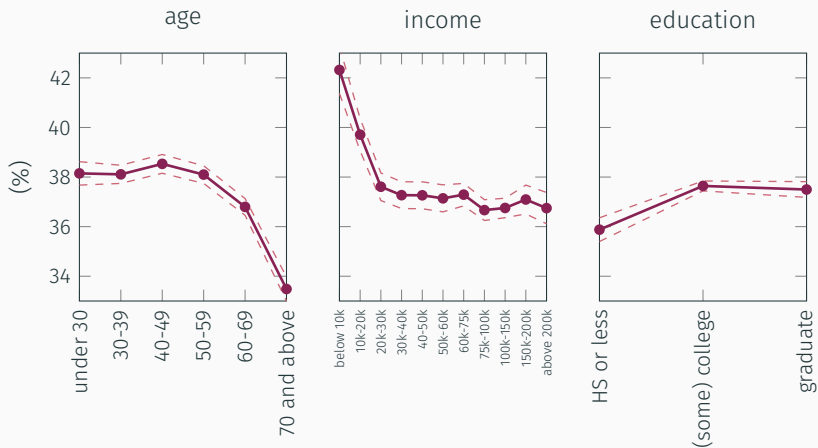
- Unemployment rate
- Inflation rate
- Stock market

Demographic groups

- Age
- Income
- Education

UNEMPLOYMENT

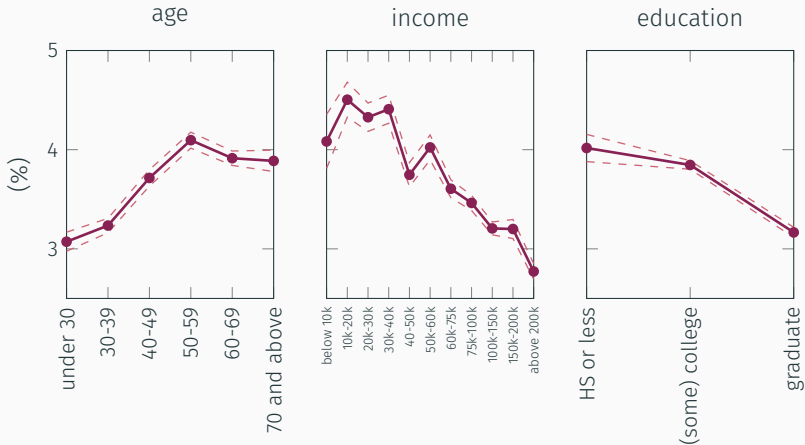
Survey question: "What do you think is the percent chance that 12 months from now the unemployment rate in the U.S. will be higher than it is now?"



Bold line: average response for the group; **dashed lines:** 95% confidence interval.

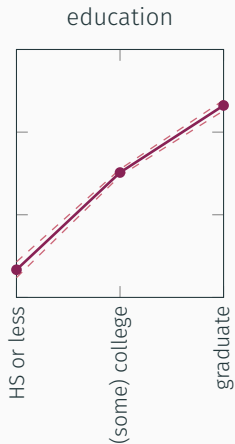
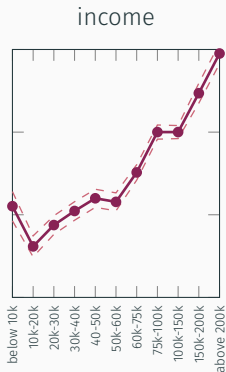
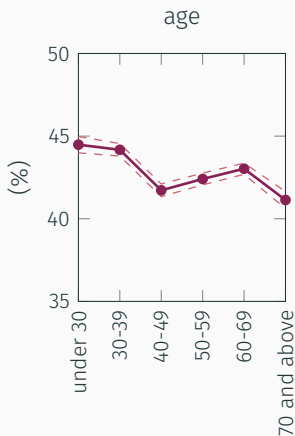
INFLATION

Survey question: "In your view, what would you say is the percent chance that, over the next 12 months, the rate of inflation will be [within 10 listed bins]." \implies answer computed as average over the histogram

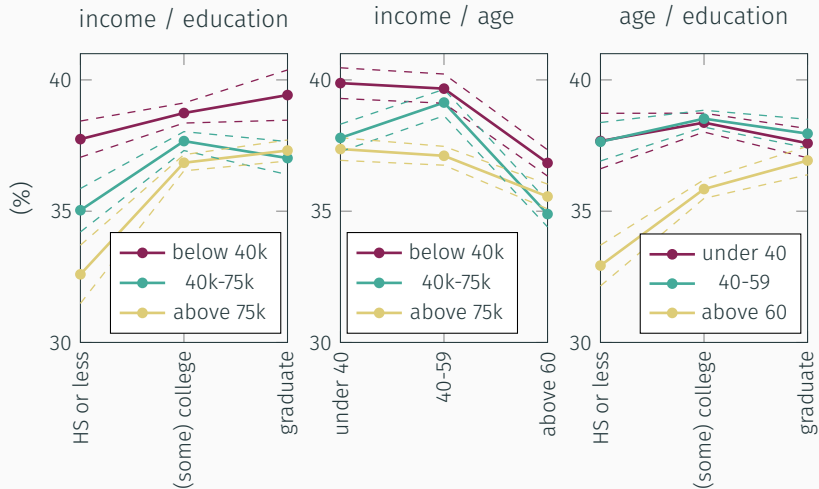


STOCK MARKET

Survey question: "What do you think is the percent chance that 12 months from now, on average, stock prices in the U.S. stock market will be higher than they are now?"

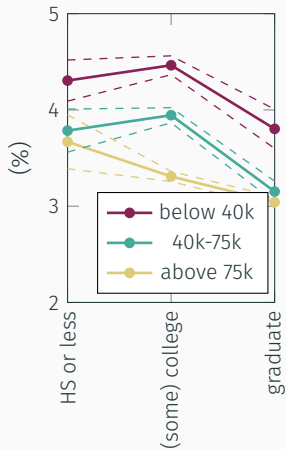


UNEMPLOYMENT TWO-WAY SORTS

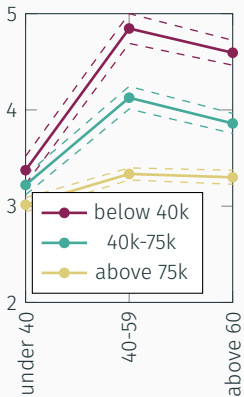


INFLATION TWO-WAY SORTS

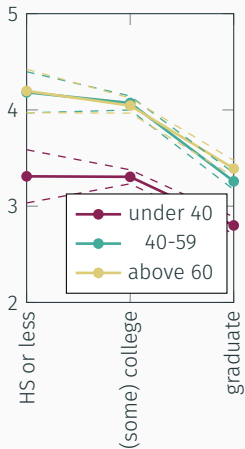
income / education



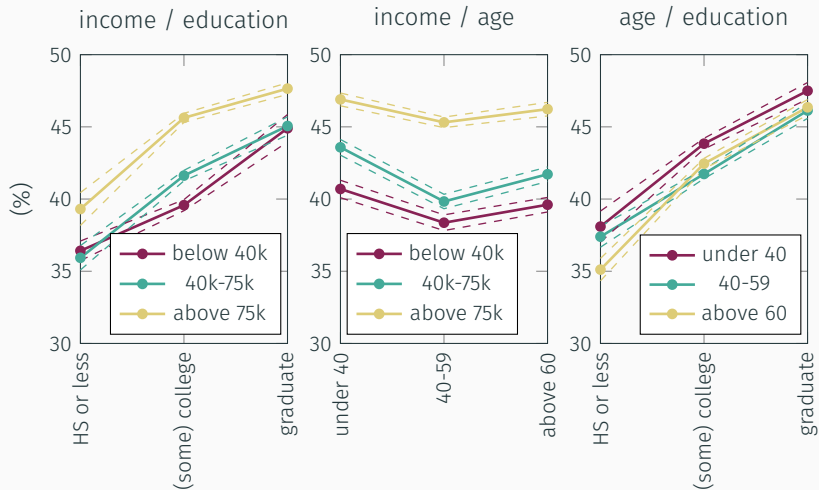
income / age



age / education



STOCK MARKET TWO-WAY SORTS



Unemployment (probability of unemployment increase)

- decreasing with age
- decreasing in income

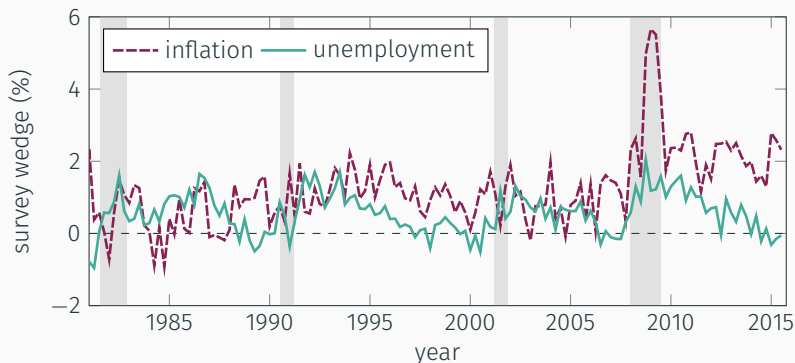
Inflation

- decreasing with income

Stock market (probability of stock market increase)

- increasing with income
- increasing with education

BELIEF WEDGES: MICHIGAN SURVEY MINUS VAR FORECAST



1981Q2–2015Q4	mean	std	correlation matrix			
			$\Delta(u)$	$\Delta(\pi)$	output gap	GDP growth
unemp. wedge $\Delta(u)$	0.58	0.54	1.00	0.23	-0.54	-0.32
inflation wedge $\Delta(\pi)$	1.25	1.03		1.00	-0.37	-0.53

See Bhandari, Borovička and Ho (2018) for details on construction.

Substantial dispersion in forecasts across demographic groups.

Systematic relationship across questions, also holds for other variables

- Forecasts of earnings growth, job separation rates, and job finding rates in FRBNY Survey of Consumer Expectations
- Consistent patterns in the Michigan Survey of Consumers

Interpretation: Household-level heterogeneity in magnitude of belief biases but these biases share a common origin.

Next introduce a model of subjective beliefs to rationalize these findings.

SUBJECTIVE BELIEFS AND DECISION-MAKING

Assumption: Survey responses are consistent with agents' decisions under a subjective belief model.

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Asset pricing

- **Greenwood and Shleifer (2014):** return expectations and subsequent realized returns
- **Nagel and Xu (2018):** stock market dynamics

Corporate finance

- **Gennaioli, Ma, Shleifer (2015):** managers' surveys and firm investment

Macroeconomics

- **Malmendier and Nagel (2016):** Michigan survey responses and borrowing and lending decisions
- **Bachmann, Berg and Sims (2015):** Michigan survey responses and consumer spending
- **Crump, Eusepi and Tambalotti (2015):** New York Fed survey responses and planned consumption

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- preferences of an agent with concern for model misspecification

$$V_t = \log C_t + \beta E_t [V_{t+1}]$$

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$$V_t = \min_{\substack{m_{t+1} \\ E[m_{t+1}] = 1}} \log C_t + \beta E_t [m_{t+1} V_{t+1}] + \beta \frac{1}{\theta} E_t [m_{t+1} \log m_{t+1}]$$

- penalty parameter θ (rational expectations $\theta = 0$)

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- penalty parameter θ (rational expectations $\theta = 0$)
- implied belief distortion m_{t+1} defines a probability measure \tilde{P}

$$m_{t+1} = \frac{\exp(-\theta V_{t+1})}{E_t[\exp(-\theta V_{t+1})]}$$

- θ controls the magnitude of the belief distortion
 - sign of θ determines whether beliefs are pessimistic or optimistic

Belief wedges

$$\Delta_t^{(1)} = \tilde{E}_t [x_{t+1}] - E_t [x_{t+1}] = \text{Cov}_t (m_{t+1}, x_{t+1}) \approx -\theta \text{Cov}_t (V_{t+1}, x_{t+1})$$

- $\text{Cov}_t (V_{t+1}, x_{t+1})$ endogeneously determines which states are 'bad'
 - \tilde{P} overweighs states with low continuation utility V_{t+1} (when θ positive)

Theory of subjective beliefs

- testable using consumption exposures that determine V_t

$$V_t = \log C_t - \frac{\beta}{\theta} \log E_t [\exp(-\theta V_{t+1})]$$

- belief heterogeneity emerges from heterogeneity in exposures or θ
- can be embedded in GE framework with endogenous x_{t+1} and V_{t+1}

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Specify dynamics for consumption growth for demographic group i

- implies heterogeneous subjective beliefs across demographics

Use Consumer Expenditure Surveys (CEX) data

- construct average consumption time series by demographic groups
- estimate exposures of group-specific consumption to aggregate shocks

Assess model-implied heterogeneity in belief wedges

State dynamics

$$X_{t+1} = \phi_x X_t + \phi_w W_{t+1}$$

Consumption growth for demographic group i

$$\log C_{i,t+1} - \log C_{i,t} = \iota'_{i,c} X_t$$

Scaled continuation value

$$v_{i,t} = V_{i,t} - \log C_{i,t} = \iota'_{i,v} X_t$$

- exposure vector $\iota_{i,v}$ is a solution to the continuation value recursion

Belief distortion

$$m_{i,t+1} = \frac{\exp(-\theta_i (\iota_{i,v} + \iota_{i,c})' X_{t+1})}{E_t [\exp(-\theta_i (\iota_{i,v} + \iota_{i,c})' X_{t+1})]}$$

Forecasted variable (measured in survey data)

$$Z_t = \iota'_z X_t$$

One-period belief distortions

$$\Delta_{i,t}^{(1)} = \tilde{E}_t^i [Z_{t+1}] - E_t [Z_{t+1}] = -\theta_i \iota'_z \phi_w \phi'_w \iota_{i,v}$$

Multi-period belief distortions

$$\Delta_{i,t}^{(j)} = \tilde{E}_t^i [Z_{t+j}] - E_t [Z_{t+1}] = -\theta_i \iota'_z \left(\sum_{k=0}^{j-1} (\phi_x)^k \right) \phi_w \phi'_w \iota_{i,v}$$

State dynamics

- X_t — aggr. consumption growth, labor income growth, real S&P500 return, log price-dividend ratio, realized variance of industrial production growth, inflation, unemployment rate
- quarterly data

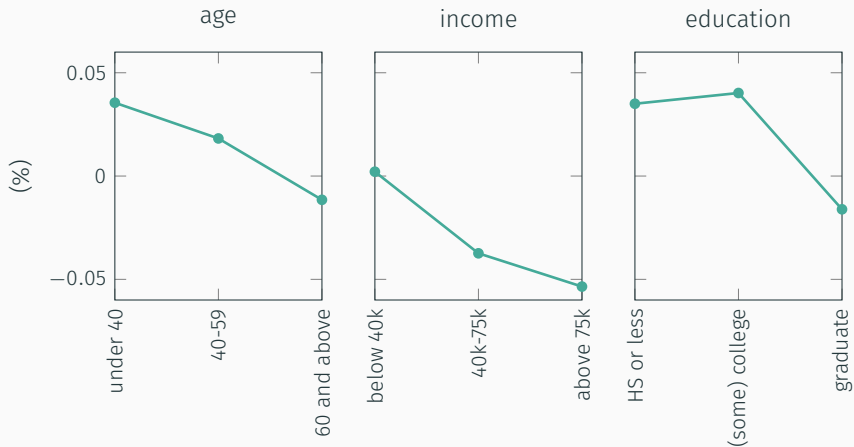
Consumption data

- CEX interview micro data (total expenditure, food expenditure)
- Construct quarterly average consumption time series by demographic group (1985–2017)

Specification of θ_i and β_i

- Common across groups: $\theta_i = \theta, \beta_i = \beta$

MODEL-IMPLIED BELIEF WEDGES: UNEMPLOYMENT



Food consumption used. Wedges relative to belief of a representative agent.

MODEL-IMPLIED BELIEF WEDGES: INFLATION



MODEL-IMPLIED BELIEF WEDGES: STOCK MARKET RETURN



A fully specified model of consumption exposures

- incomplete markets
- life-cycle dynamics

Relaxing restrictions on θ

- θ can be heterogeneous across households / groups
- exploit cross-question restrictions

Explore implications for forecasts of household-specific variables

- relevant for household decision-making

TBW if needed.

[back to factor model](#)