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:

- construct expectation errors on individual household level
- systematic bias: current income predicts expectation error - households overestimate persistence

▸ literature

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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

  $\Rightarrow$ overpersistence bias: model can fit joint distribution of income and liquid assets!

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  $\Rightarrow$ overpersistence bias: model can fit joint distribution of income and liquid assets!

3) aggregate implications:

- MPC of low income households lower under biased expectations

  $\Rightarrow$ fiscal transfers less effective!

▸ literature

Roadmap

1) Household Expectations in Micro Data
   (a) Data & Interview time structure
   (b) Expectation Errors in the Cross-Section: Overpersistence
   (c) Expectation about Aggregates

2) Model
   (a) Income process and Expectations errors
   (b) Consumption

3) Results
   (a) Distributions by Income Group
   (b) MPC and effectiveness of transfer policies
   (c) Alternative Borrowing Constraints

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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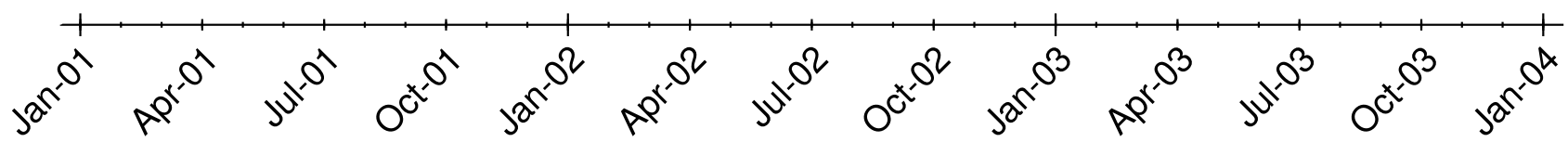
Forecast Errors:

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

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

Interview time structure: Ideal

Data



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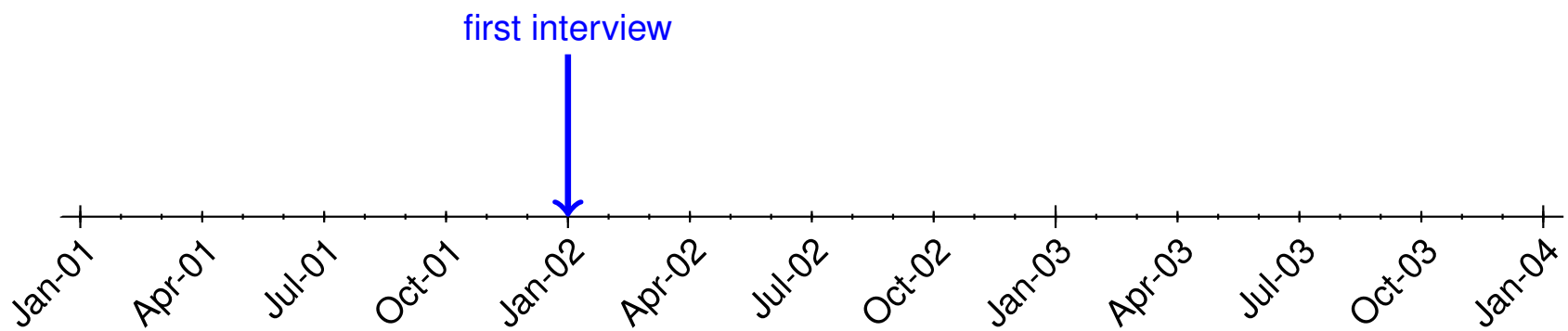

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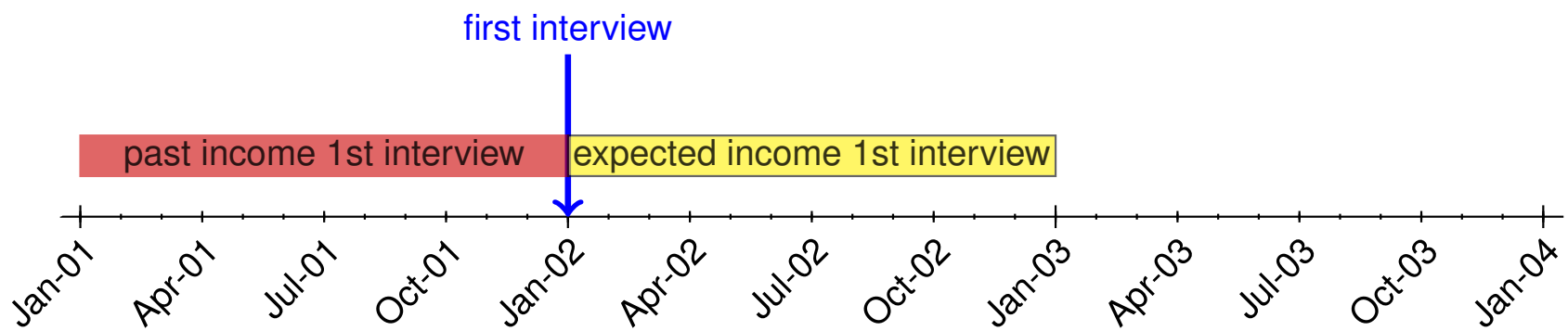

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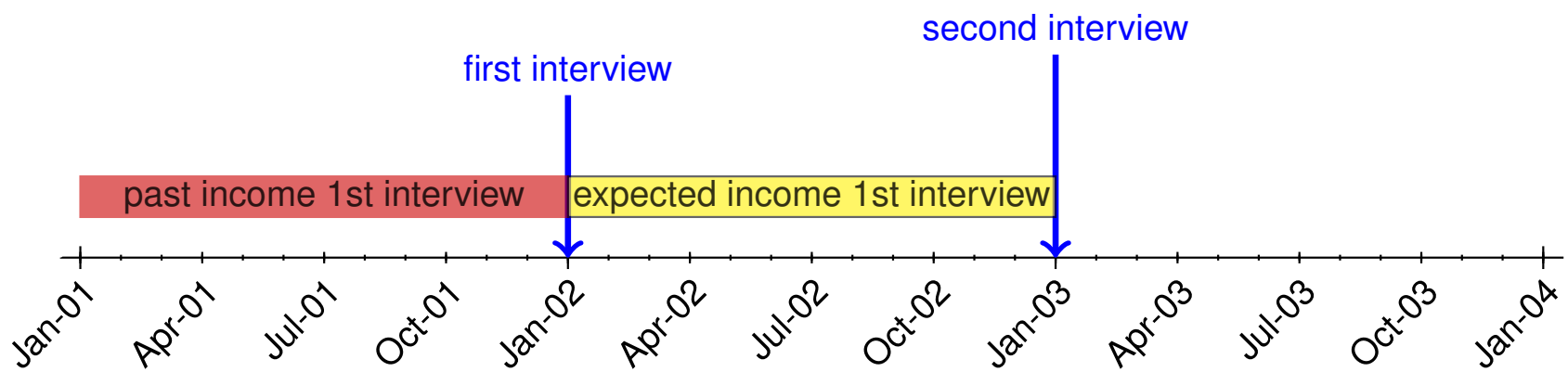

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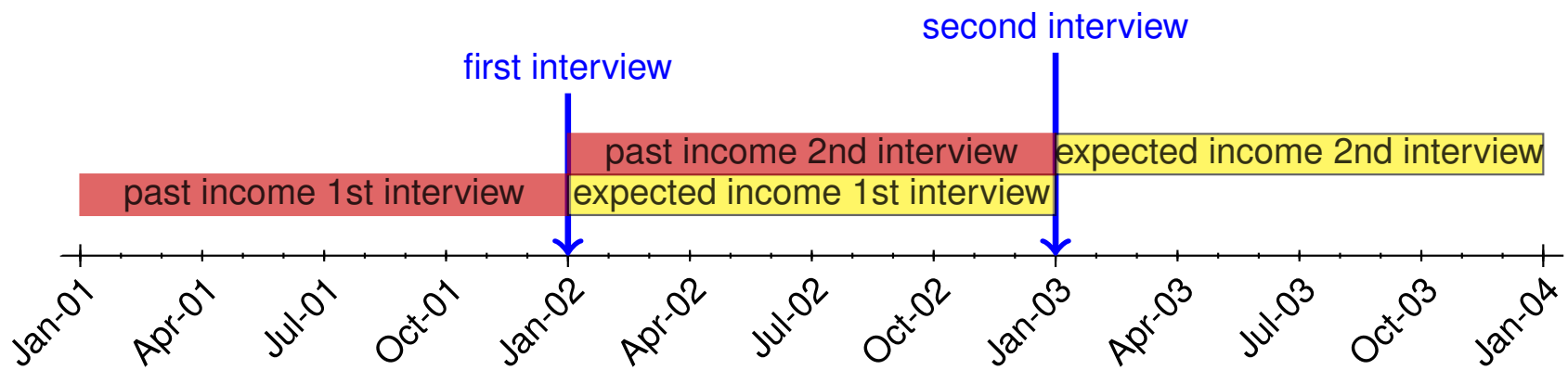
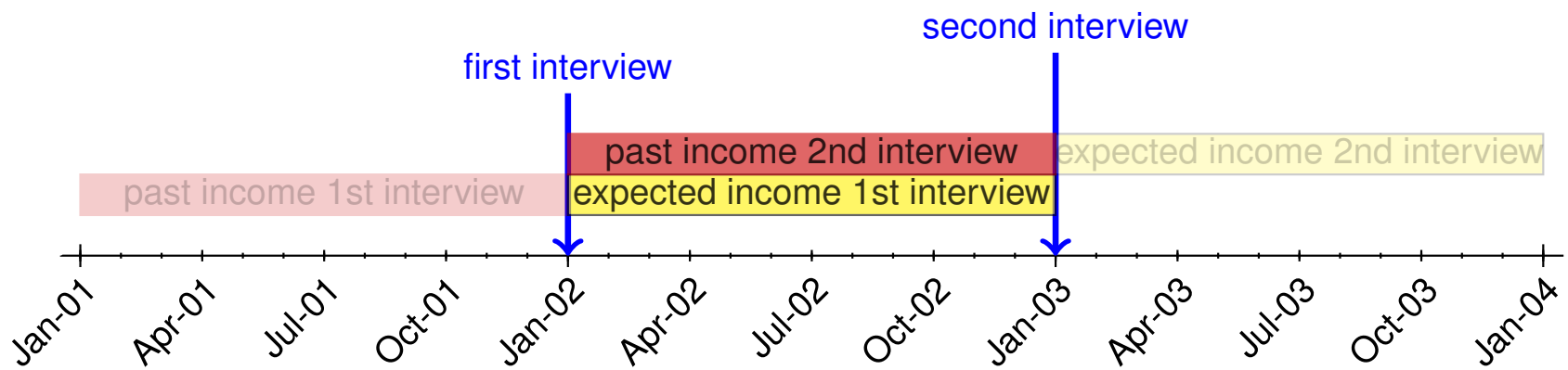


Interview time structure: Ideal

- First interview: January 2002
- Perfect overlap of expected and realised g:

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



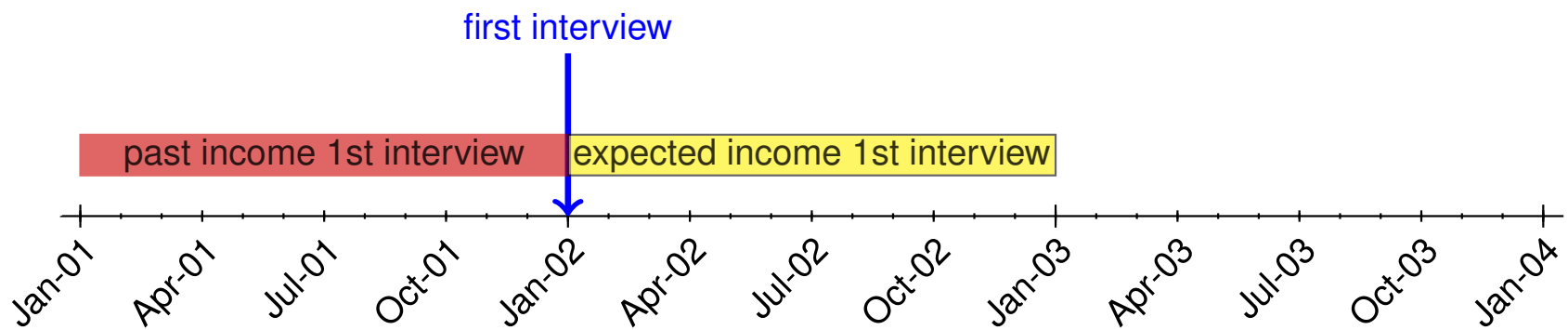
Interview time structure

- Aim: compare expectation with realization
- Challenge:
  - 6 months between interviews
  - time structure of expectations vs realizations
    - expectations: expected income growth in **next 12 months**
    - income realization: total household income in last **calendar year**

Interview time structure: Reality

Two problems:

First interview: January 2002



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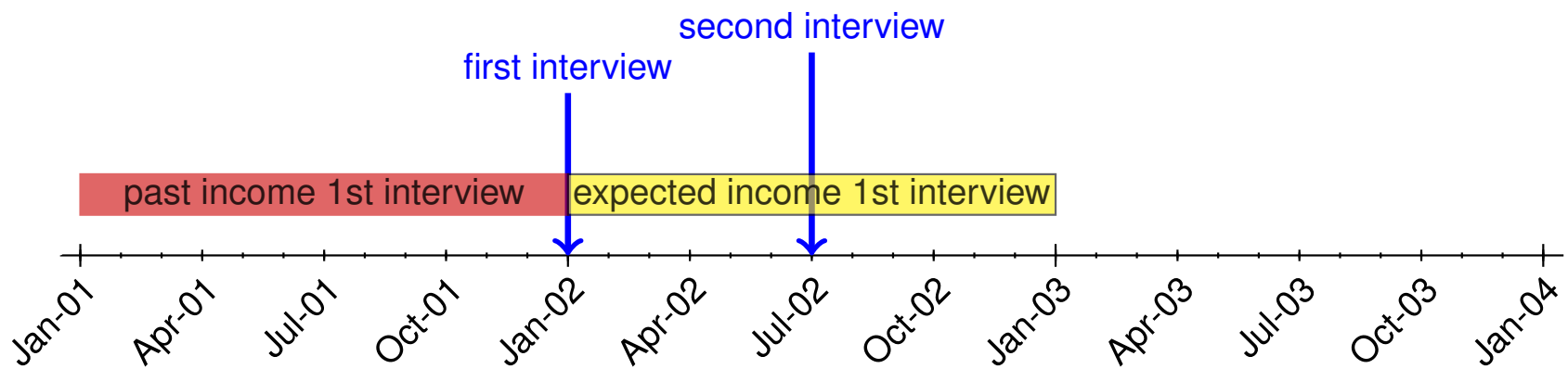

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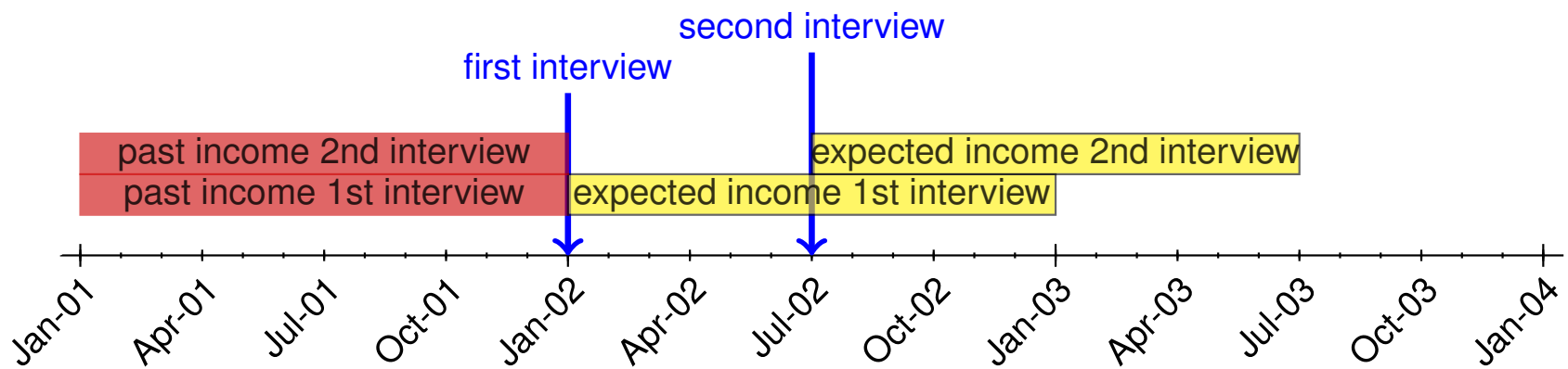

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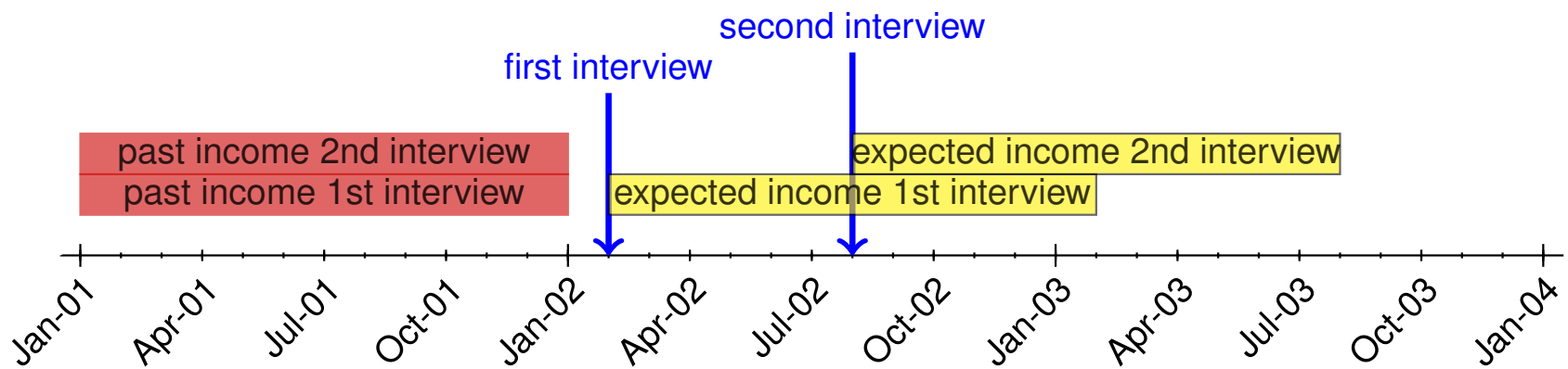
First interview: February 2002



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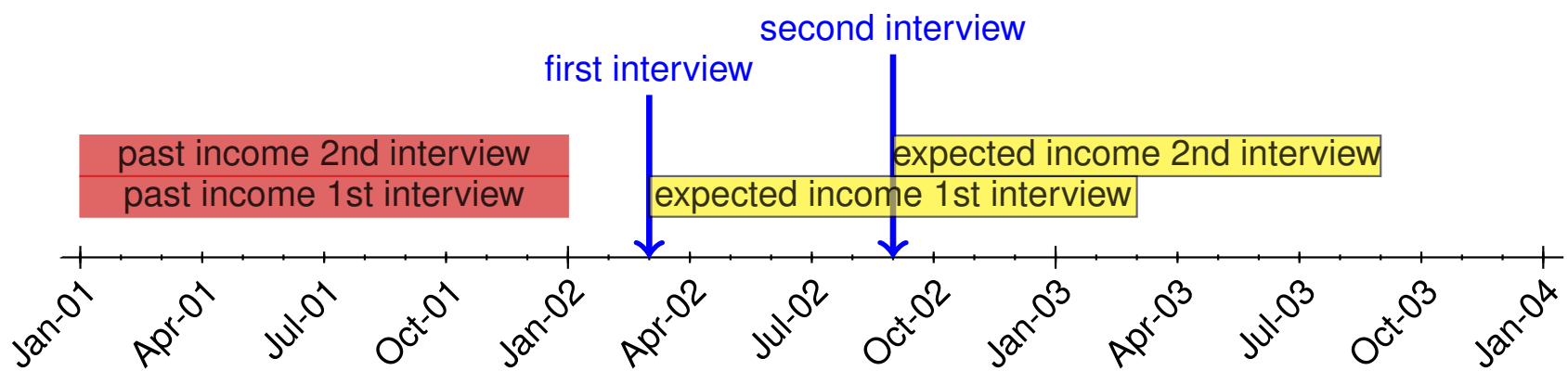
First interview: March 2002



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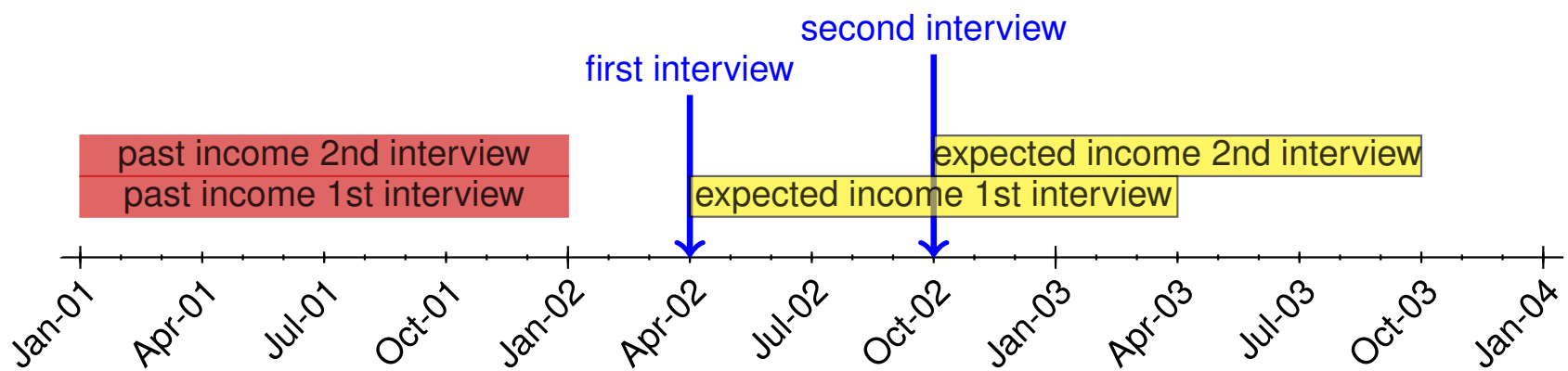
First interview: April 2002



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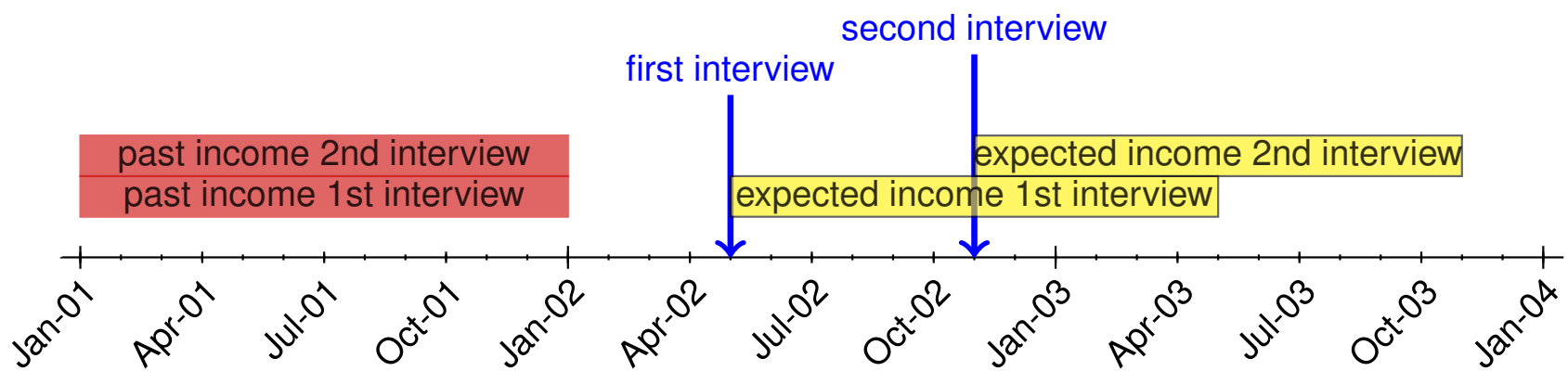
First interview: May 2002



Interview time structure: Reality

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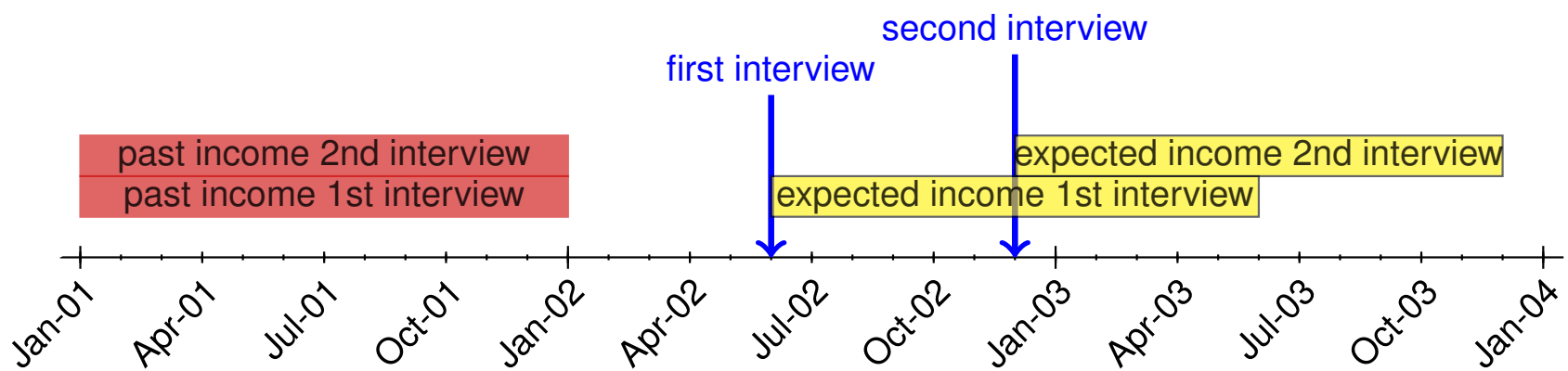
First interview: June 2002



Interview time structure: Reality

Two problems:

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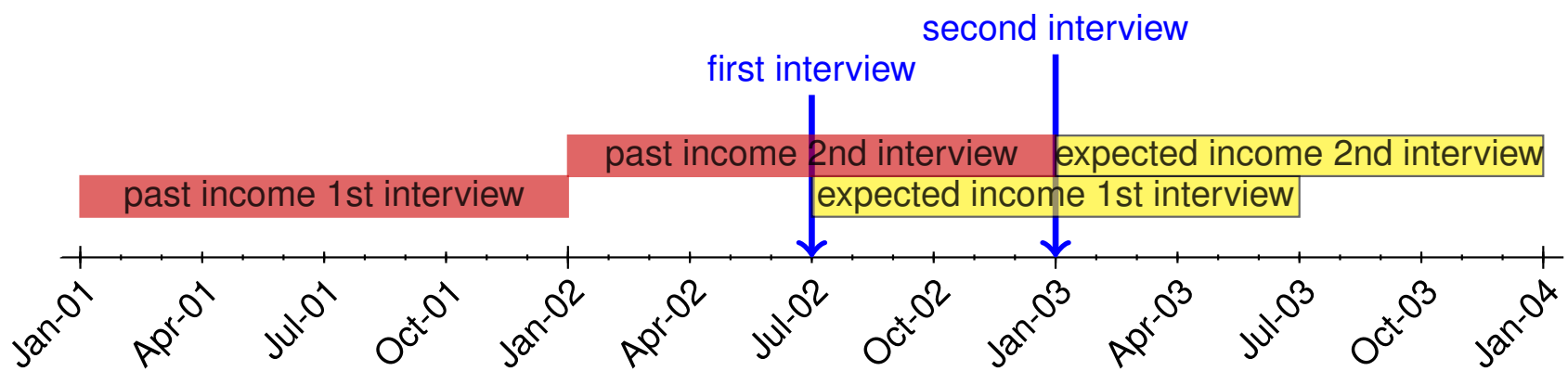
First interview: July 2002



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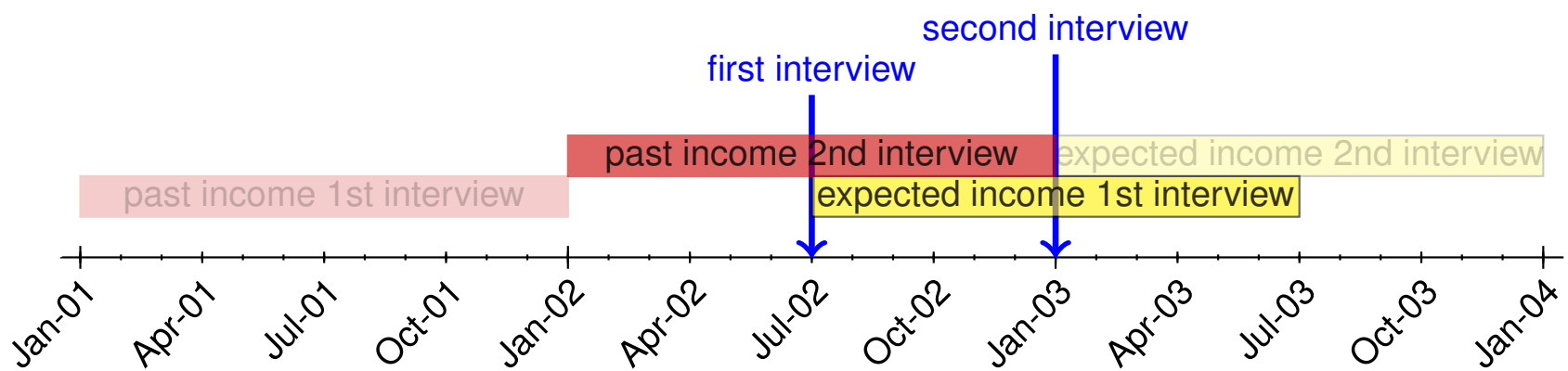
First interview: July 2002

(partial) overlap! ... ☺ (results coming)



Interview time structure: Reality

Two problems:

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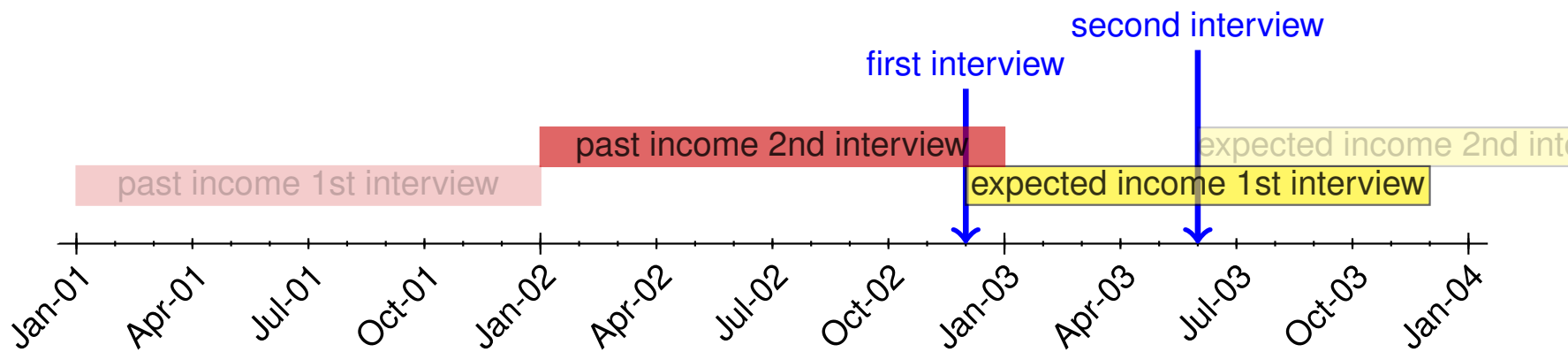
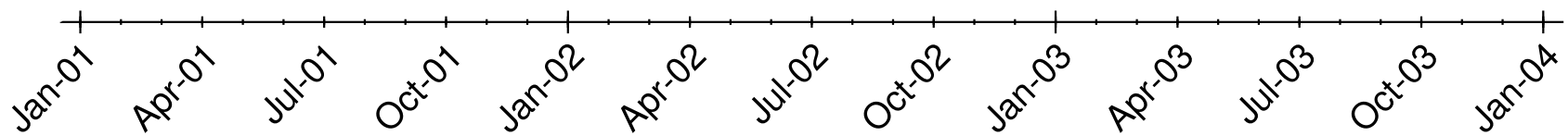
First interview: December 2002

Reality strikes back! ... ☹



Interview time structure: Imputation

Use other people to impute missing income information
First interview in second half of year $\rightarrow$ two years of income data



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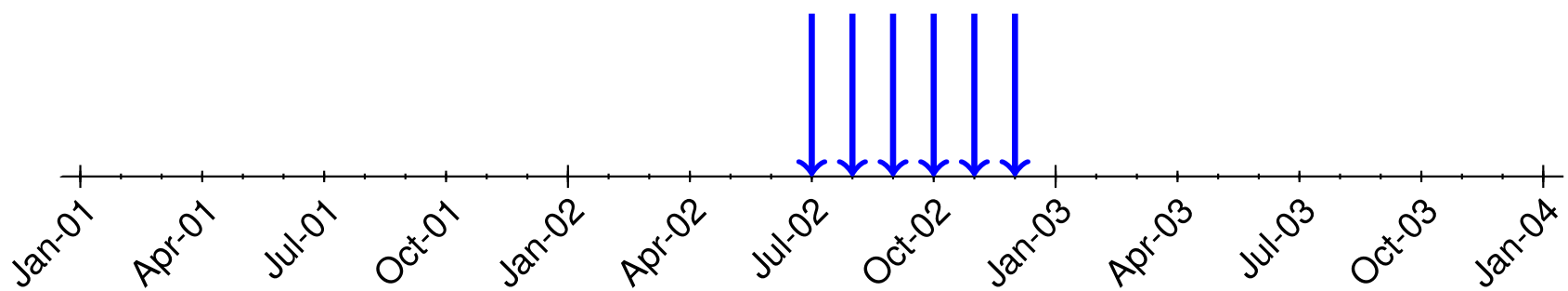

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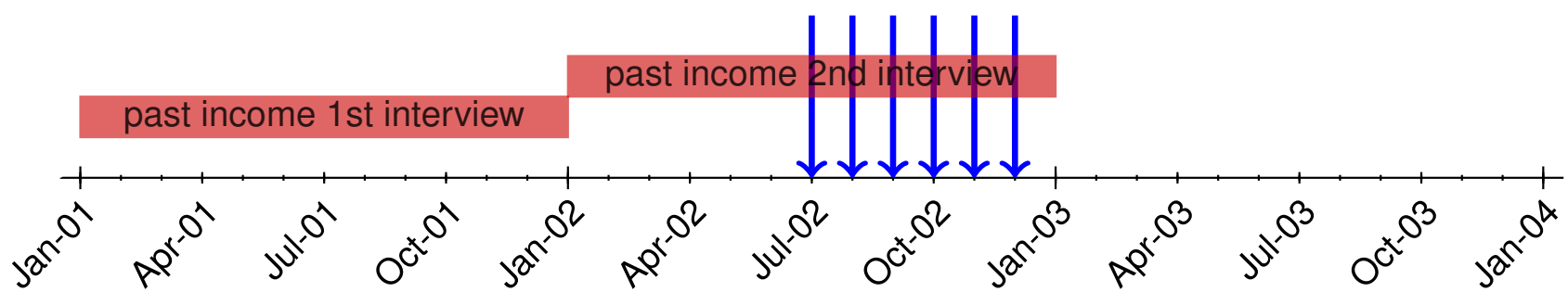

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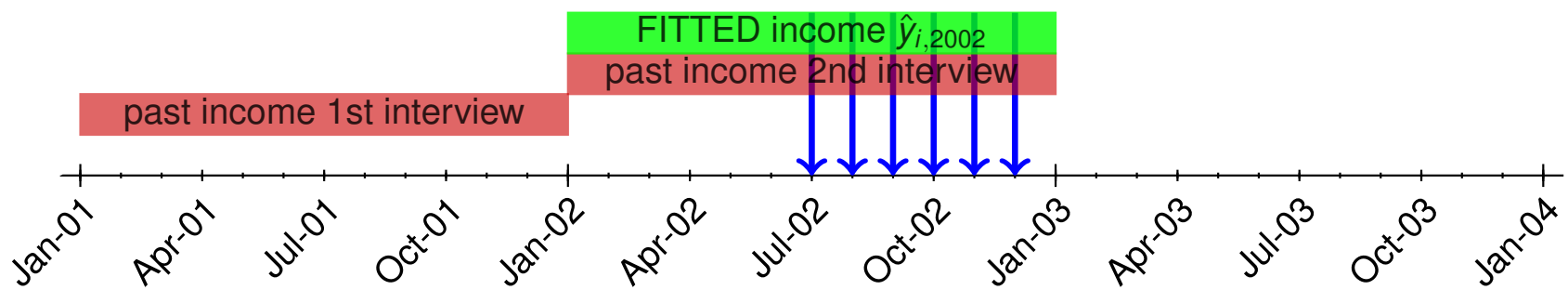

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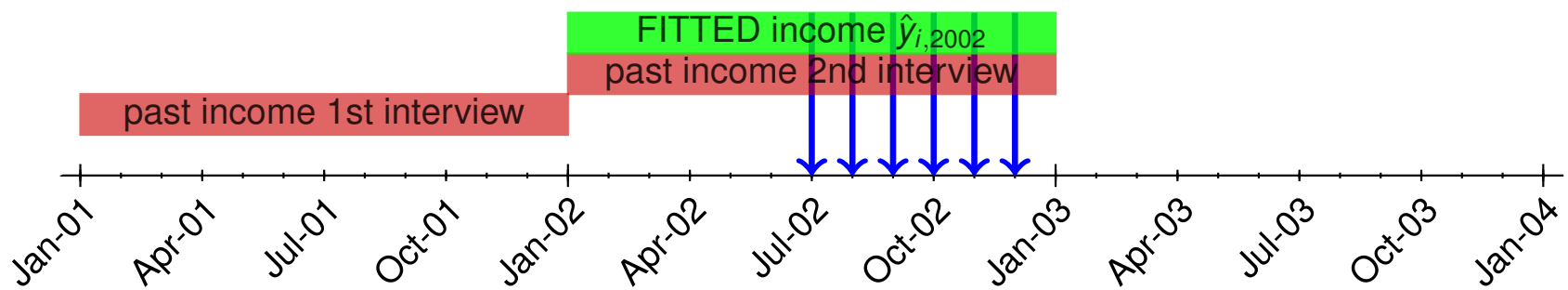

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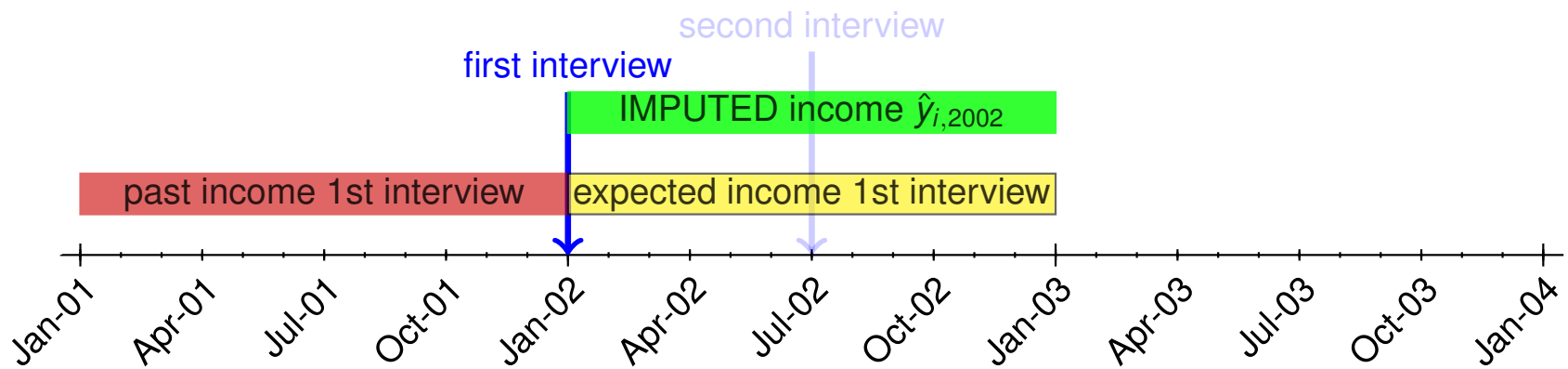
Use this to impute income realizations:

- Best case: (first interview in) January - perfect overlap



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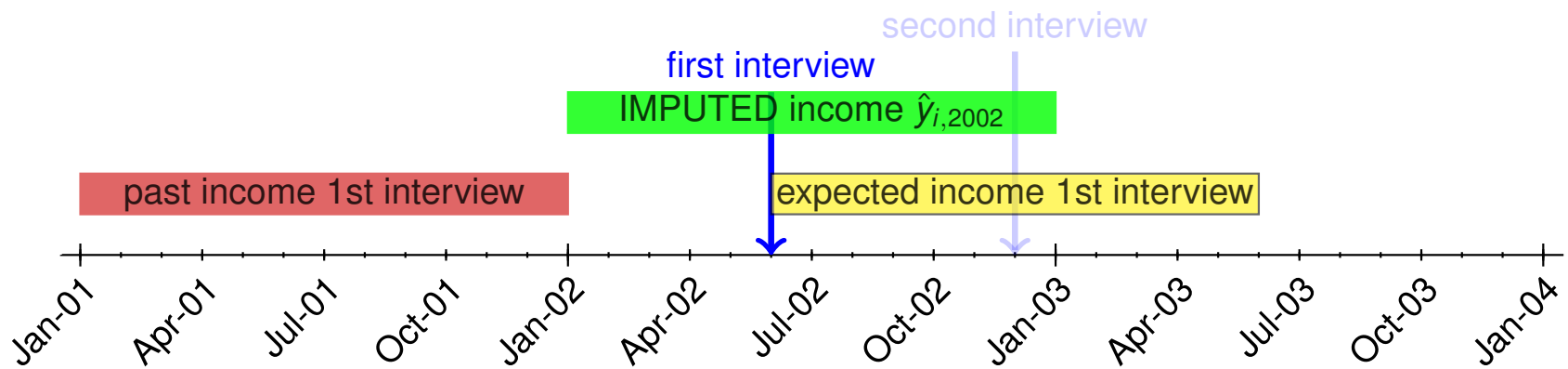
Use this to impute income realizations:

- Best case: January - perfect overlap
- Worst case: June - 7/12 overlapping



Interview time structure: Robustness

Specifications:

- baseline: realizations imputed, all months

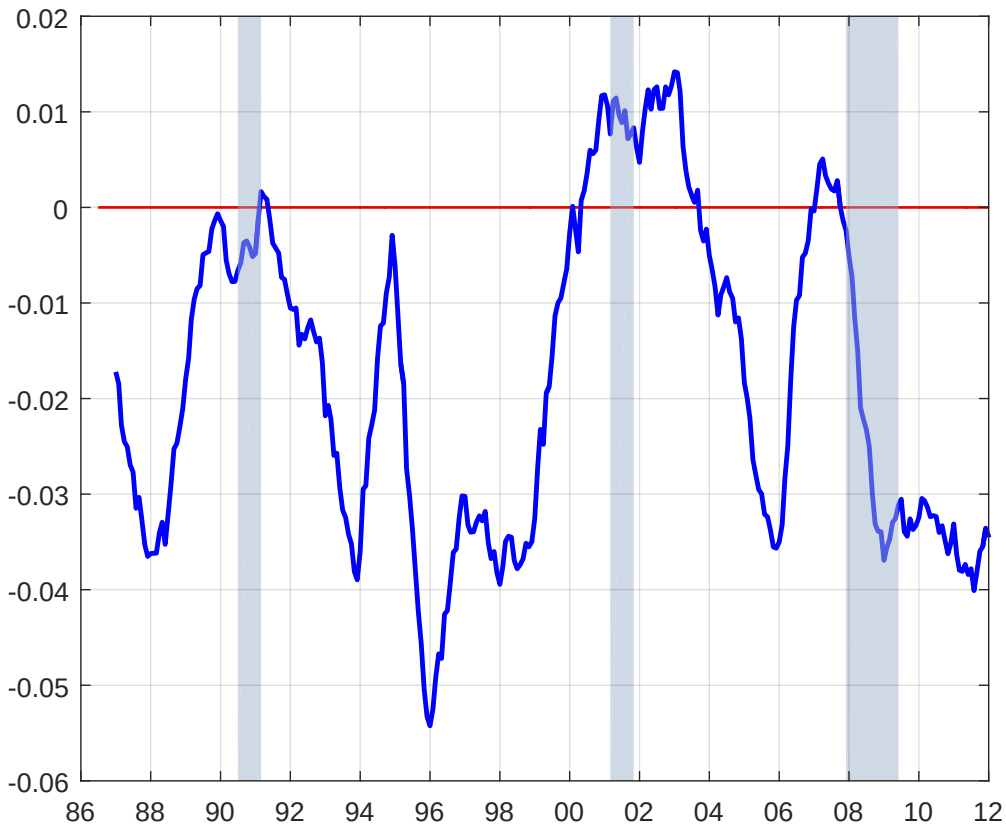
  $\rightarrow$ advantage:
  - increases overlap
  - maximizes observations

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

▸ imputation & comparison to PSID

Forecast Errors in Real Income Growth

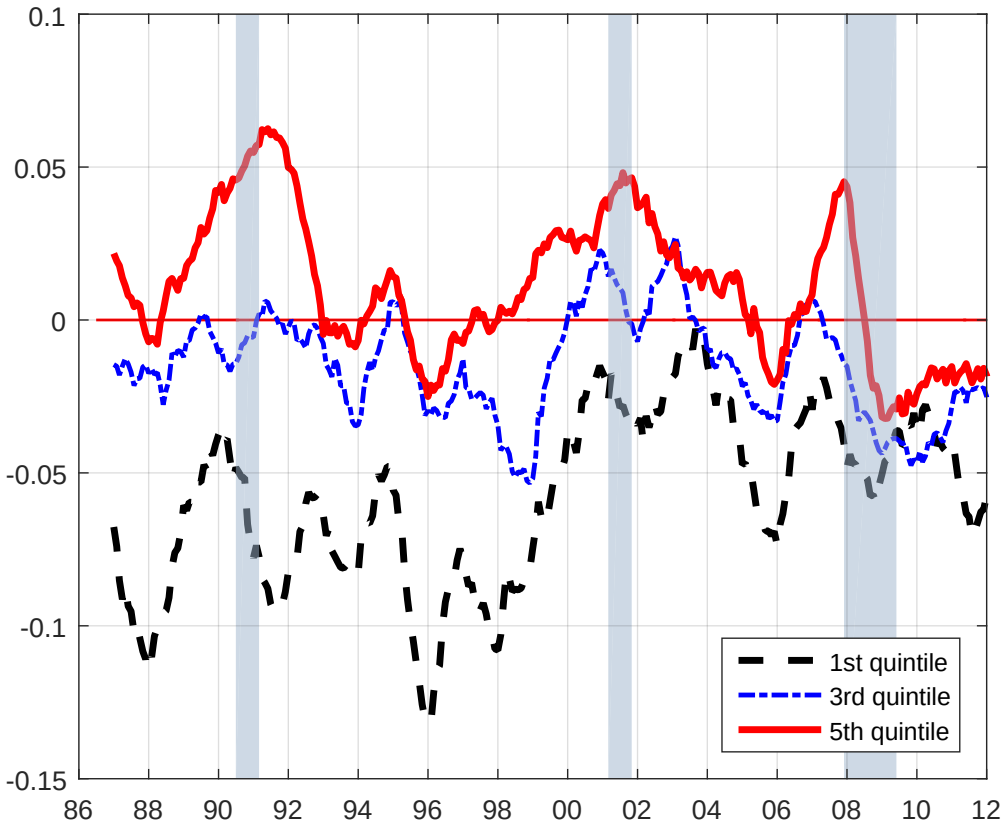
Figure: Mean forecast error



▸ construction

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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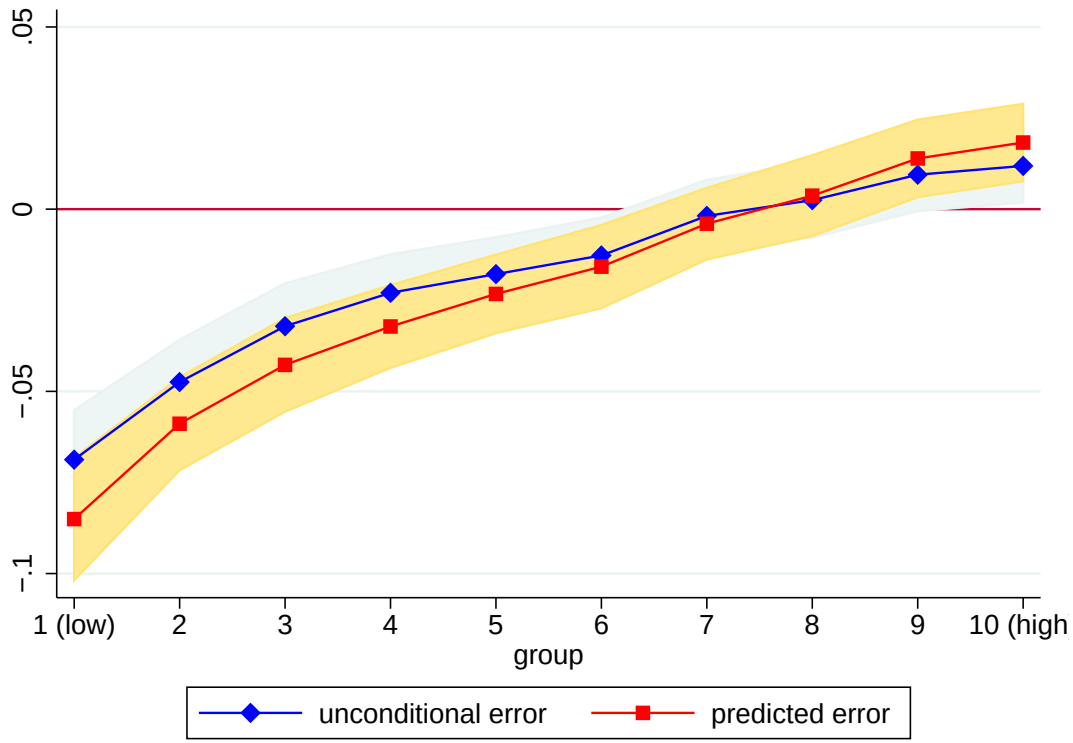
1 (low)	−0.052***	−0.046**	−0.075***	−0.049***	0.004***
	(0.006)	(0.018)	(0.021)	(0.007)	(0.000)
2	−0.018***	−0.013	−0.038*	−0.016***	0.002***
	(0.006)	(0.017)	(0.020)	(0.006)	(0.000)
4	0.019***	0.026*	0.025	0.018***	−0.002***
	(0.005)	(0.013)	(0.016)	(0.005)	(0.000)
5 (high)	0.035***	0.046***	0.067***	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

Forecast Errors in Real Income Growth

Figure: Mean forecast errors by income



→ robust to controlling for household characteristics!

Overpersistence Bias

Mechanism

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 $P_{it} < \bar{P}$

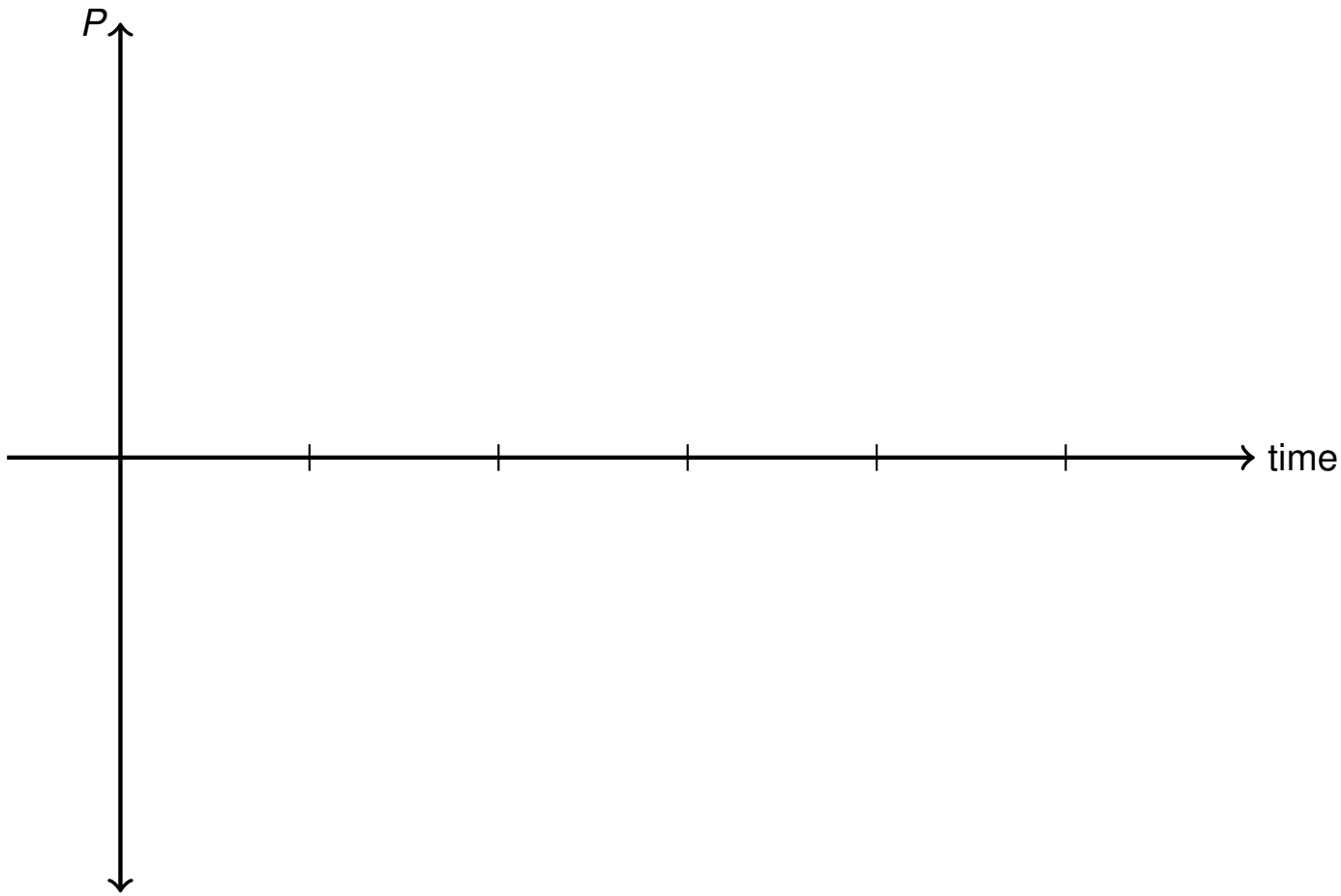
(b) *let* $\Delta_{it} \equiv P_{it} - \bar{P}$*, then*

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

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

Overpersistence Bias

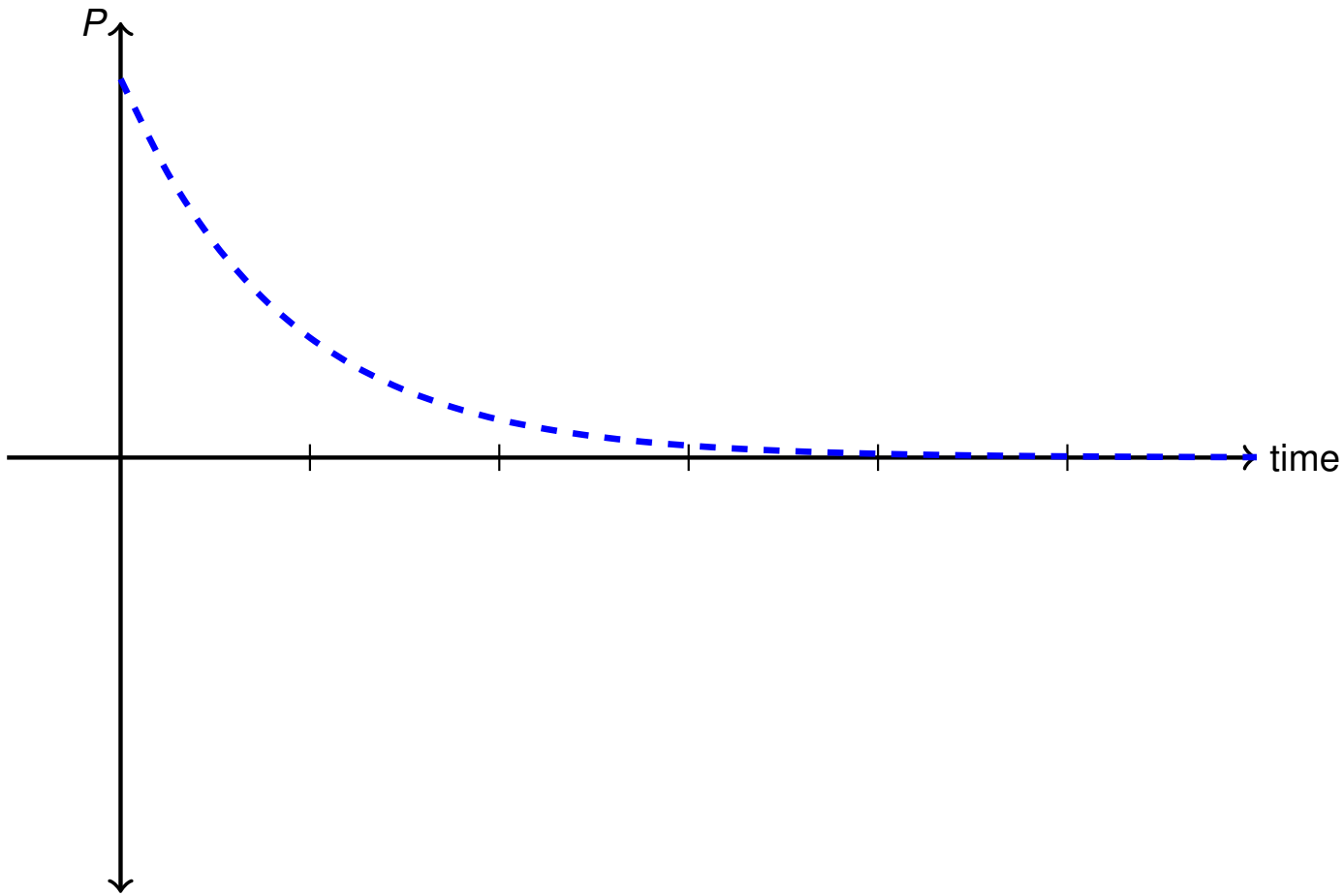
Intuition



Overpersistence Bias

Intuition

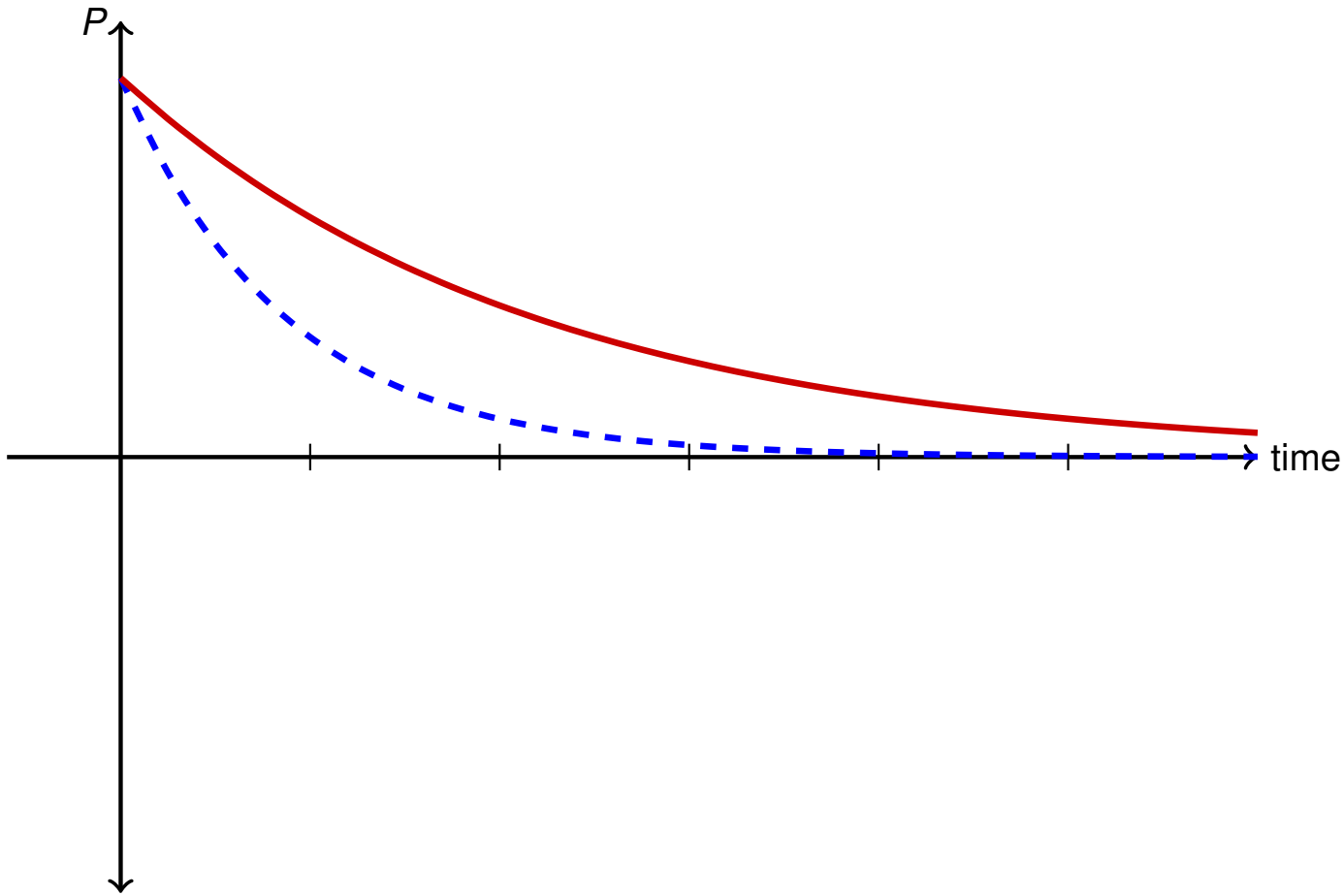
Persistent shocks decay over time
example AR(1): $P_{t+1} = \rho P_t + \varepsilon_{t+1}$



Overpersistence Bias

Intuition

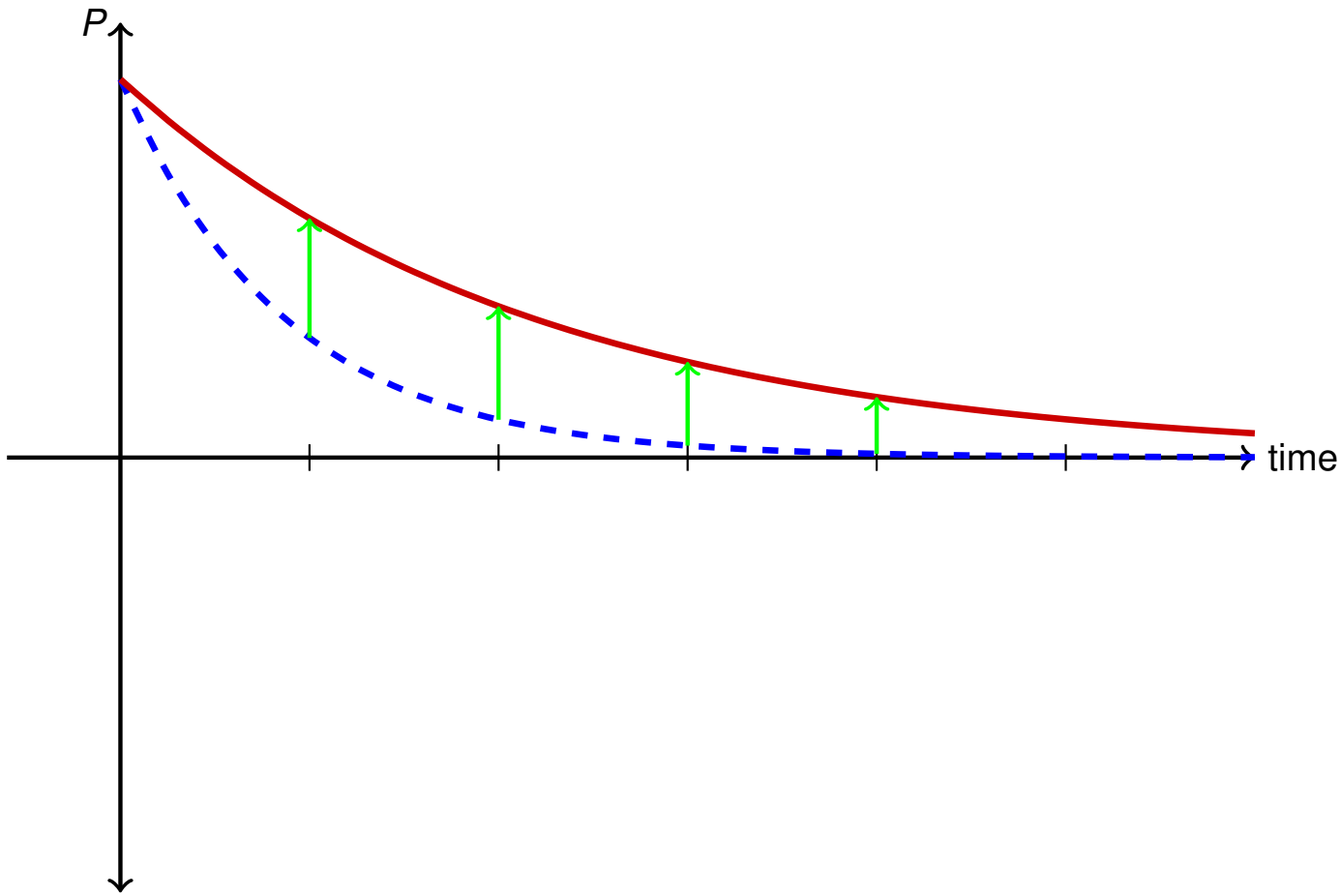
Persistent shocks decay over time
more persistence (larger ρ) $\rightarrow$ slower decay



Overpersistence Bias

Intuition

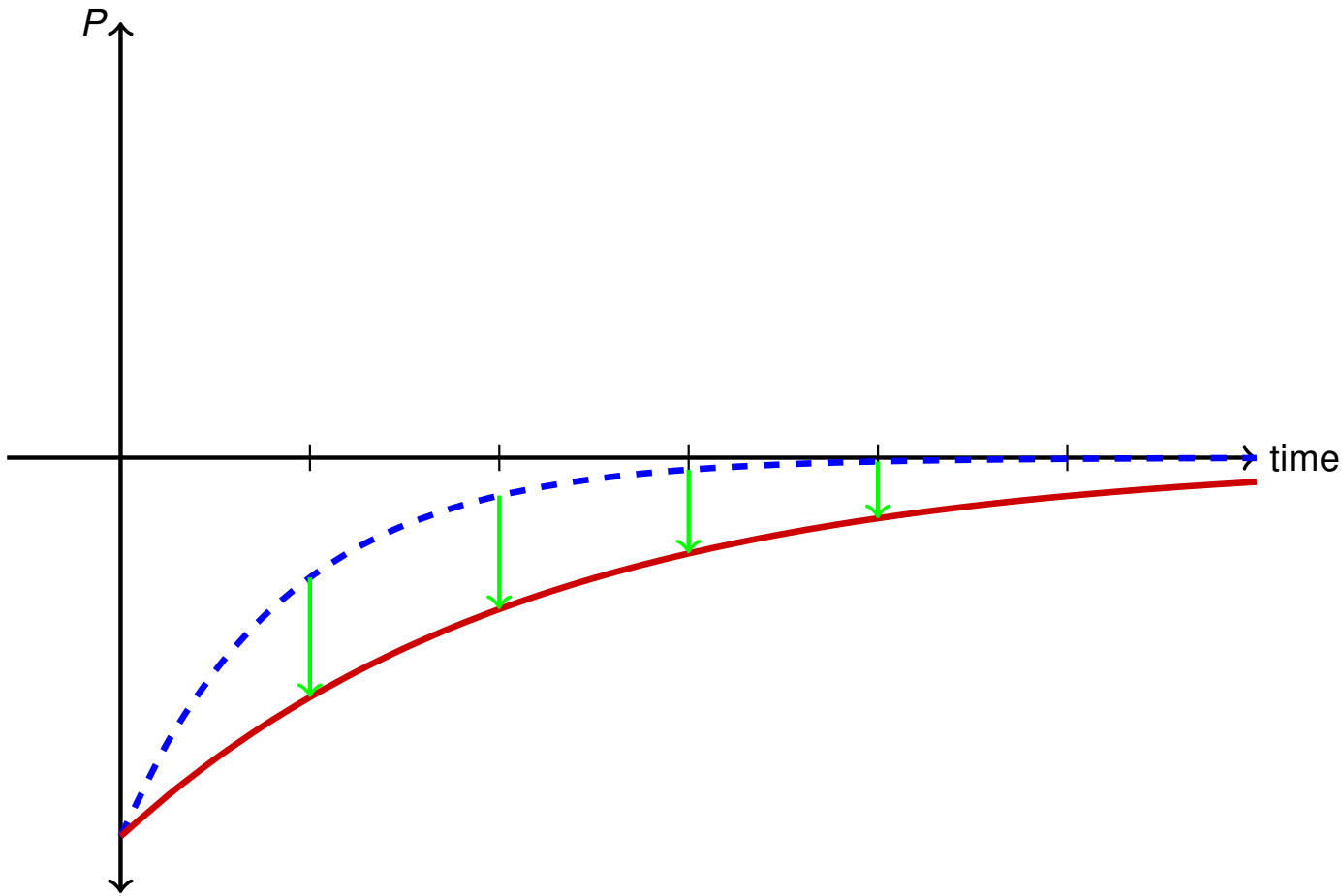
Persistent shocks decay over time
more persistence (larger ρ) $\rightarrow$ slower decay
$\Rightarrow$ good shocks $\rightarrow$ optimism



Overpersistence Bias

Intuition

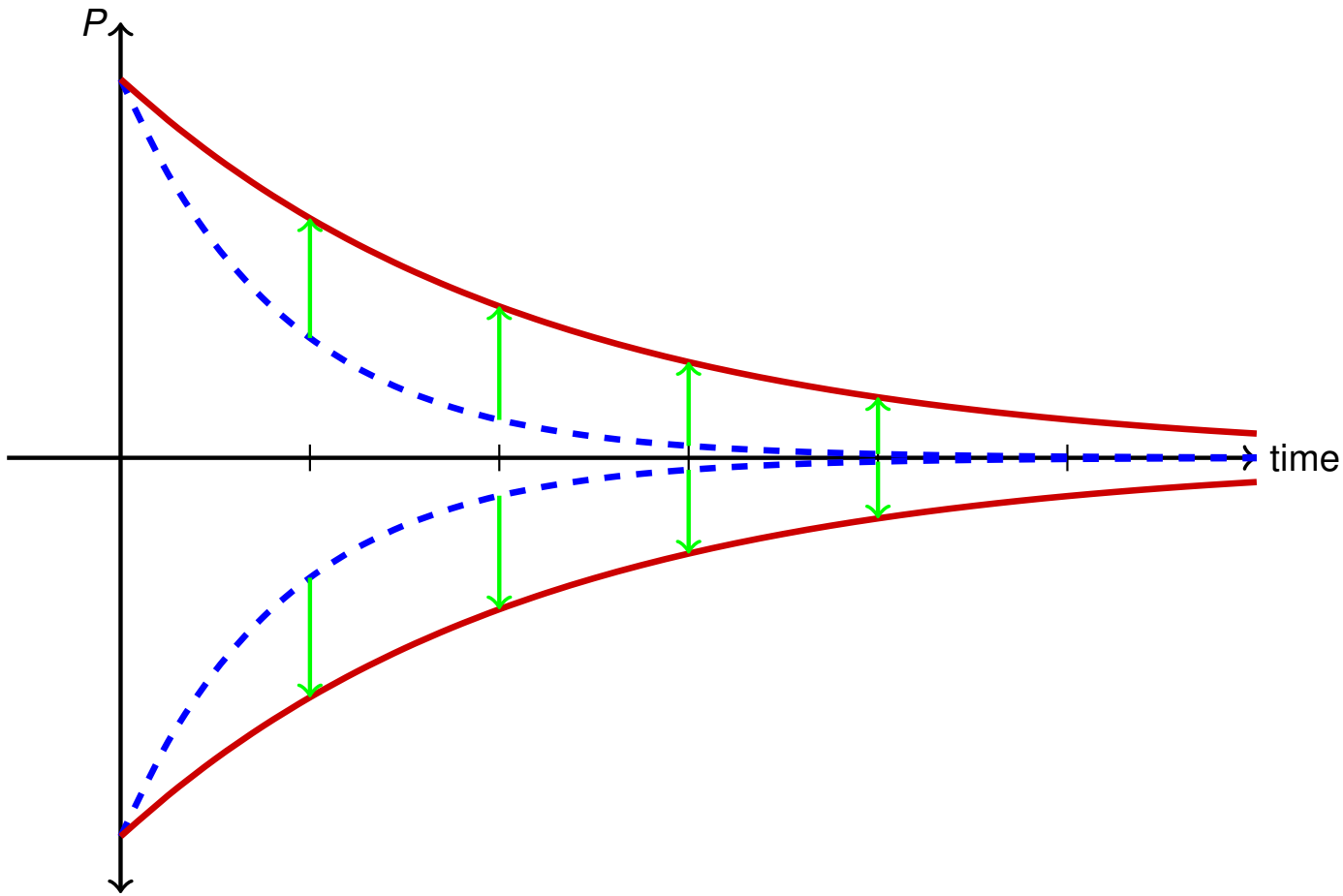
Persistent shocks decay over time
more persistence (larger ρ) $\rightarrow$ slower decay
$\Rightarrow$ bad shocks $\rightarrow$ pessimism



Overpersistence Bias

Intuition

Persistent shocks decay over time
more persistence (larger ρ) $\rightarrow$ slower decay
$\Rightarrow$ one parameter $\rightarrow$ heterogenous error sign

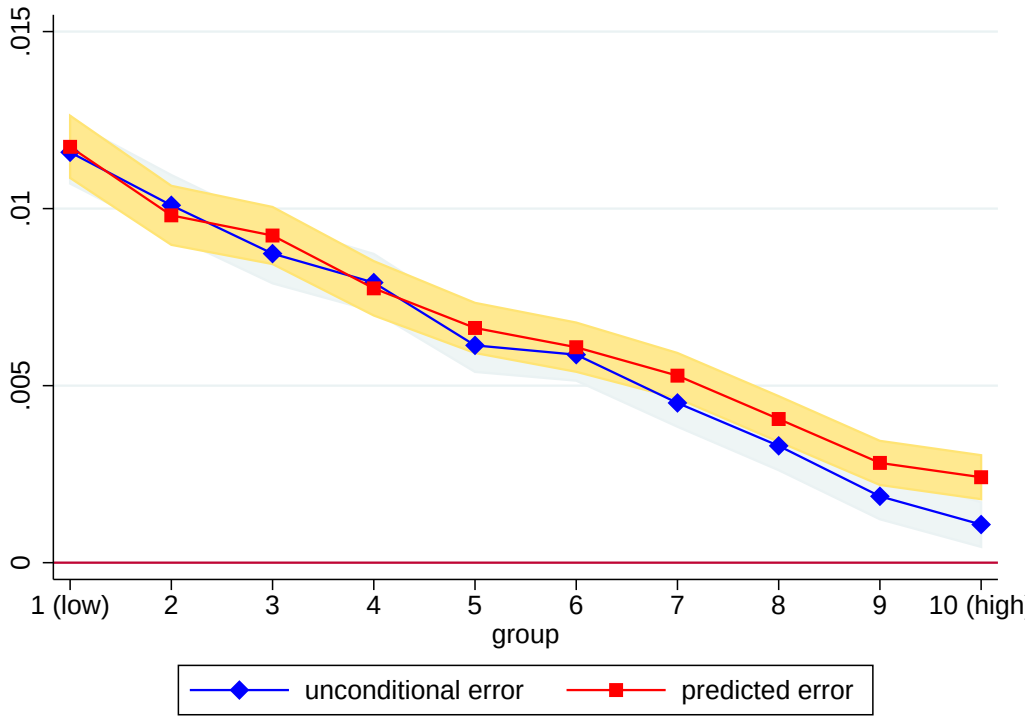


▸ alternative mechanisms (not consistent)

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

Modeling income and expectations

Income process

Model

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

Income process

Model

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

- 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

Model

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

- persistent idiosyncratic shock:

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

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

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

- persistent aggregate state:

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

Aggregate Pessimism:

$$\hat{Z}_{t+1|t} = \mu \cdot \mathsf{E} Z_{t+1} = \mu \cdot \Pi_Z(Z_t)\mathbb{Z}$$

Parameters of the income process

Calibration

Parameter		Value
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%

ρ, σ_P, σ_T: Storesletten et al. (2004); Berger and Vavra (2015)
Z: NBER recessions vs booms frequencies and average HPF GDP deviation

Replicating forecasting errors

Model

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

Modeling consumption

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

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

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

Household Optimization Problem

Model

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

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

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

Household Optimization Problem

Model

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

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

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

Household Optimization Problem

Model

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

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

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

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

Household Optimization Problem

Model

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

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

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

Parameters of the Environment

Calibration

Parameter		Value
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	0.8
depreciation rate	δ	0.05
adjustment costs	F^d	0.3

▸ details

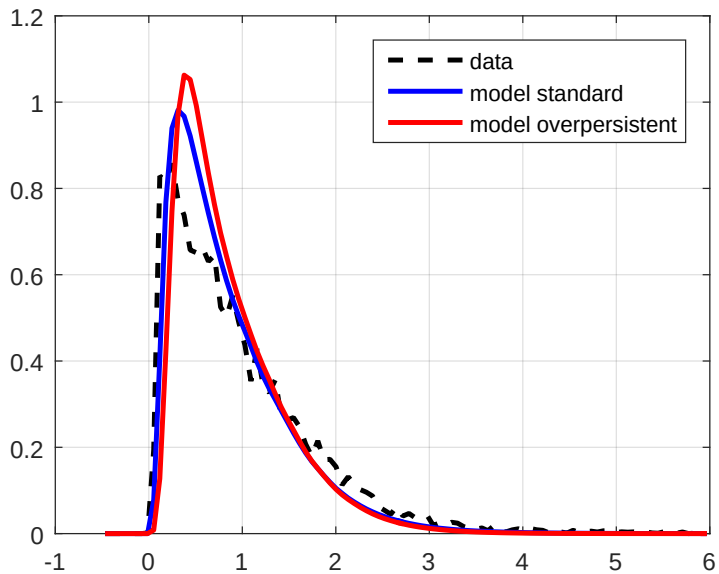
Belief and Preference Parameters

Calibration

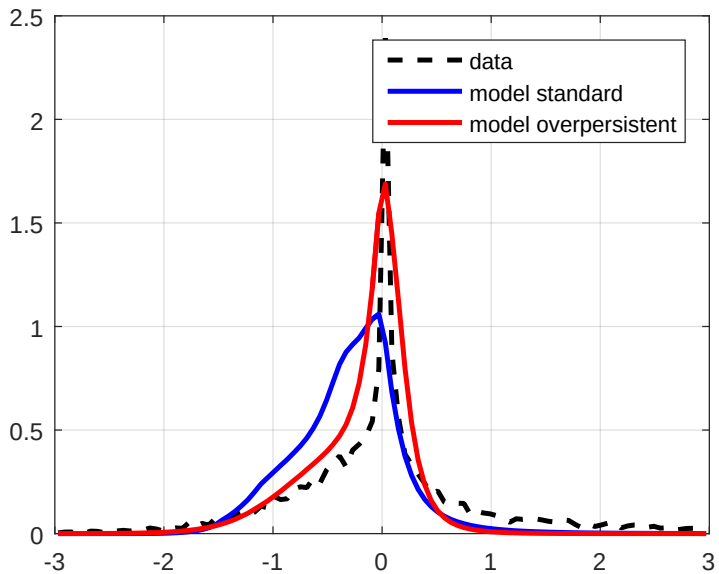
Parameter		Value
beliefs:		
persistence of P	$\hat{\rho}$	0.9831
pessimism	μ	0.9778
preferences:		
discount factor	β	0.9825
risk aversion	γ	1.5
weight of durable goods in utility	θ	0.075
elasticity of substitution in utility	ξ	3
free durable services	$\underline{d}$	0.5

Preferences parameters

Calibration



(a) d, aggregate



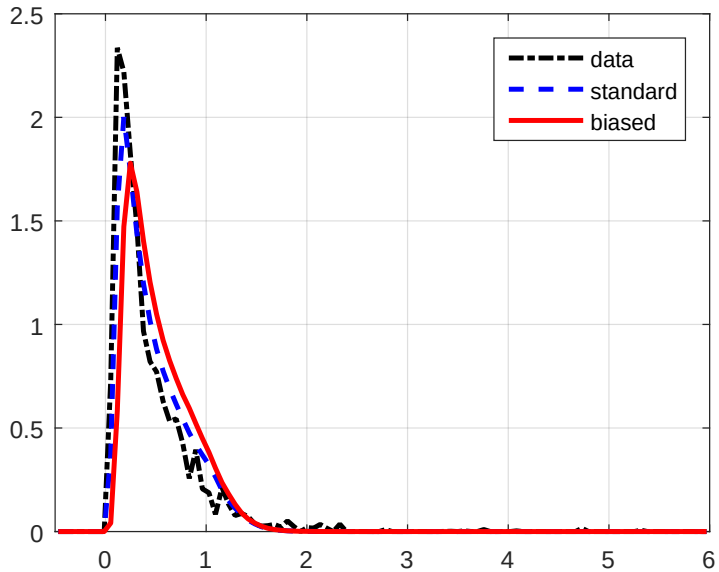
(b) s, aggregate

Results

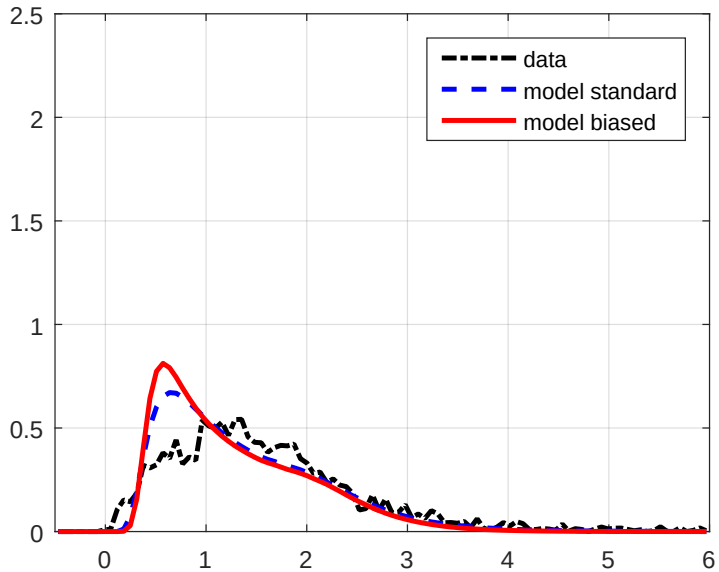
Distribution of durable stock

Results

Figure: Durable stock *d* by income



(a) first quintile



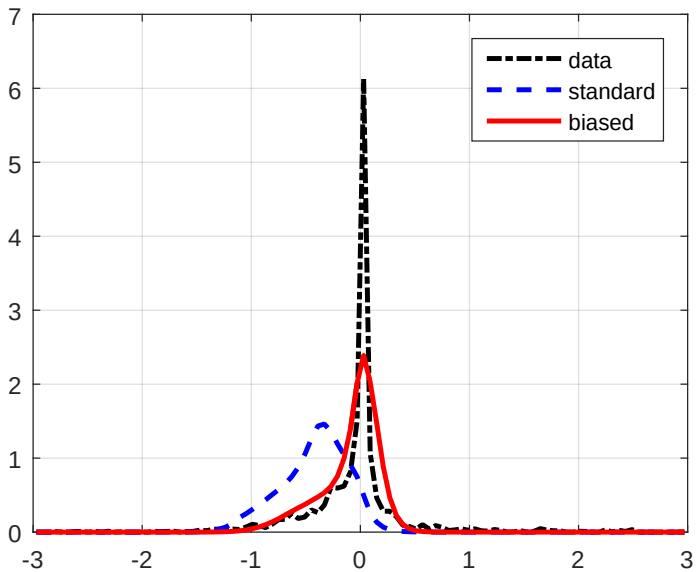
(b) fifth quintile

observation: durables not much affected by bias

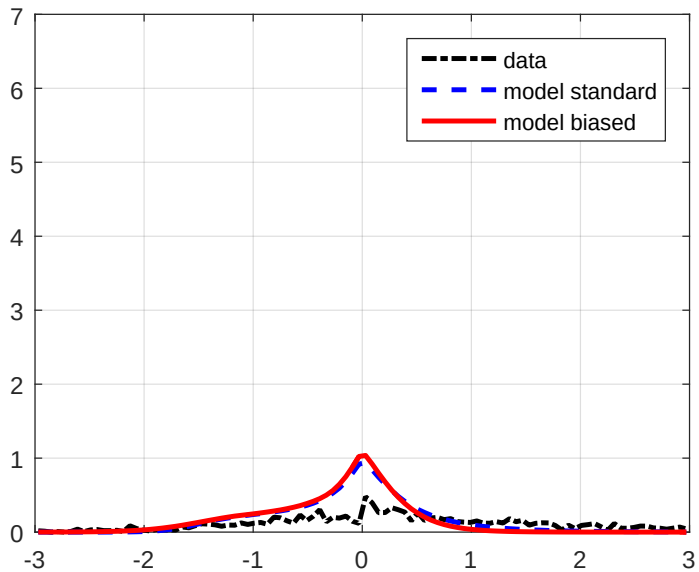
Distribution of liquid savings

Results

Figure: Liquid savings s by income



(a) first quintile



(b) fifth quintile

observation: low income households borrow less

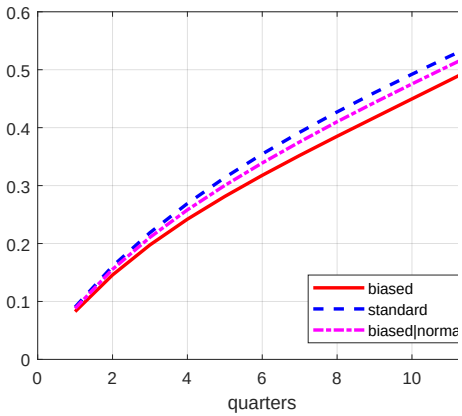
$\rightarrow$ do not borrow even though borrowing constraint not binding!

standard

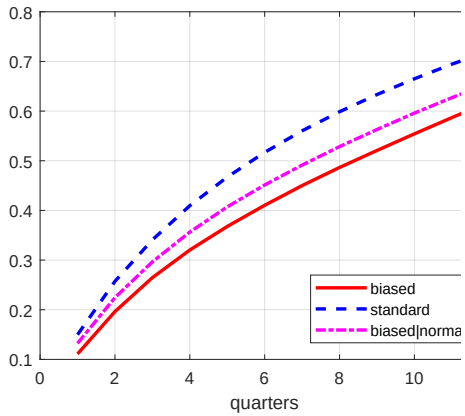
Propensity to Consume

Results

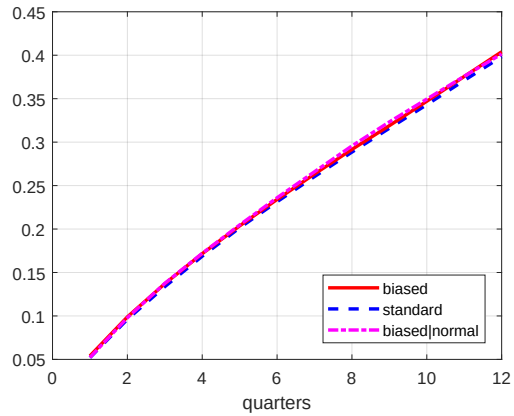
Figure: MPC out of unexpected transfer (non-durable goods)



(a) aggregate



(b) first quintile

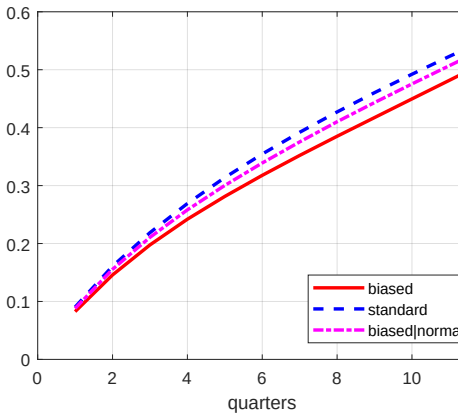


(c) fifth quintile

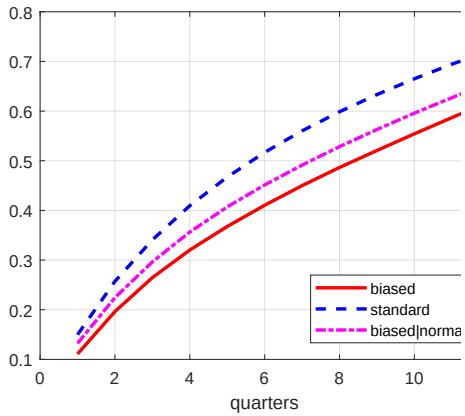
Propensity to Consume

Results

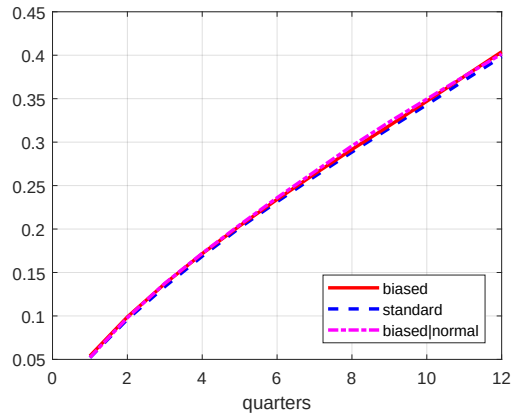
Figure: MPC out of unexpected transfer (non-durable goods)



(a) aggregate



(b) first quintile



(c) fifth quintile

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

Propensity to Consume

Results

	model		data	
	biased beliefs	rational beliefs	stimulus 2001[1]	stimulus 2008[2]
low/high	1.94	2.86	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)

Alternative Borrowing Constraints

overpersistence bias can explain why households don't borrow more

alternative way to avoid large borrowing: tighter borrowing constraints

- benchmark model:

$$s_t \geq -(\kappa_y P_t + \kappa_v d_t)$$

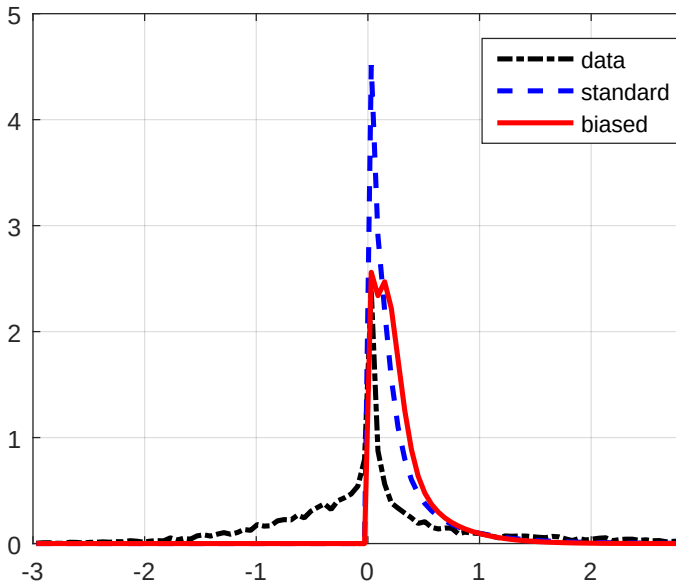
- alternative:

$$s_t \geq -\underline{s}, \qquad \underline{s} \in [0, 4]$$

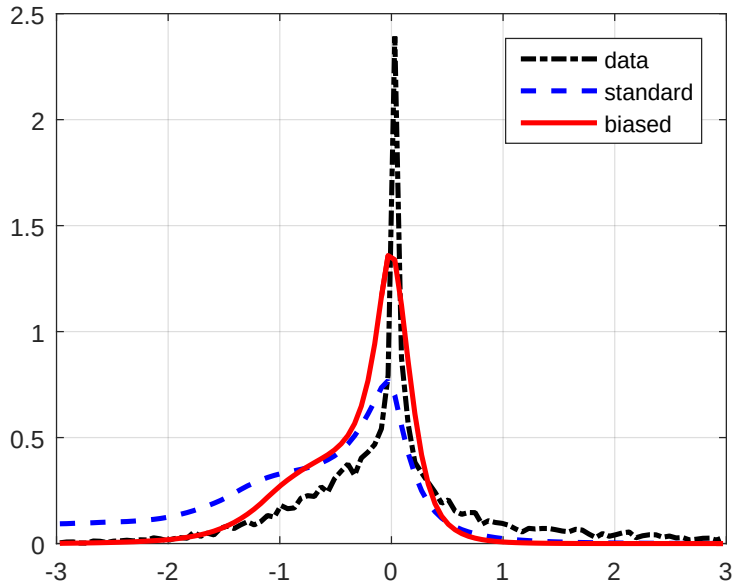
Alternative Borrowing Constraints

Results

Figure: Liquid savings for different borrowing constraints



(a) no borrowing



(b) limit = median annual income

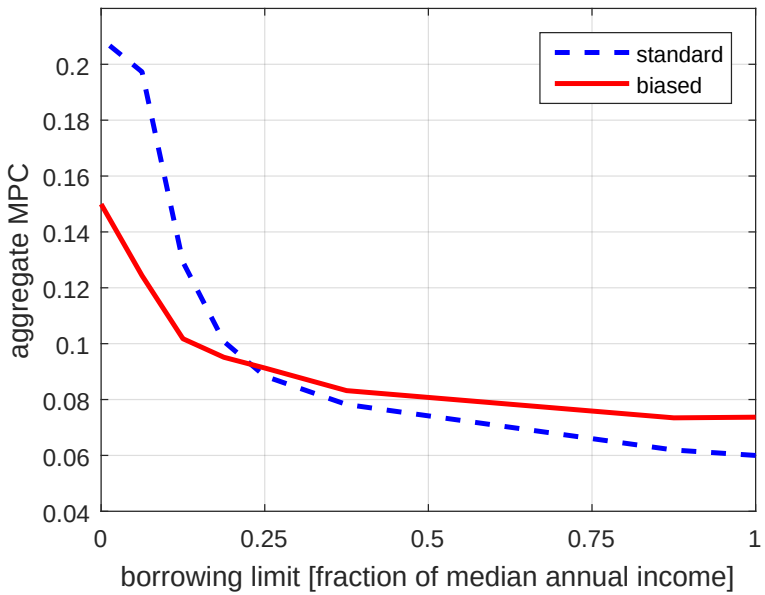
observation:

- tightening the borrowing limit increases share with positive assets
- rational agents especially responsive to borrowing limit

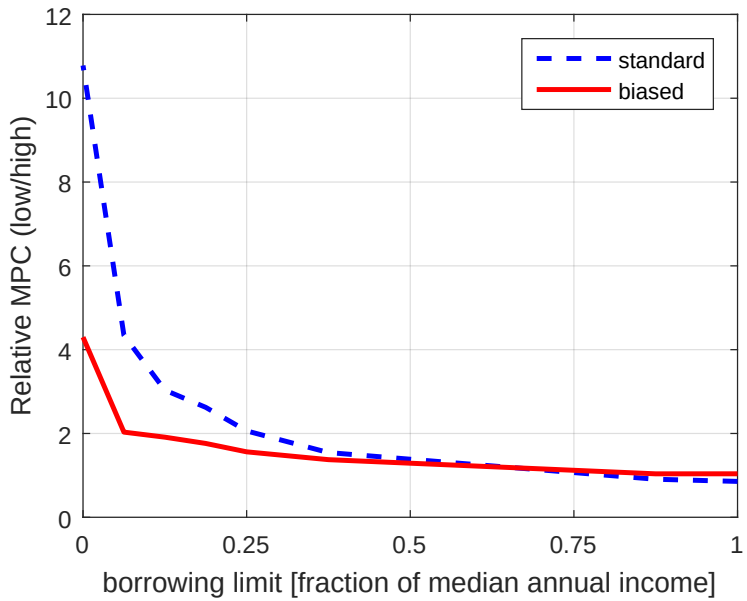
Alternative Borrowing Constraints

Results

Figure: Liquid savings for different borrowing constraints



(a) Aggregate MPC



(b) relative MPC

observation: borrowing limit strongly affects MPC!

$\rightarrow$ choice of mechanism that avoids borrowing is not innocuous!

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

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Literature

Household expectations:

- expectations about aggregates:
  - inflation: Carroll (2003), Andolfatto et al. (2008), Malmendier and Nagel (2015), Coibion et al. (2015) etc.
  - house prices: Gerardi et al. (2008), Piazzesi and Schneider (2009), Case et al. (2012) etc.
  - excess bond returns: Piazzesi et al. (2015)
  - credit spreads: Bordalo et al. (2017)

- individual income expectations:
  Dominitz and Manski (1997), Dominitz (1998), Das and van Soest (1999), Souleles (2004)

Structural models of consumption:

- Kaplan and Violante (2014)
- Berger and Vavra (2015)

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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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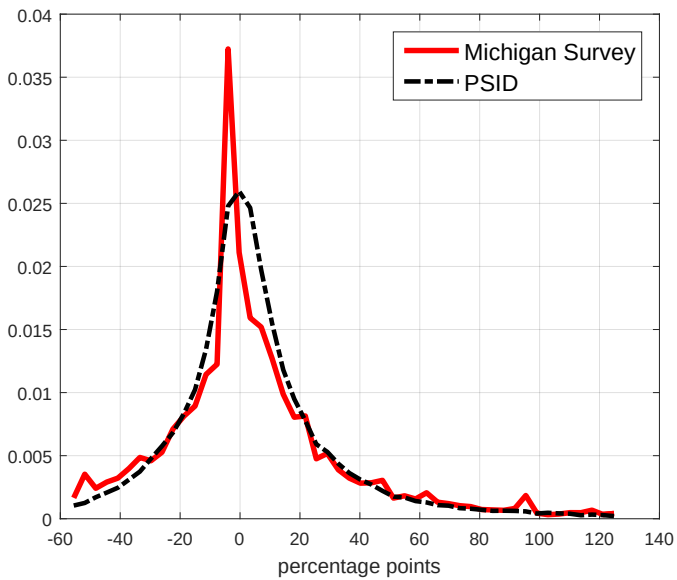
Imputation & Comparison to PSID

Table: Distribution of reported income changes and imputed values

	mean	p5	p25	p50	p75	p95
directly reported	0.034	-0.378	-0.097	-0.015	0.133	0.572
imputed	0.032	-0.365	-0.103	-0.016	0.130	0.577



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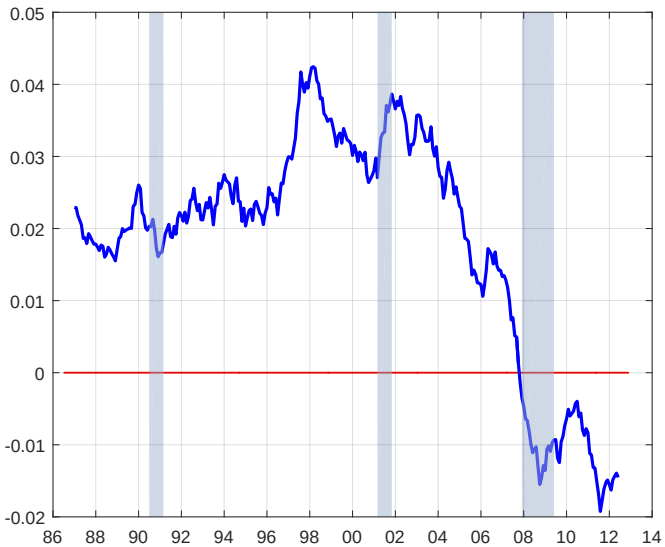
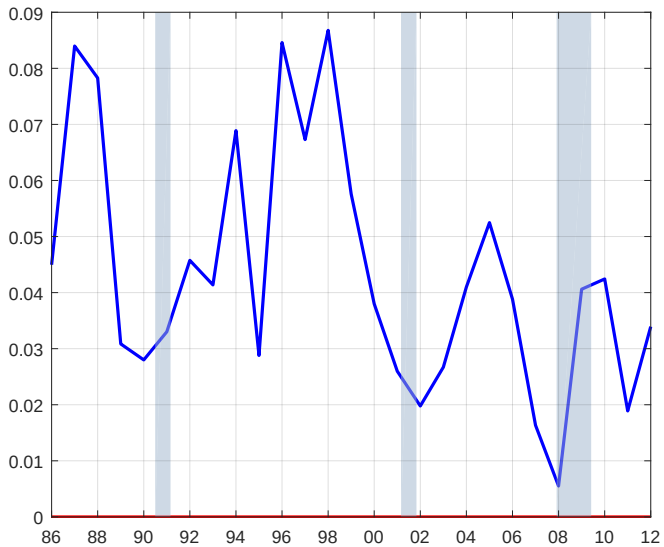
Forecast Errors in Real Income Growth

Figure: Mean income growth



(a) expectations



(b) realisations

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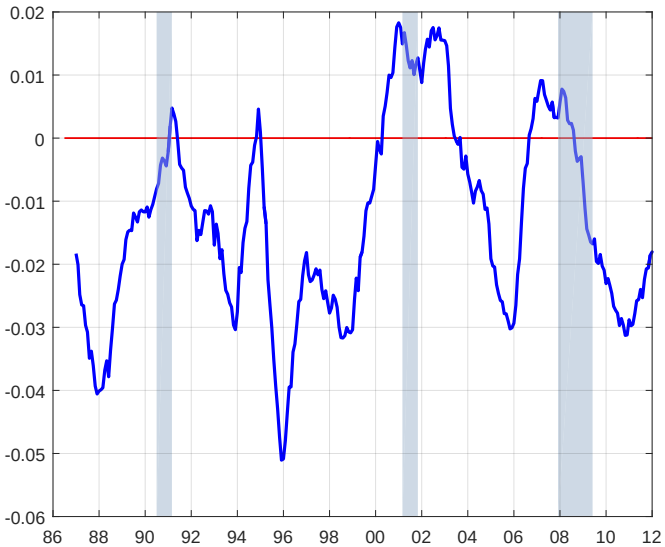
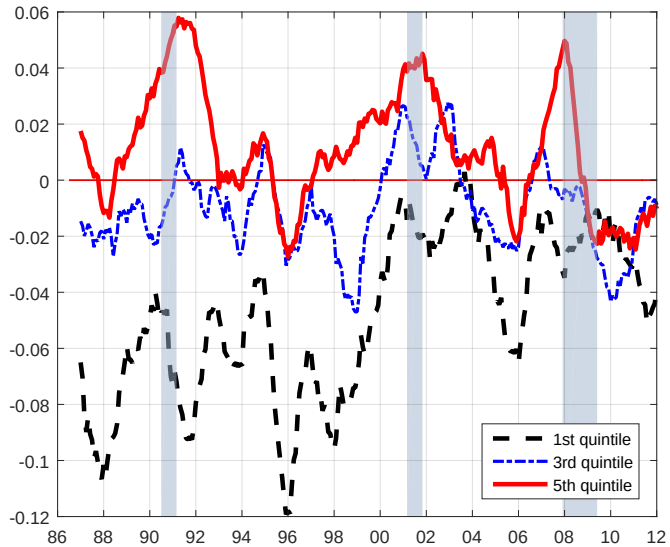
Forecast Errors in Nominal Income Growth



(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:

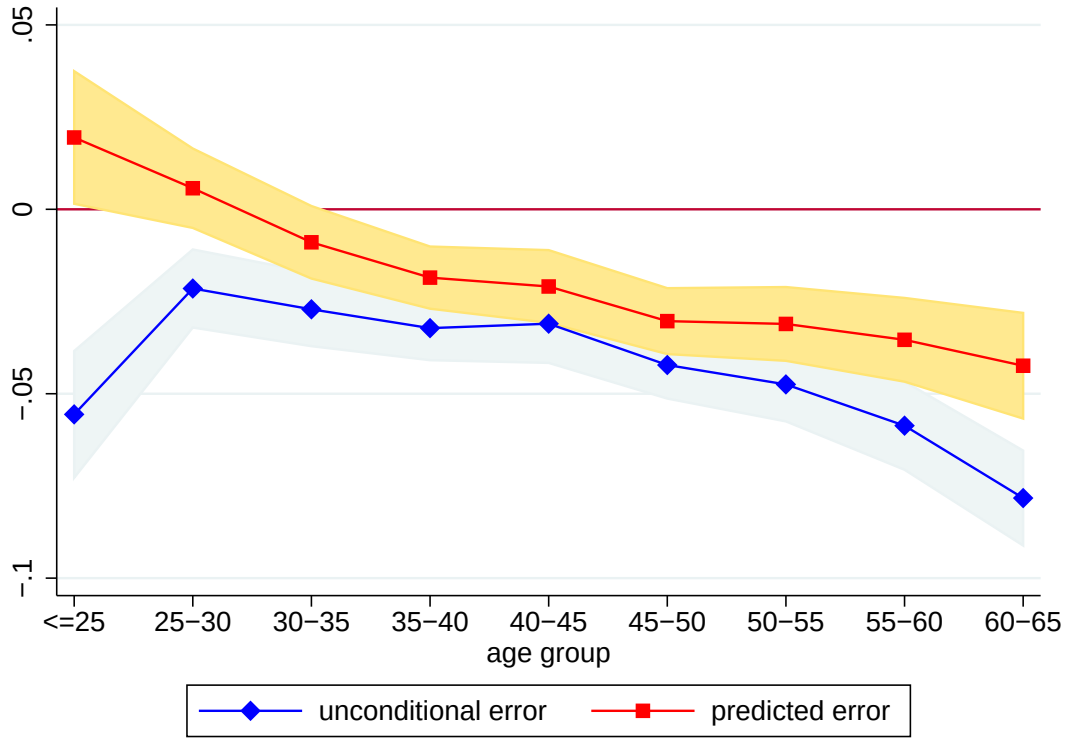
  not consistent: cannot generate systematic bias based on past shock realizations (Kalman Filtering (also conditionally) optimal and unbiased)
- Systematically Wrong Expectations about Aggregates:

  not consistent: across income distribution households too pessimistic about aggregates (inflation and unemployment rate)
- Measurement noise

  quantitatively not strong enough

Forecast Errors By Age

Figure: Forecast errors by age



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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Parametrization

Sources

- $r^l = 0.0016$: mean real interest rate on 3 month treasury bills
- $r^b = 0.02$: credit cards and on auto loans
- κ_y, κ_v: SCF borrowing limit credit card in 1992-2010, 80% of durables (average financing share at purchase = 0.78 according to Attanasio et al. (2008))
- F^d, δ: 30% lost a new car resell, 10 years lifetime of a car
- ρ, σ_P, σ_T: Storesletten, Telmer and Yaron (2004)
- Z: NBER recessions vs booms frequencies and average HPf GDP deviation

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Definition Liquid Assets

sample: car owners,
Survey of Consumer Finances (SCF) 1992-2010

liquid assets:

- checking accounts
- savings accounts
- stocks, bonds, mututal funds, brokerage accounts
- - credit card debt outstanding
- - car loan outstanding

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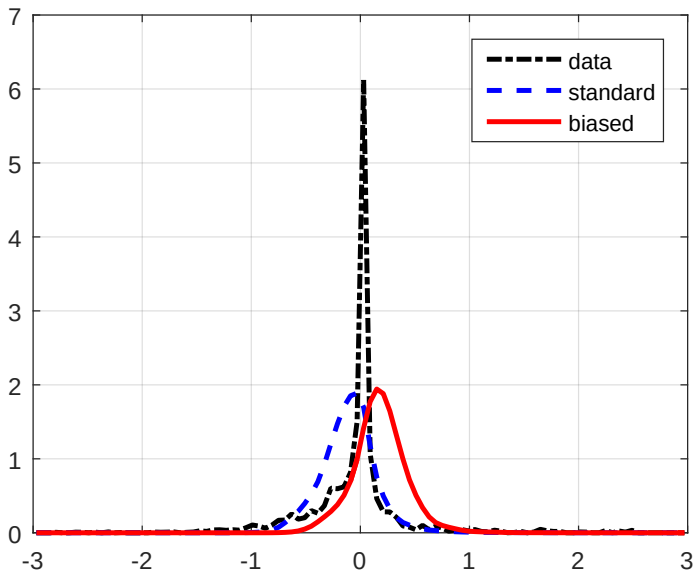
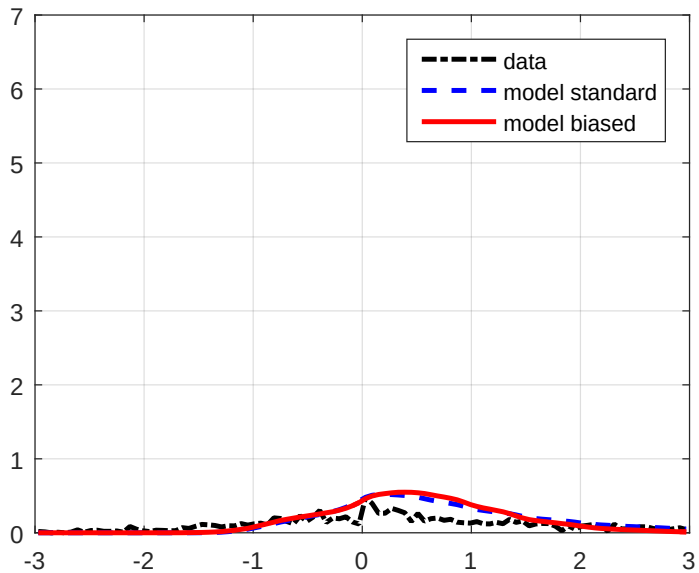
Model Calibrated for Rational Agents

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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