IQ, Expectations, and Choice

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Households' Inflation Expectations Are Important

- Policy assumes households understand economic incentives fully
  - Forward guidance

    Eggertsson & Woodford (2003)
  - Unconventional fiscal policies

    D'Acunto, Hoang, & Weber (2018)
  - Conventional fiscal policies

    Farhi & Werning (2017)
- **BUT** policies often less effective: e.g., *forward guidance puzzle*

  Del Negro, Giannoni, & Patterson (2015)
- Recent progress: heterogeneous agents & incomplete market

  McKay, Nakamura, & Steinsson (2016); Hagedorn, Luo, Mitman & Manovski (2019)

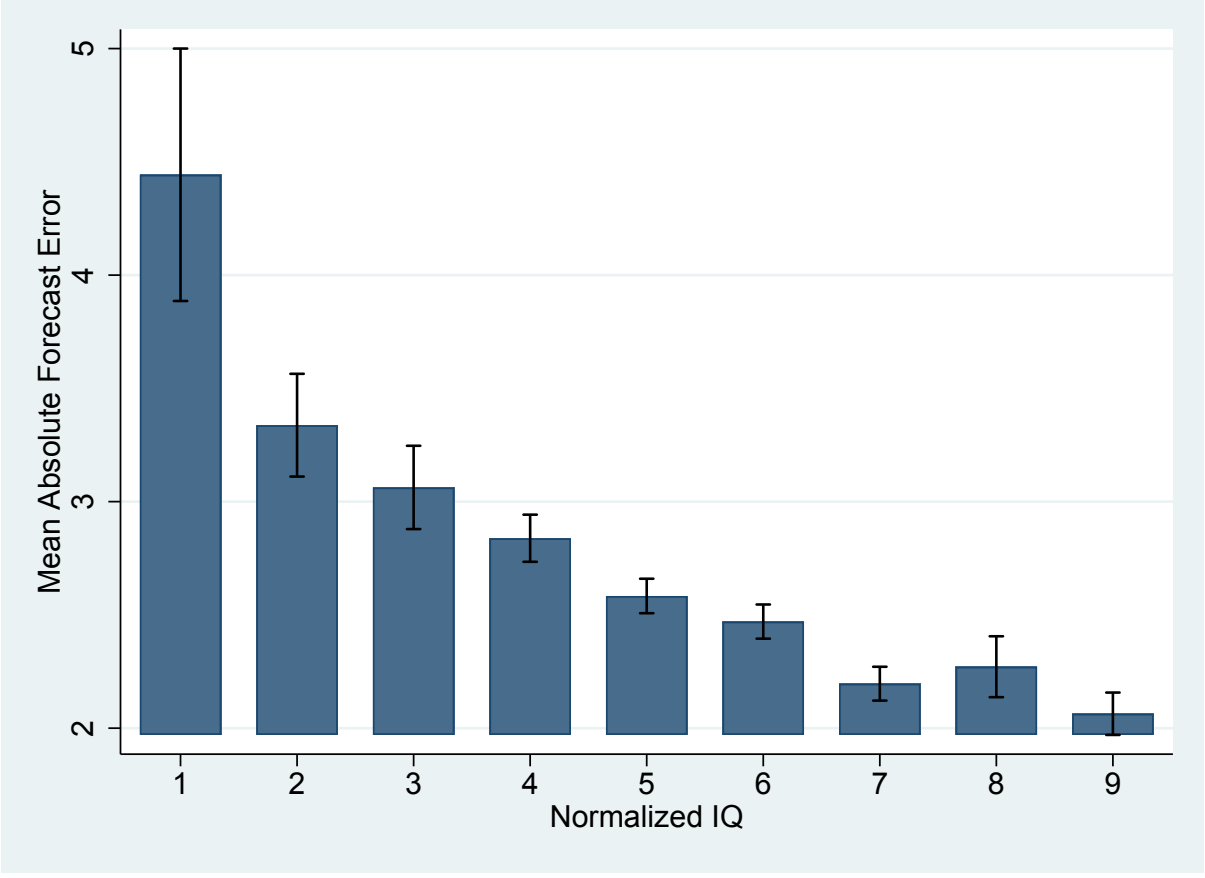
Theory: Heterogeneous Cognition Might Matter

- Recent macro theory: limited cognitive abilities, bounded rationality
  Farhi & Werning (2018), Woodford (2018), Angeletos (2019), Ilut & Valchev (2018)
  - Obtain deviations from FIRE, discounted Euler equation
  - If het. agents, muted effects if low cognitive abilities
- (How much) Do cognitive abilities matter for expectations?
- Main empirical hurdles
  - Need to measure cognitive abilities for a representative population
  - Need to measure expectations, plans for a representative population

This Paper: Cognition and Inflation Expectations

- Measure IQ for all men in Finland from Finnish Defence Forces
- Match with unique data on personal & macro expectations, plans
- Link to tax records, full households' balance sheets
- Further analysis in controlled environment to assess channels

Overview of Results: Absolute Forecast Error by IQ



- Men with low IQ: absolute forecast error for inflation of 4.5%
- Forecast error still large for the highest-IQ group (2%)
- Economically and statistically different across the IQ distribution
- Effect barely changes when partialling out income and education levels

Data Sources

- European harmonized survey on consumption climate (*EU*)
  - 1,500 representative Finnish individuals every month
  - Questions about aggregate and personal economic expectations
  - Sample period: March 1995–March 2015
  - Rich demographics (age, income, marital status, city size, kids, job)
- Military entrance test data (men) from *Finnish Armed Forces*
- Tax and other administrative data from *Statistics Finland*

Cognitive Ability Data

- Mandatory military service in Finland: Finnish Armed Forces (FAF)
- Around age 19, 120 questions to measure cognitive abilities
- FAF aggregates scores into a composite: IQ
- FAF standardizes IQ to follow a stanine distribution
  - 9 points to approximate normal
  - Lowest 4% of scores at least 1.75 std from mean: standardized IQ of 1
  - 4% with highest test scores: standardized IQ of 9

Inflation Expectations by IQ

	Low IQ	2	3	4	5	6	7	8	High IQ
Mean	3.46	2.80	2.58	2.42	2.40	2.36	2.28	2.30	2.26
Std	8.70	5.93	5.52	4.66	4.66	4.16	3.47	4.13	3.31
Nobs	928	2,221	2,860	7,011	9,528	8,099	6,030	3,213	2,688

Low IQ men have

- Higher average inflation expectations
- Larger forecast dispersion

Plan

- Cross-section of Expectations: Forecast Errors
- Within-individual Expectations updating over Time
- Inflation Expectations and Choice
- Channels: Information, Numeracy, Economic Knowledge

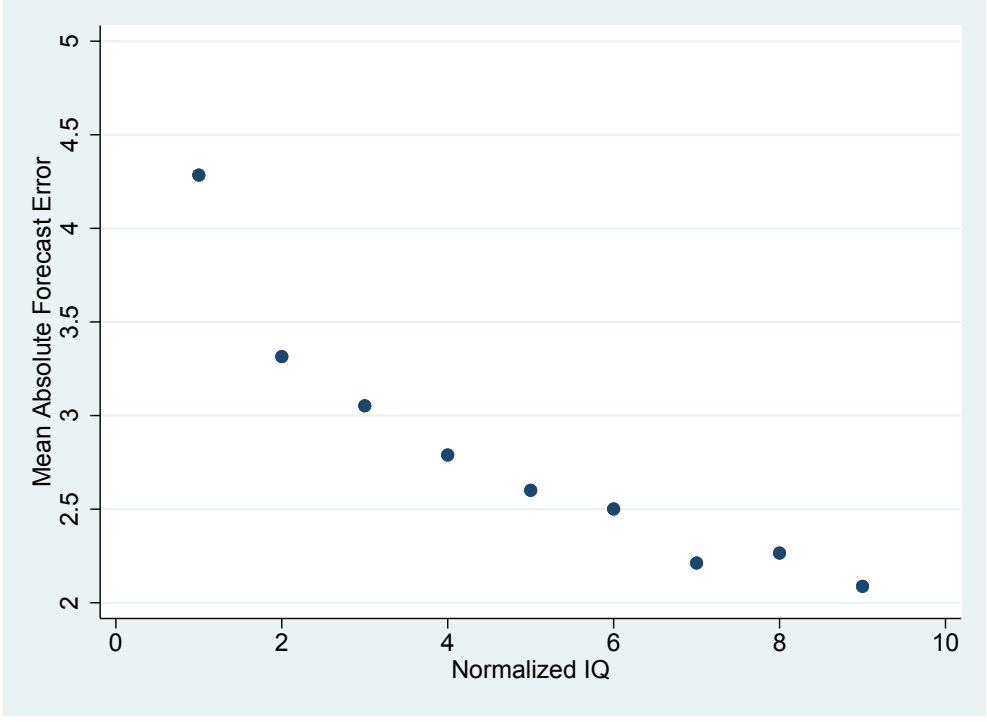
Forecast Error by IQ

- General upward bias in inflation expectations
- Measure forecast accuracy by forecast error:

$$\textit{Inflation forecast error} = E_t \pi_{t+12} - \pi_{t+12}$$

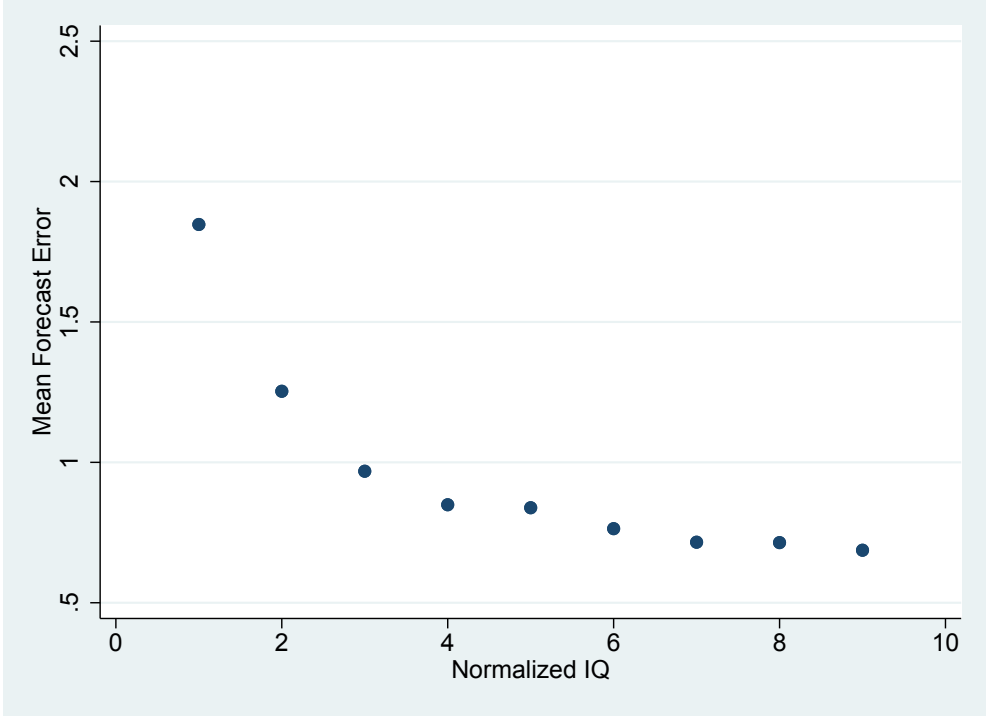
- Forecast error: predicted inflation minus ex-post realized inflation

Mean Absolute Forecast Error by IQ cont.



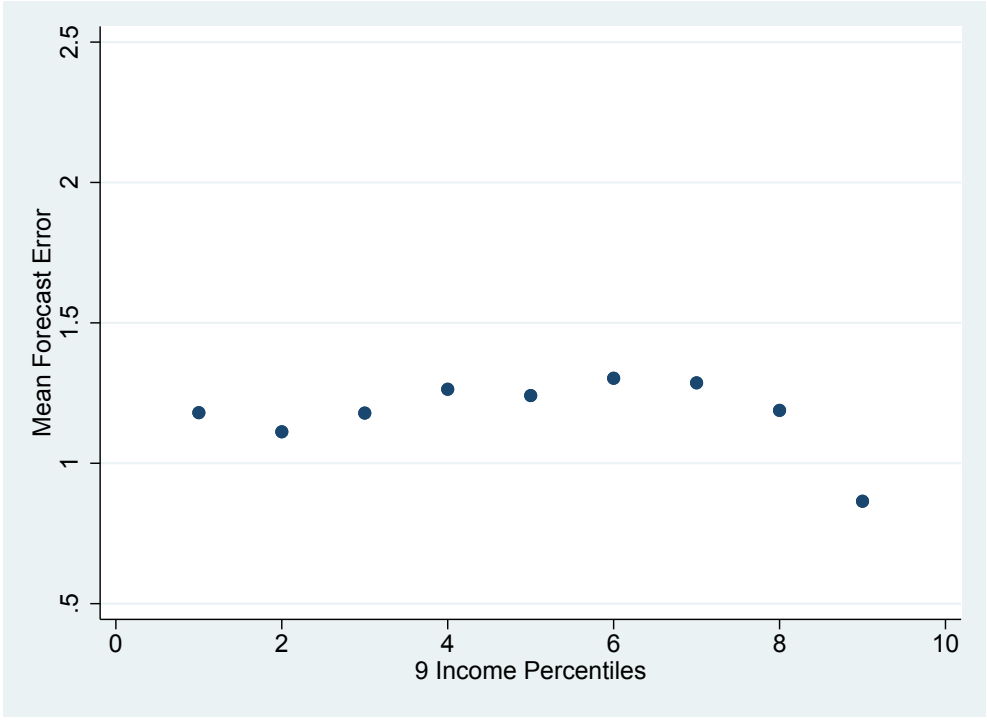
- Absolute forecast errors twice as large for low IQ men than for high IQ men
- Monotonic relationship btw absolute forecast error and IQ

Mean Forecast Error by IQ cont.



- Similar pattern for average forecast error
- Monotonic relationship btw forecast error and IQ

Forecast Error by Income

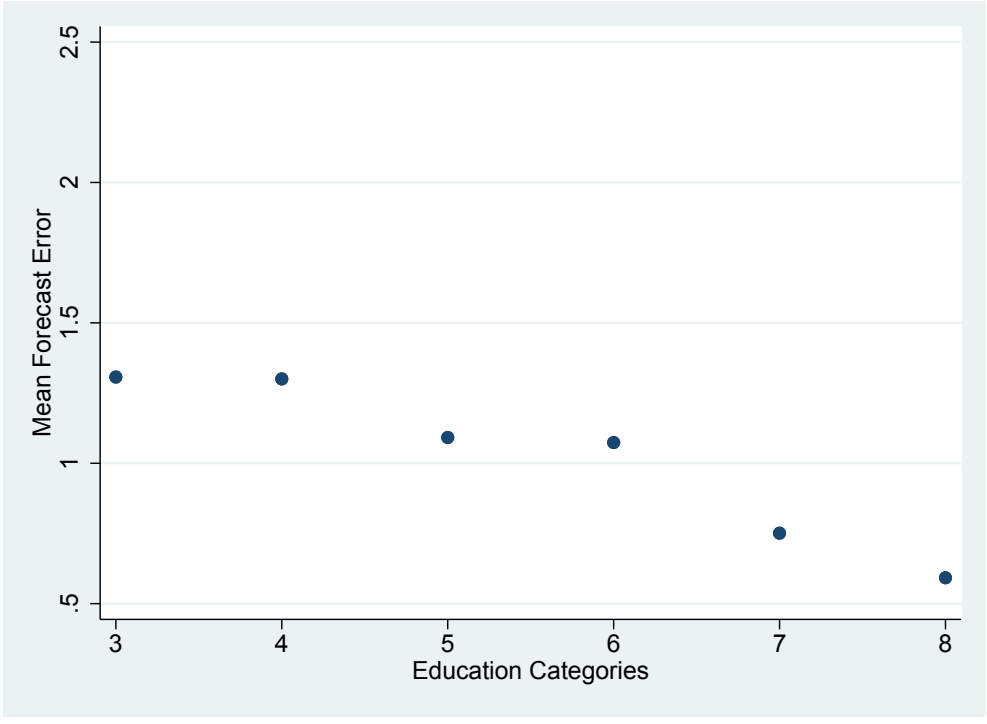


- Taxable income: 9 income percentile dummies
- No relationship between average forecast error and income

IQ versus Education

- IQ: innate cognitive abilities or education?
- Difference important for policy
- IQ measured at age of 19 before college
  - Homogeneous society and all education free
- Baseline results control for education
- Compare forecast errors by college and IQ

Forecast Error by Education Levels



- Education dummies: International Standard Classification of Education
- Exploit variation in IQ *within* degree levels

Heterogeneity and Multivariate Analysis

- Holds after absorbing education levels, income deciles, other demos
- Also when absorbing determinants of HH consumption bundles (D'Acunto, Malmendier, Ospina, Weber, 2019)
- Heterogeneity: High IQ more relevant if:
  - Rural
  - No College Degree
  - Younger
- Association vanishes only for Econ/Business Degrees

Plan

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Full Information Rational Expectations (FIRE)

- Rotating panel from 1995 until 1999
- Three times with 6-month lag
- Realized inflation highly persistent
- Test 1: **If no news** across periods:
  - RE $\rightarrow$ corr(past expectation, current expectation) > 0
  - Regress current inflation expectations on past expectations

Current Expectations and Past Expectations

	High IQ	Low IQ	High IQ	Low IQ
	(1)	(2)	(3)	(4)
Past Inflation expectation (6m)	0.28***	0.03		
	(5.33)	(1.00)		
Past Inflation expectation (12m)			0.26***	0.03
			(2.38)	(1.21)
Time fixed effects	X	X	X	X
Demographics	X	X	X	X
adj. R^2	0.02	0.01	0.01	0.00
Nobs	1,368	1,192	563	482

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- Strong association for men with high IQ both for 6 and 12 months ago expectations
- Weak association for men with low IQ
- Results only true during periods of persistent inflation

Overreaction of Inflation Expectations to News?

- Expectations of both high- and low-IQ men deviate from FIRE
- Do individuals over- or underreact to news?
- Individuals' information set unobserved
- Test 2: Forecast errors and forecast revisions:
  - Coibion & Gorodnichenko (2012,5); Bordalo et al. (2018): Regress forecast errors on revisions

$$x_{t+1} - x_{i,t+1|t} = \alpha + \beta FR_{i,t,1} + \varepsilon_{i,t}$$

  - $\beta < 0$ indicates overreaction at individual level

Forecast Errors and Forecast Revisions cont.

$$x_{t+1} - x_{i,t+1|t} = \alpha + \beta FR_{i,t,1} + \varepsilon_{i,t}$$

	High IQ (1)	Low IQ (2)	High IQ (3)	Low IQ (4)
Forecast revision	−0.76***	−0.52***	−0.87***	−0.52
	(0.10)	(0.15)	(0.11)	(0.42)
Year-Month FE			X	X
Demographics			X	X
Individual FE			X	X
adj. R^2	0.6545	0.4817	0.9581	0.9426
Nobs	1,377	1,203	1,082	774

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- Consistent overreaction for high-IQ men
- Weak evidence for overreaction for men with low IQ: *anything goes*

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Inflation Expectations and Purchasing Propensities

- Does heterogeneity in IQ matter for economic choice?

  Vellekoop and Wiederholt (2017)

- E.g., do consumption plans respond to changing inflation expectations?

- Relate inflation expectations to propensity to buy durables by IQ

EU Survey: Purchasing Plans

Question

In view of the general economic situation, do you think that now it is the right moment for people to make major purchases such as furniture, electrical/ electronic devices, etc.?

Answer choices: "it is neither the right moment nor the wrong moment," "no, it is not the right moment now," or "yes, it is the right moment now."

- Estimate quasi Euler equations à la Bachmann, Berg, Sims (2015)

Euler Equations

Marginal Effects: $$\frac{\partial P(y=t|x)}{\partial x} = P(y=t|x)\left[\beta_{tx} - \sum_{z=0,1,2} P(y=z|x)\beta_{zx}\right]$$

	Men with IQ data	Men high IQ	Men low IQ
Expect Higher Inflation			
Demographics			
Pseudo R^2			
Nobs			

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- LHS: Answer for good time to buy
- RHS: Dummy for inflation increase
- Demo: age, age2, male, single, log income, unemployed, kids, urban, helsinki, college

Euler Equations cont.

Marginal Effects: $$\frac{\partial P(y=t|x)}{\partial x} = P(y=t|x)\left[\beta_{tx} - \sum_{z=0,1,2} P(y=z|x)\beta_{zx}\right]$$

	(1)	Men with IQ data (2)	Men high IQ (3)	Men low IQ (4)
Expect Higher Inflation	0.0214***	0.0147	0.0358***	−0.0096
	(0.0047)	(0.0100)	(0.0119)	(0.0138)
Demographics	X	X	X	X
Pseudo R^2	0.0067	0.0107	0.0108	0.0091
Nobs	311,164	32,862	16,606	16,256

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

All Finns: Higher inflation → 2% more likely to answer "good time to purchase durables"

Euler Equations cont.

Marginal Effects: $$\frac{\partial P(y=t|x)}{\partial x} = P(y=t|x)\left[\beta_{tx} - \sum_{z=0,1,2} P(y=z|x)\beta_{zx}\right]$$

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Finnish men with IQ data: no association btw inflation expectations and purchasing propensities

Euler Equations cont.

Marginal Effects: $$\frac{\partial P(y=t|x)}{\partial x} = P(y=t|x)\left[\beta_{tx} - \sum_{z=0,1,2} P(y=z|x)\beta_{zx}\right]$$

		Men with IQ data	Men high IQ	Men low IQ
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- Strong association for men with high IQ
- No association for men with low IQ
- Holds irrespective of financial constraints, income expectations
- Holds for low IQ who know the current inflation rate, forecast inflation accurately

Plan

- Cross-section of Expectations: Forecast Errors
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Channels

- Why might cognitive abilities matter?
  - Differences in concept of inflation by IQ levels
  - Difference in ability to forecast random variables (irrespective of inflation)
  - Differences in mapping economic information into choices

    Ilut & Valchev (2017); Andre, Pizzinelli, Roth, Wohlfart (2019)

Survey Instrument to Disentangle Channels

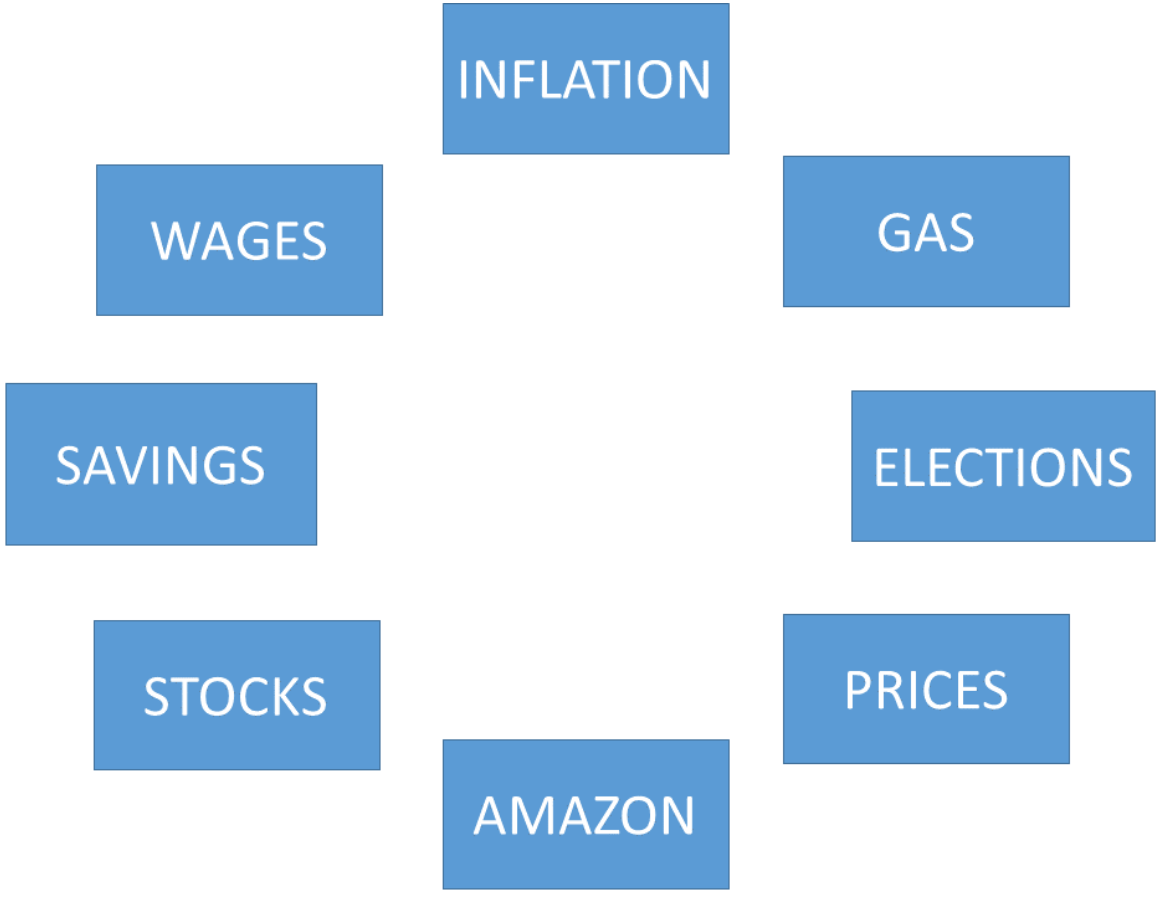
- Two waves on mTurk (US), 1,000 respondents in August 2019
- Measure IQ with cognitive reasoning test and "brainteasers"
- Ad hoc incentivized tasks to assess channels
- Average time completion: 30m 12s

Differences in concept of inflation by IQ

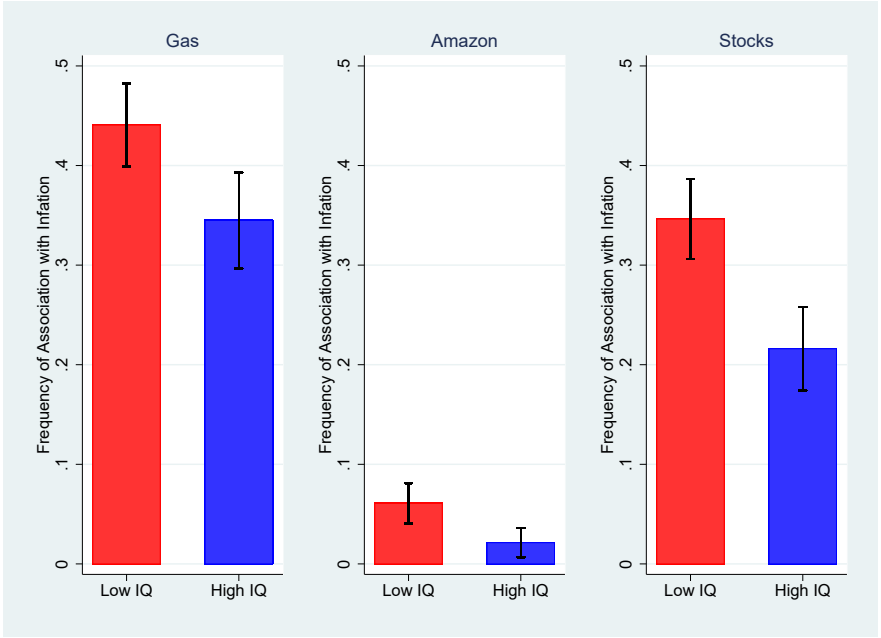
Association game: Leiser and Drori (2005)

"Pick 3 words that come to mind when thinking about inflation"

(out of a list of 6 words: 3 concrete words, 3 abstract words)



Differences in concept of inflation by IQ



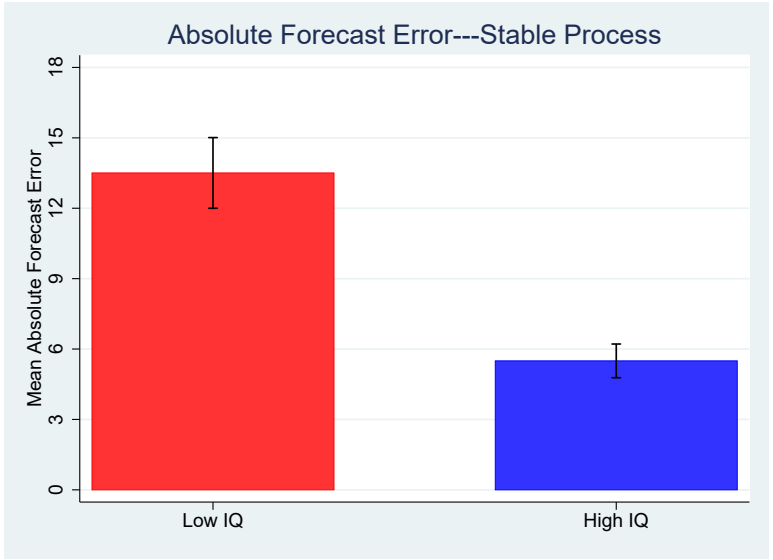
- Low-IQ $\rightarrow$ concrete goods (see also D'Acunto, Malmendier, Weber, 2020)

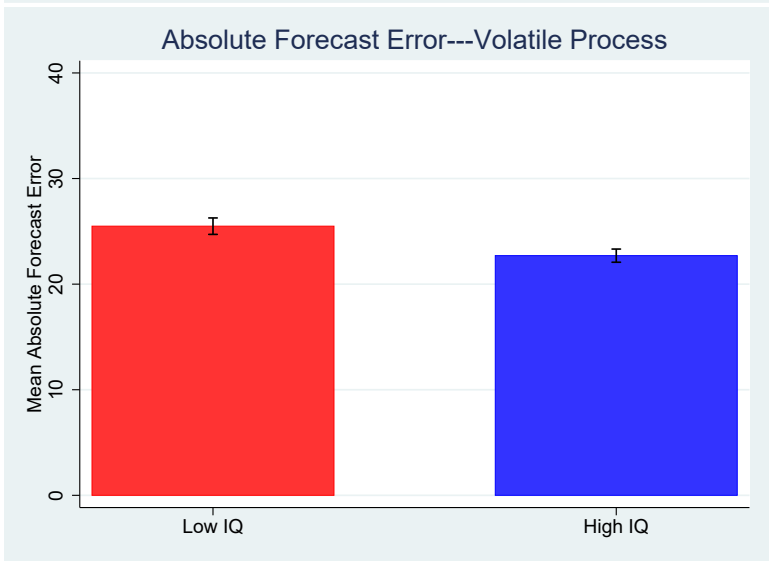
Difference in ability to forecast random variables

Forecasting game: Landier, Ma, and Thesmar (2018)

- Forecast AR(1) zero-mean processes w/ $\rho = 0.9$
- Forecast 2 processes for 15 periods and display first 40 observations
- Realization displayed after each forecast
- Randomized order: $\sigma = 5$ (stable) vs $\sigma = 20$ (volatile)
- Incentivized forecast accuracy

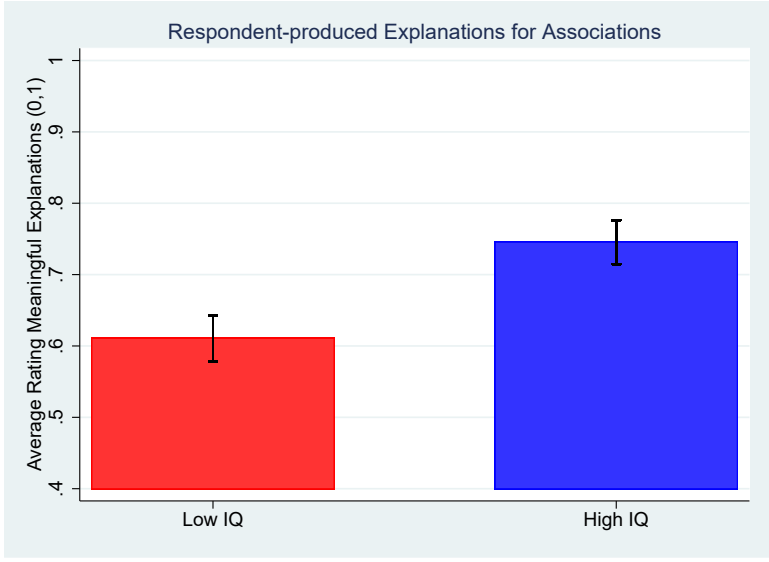
Difference in ability to forecast random variables

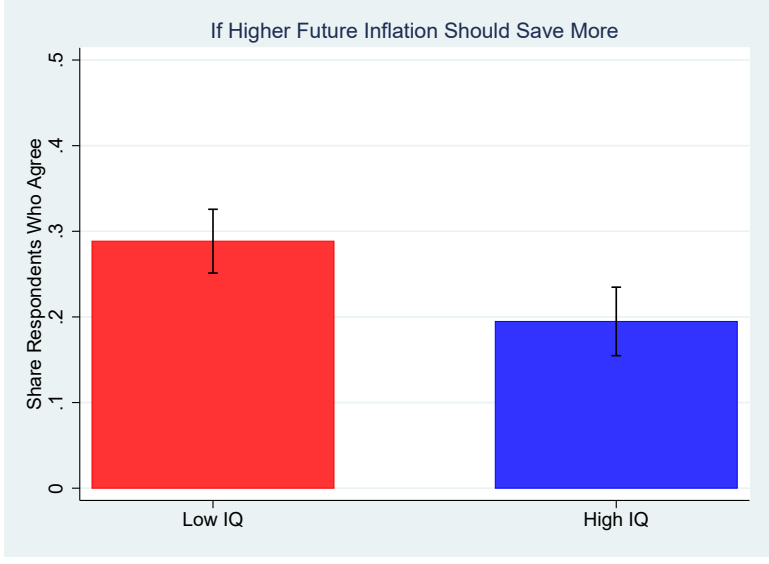




- Lower mean absolute forecast error for high IQ with stable process
- Large absolute forecast error for everyone in volatile process

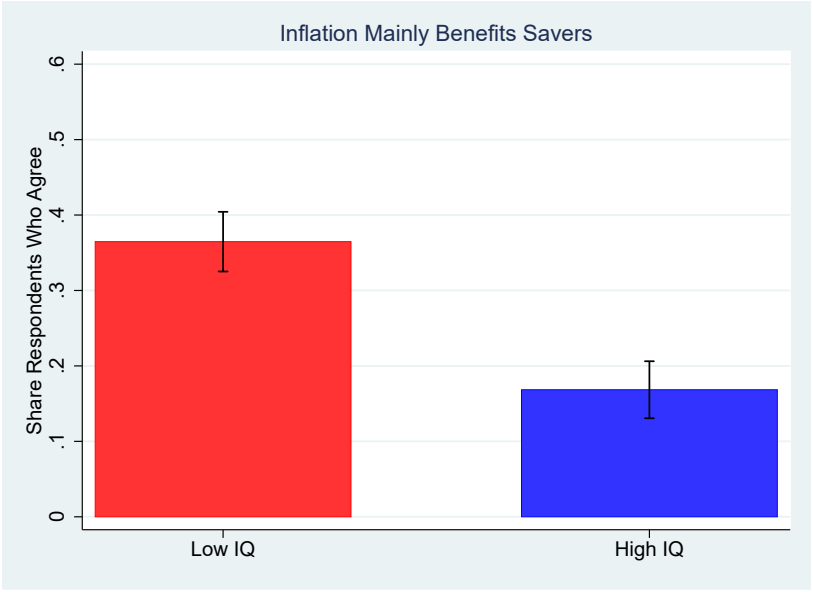
Differences in mapping economic information into choices

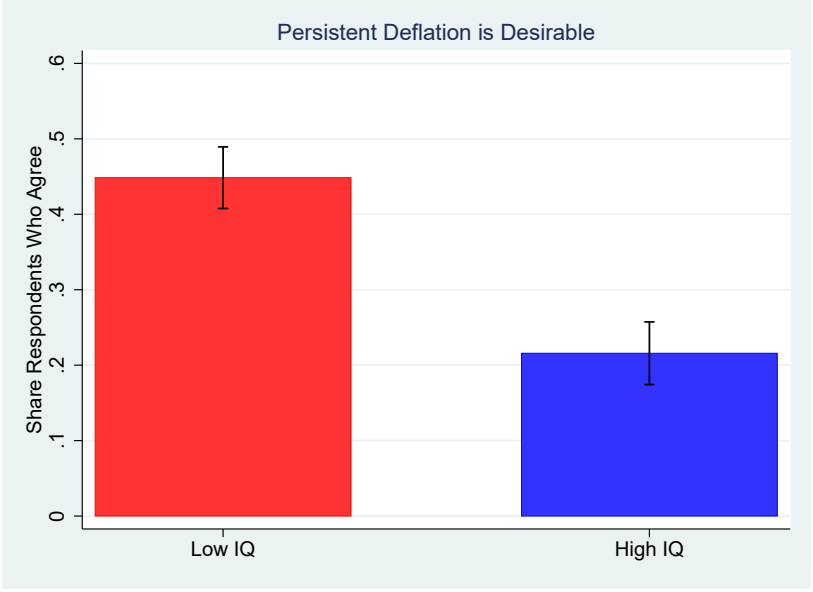




- Low-IQ participants less likely to follow Euler logic

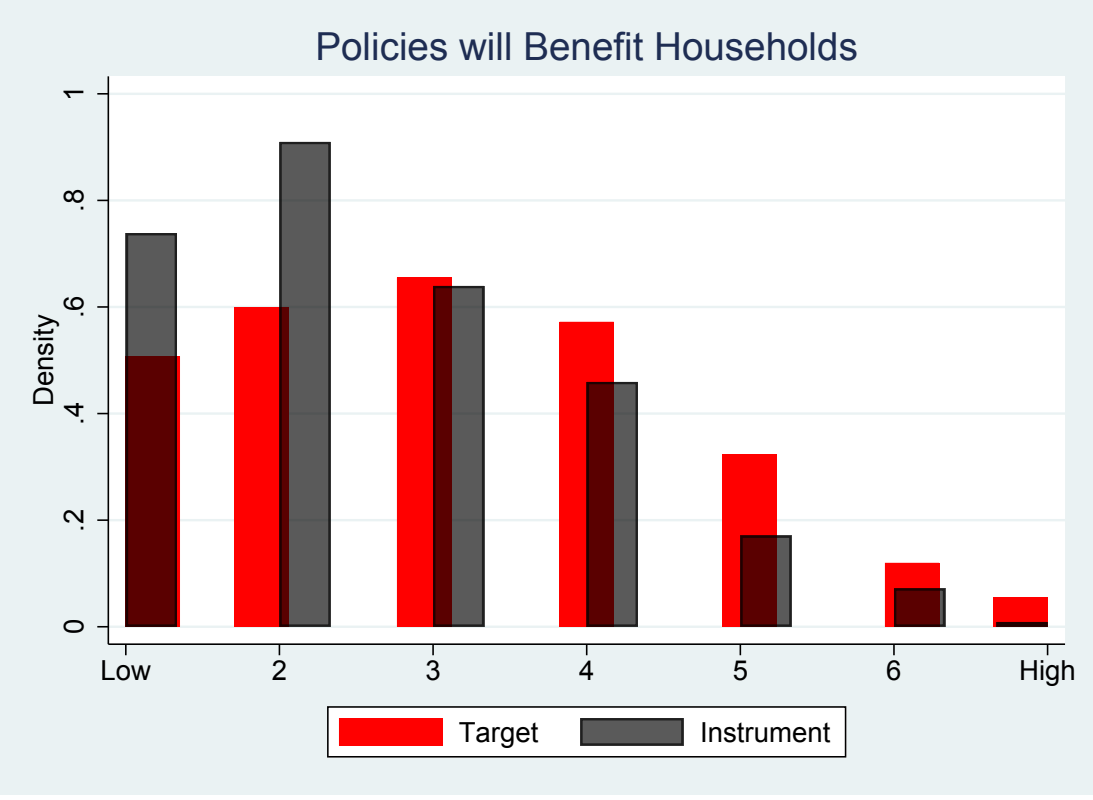
Differences in mapping economic information into choices





- Low-IQ participants think inflation benefits savers, deflation desirable

Follow-Up Work: Instrument vs Target Communication



- Customized surveys stratified by IQ
- Study effectiveness of target vs instrument communication
  (Angeletos & Sastry (2020))
- Target communication shifts income expectations upwards, esp for low IQ men

Conclusion

- Low cognitive abilities:
  - Larger forecast errors
  - Larger forecast dispersion
  - No adjustments in consumption plans
- Cognitive abilities impediment to effectiveness of policy
- Unintended consequences: redistribution from low to high IQ agents
- If IQ innate, unintended discrimination by policy institutions

Implications for the Conduct of Monetary Policy

- Salience, fin education, & policy communication important
- Households react to salient policy changes
  D'Acunto, Hoang, & Weber (2018)
- Coverage in media not sufficient for communication effectiveness
  Coibion, Gorodnichenko, & Weber (2018)
- Simple, easy-to-understand, & repeated communication required

Only if Low Perception Error

- Restrict to men who have info on current level of inflation

	Abs Perception Error$_{it}$ $<=$ **Median**$_t$	
	Men high IQ	Men low IQ
	(1)	(2)
Inflation expectation	0.0472***	0.0209
	(0.0153)	(0.0165)
Demographics	X	X
Pseudo R^2	0.0104	0.0061
Nobs	10,115	8,984

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- Strong association for men with high IQ and accurate inflation perceptions
- No association for men with low IQ even if accurate inflation perceptions

Only if Low Forecast Error

- Restrict to men who can forecast future inflation well

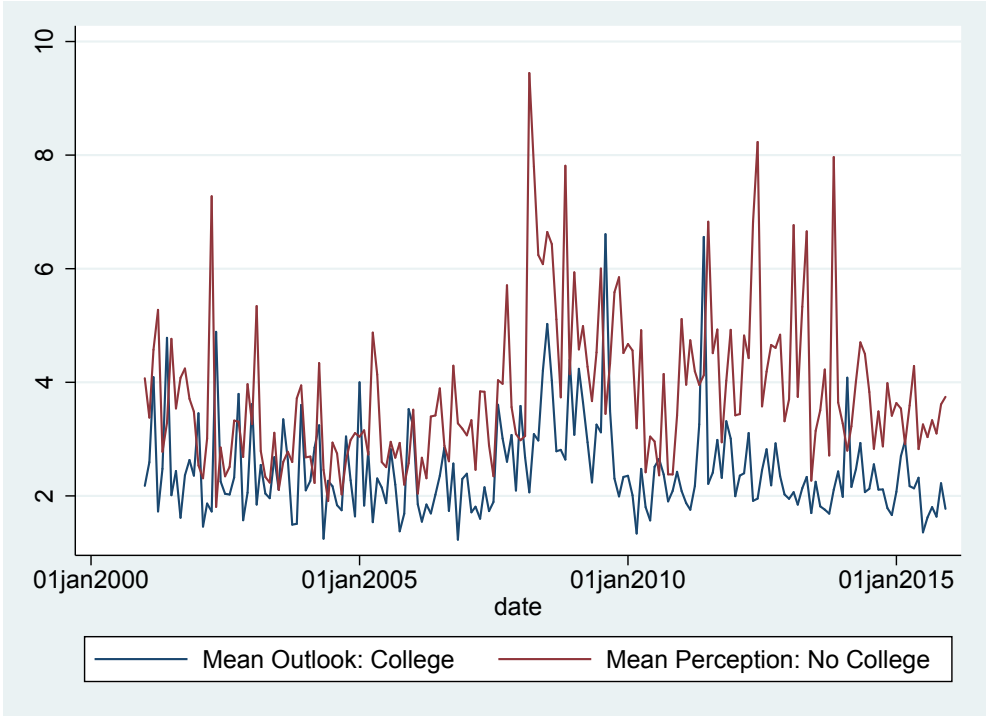
	Abs Forecast Error$_{it}$ $<=$ **Median**$_t$	
	Men high IQ	Men low IQ
	(1)	(2)
Inflation expectation	0.0401**	0.0069
	(0.0184)	(0.0243)
Demographics	X	X
Pseudo R^2	0.0101	0.0083
Nobs	9,699	8,694

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

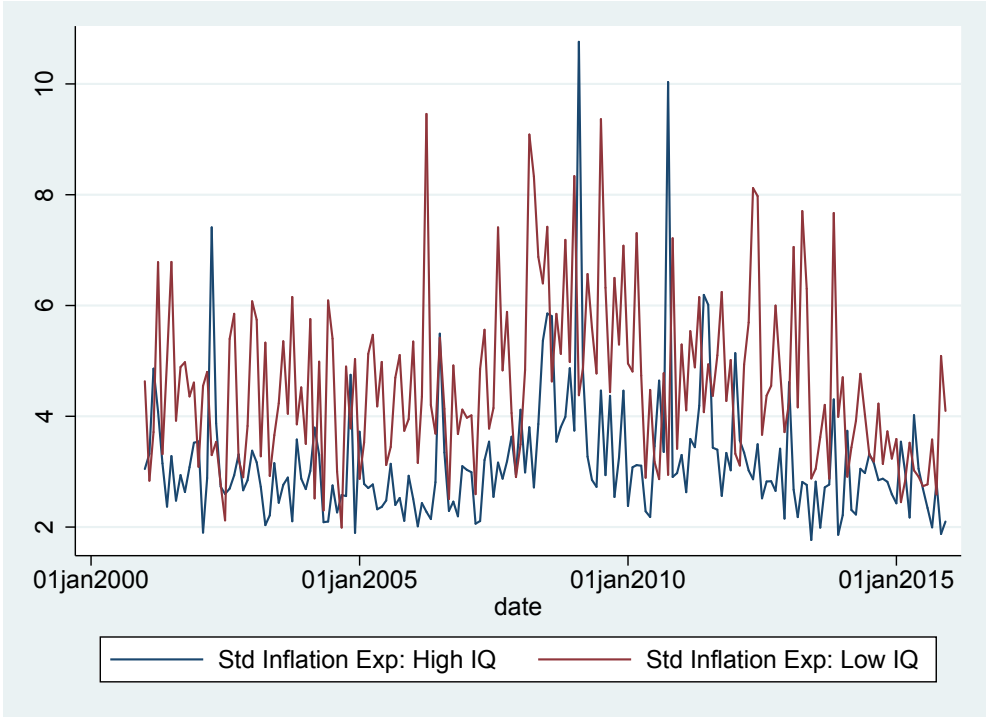
- Strong assocation for men with high IQ both for high and low forecast errors
- No assocation for men with low IQ even if accurate inflation expectations

Forecast Dispersion in Inflation Expectation by College



- XS std for men w no college and college highly correlated
- XS std for men w no college only elevated during Great Recession & Sovereign Debt Crisis

Forecast Dispersion in Inflation Expectation by IQ



- XS std twice as large for low IQ throughout
- IQ both in normal times and in crisis associated w/ larger differences in uncertainty
- Low correlation in XS std for men with low and high IQ
- IQ and college eductation capture different dimensions

Euler Equations vs Income Expectations

- Inflation expectations possibly correlated with income expectations
  - Phillips curve
  - Indirect effects of monetary policy (Kaplan, Moll, & Violante (2018))
- Split sample by personal economic outlook
  - Answer to "Do you think your household's income will increase?"

Euler Equations vs Income Expectations cont.

Marginal Effects: $$\frac{\partial P(y=t|x)}{\partial x} = P(y=t|x)\left[\beta_{tx} - \sum_{z=0,1,2} P(y=z|x)\beta_{zx}\right]$$

	High Income Expectations		**Low Income Expectations**	
	Men high IQ	Men low IQ	Men high IQ	Men low IQ
	(1)	(2)	(3)	(4)
Inflation expectation	0.0294*	−0.0166	0.0371**	−0.0046
	(0.0165)	(0.0190)	(0.0158)	(0.0176)
Past Inflation	−0.0709***	−0.0571***	−0.0750***	−0.0653***
	(0.0099)	(0.0090)	(0.0081)	(0.0075)
Demographics	X	X	X	X
Pseudo R^2	0.0115	0.0083	0.0106	0.0104
Nobs	7,337	6,409	9,269	9,847

Standard errors in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- Strong association for men with high IQ
- No association for men with low IQ

Decreasing Rates

- Focus on sample Jan 2001 to June 2003

$$\text{Loan}_{i,t} = \text{cons} + \beta_1 \text{ High IQ}_i + \beta_2 \text{ Post}_t + \beta_3 \text{ High IQ}_i \times \text{Post}_t$$

- Loan: dummy 1 if says good time to take out loan
- High IQ: dummy 1 if normalized IQ is larger than 5
- Post: dummy 1 if after May 2001

Decreasing Rates cont.

	OLS (1)	Logit (2)	Probit (3)	OLS (4)	Logit (5)	Probit (6)
High IQ	−0.028	−0.0241	−0.0248	−0.048	−0.0445	−0.0448
	(−0.95)	(−0.88)	(−0.88)	(−1.48)	(−1.51)	(−1.45)
Post	0.062***	0.059***	0.060***	0.065***	0.060**	0.062**
	(2.84)	(2.66)	(2.65)	(2.58)	(2.31)	(2.35)
Post × High IQ	0.095***	0.091***	0.092***	0.088***	0.088***	0.088***
	(2.96)	(3.18)	(3.09)	(2.51)	(2.80)	(2.71)
Demographics				X	X	X
R^2	0.0116	0.0101	0.0101	0.0479	0.0463	0.0464
Nobs	5,850	5,850	5,850	4,070	4,070	4,070

t-stats in parentheses

$*p < 0.10, **p < 0.05, ***p < 0.01$

- Unconditional higher likelihood (6%) to say good time to take out loan
- Effect twice as large for men with high IQ

Increasing Rates

- Focus on sample July 2003 to Dec 2006

$$\text{Loan}_{i,t} = \text{cons} + \beta_1 \text{ High IQ}_i + \beta_2 \text{ Post}_t + \beta_3 \text{ High IQ}_i \times \text{Post}_t$$

- Loan: dummy 1 if says good time to take out loan
- High IQ: dummy 1 if normalized IQ is larger than 5
- Post: dummy 1 if after Dec 2005

Increasing Rates cont.

	OLS (1)	Logit (2)	Probit (3)	OLS (4)	Logit (5)	Probit (6)
High IQ	0.079***	0.081***	0.081***	0.036***	0.041***	0.041***
	(7.27)	(7.44)	(7.46)	(2.89)	(3.24)	(3.18)
Post	0.005	0.005	0.005	−0.033**	−0.031**	−0.034**
	(0.37)	(0.36)	(0.36)	(−2.12)	(−2.00)	(−2.15)
Post × High IQ	−0.075***	−0.086***	−0.083***	−0.082***	−0.094***	−0.095***
	(−3.72)	(−3.67)	(−3.69)	(−3.77)	(−3.58)	(−3.70)
Demographics				X	X	X
R^2	0.0067	0.0067	0.0067	0.0442	0.0465	0.0475
Nobs	8,601	8,601	8,601	5,937	5,937	5,937

t-stats in parentheses

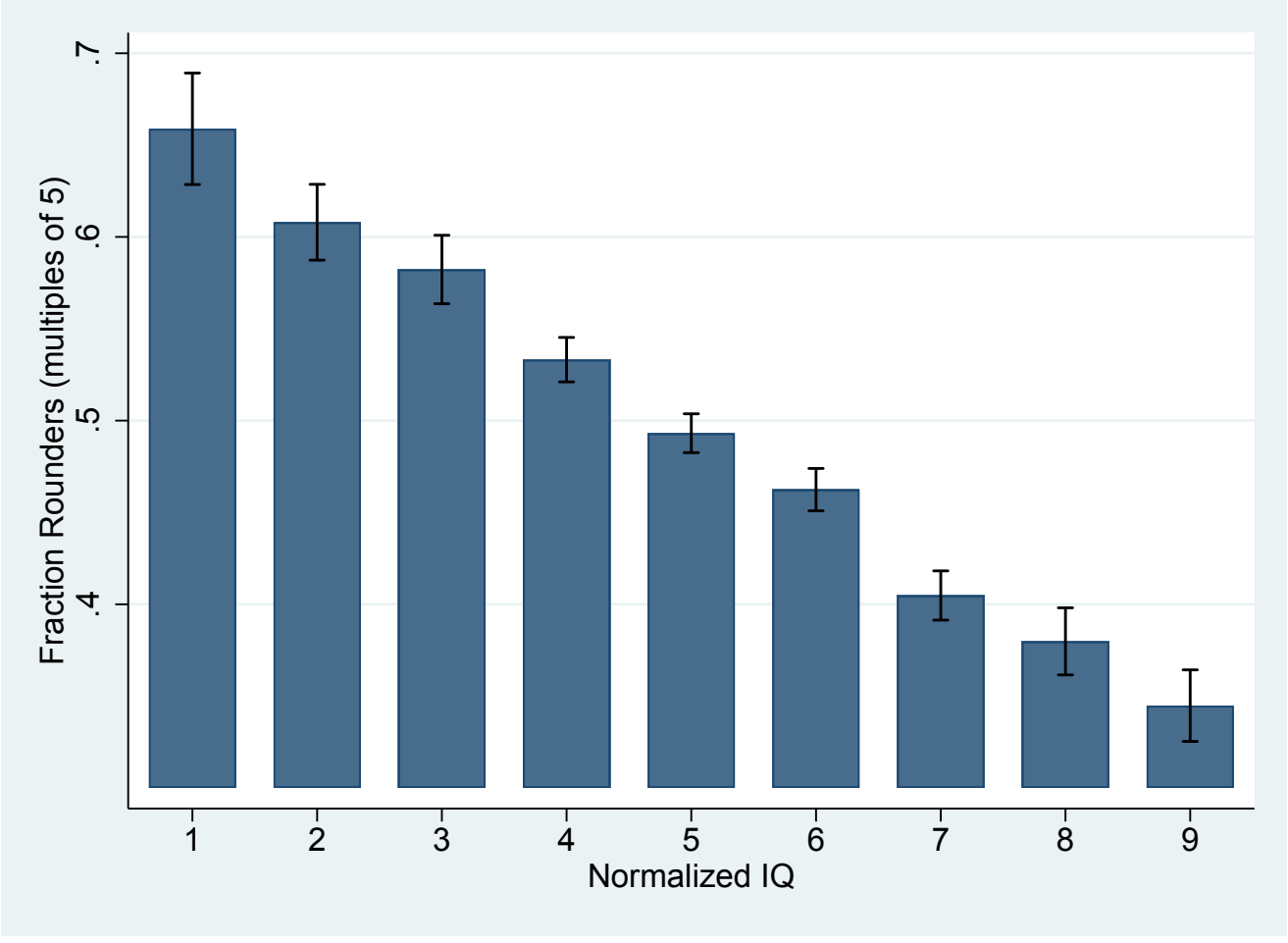
$*p < 0.10, **p < 0.05, ***p < 0.01$

- Weak decrease to say good time to take out loan to increasing rates
- High IQ large decrease in propenstiy to take out loan

IQ, Rounding & Implausible Values

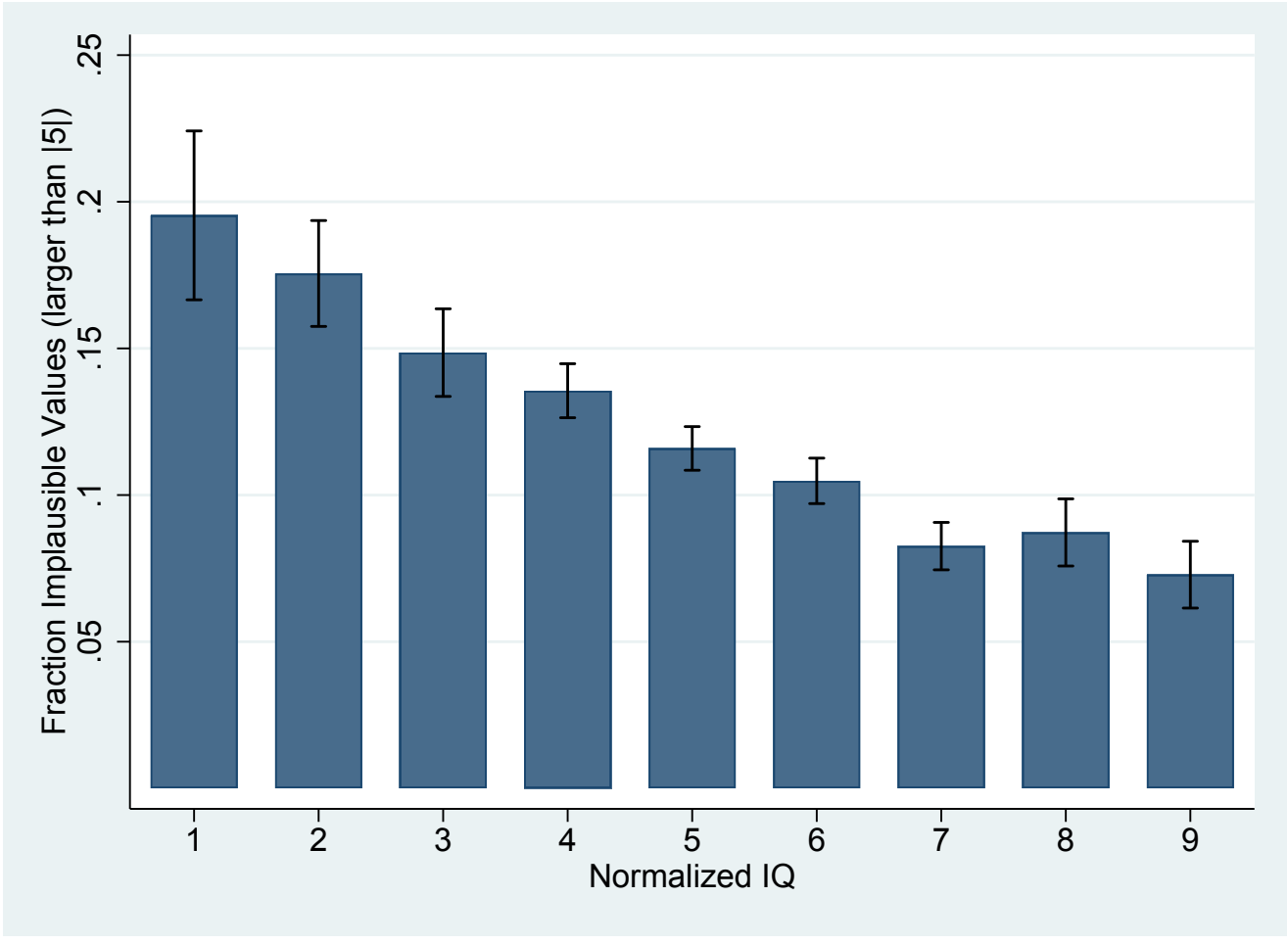
- Inflation difficult concept, non-economist often uncertain
- Rounding to multiples of 5 as evidence of uncertainty
  Binder (2017), Manski & Molinari (2010)
- Household survey show general upward bias in expectations
- During sample actual inflation hoovered around 2%
- Are low IQ men more likely to report "implausible" values?

IQ and Rounding



- Monotonic relationship btw fraction of rounders and IQ
- Fraction of rounders twice as large for low IQ compared to high IQ men

IQ and Implausible Values



- Monotonic relationship btw fraction of respondends with large values and IQ
- Fraction almost 3 times larger for low IQ compared to high IQ men