Overpersistence bias in individual income expectations and its aggregate implications

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Motivation

Households make decisions under uncertainty

$\rightarrow$ income risk is one of the most important sources of risk

Income expectations important for

- consumption vs savings
- durable vs non-durable consumption

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This paper:

1. What are typical features of household income expectations?
2. How do these features affect consumption/savings choices? Aggregate Implications?

This Paper

1) household income expectations in micro data:

- systematic bias: current income predicts expectation error - households overestimate persistence

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2) effects of household income expectations on consumption choices:

- partial equilibrium model with durable and non-durable consumption
- allowing for biased income expectations
- overpersistence belief: low income people do not want to borrow even though their borrowing constraint is not binding

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- systematic bias: current income predicts expectation error - households overestimate persistence

2) effects of household income expectations on consumption choices:

- partial equilibrium model with durable and non-durable consumption
- allowing for biased income expectations
- overpersistence belief: low income people do not want to borrow even though their borrowing constraint is not binding

3) aggregate implications:

- MPC of low income households lower under biased expectations
  $\Rightarrow$ fiscal transfers less effective

Data

Michigan Survey of Consumers

Survey characteristics:

- 500 observations each month (micro data since 1987M7)
- content: household characteristics,
  expectations about unemployment, inflation,
  interest rates, purchasing conditions
  and individual income expectations
- mix of repeated cross-section and short panel:
  - short panel dimension: 1/3 re-interviewed after 6 months

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Forecast Errors:

$$\psi_{i,t} = \hat{g}_{i,t+1|t} - g_{i,t+1}$$

where $g_{i,t+1} = Y_{i,t+1} / Y_{i,t}$

Challenge: Time Structure

- aim: compare expectation with realization
- challenge: time structure of expectations vs realizations
  - expectations: expected income growth in **next 12 months**
  - income realization: total household income in last **calendar year**

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  - overlap of expectations and realizations not perfect (max 6 / 12 months)
- solution: impute income growth realization (using households with same characteristics but in different month)

Challenge: Time Structure

Specifications:

- baseline: realizations imputed, all months

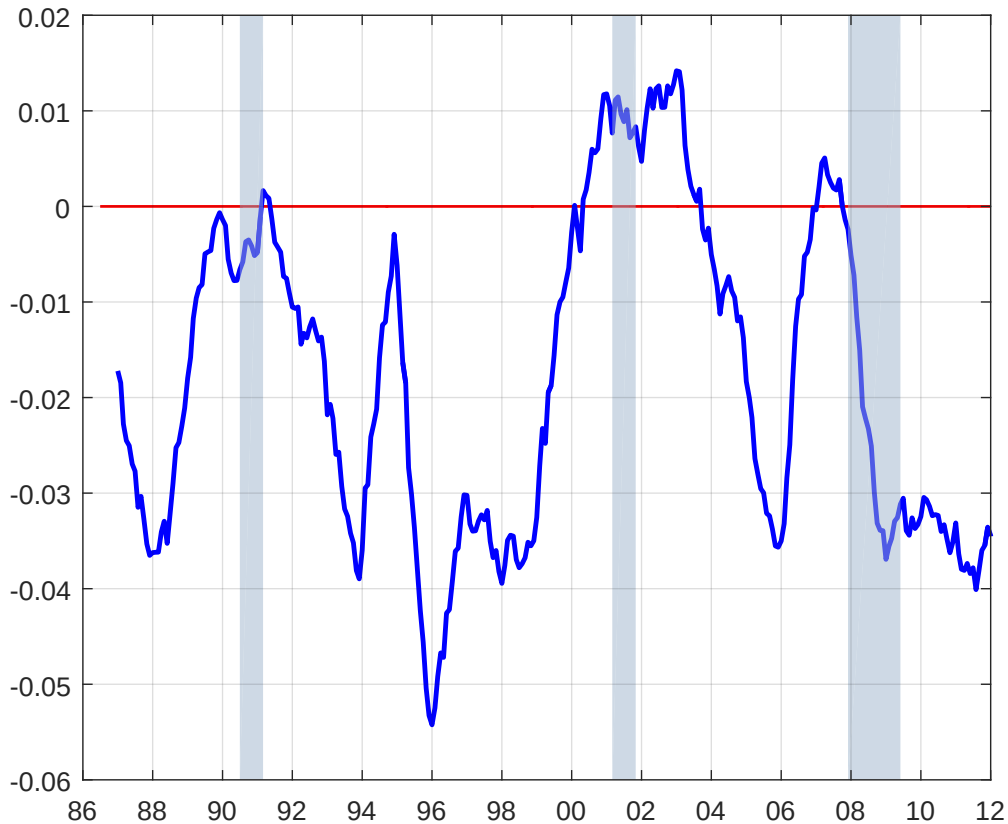
  $\rightarrow$ advantage:
  - increases overlap
  - maximizes observations

- robustness:
  - July only, directly reported data: no imputation
  - January only, imputed: perfect overlap

Forecast Errors in Real Income Growth

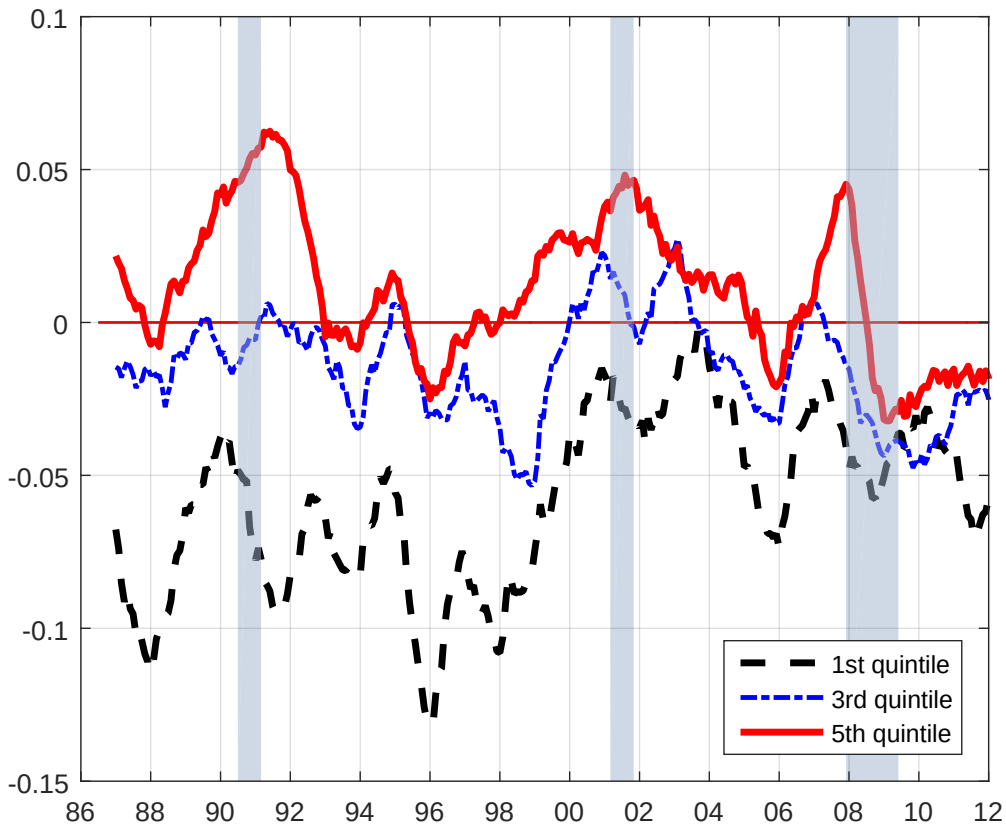
Data

Figure: Mean forecast error



Forecast Errors in Real Income Growth

Figure: Mean forecast error by income



observation:
- low income households too pessimistic
- high income households too optimistic

▸ nominal

Forecast Errors on Observables

	(1) real	(2) real	(3) real	(4) nominal	(5) inflation
Income Quintile					
1 (low)	−0.052***	−0.046**	−0.075***	−0.049***	0.004***
	(0.006)	(0.018)	(0.021)	(0.007)	(0.000)
2	−0.018***	−0.013	−0.038*	−0.016***	0.002***
	(0.006)	(0.017)	(0.020)	(0.006)	(0.000)
4	0.019***	0.026*	0.025	0.018***	−0.002***
	(0.005)	(0.013)	(0.016)	(0.005)	(0.000)
5 (high)	0.035***	0.046***	0.067***	0.032***	−0.004***
	(0.006)	(0.015)	(0.017)	(0.006)	(0.000)
Education					
no high school	0.014	0.015	0.000	0.019	0.002**
	(0.013)	(0.029)	(0.036)	(0.013)	(0.001)
college	−0.014***	−0.024**	−0.032**	−0.017***	−0.003***
	(0.004)	(0.012)	(0.013)	(0.004)	(0.000)
Age					
age	−0.004***	−0.003	−0.006	−0.004***	0.000***
	(0.001)	(0.003)	(0.004)	(0.002)	(0.000)
age × age	0.000**	0.000	0.000	0.000*	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sample	MAIN	JAN	JULY	MAIN	INF
Imputation	yes	yes	no	yes	no
Observations	58369	6973	2805	58369	88017

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses.

additional controls: ethnic background, number of adults, gender, marriage status, region, month, constant

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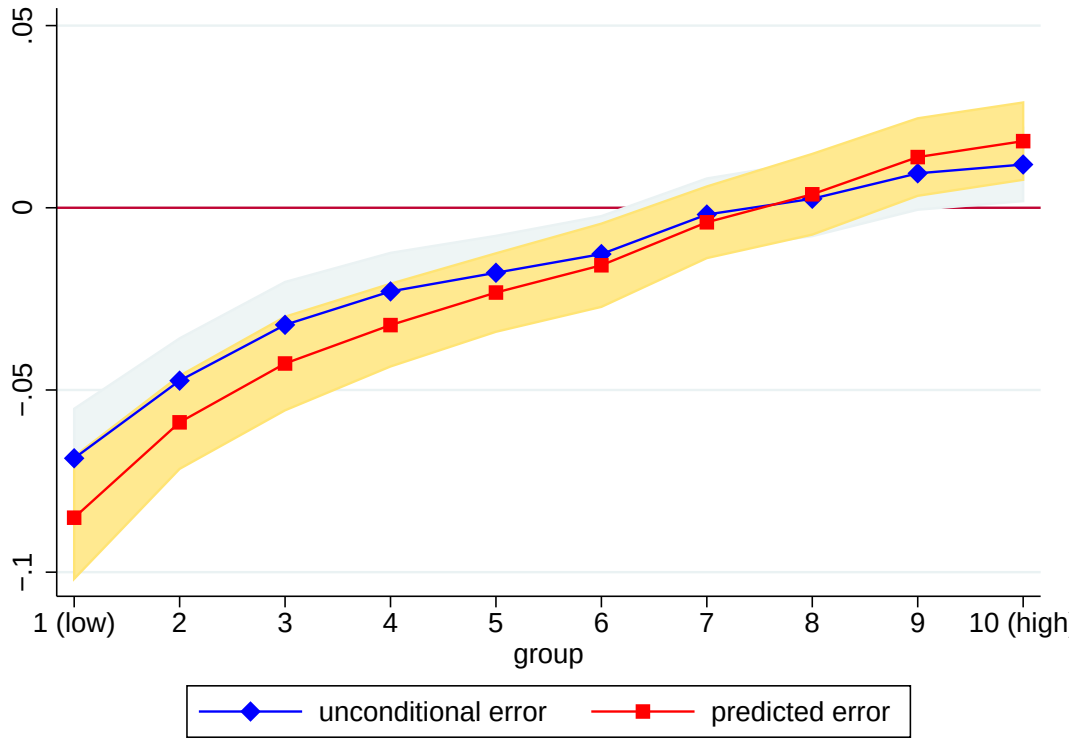
Forecast Errors in Real Income Growth

Figure: Mean forecast errors by income



→ robust to controlling for household characteristics!

Overpersistence Belief

Assumption

- *Individual income Y has transitory (T) and persistent (P) component*[1]
- *Households overestimate persistence in P*

Theorem

(a) $\exists! \bar{P}$*:*

$$E\left[\log(Y_{it+1|t}) - \log(Y_{it+1}) | P_{it} > \bar{P}\right] > 0$$

and vice versa for $P_{it} < \bar{P}$

(b) *let* $\Delta_{it} \equiv P_{it} - \bar{P}$*, then*

$$\frac{\partial E\left[\log(Y_{it+1|t}) - \log(Y_{it+1}) | \Delta_{it}\right]}{\partial \Delta_{it}} > 0$$

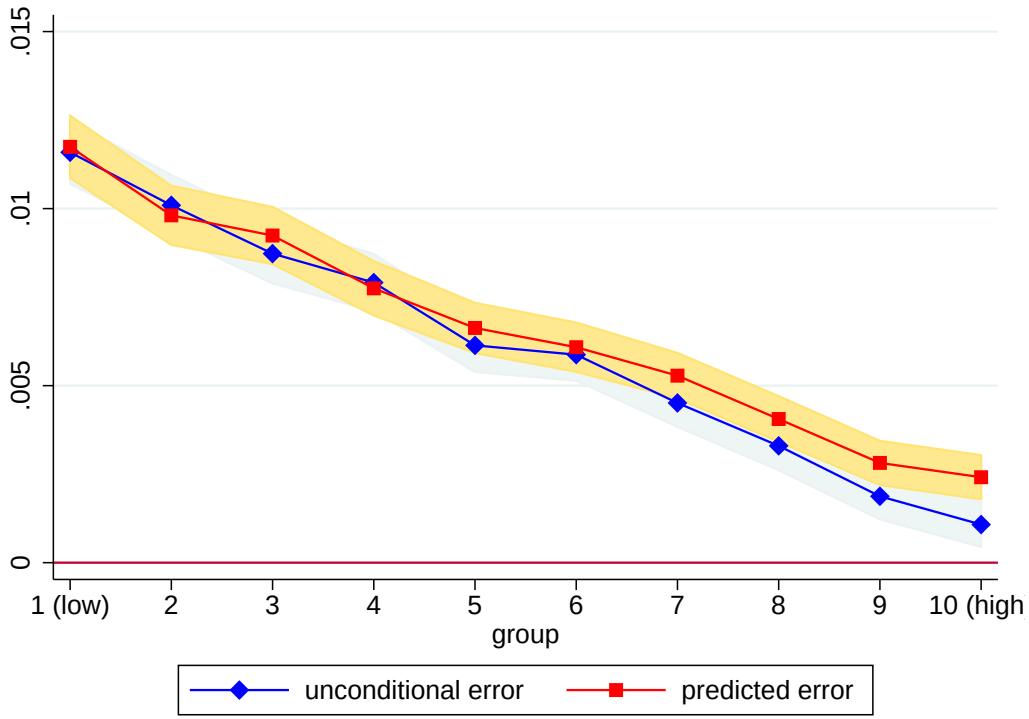
▸ alternative mechanisms (not consistent with data)

[1] T: lognormal, P: AR(1) in logs with normal innovations

Forecast Errors in Aggregates

Data

Figure: Forecast errors in inflation by income



- people overestimate inflation across the whole income distribution
- similar to unemployment expectations = too pessimistic across whole income distribution

Summary Empirical Findings

1. Overpersistence Bias in Income Expectations:
   - low income households too pessimistic
   - high income households too optimistic
2. Aggregate Pessimism:

   all income groups too pessimistic about aggregates

Model

Overview

Model

- partial equilibrium analysis, infinite horizon
- household obtains utility from two goods:
  - non-durable consumption
  - durable good
- household can invest in two assets:
  - durable good: adjustment costs & depreciation
  - liquid asset: earns risk-free interest

    $\rightarrow$ borrowing possible at higher interest rate
- only source of risk: exogenous income

Household Optimization Problem

Model

$$\max_{\{c_t\}_{t=0}^{\infty},\{d_t\}_{t=0}^{\infty},\{s_t\}_{t=0}^{\infty}} \quad \mathrm{E}\sum_{t=0}^{\infty} \beta^t \; U(c_t, d_t)$$

$$s.t. \quad c_t + d_t + s_t + \; A(d_t, d_{t-1}) \; \leq \; R(s_{t-1}) \; + \; Y_t \; + (1-\delta)d_{t-1}$$

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$$U(c,d) = \frac{\left[\left((1-\theta)c^{\frac{\xi-1}{\xi}} + \theta(\bar{d}+d)^{\frac{\xi-1}{\xi}}\right)^{\frac{\xi}{\xi-1}}\right]^{1-\gamma}}{1-\gamma}$$

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$$s.t. \quad c_t + d_t + s_t + A(d_t, d_{t-1}) \leq R(s_{t-1}) + Y_t + (1-\delta)d_{t-1}$$

$$A(d_t, d_{t-1}) = \begin{cases} 0 & \text{if } d_t = (1-\delta)d_{t-1} \\ F^d(1-\delta)d_{t-1} & \text{otherwise} \end{cases}$$

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$$Y_{it} = Z_t \cdot P_{it} \cdot T_{it}$$

- Components to income:
  - aggregate persistent (Z)
  - idiosyncratic persistent (P)
  - transitory (T)

Household Optimization Problem

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$$R(s_t) = [1 + r\,(s_t)]s_t, \text{ where } r(s_t) = \begin{cases} r^l & \text{if } \; s_t > 0 \\ r^b & \text{if } \; -(\kappa_y P_t + \kappa_d d_t) \leq s_t \leq 0 \end{cases}$$

Income process

Model

$$Y_{it} = Z_t \cdot P_{it} \cdot T_{it}$$

Income process

Model

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- transitory shock:

$$T_{it} \sim \log N\left(-\frac{\sigma_T^2}{2}, \sigma_T^2\right)$$

Income process

Model

$$Y_{it} = Z_t \cdot P_{it} \cdot T_{it}$$

- persistent idiosyncratic shock:

$$\log P_{it} = \rho \log P_{it-1} + \epsilon^P_{it}, \qquad \epsilon^P_{it} \sim N(0, \sigma^2_P)$$

Income process

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Overpersistence Bias:

$$\log P_{it} = \hat{\rho} \log P_{it-1} + \epsilon^P_{it}, \qquad \epsilon^P_{it} \sim N(0, \sigma^2_P)$$

$\rightarrow$ find $\hat{\rho}$ to match the observed forecasting errors

Income process

Model

$$Y_{it} = Z_t \cdot P_{it} \cdot T_{it}$$

- persistent aggregate state:

$$\mathbb{Z} = \begin{bmatrix} Z^h \\ Z^l \end{bmatrix}, \qquad \Pi_Z = \begin{bmatrix} \pi_{11} & 1-\pi_{11} \\ 1-\pi_{22} & \pi_{22} \end{bmatrix}$$

Income process

Model

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Aggregate Pessimism:

$$\hat{Z}_{t+1} = \mu \mathsf{E} Z_{t+1} = \mu \Pi_Z Z_t.$$

Parameters of the Environment

Calibration

Parameter		Value
technology:		
interest rate (lending)	r^l	0.0016
interest rate (borrowing)	r^b	0.02
loan-to-income constraint	κ_y	0.56
loan-to-value constraint	κ_d	0.6
depreciation rate	δ	0.05
adjustment costs	F^d	0.3
income:		
persistence of idiosyncratic income process	ρ	0.9774
std dev of idiosyncratic persistent shocks	σ_P	0.0424
std dev of idiosyncratic transitory shocks	σ_V	0.1
high aggregate income state	Z^h	1.0040
low aggregate income state	Z^l	0.9790
prob. of entering recession	$1-\pi_{11}$	6.85%
prob. of leaving recession	$1-\pi_{22}$	36.04%

Belief and Preference Parameters

Calibration

Parameter		Value
beliefs:		
persistence of P	$\hat{\rho}$	0.9831
pessimism	μ	0.9778
preferences:		
discount factor	β	0.9825
risk aversion	γ	1.5
weight of durable goods in utility	θ	0.075
elasticity of substitution in utility	ξ	3
free durable services	$\underline{d}$	0.5

Beliefs about Persistence

Overpersistence bias (fitted): $\hat{\rho} = 0.9831$, (true $\rho = 0.9774$)

Aggregate pessimism (fitted): $\mu = 0.9778$

Table: Mean expectation errors in income growth

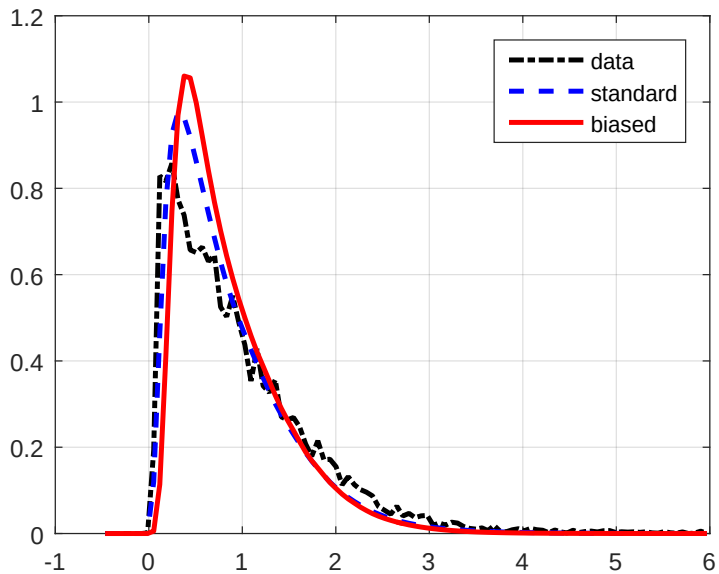
	data	model
income quintile 1	-0.072	-0.068
income quintile 2	-0.037	-0.040
income quintile 3	-0.019	-0.021
income quintile 4	-0.000	-0.004
income quintile 5	0.016	0.020

Note: These depend only on parameters in DGP of income!

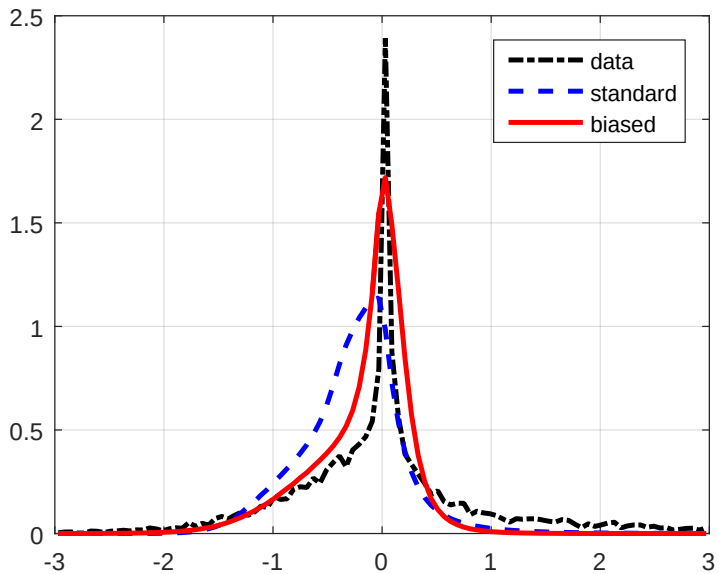
Preferences parameters

Calibration

Pick $\beta, \gamma, \theta, \xi$ and $\bar{d}$ to match the whole distribution of d and s



(a) d, aggregate



(b) s, aggregate

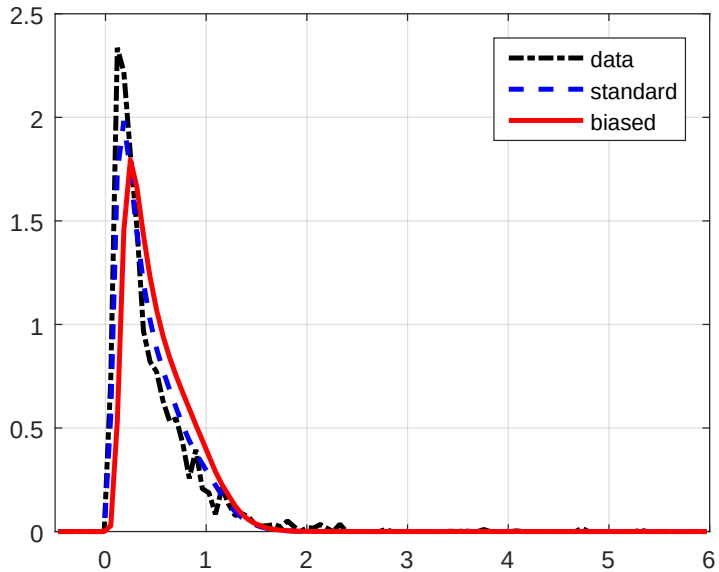
▸ details

Results

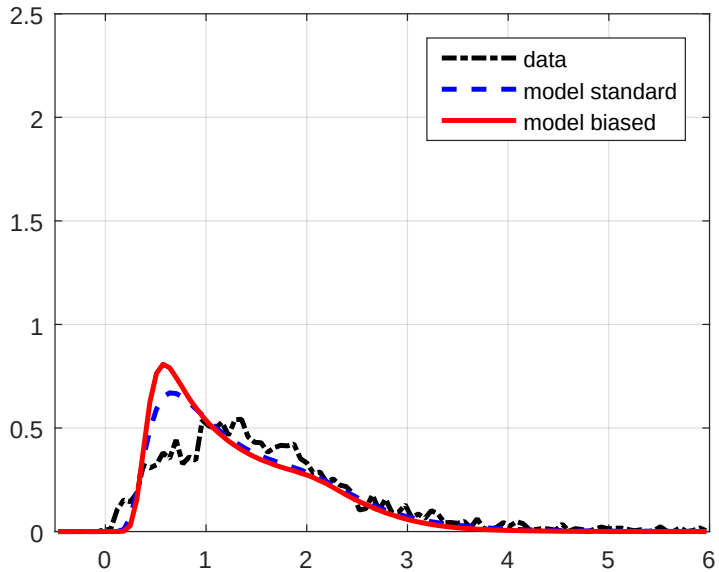
Distribution of durable stock

Results

Figure: Durable stock *d* by income



(a) first quintile



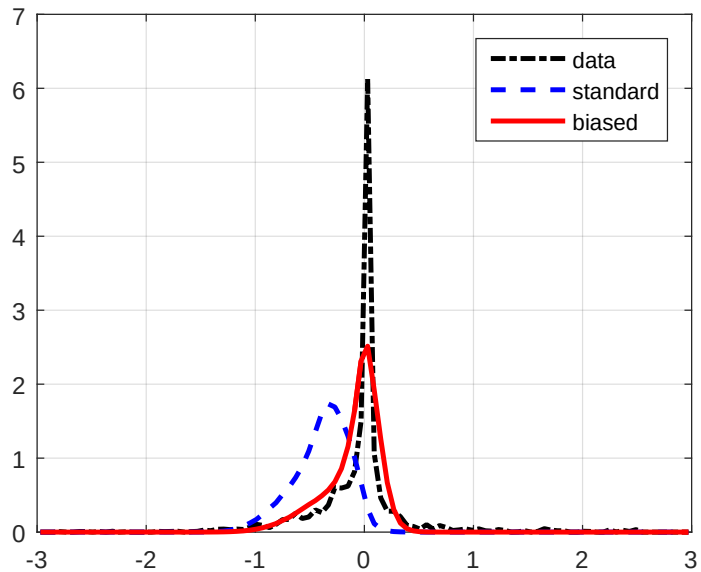
(b) fifth quintile

observation: durables not much affected by bias

Distribution of liquid savings

Results

Figure: Liquid savings s by income



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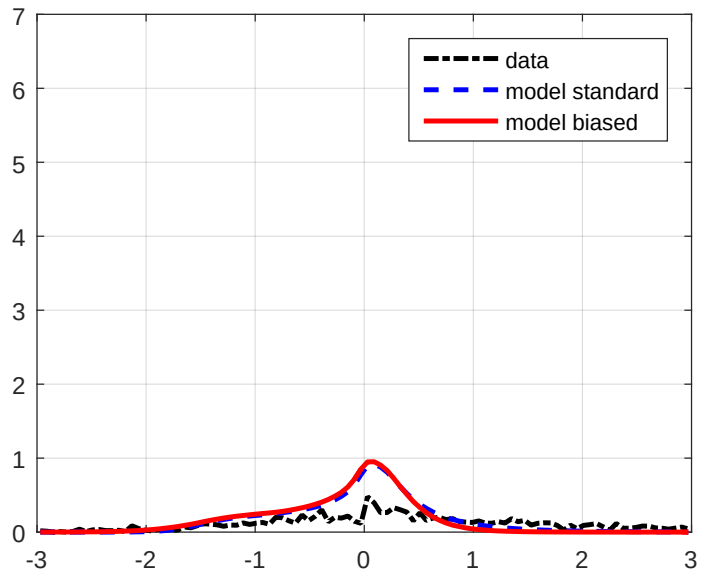


(b) fifth quintile

observation: low income households borrow less

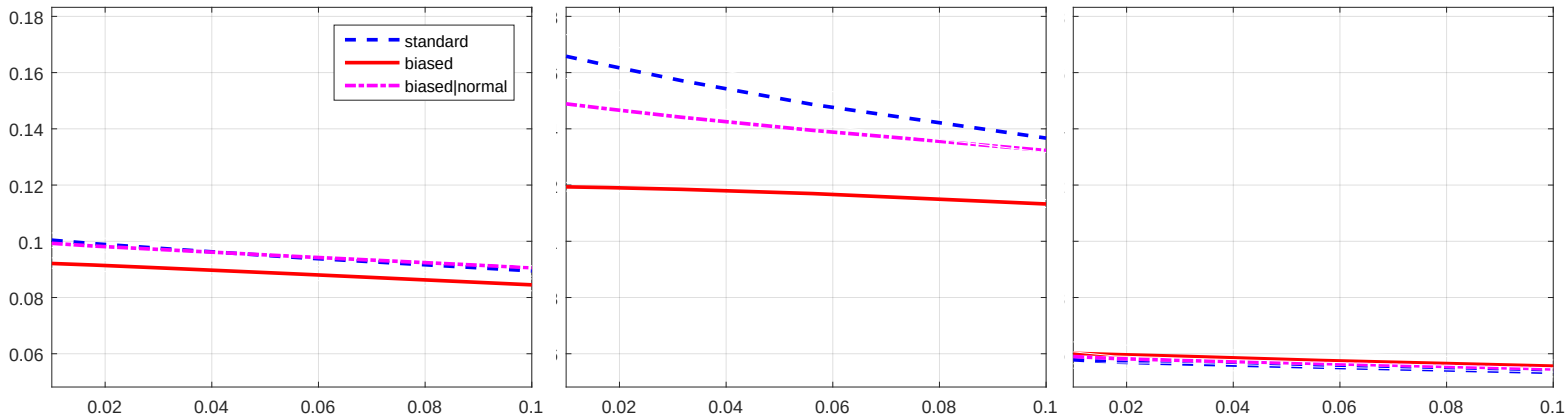
$\rightarrow$ do not borrow even though borrowing constraint not binding!

standard

Propensity to Consume

Results

Figure: MPC out of unexpected transfer (non-durable goods)



(a) aggregate (b) first quintile (c) fifth quintile

observation:
- overall: lower MPC with biased expectations
- low income: lower MPC with biased expectations

▸ standard

Propensity to Consume

Results

	model		data	
	biased beliefs	rational beliefs	stimulus 2001[1]	stimulus 2008[2]
MPC low income	0.12	0.16	0.60	0.24
MPC high income	0.06	0.06	0.26	0.21
low/high	**1.88**	**2.61**	**2.33**	**1.16**

observation: model with rational beliefs overestimates ratio of MPCs (low to high income)

$\rightarrow$ overestimates effectiveness of fiscal stimulus!

[1] Johnson, Parker and Souleles (AER 2006)

[2] Parker, Souleles, Johnson and McClelland (AER 2013)

Summary

1) household income expectation in micro data:

- data: Michigan Survey of Consumers
- findings: current income predicts expectation error
- interpretation: households overestimate persistence of income

2) model of durable and non-durable consumption:

- partial equilibrium model, allowing for overpersistence bias
- overpersistence bias: low income households do not want to borrow even though they could

  $\Rightarrow$ allows model to fit low end of liquid asset distribution!

3) aggregate implications:

- MPC smaller for low income households

  $\Rightarrow$ model with rational expectations overestimates effectiveness of stimulus

Questions about Income Expectations

- income:
  - *Q1a: During the next 12 months, do you expect your income to be higher or lower than during the past year?*
  - *Q1b: By about what percent do you expect your income to (increase/decrease) during the next 12 months?*
- inflation:
  - *Q2a: During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?*
  - *Q2b: By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?*

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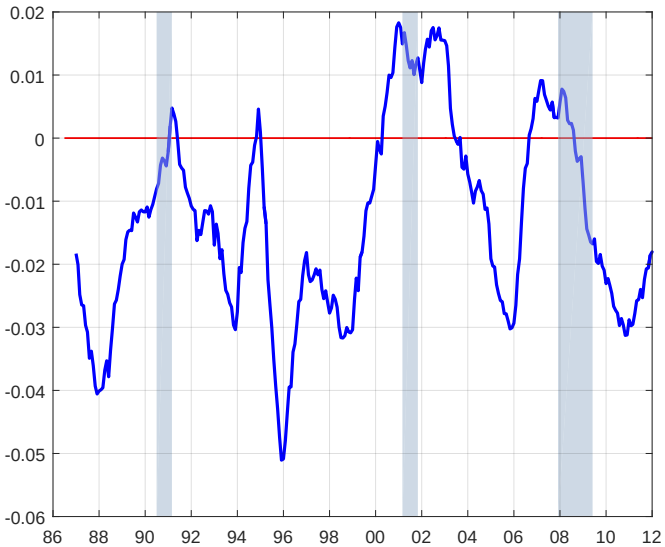
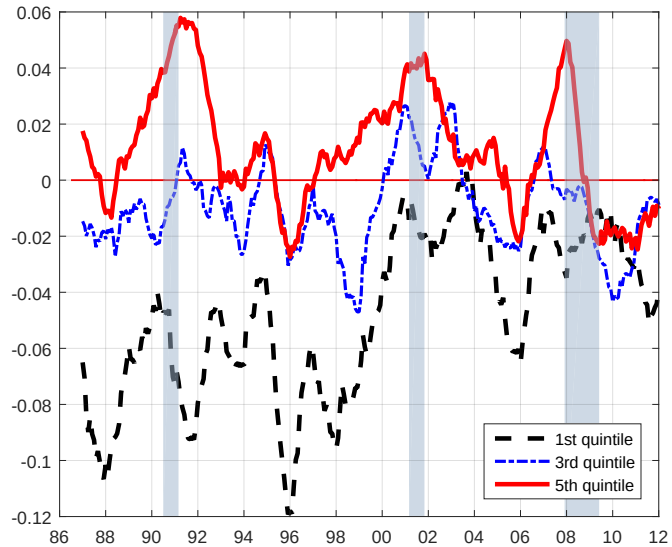
Forecast Errors in Nominal Income Growth



(a) mean nominal error



(b) nominal error by income

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Alternative Mechanisms - not consistent with data

- Learning:

  not consistent: forecast errors do not improve with age ▸ graph

- Extrapolation of Recent Past:

  not consistent: income expectations do not extrapolate from recent income growth ▸ regression

- Unobservable: Persistent vs Transitory Shocks:

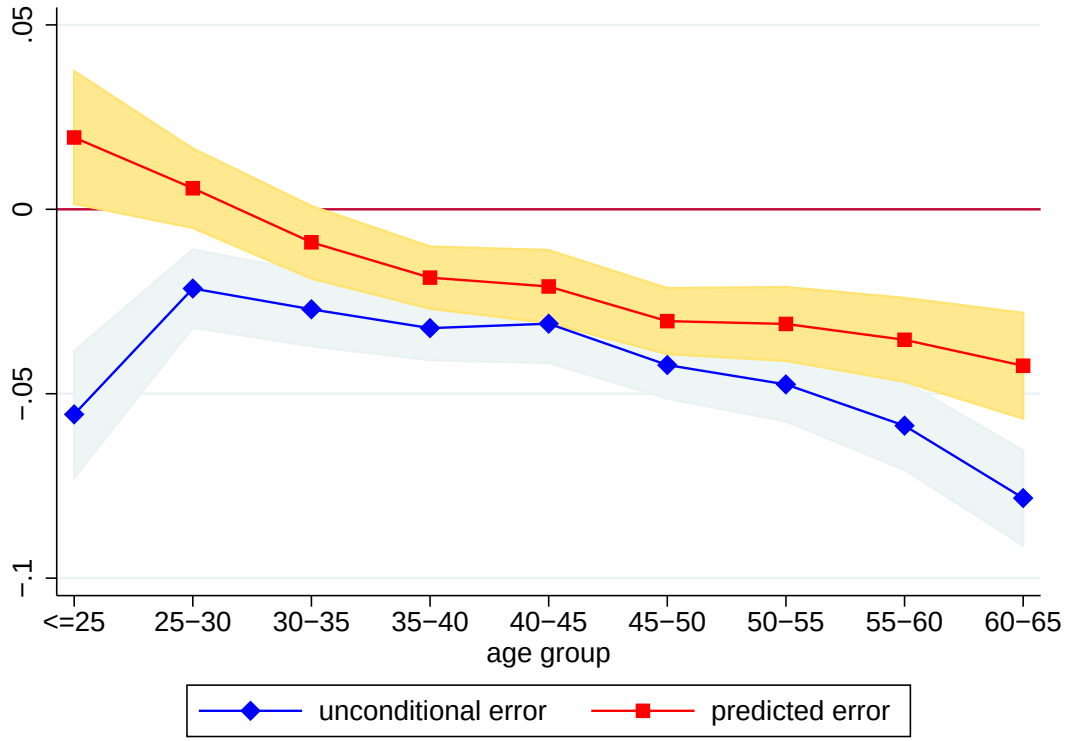
  not consistent: cannot generate systematic bias based on past shock realizations (Kalman Filtering (also conditionally) optimal and unbiased)

- Systematically Wrong Expectations about Aggregates:

  not consistent: across income distribution households too pessimistic about aggregates (inflation and unemployment rate) ▸ back

Forecast Errors By Age

Figure: Forecast errors by income



observation: forecast errors do not improve with age!

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Extrapolation of recent Past?

	(1) exp. growth (real)	(2) exp. growth (real)	(3) exp. growth (nominal)	(4) exp. growth (nominal)
past expectation	0.372***	0.374***	0.373***	0.374***
	(0.016)	(0.016)	(0.016)	(0.016)
past realized growth		−0.021***		−0.022***
		(0.004)		(0.004)
Income Quintile				
1st	0.004	0.007	0.007	0.009**
	(0.004)	(0.004)	(0.004)	(0.004)
2nd	0.002	0.003	0.004	0.005
	(0.004)	(0.004)	(0.004)	(0.004)
4th	−0.005	−0.006*	−0.005	−0.006*
	(0.004)	(0.004)	(0.003)	(0.003)
5th	−0.008**	−0.010**	−0.008**	−0.010**
	(0.004)	(0.004)	(0.004)	(0.004)
Constant	0.061***	0.059***	0.070***	0.068***
	(0.022)	(0.022)	(0.022)	(0.021)
Observations	15931	15931	17210	17210
R^2	0.185	0.187	0.182	0.184

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses.

observation: households do not extrapolate from recent past!

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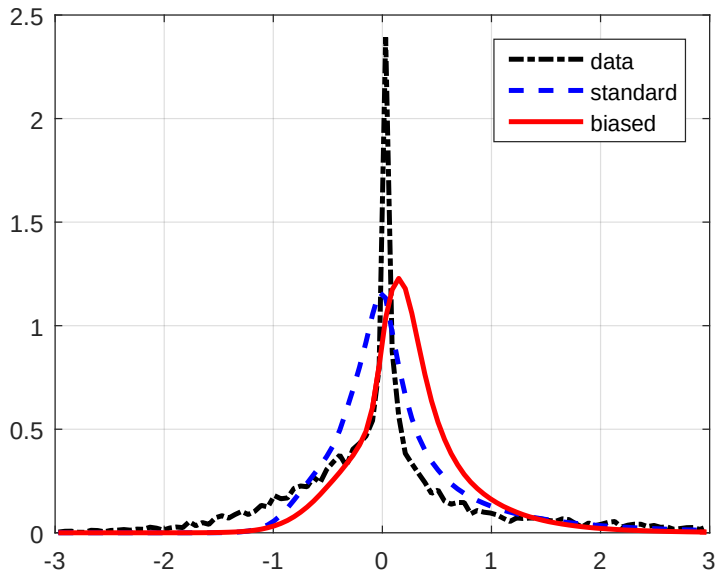
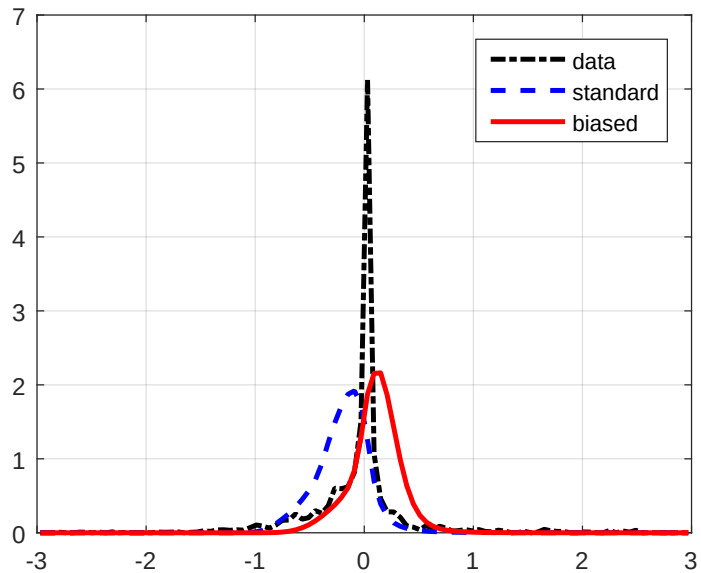
Model Calibrated for Rational Agents

Results

Figure: Liquid savings s by income



(a) aggregate



(b) first quintile

observation: results hold for model calibrated for rational expectations!

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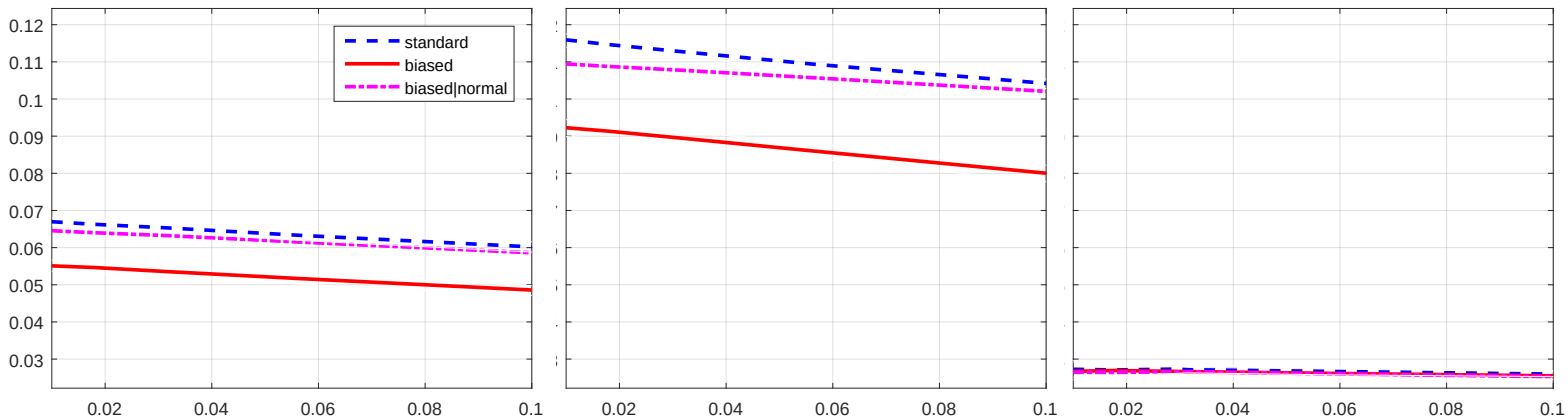
Propensity to Consume

Results

Figure: MPC out of unexpected transfer (non-durable goods)



(a) aggregate (b) first quintile (c) fifth quintile

observation: results hold for model calibrated for rational expectations!

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Preferences parameters

Calibration

5 parameters left: $\Omega = \{\beta, \gamma, \theta, \xi, \bar{d}\}$

$$\Omega = \arg\min \sum_{X} \left(\sum_{i}^{\bar{i}_X} |q_i(X) - \tilde{q}_i(X)| \right)$$

Table: Model fit

		quantile							mode
		0.05	0.10	0.25	0.50	0.75	0.80	0.90	
liquid assets	data	-1.29	-0.88	-0.30	0.03	0.76	1.36	5.46	-0.02
	model	-1.04	-0.79	-0.37	-0.05	0.10	0.14	0.25	0.01
durables	data	0.13	0.20	0.39	0.79	1.43	1.62	2.21	0.23
	model	0.24	0.30	0.44	0.72	1.16	1.29	1.65	0.40

Note: Selected moments generated by the model compared to Survey of Consumer Finances.

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