Who Is (More) Rational?

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Introduction

- Traditional economic analysis assumes that choices are rational.

- In this standard view, heterogeneity in choices is attributed to heterogeneity in
  - *constraints*;
  - *information*;
  - *preferences*;
  - *beliefs*.

Background: decision-making quality

- Recent literature also allows heterogeneity in choices driven by heterogeneity in *decision-making quality*.
  - e.g., Ameriks et al (2003); Bernheim and Garrett (2003); Agarwal et al (2009); Banks (2010) and EJ special issue (2010).

- This new view suggests wedges between actual choices and the choices that people would make if they had skills/knowledge to make "better" decisions.

- These wedges are important because positive predictions and policy recommendations based on revealed preference may be misguided.

Twin problems

- In general, how can we tell if someone has made a low quality decision?

- What, precisely, do we mean by "decision-making quality"?

$\Rightarrow$ **Identification problem**

  - to distinguish differences in decision-making quality from unobserved differences in preferences, information, beliefs or constraints.

$\Rightarrow$ **Measurement problem**

  - to define and implement a quantitative measure of decision-making quality that is economically interpretable and portable.

Our approach

$\Rightarrow$ We address the *identification problem* with an experiment:

- the experiment controls for some unobservables (such as information and constraints).

$\Rightarrow$ We address the *measurement problem* with existing theory and novel techniques:

- measure aspects of quality by calculating how nearly experimental choices comply with utility maximization (GARP);

- implement a novel experimental technique (Choi et al, 2007) that allows high power tests of compliance with GARP.

- We adopt the traditional view: quality $\Longleftrightarrow$ rationality
  - because choices that are more consistent with utility maximization are more purposeful and reflect more consistent treatment of tradeoffs.

- Inconsistency in choices may be symptoms of many things:
  - a lack of understanding how to implement choices according to an objective;
  - inattention;
  - incompleteness.

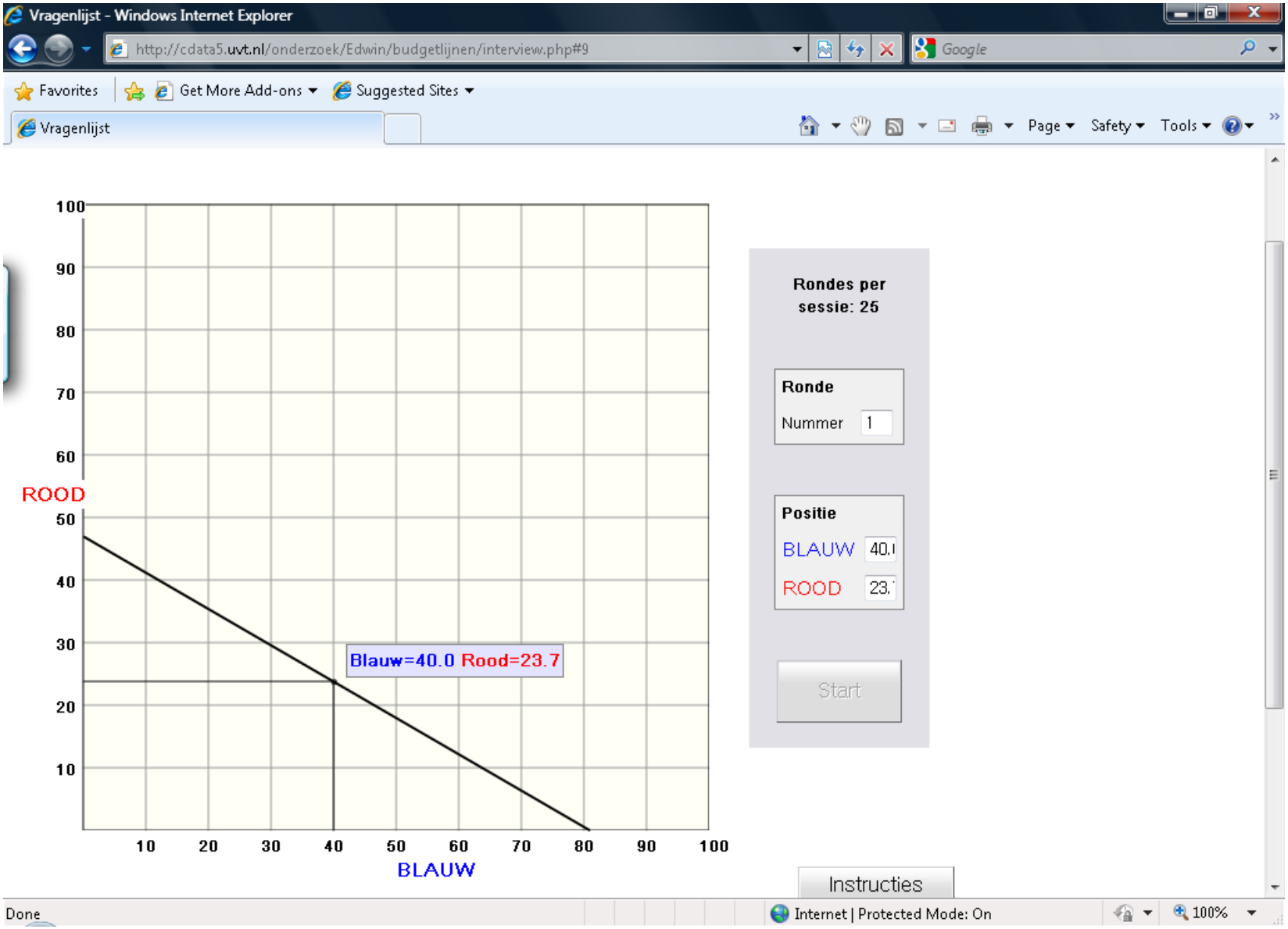
Decision in the Experiment

- Subjects are presented with a standard portfolio choice problem. There are two states of natures, $s = 1, 2$, that occur equally likely, and two Arrow securities corresponding to the two states.

- Subjects are allowed to choose any non-negative portfolio $x = (x_1, x_2)$ satisfying the budget constraint

$$p_1 x_1 + p_2 x_2 = 1.$$

- A graphical experimental interface displays randomly generated budget sets from which subjects make choices by "pointing and clicking".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BLAUW
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Rondes per sessie: 25
Ronde
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Environment

- The field environment is the CentERpanel that consists of over 2,000 households (5,000 individual members) in the Netherlands.

- The panel members complete survey questionnaires on the internet from home over weekends.

- Incorporating the graphical interface into the CentERpanel survey allows large scale, web-based experiments.

- The surveys include data on individual socio-demographic variables and economic activities such as saving and investment.

Experimental procedures

- The experiment was conducted in May 2009. Among 2340 panel members who were randomly chosen for inviation, 1372 members logged on to the experiment.

- 1182 members (86.2%) completed the experiment while 190 subjects (13.8%) did not.

- Each subject repeated 25 independent decisions, one of which was randomly selected for payment at the end.

Descriptive statistics

	Final sample	Drop-outs	Non-participants
Female	45.43	37.89	50.00
Age			
Age 16 - 34	18.53	3.16	26.14
Age 35 - 49	26.14	12.11	32.13
Age 50 - 64	35.62	38.42	27.58
Age 65 +	19.71	46.32	14.15
Education			
Low	33.59	42.63	30.99
Medium	29.70	22.63	31.61
High	36.72	34.74	37.40
Income			
Less than EUR 2500	22.42	34.73	21.28
EUR 2500 - 3499	25.13	26.32	18.90
EUR 3500 - 4999	28.85	16.32	28.93
EUR 5000 +	23.60	22.63	30.89
Occupation			
Paid work	53.13	39.47	62.91
House work	11.59	7.89	8.78
Retired	20.90	42.63	13.95
Others	14.38	10.00	14.36
Household composition			
Partner	80.88	67.89	82.64
# of kids	0.84	0.32	1.09
# of observations	1182	190	968

Outline and summary

1. Observe considerable heterogeneity in decision-making quality.

2. Investigate who, in terms of socio-demographic information, is (more) rational.

   – High-income, high-education, younger and males make higher quality decisions.

3. Ask if the experimental measure of quality can explain important economic outcomes:

- One standard deviation increase in our measure of quality is associated with 15-19% more household wealth.

- Higher quality predicts home ownership and higher share of wealth in house.

Rationality as decision-making quality

- Let $\{(p^t, x^t)\}_{t=1}^{25}$ be some observed individual data (p^t denotes the t-th observation of the price vector and x^t denotes the associated portfolio).

- **Generalized Axiom of Revealed Preference (GARP)** *If x^t is revealed preferred to x^s, then x^s is not strictly directly revealed preferred (i.e. $p^s \cdot x^s \leq p^s \cdot x^t$) to x^t.*

- **Afriat's Theorem** *If the data satisfies GARP, then there exists a utility function that rationalizes the observed choices. Moreover, the utility function may be chosen to be increasing, continuous and concave.*

Measuring decision-making quality

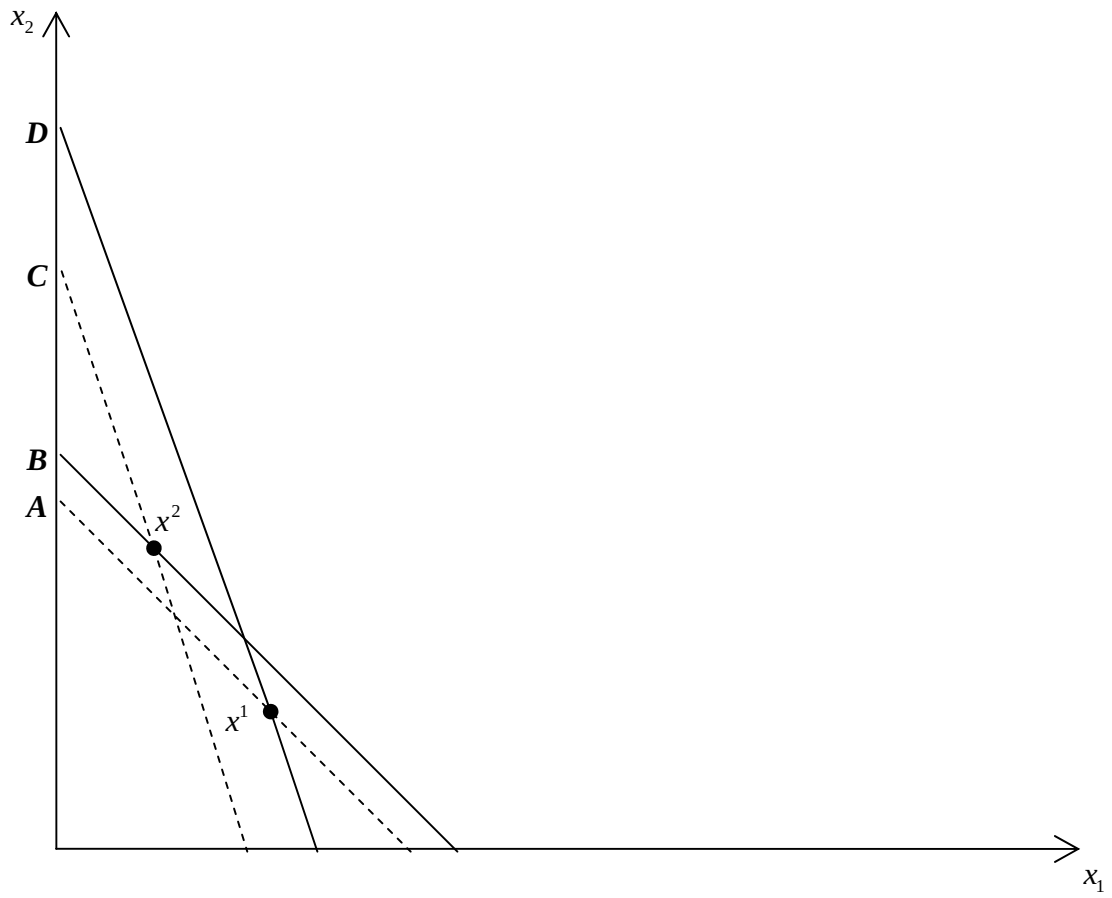
- Using GARP to measure quality faces a problem of quantification: choice data either satisfy GARP or not.

- One measure of quantifying the extent of GARP violations is Afriat's (1972) Critical Cost Efficiency Index (CCEI).

- CCEI $\in [0, 1]$ measures the amount by which each budget constraint must be relaxed in order to remove all violations of GARP.

- The closer it is to one, the smaller the perturbation required to remove all violations and thus the closer the data are to satisfying GARP.

The construction of the CCEI for a simple violation of GARP.



Advantages of the measure and experimental method

- *Portable*: can be applied to many other choice domains.
- *Practical and powerful*: enough variations in budget sets to provide a strong test of consistency.
- *Autonomous*: CCEI is independent of preferences.
- *Quantifiable and comparable*: If the choices can be mapped to budget sets, CCEI gives standardized quantities.

How powerful is GARP?

- The power of Bronars' (1987) test is defined to be the probability that a hypothetical subject whose choice is uniformly distributed over the budget line violates GARP.

- The power of test depends on the number of decisions made by each random subject.

CCEI	# of decisions		
	10	25	50
$0.95 - 1.0$	0.202	0.043	0.001
$0.9 - 0.95$	0.171	0.100	0.007
$0.85 - 0.9$	0.133	0.146	0.026

The distribution of CCEI scores

			Percentiles					
	Mean	Std. Dev.	10	25	50	75	90	# of obs.
All	0.881	0.141	0.676	0.808	0.930	0.998	1.000	1182
Female	0.874	0.147	0.666	0.796	0.928	0.998	1.000	537
Age								
16-34	0.920	0.119	0.734	0.881	0.979	1.000	1.000	219
35-49	0.906	0.123	0.708	0.853	0.966	1.000	1.000	309
50-64	0.863	0.142	0.666	0.784	0.901	0.985	1.000	421
65+	0.843	0.164	0.595	0.770	0.882	0.981	1.000	233

- Large fractions of subjects have virtually no violations.

- Substantial heterogeneity within and across demographic groups.

Beyond consistency

- Choices can satisfy GARP but not meet other normatively appealing criteria of quality:
  - Always allocating all tokens to x_1 leads to CCEI $= 1$.
- It is natural to add symmetry $(x_1, x_2) \sim (x_2, x_1)$ as a criterion of quality.
- The symmetry implies the monotonicity with respect to FOSD.
  - never allocate *fewer* tokens to the *cheaper* asset.

Measuring compliance with symmetry

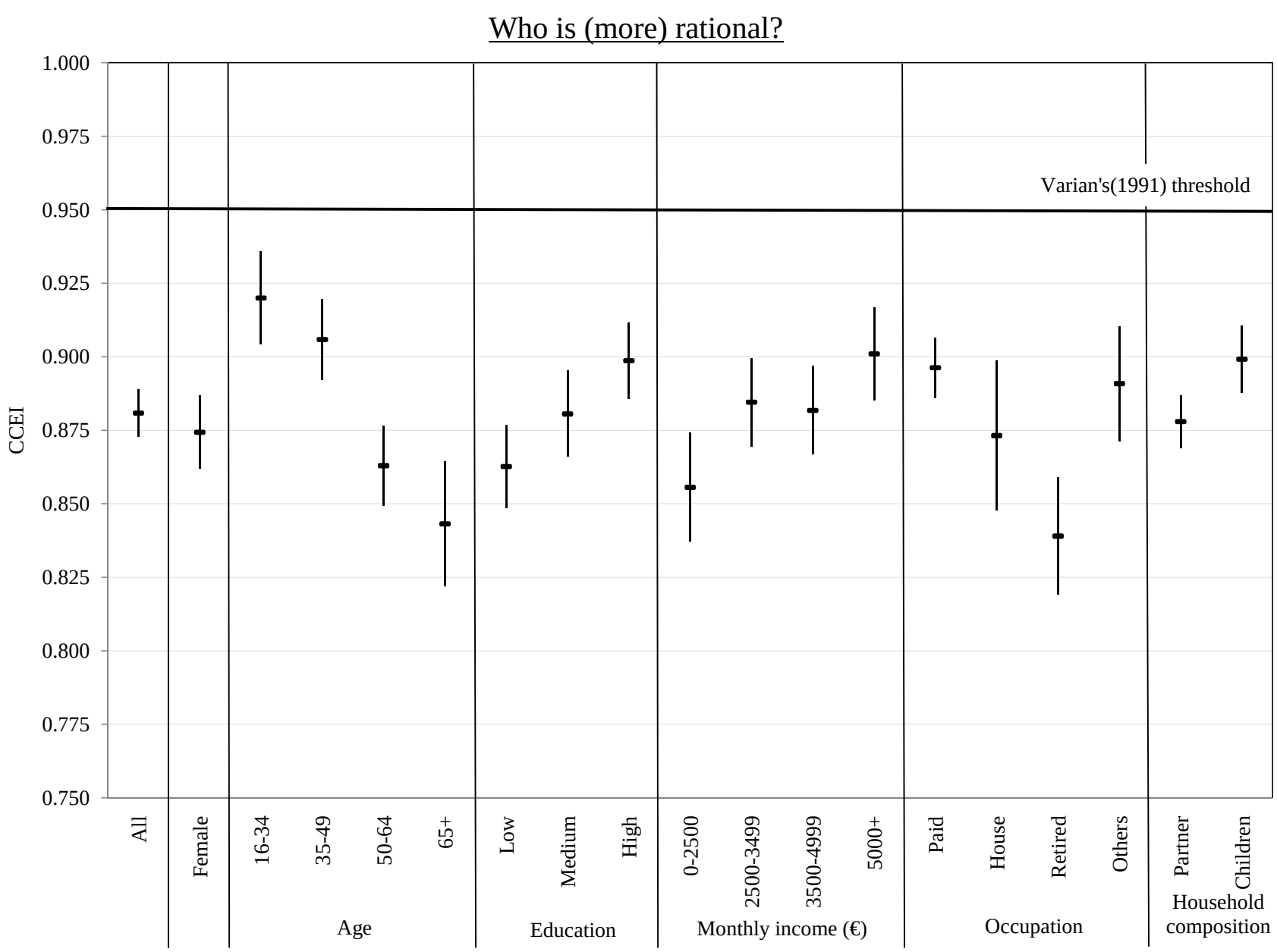
- Combine the actual choice data from the experiment with the mirror image of those choices.
  - $p_1 x_1 + p_2 x_2 = 1 \Longrightarrow p_2 x_2 + p_1 x_1 = 1$
- Compute the CCEI associated with these combined data.
- Note that the CCEI with combined data must be weakly lower.

The distribution of CCEI scores for the combined data set

			Percentiles					Δ
	Mean	Std. Dev.	10	25	50	75	90	Mean
All	0.733	0.229	0.394	0.584	0.775	0.943	0.985	0.148
Female	0.733	0.224	0.409	0.588	0.767	0.941	0.984	0.141
Age								
16-34	0.786	0.228	0.442	0.637	0.881	0.976	0.995	0.134
35-49	0.782	0.206	0.481	0.652	0.845	0.962	0.991	0.124
50-64	0.700	0.225	0.371	0.552	0.735	0.898	0.973	0.163
65+	0.679	0.242	0.334	0.489	0.703	0.902	0.968	0.165

- Imposing symmetry reduces levels of consistency.

- Heterogeneity increases.


Who is (more) rational?
CCEI
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0.800
0.775
0.750
Varian's(1991) threshold
All
Female
16-34
35-49
50-64
65+
Age
Low
Medium
High
Education
0-2500
2500-3499
3500-4999
5000+
Monthly income (€)
Paid
House
Retired
Others
Occupation
Partner
Children
Household composition

Who is (more) rational?

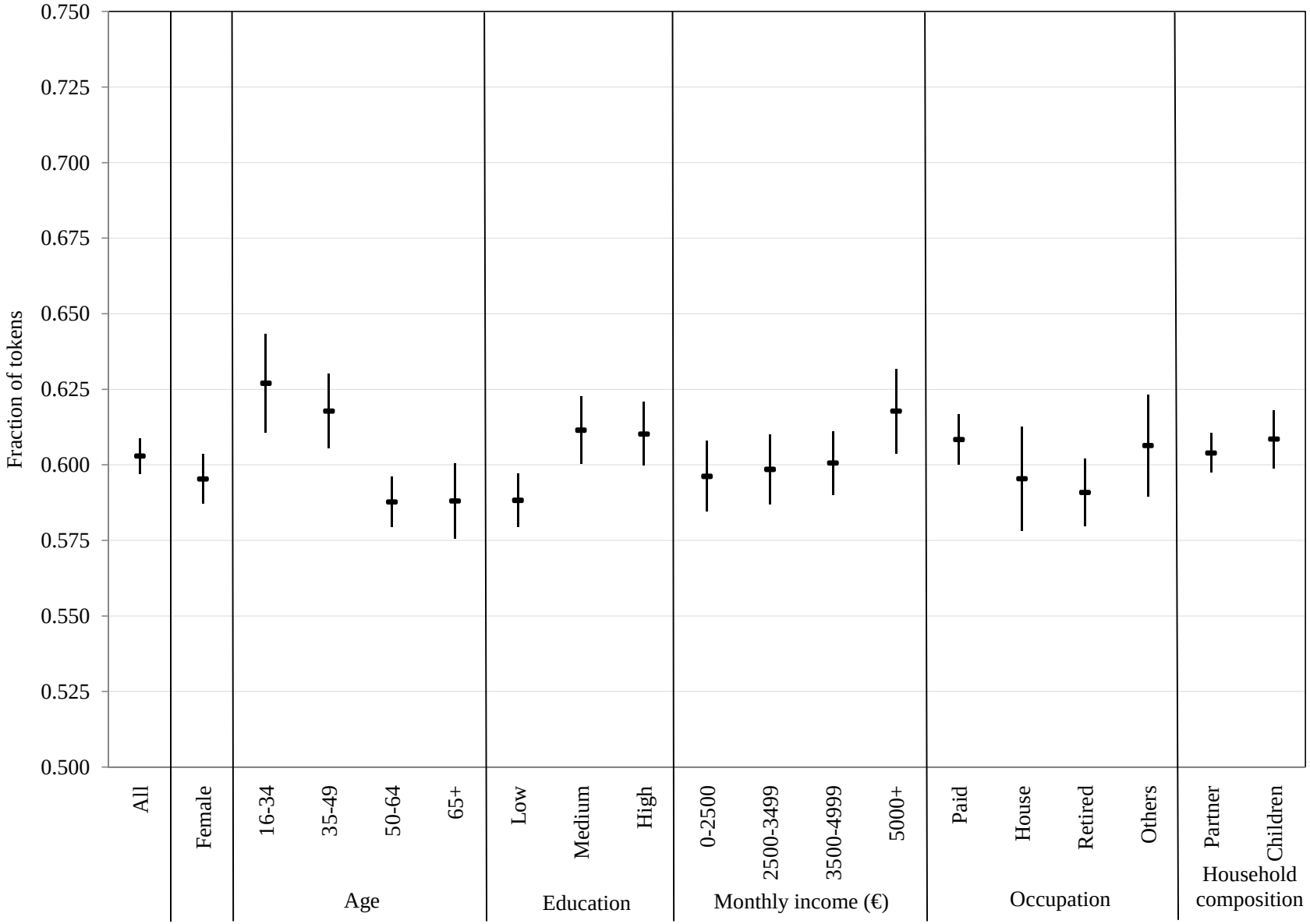
	(1)	(2)
Constant	.887***	.735***
	(.022)	(.037)
Female	-.024***	-.011
	(.009)	(.015)
Age		
35-49	-.016	-.007
	(.011)	(.020)
50-64	-.052***	-.077***
	(.011)	(.020)
65+	-.051**	-.081**
	(.020)	(.032)
Education		
Medium	.009	.021
	(.011)	(.017)
High	.026**	.060***
	(.011)	(.018)
Income		
€2500-3499	.026**	.026
	(.012)	(.019)
€3500-4999	.020	.006
	(.013)	(.020)
€5000+	.033**	.017
	(.014)	(.022)
Occupation		
Paid work	.028	.030
	(.018)	(.026)
House work	.047**	.039
	(.021)	(.030)
Others	.037*	.035
	(.019)	(.030)
Household composition		
Partner	-.026**	-.023
	(.011)	(.018)
# of children	.001	.001
	(.004)	(.007)
R^2	.068	.058
# of obs.	1182	1182

Risk attitudes

- The experimental data also reveal rich information on individual-level risk attitudes.

- One easy way of looking at the demand behavior is to compute average token shares for cheaper asset: $x_{cheaper} / (x_1 + x_2)$.

Figure 3. The average fraction of tokens allocated to the cheaper asset



The correlation of average token shares of cheaper asset and subjects' individual characteristics

Variable	All samples	CCEI ≥ 0.95	CCEI ≥ 0.9	CCEI ≥ 0.8
Constant	.632***	.648***	.645***	.644***
	(.015)	(.027)	(.023)	(.019)
Female	-.020***	-.034***	-.026***	-.021***
	(.007)	(.012)	(.010)	(.008)
Age				
Age 35 - 49	-.010	-.030*	-.019	-.011
	(.011)	(.016)	(.014)	(.012)
Age 50 - 64	-.045***	-.066***	-.054***	-.048***
	(.010)	(.016)	(.013)	(.011)
Age ≥ 65	-.052***	-.076***	-.067***	-.054***
	(.014)	(.024)	(.021)	(.018)
Education				
Medium	.018**	.027*	.025**	.018*
	(.008)	(.014)	(.012)	(.009)
High	.015**	.036***	.026**	.016
	(.008)	(.013)	(.012)	(.009)
Income				
EUR 2500 - 3499	-.002	-.007	-.007	-.005
	(.008)	(.016)	(.013)	(.011)
EUR 3500 - 4999	-.003	-.008	-.006	-.008
	(.009)	(.018)	(.014)	(.011)
EUR 5000 +	.013	.006	.003	.009
	(.011)	(.020)	(.016)	(.013)
Occupation				
Paid work	-.006	-.013	-.014	-.009
	(.011)	(.020)	(.017)	(.014)
House work	.011	.003	.006	.007
	(.013)	(.021)	(.020)	(.017)
Others	.003	-.018	-.010	-.006
	(.012)	(.023)	(.020)	(.016)
Household composition				
Partner	.004	.010	.006	.007
	(.009)	(.015)	(.013)	(.010)
# of kids	-.007	-.006	-.004	-.005
	(.003)	(.005)	(.005)	(.004)
R-squared	0.048	0.071	0.054	0.045
# of observations	1182	534	681	901

Decision-making quality and wealth

- To the extent that rationality in simple experimental domain reflects a "trait", it may predict some imporant, real-life behavior.

- Much of the research on decision-making quality concerns financial choices.

- Conditional on income, wealth summarizes innumerable financial decisions.

- One puzzle in economics is whether variation in wealth among observationally similar households is (not) easily explained by standard sources of unobserved heterogeneity:
  - Bernheim et al (2001), Ameriks et al (2003), Hurst (2006), Scholz, Seshadri, Khitatrakun (2006).

- This suggests that wealth accumulation and portfolio choices may be a good testing ground for our measures.

- If consistency in the experiment were a good proxy for financial decision-making quality, it should help explain the patterns of wealth accumulation.

Wealth measure in CentERpanel

- The CentERpanel collects information about wealth on an annual basis.
- All household members whose ages are above 16 respond to questions regarding assets and liabilities they hold alone.
- In addition, one member in the houshold, identified as a financial respondent, provides information about assets and liabilities that are jointly held.
- Our analysis focuses on household net worth, calculated by summing net worth over household members, as averaged over 2008 and 2009.

Table 6. Household 2008-2009 net worth summary statistics

(2008 Euros)

Mean		164,130
Std. Dev.		243,548
Max		3,984,151
Min		-180,700
Percentiles	1	-68,237
	5	-4,810
	10	0
	25	10,780
	50	92,979
	75	242,054
	90	412,494
	95	523,839
	99	955,599
# of obs.		703

Regression analysis

- (Benchmark) We regress the log of household wealth on demographic variables, log of household income, and measures of decision-making quality for financial respondent.

- We find economically large, significant relation between CCEI and household wealth: a standard deviation increase in CCEI is associated with 15% ~19% more household wealth

- Higher CCEI is associated with the increase of home ownership and higher share of wealth in house

  – may be driven by generous tax treatment of owner-occupied housing in the Netherlands (Van Ewijk et al, 2007).

Regressions of ln(wealth) on CCEI and socioeconomic information (ages above 35)

CCEI	1.425**	1.490***	1.348*	1.545***	1.563**	1.781**	1.728**
	(0.565)	(0.574)	(0.714)	(0.591)	(0.735)	(0.746)	(0.750)
CCEI (combined data)			0.078		-0.018	-0.091	-0.038
			(0.381)		(0.373)	(0.381)	(0.384)
Risk Attitude				-1.166	-1.165	-1.361	-1.366
				(0.828)	(0.829)	(0.838)	(0.840)
Conscientiousness							0.103
							(0.072)
ln(hhld income '08)	0.601***	0.629***	0.602***	0.595***	0.595***	0.520***	0.514***
	(0.127)	(0.124)	(0.127)	(0.128)	(0.129)	(0.121)	(0.121)
female	-0.228	-0.258	-0.229	-0.232	-0.232	-0.299	-0.321
	(0.164)	(0.162)	(0.164)	(0.166)	(0.166)	(0.168)	(0.169)
age	-0.286	-0.277	-0.284	-0.307	-0.308	-0.310	-0.282
	(0.316)	(0.318)	(0.316)	(0.313)	(0.315)	(0.319)	(0.316)
age^2	0.006	0.006	0.006	0.007	0.007	0.007	0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
age^3	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004	-0.00004
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Partnered	0.682***	0.683***	0.682***	0.726***	0.725***	0.733***	0.714***
	(0.183)	(0.184)	(0.183)	(0.187)	(0.188)	(0.191)	(0.191)
Number of Children	0.103	0.106	0.103	0.092	0.092	0.095	0.090
	(0.092)	(0.093)	(0.093)	(0.094)	(0.095)	(0.095)	(0.095)
Education Contols?	yes	no	yes	yes	yes	yes	yes
Constant	5.932	5.451	5.888	6.938	6.947	7.797	7.371
	(5.862)	(6.110)	(5.879)	(5.786)	(5.812)	(5.880)	(5.841)
Adj	0.1794	0.1695	0.1778	0.186	0.1843	0.1801	0.1819
R-squared							
# of observations	517	517	517	517	517	494	494

Sources of the correlation in wealth regressions

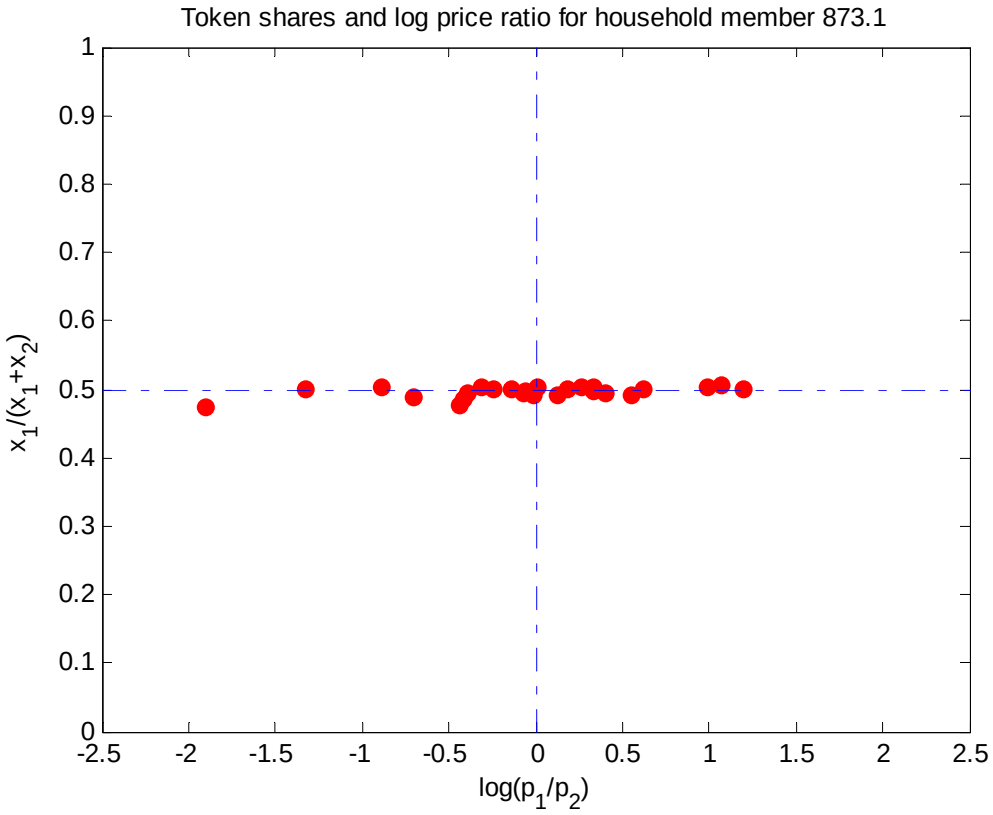
	Natural Log of Hhld Wealth	Natural Log of Hhld Wealth	Fraction of Wealth In Checking	Fraction of Wealth In Savings	Owns Stocks	Fraction of Wealth In Stocks	Owns a House	Fraction of Wealth In House
ccei	1.907**	1.792**	-0.100*	-0.179*	0.160	-0.003	0.371**	0.336***
	(0.751)	(0.705)	(0.057)	(0.096)	(0.160)	(0.050)	(0.150)	(0.129)
ln(hhld income '08)	0.686***	0.25	-0.030**	-0.062***	0.154***	0.011	0.138***	0.098***
	(0.133)	(0.184)	(0.013)	(0.021)	(0.032)	(0.010)	(0.027)	(0.023)
ln(hhld income '06)		0.467*						
		(0.262)						
ln(hhld income '04)		0.312*						
		(0.176)						
female	-0.144	-0.037	0.019	0.017	-0.005	0.005	-0.021	-0.039
	(0.188)	(0.184)	(0.018)	(0.029)	(0.046)	(0.012)	(0.044)	(0.039)
partnered	0.790***	0.740***	-0.033	-0.058*	0.003	-0.008	0.211***	0.136***
	(0.222)	(0.222)	(0.021)	(0.033)	(0.049)	(0.014)	(0.051)	(0.044)
# of children	0.111	0.123	-0.004	-0.043***	0.003	0	0.051**	0.069***
	(0.107)	(0.101)	(0.009)	(0.013)	(0.026)	(0.007)	(0.020)	(0.019)
Education and age controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
constant	4.282	-0.415	0.045	1.42	-3.326**	-0.287	-1.508	-0.777
	(5.947)	(6.032)	(0.750)	(1.197)	(1.678)	(0.388)	(1.592)	(1.289)
R-squared	0.2355	0.2692	0.0505	0.1042	0.1064	0.0292	0.1737	0.1456
N	377	377	512	502	514	514	479	479

Concluding remarks

- We provided a conceptual foundation linking decision-making quality with economic rationality.

- The field experimental design enabled us to overcome problems of identification and measurement of decision-making quality.

- On-going work: (i) analyzing risk preferences in the data; (ii) extending this study in a larger household panel; (iii) to apply similar tools into the contexts of intertemporal decisions.

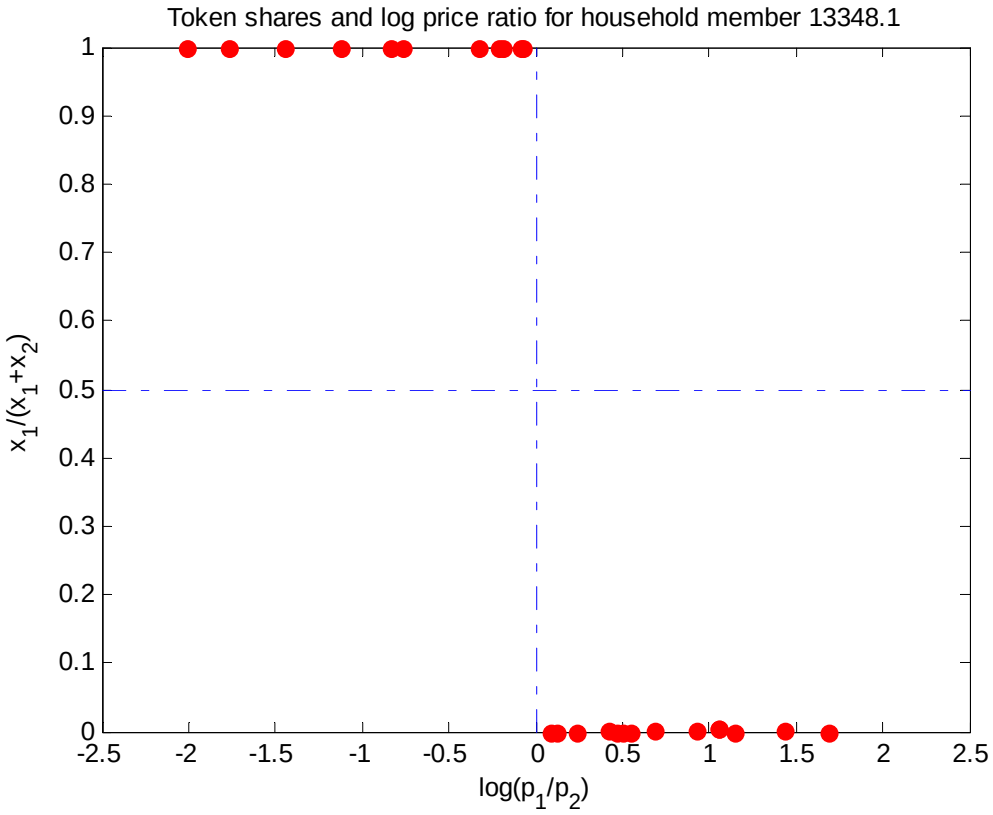


CCEI = 1; Male; 51 years old

Paid work; Mid education

HH income = €2600

# of HH members = 4

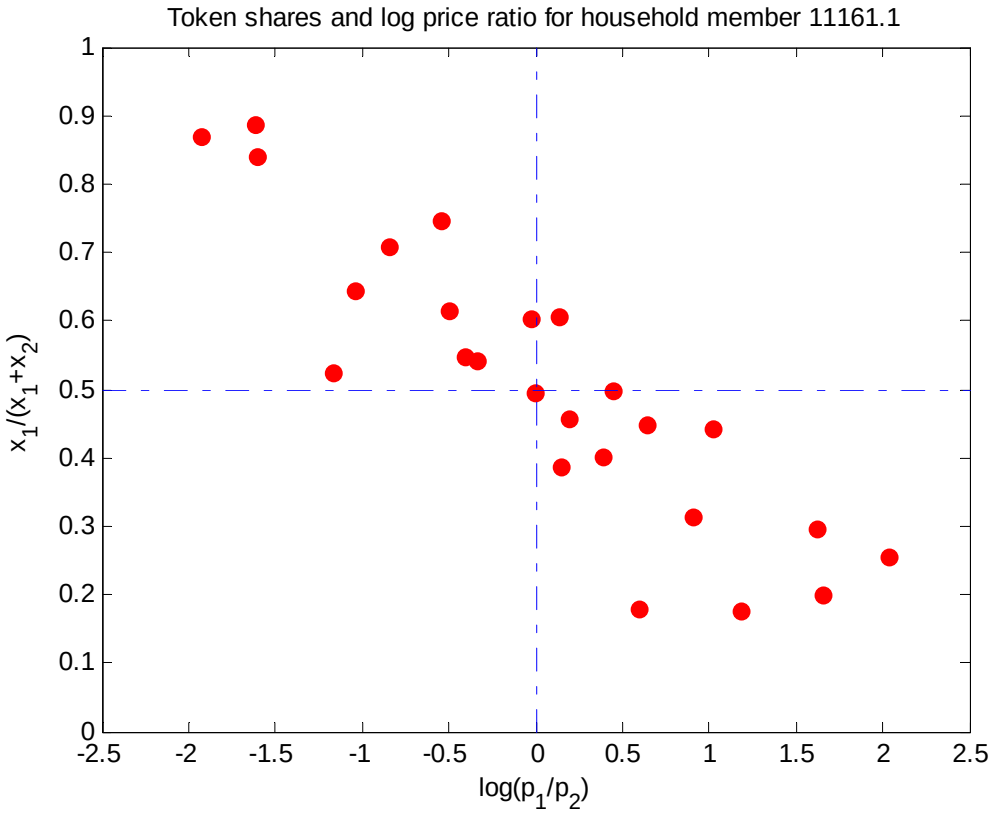


CCEI = 1; Male; 39 years old

Paid work; High education

HH income = €3500

# of HH members = 1

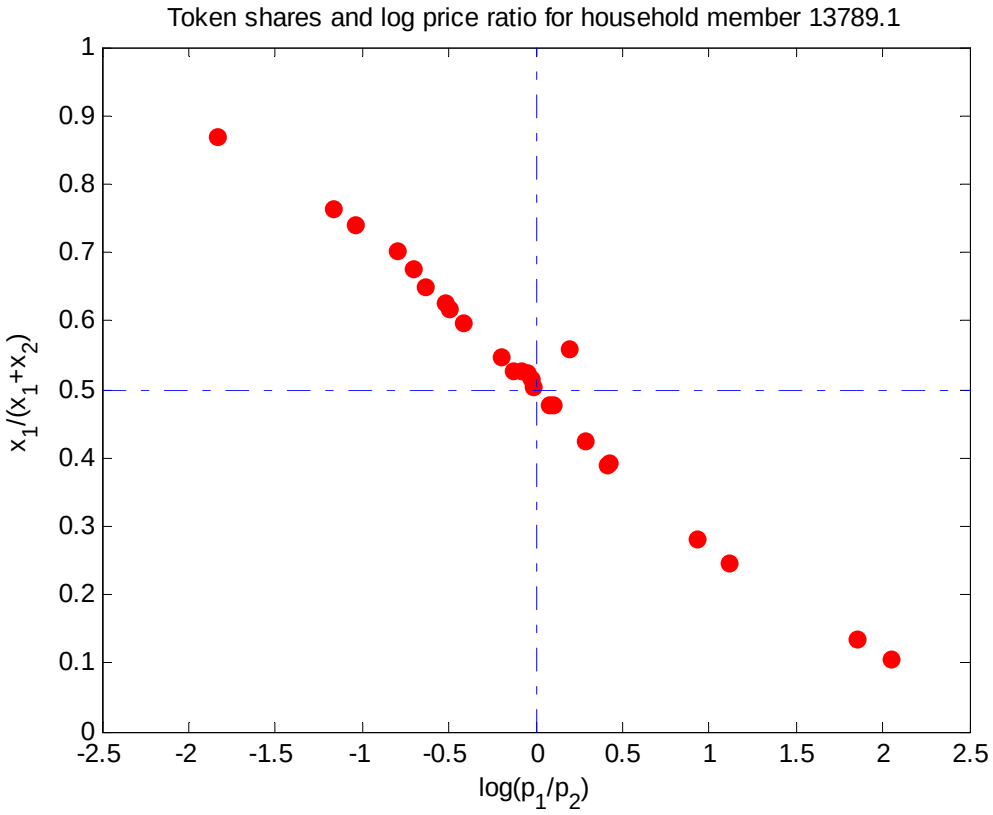


CCEI = 1; Female; 47 years old

Paid work; High education

HH income = €5164

# of HH members = 5

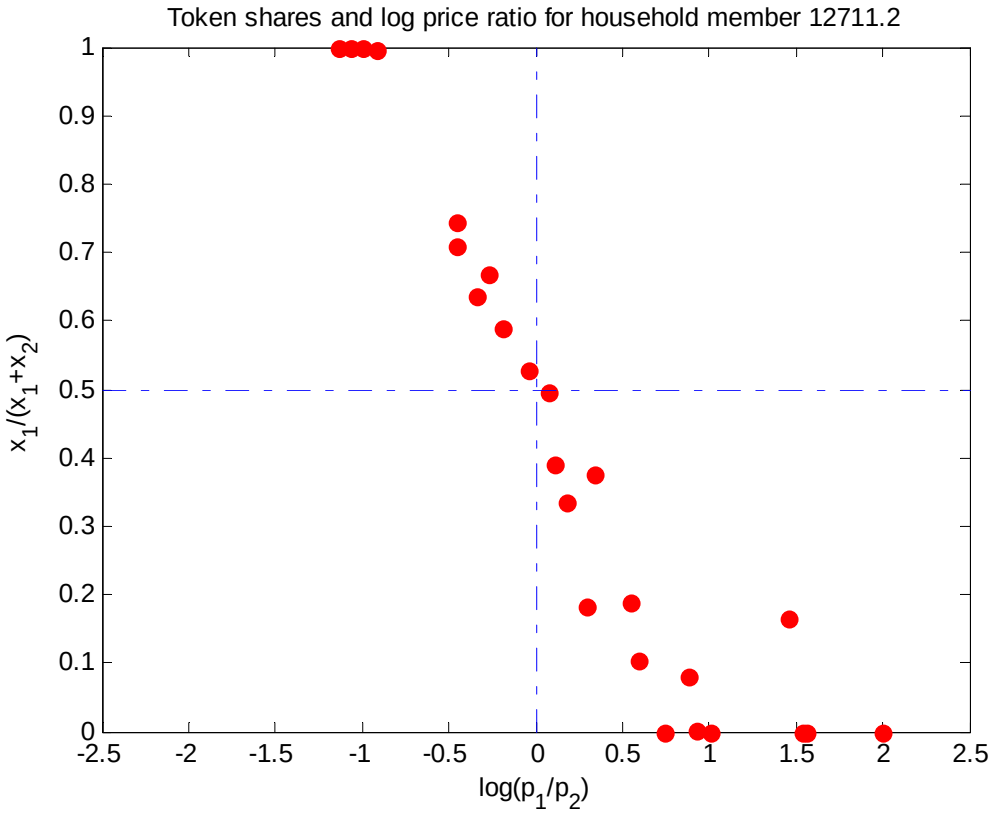


CCEI = 1; Male; 57 years old

Else; Mid education

HH income = €2500

# of HH members = 1

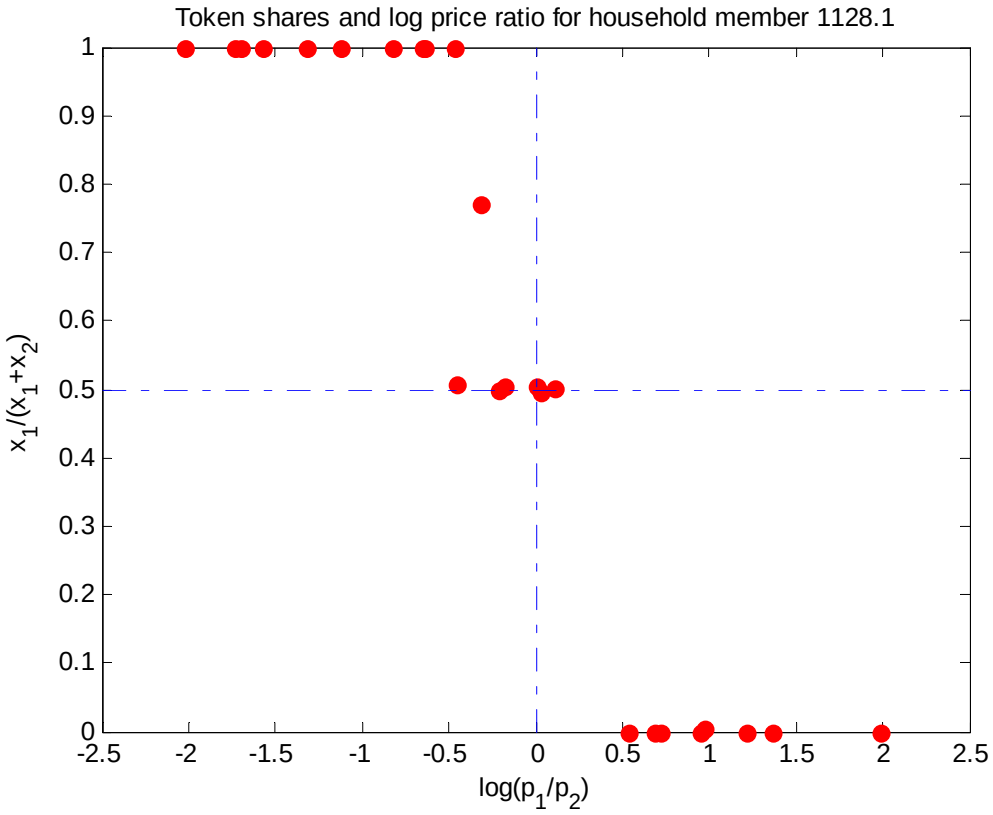


CCEI = 1; Female; 39 years old

Paid work; High education

HH income = €5432

# of HH members = 2

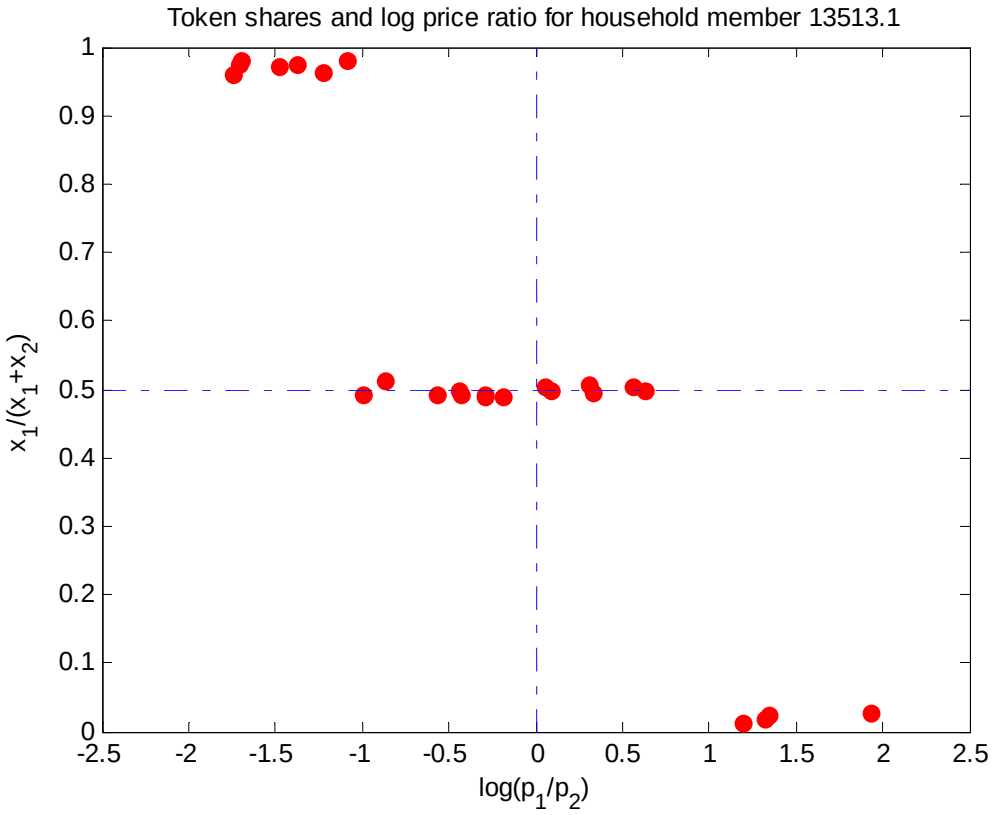


CCEI = 1; Male; 49 years old

Paid work; High education

HH income = €2860

# of HH members = 1



CCEI = 0.978; Male; 42 years old

Paid work; High education

HH income = €4700

# of HH members = 1