Mobility choices and climate change: assessing the effects of social norms and economic incentives through discrete choice experiments

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Context and motivation

- Role of transport activity in GHG emissions
  - Both technology *and* behavior change needed to reach ambitious targets of emission reduction
- Carbon taxes (CT) recognized as the most cost-effective instruments, but issue of acceptability
- Alternative instrument such as Personal Carbon Trading (PCT) i.e. carbon budgeting?
- Influences devised from social psychology in other sectors (water, energy, waste…)
- What about social norms in influencing mobility choices?

Aim

- Evaluate and compare the impacts of social norms and economic incentives when encouraging pro-environmental mobility behavior
- “Social norms” what are they?
- Economic incentives:
  - “carbon” tax (additional to current fuel duties)
  - “quotas”: Personal Carbon Allowances (“carbon trading”)
  - “bonus-malus”: a bonus for emitting less than a given threshold, a malus for emitting more (i.e. feebate)

Social norms

- Injunctive norm (IN)
  - “The high level of greenhouse gas emissions in the atmosphere (such as CO_2) can cause dangerous climate change for the planet. Climatologists are already seeing many consequences such as melting glaciers or ice field. According to scientists, to limit these effects it is necessary that all humans reduce their emissions by half.”
- Descriptive norm (DN)
  - “60% of French people personally contribute through their daily actions to reduce their emissions”

PCA: Tradable “fuel rights” for drivers

- possible allocation of free "fuel rights" (or “personal carbon allowances”, PCA) per capita
- rights to be returned in proportion of carbon content of fuel purchased
- monitoring when fuelling the car at the pump with ATM / smart cards
- example: France, 2005, 27 billion litres of fuel, ~450 rights per capita = 5,600 km *solo* driving
- selling of unused rights = incentive to "do better"

Methodology

- Elicit individual's preferences in a (hypothetical) context
  - Stated Choice (SC) Methods: Discrete Choice Experiments (DCE) rooted in Random Utility Theory
- Field experiment: long distance leisure travel
  - large quantity of emissions, can be split from routine (daily) travel behavior
- Trade-off between travel price and travel time under various framing conditions (social norms and economic incentives)
- No interaction between individuals, survey through an internet panel

Which alternatives and attributes?

- One week stay at destination (~1000 km)
  - one week: make ground transportation a plausible alternative (time)
  - for 2 people: make private car a plausible alternative (price)
- Alternatives: air, car, coach, train, no travel at all
- Attributes:
  - price, travel time + various framings
  - price: 400 to 700 € (return price for 2 people)
  - travel time: air = 3h to 10h (with connections), car and coach = 10h to 17h, train = 5h (HST) to 17h
- S-efficient design (Rose and Bliemer, 2005, 2013)

Overall study

- Framing conditions:
  1. no CO2 information (N=300) “control condition”
  2. information on CO2 for each mode (emissions amount)
  3. information on CO2 + injunctive norm,
  4. information on CO2 + injunctive + descriptive norm
  5. information on CO2 + injunctive norm + tax
  6. information on CO2 + injunctive norm + bonus-malus
  7. information on CO2 + injunctive norm + quota
- 7 different samples
  - 1st N=300 then N=100, from June 2013 to June 2014
  - quotas: gender x age, job status household, urban area (8 main French airports)

Example of choice situation (bonus/malus)

You travel with another person to a destination of your choice, located 1,000 km from home.
Here is a first transport situation that is offered to you:

	Air	Coach	Car*	Train
Duration (one way) **	10h	17h	17h	10h
Price (return for two persons)	600 €	600 €	400 €	400 €
CO_2 emitted (return for two persons)	720 kg	124 kg	408 kg	180 kg
Threshold level (kg of CO_2)	150 kg	150 kg	150 kg	150 kg
Unit amount bonus/malus per kg of CO_2	0.05 €	0.05 €	0.05 €	0.05 €
Total bonus (price increase) or malus (price decrease)	29 €	-1 €	13 €	2 €
Total price (including bonus/malus)	629 €	599 €	413 €	402 €

Based on these informations, and not taking account of your previous answers, what means of transportation do you choose? You also have the choice of renouncing travel.

Control condition

Model	**MNL**
Variables	
Air constant	6.9581*** (0.2639)
Car constant	5.8668*** (0.3380)
Coach constant	4.4862*** (0.6489)
Train constant	7.0324*** (0.2739)
Price	-0.0059*** (0.0004)
Air duration	-0.2435*** (0.0192)
Car duration	-0.1400*** (0.0219)
Coach duration	-0.1781*** (0.0538)
Train duration	-0.2631*** (0.0175)
N	1758
Log-likelihood	-1724
ρ^2 McFadden	0.3908
Estrella indicator	0.7937
Values of time	
Air	41 €
Car	24 €
Coach	30 €
Train	45 €

The "renouncing travel" alternative is the reference
Standard deviation in parenthesis
****: significant at 1%; **: significant at 5%; *: significant at 10%*

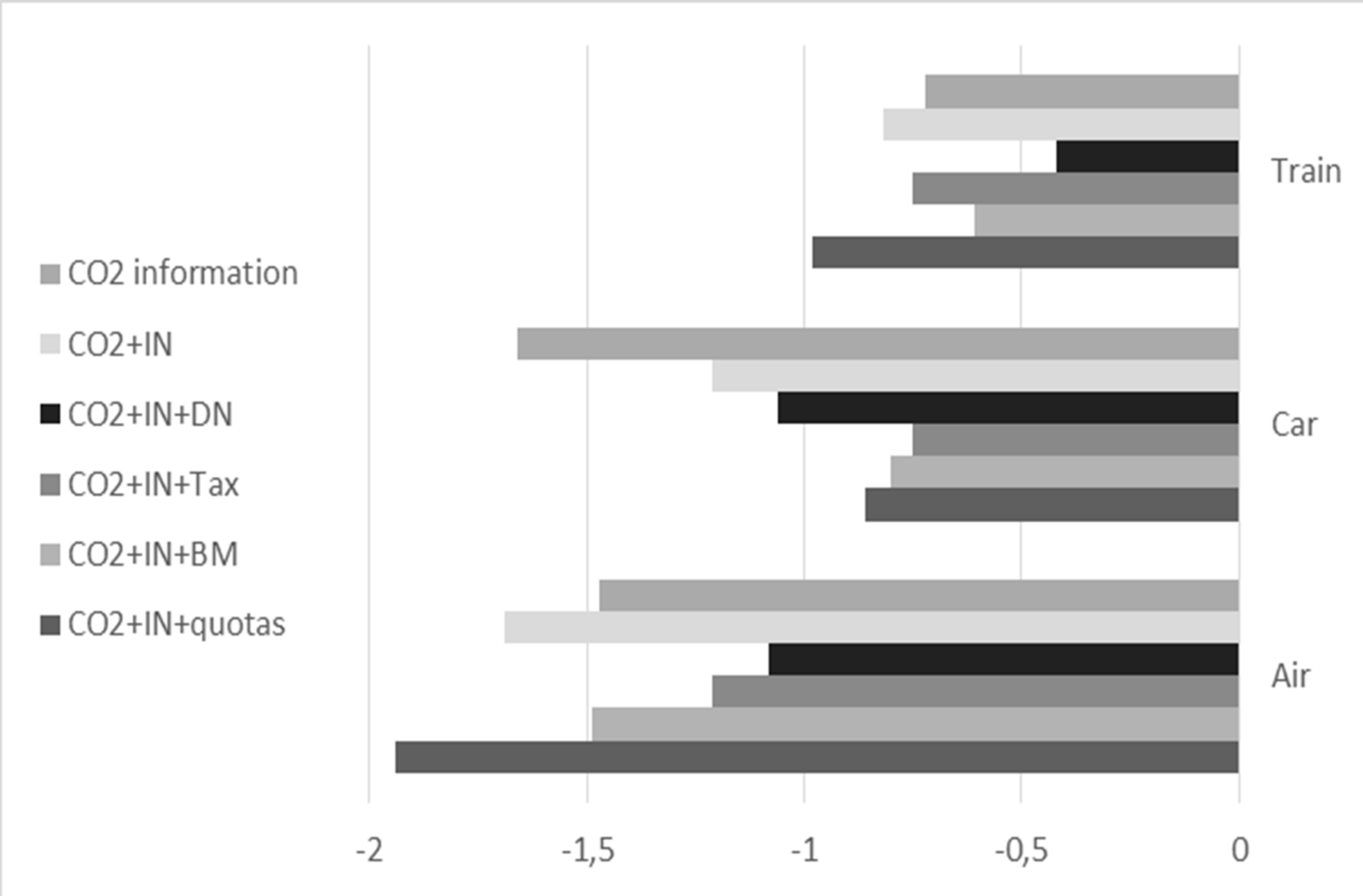
- Preference for travelling
- Values of time per mode "in line" with observed behaviour
- Gender, age, income not significant

All conditions (1 to 7)

Variables	Coefficients	
Air constant	2.1475***	(0.2806)
Car constant	1.6075***	(0.3141)
Train constant	2.0954***	(0.2868)
Price	-0.0052***	(0.0002)
Air duration	-0.2103***	(0.0112)
Car duration	-0.1640***	(0.0123)
Coach duration	-0.1844***	(0.0201)
Train duration	-0.2224***	(0.0085)
Air-CO2	-1.4720***	(0.2086)
Car-CO2	-1.6591***	(0.2471)
Train-CO2	-0.7244***	(0.2199)
Air- CO2+ IN	-1.6922***	(0.2096)
Car- CO2+IN	-1.2077***	(0.2328)
Train- CO2+IN	-0.8163***	(0.2200)
Air- CO2+ IN +DN	-1.0749***	(0.2157)
Car- CO2+ IN +DN	-1.0618***	(0.2453)
Train- CO2+ IN +DN	-0.4218*	(0.2278)
Air- CO2+ IN +Tax	-1.2101***	(0.2398)
Car- CO2+ IN +Tax	-0.7487***	(0.2567)
Train-CO2+IN+Tax	-0.7524***	(0.2491)
Air- CO2+ IN +BM	-1.4853***	(0.2364)
Car- CO2+ IN +BM	-0.8005***	(0.2566)
Train- CO2+ IN +BM	-0.6117***	(0.2468)
Air- CO2+ IN +Quota	-1.9396***	(0.2250)
Car- CO2+ IN +Quota	-0.8576***	(0.2414)
Train- CO2+ IN +Quota	-0.9780***	(0.2352)
N	5010	
Log-likelihood	-4963	
ρ^2 McFadden	0.2854	
Estrella indicator	0.6003	

The "coach" alternative is the reference
Standard deviation in parenthesis
****: significant at 1%; **: significant at 5%; *: significant at 10%*

Comparison of framing effects



Role of framing effect

Variables	Including tax framing effect	Excluding tax framing effect
Air constant	2.6309*** (0.3543)	2.6614*** (0.3475)
Car constant	2.0877*** (0.3962)	2.1523*** (0.3894)
Train constant	2.6265*** (0.3586)	2.6857*** (0.3505)
Baseline price	-0.0055*** (0.0002)	-0.0055*** (0.0002)
Amount of carbon tax	-0.0014 (0.0062)	-0.0187*** (0.0031)
Air duration	-0.2302*** (0.0139)	-0.2293*** (0.0139)
Car duration	-0.1748*** (0.0155)	-0.1729*** (0.0154)
Coach duration	-0.1548*** (0.0264)	-0.1329*** (0.0251)
Train duration	-0.2429*** (0.0110)	-0.2440*** (0.0109)
Air-CO_2	-1.4519*** (0.2092)	-1.2417*** (0.1891)
Car-CO_2	-1.6304*** (0.2480)	-1.4769*** (0.2271)
Train-CO_2	-0.6648*** (0.2221)	-0.4671** (0.1983)
Air- CO_{2+}IN	-1.6737*** (0.2101)	-1.4626*** (0.1900)
Car- CO_{2+}IN	-1.1739*** (0.2338)	-1.0200*** (0.2113)
Train- CO_{2+}IN	-0.7549*** (0.2222)	-0.5565*** (0.1984)
Air- CO_{2+}IN+Tax	-1.3077*** (0.3358)	
Car- CO_{2+}IN+Tax	-0.7860*** (0.2849)	
Train-CO_{2+}IN+Tax	-0.6883*** (0.2552)	
N	3313	3313
Log-likelihood	-3166	-3174
ρ^2 McFadden	0.3106	0.3088

Conclusion

- Psycho-social norms are effective on their own in influencing (stated) travel choices
- Providing basic information on CO2 emissions for each alternative has a significant (strong) effect
- An injunctive norm can reinforce this effect
- Normative messages through benchmarking (bonus-malus) or carbon budgeting (quotas) are stronger than a pure tax. Esp. for air
- Fiscal framing: the amount of the financial (dis)incentive in itself might not matter, the framing itself does

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Issues in SC design

- Full factorial design (not feasible), orthogonal designs (suited to linear models, not to DCM)
- Efficient design: aims at generating parameters with as small as possible standard errors
  - based on the underlying experiment and DC model and some prior information on parameters
- Allows reduction of the sample size N and the number of choices S presented
- Efficiency increased when the less attribute levels and the wider the range of attribute levels

Phasing the waves

- Wave 1: condition1 (control condition), June 2013, N=300
  - quotas: gender x age, job status household, urban area (main French airports)
- Wave 2: conditions 2, 3, 4, December 2013, N=100 in each condition (S-efficient design), same quotas
- Wave 3: conditions 5, 6, 7, June 2014, N=100 in each condition (S-efficient design), same quotas