

CENTER FOR
ECONOMIC
BEHAVIOR &
INEQUALITY

Claus Thustrup Kreiner
Oslo Macro Conference
August 2019



UNIVERSITY OF COPENHAGEN



Overview of Talk

Research Program

Behavioral Heterogeneity, Inequality
and Public Policy

Research Paper

Time Discounting and Wealth Inequality

A Macro Agenda

Share of Inequality Explained by
Behavioral Heterogeneity?

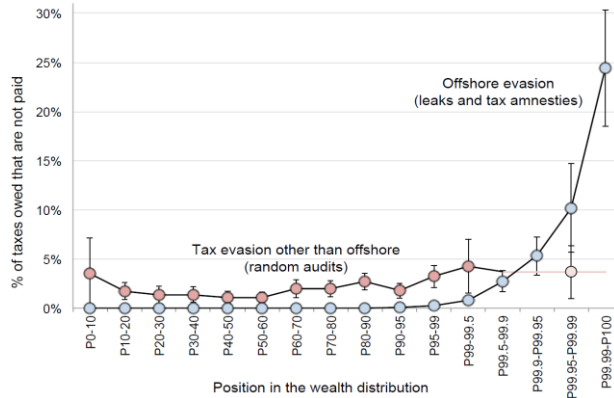
CEBI team



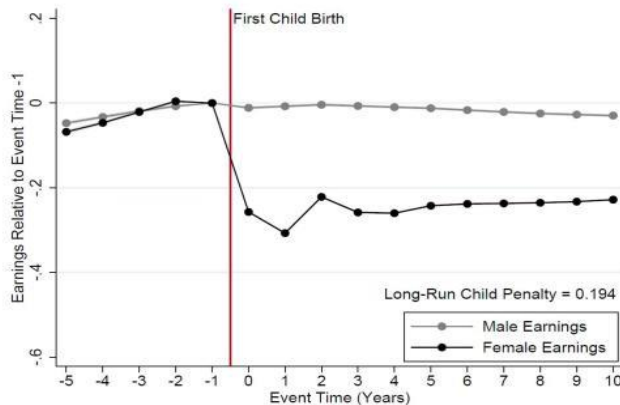
Many different fields: Public Economics, Labor Economics, Health Economics, Experimental Economics, Behavioral Economics, Household Finance, Political Economy, Microeconometrics...

CEBI research program: Examples of CEBI projects

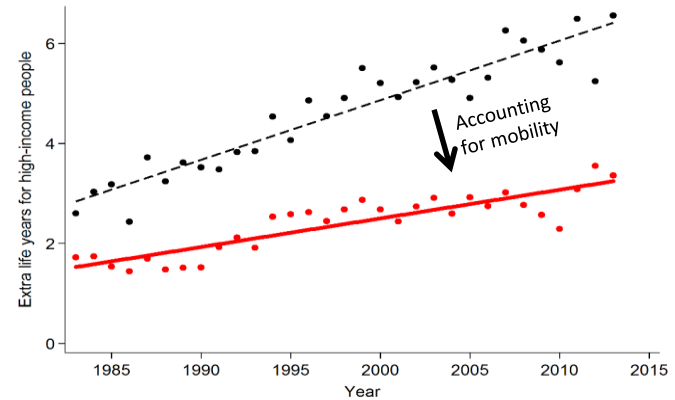
Wealth Inequality: Role of tax evasion behaviour, preference heterogeneity and wealth taxation...



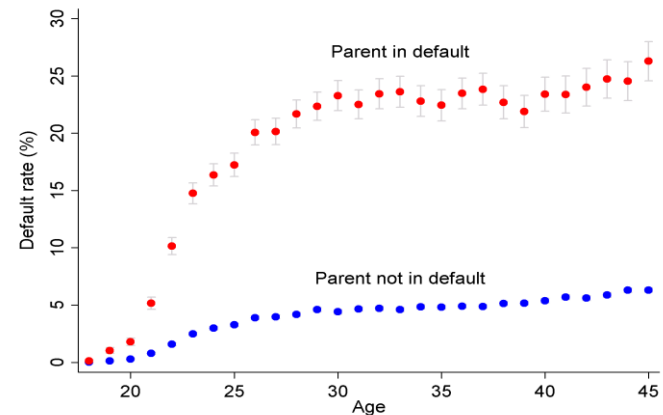
Gender inequality: Role of children, social norms and parental leave policy



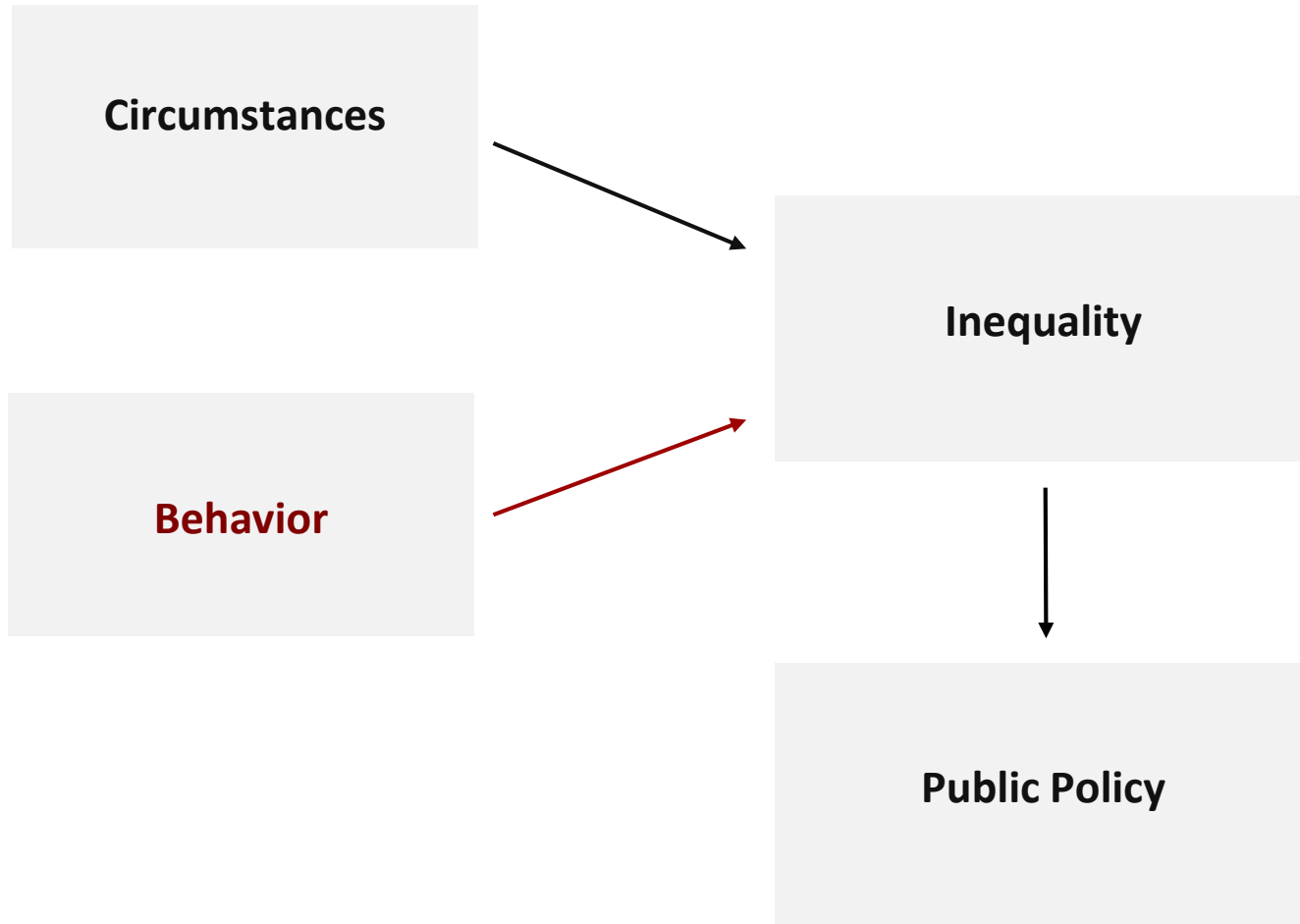
Life-expectancy inequality: Role of income mobility, innovations and technology adoption



Inequality in financial trouble: Role of shocks vs behavioral heterogeneity

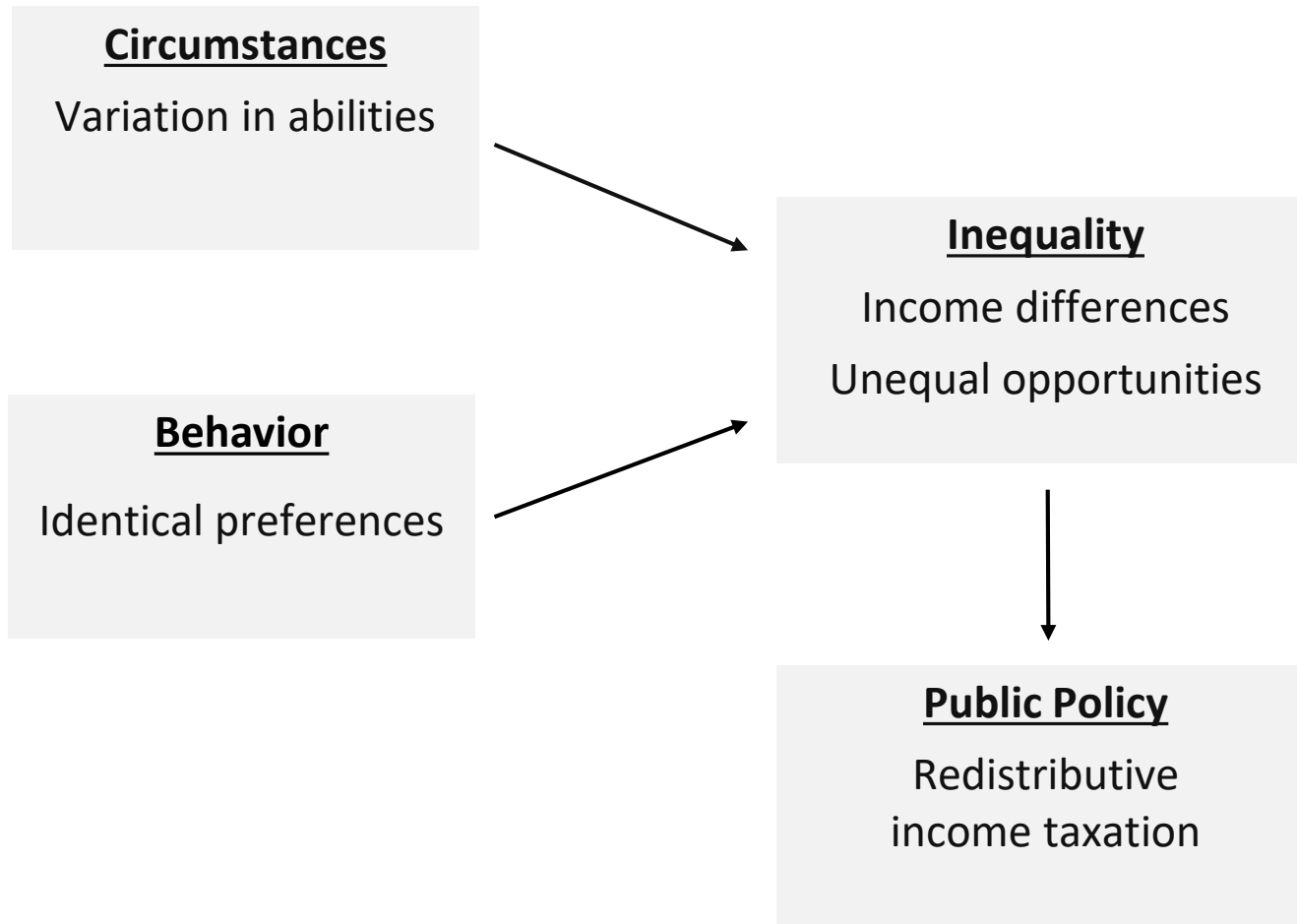


CEBI research program: Behavioral Heterogeneity, Inequality and Public Policy



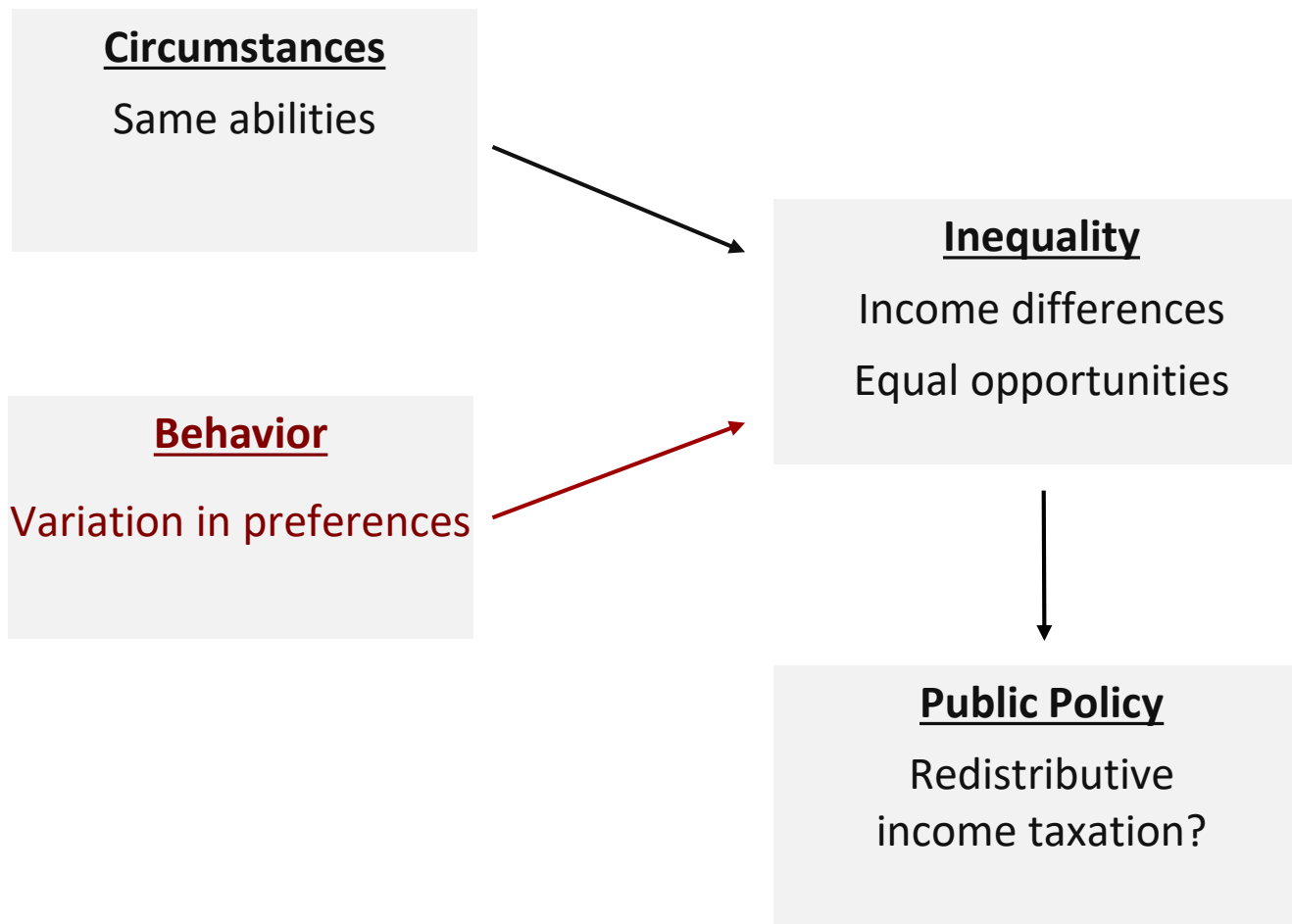
CEBI research program: Behavioral Heterogeneity, Inequality and Public Policy

Example: Standard Mirrleesian optimal tax model

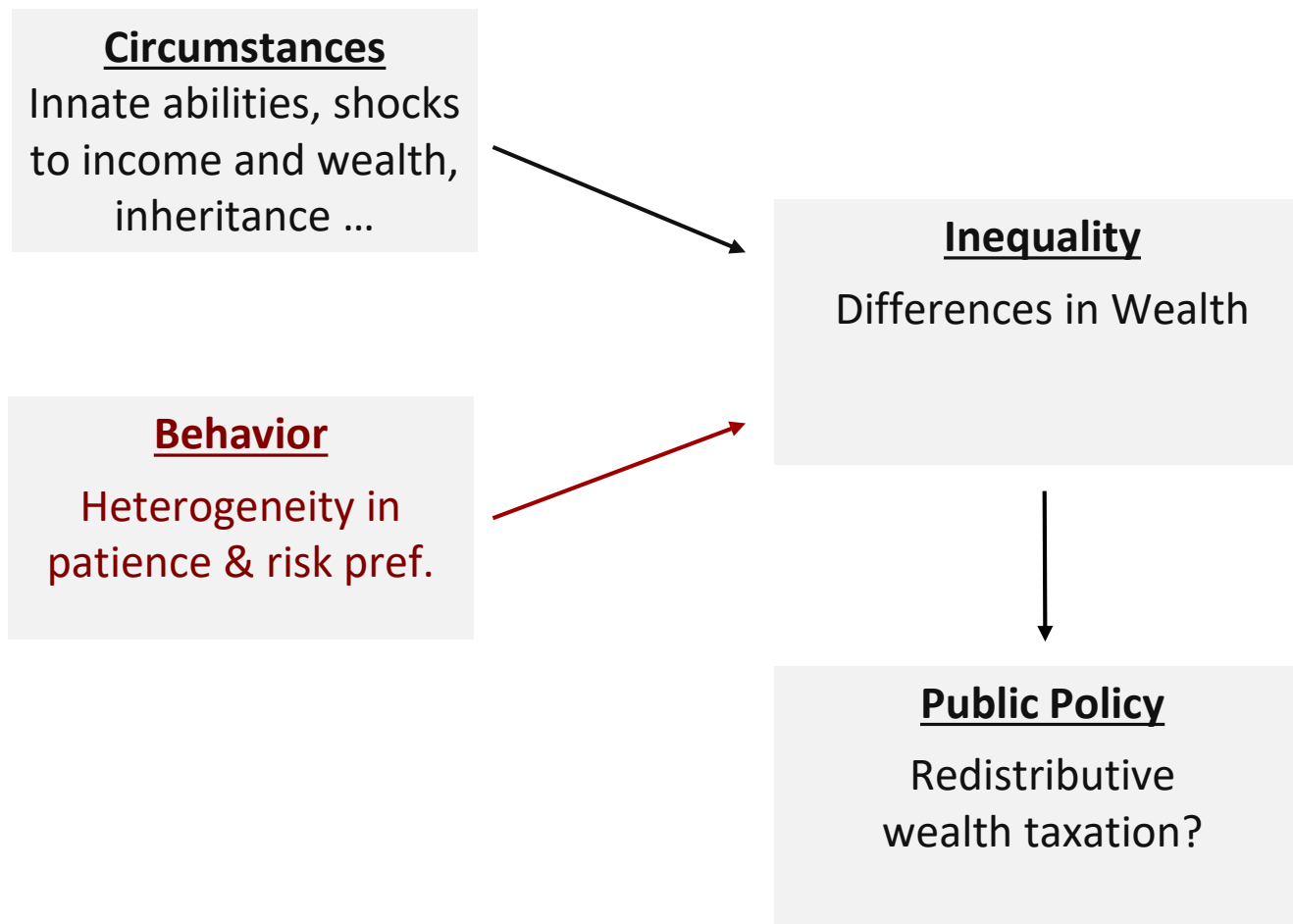


CEBI research program: Behavioral Heterogeneity, Inequality and Public Policy

Example: Alternative interpretation of Mirrleesian model



CEBI research program: Behavioral Heterogeneity, Inequality and Public Policy



CEBI research program: Redistribution attitudes depending on sources of inequality

Survey findings

random sample, 14119 obs

To what extent do you think that the government should reduce differences in wealth that are due to

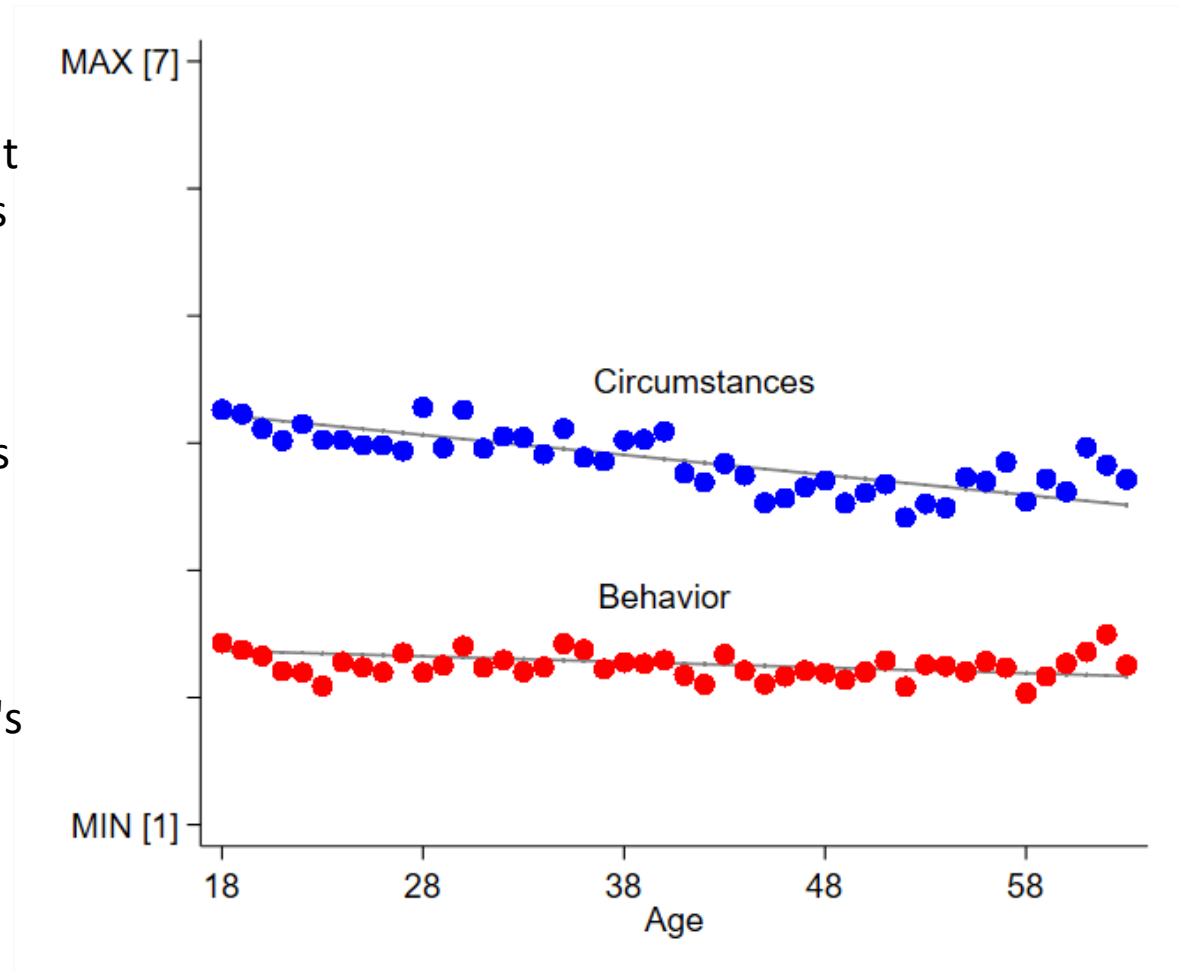
...

Q1: differences that people do not themselves influence?

[Circumstances]

Q2: differences in people's own decisions?

[Behavior]



CEBI research program: Redistribution attitudes depending on sources of inequality

Survey findings

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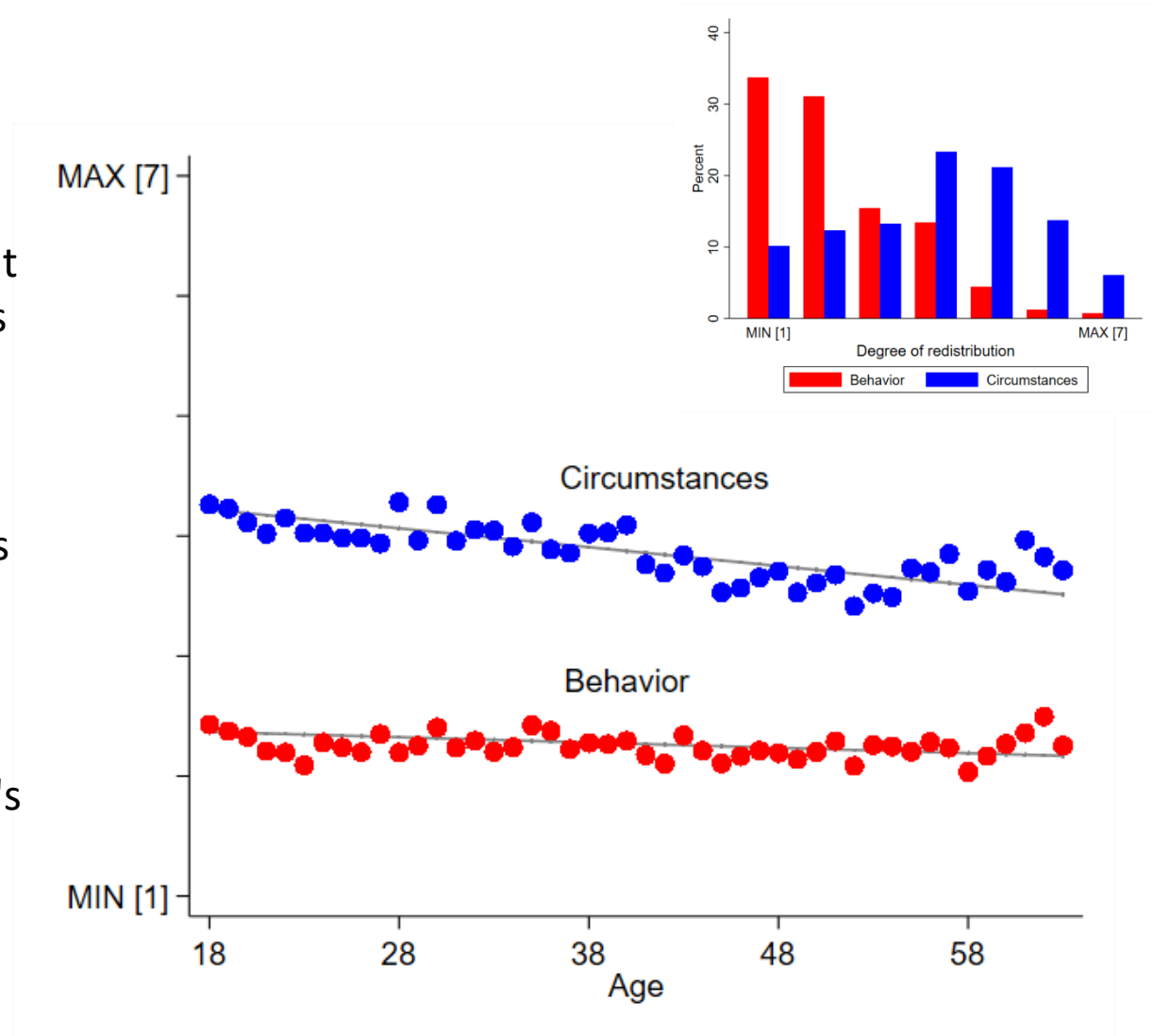
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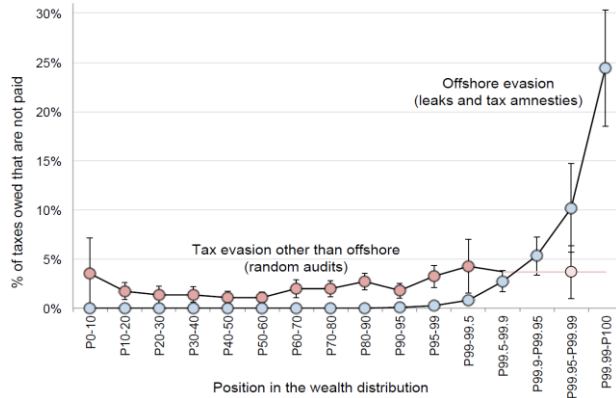


“The establishment of the proposition that one may usefully treat *tastes* as stable over time and *similar among people* is the central task of this essay.” Stigler and Becker (“De Gustibus Non Est Disputandum”, American Economic Review 1977)

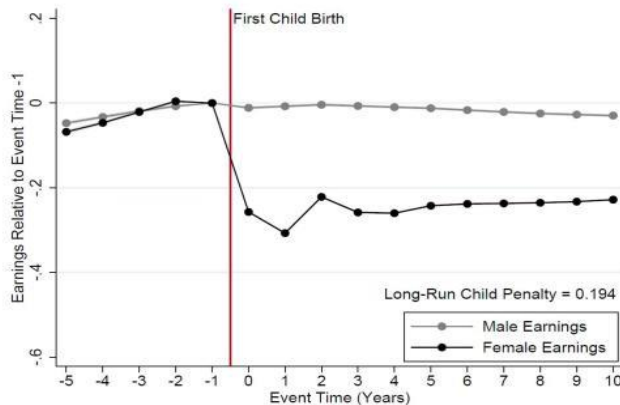
“Preference heterogeneity represents an alternative way to introduce differences in initial conditions. Historically, macroeconomists have been *reluctant to fiddle too much with preferences*, because their *inherent unobservability* puts little discipline on the exercise.” Heathcoate, Storesletten and Violante (Annual Review of Economics 2009)

CEBI research program: Examples of CEBI projects & policy relevance

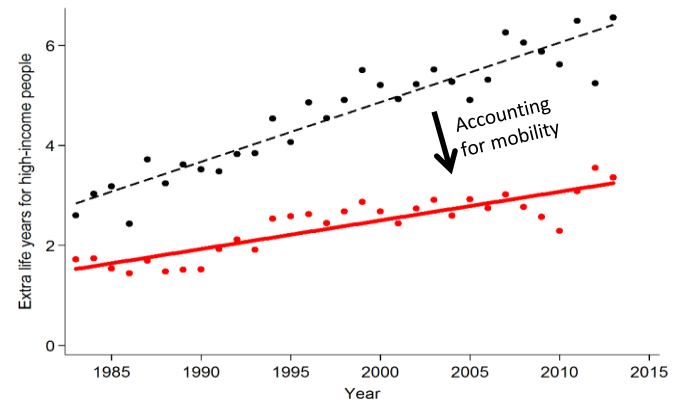
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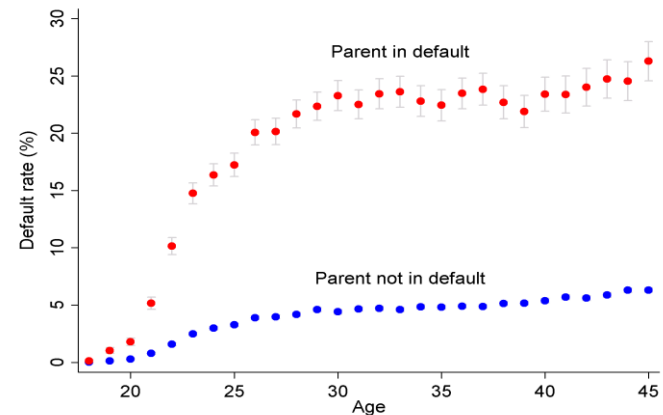
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Time Discounting and Wealth Inequality

Thomas Epper St. Gallen

Ernst Fehr Zürich

Helga Fehr-Duda Zürich

Claus Thustrup Kreiner Copenhagen

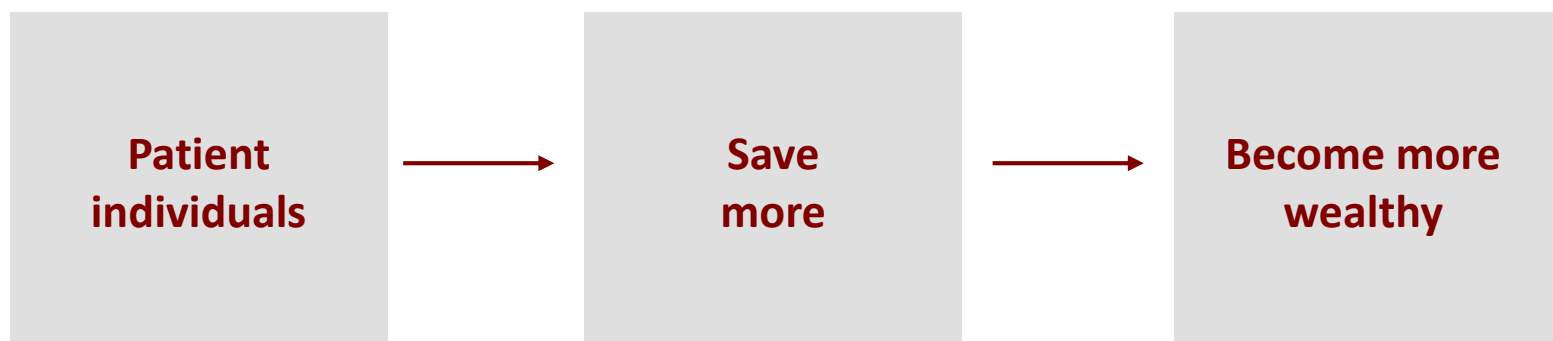
David Dreyer Lassen Copenhagen

Søren Leth-Petersen Copenhagen

Gregers Nytoft Rasmussen Copenhagen

Research agenda

Hypothesis from basic theory of savings behavior:



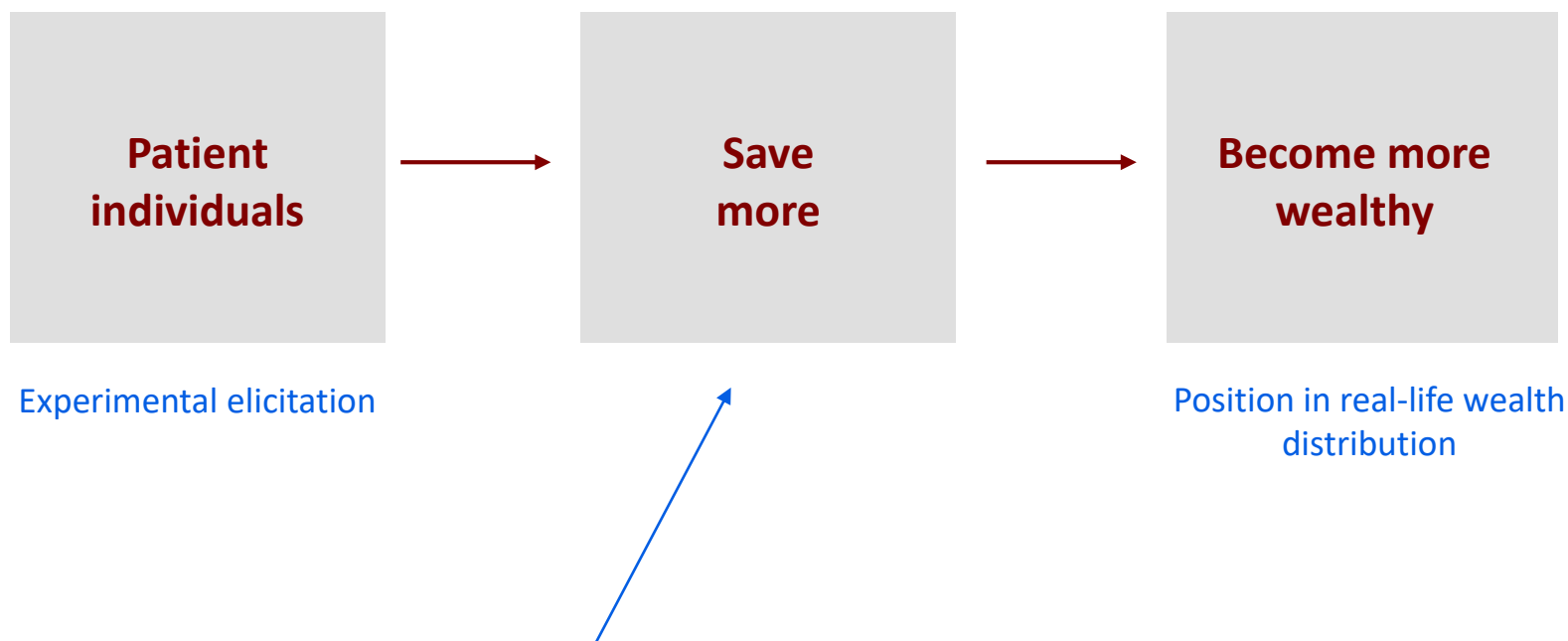
Contribution

I. Measure whether differences in patience predict wealth inequality:



Contribution

I. Measure whether differences in patience predict wealth inequality:



II. Provide suggestive evidence about the role of the savings channel by controlling for other factors relevant according to theory

Contribution

Public Finance and Macro literature (e.g. Krusell & Smith 1998; Carroll et al. 2014, 2017; Krueger et al. 2016; Boserup et al. 2016, 2018; De Nardi and Fella 2017; ...)

Models with heterogeneity in time discounting better at matching wealth inequality + propagation of business cycle shocks and effects of stimulus policy

Experimental literature (e.g. Mishel et al 1989; Harrison et al 2002; Andreoni & Sprenger 2012; Attema et al 2016; ...)

Evidence starting with the famous marshmallow experiments w. children in the 60s to recent research using intertemporal choices of adults point to pervasive heterogeneity in time discounting

Has predictive power of behavior outside the laboratories

We bridge these literatures

Q: Do differences in *elicited* time discounting predict *real-life* wealth inequality?

Savings Theory

$$\max_{(c(a))_0^T} U = \int_0^T \frac{c(a)^{1-\theta}}{1-\theta} e^{-\rho a} da$$

$$\text{s.t. } \dot{w} = rw(a) + y(a) - c(a)$$

⇓

$$w(a) = Y \left(\gamma(a) - \frac{1 - e^{\frac{r(1-\theta)-\rho}{\theta} a}}{1 - e^{\frac{r(1-\theta)-\rho}{\theta} T}} \right) e^{ra}$$

where

- Y is life-time resources/permanent income
- $\gamma(a)$ is share of life-time resources received up to age a

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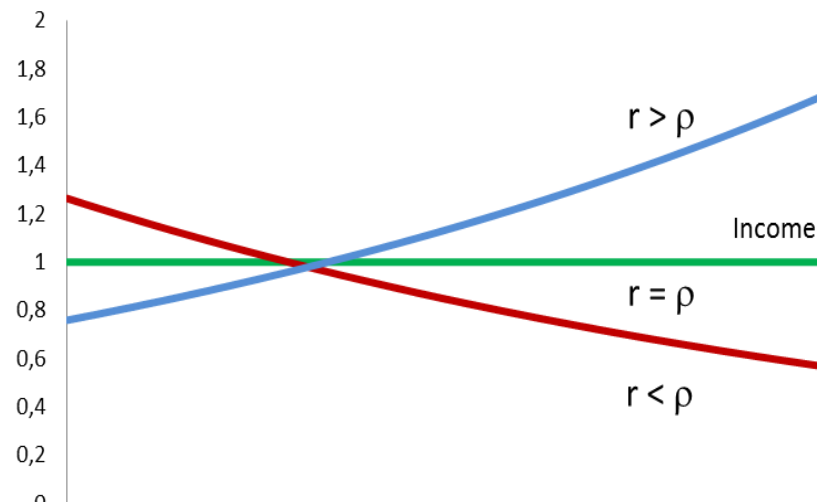
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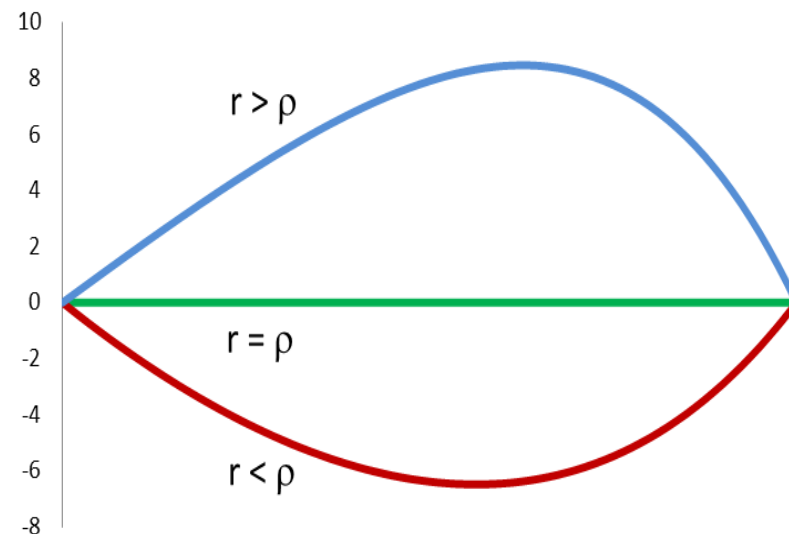
where

- Y is life-time resources/permanent income
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Income/consumption over the lifecycle



Wealth over the lifecycle



Savings Theory

Lessons

- Patient individuals hold more wealth *at all ages* in the life cycle
 (Conditional on permanent income, timing of income, market interest rate, CRRA parameter)
- No clear cross sectional relationship between patience and levels of consumption and savings \Rightarrow focus on wealth
- Borrowing constraints
 - Low-patience individuals more likely to be borrowing constrained
 - No patience-wealth relationship for borrowing constrained individuals (\Rightarrow mutes the association btw. patience and wealth inequality)

Data: overview

Experimental data

Online Experiment 2015

Invite individuals born in
Copenhagen 1973-83

3620 respondents

Choice tasks measuring:

- Patience
- Risk aversion
- Altruism

Typical after-tax payout:
245 DKK (\approx €33)

Pay-out transferred
directly to bank account

CPR



Administrative data

Info during adulthood about

- Wealth
 - Bank deposits
 - Market value stocks, bonds
 - Tax assessed property value
 - Pension wealth and market value of cars (only 2014-)
- Income
- Education
- Demographics

Also information for

- non-respondents
- 10% random sample

Data construction: Experiment



Notes: (a) Five savings tasks with different gains from postponing
(b) 100 points = DKK 25 ≈ €3.60

Data construction: Experiment

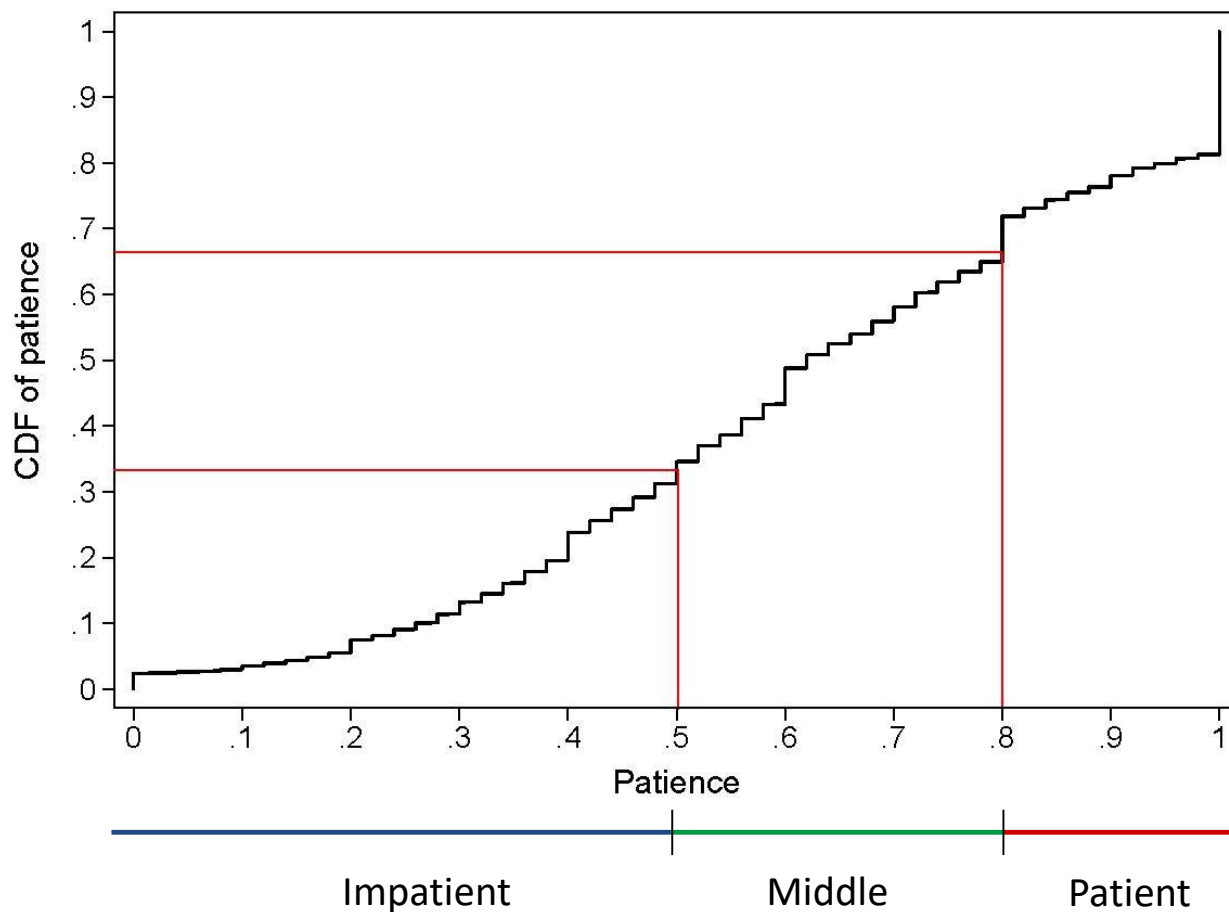
The interface shows a choice between two options: "save more +" and "save less -". The "save more +" option is selected, indicated by a blue bar. Below this, there are four green bars, each containing the number "100". To the right of these bars are four grey bars, each containing the number "105". A blue bar in the center contains the text "you keep 400", "you save 600", and "you receive 630". Below this, there are seven grey bars, each containing the number "100", and seven green bars, each containing the number "105". At the bottom, there are three columns labeled "today", "in 8 weeks", and "in 16 weeks". A red "Confirm" button is located at the bottom right.

today	in 8 weeks	in 16 weeks
	save more +	
	save less -	
	100	105
	100	105
	100	105
	100	105
	you keep 400	you receive 630
	you save 600	
	100	105
	100	105
	100	105
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	100	105
	100	105
	100	105
		Confirm

Notes: (a) Five savings tasks with different gains from postponing
(b) 100 points = DKK 25 ≈ €3.60

Data construction: Elicited patience

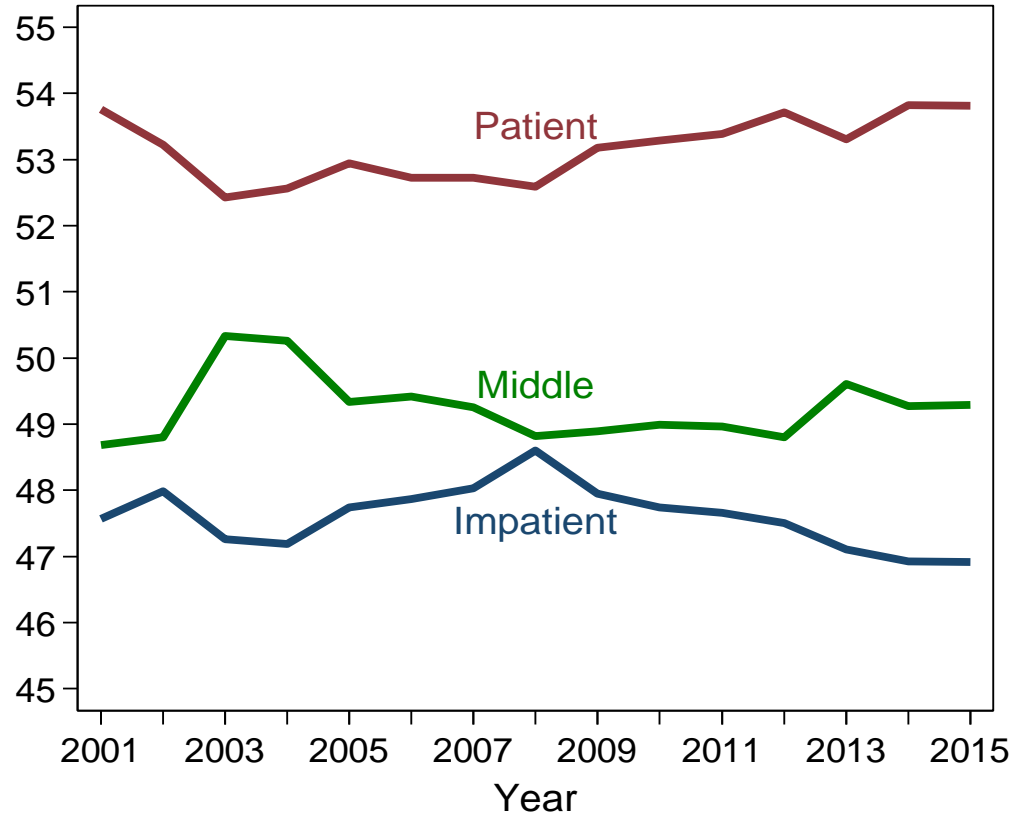
Measure of patience: $\text{mean}\left(\frac{z_1}{10}, \dots, \frac{z_n}{10}\right)$, where z_i is # blocks saved



Results:

Patience and position in the wealth distribution

Wealth rank by patience group, 2001-2014

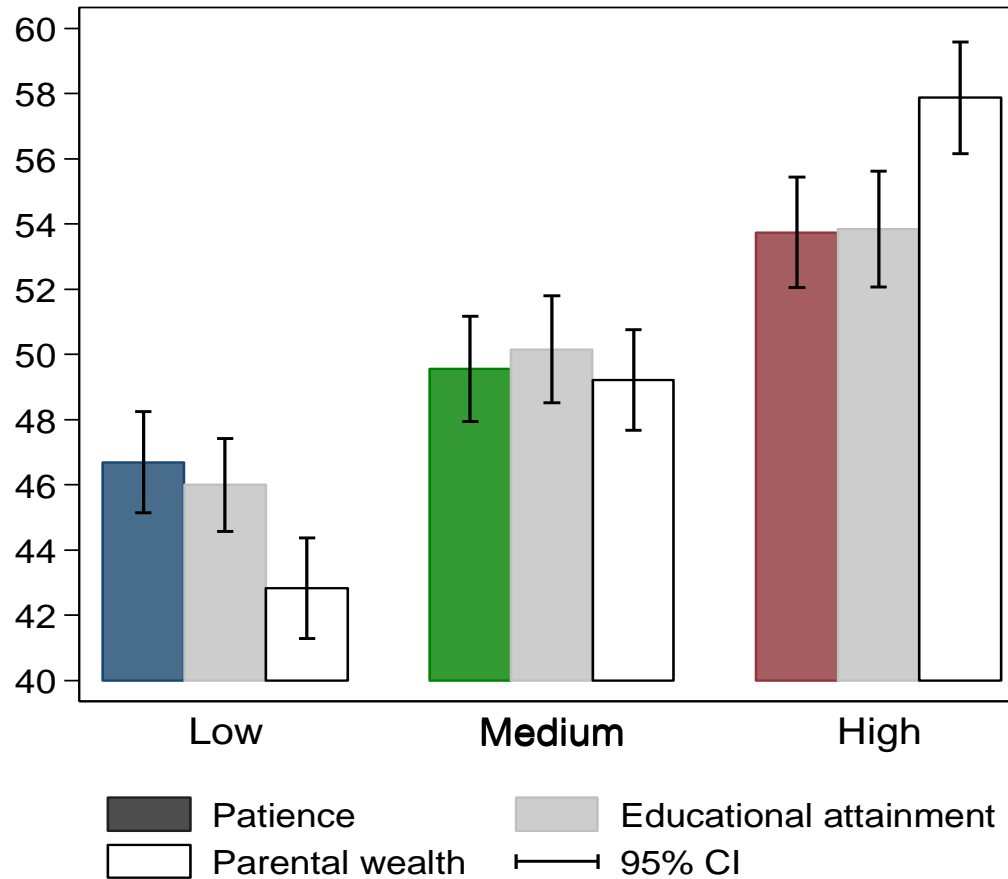


Stable association over more than a decade

Results:

Patience and position in the wealth distribution

Wealth rank by patience, education, and parental wealth

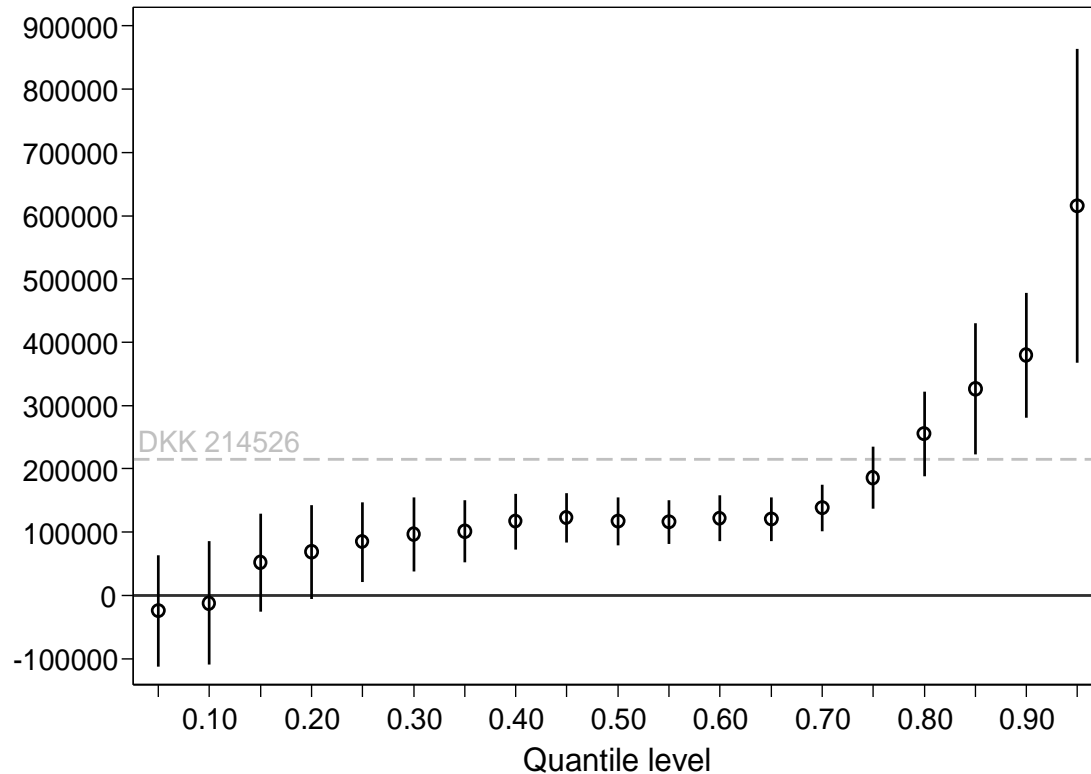


Association is quantitatively important

Results:

Patience and position in the wealth distribution

Quantile regression of wealth on patience



Association exists throughout the wealth distribution

Results:

Effect still large in multivariate setting

Dep. var.: Wealth	(1) Rank	(2) Rank	(3) Rank	(4) DKK	(5) Rank	(6) Rank	(7) Rank	(8) Rank
Patience	11.37*** (1.73)	9.59*** (1.75)	8.45*** (1.75)	146914.66*** (39742.53)	9.45*** (1.92)	-1.44 (2.29)	11.14*** (2.41)	7.71*** (2.25)
Risk aversion			2.53 (2.04)	49227.45 (56820.65)	2.45 (2.04)	-2.81 (2.84)	5.31* (2.70)	3.18 (2.54)
Altruism					-3.67 (2.16)			
Future bias=1					2.58 (1.32)			
Present bias=1					1.23 (1.33)			
Non-monotonic choices in time tasks=1					-1.99 (1.07)			
Interest rate on liquidity								-1.63*** (0.10)
Owned stocks, 2008-2014=1								6.21*** (1.56)
Rate of return on stocks, 2008-2014								0.36 (0.54)
Year dummies for educational attainment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gross income decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
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Demographic controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
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Constant	42.81*** (1.16)	39.56*** (1.82)	31.84*** (3.94)	-305236.88*** (82509.23)	32.13*** (4.24)	38.56*** (4.95)	26.64*** (6.40)	45.80*** (6.00)
Observations	3620	3620	3552	3552	3552	1353	2157	2157
Adj. R-squared	0.01	0.02	0.08	0.08	0.08	0.03	0.08	0.19

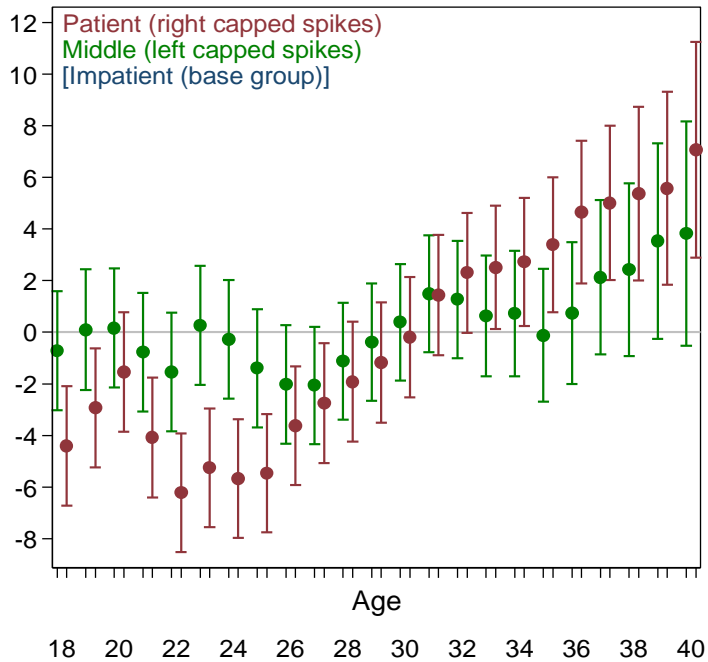
Bivariate

Results:

Controlling for level and timing of income

Patient individuals have different permanent income and timing of income

Income profiles and patience



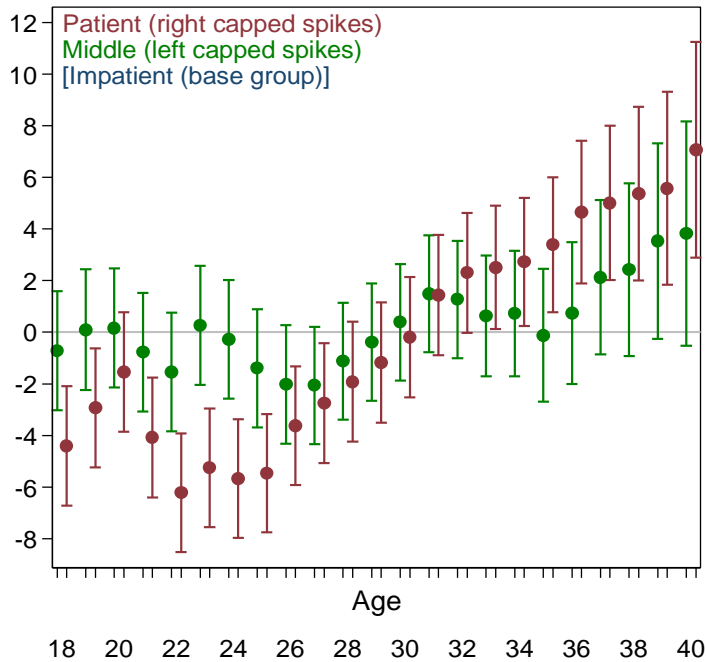
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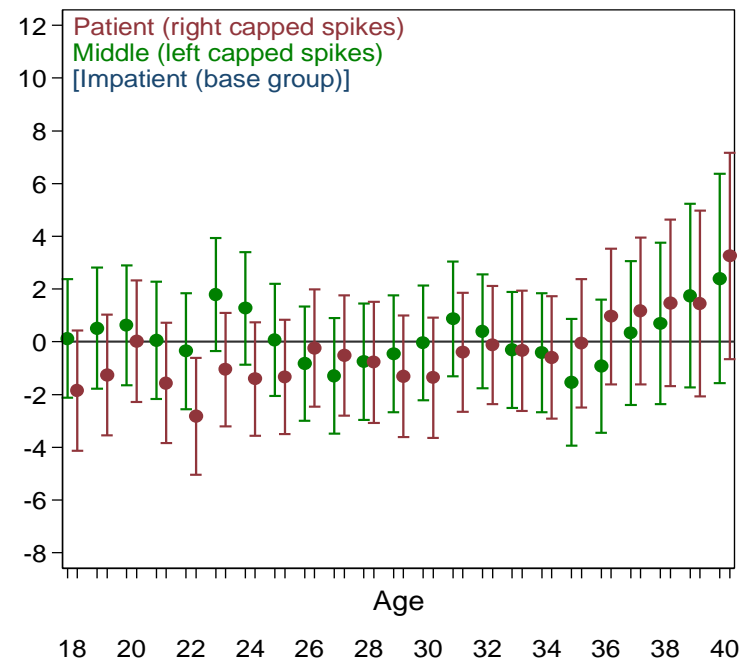
Patient individuals have different permanent income and timing of income

These differences vanish when controlling for education

Income profiles and patience



After controlling for education



Results:

Effect still large in multivariate setting

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Risk aversion + Education + Income + Income growth + Expected income growth
+ GPA + Initial wealth + Parental wealth + Demographics

Results:

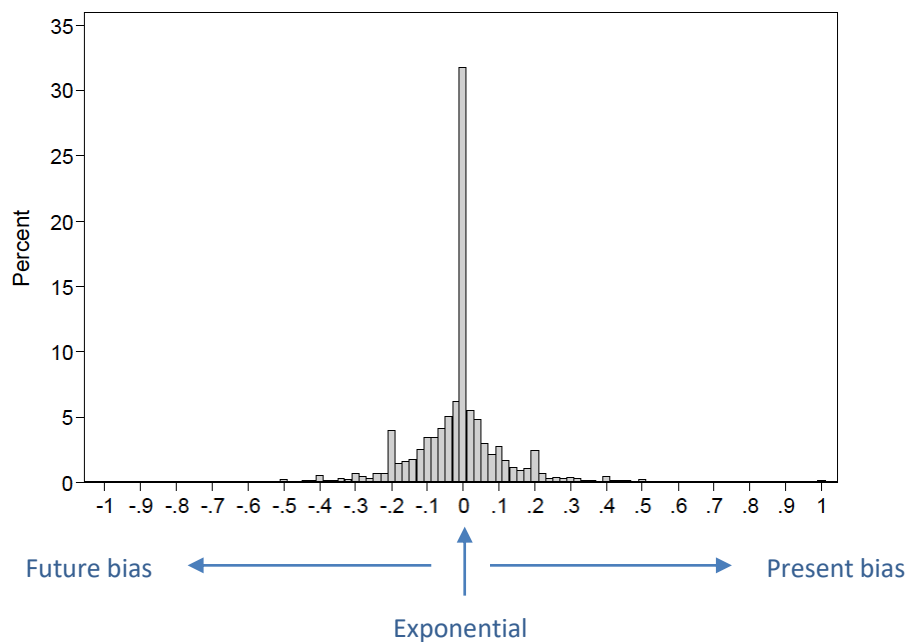
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Quantitative effect still large with
controls (median: 487k)

Non-constant discounting and monotonicity violations

- Non-constant discounting:
 - # blocks paid out early: (0;8) - (8;16)
 - For each of five interest rates offered in the experiment
 - Calculate average within each individual.



- Monotonicity violations in choice tasks: dummy.

Results:

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Parental wealth decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Wealth at age 18 decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Demographic controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Age dummies	No	No	No	Yes	No	No	No	No
Constant	42.81*** (1.16)	39.56*** (1.82)	31.84*** (3.94)	-305236.88*** (82509.23)	32.13*** (4.24)	38.56*** (4.95)	26.64*** (6.40)	45.80*** (6.00)
Observations	3620	3620	3552	3552	3552	1353	2157	2157
Adj. R-squared	0.01	0.02	0.08	0.08	0.08	0.03	0.08	0.19

Non-constant time discounting +
monotonicity violations + altruism

- **Credit constraint:** $1[\text{Liquid assets} < 1 \text{ month disposable income}]$
E.g. Zeldes 1989; Johnson et al. 2006; Leth-Petersen 2010

- **Soft credit constraint / marginal interest rate**
 - Use account level data for all our subjects (from tax authorities), 2014
 - Marginal interest rate = highest rate from loan accounts or lowest rate from deposit accounts if no loans
 - Kreiner et al. (AEJ: POL 2019)

- **Stock market participation and rate of return**
E.g. Fagereng et al. (2018)

Results:

Effect still large in multivariate setting

Dep. var.: Wealth	(1) Rank	(2) Rank	(3) Rank	(4) DKK	(5) Rank	(6) Rank	(7) Rank	(8) Rank
Patience	11.37*** (1.73)	9.59*** (1.75)	8.45*** (1.75)	146914.66*** (39742.53)	9.45*** (1.92)	-1.44 (2.29)	11.14*** (2.41)	7.71*** (2.25)
Risk aversion			2.53 (2.04)	49227.45 (56820.65)	2.45 (2.04)	-2.81 (2.84)	5.31* (2.70)	3.18 (2.54)
Altruism					-3.67 (2.16)			
Future bias=1					2.58 (1.32)			
Present bias=1					1.23 (1.33)			
Non-monotonic choices in time tasks=1					-1.99 (1.07)			
Interest rate on liquidity								-1.63*** (0.10)
Owned stocks, 2008-2014=1								6.21*** (1.56)
Rate of return on stocks, 2008-2014								0.36 (0.54)
Year dummies for educational attainment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gross income decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Steepness of income profile decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Expected income growth decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Self-reported school grades decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Parental wealth decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Wealth at age 18 decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Demographic controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Age dummies	No	No	No	Yes	No	No	No	No
Constant	42.81*** (1.16)	39.56*** (1.82)	31.84*** (3.94)	-305236.88*** (82509.23)	32.13*** (4.24)	38.56*** (4.95)	26.64*** (6.40)	45.80*** (6.00)
Observations	3620	3620	3552	3552	3552	1353	2157	2157
Adj. R-squared	0.01	0.02	0.08	0.08	0.08	0.03	0.08	0.19

Low / high
Split by hard constraint

Results:

Effect still large in multivariate setting

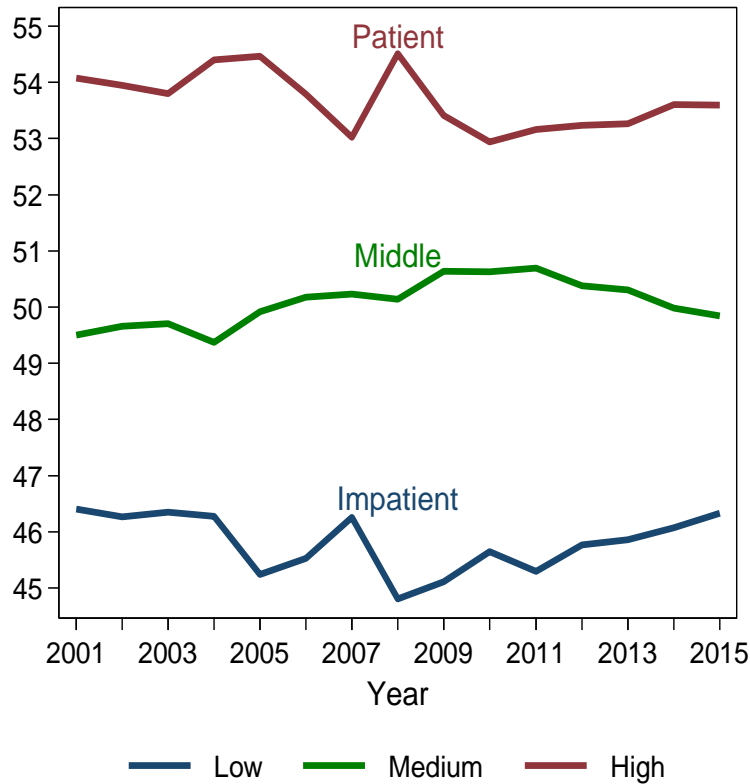
Dep. var.: Wealth	(1) Rank	(2) Rank	(3) Rank	(4) DKK	(5) Rank	(6) Rank	(7) Rank	(8) Rank
Patience	11.37*** (1.73)	9.59*** (1.75)	8.45*** (1.75)	146914.66*** (39742.53)	9.45*** (1.92)	-1.44 (2.29)	11.14*** (2.41)	7.71*** (2.25)
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Demographic controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
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Constant	42.81*** (1.16)	39.56*** (1.82)	31.84*** (3.94)	-305236.88*** (82509.23)	32.13*** (4.24)	38.56*** (4.95)	26.64*** (6.40)	45.80*** (6.00)
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High Liquid asset group: marginal interest rate + stock ownership + stock return

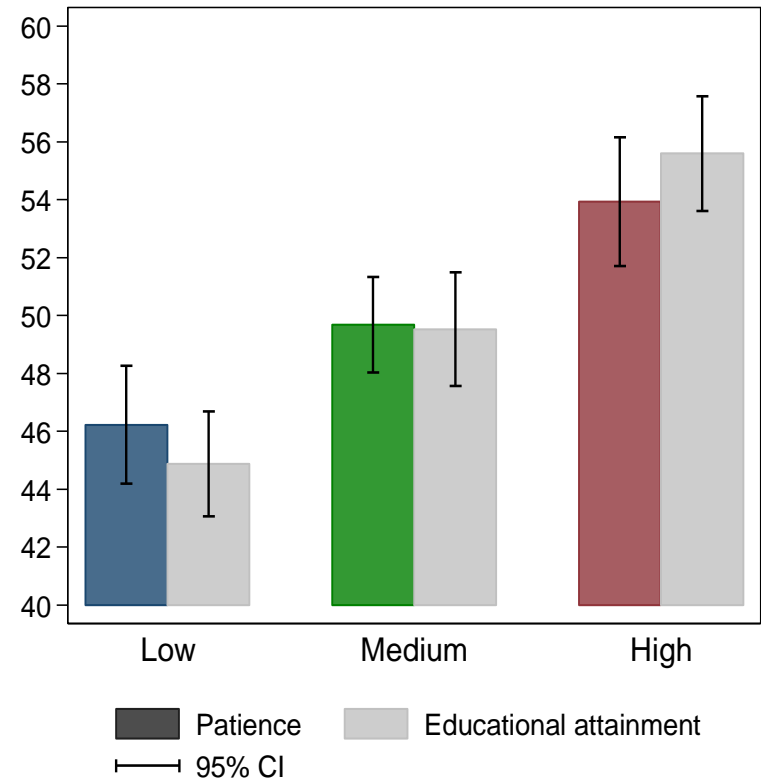
Robustness: Measure of time discounting thirty years earlier

Patience 1973 and wealth rank

Patience 1973 and wealth rank, 2001-2015



Patience 1973 vs education, wealth rank 2001



Robustness - summary

- Broad wealth concept (housing, car assets, pension wealth – only 2014)
- Narrow wealth concept (financial wealth)
- Structural estimation of preferences (RUM), including present bias
- 248 education groups
- Subsample: Stable income (no health events, no unemployment shocks), average income and wealth over 3, 5, 7 years to reduce importance of transitory components...
- Rank based on wealth-to-permanent income
- Selection into experiment: Inverse probability weighting
 - respondents vs. non-respondents
 - respondents vs. population
-

Summary and conclusion

Association between patience and position in the wealth distribution:

- Quantitatively important
- Precisely estimated
- Stable over time
- Operates throughout the wealth distribution

Still large association when including a comprehensive set of theory motivated controls for life-time resources \Rightarrow suggests that savings behaviour is a driver as predicted by standard savings theory

Point to the fruitfulness of incorporating heterogeneous time discounting in models of consumption and savings behavior

Krusell and Smith (1998), Hubmer et al. (2016), Krueger et al. (2016), Carroll et al. (2017), De Nardi and Fella (2017) and Alan et al. (2018)

More generally, the findings suggest that behavioral heterogeneity has an important role to play in the formation of inequality

CENTER FOR
ECONOMIC
BEHAVIOR &
INEQUALITY

Claus Thustrup Kreiner
Oslo Macro Conference
August 2019



UNIVERSITY OF COPENHAGEN



On Our Macro Agenda

**Relative Importance of Behavioral
Heterogeneity for Inequality Formation?**

Claus Thustrup Kreiner Copenhagen
Jeppe Druedahl Copenhagen

...

How much of the observed wealth inequality is due to differences in discounting behavior?

Structural approach

- **Basic framework:** Incomplete market model
- **Circumstances:** Differences in innate abilities, income shocks, shocks to wealth/rate of return
- **Behavioral heterogeneity:** Differences in patience
- **Individual choices:** Education and savings over life cycle
- **Calibration:** Match mean + variance of income and wealth over life cycle AND correlation of patience rank with (a) education choices + (b) income rank over life cycle + (c) wealth rank over life cycle
- **Estimate role of behavioural heterogeneity:** Compute counterfactual wealth inequality without heterogeneity in patience

EXTRA SLIDES

CEBI research program: Beliefs about sources of wealth inequality

Survey findings

random sample, 14119 obs

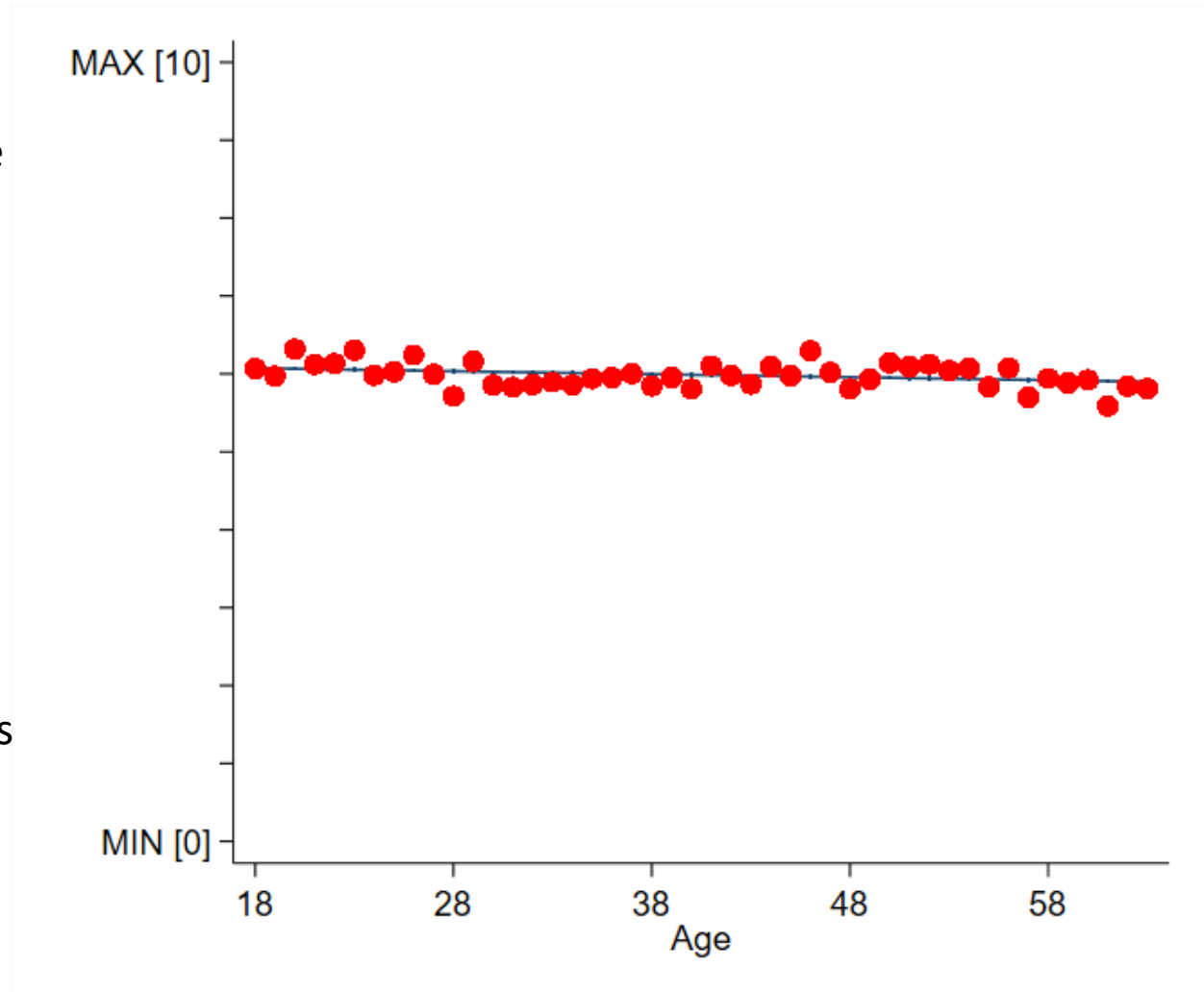
Q: What do you think are the main reasons why there are differences in people's wealth in Denmark?

0 = differences in factors that people do not themselves influence?

[Circumstances]

10 = differences in factors that people themselves influence

[Behavior]



CEBI research program: Beliefs about sources of wealth inequality

Survey findings

random sample, 14119 obs

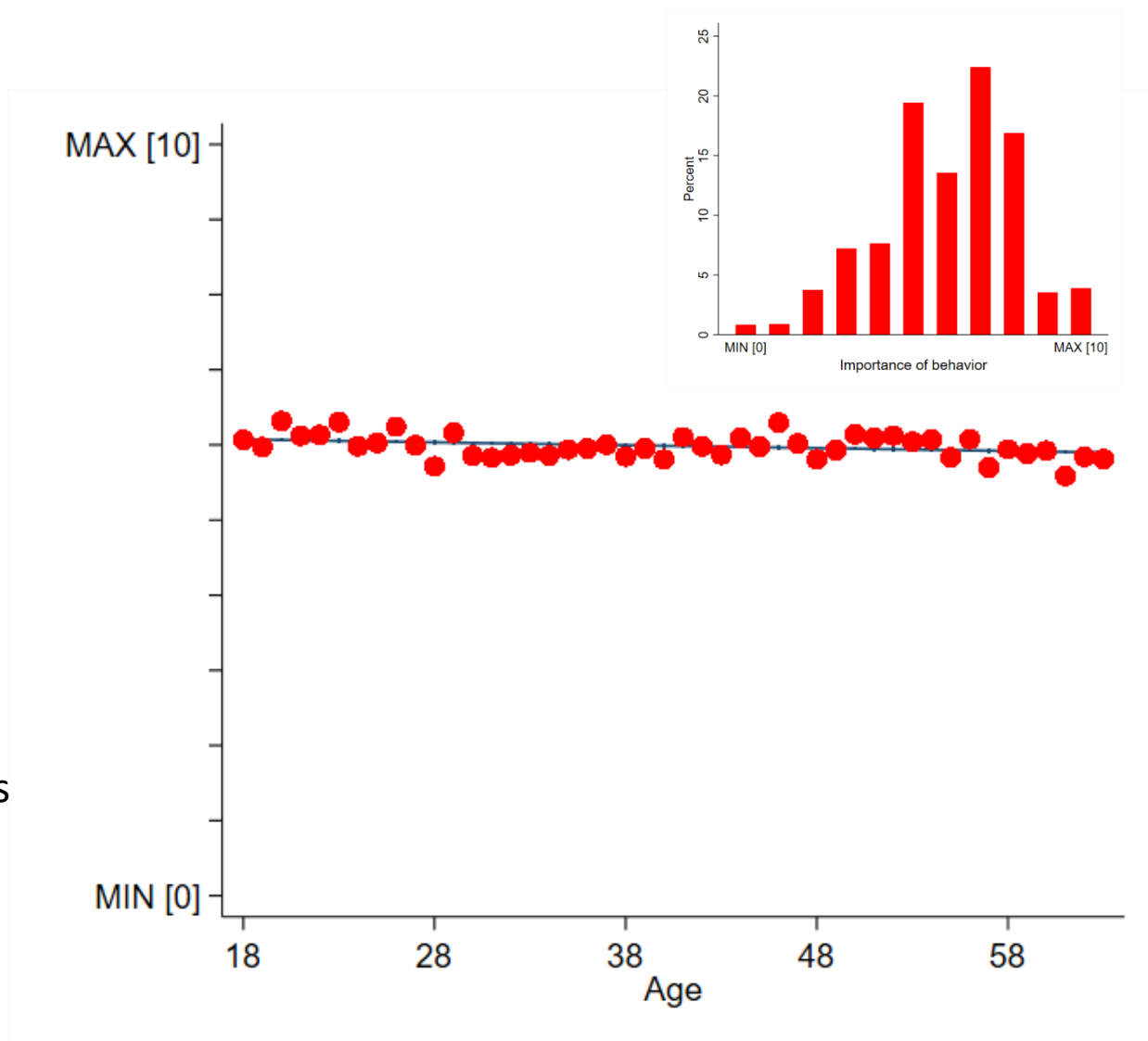
Q: What do you think are the main reasons why there are differences in people's wealth in Denmark?

0 = differences in factors that people do not themselves influence?

[Circumstances]

10 = differences in factors that people themselves influence

[Behavior]



Data construction: Summary statistics

	(1) Respondents vs. non-respondents			(2) Respondents vs. 10% of population	
	(a) Respondents	(b) Non-respondents	(c) Difference, (a)-(b)	(d) Population	(e) Difference, (a)-(d)
Age	37.32	36.46	0.86	37.37	-0.05
Woman (=1)	0.50	0.49	0.01	0.51	-0.01
Single (=1)	0.28	0.38	-0.10	0.28	0.00
Dependent children (=1)	0.61	0.57	0.04	0.63	-0.02
Years of education	14.89	14.16	0.73	14.64	0.25
<u>Gross income distribution</u>					
p5	135745	98974	36772	130343	5402
p25	287472	234966	52506	270900	16572
p50	383040	341611	41429	360132	22908
p75	484472	434678	49795	456263	28209
p95	720178	654999	65179	700517	19661
<u>Wealth distribution</u>					
p5	-337615	-351123	13507	-241803	-95812
p25	93898	48919	44978	144177	-50280
p50	487002	317400	169602	483217	3785
p75	1066942	800074	266868	972420	94522
p95	2397821	2024448	373373	2254289	143532
Observations	3620	23626	27246	67539	71159

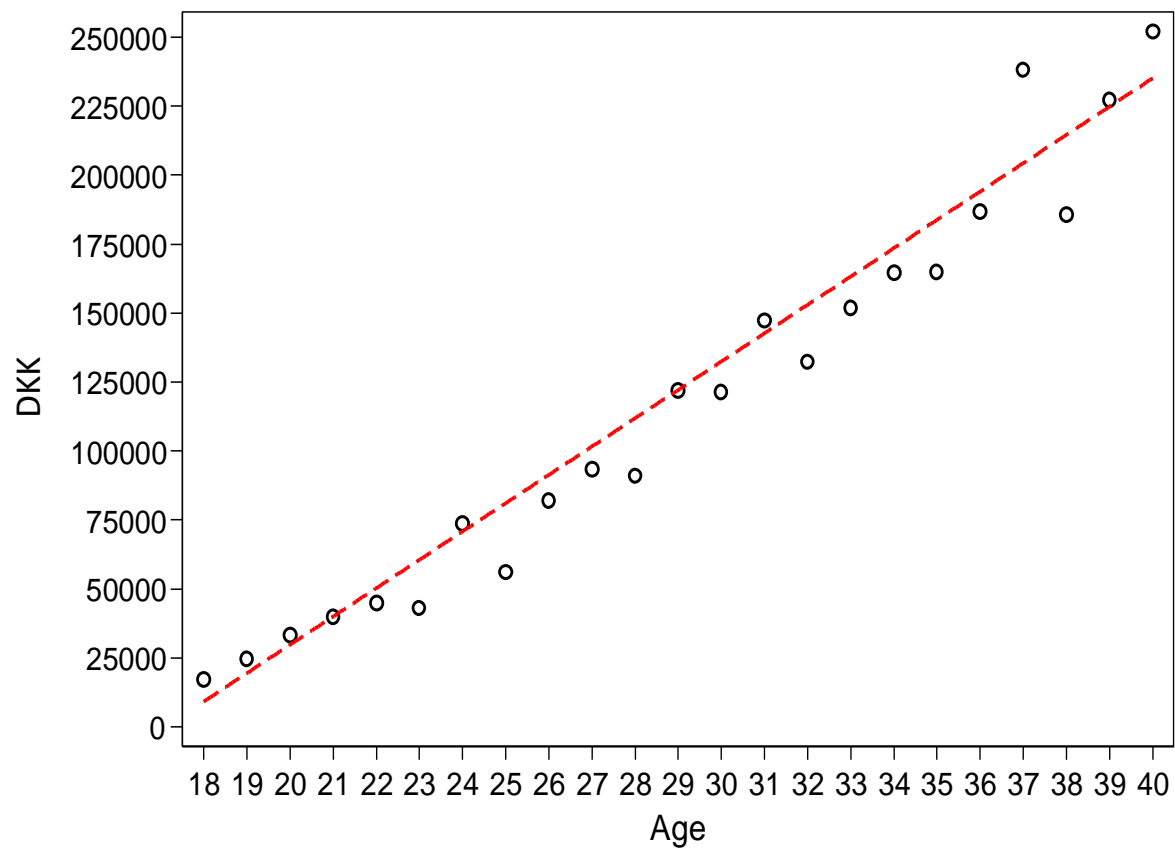
Data construction: Summary statistics

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Age	37.32	36.46	0.86	37.37	-0.05
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Relationship between wealth and patience by age



Early measurement of time discounting

Danish Longitudinal Survey of Youth (DLSY)

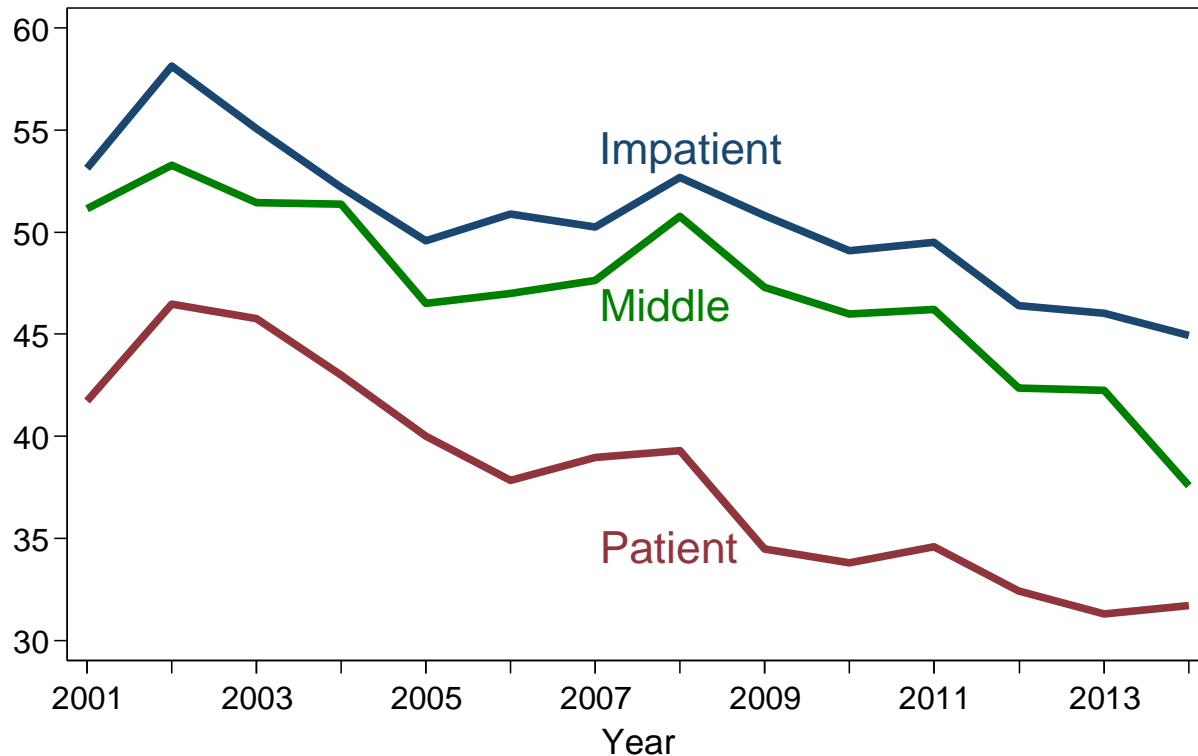
Crude measure of time discounting collected in 1973 for a sample of 2,389 individuals from the 1952-1955 cohorts

If given the offer between the three following jobs, which one would you choose?

- (i) A job with an average salary from the start (impatient)*
- (ii) A job with low salary the first two years but high salary later (middle).*
- (iii) A job with very low salary the first four years but later very high salary (patient)*

Results:

Credit constraints, market interest rates, asset returns



Persistent differences across patience groups over a long period \Rightarrow

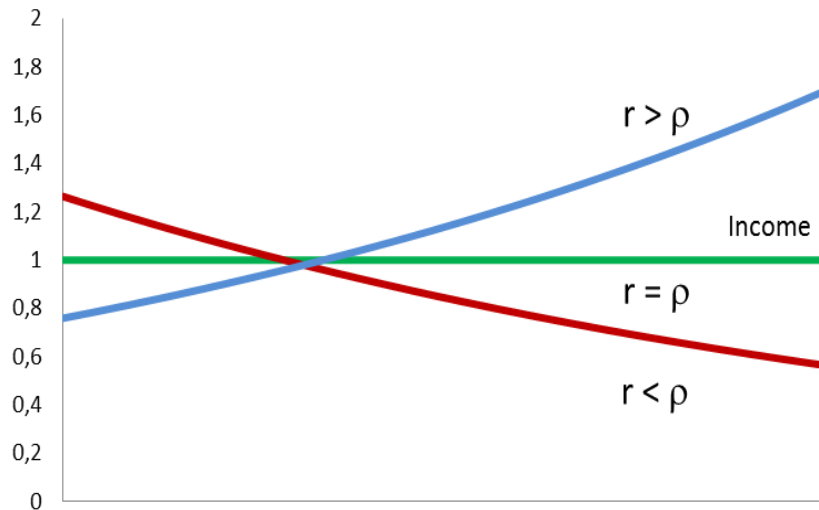
- pattern not generated by short-term shocks
- suggests a persistent behavioural factor at work

Early measurement of time discounting

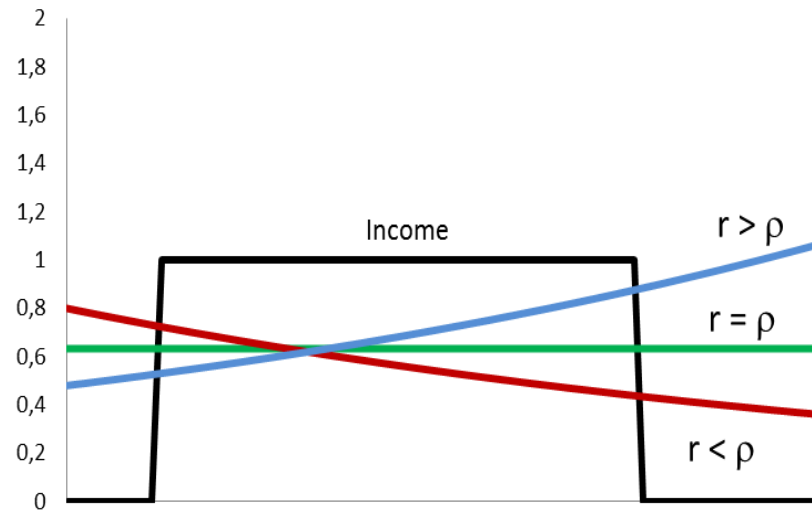
Dep. var.: Wealth	(1) Rank	(2) Rank	(3) DKK
Patience, high	7.71*** (1.54)	3.24* (1.51)	111500.56* (44864.69)
Patience, medium	3.49** (1.34)	1.54 (1.30)	55350.96 (57706.25)
Year dummies for educational attainment	No	Yes	Yes
Gross income decile dummies	No	Yes	Yes
Wealth decile dummies, 1983	No	Yes	Yes
Demographic controls	No	Yes	Yes
Constant	46.23*** (1.04)	25.69*** (2.89)	-120010.35 (216098.58)
Observations	2546	2546	2546
Adj. R-squared	0.01	0.13	0.03

Savings Theory

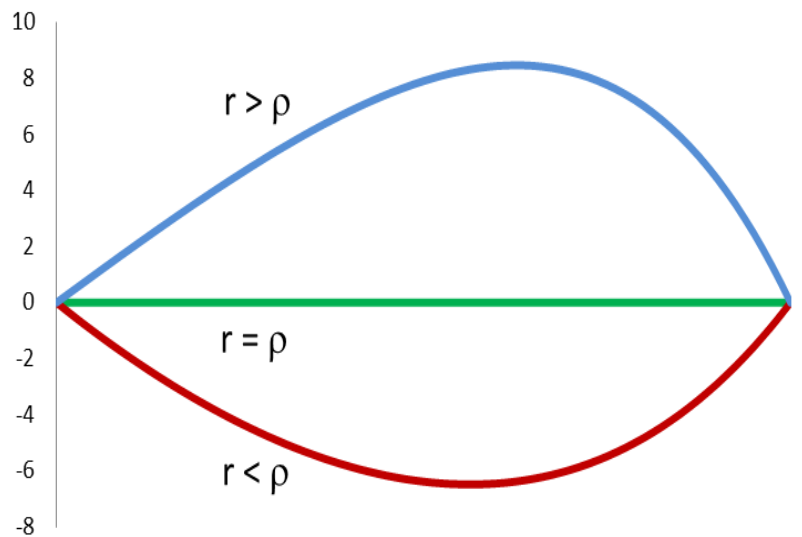
Income/consumption over the lifecycle



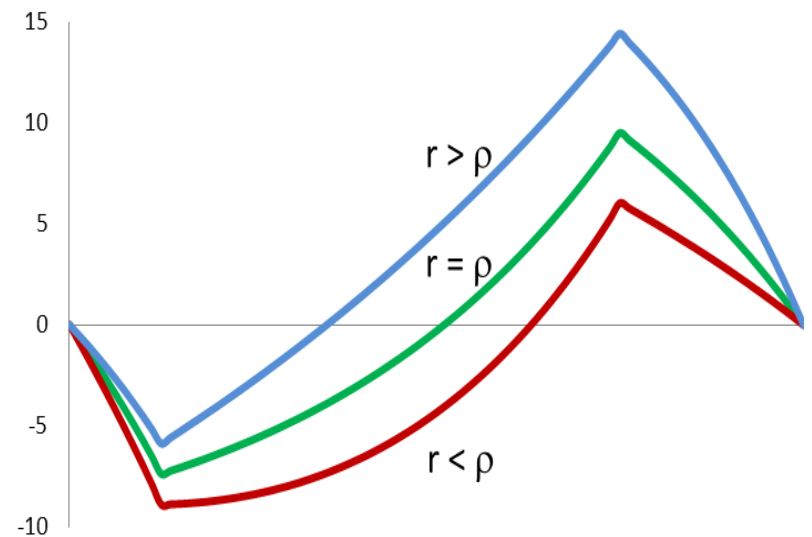
Income/consumption over the lifecycle



Wealth over the lifecycle



Wealth over the lifecycle



Some open issues

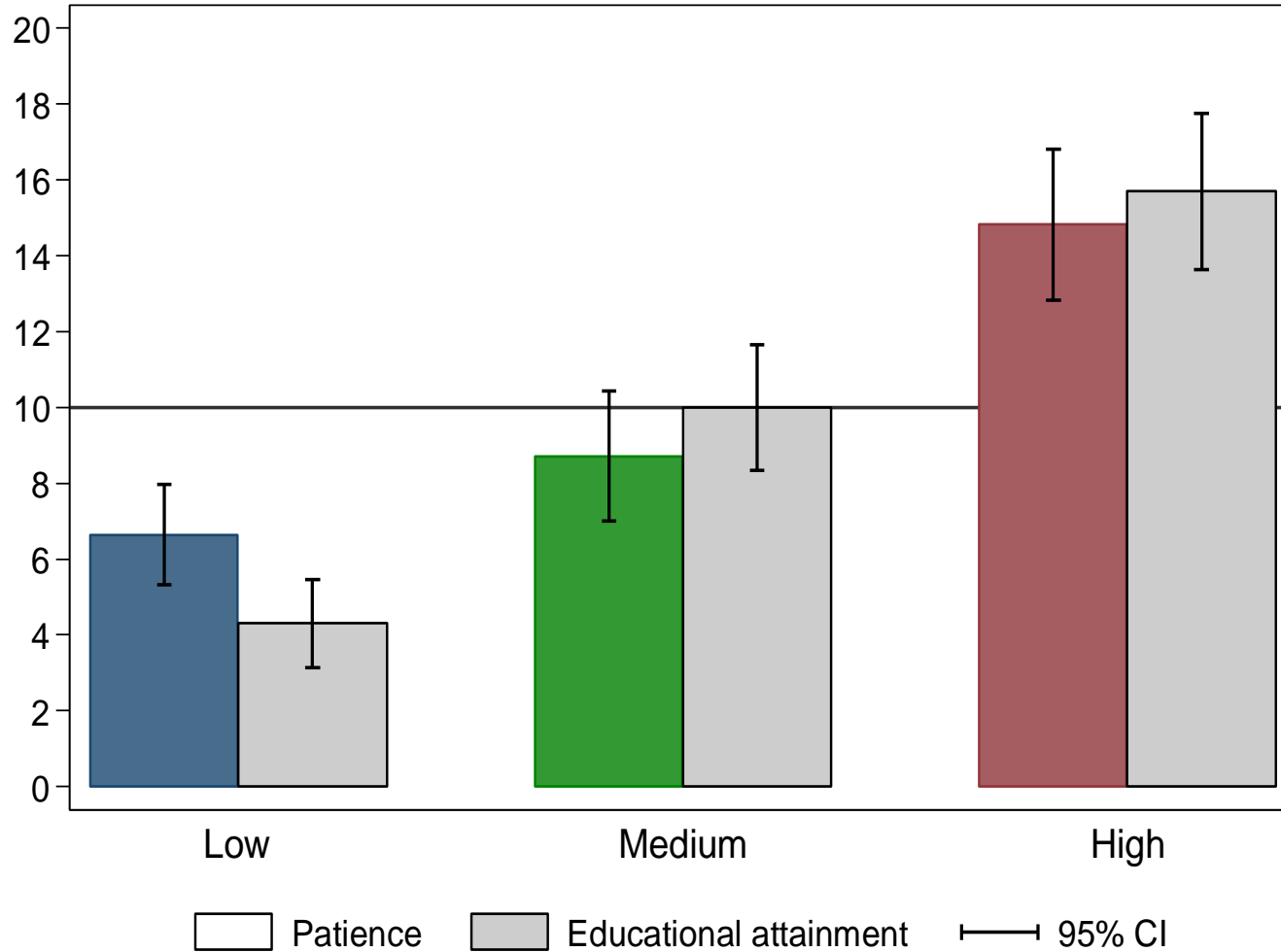
Closer link between experimental literature and Macro?

- Making a direct link between experimentally elicited discounting behavior and discount rates entering models of aggregate savings behavior would be a natural next step, but a challenge in practice...
- Elicited discount rates in small-stake experiments much higher than what is implied by aggregate models of discounting (our results rely only on the ordering of patience across individuals)

Normative implications?

- Differences in patience generate wealth inequality for individuals having similar life-time consumption possibilities (equal opportunities) \Rightarrow does not call for redistribution policy
- High degree of impatience may reflect behavioral biases, which might call for policies that reduce wealth inequality, e.g. forced pensions savings schemes (Chetty et al 2014)

Results: Top 10% wealthiest



APPENDIX: Mirrleesian optimal tax theory

Example: Standard Mirrleesian optimal tax theory

$$\max_{T(z)} \int_{\underline{\theta}}^{\bar{\theta}} S \left(u \left(z - T(z), \frac{z}{\theta} \right) \right) f(\theta) d\theta \quad \text{st.} \quad \int_{\underline{\theta}}^{\bar{\theta}} T(z) f(\theta) d\theta \geq 0$$

where $S(\cdot)$ is social prefs, $u(\cdot)$ is individual utility, z is earnings, $T(\cdot)$ is the tax function, and θ is the hourly wage rate (innate ability).

Variation in abilities (θ) \Rightarrow unequal income \Rightarrow redistribution policy

Example: Standard Mirrleesian optimal tax theory

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Variation in abilities (θ) \Rightarrow unequal income \Rightarrow redistribution policy

Alternative interpretation

Variation in leisure preferences (θ) \Rightarrow unequal income \Rightarrow redistribution policy?

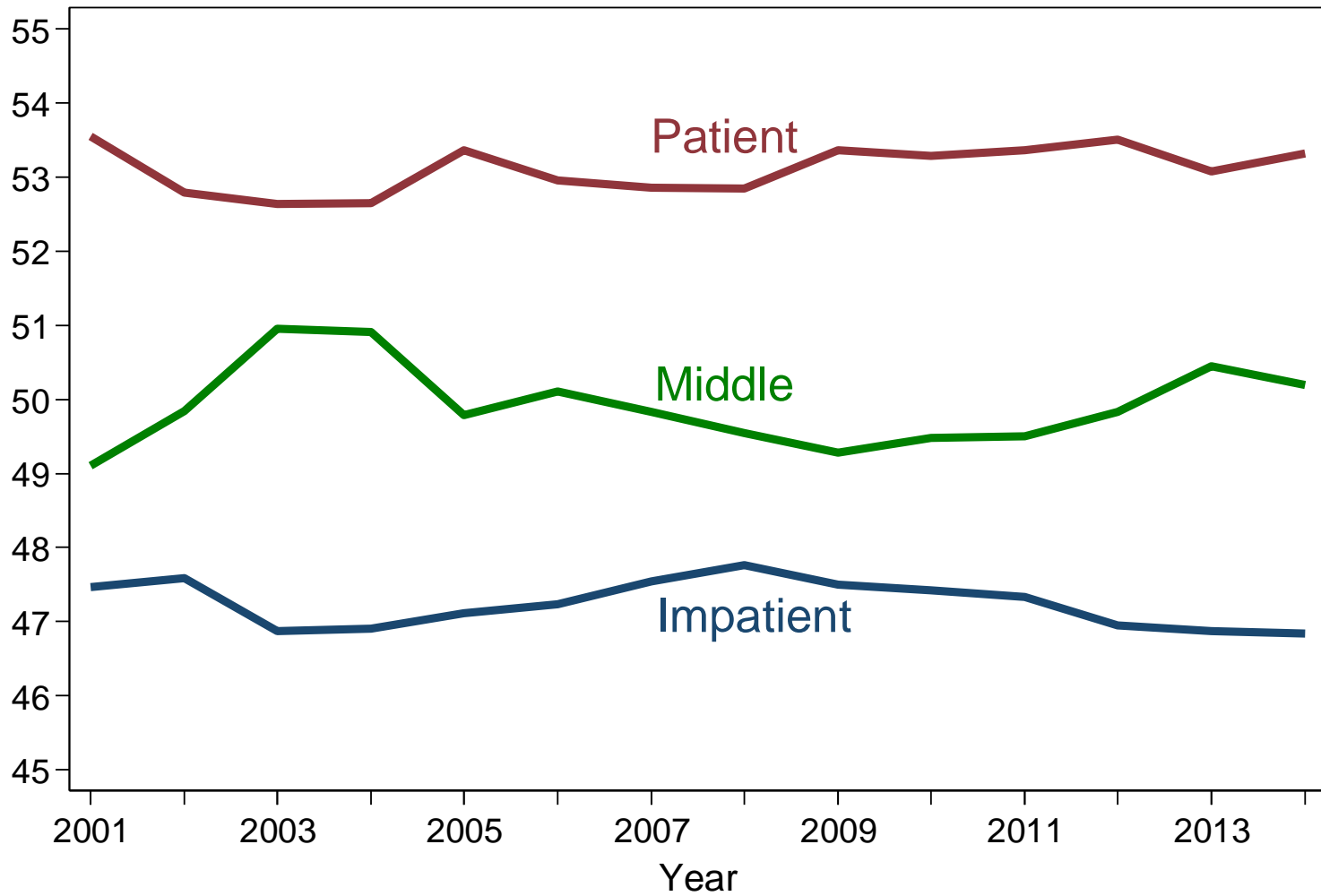
Unequal opportunities in the standard model, but not in the alternative interpretation!

APPENDIX I

FURTHER SENSITIVITY ANALYSES

Results:

Rank based on wealth to permanent income



Note: Dependent variable is the percentile rank of net wealth/average income (avg 2012-2014)

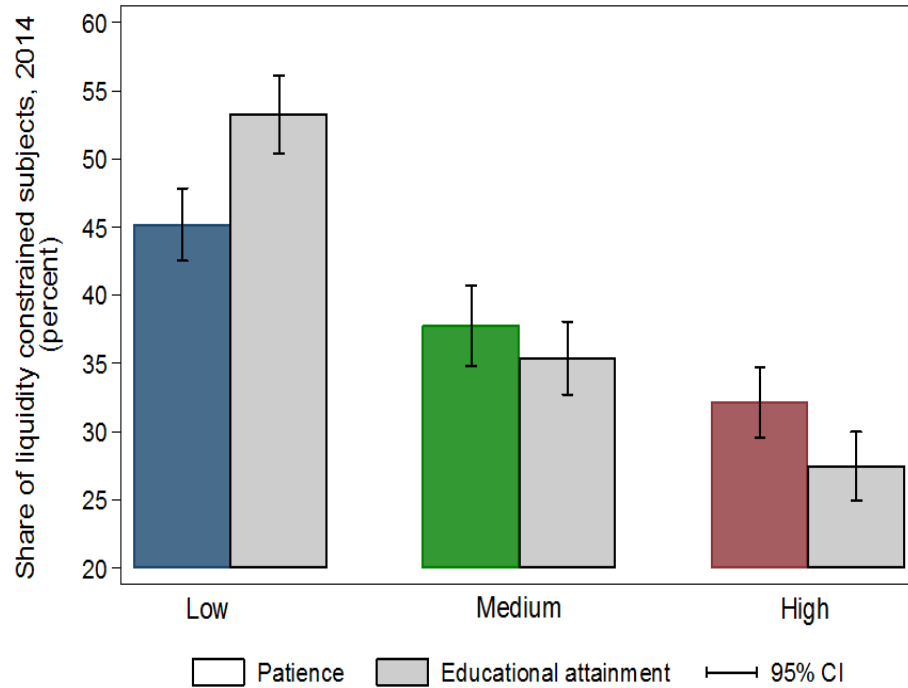
Robustness analyses: Regressions with savings rates

Dep. var.: Savings rate percentile rank	(1) (W_t - W_{t-1})/Y_t	(2) (W_14 - W_04)/Y_14
Patience	1.67*** (0.45)	5.29*** (1.54)
Risk aversion	1.25* (0.57)	4.39* (1.96)
Year dummies for educational attainment	Yes	Yes
Gross income decile dummies	Yes	Yes
Self-reported school grades decile dummies	Yes	Yes
Parental wealth decile dummies	Yes	Yes
Demographic controls	Yes	Yes
Year dummies	Yes	No
Constant	34.02*** (1.49)	38.24*** (3.44)
Observations	36320	3352
Adj. R-squared	0.03	0.03

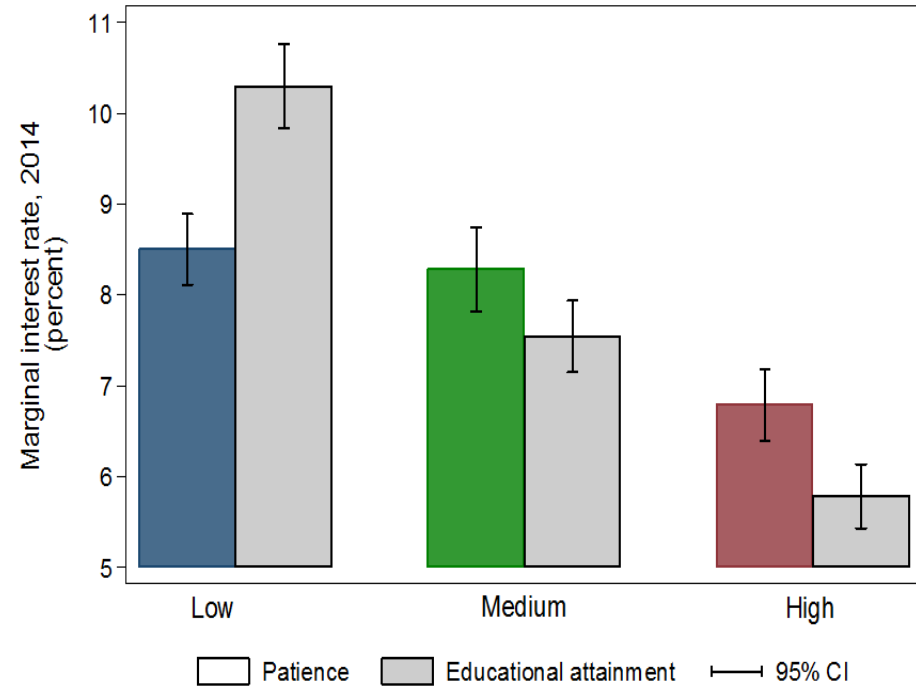
Results:

Credit constraints, market interest rates, asset returns

Hard credit constraints

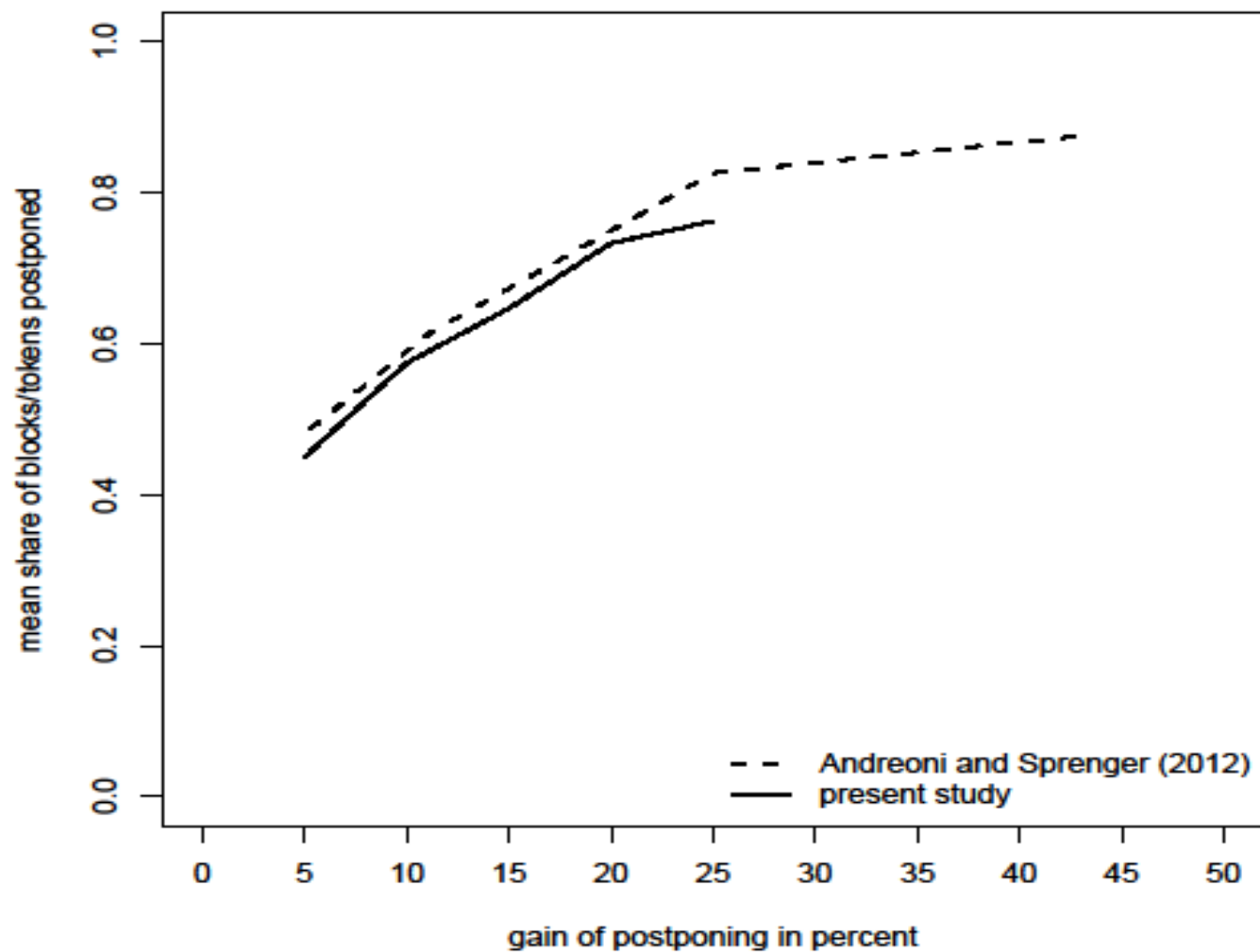


Soft credit constraints



APPENDIX II
COMPARISON TO PREVIOUS EXPERIMENTAL STUDIES
ESTIMATION OF DISCOUNT RATES

Comparison of distribution of choices



Structural estimation of time discounting

RUM with discount rate + linear utility + additive choice noise

Mean discount rate: 0.52

Nonparametric impatience index and estimated discount rates highly correlated : Spearman's rho = 0.92; p = 0.0000

Main table with patience rank based on estimated discount rates

Dep. var.: Wealth percentile rank	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank of estimated discount rate	8.85*** (1.80)	7.54*** (1.81)	7.45*** (1.81)	7.85*** (1.89)	7.22*** (1.86)	6.03** (1.84)	6.24*** (1.86)	6.26*** (1.87)
Risk aversion							2.10 (2.12)	2.12 (2.13)
Year dummies for educational attainment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gross income decile dummies	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Self-reported school grades decile dummies	No	No	No	Yes	Yes	Yes	Yes	Yes
Wealth at age 18 decile dummies	No	No	No	No	Yes	Yes	Yes	Yes
Parental wealth decile dummies	No	No	No	No	No	Yes	Yes	Yes
Demographic controls	No	No	No	No	No	No	No	Yes
Constant	54.72*** (1.06)	51.27*** (1.78)	52.18*** (2.08)	51.51*** (2.59)	44.99*** (2.80)	41.51*** (3.24)	40.60*** (3.36)	40.95*** (3.51)
Observations	3097	3097	3097	2871	2871	2871	2871	2871
Adj. R-squared	0.01	0.02	0.03	0.03	0.05	0.07	0.07	0.07

Structural estimation of time discounting

Quasi-hyperbolic discount function + utility curvature + error term

No evidence of present bias (i.e. choices in 0-2 and 2-4 tradeoffs do not differ significantly)

Only very weak concavity (consistent with most choices being at the boundaries)

Mean discount rate: 0.58

Positive correlation between nonparametric impatience and estimated discount rate (specification 2): Spearman's $\rho = 0.75$; $p = 0.0000$

Structural estimation

- **Specification 1: Discount rate + const. MU of income + error term**
 - Discount function: exponential

$$d(t, \rho) = e^{-\rho \frac{t}{12}}$$

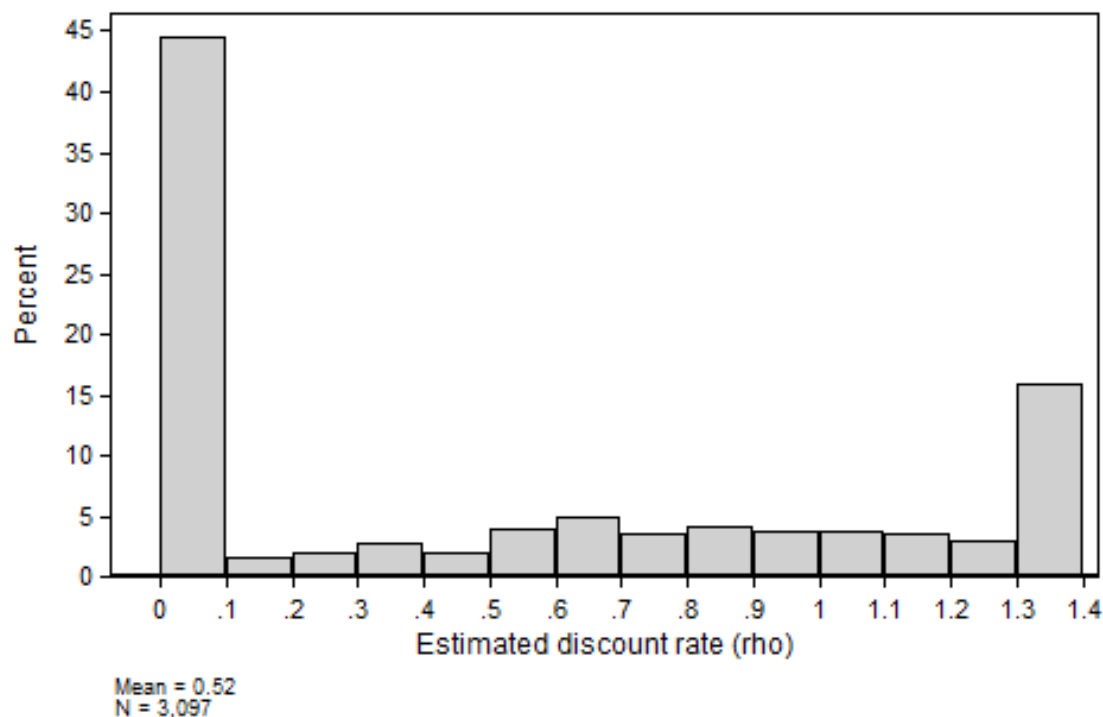
- Stochastic choice: Random Utility Model with additive choice noise => choice probabilities

$$pr(S_j) = pr(U(S_j) - U(S_{-j}) > \varepsilon_{-j} - \varepsilon_j) = \frac{e^{\lambda V(S_j)}}{\sum_{k \in J} e^{\lambda V(S_k)}}$$

- For comparability with our nonparametric measure, we take only the 2-4 mt choice situations
 - Maximum likelihood estimation

Results: Specification 1

- Assign maximum discount rate (1.40) to subjects who always keep all blocks
- Assign minimum discount rate (0.00) to subjects who always save all blocks



- Positive correlation between nonparametric impatience and estimated discount rate (specification 1): Spearman's rho = 0.92; $p = 0.0000$

Structural estimation

- **Specification 2: More flexible discount function + utility curvature + error term**

- Discount function: quasi-hyperbolic

$$d(t = 0, \psi, \rho) = 1$$

$$d(t > 0, \psi, \rho) = (1 - \psi)e^{\frac{-\rho t}{12}}$$

- Utility function: isoelastic

$$u(x, \mu = 1) = \ln x$$

$$u(x, \mu \neq 1) = \frac{x^{1-\mu}}{1-\mu}$$

- Stochastic choice: random utility model with additive choice noise
 - Including all choice situations

APPENDIX III

FURTHER INFORMATION ABOUT EXPERIMENT

Overview over time choice tasks

- X1 (X2) is value of block allocated to t1 (t2)
- Rate is the implied annual rate of return

choiceId	x1	x2	t1	t2	delay	rate	
1	100	105	0	2	2	0.340	
2	100	110	0	2	2	0.772	
3	100	115	0	2	2	1.313	
4	100	120	0	2	2	1.986	
5	100	125	0	2	2	2.815	
6	100	105	0	4	4	0.158	
7	100	115	0	4	4	0.521	
8	100	125	0	4	4	0.953	
9	100	135	0	4	4	1.460	
10	100	145	0	4	4	2.049	
11	100	105	2	4	2	0.340	
12	100	110	2	4	2	0.772	
13	100	115	2	4	2	1.313	-----
14	100	120	2	4	2	1.986	-1.200
15	100	125	2	4	2	2.815	-1.250

Alternative patience measures: Overview over time choice tasks

■ X1 (X

■ Rate

choiceId	x1	x2	t1	t2	delay	rate
1	100	105	0	2	2	0.340
2	100	110	0	2	2	0.772
3	100	115	0	2	2	1.313
4	100	120	0	2	2	1.986
5	100	125	0	2	2	2.815
6	100	105	0	4	4	0.158
7	100	115	0	4	4	0.521
8	100	125	0	4	4	0.953
9	100	135	0	4	4	1.460
10	100	145	0	4	4	2.049
11	100	105	2	4	2	0.340
12	100	110	2	4	2	0.772
13	100	115	2	4	2	1.313
14	100	120	2	4	2	1.986
15	100	125	2	4	2	2.815

2 vs 4 months

Alternative patience measures: Overview over time choice tasks

	choiceId	x1	x2	t1	t2	delay	rate
■ X1 (X	1	100	105	0	2	2	0.340
■ Rate	2	100	110	0	2	2	0.772
	3	100	115	0	2	2	1.313
	4	100	120	0	2	2	1.986
	5	100	125	0	2	2	2.815
	6	100	105	0	4	4	0.158
	7	100	115	0	4	4	0.521
	8	100	125	0	4	4	0.953
	9	100	135	0	4	4	1.460
	10	100	145	0	4	4	2.049
	11	100	105	2	4	2	0.340
	12	100	110	2	4	2	0.772
	13	100	115	2	4	2	1.313
	14	100	120	2	4	2	1.986
	15	100	125	2	4	2	2.815

0 vs 4 months

Alternative patience measures: Overview over time choice tasks

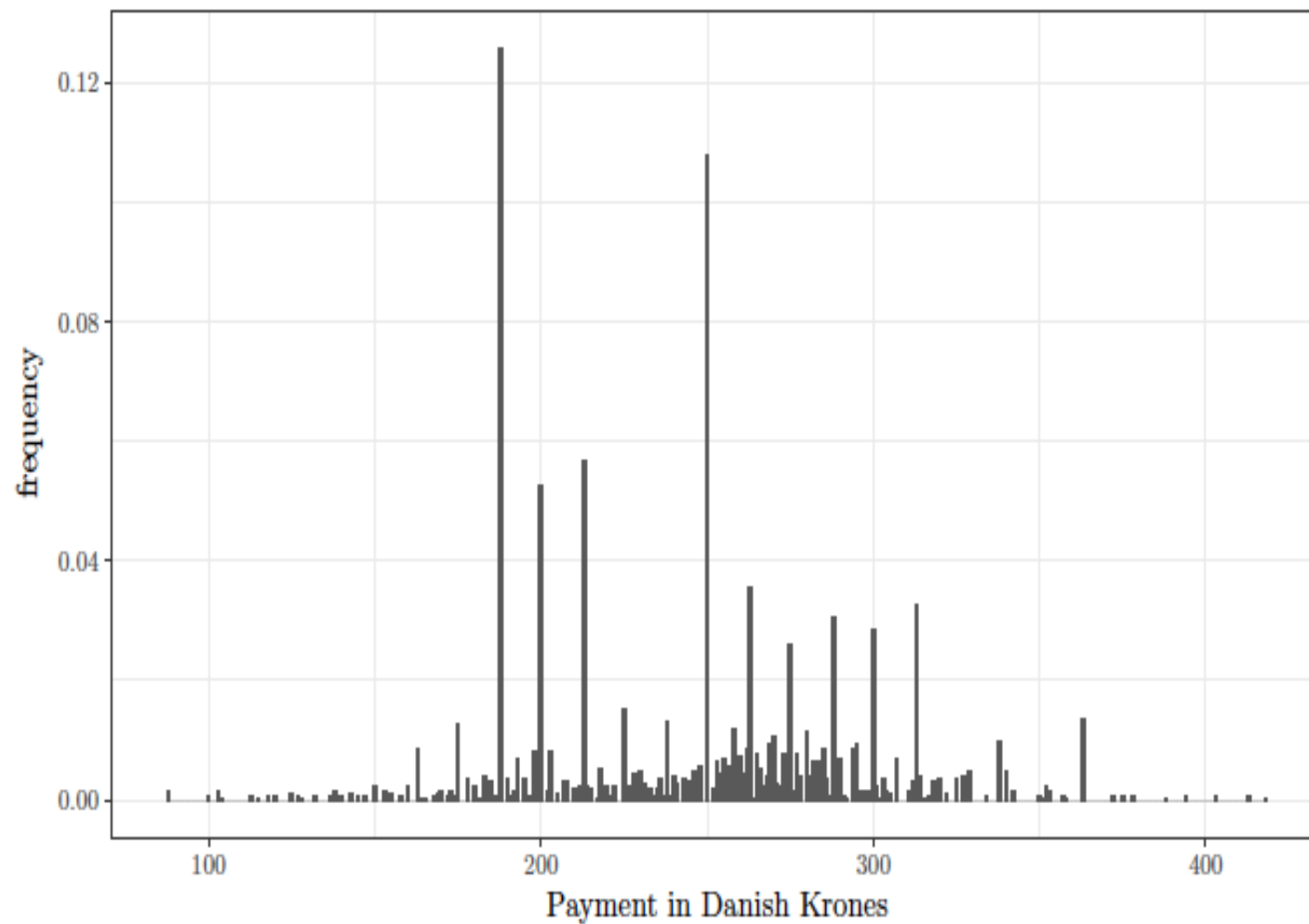
■ X1 (X

■ Rate

0 vs 2 months

choiceId	x1	x2	t1	t2	delay	rate
1	100	105	0	2	2	0.340
2	100	110	0	2	2	0.772
3	100	115	0	2	2	1.313
4	100	120	0	2	2	1.986
5	100	125	0	2	2	2.815
6	100	105	0	4	4	0.158
7	100	115	0	4	4	0.521
8	100	125	0	4	4	0.953
9	100	135	0	4	4	1.460
10	100	145	0	4	4	2.049
11	100	105	2	4	2	0.340
12	100	110	2	4	2	0.772
13	100	115	2	4	2	1.313
14	100	120	2	4	2	1.986
15	100	125	2	4	2	2.815

Distribution of payments from the experiment



Risk Task

invest more +

invest less -



40%

60%

in 40 of 100 cases
you receive a total
of 760

in 60 of 100 cases
you receive a total
of 1240

100		70	130
100		70	130
you keep 200	you invest 800	you receive 560	you receive 1040
100		70	130
100		70	130
100		70	130
100		70	130
100		70	130
100		70	130
100		70	130
100		70	130

Confirm

Risk Choice Situations

choiceId	vb	m1	m2	p
1	100	1.21	0.81	0.5
2	100	1.41	0.91	0.2
3	100	1.11	0.61	0.8
4	100	1.31	0.71	0.5
5	100	1.61	0.86	0.2
6	100	1.16	0.41	0.8
7	100	1.35	0.75	0.5
8	100	1.65	0.90	0.2
9	100	1.20	0.45	0.8
10	100	1.50	0.40	0.6
11	100	1.72	0.62	0.4
12	100	1.45	0.35	0.6
13	100	1.67	0.57	0.4
14	100	1.51	0.50	0.5
15	100	1.61	0.60	0.5

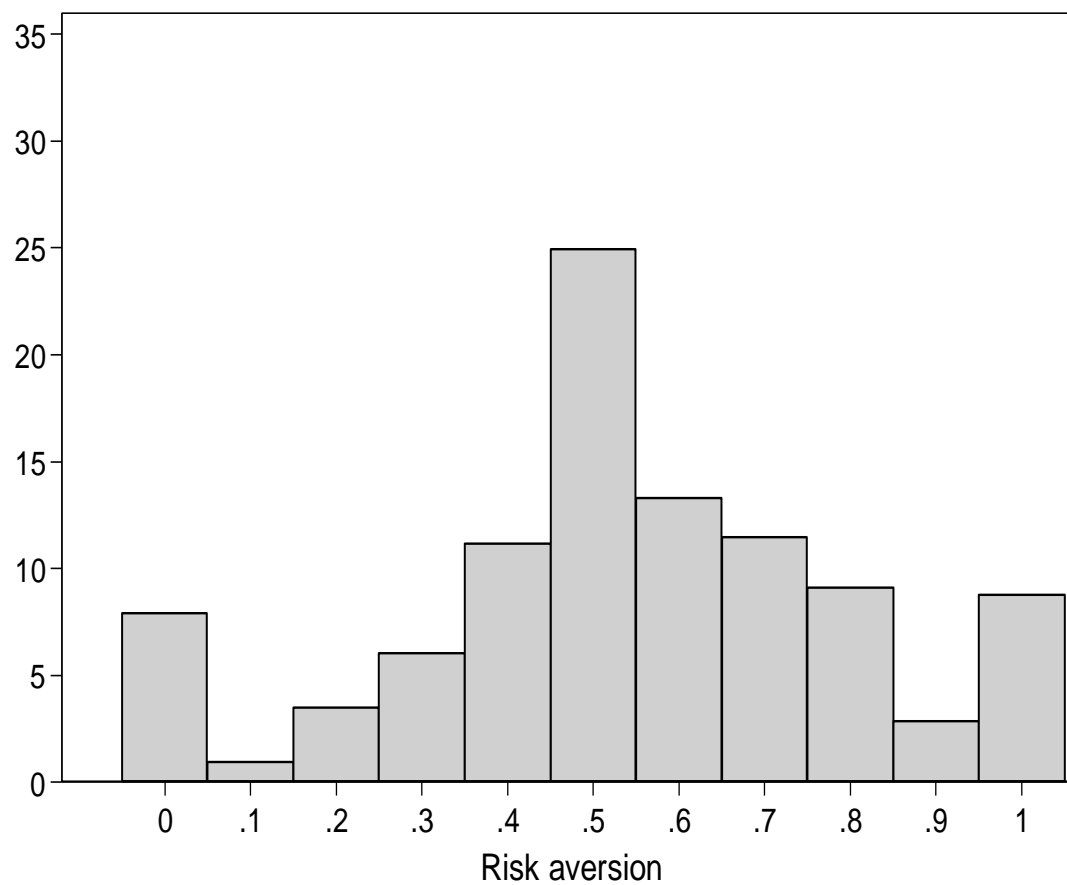
Risk aversion index

- Focus on choice tasks involving $p = 0.5$
- Risk aversion index:

$$\phi_{riskaversion} = average\left(\frac{z}{10}\right)$$

- z is the number of blocks kept in the safe account in each choice situation
- $\phi_{riskaversion} \in [0,1]$. High values indicate greater risk aversion

Distribution of risk aversion measure

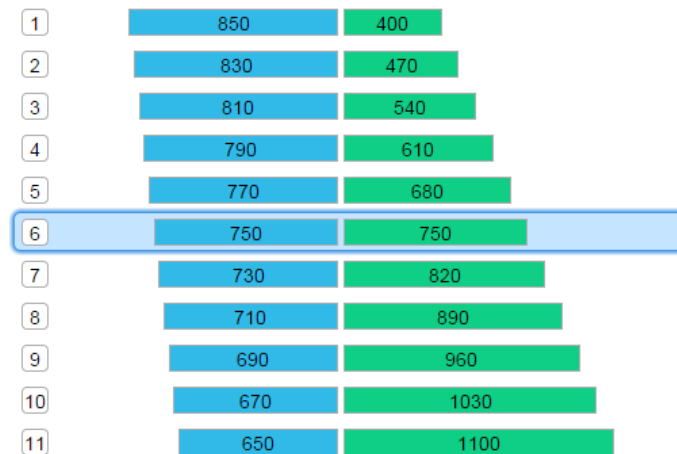


DELING AF PENGEBELØB IMELLEM DIG OG EN ANDEN PERSON

Hjælp

Beslutningssituation 1 af 12

Du får ■ | ■ Anden person får



Bekræft

Altruism index: $\phi_{Altruism} = average\left(\frac{z}{11}\right)$

CRRA

- CRRA has ambiguous effect on wealth depending on the relative size of the rate of time preference and the real interest rate on savings
- $\frac{\partial w}{\partial \theta} \leq 0$ if $r > \rho$ and $\frac{\partial w}{\partial \theta} \geq 0$ if $r < \rho$, and $\frac{\partial w}{\partial \theta} = 0$ if $r = \rho$

	Low patience (1)	Medium patience (2)	High patience (3)	Low patience (4)	Medium patience (5)
Risk aversion	6.06+ (3.16)	5.00 (4.10)	0.46 (2.82)	6.45* (3.14)	5.15 (4.09)
Patience				8.54* (3.82)	9.22 (8.21)
Constant	43.58*** (1.97)	47.85*** (2.28)	52.62*** (1.74)	40.90*** (2.31)	41.14*** (6.40)
Observations	1355	1044	1235	1355	1044
Adj. R-squared	0.00	0.00	-0.00	0.00	0.00

Notes: OLS regressions. Dep. var.: Within-cohort average net asset percentile rank, 2012-2014. Robust standard errors in parentheses. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Columns 4 and 5 control for variation in the patience measure within the 'Low' and 'Medium' patience groups, respectively. In the 'High' patience group, there is no variation in the patience measure (=1 for all).

APPENDIX IV
INVITATION LETTER

Invitation letter (original in Danish)

ØKONOMISK INSTITUT
KØBENHAVNS UNIVERSITET



Kære [REDACTED]

FEBRUAR 2015

Københavns Universitet inviterer dig til at deltage i en undersøgelse på internettet. Undersøgelsen er en del af et forskningsprojekt, der handler om at forstå grundlaget for danskernes økonomiske beslutninger. Vi ved allerede meget mere om folks privatøkonomiske beslutninger, end vi gjorde før den finansielle krise, men der er stadig meget, vi mangler at forstå – og det er derfor, vi spørger om din hjælp.

ØKONOMISK INSTITUT

ØSTER FARIMAGSGADE 5,

BYGNING 26

1353 KØBENHAVN K

TLF 35 33 02 77

analyse@econ.ku.dk

Det tager ca. 30-50 minutter at gennemføre undersøgelsen. Når du er færdig, vil du typisk modtage et præmiebeløb, og det vil automatisk blive overført til din NemKonto. Beløbets størrelse afhænger bl.a. af de valg, som du træffer i undersøgelsen og vil i gennemsnit svare til en god timeløn.

Undersøgelsen foregår på internettet. Du vil bl.a. blive bedt om at tage stilling til spørgsmål om opsparing og investering. Reglerne bliver forklaret, når du har logget ind. Undersøgelsen er åben for deltagelse til og med fredag d. 27. februar 2015.

Datatilsynet har godkendt forskningsprojektet, hvilket betyder, at vores procedurer opfylder persondatalovens krav til behandling af data. En vigtig del af Datatilsynets krav er, at dine svar bliver behandlet anonymt. For at sikre dig anonymitet har vi dannet et tilfældigt brugernavn til dig. For at deltage skal du logge ind på hjemmesiden: analyse.econ.ku.dk.

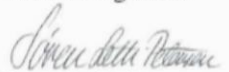
Dataansvarlig: Søren Leth-Petersen,
Professor

Brugernavn: deltager5795

Password: n4mw9!uay

Invitationen er personlig, og vi beder derfor om, at du ikke videregiver brugernavn og password til andre. Du er velkommen til at kontakte os, hvis du har problemer med at logge ind eller har yderligere spørgsmål. Du kan ringe til projektkoordinator Gregers Nytoft Rasmussen på telefonnummer 35 33 02 77 mandag-torsdag kl. 14.00-17.30 eller skrive til adressen analyse@econ.ku.dk.

Med venlig hilsen


Søren Leth-Petersen
Projektleder, professor

Invitation letter (translated into English)

Dear «name»,

University of Copenhagen invites you to participate in a study on the Internet. The study is part of a research project about understanding the basis for the Danes' financial decisions. We already know a lot more about people's personal financial decisions than we did before the financial crisis, but there is still much we need to understand - and that is why we are asking for your help.

It takes about 30-50 minutes to complete the study. When you are finished, you will typically receive prize money and it will be automatically transferred to your NemKonto. The amount depends, i.a., on the choices that you make during the study and will on average correspond to a decent hourly wage.

The study is conducted on the Internet. You will consider questions concerning savings and investments, among other things. The rules will be explained once you have logged in. The study is open for participation through «date».

The Data Protection Agency has approved the research project, which means that our procedures comply with the Act on Processing of Personal Data. An important part of the Data Protection Agency's requirements is that your answers will be treated anonymously. To ensure anonymity, we have formed a random username for you. To participate, please log in at the following website: **analyse.econ.ku.dk**.

Username: «username» Password: «password»

The invitation is personal and we therefore ask you not to pass on username and password to others. Please feel free to contact us if you are having trouble logging in or have any further questions. You can call project coordinator Gregers Nytoft Rasmussen at phone number 35 33 02 77 Monday-Thursday 2:00 p.m. - 5:30 p.m. or write to the address analyse@econ.ku.dk.

Sincerely yours,
Søren Leth-Petersen
Project manager, professor