

A convenient truth  
between-subject random incentives and  
preferences towards risk and time

N. Berlin\* E. Kemel\* V. Lenglin\* A.Nebout\*

University of Paris Nanterre, HEC Paris & CNRS\* & Lille Catholic University & INRAE

IRISK Seminar, December 2021

# Table of Contents

- 1 Introduction
- 2 Modeling risk and time preferences
- 3 The possible impact of  $\pi$
- 4 The experiment
- 5 The results
  - Model free analysis
  - Econometric estimations
- 6 Discussion

# Introduction

# Real incentives

Economists have access to

- revealed preferences: no control
  - impossibility to identify all the possible factors impacting the decisions
  - impossibility to identify causality
  - impossibility to address non-existing contexts
- stated preferences: not incentivized
  - respondents may not respond seriously
  - respondents may give socially-desirable answers

Experimental economists design incentivized choices in controlled environments

- experimentalists design and manipulate the choice environment
- subjects are incentivized to provide sincere answers

	Incentives	Control
Revealed preferences	✓	
Stated preferences		✓
Economic experiments	✓	✓

# Real incentives

Economists have access to

- revealed preferences: no control
  - impossibility to identify all the possible factors impacting the decisions
  - impossibility to identify causality
  - impossibility to address non-existing contexts
- stated preferences: not incentivized
  - respondents may not respond seriously
  - respondents may give socially-desirable answers

Experimental economists design incentivized choices in controlled environments

- experimentalists design and manipulate the choice environment
- subjects are incentivized to provide sincere answers

	Incentives	Control
Revealed preferences	✓	
Stated preferences		✓
Economic experiments	✓	✓

# The random incentive system: motivation

More often than not, we ask more than one question...

- in order to address consistency (e.g. Allais paradoxes)
- because repetition changes the choice situation (e.g. repeated games)
- in order to reduce the average time cost of data collection (recruiting and instructing subjects is a high fixed cost)

However, incentivizing all the choices

- can create wealth effects
- can create portfolio effects
- can be costly

# The random incentive system: motivation

More often than not, we ask more than one question...

- in order to address consistency (e.g. Allais paradoxes)
- because repetition changes the choice situation (e.g. repeated games)
- in order to reduce the average time cost of data collection (recruiting and instructing subjects is a high fixed cost)

However, incentivizing all the choices

- can create wealth effects
- can create portfolio effects
- can be costly

# The random incentive system: motivation

More often than not, we ask more than one question...

- in order to address consistency (e.g. Allais paradoxes)
- because repetition changes the choice situation (e.g. repeated games)
- in order to reduce the average time cost of data collection (recruiting and instructing subjects is a high fixed cost)

However, incentivizing all the choices

- can create wealth effects
- can create portfolio effects
- can be costly

The random incentive system consists in randomly selecting one option that is payed



# The random incentive system: principle

If the questions consist in categorical answers:  
one of the questions is selected and the chosen option is payed

If the questions consist in continuous answers (e.g. WTP, probability, indifference)

- the continuous answer is approximated by a series of questions, grouped in a list
- the Becker DeGroot Marschak (BDM) procedure can be used
  - a subject bids  $b$  for a good  $G$
  - a random number  $v$  is generated
    - if  $b \geq v$  the subject must buy the good for  $v$
    - if  $b < v$  the subject does not pay and does not get the good

# The random incentive system: principle

If the questions consist in categorical answers:  
one of the questions is selected and the chosen option is payed

If the questions consist in continuous answers (e.g. WTP, probability, indifference)

- the continuous answer is approximated by a series of questions, grouped in a list
- the Becker DeGroot Marschak (BDM) procedure can be used
  - a subject bids  $b$  for a good  $G$
  - a random number  $v$  is generated
    - if  $b \geq v$  the subject must buy the good for  $v$
    - if  $b < v$  the subject does not pay and does not get the good

## Between-subject random incentives

Even with the random incentive system, experimentalists are constrained by the magnitude of the choice consequences

e.g. the maximum outcome in the Holt and Laury (2002) task is \$3.85

This is problematic because

- real economic decisions involve larger consequences
- the literature has reported magnitude effects
  - for risk preferences (?, ?)
  - for time preferences (?)

A solution consists in considering larger consequences, and applying the random incentive system only to a fraction  $\pi$  of subjects

- Each subject has a probability  $\pi$  to be selected
- If the subject is selected, one of her choice is payed

## Between-subject random incentives

Even with the random incentive system, experimentalists are constrained by the magnitude of the choice consequences

e.g. the maximum outcome in the Holt and Laury (2002) task is \$3.85

This is problematic because

- real economic decisions involve larger consequences
- the literature has reported magnitude effects
  - for risk preferences (?, ?)
  - for time preferences (?)

A solution consists in considering larger consequences, and applying the random incentive system only to a fraction  $\pi$  of subjects

- Each subject has a probability  $\pi$  to be selected
- If the subject is selected, one of her choice is payed

# Vocabulary: RIS, WRIS, BRIS and WRIS

A distinction introduced by ?

	Number of choices	
Selection probability $\pi$	1	$> 1$
0	hypothetical	
$0 < \pi < 1$	BRIS	HRIS
$\pi = 1$	IS	WRIS

# What we do

We focus on the selection probability  $\pi$

We measure the impact of  $\pi$  on risk and time preferences

	Number of choices	
Selection probability $\pi$	1	$> 1$
0	hypothetical	
$0 < \pi < 1$	BRIS	HRIS
$\pi = 1$	IS	WRIS

## Contributions

- an empirical answer to a question frequently asked by referees
- some insights about preferences towards risk and time

## Modeling risk and time preferences

## Risk preferences: normative approach

Under risk, choice objects are lotteries, i.e. probability distributions over outcomes  
Under the model of rational choice, Expected Utility (EU), a lottery  $(x_1, p_1; \dots; x_k, p_k)$  is valued

$$\sum_i p_i u(x_i)$$

EU assumes

- **reduction of compound lotteries**

for  $P = (x_1, p_1; \dots; x_k, q_k)$ ,  $R = (x_1, r_1; \dots; x_k, r_k)$  and  $\lambda \in [0, 1]$ ,  
 $\lambda P + (1 - \lambda)R$  is the lottery  $(x_1, \lambda p_1 + (1 - \lambda)r_1; \dots; x_k, \lambda p_k + (1 - \lambda)r_k)$

- **independence:** for any three lotteries  $P, Q$  and  $R$  and  $\lambda \in [0, 1]$ ,  
 $P \succ Q \Leftrightarrow \lambda P + (1 - \lambda)R \succ \lambda Q + (1 - \lambda)R$



# Risk preferences: behavioral approach

- Violation of independence  
Allais' paradoxes challenge the independence axiom

Common ratio effect

$P = (90, 1)$   $Q = (100, 0.9; 0)$  and  $\lambda = 0.1$   
 $90 \succ (100, 0.9; 0)$  but  $(90, 0.1; 0) \prec (100, 0.09; 0)$

- Editing  
According to Prospect Theory (?)  
Subjects do not always reduce compound lotteries,  
 $\lambda P + (1 - \lambda)R$  vs  $\lambda Q + (1 - \lambda)R$  is treated as  $P$  vs  $Q$

# Risk preferences: behavioral approach

- Violation of independence  
Allais' paradoxes challenge the independence axiom

Common ratio effect

$P = (90, 1)$   $Q = (100, 0.9; 0)$  and  $\lambda = 0.1$   
 $90 \succ (100, 0.9; 0)$  but  $(90, 0.1; 0) \prec (100, 0.09; 0)$

- Editing  
According to Prospect Theory (?)  
Subjects do not always reduce compound lotteries,  
 $\lambda P + (1 - \lambda)R$  vs  $\lambda Q + (1 - \lambda)R$  is treated as  $P$  vs  $Q$

# Time preferences: normative approach

For inter-temporal choice, objects are streams of dated outcomes  
Under the model of rational choice, discounted utility (DU), a lottery  $(x_1, t_1; \dots; x_k, t_k)$  is valued

$$\sum_i D(t_i)u(x_i) \text{ with } D(t_i) = e^{-\rho t_i}$$

DU assumes that

- future outcomes are received for sure
- discounting is exponential

# Time preferences: behavioral approach

Many anomalies have been listed ?

- non constant discounting
- gain loss asymmetry
- magnitude effect
- sub additivity

The most documented one is present bias

$$(x, 0) \succ (y, t) \text{ but } (x, \Delta) \prec (y, t + \Delta)$$

that is accommodated by non-exponential discount functions

# Time preferences: behavioral approach

Many anomalies have been listed ?

- non constant discounting
- gain loss asymmetry
- magnitude effect
- sub additivity

The most documented one is present bias

$$(x, 0) \succ (y, t) \text{ but } (x, \Delta) \prec (y, t + \Delta)$$

that is accommodated by non-exponential discount functions

## Risk and time: normative approach

When risk and time are combined, the usual framework is that objects of choice are lotteries over streams of outcomes

$[(x_{1,1}, t_1; \dots; x_{1,k}, t_k), p_1; \dots; (x_{m,1}, t_1; \dots; x_{m,k}, t_k), p_m]$  is valued

$$\sum_i p_i [\sum_j D(t_j) u(x_{i,j})]$$

DEU assumes that

- the utility of risk is the same as the utility of time
- discounting under certainty is the same as discounting under uncertainty

# Risk and time: behavioral approach

A “recent” literature questions DEU (e.g. Epper and Fehr Duda, 2018)

- the utility for risk is not the utility for time (e.g. ?)  
the former is concave, whereas the latter is close to linear
- discounting under certainty is not discounting under risk (e.g. ?)
  - more patience is observed under risk
  - If present bias is due to a “certainty effect”, then it should be reduced when both the present and the future are risky (?)

# Risk and time: behavioral approach

A “recent” literature questions DEU (e.g. Epper and Fehr Duda, 2018)

- the utility for risk is not the utility for time (e.g. ?)  
the former is concave, whereas the latter is close to linear
- discounting under certainty is not discounting under risk (e.g. ?)
  - more patience is observed under risk
  - If present bias is due to a “certainty effect”, then it should be reduced when both the present and the future are risky (?)



# Risk and time: behavioral approach

A “recent” literature questions DEU (e.g. Epper and Fehr Duda, 2018)

- the utility for risk is not the utility for time (e.g. ?)  
the former is concave, whereas the latter is close to linear
- discounting under certainty is not discounting under risk (e.g. ?)
  - more patience is observed under risk
  - If present bias is due to a “certainty effect”, then it should be reduced when both the present and the future are risky (?)

## The possible impact of $\pi$

# Dilution

According to ?

- the expected reward of the decision must exceed the decision cost
- otherwise, errors are increased, as well as deviations from the predictions of rational models

Random incentive systems decrease (delude) expected value of the reward through

- the number of choices (in WRIS)
- the selection probability  $\pi$  (in HRIS)

(it seems that) the dilution effect would create a magnitude effect

- risk aversion should increase when  $\pi$  increases
- impatience should decrease when  $\pi$  increases

# Dilution

According to ?

- the expected reward of the decision must exceed the decision cost
- otherwise, errors are increased, as well as deviations from the predictions of rational models

Random incentive systems decrease (delude) expected value of the reward through

- the number of choices (in WRIS)
- the selection probability  $\pi$  (in HRIS)

(it seems that) the dilution effect would create a magnitude effect

- risk aversion should increase when  $\pi$  increases
- impatience should decrease when  $\pi$  increases

# Compounding

The random incentive system creates a meta lottery over choices

Consider two binary choices:  $P_1$  vs  $Q_1$  and  $P_2$  vs  $Q_2$

- With WRIS and reduction, the two choices are into one choice between four lotteries

$$(P_1, 0.5; P_2, 0.5)$$

$$(P_1, 0.5; Q_2, 0.5)$$

$$(Q_1, 0.5; P_2, 0.5)$$

$$(Q_1, 0.5; Q_2, 0.5)$$

- With HRIS and reduction, the two choices are turned into one choice between four lotteries

$$(P_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(P_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

# Compounding

The random incentive system creates a meta lottery over choices

Consider two binary choices:  $P_1$  vs  $Q_1$  and  $P_2$  vs  $Q_2$

- With WRIS and reduction, the two choices are into one choice between four lotteries

$$(P_1, 0.5; P_2, 0.5)$$

$$(P_1, 0.5; Q_2, 0.5)$$

$$(Q_1, 0.5; P_2, 0.5)$$

$$(Q_1, 0.5; Q_2, 0.5)$$

- With HRIS and reduction, the two choices are turned into one choice between four lotteries

$$(P_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(P_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

# Compounding

The random incentive system creates a meta lottery over choices

Consider two binary choices:  $P_1$  vs  $Q_1$  and  $P_2$  vs  $Q_2$

- With WRIS and reduction, the two choices are into one choice between four lotteries

$$(P_1, 0.5; P_2, 0.5)$$

$$(P_1, 0.5; Q_2, 0.5)$$

$$(Q_1, 0.5; P_2, 0.5)$$

$$(Q_1, 0.5; Q_2, 0.5)$$

- With HRIS and reduction, the two choices are turned into one choice between four lotteries

$$(P_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(P_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

# Compounding

The random incentive system creates a meta lottery over choices

Consider two binary choices:  $P_1$  vs  $Q_1$  and  $P_2$  vs  $Q_2$

- With WRIS and reduction, the two choices are into one choice between four lotteries

$$(P_1, 0.5; P_2, 0.5)$$

$$(P_1, 0.5; Q_2, 0.5)$$

$$(Q_1, 0.5; P_2, 0.5)$$

$$(Q_1, 0.5; Q_2, 0.5)$$

- With HRIS and reduction, the two choices are turned into one choice between four lotteries

$$(P_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(P_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; P_2, 0.5\pi; 0)$$

$$(Q_1, 0.5\pi; Q_2, 0.5\pi; 0)$$

Preferences measured under RIS are valid if the independence axiom holds, or if subject isolate choices



## Compounding under WRIS and HRIS

Available studies on WRIS concluded that the subjects isolate choices ( ?, ? )  
⇒ WRIS is valid, even though the independence axiom is violated

In the present study, we do not address the validity of WRIS,  
we assume that subjects isolate each choice from the series of choices

However, subjects may (easily) compound each lottery with the selection probability  $\pi$

A binary choices:  $P$  vs  $Q$  would be turned into  $(P, \pi; 0)$  vs  $(Q, \pi; 0)$

In this case, according to the common ratio effect, we should observe more risk taking when  $\pi < 1$

# Compounding and time

- We consider the possible impact of  $\pi$  on inter-temporal choices  
A binary choices:  $P$  vs  $Q$  would be turned into  $(P, \pi; 0)$  vs  $(Q, \pi; 0)$
- If subject do not isolate from time choices from  $\pi$  we should observe:
  - less impatience when  $\pi < 1$
  - less present bias when  $\pi < 1$

# A series of hypothesis

	for risk	for time
compounding	more risk taking for $0 < \pi < 1$ than for $\pi = 1$	more patience for $0 < \pi < 1$ than for $\pi = 1$
		less present bias for $0 < \pi < 1$ than for $\pi = 1$
dilution	more risk taking and more errors for $\pi < 1$ than for $\pi = 1$	more impatience and more errors for $\pi < 1$ than for $\pi = 1$
	more inverse S for $\pi < 1$ than for $\pi = 1$	more present bias and more errors for $\pi < 1$ than for $\pi = 1$
isolation	no difference	no difference

Table: Hypothesis about the impact of  $\rho$  on risk and time preferences

## The experiment

# Measuring risk and time preferences

The stimuli we consider

- four certainty equivalents  $ce \sim (x, p; y)$
- four sooner equivalents  $(se, t) \sim (x, t + \tau)$

Risk			Time		
x	y	p	x	$\tau$	t
80	0	0.25	80	3	0
80	0	0.50	80	6	0
80	0	0.75	80	12	0
100	20	0.5	80	6	6

The indifferences are elicited using four steps of bisection: this gives a precision of  $\pm 2.5$  euros.

Advertising: these stimuli

- have been used in ELIPSS survey: 2000 respondents representative of French population, with about 200 questions about socio-economic, health and food behavior
- should be included in CONSTANCE cohort: 20,000 respondents representative of French population, with additional question and matching with health data

# Measuring risk and time preferences

The stimuli we consider

- four certainty equivalents  $ce \sim (x, p; y)$
- four sooner equivalents  $(se, t) \sim (x, t + \tau)$

Risk			Time		
x	y	p	x	$\tau$	t
80	0	0.25	80	3	0
80	0	0.50	80	6	0
80	0	0.75	80	12	0
100	20	0.5	80	6	6

The indifferences are elicited using four steps of bisection: this gives a precision of  $\pm 2.5$  euros.

Advertising: these stimuli

- have been used in ELIPSS survey: 2000 respondents representative of French population, with about 200 questions about socio-economic, health and food behavior
- should be included in CONSTANCE cohort: 20,000 respondents representative of French population, with additional question and matching with health data

# The display

Voici une nouvelle série de questions dans laquelle **l'option A a changé**.  
Vous devez choisir entre l'option A ou l'option B.  
Cliquez sur l'option que vous préférez puis validez.

L'option A vous donne 75% de chance de gagner 80€ et 25% de chance de gagner 0€.

L'option B vous donne 40€ de façon certaine.

Option A		Option B	
75%	80€	100%	40€
25%	0€		

Vous devez choisir entre l'option A ou l'option B.  
Cliquez sur l'option que vous préférez puis validez.

L'option A est un montant de 80€ que vous recevrez dans 3 mois.

L'option B est un montant de 40€ que vous recevrez demain.

Option A					
	80€				
Demain	3 mois	6 mois	9 mois	12 mois	

Option B					
	40€				
Demain	3 mois	6 mois	9 mois	12 mois	

# The design

- risk and time measurements are made in a within-subject design
- treatments related to  $\pi$  are made in a between-subject design

	0	0.1	0.5	1	Total
$n$	84	81	88	82	335
Expected gain	0	6üŸŒ	30üŸŒ	60üŸŒ	



# Procedure

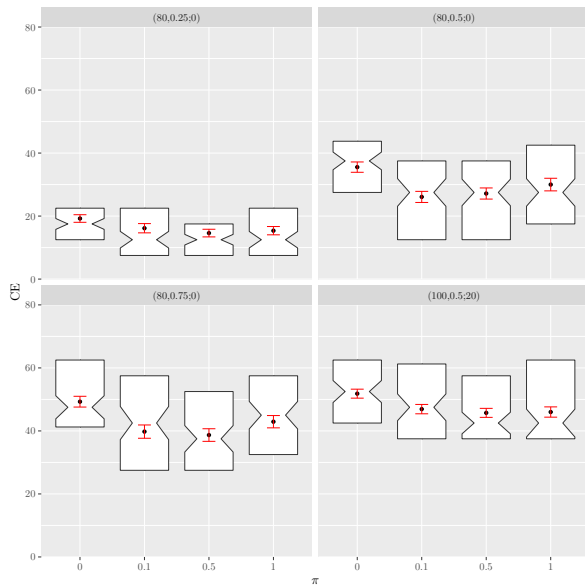
- Subjects recruited from the INSEAD Lab
- Zoom sessions ran in March and April 2021 between 13 and 20 participants
  - instructions made by the experimenter, using a beamer
  - all the subjects from a given session belong to the same treatment
- Implementation of the incentives
  - a lottery played probability  $\pi$  to determine if WRIS applies
  - a lottery with probability 0.5 determines if the selected choice deals with risk or time
  - a lottery chooses among the four stimuli  $S$  for which an indifference has been measured.
  - for the given stimuli, a value  $v$  is chosen in  $\{5, \dots, 75\}$ ,
    - if  $v$  is larger than the indifference value, the subject receives  $v$
    - otherwise, she receives  $S$

## The results

# Outline

- 1 Introduction
- 2 Modeling risk and time preferences
- 3 The possible impact of  $\pi$
- 4 The experiment
- 5 The results**
  - Model free analysis
  - Econometric estimations
- 6 Discussion

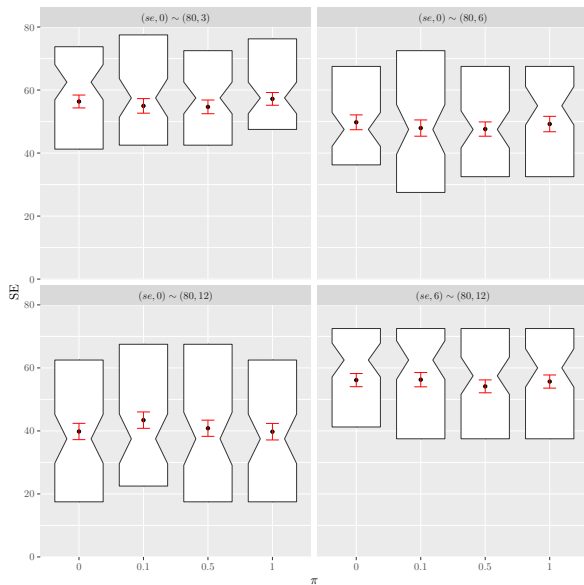
# Risk data



## Risk data: tests

	(80, 0.25; 0)	(80, 0.5; 0)	(80, 0.75; 0)	(100, 0.5; 20)
0 vs 0.1	0.016	<0.001	0.0012	0.03
0.1 vs 0.5	0.57	0.740	0.61	0.58
0.5 vs 1	0.81	0.37	0.11	0.98
Anova ( $\pi \in \{0, 0.1, 0.5, 1\}$ )	0.063	0.041	0.005	0.001
Anova ( $\pi \in \{0.1, 0.5, 1\}$ )	0.71	0.82	0.31	0.31
BF ( $\pi \in \{0.1, 0.5, 1\}$ )	0.06	0.05	0.12	0.12

# Time data



## Time data: tests

	$(se, 0) \sim (80, 3)$	$(se, 0) \sim (80, 6)$	$(se, 0) \sim (80, 12)$	$(se, 6) \sim (80, 12)$
0 vs 0.1	0.90	0.66	0.37	0.81
0.1 vs 0.5	0.79	0.83	0.49	0.38
0.5 vs 1	0.44	0.61	0.73	0.63
Anova ( $\pi \in \{0, 0.1, 0.5, 1\}$ )	0.82	0.91	0.73	0.88
BF ( $\pi \in \{0, 0.1, 0.5, 1\}$ )	0.06	0.05	0.06	0.05

# Bayesian ANOVA

- We consider two models  $M_1$  and  $M_0$  with  $M_0$  enforcing the Null
- The Bayes factor is

$$B_{10} = \frac{\Pr(\text{Data}|M_1)}{\Pr(\text{Data}|M_0)} = \frac{1}{B_{01}}$$

- The base factor
  - offers a benchmark to compare the likelihood of the data
  - allows to support the Null
  - allows the analyst to use her own priors

$$\frac{\Pr(M_1|\text{Data})}{\Pr(M_0|\text{Data})} = B_{10} \frac{\Pr(M_0)}{\Pr(M_1)}$$

- Rouder et al. (2012) propose “convenient” and “plausible” priors to compute BF in the context of ANOVAs.



# Outline

- 1 Introduction
- 2 Modeling risk and time preferences
- 3 The possible impact of  $\pi$
- 4 The experiment
- 5 The results**
  - Model free analysis
  - **Econometric estimations**
- 6 Discussion

# The models

We considered 3 models

- DEU
- Hyperbolic Rank Dependent Utility (HRDU): with probability weighting and quasi-hyperbolic discounting
- Hyperbolic Rank Dependent Utility 2 (HRDU2): with probability weighting and quasi-hyperbolic discounting, and a linear utility for time

	Models	
Model	CE $ce \sim (x, p; y)$	SE $(se, t) \sim (x, t + \tau)$
DEU	$u^{-1}[p[u(x) - u(y)] + u(y)]$	$u^{-1}[e^{-\rho\tau}u(x)]$
HRDU	$u^{-1}[w(p)[u(x) - u(y)] + u(y)]$	$u^{-1}\left[\frac{D(t+\tau)}{D(t)}u(x)\right]$
HRDU2	$u^{-1}[w(p)[u(x) - u(y)] + u(y)]$	$\frac{D(t+\tau)}{D(t)}x$

# The specifications

## The specification

- Power utility function:  $u(x) = x^\alpha$
- Prelec (one-parameter) weighting function:  $w(p) = e^{-[-\log(p)]^\gamma}$
- Quasi-hyperbolic discounting

$$\begin{aligned} D(t) &= 1 && \text{for } t = 0 \\ &= \beta e^{-\rho t} && \text{for } t > 0 \end{aligned}$$

- Normally distributed errors on CEs and SEs, with different std  $\sigma$

## Estimation by (log)likelihood maximization

# Capturing treatment effects

## The specification

- Comparing treatments two-by-two  
For each coefficient  $\theta$ , we consider that

$$\theta = \theta_0 + \Delta_{0.1-0}1_{\pi=0.1} + (\Delta_{0.1-0} + \Delta_{0.5-0.1})1_{\pi=0.5} + (\Delta_{0.1-0} + \Delta_{0.5-0.1} + \Delta_{1-0.5})1_{\pi=1}$$

such that:

$$\Delta_{m-n} = \theta_m - \theta_n$$

- HRIS vs hypothetical and WRIS: treatments  $\pi = 0.1$  and  $\pi = 0.5$  are grouped in "HRIS"

$$\theta = \theta_{HRIS} + \Delta_{Hyp}1_{\pi=0} + \Delta_{WRIS}1_{\pi=1}$$

- Linear effect of  $\pi$ : we focus on case where  $\pi > 0$  and we consider that  $\theta = \theta_c + s\pi$

# Capturing treatment effects

## The specification

- Comparing treatments two-by-two  
For each coefficient  $\theta$ , we consider that

$$\theta = \theta_0 + \Delta_{0.1-0}1_{\pi=0.1} + (\Delta_{0.1-0} + \Delta_{0.5-0.1})1_{\pi=0.5} + (\Delta_{0.1-0} + \Delta_{0.5-0.1} + \Delta_{1-0.5})1_{\pi=1}$$

such that:

$$\Delta_{m-n} = \theta_m - \theta_n$$

- HRIS vs hypothetical and WRIS: treatments  $\pi = 0.1$  and  $\pi = 0.5$  are grouped in “HRIS”

$$\theta = \theta_{HRIS} + \Delta_{Hyp}1_{\pi=0} + \Delta_{WRIS}1_{\pi=1}$$

- Linear effect of  $\pi$ : we focus on case where  $\pi > 0$  and we consider that  $\theta = \theta_c + s\pi$

# Capturing treatment effects

## The specification

- Comparing treatments two-by-two  
For each coefficient  $\theta$ , we consider that

$$\theta = \theta_0 + \Delta_{0.1-0}1_{\pi=0.1} + (\Delta_{0.1-0} + \Delta_{0.5-0.1})1_{\pi=0.5} + (\Delta_{0.1-0} + \Delta_{0.5-0.1} + \Delta_{1-0.5})1_{\pi=1}$$

such that:

$$\Delta_{m-n} = \theta_m - \theta_n$$

- HRIS vs hypothetical and WRIS: treatments  $\pi = 0.1$  and  $\pi = 0.5$  are grouped in “HRIS”

$$\theta = \theta_{HRIS} + \Delta_{Hyp}1_{\pi=0} + \Delta_{WRIS}1_{\pi=1}$$

- Linear effect of  $\pi$ : we focus on case where  $\pi > 0$  and we consider that  $\theta = \theta_c + s\pi$

## Results: reference treatment

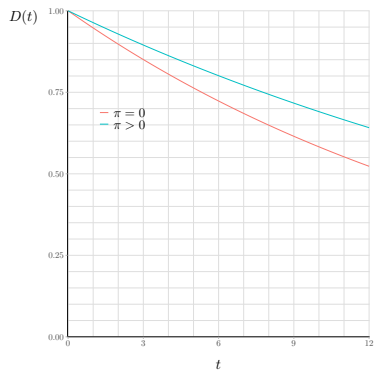
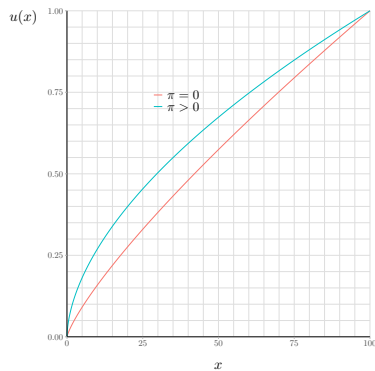
Parameter	DEU	HRDU	HRDU2
$\alpha_0$	0.798 (0.046)	0.90 (0.039)	0.90 (0.039)
$\delta_0$	0.054 (0.006)	0.046 (0.005)	0.051 (0.005)
$\beta_0$		0.861 (0.023)	0.847 (0.028)
$\gamma_0$		0.671 (0.040)	0.671 (0.039)
$\sigma_0^r$	14.65 (2.15)	13.95 (1.948)	13.95 (4.86)
$\sigma_0^t$	21.42 (4.96)	20.84 (0.744)	20.84 (3.71)
LL	-7388.14	-7255.68	-7255.68

# Results: treatment effects

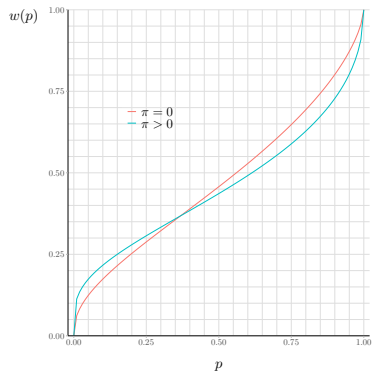
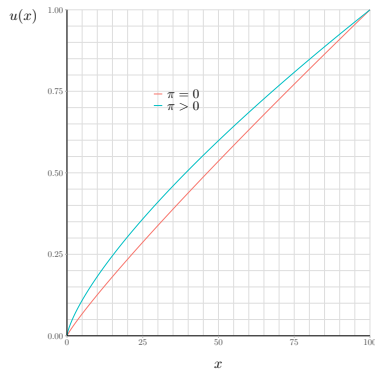
Parameter		DEU		HDRDU		HDRDU2	
$\alpha$	$\alpha_{0.1} - \alpha_0$	<b>-0.239</b>	<b>0.000</b>	<b>-0.164</b>	<b>0.004</b>	<b>-0.164</b>	<b>0.003</b>
	$\alpha_{0.5} - \alpha_{0.1}$	-0.012	0.853	-0.015	0.775	-0.015	0.790
	$\alpha_1 - \alpha_{0.5}$	0.073	0.239	0.041	0.433	0.041	0.472
$\delta$	$\delta_{0.1} - \delta_0$	<b>-0.017</b>	<b>0.020</b>	-0.012	0.060	-0.005	0.476
	$\delta_{0.5} - \delta_{0.1}$	0.002	0.774	0.004	0.495	0.006	0.384
	$\delta_1 - \delta_{0.5}$	0.004	0.569	0.002	0.695	0.000	0.973
$\beta$	$\beta_{0.1} - \beta_0$			0.002	0.948	-0.028	0.489
	$\beta_{0.5} - \beta_{0.1}$			0.013	0.586	0.014	0.670
	$\beta_1 - \beta_{0.5}$			0.012	0.631	0.023	0.470
$\gamma$	$\gamma_{0.1} - \gamma_0$			<b>-0.158</b>	<b>0.005</b>	<b>-0.158</b>	<b>0.007</b>
	$\gamma_{0.5} - \gamma_{0.1}$			-0.001	0.985	-0.001	0.989
	$\gamma_1 - \gamma_{0.5}$			0.070	0.254	0.070	0.351
$\sigma_0^r$	$\sigma_{0.1}^r - \sigma_0^r$	2.445	0.076	1.784	0.322	1.784	0.840
	$\sigma_{0.5}^r - \sigma_{0.1}^r$	-0.084	0.970	-0.111	0.978	-0.111	0.986
	$\sigma_1^r - \sigma_{0.5}^r$	0.128	0.934	0.500	0.942	0.500	0.939
$\sigma_0^t$	$\sigma_{0.1}^t - \sigma_0^t$	1.553	0.592	1.324	0.373	1.323	0.872
	$\sigma_{0.5}^t - \sigma_{0.1}^t$	-0.854	0.837	-0.717	0.741	-0.716	0.919
	$\sigma_1^t - \sigma_{0.5}^t$	-0.776	0.776	-0.608	0.736	-0.608	0.927
LL		-7418.426	0.000	-7286.503	0.000	-7286.503	0.000



# Illustration: under DEU



# Illustration: under HRDU



## Other specifications: HRIS vs hypothetical and WRIS

Parameter		DEU		HRDU		HRDU2	
$\alpha$	$\alpha_0 - \alpha_{0<\rho<1}$	<b>0.245</b>	<b>0.000</b>	<b>0.172</b>	<b>0.000</b>	<b>0.172</b>	<b>0.000</b>
	$\alpha_{0<\rho<1} - \alpha_1$	0.067	0.222	0.034	0.462	0.034	0.467
$\delta$	$\delta_{0<\rho<1} - \delta_0$	<b>0.016</b>	<b>0.011</b>	0.010	0.077	0.002	0.774
	$\delta_{0<\rho<1} - \delta_1$	0.004	0.421	0.004	0.422	0.003	0.605
$\beta$	$\beta_0 - \beta_{0<\rho<1}$			-0.009	0.725	0.021	0.482
	$\beta_{0<\rho<1} - \beta_1$			0.018	0.417	0.030	0.301
$\gamma$	$\gamma_0 - \gamma_{0<\rho<1}$			0.159	0.001	0.159	0.001
	$\gamma_{0<\rho<1} - \gamma_1$			0.069	0.194	0.069	0.193
$\sigma_0^r$	$\sigma_0^r - \sigma_{0<\rho<1}^r$	-2.403	0.115	-1.728	0.009	-1.728	0.027
	$\sigma_{0<\rho<1}^r - \sigma_1^r$	0.086	0.966	0.445	0.603	0.445	0.618
$\sigma_0^t$	$\sigma_0^t - \sigma_{0<\rho<1}^t$	-1.124	0.553	-0.969	0.291	-0.969	0.559
	$\sigma_{0<\rho<1}^t - \sigma_1^t$	-1.201	0.316	-0.970	0.495	-0.969	0.346
LL		-7388.823		-7256.445		-7256.445	
		-7418.426	0.000	-7286.503	0.000	-7286.503	0.000

## Other specifications: linear effect of $\pi$ when $\pi > 0$

Parameter		DEU		HDRDU		HDRDU2	
slope of $\pi$	$\alpha$	0.070	0.317	0.030	0.601	0.030	0.745
	$\delta$	0.006	0.416	0.007	0.327	0.007	0.487
	$\beta$			0.028	0.342	0.042	0.360
	$\gamma$			0.077	0.248	0.078	0.549
	$\sigma^r$	0.053	0.968	0.449	0.766	0.448	0.963
	$\sigma^t$	<b>-1.794</b>	<b>0.044</b>	-1.458	0.400	-1.458	0.886
LL		-5583.121		-5476.502		-5476.50	
		-5585.377	0.34	-5479.01	0.54	-5479.01	0.54

## Discussion

# Main results

We report the first study investigating the impact of the selection probability  $\pi$  on risk and time preferences

- for risk:
  - a difference between  $\pi = 0$  and  $\pi > 0$
  - no difference between treatments when  $\pi > 0$
- for time
  - no impact of  $\pi$

# Main results

We report the first study investigating the impact of the selection probability  $\pi$  on risk and time preferences

- for risk:
  - a difference between  $\pi = 0$  and  $\pi > 0$
  - no difference between treatments when  $\pi > 0$
- for time
  - no impact of  $\pi$

# Main results

We report the first study investigating the impact of the selection probability  $\pi$  on risk and time preferences

- for risk:
  - a difference between  $\pi = 0$  and  $\pi > 0$
  - no difference between treatments when  $\pi > 0$
- for time
  - no impact of  $\pi$

Preliminary conclusion: real incentive matter but subjects isolate from  $\pi$



# Additional findings

- Inverse  $S$  probability weighting is
  - more pronounced for  $\pi > 0$
  - not due do absence of incentives
- Under DEU, controlling for the time utility using the risk utility may create distortions
  - here it creates the spurious impression that incentives impact discounting
  - another illustration that risk preferences are not time preferences (incentives impact the risk utility but not the time utility)

# Back to our set of hypothesis

	for risk	for time
compounding	more risk taking for $0 < \pi < 1$ than for $\pi = 1$	more patience for $0 < \pi < 1$ than for $\pi = 1$ less present bias for $0 < \pi < 1$ than for $\pi = 1$
dilution	more risk taking and more errors for $\pi < 1$ than for $\pi = 1$ more inverse S for $\pi < 1$ than for $\pi = 1$	more impatience and more errors for $\pi < 1$ than for $\pi = 1$ more present bias and more errors for $\pi < 1$ than for $\pi = 1$
isolation	no difference	no difference

# Preference for simplicity?

- The random incentive system creates complexity about
  - how questions are selection
  - how lotteries are played
- In order to avoid this complexity, subject may select the sure outcome more often which would produce
  - more risk aversion
  - more certainty effect, hence more inverse S probability weighting

Thank you!