Heterogeneity in what?
Cognitive skills, beliefs and the liquid wealth distribution

Oliver Pfäuti
University of Mannheim

Fabian Seyrich
FU Berlin, DIW Berlin

Jonathan Zinman
Dartmouth

Bank of Finland and CEPR Joint Conference
June 17, 2023

Which dimensions of household heterogeneity matter?

- Households are vastly heterogeneous in their savings behavior and financial situations...

... which matters greatly for aggregate fluctuations and macro policies

Which dimensions of household heterogeneity matter?

- Households are vastly heterogeneous in their savings behavior and financial situations...

... which matters greatly for aggregate fluctuations and macro policies

Q: But why do households differ along these dimensions?

Which dimensions of household heterogeneity matter?

- Households are vastly heterogeneous in their savings behavior and financial situations...

... which matters greatly for aggregate fluctuations and macro policies

Q: But why do households differ along these dimensions?

Cognitive skills? Beliefs about these skills?

Which dimensions of household heterogeneity matter?

- Households are vastly heterogeneous in their savings behavior and financial situations...

... which matters greatly for aggregate fluctuations and macro policies

Q: But why do households differ along these dimensions?

Cognitive skills? Beliefs about these skills?

Q: How does heterogeneity in cognitive skills and beliefs matter for fiscal policy?

Results preview

Empirical results:

- HHs with lower cognitive skills overestimate their skills ("overconfidence")
- Overconfident HHs more likely to overestimate their future financial situations and to be hand-to-mouth

Results preview

Empirical results:

- HHs with lower cognitive skills overestimate their skills ("overconfidence")
- Overconfident HHs more likely to overestimate their future financial situations and to be hand-to-mouth

HANK model with skill and belief heterogeneity:

- accounts for the empirical findings
- matches empirical estimates of average MPCs even when all wealth is liquid

Results preview

Empirical results:

- HHs with lower cognitive skills overestimate their skills ("overconfidence")
- Overconfident HHs more likely to overestimate their future financial situations and to be hand-to-mouth

HANK model with skill and belief heterogeneity:

- accounts for the empirical findings
- matches empirical estimates of average MPCs even when all wealth is liquid
- optimal government debt level lower than in rational model: 100% vs. 300% of GDP
- increasing targeted transfers to low-income households less effective

Results preview

Empirical results:

- HHs with lower cognitive skills overestimate their skills ("overconfidence")
- Overconfident HHs more likely to overestimate their future financial situations and to be hand-to-mouth

HANK model with skill and belief heterogeneity:

- accounts for the empirical findings
- matches empirical estimates of average MPCs even when all wealth is liquid
- optimal government debt level lower than in rational model: 100% vs. 300% of GDP
- increasing targeted transfers to low-income households less effective

$\Rightarrow$ accounting for **systematic differences** of households matters greatly for policy

Literature Review

- Cognitive skills, behavioral biases, subjective income risk, macroeconomic policies: D'Acunto, Hoang, Paloviita, and Weber (2019, 2020, 2022), Stango and Zinman (forthcoming), Balleer et al. (2022), Rozsypal and Schlafmann (forthcoming), Chapman et al. (forthcoming), Wang (2023), Caplin et al. (2023)

- HA(NK) models deviating from FIRE: Farhi and Werning (2019), Broer, Kohlhas, Mitman, and Schlafmann (2021), Auclert et al. (2020), Angeletos and Huo (2021), Kaplan and Violante (2022), Laibson et al. (2021), Pfäuti and Seyrich (2022), Sergeyev et al. (2022), Guerreiro (2023), Ilut and Valchev (2023)

$\Rightarrow$ **Contribution:**

- link cognitive skills to beliefs, savings behavior and financial situations
- HANK model w/ skill + belief heterogeneity and characterize its fiscal policy implications

Outline

1. **Empirics**
2. Model
3. Cognitive Skills, Overconfidence and MPCs
4. Implications for Fiscal Policy

Data: Cognitive Skills and Overconfidence

American life panel, two rounds on behavioral biases, preferences and cognitive skills (Stango/Zinman, REStud 2023):

Data: Cognitive Skills and Overconfidence

American life panel, two rounds on behavioral biases, preferences and cognitive skills (Stango/Zinman, REStud 2023):

- cognitive skills: measured by standard tests on
  - general or fluid intelligence
  - numeracy
  - cognitive control/executive function
  - financial literacy

Data: Cognitive Skills and Overconfidence

American life panel, two rounds on behavioral biases, preferences and cognitive skills (Stango/Zinman, REStud 2023):

- cognitive skills: measured by standard tests on
  - general or fluid intelligence
  - numeracy
  - cognitive control/executive function
  - financial literacy
- overconfidence:

$$\tilde{\mathbb{E}}_i[rank_i] - rank_i$$

  - highly correlated with other measures of overconfidence
  - behavioral bias that is most strongly correlated with cognitive skills (Stango/Zinman)

Data: Financial Situations and Savings Behavior

- financial-situation forecast errors:
  - expected future financial situation vs. actual future financial situation

Data: Financial Situations and Savings Behavior

- financial-situation forecast errors:
  - expected future financial situation vs. actual future financial situation
- 8 measures of Hand-to-Mouth status:
  1. financial distress
  2. based on net worth
  3. difficulty to cover $2k unexpected expense
  4. say that they "wish they saved more"
  5. say that they "wish they saved a lot more"
  6. lives paycheck-to-paycheck
  7. lives paycheck-to-paycheck during Covid
  8. lacks precautionary savings

Overconfidence and cognitive skills are negatively correlated

We find that

- about 38% of households are persistently overconfident
- households with lower cognitive skills are more likely to be overconfident
  - holds for all cognitive-skill measures ▸ Details

Overconfidence and cognitive skills are negatively correlated

We find that

- about 38% of households are persistently overconfident
- households with lower cognitive skills are more likely to be overconfident
  - holds for all cognitive-skill measures ▸ Details
- cognitive skills are strongly correlated with income
- overconfident households are about 1.5 times as likely to be overly optimistic about their future financial situations ▸ Details
  - there is little evidence for learning or overcorrection

Overconfidence and cognitive skills are negatively correlated

We find that

- about 38% of households are persistently overconfident
- households with lower cognitive skills are more likely to be overconfident
  - holds for all cognitive-skill measures ▸ Details
- cognitive skills are strongly correlated with income
- overconfident households are about 1.5 times as likely to be overly optimistic about their future financial situations ▸ Details
  - there is little evidence for learning or overcorrection
- overconfident households are more likely to be Hand-to-Mouth ▸ Details
  - much weaker correlations between "patience" and HtM measures

Outline

1. Empirics
2. **Model**
3. Cognitive Skills, Overconfidence and MPCs
4. Implications for Fiscal Policy

Model Overview

Households:

- incomplete markets, idiosyncratic risk, permanent heterogeneity in skills and beliefs

Firms:

- representative final goods producer, flexible prices, production: $Y_t = N_t$

Labor unions:

- sticky wages, all households work same number of hours

Government:

- fiscal policy: issues bonds B_t, raises taxes, transfers (later)
- monetary policy: controls real rate r_t

Households

Continuum of infinitely-lived households:

$$V_{g,t}\left(b_{t-1}, e_t\right) = \max_{c_t, b_t} \left\{ \frac{c_t^{1-\gamma}}{1-\gamma} - \frac{n_t^{1+\varphi}}{1+\varphi} + \beta \tilde{\mathbb{E}}_{g,t} \Big[V_{g,t+1}\left(b_t, e_{t+1}\right) \Big] \right\}$$

subject to

$$c_t + \frac{b_t}{1+r_t} = b_{t-1} + (1-\tau_t) w_t \bar{e}_g e_t n_t$$

$$b_t \geqslant -\underline{b},$$

Households

Continuum of infinitely-lived households:

$$V_{g,t}\left(b_{t-1}, e_t\right) = \max_{c_t, b_t} \left\{ \frac{c_t^{1-\gamma}}{1-\gamma} - \frac{n_t^{1+\varphi}}{1+\varphi} + \beta \tilde{\mathbb{E}}_{g,t} \Big[V_{g,t+1}\left(b_t, e_{t+1}\right) \Big] \right\}$$

subject to

$$c_t + \frac{b_t}{1+r_t} = b_{t-1} + (1-\tau_t) w_t \bar{e}_g e_t n_t$$
$$b_t \geqslant -\underline{b},$$

- permanent heterogeneity g:
  - average skills: $\bar{e}_g$
  - beliefs: $\tilde{\mathbb{E}}_{g,t}$

Modelling overconfidence

- Skills: $e_1 < e_2 < ... < e_J$
- Transition probabilities: $p_{ij} \equiv p(e_{t+1} = e_j | e_t = e_i)$

Modelling overconfidence

- Skills: $e_1 < e_2 < ... < e_J$
- Transition probabilities: $p_{ij} \equiv p(e_{t+1} = e_j | e_t = e_i)$
- Perceived transition probabilities $\tilde{p}_{ij}$:

$$\tilde{p}_{ij} \equiv \begin{cases} \alpha p_{ij}, \text{ if } i < j \\ \frac{1}{\alpha} p_{ij}, \text{ if } i > j \\ 1 - \sum_{j \neq i} \tilde{p}_{ij}, \text{ if } i = j. \end{cases}$$

- $\alpha \geqslant 1$ captures belief accuracy:
  - $\alpha > 1$: overconfidence $\Rightarrow$ overestimate probability of reaching good states
  - $\alpha = 1$: rational

Calibration

Calibrating permanent heterogeneity:

- two groups: 38% low-skilled and overconfident, 62% high-skilled and rational
- overconfident HHs 1.5 times as likely to overestimate future earnings $\Rightarrow \alpha = 1.9$

Calibration

Calibrating permanent heterogeneity:

- two groups: 38% low-skilled and overconfident, 62% high-skilled and rational
- overconfident HHs 1.5 times as likely to overestimate future earnings $\Rightarrow \alpha = 1.9$

Parameter	Description	Value
R	Steady State Real Rate (annualized)	2%
γ	Risk aversion	2
φ	Inverse of Frisch elasticity	2
$\underline{b}$	Borrowing constraint	0
$\frac{\bar{B}}{4\bar{Y}}$	Average wealth to average income	4.0
Idiosyncratic risk		
ρ_e	Persistence of idiosyncratic risk	0.966
σ_e^2	Variance of idiosyncratic risk	0.016

Outline

1. Empirics
2. Model
3. **Cognitive Skills, Overconfidence and MPCs**
4. Implications for Fiscal Policy

Overconfidence increases HtM shares and MPCs

	Baseline
	(1)
HtM Share	0.2461
Avg. MPC	0.178
HtM rational HHs	0.0121
HtM Overconfident HHs	-
HtM rat. HHs Low-Skilled	-
HtM OC HHs LS	0.6278

Overconfidence increases HtM shares and MPCs

	Baseline (1)	Standard HANK (2)
HtM Share	0.2461	0.0228
Avg. MPC	0.178	0.031
HtM rational HHs	0.0121	0.0228
HtM OverConfident HHs	-	-
HtM rat. HHs Low-Skilled	-	-
HtM OC HHs LS	0.6278	-

Overconfidence (not skills) increases HtM shares and MPCs

	Baseline (1)	Standard HANK (2)	HANK w\skills (3)
HtM Share	0.2461	0.0228	0.0227
Avg. MPC	0.178	0.031	0.031
HtM rational HHs	0.0121	0.0228	0.0227
HtM OverConfident HHs	-	-	-
HtM rat. HHs Low-Skilled	-	-	0.0226
HtM OC HHs LS	0.6278	-	-

Overconfidence (not skills) increases HtM shares and MPCs

	Baseline (1)	Standard HANK (2)	HANK w\skills (3)	HANK w\OC (4)
HtM Share	0.2461	0.0228	0.0227	0.2489
Avg. MPC	0.178	0.031	0.031	0.1833
HtM rational HHs	0.0121	0.0228	0.0227	0.0108
HtM OverConfident HHs	-	-	-	0.6374
HtM rat. HHs Low-Skilled	-	-	0.0226	-
HtM OC HHs LS	0.6278	-	-	-

Overconfidence (not skills) increases HtM shares and MPCs

	Baseline (1)	Standard HANK (2)	HANK w\skills (3)	HANK w\OC (4)
HtM Share	0.2461	0.0228	0.0227	0.2489
Avg. MPC	0.178	0.031	0.031	0.1833
HtM rational HHs	0.0121	0.0228	0.0227	0.0108
HtM OverConfident HHs	-	-	-	0.6374
HtM rat. HHs Low-Skilled	-	-	0.0226	-
HtM OC HHs LS	0.6278	-	-	-

Our baseline model further produces:

- median wealth of 1.67 (vs. 1.5 in data), no "missing middle" problem ▸ Wealth Distribution
- top 10% wealth share of 40%

Outline

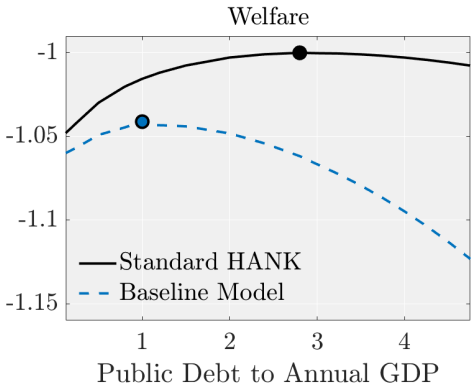
1. Empirics
2. Model
3. Cognitive Skills, Overconfidence and MPCs
4. **Implications for Fiscal Policy**

Optimal government debt level

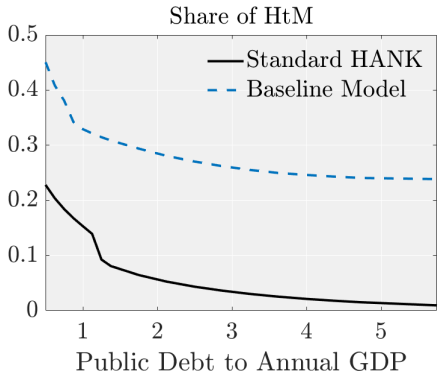
- Utilitarian social welfare function:
  average expected discounted lifetime utility of households
- paternalistic planner: evaluates welfare using rational expectations

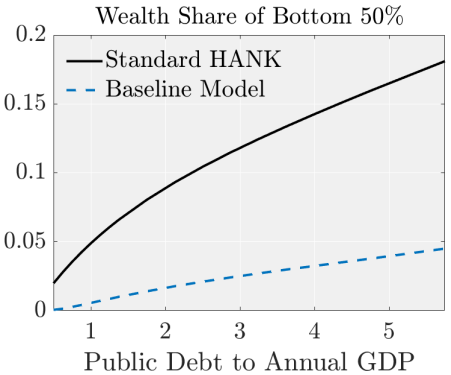
Optimal government debt level

- Utilitarian social welfare function: average expected discounted lifetime utility of households
- paternalistic planner: evaluates welfare using rational expectations



Poor households remain poor





$\Rightarrow$ liquidity mainly goes to rational households, but all pay higher taxes

$\Rightarrow$ optimal debt level substantially lower than in rational model!

Targeted transfers

- now, consider a different policy: targeted transfers to below-median income HHs
- re-calibrate wealth in standard HANK to have the same average MPC
  - Details
  - Stationary equilibrium

Targeted transfers

- now, consider a different policy: targeted transfers to below-median income HHs
- re-calibrate wealth in standard HANK to have the same average MPC
  - ▸ Details ▸ Stationary equilibrium

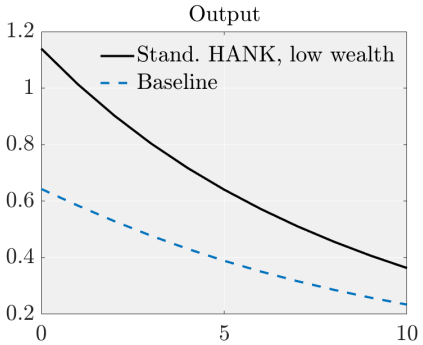
Q: what happens if we temporarily increase these transfers?

Targeted transfers

- now, consider a different policy: targeted transfers to below-median income HHs
- re-calibrate wealth in standard HANK to have the same average MPC

  ▸ Details ▸ Stationary equilibrium

Q: what happens if we temporarily increase these transfers?



Two channels:

1. average MPC of transfer recipients smaller in our baseline model
2. temporary relaxation of income risk also weaker in our baseline model

$\Rightarrow$ smaller output response

Additional results

- Two-asset model with overconfidence: lowers required return gap ▸ Details
- Discount factor heterogeneity: even higher optimal debt level than rational model and not supported by data ▸ Details

Conclusion

In this paper, we...

... provide new evidence on cognitive skills, believed skills and financial situations

... introduce belief heterogeneity in a HANK model

- show how to discipline behavioral bias
- model does a good job in matching "skill-belief-liquidity distribution"

... find that the underlying reason why households do not hold liquidity matters

- lower optimal government debt level
- targeted transfers are less stimulating

Appendix

Cognitive Skills and Overconfidence

▸ back

	1 = oc both rounds		oc percentile rank	
	Unweighted	Weighted	Unweighted	Weighted
	(1)	(2)	(3)	(4)
Population share	0.340	0.377		
s.e.	0.017	0.035		
N	817	817		
Cognitive skill measures				
Summary: 1st principal component	-0.546	-0.542	-0.818	-0.830
s.e.	0.030	0.045	0.032	0.049
N	733	733	733	733
Component: Fluid intelligence	-0.718	-0.734	-1.049	-1.065
s.e.	0.026	0.047	0.026	0.055
N	817	817	817	817
Component: Numeracy	-0.362	-0.453	-0.573	-0.656
s.e.	0.040	0.068	0.046	0.077
N	798	798	798	798
Component: Financial literacy	-0.321	-0.242	-0.467	-0.362
s.e.	0.038	0.087	0.041	0.087
N	813	813	813	813
Component: Executive function	-0.316	-0.407	-0.444	-0.600
s.e.	0.045	0.072	0.052	0.090
N	749	749	749	749

Overconfidence and Financial Situation Forecast Errors

$\frac{\text{(Optimist share} \mid \text{overconfident)}}{\text{(Optimist share} \mid \text{not oc)}}$	Optimism measure	
	$1 = \text{(Consec. Opt. FEs)}$	$1 = \text{(Prop. Opt. FEs} \geq 0.5)$
Unweighted	1.51	1.77
Weighted	1.17	1.63

▸ back

Overconfidence and HtM Status I

back

	1=O/c both rounds		O/c pctile rank		Row variable, unw.	Row variable, w.
	Unweighted	Weighted	Unweighted	Weighted	Pop. share	Pop. share
	(1)	(2)	(3)	(4)	(5)	(6)
1=(Severe financial distress)	0.176	0.273	0.194	0.180	0.277	0.305
s.e.	0.059	0.119	0.039	0.078	0.016	0.035
N	813	813	813	813		
1=(Low net worth)	0.250	0.198	0.226	0.086	0.397	0.468
s.e.	0.057	0.097	0.041	0.073	0.018	0.032
N	760	760	760	760		
1=(Wishes saved more)	-0.003	0.080	0.025	-0.041	0.611	0.615
s.e.	0.058	0.111	0.041	0.075	0.017	0.033
N	813	813	813	813		
1=(Wishes saved a lot more)	0.172	0.359	0.131	0.183	0.156	0.156
s.e.	0.066	0.127	0.041	0.084	0.013	0.035
N	813	813	813	813		

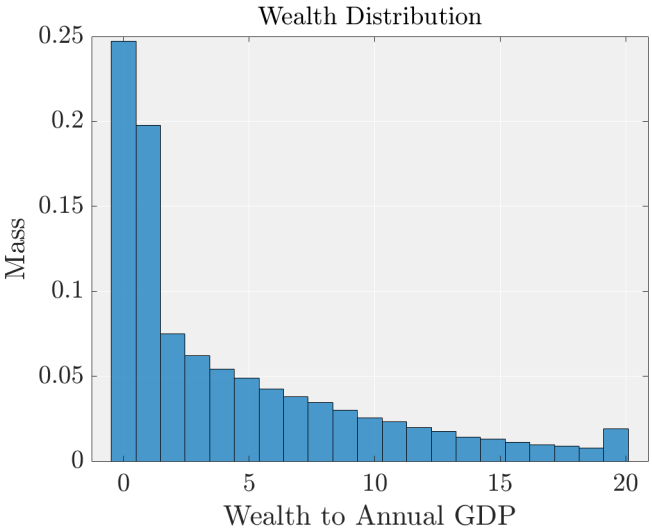
Overconfidence and HtM Status II

back

	1=O/c both rounds		O/c pctile rank		Row variable, unw.	Row variable, w.
	Unweighted	Weighted	Unweighted	Weighted	Pop. share	Pop. share
	(1)	(2)	(3)	(4)	(5)	(6)
1=(paycheck-to-paycheck c. 2012)	0.151	0.023	0.154	0.155	0.588	0.561
s.e.	0.099	0.181	0.074	0.099	0.031	0.056
N	255	255	255	255		
paycheck-to-paycheck, COVID era	0.224	0.220	0.301	0.290	0.404	0.440
s.e.	0.053	0.085	0.049	0.077	0.018	0.028
N	516	516	516	516		
1=(Lacks prec. savings in 2012 & 2018)	0.112	0.104	0.181	0.205	0.634	0.691
s.e.	0.101	0.133	0.071	0.086	0.030	0.037
N	262	262	262	262		
Difficult covering $\$2k$ emergency expense	0.230	0.314	0.222	0.281	0.513	0.543
s.e.	0.065	0.078	0.050	0.058	0.021	0.026
N	485	485	485	485		

Wealth Distribution

back



Targeted Transfers

$$tr_{it} = \max\{0, \epsilon_t^{TT} a_1 \bar{y} - a_2 w_t n_{i,t} e_{i,t}\},$$

$\bar{y}$: median income in stationary equilibrium

No transfers to households whose labor income $w_t n_{i,t} e_{i,t} \geqslant \epsilon_t^{TT} \frac{a_1}{a_2} \bar{y}$

Calibration: $a_1 = 0.5$ and $a_2 = 0.8$

Aggregate shock: $\epsilon_t^{TT} > 1$ ‣ back

Stationary Equilibrium Effects of Targeted Transfers

- Targeted transfers to below-median income HHs

  $\Rightarrow$ reduces precautionary savings motive...

Stationary Equilibrium Effects of Targeted Transfers

- Targeted transfers to below-median income HHs
  - $\Rightarrow$ reduces precautionary savings motive... especially for rational households
  - $\Rightarrow$ rational model: average MPC increases from 0.18 to 0.23 and HtM share from 0.23 to 0.3

Stationary Equilibrium Effects of Targeted Transfers

- Targeted transfers to below-median income HHs
  - $\Rightarrow$ reduces precautionary savings motive... especially for rational households
  - $\Rightarrow$ rational model: average MPC increases from 0.18 to 0.23 and HtM share from 0.23 to 0.3
  - $\Rightarrow$ baseline model: average MPC from 0.18 down to 0.17 and HtM share barely changed

$\Rightarrow$ crowding-out effects of income insurance are dampened back

Two-Asset Model: Details

back

$$c_t + \frac{b_t}{1+r_t} + k_t = b_{t-1} + (1 + r_t^k)k_{t-1} + (1-\tau_t)w_t \bar{e}_g e_t n_t$$

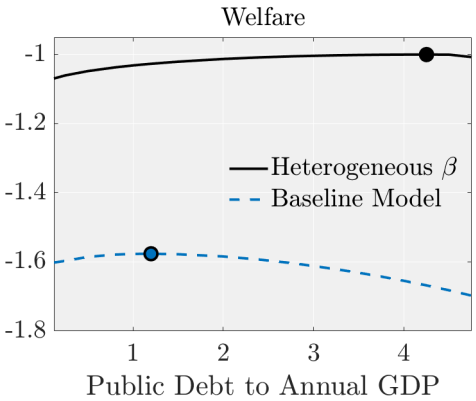
- k illiquid: only fraction λ participate in capital markets in a given period

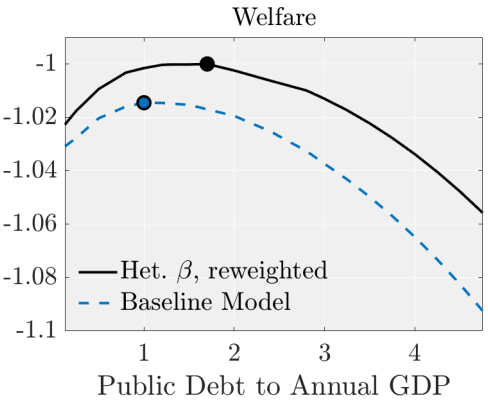
$$Y_t = K_{t-1}^{\alpha} N_t^{1-\alpha}$$

	baseline two-asset	rational two-asset	two-asset recalib.
HtM	0.27	0.06	0.23
Avg. MPC	0.16	0.058	0.16
return gap	1.6%	1.5%	4.8%
HtM rat. HHs	0.0658	0.06	0.23
Avg. MPC rat. HHs	0.060	0.058	0.16
HtM OC HHs ls	0.600	-	-
Avg. MPC OC HHs ls	0.323	-	-

Optimal Debt Level with Discount Factor Heterogeneity

back





Literature I

Angeletos, G.-M. and Z. Huo (2021): "Myopia and anchoring," *American Economic Review*, 111, 1166–1200.

Auclert, A., M. Rognlie, and L. Straub (2020): "Micro jumps, macro humps: Monetary policy and business cycles in an estimated HANK model." .

Balleer, A., G. Duernecker, S. Forstner, and J. Goensch (2022): "The Effects of Biased Labor Market Expectations on Consumption, Wealth Inequality, and Welfare," .

Broer, T., A. Kohlhas, K. Mitman, and K. Schlafmann (2021): "Information and Wealth Heterogeneity in the Macroeconomy," .

Caplin, A., V. Gregory, E. Lee, S. Leth-Petersen, and J. Sæverud (2023): "Subjective Earnings Risk," .

Chapman, J., M. Dean, P. Ortoleva, E. Snowberg, and C. Camerer (forthcoming): "Econographics," *Journal of Political Economy: Micro*.

Literature II

D'Acunto, F., D. Hoang, M. Paloviita, and M. Weber (2019): "Cognitive abilities and inflation expectations," in *AEA Papers and Proceedings*, vol. 109, 562–66.

——— (2020): "IQ, expectations, and choice," *Review of Economic Studies (forthcoming)*.

——— (2022): "Human frictions in the transmission of economic policies," .

Farhi, E. and I. Werning (2019): "Monetary policy, bounded rationality, and incomplete markets," *American Economic Review*, 109, 3887–3928.

Guerreiro, J. (2023): "Belief Disagreement and Business Cycles," .

Ilut, C. and R. Valchev (2023): "Economic agents as imperfect problem solvers," *The Quarterly Journal of Economics*, 138, 313–362.

Kaplan, G. and G. L. Violante (2022): "The marginal propensity to consume in heterogeneous agent models," *Annual Review of Economics*, 14, 747–775.

Laibson, D., P. Maxted, and B. Moll (2021): "Present bias amplifies the household balance-sheet channels of macroeconomic policy," .

Literature III

Pfäuti, O. and F. Seyrich (2022): "A behavioral heterogeneous agent new keynesian model," .

Rozsypal, F. and K. Schlafmann (forthcoming): "Overpersistence bias in individual income expectations and its aggregate implications," *American Economic Journal: Macroeconomics*.

Sergeyev, D., C. Lian, and Y. Gorodnichenko (2022): "The Economics of Financial Stress," .

Stango, V. and J. Zinman (forthcoming): "We are all behavioral, more or less: A taxonomy of consumer decision making," *Review of Economic Studies*.

Wang, T. (2023): "Perceived versus calibrated income risks in heterogeneous-agent consumption models," .