The Convergent and External Validity of Risk and Time Preference Measures:

Controlling for Measurement Error in a Large Dutch Sample

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Motivation

- **Important to know people's risk and time preferences**
  - Key building blocks in economics
  - Required for financial institutions
  - New Dutch pension agreement: implement investment policies in line with clients' risk preference and risk capacity

- **Numerous risk and time preference elicitation methods** exist
  - Revealed preference methods (incentivized multiple price lists, convex budget, lottery choice tasks, investment task, …)
  - Stated preference methods (e.g., general risk or time question, hypothetical investment choices, …)

Motivation

- **Crucial questions**: Do these methods accurately elicit people's willingness to take risk and trade-offs over time? Do measured preferences correlate with relevant choices in the field (e.g., investments, savings)? Which method should we use for modeling and advise for policy ends?

- Three important **conceptual issues** (Mata et al., 2018):
  i. Do different measures capture the same underlying latent trait? (**convergent validity**)
  ii. Can measures explain or predict field behavior? (**external validity**)
  iii. Is measurement stable over time? (temporal stability; see Schildberg-Hörisch, 2018 for a review)

Motivation

- Debate on the **convergent and external validity** of commonly used measures for the elicitation of (risk) preferences

  - **Low correlation** between different (risk) preference elictation methods (e.g., Pedroni et al., 2017, Mata et al. 2018)
  - **Scarce evidence** regarding the relationship with economic (financial) field behavior (e.g., Charness et al., 2020; Galizzi et al., 2016, Epper et al., 2020)
  - **Mixed evidence** for a relationship with field behavior in other domains, such as health (e.g., Galizzi et al., 2016; Anderson & Mellor, 2008)

Our contribution

- Two main **concerns with previous literature**:
  - Most papers do not consider measurement error
  - Most papers rely on stated field behavior

- **Our study**:
  - We have a **large general population sample**
  - We use a large of **variety of risk and time elicitation methods** allowing us to **control for measurement error** by applying the obviously related instrumental variable approach (ORIV) by Gillen et al. (2019)
  - We use **register data** and **questionnaire data** to relate preference measures to **field behavior**

Design and implementation

- **Data collection:** large survey, including incentivized experiments; in two waves within a month
- **Invited sample:** 18,000 employees and 18,000 self-employed in the Netherlands were invited by letter for a two-wave study (May and June 2020)
- **Final sample:** N=4,282 with a median completion time of 46 and 51 min. respectively in wave 1 and 2
- **Incentives:** 1/5 of participants paid on average €77 (€0-€186) for their decision in a randomly selected task (average €15.42 across all participants; 150% of hourly minimum wage). One iPad raffled among all participants.
- **Register data:** survey data enriched with data from Statistics Netherlands

Our preference measures (1)

- **Revealed risk preferences - incentivized:**
  Multiple Price Lists (MPL) > List of choice between two lotteries; in total 5 MPLs, using different formats
  Measure of risk preference: average # risky choices per MPL
- **Revealed time preferences - incentivized:**
  Multiple Price Lists (MPL) > List of choice between lower early and higher late reward; in total 2 MPLs, using different delays
  Measure of time preference: # of patient choices per MPL
- **Revealed risk & time preferences - incentivized:**
  Convex Time Budgets with risky outcomes (CTB) > Allocation of money between certain early payment and (un)certain payment at later date; two sets of 12 decision tasks
  Measure of risk preferences (rCTB) and time preferences (tCTB)

Our preference measures (2)

- **Stated risk preferences - hypothetical:**
  General risk question (rGRQ, Dohmen et al. 2011)
  Domain specific risk questions …
  … in financial matters (rFRQ)
  … in career matters (rCRQ)
  … in health matters (rHRQ)
  Each asked twice: once in each wave
  Measures: Likert score, standardized

- **General time question** (tGRQ):
  Each asked twice: once in each wave
  Measures: Likert score, standardized

Field Behavior Variables

- **Register data** (economic variables): investments (stocks and bonds), debt (excluding mortgage and study debt), and self-employment status
- **Survey data** (health related variables): extent to which an individual follows COVID-19 guidelines for social distancing and handwashing

	Unit	Mean	SD	Min	Max	N
Financial						
Savings	Log	9.99	1.71	0.00	14.49	4,276
Investments	Yes (1)/No (0)	0.30	0.46	0.00	1.00	4,276
Investments	Ratio	0.34	0.30	0.00	1.00	1,302
Debt	Yes (1)/No (0)	0.36	0.48	0.00	1.00	4,276
Occupation						
Self-employed	Yes (1)/No (0)	0.35	0.48	0.00	1.00	4,282
Health						
Distancing	Likert Item 0-5*	3.95	0.80	0.00	5.00	4,266
Handwashing	Likert Item 0-5*	3.79	0.95	0.00	5.00	4,270

Empirical Strategy

- **Preference measures:** standardized measures of risky and patient choices (MPL/CTB) and standardized Likert score (RQs)
- **Control for measurement error:** obviously related instrumental variable approach (ORIV) by Gillen et al. (2019)
- **Idea behind ORIV** is to instrument two duplicates of a noisy measure (say x_1 and x_2) on each other to reduce attenuation bias and increase the significance of estimated coefficients

Results – Risk - Convergent Validity

Table 8: **ORIV**/Raw Correlation - Risk Preference Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CTB	1							
(2) PGp	**0.34**/0.20	1						
(3) SGsure	**0.39**/0.22	**0.60**/0.29	1					
(4) PGhigh	**0.30**/0.20	**0.88**/0.45	**0.67**/0.31	1				
(5) GRQ	**0.38**/0.26	**0.39**/0.23	**0.39**/0.22	**0.30**/0.20	1			
(6) FRQ	**0.31**/0.21	**0.30**/0.18	**0.37**/0.21	**0.24**/0.16	**0.94**/0.62	1		
(7) CRQ	**0.19**/0.12	**0.20**/0.11	**0.23**/0.12	**0.16**/0.10	**0.77**/0.49	**0.71**/0.45	1	
(8) HRQ	**0.18**/0.12	**0.15**/0.09	**0.21**/0.12	**0.11**/0.07	**0.53**/0.35	**0.70**/0.46	**0.56**/0.35	1

Notes: We apply ORIV one-sided (Equation 1) for PGhigh and two-sided (Equation 2) for all other measures. All correlations are statistically significant ($p < 0.01$).

- **ORIV substantially improves correlations between measures**, especially for measures that have a similar design.
- **Correlations within given method** (revealed and stated) tend to be **higher** than those across methods.

Results – Risk - External Validity

Table 7: Regressions - Risk Preference Measures and Field Behavior

	Financial				Occupation	Health	
	Savings log	Investments y/n	Investments ratio	Debt y/n	Self-Employed y/n	Distancing z-score	Handwashing z-score
CTB	0.02	0.01	0.00	-0.01	0.02*	-0.07**	-0.03
	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
PGp	-0.04	0.02	0.01	0.01	0.02	-0.12**	-0.05
	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)
SGsure	0.02	0.02	0.06*	-0.01	0.02	-0.14**	-0.12**
	(0.07)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)
PGhigh	-0.03	0.01	0.01	0.01	0.01	-0.06**	0.00
	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
GRQ	-0.22***	0.05***	0.06***	0.06***	0.08***	-0.11***	-0.04
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
FRQ	-0.12***	0.11***	0.07***	0.04***	0.09***	-0.16***	-0.11***
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
CRQ	-0.20***	0.02	0.04**	0.06***	0.12***	-0.07**	-0.05*
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
HRQ	-0.13***	0.01	0.02*	0.03**	0.06***	-0.29***	-0.26***
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
N	4,276	4,276	1,302	4,276	4,282	4,266	4,270
Controls	✓	✓	✓	✓	✓	✓	✓

- **Stated preferences methods** correlate significantly with most types of field behavior.
- **Revealed preferences methods** are at best weakly related to most types of field behavior.

Results – Time - Convergent Validity

Table A25: **ORIV**/Raw Correlation - Time Preference Measures

	(1)	(2)	(3)
(1) tCTB	1		
(2) tMPL	**0.39**/0.25	1	
(3) GTQ	**0.28**/0.15	**0.27**/0.18	1

Notes: All correlations are statistically significant ($p < 0.01$).

- **ORIV improves correlations between measures**, also across incentivized and hypothetical measures.

Results – Time - External Validity

Table A26: Regressions - Time Preference Measures and Field Behavior

	Financial				Occupation	Health	
	Savings log	Investments y/n	Investments ratio	Debt y/n	Self-Employed y/n	Distancing z-score	Handwashing z-score
tCTB	0.15***	0.05***	0.03	-0.03*	-0.02	0.03	-0.00
	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)	(0.03)
tMPL	0.26***	0.04***	0.02*	-0.04***	-0.01	0.03	-0.02
	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
GTQ	0.12**	0.10***	0.04*	-0.01	0.06***	0.09**	0.02
	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)
N	4,276	4,276	1,302	4,276	4,282	4,266	4,270
Controls	✓	✓	✓	✓	✓	✓	✓

- **Revealed preferences** correlate significantly with financial field behavior (except investment ratio) but not with occupation and health related field behavior.
- **Stated preferences methods** correlate significantly with financial variables (except debt), occupation and distancing.

Discussion & Conclusion

- **Replicate** and **extend** Gillen et al. (2019) to
  - a larger set of incentivized and hypothetical **risk** preferences measures
  - incentivized and hypothetical **time** preferences measures

- **ORIV correction increases**
  - correlation between measures (convergent validity)
  - effect size but not statistical significance wrt field behavior (external validity)

- **Incentivized risk** measures do **not correlate** with **field behavior**
- **Hypothetical risk** measures do **correlate** with **field behaviour**

- **Incentivized** and **hypothetical time** measures do **correlate** with **field behaviour**

Discussion & Conclusion

- Why is the **external validity of incentivized risk measures relatively low**, especially in the financial domain?
  - Potential explanation: economic consequences of the decisions in the experimental tasks are low, but this also holds for time preference measures, which have predictive power
  - People's considerations are not driven by economic risk preference construct

- Investigated **stated preferences measures do correlate with field behavior but do not allow for quantitative conclusions**

Discussion & Conclusion

- Important to **develop reliable quantitative measure** for risk preferences

- Systematically explore **which specific factors** of incentivized measures **improve or deteriorate the external validity**
  - For example, combination of real (low-stake) and hypothetical (high-stake) decisions (e.g. Potters et al., 2016)

Thank you for your attention!

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Motivation

- Existing empirical **evidence**

  - Moderate to high correlations between general and domain specific risk questions (e.g., Dohmen et al., 2011)
  - Some studies find a relationship between stated elicitation methods (mainly “General risk question”) and field behavior (e.g., Beauchamp et al., 2017; …)
  - Generally, revealed preference methods seem to perform worse than stated preference methods in terms of convergent and external validity (Mata et al., 2018)

Revealed Preferences Measure – Several Risk Multiple Price List (rMPL, Holt and Laury, 2002)

	Optie A					Optie B		
1	€68		€50	○	○	€106		€10
2	€68		€50	○	○	€106		€10
3	€68		€50	◉	○	€106		€10
4	€68		€50	○	○	€106		€10
5	€68		€50	○	○	€106		€10

- Choice between two lotteries
- Altogether **5 MPLs, using different formats**
- **Measure of risk preference**: average # risky choices per MPL, standardized
  Note: We opt for model-free measures; more data, no assumptions needed

Methods - rMPL

2x PGp (Holt & Laury, 2002)

List 1

Decision	Option A				EV(A)	Option B				EV(B)
	p	€	p	€		p	€	p	€	
#1	0.1	80	0.9	64	€66	0.1	154	0.9	4	€19
#2	0.2	80	0.8	64	€67	0.2	154	0.8	4	€34
#3	0.3	80	0.7	64	€69	0.3	154	0.7	4	€49
#4	0.4	80	0.6	64	€70	0.4	154	0.6	4	€64
#5	0.5	80	0.5	64	€72	0.5	154	0.5	4	€79
#6	0.6	80	0.4	64	€74	0.6	154	0.4	4	€94
#7	0.7	80	0.3	64	€75	0.7	154	0.3	4	€109
#8	0.8	80	0.2	64	€77	0.8	154	0.2	4	€124
#9	0.9	80	0.1	64	€78	0.9	154	0.1	4	€139
#10	1	80	0	64	€80	1	154	0	4	€154

List 2

Decision	Option A				EV(A)	Option B				EV(B)
	p	€	p	€		p	€	p	€	
#1	0.1	99	0.9	41	€ 47	0.1	134	0.9	19	€31
#2	0.2	99	0.8	41	€ 53	0.2	134	0.8	19	€42
#3	0.3	99	0.7	41	€ 58	0.3	134	0.7	19	€54
#4	0.4	99	0.6	41	€ 64	0.4	134	0.6	19	€65
#5	0.5	99	0.5	41	€ 70	0.5	134	0.5	19	€77
#6	0.6	99	0.4	41	€ 76	0.6	134	0.4	19	€88
#7	0.7	99	0.3	41	€ 82	0.7	134	0.3	19	€100
#8	0.8	99	0.2	41	€ 87	0.8	134	0.2	19	€111
#9	0.9	99	0.1	41	€ 93	0.9	134	0.1	19	€123
#10	1	99	0	41	€ 99	1	134	0	19	€134

Notes: EV(A) and EV(B) list the expected value of the related lottery.

Measures: number of risky lottery choices, standardized (PGp1 & PGp2)

2x SGsure (Certainty Equivalent)

List 1

Decision	Option A		EV(A)	Option B				EV(B)
	p	€		p	€	p	€	
#1	1	52	€52	0.5	30	0.5	130	€80
#2	1	57	€57	0.5	30	0.5	130	€80
#3	1	63	€63	0.5	30	0.5	130	€80
#4	1	68	€68	0.5	30	0.5	130	€80
#5	1	73	€73	0.5	30	0.5	130	€80
#6	1	78	€78	0.5	30	0.5	130	€80
#7	1	82	€82	0.5	30	0.5	130	€80
#8	1	88	€88	0.5	30	0.5	130	€80
#9	1	94	€94	0.5	30	0.5	130	€80
#10	1	101	€101	0.5	30	0.5	130	€80

List 2

Decision	Option A		EV(A)	Option B				EV(B)
	p	€		p	€	p	€	
#1	1	39	€39	0.33	20	0.67	110	€80
#2	1	46	€46	0.33	20	0.67	110	€80
#3	1	56	€56	0.33	20	0.67	110	€80
#4	1	64	€64	0,33	20	0,67	110	€80
#5	1	70	€70	0,33	20	0,67	110	€80
#6	1	75	€75	0,33	20	0,67	110	€80
#7	1	79	€79	0,33	20	0,67	110	€80
#8	1	84	€84	0,33	20	0,67	110	€80
#9	1	88	€88	0,33	20	0,67	110	€80
#10	1	93	€93	0,33	20	0,67	110	€80

Notes: EV(A) and EV(B) list the expected value of the related lottery.

Measures: number of risky lottery choices, standardized (SGsure1 & SGsure2)

1x PGhigh (Certainty Equivalent)

List 1

Decision	Option A				EV(A)	Option B				EV(B)
	p	€	p	€		p	€	p	€	
#1	0.5	90	0.5	70	€80	0.5	103	0.5	35	€69
#2	0.5	90	0.5	70	€80	0.5	109	0.5	35	€72
#3	0.5	90	0.5	70	€80	0.5	115	0.5	35	€75
#4	0.5	90	0.5	70	€80	0.5	122	0.5	35	€79
#5	0.5	90	0.5	70	€80	0.5	128	0.5	35	€82
#6	0.5	90	0.5	70	€80	0.5	131	0.5	35	€83
#7	0.5	90	0.5	70	€80	0.5	138	0.5	35	€87
#8	0.5	90	0.5	70	€80	0.5	153	0.5	35	€94
#9	0.5	90	0.5	70	€80	0.5	170	0.5	35	€103
#10	0.5	90	0.5	70	€80	0.5	186	0.5	35	€111

Notes: EV(A) and EV(B) list the expected value of the related lottery.

Measures: number of risky lottery choices, standardized (PGhigh1)

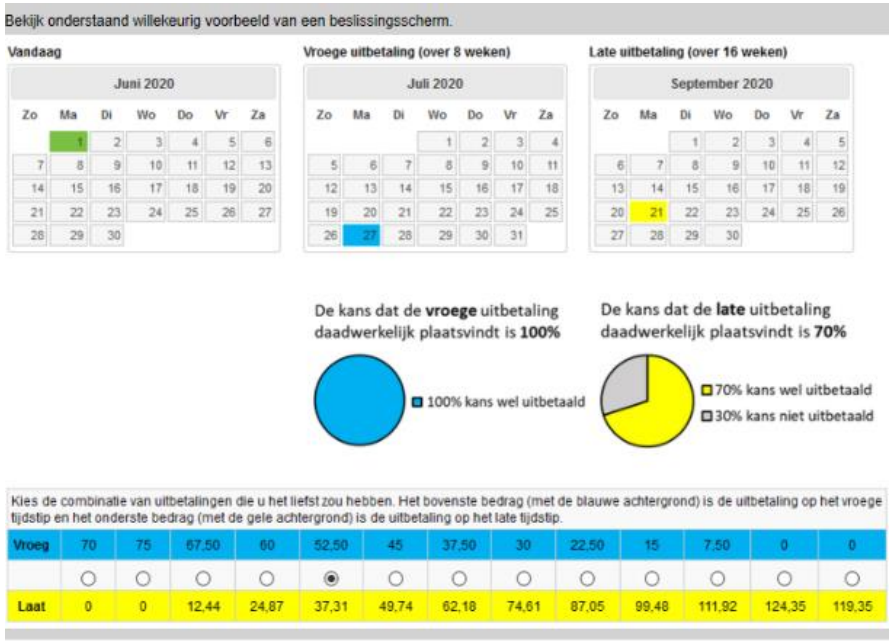
Revealed Preferences Measure – Several Time Multiple Price List (tMPL)

	Option A		Option B	
	€	Delay Period	€	Delay Period
#1	75	8 weeks	75	16 weeks
#2	75	8 weeks	76	16 weeks
#3	75	8 weeks	77	16 weeks
#4	75	8 weeks	79	16 weeks
#5	75	8 weeks	81	16 weeks
#6	75	8 weeks	84	16 weeks
#7	75	8 weeks	87	16 weeks
#8	75	8 weeks	91	16 weeks
#9	75	8 weeks	95	16 weeks

	Option A		Option B	
	€	Delay Period	€	Delay Period
#1	75	8 weeks	75	24 weeks
#2	75	8 weeks	76	24 weeks
#3	75	8 weeks	77	24 weeks
#4	75	8 weeks	79	24 weeks
#5	75	8 weeks	81	24 weeks
#6	75	8 weeks	84	24 weeks
#7	75	8 weeks	87	24 weeks
#8	75	8 weeks	91	24 weeks
#9	75	8 weeks	95	24 weeks

- Choice between early and late reward
- **2 MPLs, using different delays** (8 weeks vs 16 weeks, 8 weeks vs 24 weeks)
- **Measure of time preference**: # of patient choices per MPL, standardized
  Note: We opt for model-free measures; more data, no assumptions needed

Revealed Preferences Measure – Convex Time Budget (CTB, Andreoni & Sprenger, 2012)



- Allocation of money between certain early payment and (un)certain payment at later date
- **Two sets of 12 decision tasks**; allocation of 75 Euro between an earlier date (t), 8 weeks from the day of participation, and a later date (k), either 16 weeks (set 1) or 24 weeks (set 2) from the day of participation

Revealed Preferences Measure – Convex Time Budget (CTB)

Task	t	k	a_t	a_{t+k}	p_{t+k}	$EV(a_{t+k})$	1+r	1+r'
#1	8	16	€75	€75.00	1	€75.00	1.00	1.00
#2	8	16	€75	€79.50	1	€79.50	1.06	1.06
#3	8	16	€75	€93.00	1	€93.00	1.24	1.24
#4	8	16	€75	€83.40	0.9	€75.00	1.11	1.00
#5	8	16	€75	€88.35	0.9	€79.50	1.18	1.06
#6	8	16	€75	€103.35	0.9	€93.00	1.38	1.24
#7	8	16	€75	€107.10	0.7	€75.00	1.43	1.00
#8	8	16	€75	€113.55	0.7	€79.50	1.51	1.06
#9	8	16	€75	€132.75	0.7	€93.00	1.77	1.24
#10	8	16	€75	€150.00	0.5	€75.00	2.00	1.00
#11	8	16	€75	€159.00	0.5	€79.50	2.12	1.06
#12	8	16	€75	€186.00	0.5	€93.00	2.48	1.24

- **Measure of risk preference**: sum of risk averse (-1), risk neutral (0) and risk seeking (1) decisions in #4 to #12, standardized (rCTB)
- **Measure of time preferences**: average euro amount a participant allocates to the late period in risk-free decision situations (tCTB)
- Separately for each set CTB1 & CTB2

Stated Preferences Measure – Survey Risk Questions

General risk question (rGRQ, Dohmen et al. 2011):
"How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" (0-10)

Domain-specific risk questions:
"People can behave differently in different situations. How would you rate your willingness to take risks in the following areas? (0-10)
How is it …

… in financial matters (rFRQ)
… in career matters (rCRQ)
… in health matters (rHRQ)

Each asked twice: once in each wave
Measures: Likert score, standardized

Stated Preferences Measure – Survey Time Questions

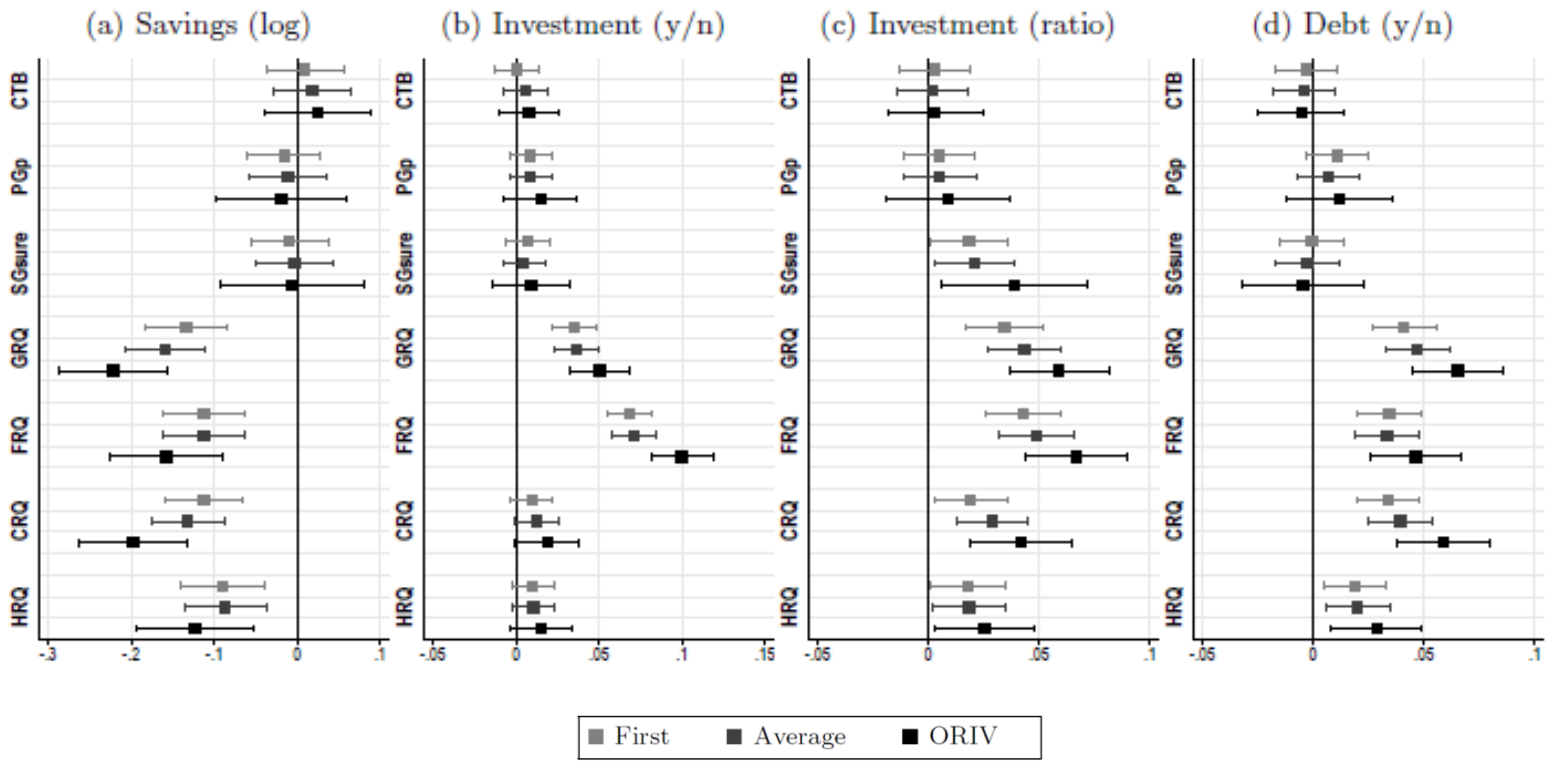
General time question (tGRQ):
"To what extent are you willing to...
a) to give up something that is beneficial to you today, in order to benefit more in the near future? (0-10)
b) to give up something that is beneficial to you today, in order to benefit more from it in the distant future?"(0-10)

Asked twice: once in each wave

Measures: Average across both, Likert score, standardized

Results – Risk - Effect of ORIV?

Figure 1: The effect of controlling for measurement error with ORIV on regression coefficients



Effect sizes increase in case of significant relation without ORIV correction, but generally no effect on significance per se.

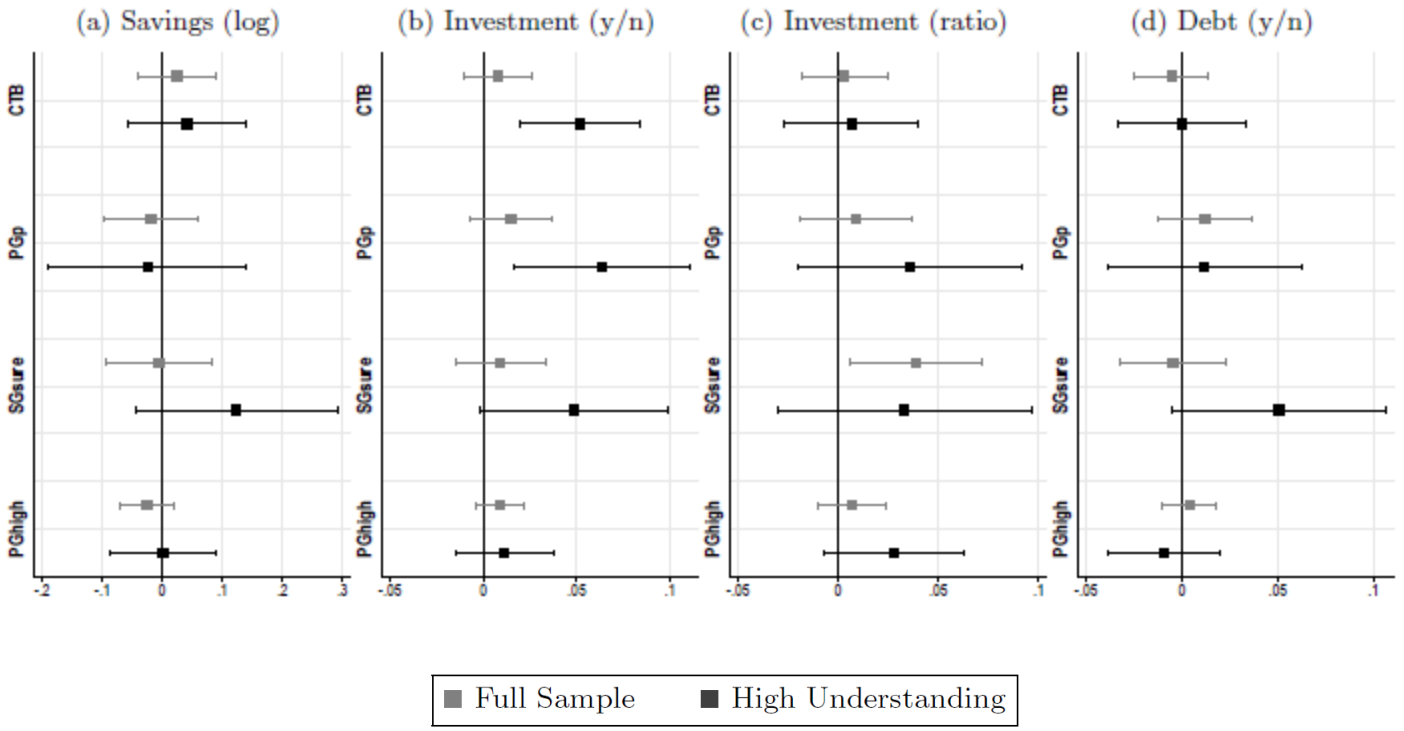
Results – Risk - Robustness

- **Understanding:** For the sample of participants with a **high understanding** of the revealed preferences method, the **predictive power** does improve in some cases but overall there is no strong effect.

- **Higher order risk preferences** (Schneider and Sutter, 2021): Controlling for prudence and temperance does **not affect** results.

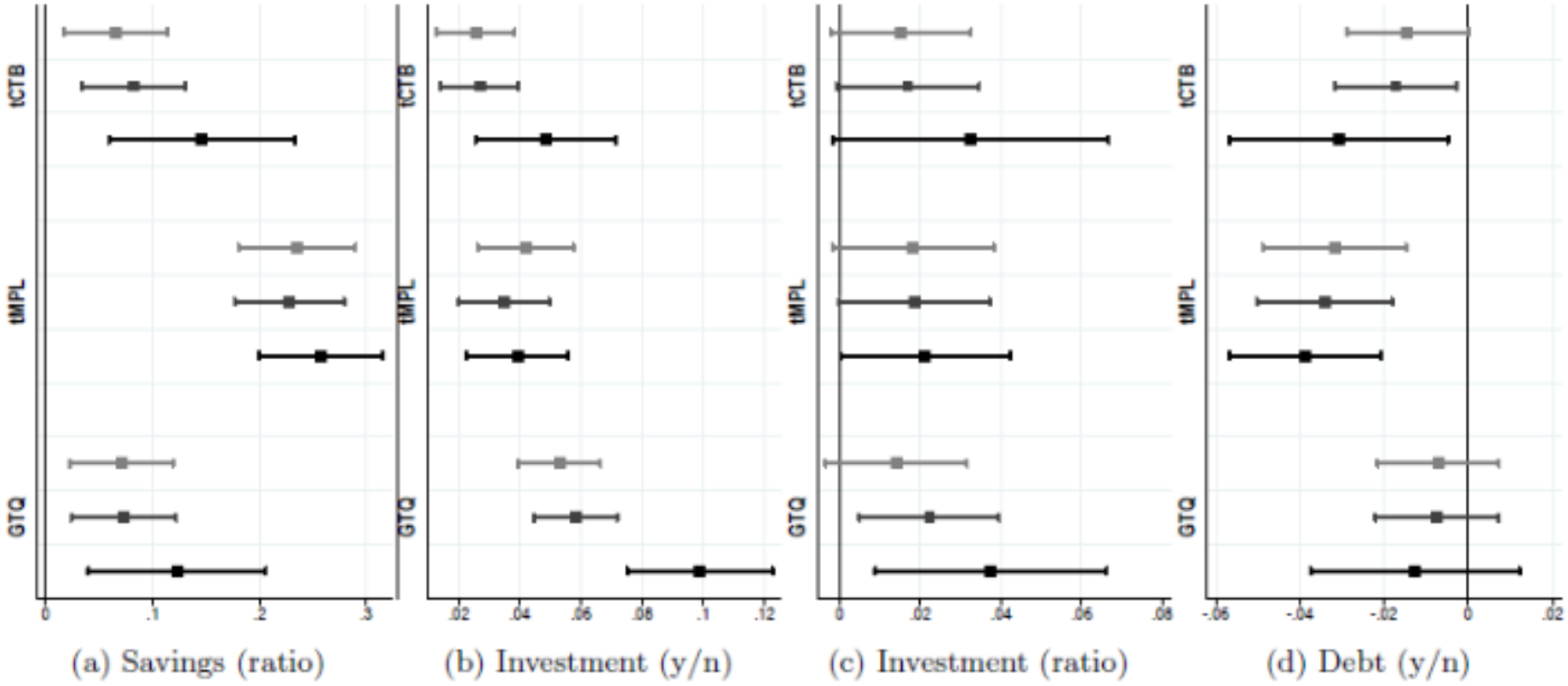
Results – Risk - Effect of Understanding?

Figure 2: The effect of high understanding on regression coefficients



For the sample of participants with a **high understanding** of the revealed preferences method, the **predictive power** does improve in some cases but overall there is no strong effect.

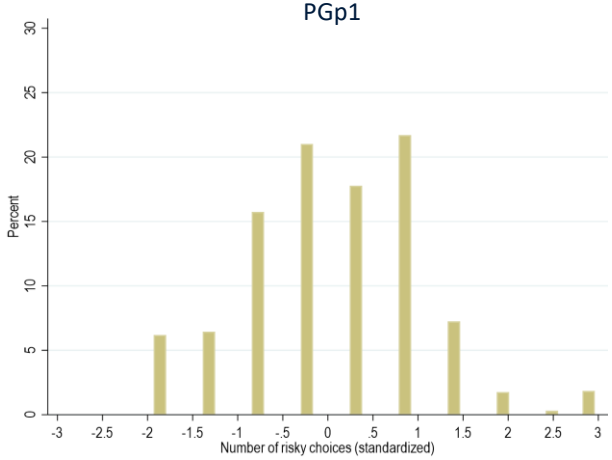
Results – Time - Effect of ORIV?



Effect sizes mostly **increase** when there is a significant relation without correction, but generally no effect on significance per se. Similar for non-financial variables.

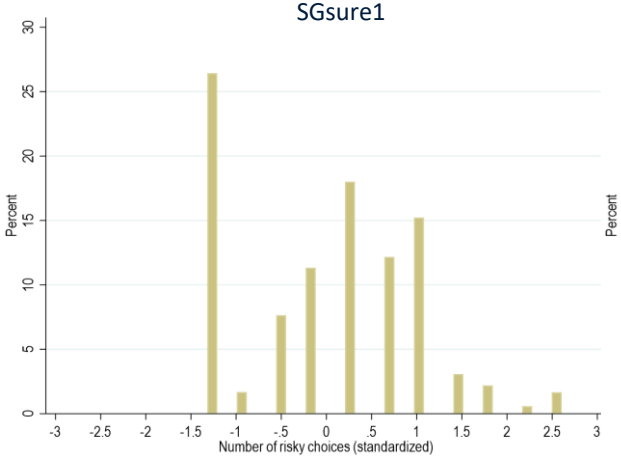
Descriptive Statistics - MPL

PGp1



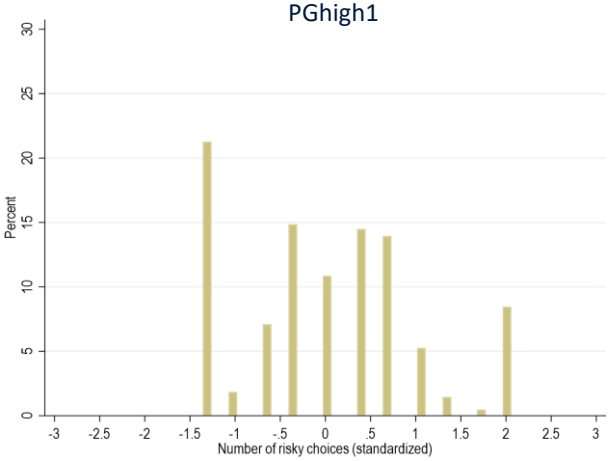
Multiple/Inverse: 204 (4.8%)
Dominated: 98 (2.3%)
Both: 77 (1.8%)

SGsure1



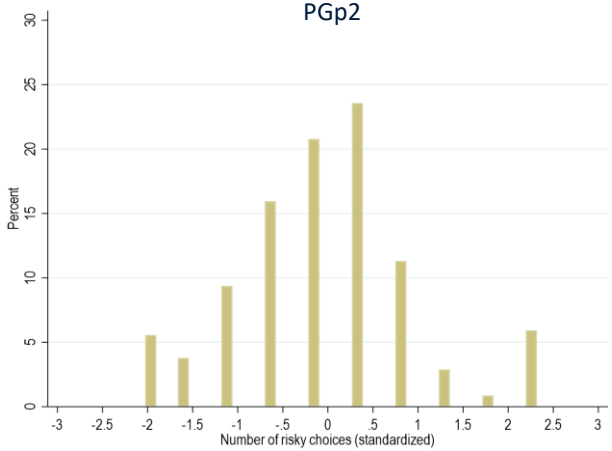
Multiple/Inverse: 254 (5.9%)
Dominated: N/A
Both: N/A

PGhigh1



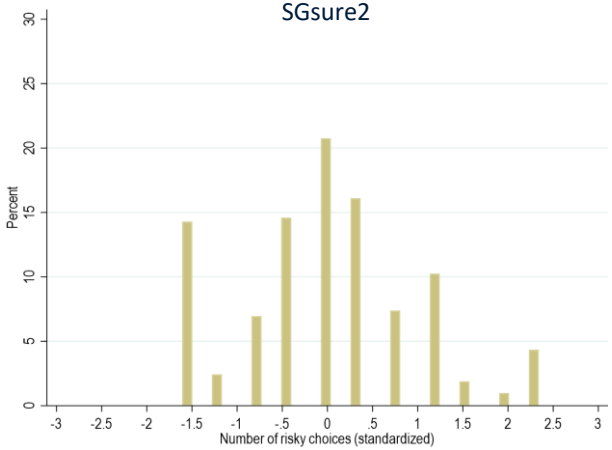
Multiple/Inverse: 241 (5.0%)
Dominated: N/A
Both: N/A

PGp2



Multiple/Inverse: 189 (4.4%)
Dominated: 102 (2.4%)
Both: 99 (2.3%)

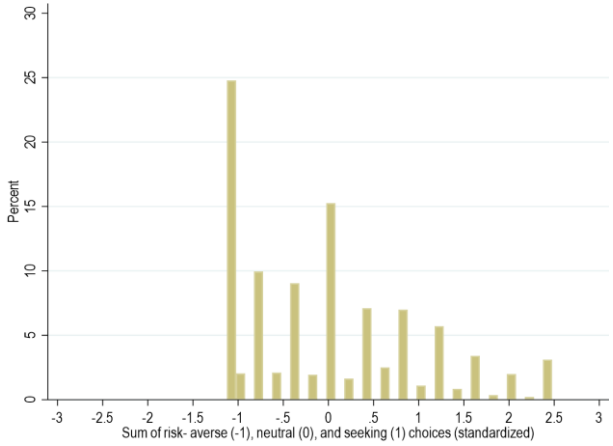
SGsure2



Multiple/Inverse: 185 (4.3%)
Dominated: N/A
Both: N/A

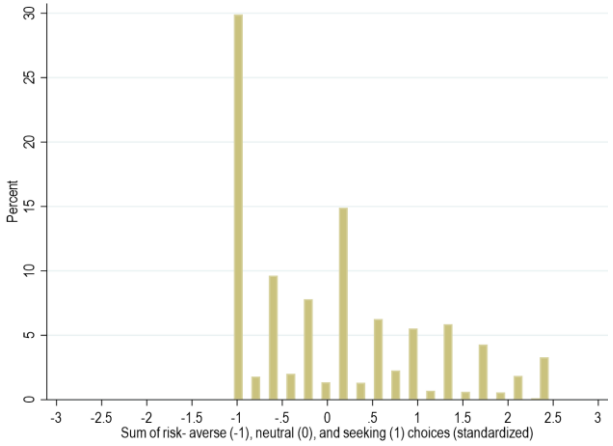
Descriptive Statistics - CTB

CTB1



At least one dominated choice: 10%

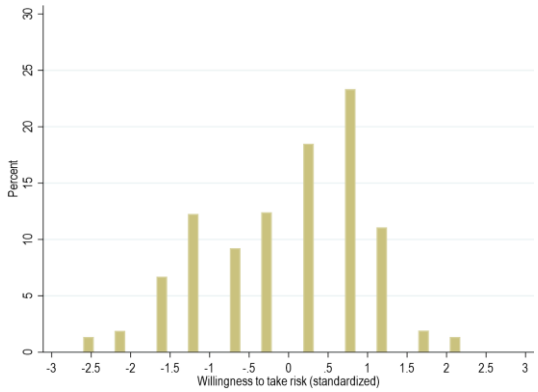
CTB2



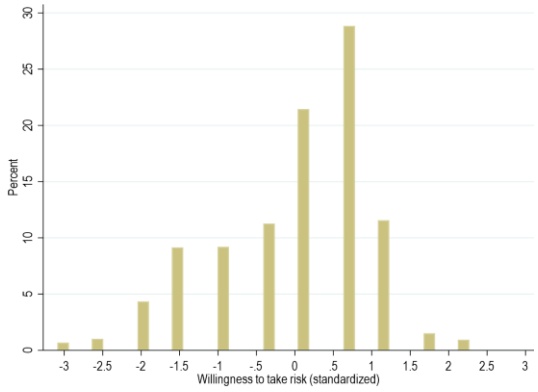
At least one dominated choice: 5%

Descriptive Statistics – Risk Questions

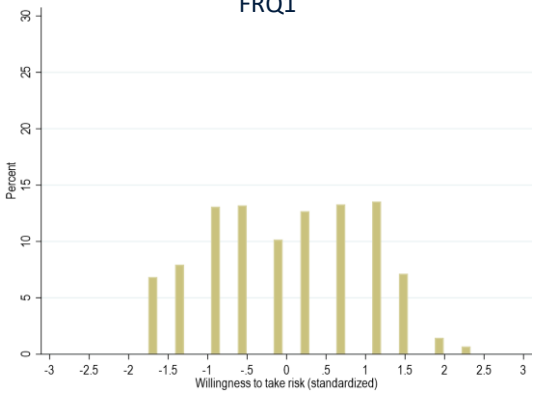
GRQ1



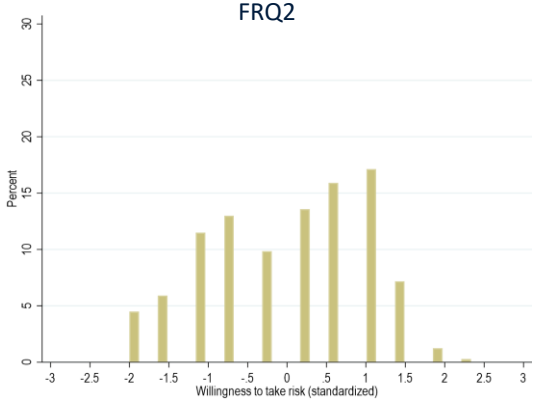
GRQ2



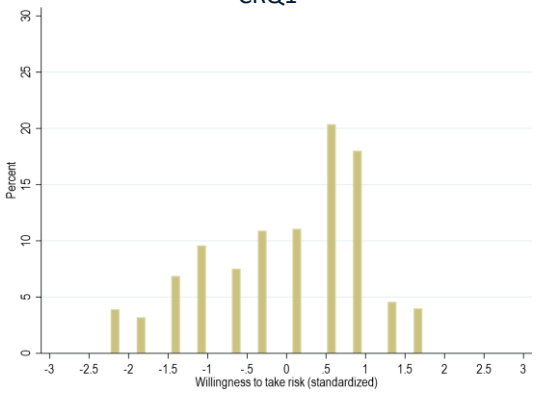
FRQ1



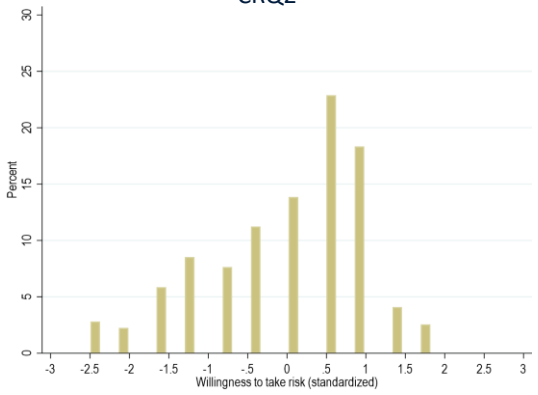
FRQ2



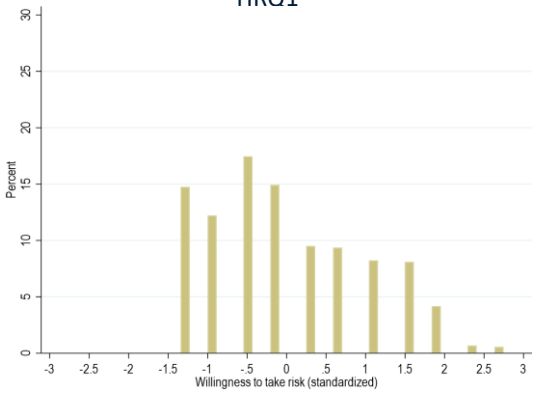
CRQ1



CRQ2



HRQ1



HRQ2

Empirical Strategy

- **Risk preference measures:** standardized number of risky choices (MPL/CTB) and standardized Likert score (RQs)

- **Measurement error:** obviously related instrumental variable approach (ORIV) by Gillen et al. (2019).
  - The idea behind ORIV is to instrument two duplicates of a noisy measure (say x_1 and x_2) on each other to reduce attenuation bias and increase the significance of estimated coefficients.
  - In particular, the following models are estimated (stacked 2sls regression):

$$\begin{pmatrix} y \\ y \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} + \beta \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \epsilon \quad (1)$$

$$\text{instrumenting} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} \text{ with } W = \begin{pmatrix} x_2 & 0_N \\ 0_N & x_1 \end{pmatrix}$$

$$\begin{pmatrix} y_1 \\ y_2 \\ y_1 \\ y_2 \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_1 \\ \alpha_2 \end{pmatrix} + \beta \begin{pmatrix} x_1 \\ x_2 \\ x_1 \\ x_2 \end{pmatrix} + \epsilon \quad (2)$$

$$\text{instrumenting} \begin{pmatrix} x_1 \\ x_2 \\ x_1 \\ x_2 \end{pmatrix} \text{ with } W = \begin{pmatrix} x_2 & 0_N & 0_N & 0_N \\ 0_N & x_1 & 0_N & 0_N \\ 0_N & 0_N & x_2 & 0_N \\ 0_N & 0_N & 0_N & x_1 \end{pmatrix}$$

Previous insights

- Effects of exogenous shocks on risk preferences (natural catastrophes, civil conflicts, and COVID-19 pandemic) vary widely (sometimes even contradictory results)

- For example, Bokern et al. (2021b) find little systematic effect of the COVID-19 pandemic on risk preferences

- (Macro-)economic fluctuations:
  - Experienced stock market developments affect willingness to take risks and stock market participation (Malmendier and Nagel 2011)
  - Investors become more risk-averse after financial crisis in 2008 (Guiso et al. 2018)

Controls for demographic and socioeconomic background

Administrative data from CBS from the years 2011 – 2019

Control variables:

- Gender
- Age (and Age^2)
- Migration Background
- Level of Education
- Wealth
- Income
- Financial Literacy
- Cognitive Reflection
- Understanding and confidence in decisions of the MPL task

Effect of individual backgrounds

- Lower risk tolerance:
  - Being female (survey and MPL)
  - Being older (survey and MPL)
  - Being married (survey)
  - Higher wealth (survey)

- Higher risk tolerance:
  - Income (survey and MPL)
  - Having children (survey and MPL)
  - Self-employed (survey)
  - Being divorced (survey)

Sample characteristics

	Unweighted	Weighted
	Average/Share in %	Average/Share in %
Sex		
Male	57	54
Female	43	46
Marital status 2019		
Not married	33	37
Married incl. registered partnership	58	52
Widowed	1	1
Divorced	9	10
Occupational status 2019		
Employee	52	74
Self-employed	35	14
Employed as well as self-employed	9	7
Unemployed	0	1
Pension	2	2
Other	2	2
Children 2019		
No children	32	34
Children	68	66
Migration background		
Native	87	80
Western background	9	11
Non-Western background	4	9
Educational level		
Low	4	5
Middle	23	26
High	46	45
Unknown	27	24
Wealth tertiles*		
1 (Low tertile)	33	44
2 (Middle tertile)	33	32
3 (High tertile)	33	23
Income tertiles*		
1 (Low tertile)	33	40
2 (Middle tertile)	33	35
3 (High tertile)	33	26
Age (SE)	47 (0.2)	45 (0.2)
N	4,282	7,173,795**

Note: The table lists the demographic and socio-economic characteristics of the participants in our sample. Unweighted averages/shares refer to unweighted data; weighted averages/shares refer to population-weighted data; income tertiles are based on the sample; * data on income and wealth include six missing observations and are thus based on 4,276 individuals; ** number of weighted observations.