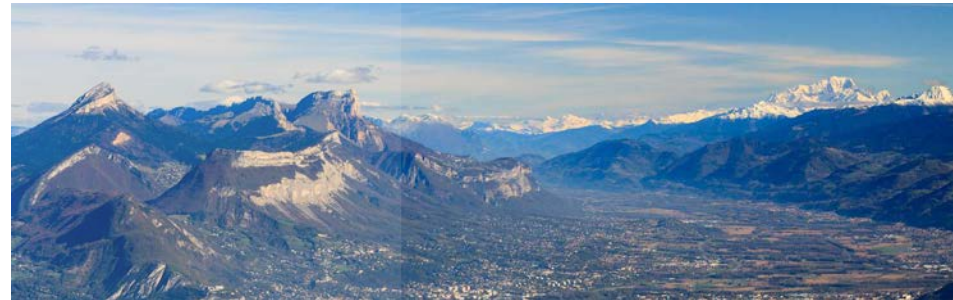




Grenoble Applied
Economics Lab



Linear vs. non-linear pricing:

what can we learn from the lab about individual preferences for electricity tariffs?

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Context: multidimensional paradigm shift

- Electricity retail competition: gain/hold residential consumers
- Price increase: energy costs will continue to rise over the next years... so should electricity prices & Energy Bill (at the expense of vulnerable consumers)
- Innovations/ disruptive technologies: smart grid, smart meters, storage devices, distributed generation
- Energy transition: demand response and energy conservation programs

New pricing mechanisms for consumer are possible and needed

Diversity and complexity of electricity tariffs

Time variant pricing (TVP)

- Real-time pricing (RTP)
- Time-of-use pricing (TOU)
 - French HP/HC since 1965
- Variable Peak pricing (VPP)
- Critical peak pricing (CPP)
 - French EJP tariff (22 days a year) since 1982
- Peak-time rebates (PTR)
- Critical Peak Rebate (CPR)
 - consumer are paid for « not consuming » (resell) relative to a baseline (to be defined)
- ...

Others

- Flat tariffs
- Two-part tariffs
- Tiered Rates
 - Inclining-block rate
 - Declining block rate
- Pre-paid tariff
- Pay monthly bill with carryover
- Pay monthly bill without carryover
- Green tariffs
- Peer-to-peer posted offer
-

Which one to choose?

Design and choose a tariff

- What is the effect targeted?
- Is it efficient to produce the expected change of consumption?
- Is it understandable for consumers?
- Is it acceptable/preferred by consumers?
- We focus on tariff perception by consumers and preference towards different tariffs

Objectives

- Understand the foundation of consumer's tariff choice through the lense of behavioral economics.
- Experiment in the lab and the field to:
 - Assess subjects' attitude toward different tariff
 - Identify specific biases that may hinder comprehension and acceptability by consumers
 - Disentangle the different motivations for the rejection of more complex tariff
- Start with simplest tariffs:
 - Linear tariff: per-unit charge
 - Two part tariff: a lump-sum fee as well as a per-unit charge
 - Inclining-block rate

Litterature on tariff perception and choice

- Tariff might be **complex and sophisticated** and induce consumers cognitive bias
 - Behavioral IO: using price complexity as a method of obfuscation (Carlin, 2009)
 - Procedural rationality (Simon, 1976): searching for « easier but wrong » methods : average price instead of marginal price in non-linear tariffs & increasing block tariff (Ito, 2010, 2014), De Bartolome (1991, 1995)

Two experiments

- Conventional lab experiment
 - Standard subject pool: students
 - Abstract framing of decision : consumption of a fictitious good with constant marginal value and uncertain level of demand
- Framed field experiment
 - Non standard subject pool: representative consumers
 - Electricity framed context of decision with elicitation of subjects' household annual consumption

Lab experimental design

- Consumption for a fictitious product (uncertainty on the quantity to be consumed)
- Choice between two tariffs
 - Tariff 1 – the tariff favored by a bias under study
 - Tariff 2 – higher expected gain, less risky
- Consumption is randomly determine after decision
- Decision gain for one period
$$\text{Value} * \text{Quantity} - \text{Cost}(\text{Tariff}, \text{quantity})$$

Experiment

- 141 participants
- 10 experimental sessions (GATE-Lab)
- 30 decisions between two tariffs
 - 30 periods, two periods are randomly selected for payment at the end of the session
 - Random order of appearance
- Risk elicitation test
- Final questionnaire (gender, education, age...)

Decision screen

The value of a unit of good is 4 ECU.

Tariff X

The price for each unit of good is 2.6 ECU, regardless of the quantity consumed

Quantity	Probability
20	20%
40	20%
60	20%
80	20%
100	20%

Tariff Y

For a quantity consumed between 1 and 40 units, the price for each unit is of 1.5 ECU

For a quantity consumed between 41 and 80 units, the price for each unit is of 2.4 ECU

For a quantity consumed between 81 and 100 units, the price for each unit is of 3.2 ECU

Decision and treatments

Tariff expected bias	Tariff 1	Tariff 2
Simplest tariff	Linear tariff	Inclining-block tariff
Fixed part aversion	Linear tariff	Two part tariff
Fixed part aversion	Two part tariff with lowest fixed part	Two part tariff with highest fixed part

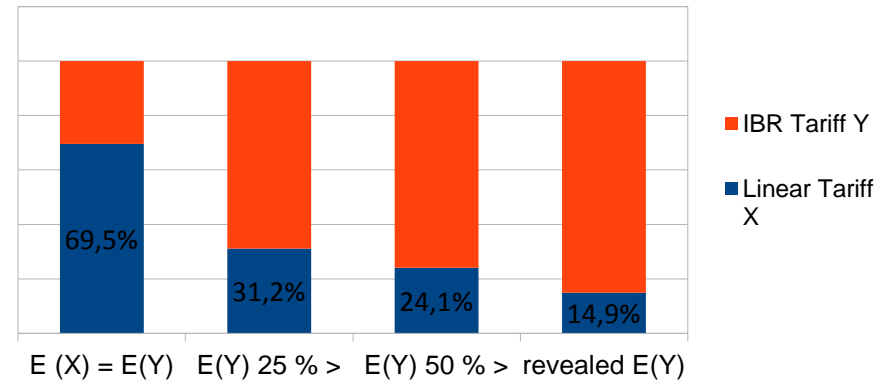
For each comparison : four treatments

- Equal expected value
- EV for tariff 2 is 25% higher
- EV for tariff 2 is 50% higher
- EV for tariff 2 is 25% higher and this information is given before decision

Linear vs. inclining-block tariff

Determinants of the choice for tariff Y for decision group 1

Dependent variable - Choice of Y	Probit Model						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
25%	.312*** (.042)	.309*** (.042)	.310*** (.042)	.301*** (.044)	.297*** (.051)	.301*** (.044)	.359*** (.059)
50%	.377*** (.041)	.385*** (.041)	.385*** (.041)	.381*** (.042)	.359*** (.047)	.381*** (.042)	.464*** (.054)
info	.478*** (.041)	.485*** (.040)	.485*** (.041)	.481*** (.041)	.480*** (.046)	.481*** (.041)	.574*** (.052)
over30		-.174*** (.053)	-.167*** (.053)	-.191*** (.059)	-.201*** (.062)	-.187*** (.061)	-.199*** (.061)
female			-.032 (.036)	-.027 (.037)	.008 (.042)	-.027 (.037)	-.116** (.055)
profile math				.191** (.078)	.182** (.088)	.193** (.079)	.326*** (.115)
risk (final questionnaire)					.0003 (.0107)		
risk (decision7)						.006 (.014)	
risk (HL)							-.031** (.014)



Preference for the simple linear tariff X

Diminishing tendency when T2 becomes more advantageous.

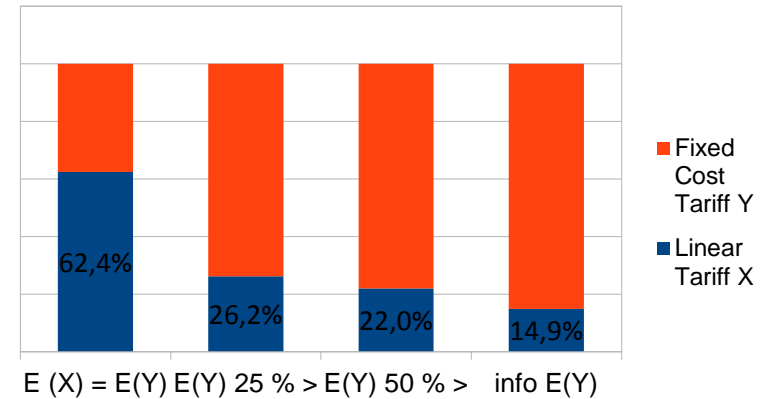
Minimum when full information on expected gain

The probability to choose the non-linear tariff is positively influenced if the participants have an higher educational background and negatively if they are women or they have more than 30 years

Linear vs. fixed cost tariff

Determinants of the choice for tariff Y for decision group 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
25%	.312*** (.042)	.292*** (.043)	.292*** (.043)	.286*** (.044)	.273*** (.051)	.286*** (.044)	.352*** (.057)
50%	.324*** (.042)	.329*** (.043)	.329*** (.043)	.338*** (.044)	.336*** (.044)	.337*** (.044)	.388*** (.044)
info	.421*** (.042)	.421*** (.042)	.421*** (.042)	.426*** (.044)	.411*** (.049)	.426*** (.043)	.455*** (.058)
over30		-.110** (.053)	-.105** (.054)	-.110* (.059)	-.126** (.061)	-.094 (.061)	-.122** (.051)
female			-.022	-.029	-.013	-.031 (.036)	-.131**
profile math				.031 (.068)	.031 (.081)	.041 (.066)	.0008 (.073)
risk (final questionnaire)					.009 (.0109)		
risk (decision7)						.028** (.014)	
risk (HL)							.014 (.015)



Preference for the linear tariff without a fixed cost or as low as possible

This preference is less obvious when tariff Y becomes more advantageous.

Mainly those over 30 years old and those with a lower educational level choose X.

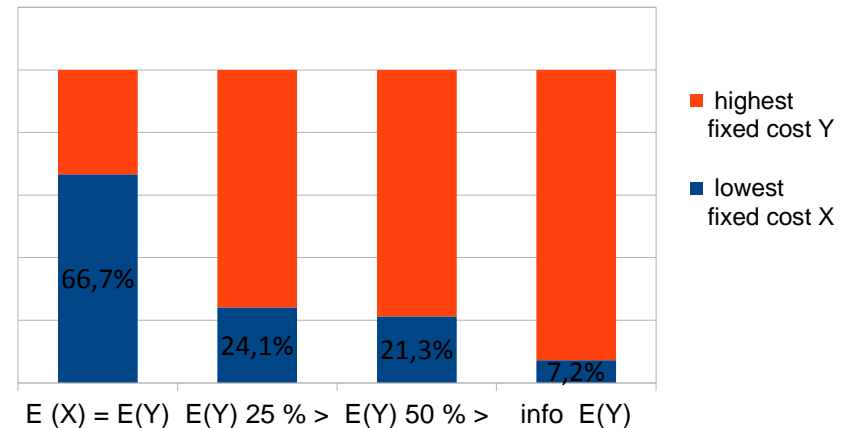
The probability to choose the fixed part tariff is negatively affected if the participants have more than 30 years old and are women

Results – fixed part aversion

Facing two tariffs with a marginal constant price, the participants show a preference for the one with the lowest fixed cost.

Mostly women, participants over 30 and those with a lower educational level chose X.

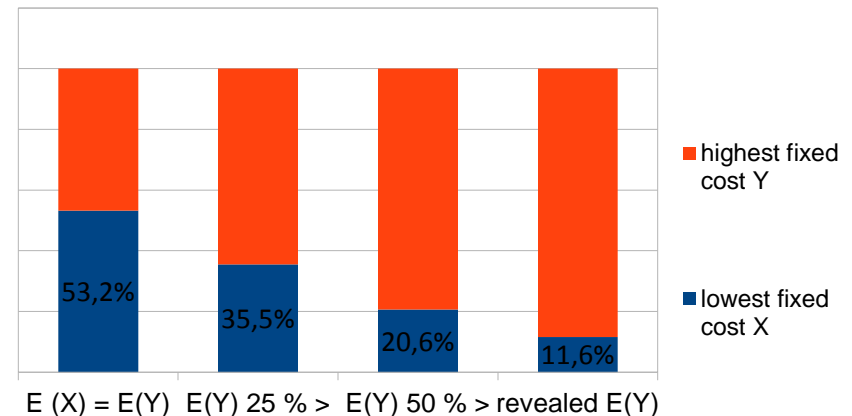
The probability to choose Y is negatively influenced if the subjects have over 30 years.



Facing two increasing block tariffs, a certain preference for the tariff with the lowest fixed part is observed.

This tendency is more salient for women, participants over 30 years and a lower educational level.

The probability to choose Y is negatively influenced if the participants are more than 30 years or they are women.



Framed field experience design

- Consumption for electricity
- Choice between two tariffs
 - Tariff 1 – the tariff favored by a bias under study
 - Tariff 2 – higher expected gain, less risky
- Consumption is elicited (5 questions about household and housing)
- Decision gain
 - 25€ of show up fee
 - Bonus of 1 € if the tariff chosen produces the lower electricity bill.

Experiment

- 308 participants
- 22 experimental sessions (Paris and Lyon)
- 14 decisions between two tariffs, Random order of appearance
- Risk elicitation test, CRT test
- Final questionnaire (gender, education, age...)

Decision screen

Je choisis entre deux tarifs

OPTION 1



JE PAYE UN ABONNEMENT
MENSUEL
LE kWh EST TOUJOURS
AU MÊME PRIX



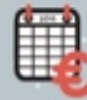
PRIX DE L'ABONNEMENT 4,88 €



PRIX DU kWh 0,156€



OPTION 2



JE PAYE UN ABONNEMENT
MENSUEL
LE kWh EST TOUJOURS
AU MÊME PRIX



PRIX DE L'ABONNEMENT 14,65 €



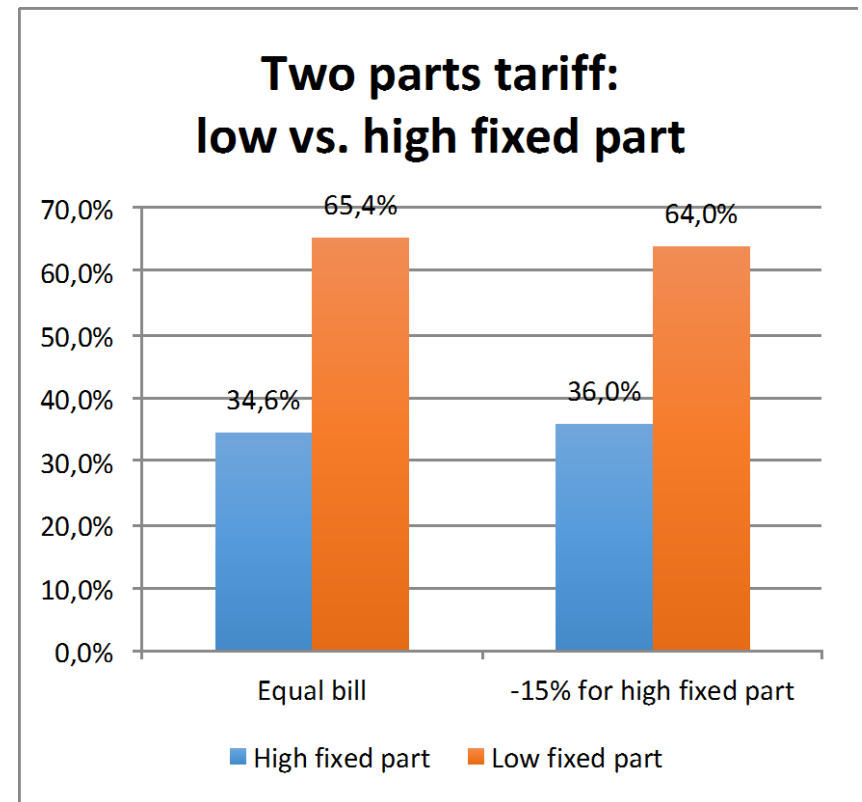
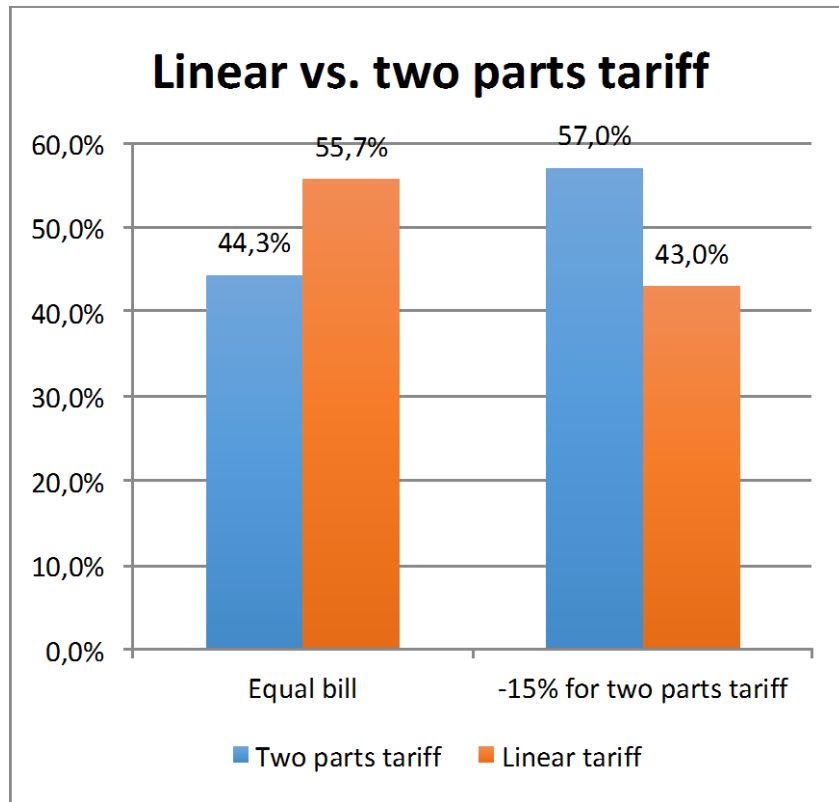
PRIX DU kWh 0,143€



L'ABONNEMENT MENSUEL DOIT ÊTRE PAYÉ CHAQUE MOIS. LE MONTANT DE L'ABONNEMENT NE DÉPEND PAS DE VOTRE CONSOMMATION EN kWh. VOUS DEVEZ PAYER L'ABONNEMENT MÊME QUAND VOUS NE CONSOMMEZ PAS D'ÉLECTRICITÉ.

SUIVANT

Results – fixed part aversion



External validity of lab results

Main results

- From the lab, consumers constantly stick to the tariff with the most simple structure (linear pricing) even when more complex non linear tariff structures are 50% more advantageous
- Subjects repeatedly avoid pricing instruments containing a lump-sum fee.
- Complementary research to explain the lump-sum fee aversion