Citizens in energy transition: Highlighting the role played by spatial preference heterogeneity in public acceptance of biofuels

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An example of DCE methods applied to the development of biofuels in the transportation sector.

• **Results** of an **article** written with:

- Anthony Paris (IFPEN, Univ. Paris-Nanterre);
- Pascal GASTINEAU (Univ. Gustave Eiffel)
- Pierre-Alexandre MAHIEU (Univ. Nantes)
- This paper investigates the acceptance to pay a new tax dedicated to the development of new biofuels in order to reduce greenhouse gas (GHG) emission in the transportation sector.
 - Revealing preferences for different biofuels characteristics & development policies

A survey has been conducted with a Discrete Choice Experiment (DCE), a particular methodology:

- in march 2018
- among 1000 respondents, representative of the French population

Citizens in energy transition: Highlighting the role played by spatial preference heterogeneity in public acceptance of biofuels

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Abstract

Renewable fuels development is an integral part of the public policies mix highlighted by policy makers to decarbonize the transportation sector. Widespread deployment of energy transition technologies will largely depend on the attitudes of consumers and citizens. This paper investigates the acceptance by the French population to pay a new annual tax to finance the development of new biofuels in order to reduce greenhouse gas (GHG) emission in this sector. With a Discrete Choice Experiment conducted among about 997 French citizens in 2018, we analyze preferences for different biofuel development policies. Using a two-stage method, we are particularly interested in the heterogeneity of these preferences. The first stage uses a random parameters logit model. It highlights the heterogeneity of preferences for the attributes within our sample. The means of marginal willingness to pay stemming from the random parameter model are 71, 105 and 142 euros for 20%, 30% and 50% reduction in GHGs emissions compared to 5% reduction. In addition, the support to agricultural sector and the avoidance of food price increase are valued, in mean, respectively at 60 euros and 39 euros. The second stage model uses a panel random-effect regression to estimate the influence of socioeconomic and spatial characteristics on marginal willingness to pay for each of the choice experiment attributes except for emissions reduction. We show that French citizens can be split into two categories depending on the agricultural specialization of its localization.

JEL Classification: C35; C83; Q01; Q42

Keywords: Biofuels; Discrete choice experiment; Social acceptance; Willingness to pay

Introduction

•The *Discret Choice Experiment* approach

- The survey: an example of a choice card
- Choice of attributes and levels
- Experimental design
- The questionnaire and data collection

• A two-stage estimation procedure

- 1. Random Parameter Logit model
- 2. Panel data analysis of the WTP (Random-effects model)

Results of the second step: analysing spatial preference heterogeneity





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INTRODUCTION INCREASING THE USE OF BIOFUELS ?

An example of Discrete Choice Experiment methods applied to the development of biofuels in the transportation sector.

In France, transportation sector accounts for:

- 34% of the final energy consumed (92 % petroleum products)
 - ➔ diversification
- 26 % of national GHG
 - → biggest emitter

Renewable fuels are one of the solution to decarbonize the transportation sector(SP95-E10 for instance):

- Incorporated in fuels with various blend rates:
 - Agricultural raw material (wheat, corn)
 - Vegetable oil (rapeseed, sunflower, palm)
 - Microalgae
 - Energy crops (switchgrass, jatropha), wood or agricultural residues



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Questionnable:

- The « *food vs. fuel* » debate
 - large increase in agricultural commodity prices during the 2000's
 - competition on the uses of arable land
 - deforestation (ILUC)

Second-generation biofuels as a solution ?

- lignocellulosic biomass
 - Energy crops (switchgrass, jatropha), wood or agricultural residues
- better score in GHG emissions reduction from LCA studies
- →Lower impact on agricultural prices
- →Less opportunities for agricultural sector Concerning

INTRODUCTION LITERATURE REVIEW

• US studies:

 Li et al. (2009); Solomon and Johnson (2009); Petrolia et al. (2010); Jensen et al. (2010, 2012); Susaeta et al. (2010); Farrow et al. (2011); Marra et al. (2012); Aguilar et al. (2015); Li and McCluskey (2017); Baral and Rabotyagov (2017); Pouliot et al. (2018).

• EU studies:

- Giraldo et al. (2010); Gracia et al. (2011); Loureiro et al. (2013); Kallas and Gil (2015);
- Savvanidou et al. (2010); Lanzini et al. (2016).

Other countries :

 Bae (2014); Lim et al. (2017); Mamadzhanov et al. (2019); Shin and Hwang (2017).

• No SP studies on the **french case**.

Analysis of consumers choices but citizen preferences.

• heterogeneity in preferences:

- socioe-economic determinants;
- spatial preference heterogeneity.



A two-stage estimation procedure (Campbell, 2007; Scarpa et al., 2011; Abildtrup et al., 2013; Yao et al., 2014, etc.)

- 1. Random Parameter Logit model;
- 2. Panel data analysis of the WTP (Random-effects model).



A QUANTITATIVE ANALYSIS OF CITIZENS' PREFERENCES

- This article investigates the factors influencing citizens (not consumers) motivations and obstacles to finance biofuels development :
 - We estimate the relative weight of various biofuels characteristics influencing citizens' acceptance.
 - Same criteria than policy makers (climate change, energy security)?
 - Spatial heterogeneity ?

• We measure citizens' valuation of these characteristics in monetary terms :

- Willingness To Pay (WTP) for these factors.
- Non-market valuation : <u>Discrete Choice Experiment (DCE).</u>
- Our survey is the first in France and the first using main biofuels characteristics to distinguish between feedstocks
 - 1. **The survey begins** with some information about biofuels in terms of actual use, political determination to develop them, their advantages and disadvantages.
 - Various successive choices are then proposed between two scenarios A and B and a status quo option.
 → Fictional choices made by respondents among several options
 - 3. Respondents **finish survey** by responding to social and economic questions allowing us to analyze impact of these citizens' characteristics on their preferences structure.

4. Econometric analysis



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METHOD: THE DISCRET CHOICE EXPERIMENT (DCE)

Theorical framework in microeconomics :

Lancaster (1966) and Mc Fadden (1974)

> Environmental Economics:

Stated Preference Methods

1/ DESIGN

- Bridges et al. (2013),
- Johnson et al. (2019)
- Attributes and levels:
- <u>Nb</u> : Marshall et al. (2011)
- <u>Content</u>: *Qualitative phase* (Coast et al., 2012; Kløjgaard et al., 2012; Louvier and Lancsar, 2009)
- Experimental design to build the scenarios

2/ SURVEY

- # of respondents
- <u>Type of survey :</u>
 - Interviews /
 - Auto-administered (online or paper) /
 - Survey institute
- <u>Content:</u>
- DCE module + other questions

3/ ANALYSIS

- Hauber et al. (2016)
- Statistics on choices and Dominant preferences:
 - Difficulty of choice or lexicographic preferences (Scott, 2002)
- Conditional logit
 - → Average preferences
- Mixed logit (Train, 2009) or Latent Class
 - Heterogeneity of preferences

OVERVIEW OF THIS DCE

This study
investigates the
acceptance by the
French population of
a new annual tax to
finance the
development of
biofuels in order to
reduce GHG
emissions in the
transportation sector.

 It analyses preferences for the main characteristics of biofuels.

1/ DESIGN

- Attributes and levels:
 - <u>#</u>: 4 attributes, 2 to 4 levels.
- <u>Content</u>: 5 choices between 2 unlabelled alternatives + opt-out (status quo).
- Experimental design
 - two different blocks (versions) containing five choices cards.
 - D-optimality criterion.



• ~ 1000 of respondents

- March 2018
- Representative of the French population
- Web survey
- <u>Content:</u>
 - DCE module + additional questions

3/ ANALYSIS

- Descriptive analysis
- <u>Two-stage method</u>
 1/ RPL model
 - → Heterogeneity
 - 2/ Panel data estimates (RE)
 - → to estimate the influence of socioeconomic and spatial characteristics on mWTPs.

• Respondents have to make choices between three options.

- In our case, respondents are citizens who choose between conserving actual biofuels level (status quo) or developing additional biofuels.
- Each option is defined by a set of attributes taking different values.
- One of these attributes is the monetary contribution of the respondents ; the others include environmental or economic implications of the issue.



• In the following choice card, which scenario do you prefer between:

• scenario A;

• scenario B;

• Statu Quo



	Scénario A	Scénario B	Statu Quo				
Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	100€	15€	0€				
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Oui	Non	Non				
Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-5%	-20%	0%				
Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non				



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Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non

In the scenario A:

- Each household have to pay a contribution of 100 euros per year during 5 years.
- There will be an increase of agricultural activities.
- The GHG emissions of this new biofuel will decrease by 5% compared to the Statu Quo.
- There will be an increase in some food prices.

	Scénario A	Scénario B	Statu Quo	
Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	100 €	15€	0€	
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Oui	Non	Non	
Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-5%	-20%	0%	
Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non	
		S	Statu Quo	

The current situation remains: no development of a new biofuel

In the scenario B:

- Each household have to pay a contribution of 15 euros per year during 5 years.
- No increase of agricultural activities.
- The GHG emissions of this new biofuel will decrease by 20% compared to the Statu Quo.

• No increase in food prices.

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THE CHOICE OF THE ATTRIBUTES

The number of attributes must be limited to avoid the cognitive burden / without omitting any fundamental attribute.

• Choice of the attributes and levels based on :

• The literature,

- Discussions with fuel and biofuels experts,
- Discussions with fuel users having knowledge of biofuels or not.



ATTRIBUTES AND LEVELS

● Annual contribution during five years ($0 \in (only SQ)$; $15 \in :50 \in :100 \in :150 \in :$

- Amount can vary depending on the new biofuels developed, the quantity needed...
- Minimal amount (15 €) corresponds to 1.25 € per month,
- Maximal amount (150 €) based on the audiovisual contribution.

• Support for agricultural sector (Yes ; No (SQ)):

• Existence of an agricultural support depends on the source of new biofuels developed.

● GHG emissions variation (0% (only SQ) ; -5% ; -20% ; -30% ; -50%).

Variations depend on the source of the new biofuels and the blend rate in traditional fuel,
 Amount of emissions based on *LCA* analysis (Edwards et al., 2014).

Impact on food prices (Yes ; No (SQ)).

• Existence of food prices impact depend on the source of the new biofuels.



THE DCE APPROACH: A BLOCK OF CHOICE SET



→ stated preference method



				Scén	ar	io	Sco	énario R			Statu Quo
Contribu Montant pa					<u>مع</u>	<u>Śnaria</u> Scénari		Scánar Scán			
5 ans	Con Mont ména	Cont Monta	Cor			Sco	énario A	Sc	énario B		Statu Quo
Appui à l française Hausse de l' des agricult	5 ans App <u>fran</u>	ménag 5 ans <u>Appı</u>	Mor mén 5 an	Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans		1	00€	1	15€		0€
Variation Réduction d serre par ra biocarburar	Hause des a <u>Vari</u>	franc Haussi des ag	<u>Ap</u> frai Hau des	Appui à la filière agricole française : Hausse de l'activité des agriculteurs			Oui	1	Non	-	Non
Impact si alimenta Augmentati	Redu serre bioca	Réduc serre p biocar	<u>Var</u> Réd serr bioc	Variation des émissions : Réduction des émissions de gaz à effet d serre par rapport au biocarburant actuel	e	-	·5%	-3	20%		0%
prix aliment	<u>Imp</u> alim Augm prix a	Impa alim Augm prix al	<u>lm</u> <u>alir</u> ^{Aug prix}	Impact sur les prix alimentaires : Augmentation de certains prix alimentaires			Oui	1	Non		Non



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THE AIM OF THE EXPERIMENTAL DESIGN

- With four attributes and two to four levels each, 4² * 2² = 64 scenarios exist and the questionnaire would be far too heavy if all combinations of attributes' levels were presented.
- How to select the options that are submitted to respondents ?



- Experimental design using the D-optimal criterion.
- Minimize the size of the variance-covariance matrix of parameters given a prior for \beta.
- We obtain a first version with 10 choice sets which were blocked into two blocks : 5 choice sets per respondent.
- This first version has been administrated to a test sample comprising 42 respondents to estimate priors.
- Estimations used in a second efficient design.



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PRESENTATION OF THE QUESTIONNAIRE

• < 15 minutes. </p>

- General questions regarding the citizens' characteristics (to achieve the sample representativeness).
- Description of the survey (biofuels actual use, advantages and disadvantages, example of a choice task).
- •<u>5</u> choice sets.
- Additional questions to respondents choosing the status quo in all choice sets.
- Final questions on socio-demographic situation, transport and environmental behaviors.



LIMITATIONS OF STATED PREFERENCE METHODS → HYPOTHETICAL BIAS (1/2)

• Two related criticisms:

- 1. Some respondents are not fully involved in the task
- 2. Responses may differ from people's real choices
- → Hypothetical bias

• Causes :

- Choice tasks are difficult to complete
- Choices are not incentive-compatible

• Consequences :

- May overestimate WTP and predicted uptake rates
- Noisy and less precise estimates

• Objective: design experiments to

- i. decrease hypothetical bias and
- ii. improve precision of welfare estimates.



LIMITATIONS OF STATED PREFERENCE METHODS → HYPOTHETICAL BIAS (2/2)

Classical solutions: Ex-ante survey designs

Origines: contingent valuation method (CVM)

- 1. "Oath statements" (Jacquement et al, 2013)
- 2. "Cheap talk" (Cumming and Taylor, 1999; Morrison and Brown, 2009):
 - Ex: Remind the negative impact of a new tax on respondent's available income.
- 3. Emphasize consequentiality of the choices (Loomis, 2014)
 - Remind political determination to develop new biofuels and the impact of responses on political choices.
 - Zawojska et al. (2019):
 - <u>Policy consequentiality</u> : respondents believe their survey responses can influence decisions related to the outcome in question.
 - <u>Payment consequentiality</u> : respondents are aware they will have to bear their share of the coercive cost if the outcome is implemented.

Other solutions:

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- Ex-post calibration with follow-up certainty scales
- Ex: Indicate certainty level on a 0-10 scale (Champ et al., 1997).



• Survey in March 2018.

• Web-survey.

●997 answers.

• 23 protesters removed and 2 surveys with errors.

● 972 respondents (sample).



DESCRIPTIVE STATISTICS (1/2)

Characteristics	Sample	2014 Survey
Size	972	-
Gender (% female)	51.0%	51%
Age		
Young (18 to 29)	20.7%	20,6%
Young adult (30 to 44)	28.3%	27,9%
Adult (45 to 59)*	26.1%	28,6%
Old (60 and older)	24.9%	22,9%

T-tests test shows significant differences * at 10% significance level; ** at 5% significance level, and *** at 1% significance level.



DESCRIPTIVE STATISTICS (2/2)

Characteristics	Sample	2014 Survey
Professional activity		
Top socio-professional category**	16.2%	13,7%
Middle socio-professional category**	16.2%	13,7%
Low socio-professional category***	32.2%	27,5%
Retired***	23.1%	32,6%
Inactive	12.2%	12,5%

T-tests test shows significant differences * at 10% significance level; ** at 5% significance level, and *** at 1% significance level.



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THEORETICAL FRAMEWORK

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Au

• Three axioms

1. Revealed preference theory

● B>A if U(B) > U(A)

2. Characteristics demand theory

• V = f (X,b)

3. Random Utility theory

● U = V + e

Econometric models:

- Conditional Logit (CL) model
- Random Parameter Logit (RPL) model

	Scénario A	Scénario B	Statu Quo
entribution monétaire : entant payé par chaque inage par an pendant ns	15€	0€	0€
opui à la filière agricole ançaise : usse de l'activité agriculteurs	Non	Oui	Non
riation des émissions : duction des émissions de gaz à effet de re par rapport au carburant actuel	-20%	-50%	0%
mentaires : gmentation de certains x alimentaires	Oui	Non	Non



• A two-stage estimation procedure

1. Random Parameter Logit model

(2)

 $U_{n,i} = \eta SQ + X_i\beta_n + \epsilon_{n,i}$

$$U_{n,i} = \begin{cases} V_{n,i} + \epsilon_{n,i} = V(X_i, \beta_n, \mu_n) + \epsilon_{n,i} = X_i \beta_n + \mu_n + \epsilon_{n,i}, & \forall i = A, B\\ V_{n,i} + \epsilon_{n,i} = V(ASC, X_i, \beta_n) + \epsilon_{n,i} = \eta SQ + X_i \beta_n + \epsilon_{n,i}, & i = SQ \end{cases}$$
(3)

2. Panel data analysis of the WTP (Random-effects model)

Campbell, 2007; Scarpa et al., 2011; Abildtrup et al., 2013; Yao et al., 2014.

$$W_{n,k} = -\frac{dx_{cost}}{dx_k} = -\frac{dU/dx_k}{dU/dx_{cost}} = -\frac{\partial V/\partial x_k}{\partial V/\partial x_{cost}} = -\frac{\beta_k}{\beta_{cost}}$$
(4)
$$W_{n,k}^l = -\frac{\beta_k^l}{\beta_{cost}}$$
(5)
$$W_{n,k}^l = \psi_n + \gamma D_{n,k}^l + \frac{\lambda Z_n}{\beta_{n,k}} + \xi_{n,k}^l$$
(6)

Figure 1:	Е	xample of a cho	ices card for surv	ey
		Scenario A	Scenario B	Status Quo
Monetary contribution: Amount paid by each household in turos per year during five years		15€	100€	0€
Support for agricultural sector: Increase agricultural activities		Yes	No	No
Variation in GHG emissions: Reduction in GHG emissions compared to actual biofasts		-20%	-50%	0%
Impact on food prices: Increase in some food prices		Yes	No	No





	CL model	R	PL model		
	Coef. (S.E.)	Coef. (S.E.)	Std. Deviation (S.E.)		
Alternative Specific Constant	-0.251***	-2.143***	-		
Monetary contribution	(0.057) -0.012*** (0.001)	(0.185) <u>-4.008</u> *** (0.087)	1.737*** (0.090)		
Agricultural support	0.509*** (0.044)	0.742*** (0.084)	0.662*** (0.137)		
No impact on food prices	0.453***	1.113****	1.130***		
Emissions variation	(0.041)	(0.0.50)	(0.1.0)		
20% reduction	0.336***	0.675***	1.732***		
30% reduction	(0.063) 0.856*** (0.073)	(0.123) 1.458*** (0.145)	(0.193) 1.380*** (0.204)		
50% reduction	0.985***	1.693***	2.476***		
Error Component	(0.041) - -	(0.162)	(0.210) $\underline{3.481^{***}}$ (0.223)		
N (Ind.)	972		972		
N (Obs.)	14,580		14,580		
McFadden R ⁴ Log Likelihood	0.0679 -4,976.61		0,2669 -3,914.10		

Note: For each variables, the first line concerns the estimated coefficient and the second line (in brackets) mentions the standard errors. The number of stars, i.e., one, two and three, refers to the 10%, 5% and 1% significance level, respectively. For the Random Parameter Logit model, the coefficient of the monetary contribution follows a log-normal distribution.

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non

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$$U_{n,i} = \begin{cases} V_{n,i} + \epsilon_{n,i} = V(X_i, \beta_n, \mu_n) + \epsilon_{n,i} = X_i \beta_n + \mu_n + \epsilon_{n,i}, & \forall i = A, B \\ V_{n,i} + \epsilon_{n,i} = V(ASC, X_i, \beta_n) + \epsilon_{n,i} = \eta SQ + X_i \beta_n + \epsilon_{n,i}, & i = SQ \end{cases}$$

Intuitive:	
Monetary contribution:	-
Agricultural support:	+
Emissions variation:	+
Impact on food prices:	+

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COMPUTING THE WILLINGNESS TO PAY (WTP) FOR EACH ATTRIBUTE

The RPL coefficients are estimated for each respondent

 $U_{n,i} = \eta SQ + X_i \widehat{\beta_n} + \epsilon_{n,i}$ Deducing the WTP for each respondent $W_{n,k} = -\frac{dx_{cost}}{dx_k} = -\frac{dU/dx_k}{dU/dx_{cost}} = -\frac{\partial V/\partial x_k}{\partial V/\partial x_{cost}} = -\frac{\beta_k}{\beta_{cost}}$

- WTP for agricultural support
- WTP for reducing the GHG emissions
- WTP for avoiding an increase in food prices

	Scénario A	Scénario B	Statu Quo
 Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
 Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
 Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non



WTP ESTIMATES

Figure 2: Distribution of the marginal willingness to pay



(a) Box plots for the marginal willingness to pay for the support for agricultural sector and avoidance of food prices increases (b) Box plots for the marginal willingness to pay for the GHGs emissions reduction compared to -5% level



RESULTS OF THE RPL MODEL



	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole francaise. Hansas de l'antivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains pris alimentaires	Oui	Non	Non

Figure 2: Kernel density of coefficients with RPL model





COMPUTING THE WILLINGNESS TO PAY (WTP) FOR EACH ATTRIBUTE

• The RPL coefficients are estimated for each respondent

 $U_{n,i} = \eta SQ + X_i \widehat{\beta_n} + \epsilon_{n,i}$ Deducing the WTP for each respondent $W_{n,k} = -\frac{dx_{cost}}{dx_k} = -\frac{dU/dx_k}{dU/dx_{cost}} = -\frac{\partial V/\partial x_k}{\partial V/\partial x_{cost}} = -\frac{\beta_k}{\beta_{cost}}$

- WTP for agricultural support
- WTP for reducing the GHG emissions
- WTP for avoiding an increase in food prices

	Scénario A	Scénario B	Statu Quo
 Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
 Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non

 $W_{n,k}^{l} = \psi_{n} + \gamma D_{n,k}^{l} + \underline{\lambda Z_{n}} + \xi_{n,k}^{l}$



Introduction

•The *Discret Choice Experiment* approach

- The survey: an example of a choice card
- Choice of attributes and levels
- Experimental design
- The questionnaire and data collection
- **O**A two-stage estimation procedure
 - 1. Random Parameter Logit model
 - 2. Panel data analysis of the WTP (Random-effects model)

Results of the second step: analysing spatial preference heterogeneity





$$W_{n,k}^{l} = \psi_{n} + \gamma D_{n,k}^{l} + \underline{\lambda Z_{n}} + \xi_{n,k}^{l}$$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : fontant payé par chaque nonge par an pendant ans	15€	0€	0€
Appui à la filière agricole rancelae : laurase de l'astivité les agriculteurs	Non	Oui	Non
Arriation des émissions ; éduction des émissions de gas à effet de erre par rapport au iocarburant actuel	-20%	-50%	0%
Impact sur les prix Ilmentaires : ugmantation da certains ris alimentaires	Oui	Non	Non

Citizens in energy transition: Highlighting the role played by <u>spatial preference heterogeneity</u> in public acceptance of biofuels

Anthony Paris^{*a}, Benoît Chèze^{a, b, c}, Pascal Gastineau^d, and Pierre-Alexandre Mahieu^e

French citizens can be split into two categories depending on the agricultural specialization of their location







Mer Méditerranée

N

100 km

ESPAGNE

$$W_{n,k}^{l} = \psi_{n} + \gamma D_{n,k}^{l} + \underline{\lambda Z_{n}} + \xi_{n,k}^{l}$$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par rapport au kiocarburant actual	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains prix alimentaires	Oui	Non	Non

		Table 4: Marginal WTP p	anel regres	ssion mod	el
		Indicator for attribute level			
2 clusters		Constant	92.53***	85.71***	40.52**
		Constant	(8.677)	(7.287)	(19.78)
		30%	34.62***	35.46^{***}	34.62***
		reduction	(4.432)	(6.527)	(4.432)
		50%	71.58***	82.59***	71.58***
		reduction	(4.432)	(6.527)	(4.432)
		Agricultural	-10.42**	-18.82***	-10.42**
		support	(4.432)	(6.527)	(4.432)
		Food price	-32.11***	-45.82***	-32.11***
ROYAUME-UNI	Les mises en valeur traditionnelles	impact	(4.432)	(6.527)	(4.432)
BELGIQUE ALLEMAGNE	Polyculture (céréales et élevage)	Indicator for agricultural specialization	6		
Manche N. PE	Élevage extensif	No agricultural	ref.		
	Des régions spécialisées	area Di-f1	10.00		
Normandie Bassin Champagne	Céréaliculture intensive	Bioruel	-19.80	J	
Bretagne	Élevage intensif	Livestock	-43 02***		
Such Such		farming area	(13.80)		
Bourgogne Suisse	(vignes, fruits et légumes)	Market gardening	-30.67*		
	Des territoires intégrés aux marchés	area	(15.87)		
and the second s	européens et mondiaux	Poly-culture	-28.96***		
OCEAN Cognac	> Principaux flux d'exportation	area	(10.90)	/ /	
LANTIQUE Massif De TALIE	de produits agricoles	Viticulture	-16.88		
Comtat	Extension de la grande culture céréalière	area	(18.95)		
Bassin	Cerealiere			—)	
Pyrénées Corse					ip <i>Energies</i> nouvelles

 $W_{n,k}^l = \psi_n + \gamma D_{n,k}^l + \lambda Z_n + \xi_{n,k}^l$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appulà la filière agricole francaise : Hausse de l'autivité des agricultaurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gaz à effet de serre par resport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains pris alimentaires	Oui	Non	Non

Table 5: Marginal WTPs panel regression model

_	(1)	(2)	(3)
-	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)
Attributes			
Constant	92.53***	85.71***	40.52**
90%	(8.677)	(7.287)	(19.78)
30% reduction	(4.492)	(6.527)	(4.492)
50 %reduction	71.58***	82.59***	71.58**
	(4.432)	(6.527)	(4.432)
Agricultural support	-10.42**	-18.82***	-10.42*
	(4.432)	(6.527)	(4.432)
No impact on food prices	-32.11	-45.82***	-32.11**
Agricultural specialization	(4.432)	(6.527)	(4.432)
No agricultural area	ref.		
ito agricultura area	-		
Biofuel crops area	-19.86		
	(13.15)		
Livestock farming area	-43.02***		
Malation	(13.89)		
Market gardening area	-30.67*		
Poly-culture area	-28.96***		
	(10.90)		
Viticulture area	-16.88		
	(18.95)	-	
Agricultural specialization subgroups		-27.58	-14.57
nteraction terms		(5.650)	(0.010
30% reduction × Agr. spec. subgroups		-1.543	
		(8.864)	
50% reduction \times Agr. spec. subgroups		-20.30**	
		(8.864)	
Agricultural support × Agr. spec. subgroups		15.49*	
No impact on food prices V Agr. spag. subgroups		(8.864)	
No impact on food prices × Agr. spec. subgroups		(8,864)	
Socioeconomic and locational variables		(,	
Income			0.008**
			(0.003
Tax burden			-20.65
Detect accientional surface share			(12.07)
Dpana, agricultural surface snare			(0.294)
Local population density			0.002**
			(0.001)
(Ind.)	972	979	972

... compared to crops, viticultures and non agricultural areas



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Livestock farming, market

gardening and poly-culture areas...

 $W_{n,k}^l = \psi_n + \gamma D_{n,k}^l + \lambda Z_n + \xi_{n,k}^l$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appulà la filière agricole française : flavose de l'astivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par repport au biocarburant actual	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains pris alimentaires	Oui	Non	Non

The second	Table	5:	Marginal	WTPs	panel	regression	mode
---	-------	----	----------	------	-------	------------	------

	(1)	(2)	(3)
	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)
Attributes			
Constant	92.53***	85.71***	40.52**
0007 1	(8.677)	(7.287)	(19.78)
30% reduction	34.62***	35.46***	34.62***
50 % reduction	71.58***	82.59***	71.58***
	(4.432)	(6.527)	(4.432)
Agricultural support	-10.42**	-18.82***	-10.42**
	(4.432)	(6.527)	(4.432)
No impact on food prices	-32.11***	-45.82***	-32.11***
A grigultural specialization	(4.432)	(6.527)	(4.432)
No agricultural area	ref		
	-		
Biofuel crops area	-19.86		
	(13.15)		
Livestock farming area	-43.02***		
Malatan Internet	(13.89)		
Market gardening area	-30.67*		
Poly-culture area	-28.96***		
,	(10.90)		
Viticulture area	-16.88		
	(18.95)		
Agricultural specialization subgroups		-27.58***	-14.57*
Internetion to and		(9.896)	(8.818)
20% reduction X Agr. spac. subgroups		1 549	
50% reduction × Agr. spec. subgroups		(8.864)	
50% reduction × Agr. spec. subgroups		-20.30**	
		(8.864)	
Agricultural support \times Agr. spec. subgroups		15.49*	
		(8.864)	
No impact on food prices × Agr. spec. subgroups		(8 864)	
Socioeconomic and locational variables		(0.004)	
Income			0.008***
			(0.003)
Tax burden			-20.65*
			(12.07)
Dptmt. agricultural surface share			0.566**
Local population density			0.002***
Local population density			(0.001)
N (Ind.)	072	972	079

... compared to crops, viticultures and non agricultural areas



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Livestock farming, market

gardening and poly-culture

areas...

 $W_{n,k}^l = \psi_n + \gamma D_{n,k}^l + \lambda Z_n + \xi_{n,k}^l$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appulà la filière agricole française : flavose de l'astivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par repport au biocarburant actual	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentation de certains pris alimentaires	Oui	Non	Non

Table 5:	Marginal	WTPs	panel	regression	mode
	0			0	

	(1)	(2)	(3)
	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)
Attributes			
Constant	92.53***	85.71***	40.52**
0007 1 (:	(8.677)	(7.287)	(19.78)
30% reduction	34.62	(6 597)	34.62***
50 % reduction	71.58***	82.59***	71.58***
//	(4.432)	(6.527)	(4.432)
Agricultural support	-10.42**	-18.82***	-10.42**
	(4.432)	(6.527)	(4.432)
No impact on food prices	-32.11***	-45.82***	-32.11***
	(4.432)	(6.527)	(4.432)
Ne secieltural specialization			
No agricultural area	rei.		
Biofuel crops area	-19.86		
	(13.15)		
Livestock farming area	-43.02***		
	(13.89)		
Market gardening area	-30.67*		
B 1 - 1	(15.87)		
Poly-culture area	-28.96***		
Viti-ulture and	(10.90)		
viticulture area	(18.05)		
Agricultural specialization subgroups	(10.00)	-27.58***	-14.57*
- Burger of the second se		(9.896)	(8.818)
nteraction terms			
30% reduction × Agr. spec. subgroups		-1.543	
		(8.864)	
50% reduction \times Agr. spec. subgroups		-20.30**	
Agricultural support \times Agr. spec. subgroups		(8,854) 15.49* (8,854)	
No impact on food prices \times Agr. spec. subgroups		(8.864) 25.28*** (8.864)	
ocioeconomic and locational variables		(0.004)	
Income			0.008***
			(0.003)
Tax burden			-20.65*
			(12.07)
Dptmt. agricultural surface share			0.566**
Local population density			(0.234)
Local population density			(0.001)
(Ind.)	079	079	079
(Ind.)	974	874	872

... compared to crops, viticultures and non agricultural areas



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Livestock farming, market

gardening and poly-culture

areas...

Local population density

N (Ind.)

 $W_{n,k}^{l} = \psi_n + \gamma D_{n,k}^{l} + \lambda Z_n + \xi_{n,k}^{l}$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par éhaquis ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole française : Française : Hausse de l'astivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par repport au biocarburant actual	-20%	-50%	0%
Impact sur les prix alimentaries : Augmentatien de certains prix alimentaries	Oui	Non	Non

Table 5: Marginal WTPs panel regression model

	(1)	(2)	(3)
	Coef.	Coef.	Coef.
	(S.E.)	(S.E.)	(S.E.)
Attributes			
Constant	92.53***	85.71***	40.52**
30% reduction	(8.677) 34.62***	(7.287) 35.46***	(19.78) 34.62***
0070 101001011	(4.432)	(6.527)	(4.432)
50 %reduction	71.58***	82.59***	71.58***
	(4.432)	(6.527)	(4.432)
Agricultural support	-10.42** (4.499)	-18.82	-10.42** (4.492)
No impact on food prices	-32.11***	-45.82***	-32.11***
··· ··· ··· ··· ··· ··· ··· ··· ··· ··	(4.432)	(6.527)	(4.432)
Agricultural specialization			
No agricultural area	ref.		
Biofuel crops area	-19.86		
and the second second	(13.15)		
Livestock farming area	-43.02***		
Market and a second sec	(13.89)		
Market gardening area	-30.67*		
Poly-culture area	-28.96***		
	(10.90)		
Viticulture area	-16.88		
A minuteral annihimeting automas	(18.95)	07 20000	14 578
Agricultural specialization subgroups		(9.896)	(8.818)
Interaction terms			· · ·
30% reduction × Agr. spec. subgroups		-1.543	
50% reduction V Arr and subseque		(8.864)	
50% reduction × Agr. spec. subgroups		(8,864)	
Agricultural support \times Agr. spec. subgroups		15.49*	
		(8.864)	
No impact on food prices × Agr. spec. subgroups		25.28	
Socioeconomic and locational variables		(0.004)	
Income			0.008***
They have been			(0,009)
lax burden			-20.65*
Dptmt, agricultural surface share			0.566**



(0.234) 0.002^{***}

(0.001)

972

972

 $W_{n,k}^l = \psi_n + \gamma D_{n,k}^l + \lambda Z_n + \xi_{n,k}^l$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant 5 ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : réduction des émissions de gas à effet de rerre par resport au biocarburant actual	-20%	-50%	0%
Impact sur les prix alimentaires Augmentaires prix alimentaires	Oui	Non	Non

Table 5: Marginal WTPs panel regression model

	(1)	(2)	(3)
-	Coef. (S.E.)	Coef. (S.E.)	Coef. (S.E.)
Attributes			
Constant	92.53***	85.71***	40.52^{**}
30% reduction	(8.677) 34.62***	(7.287) 35.46***	(19.78) 34.62***
50 %reduction	(4.432) 71.58*** (4.492)	(6.527) 82.59*** (6.527)	(4.432) 71.58*** (4.492)
Agricultural support	-10.42** (4.432)	-18.82*** (6.527)	-10.42** (4.432)
No impact on food prices	-32.11*** (4.432)	-45.82*** (6.527)	-32.11*** (4.432)
Agricultural specialization			
No agricultural area	ref.		
Biofuel crops area	-19.86		
Livestock farming area	-43.02***		
Market gardening area	-30.67* (15.87)		
Poly-culture area	-28.96*** (10.90)		
Viticulture area	-16.88 (18.95)		\frown
Agricultural specialization subgroups	(1000)	-27.58*** (9.896)	-14.57* (8.818)
Interaction terms			
30% reduction \times Agr. spec. subgroups		-1.543 (8.864)	\square
50% reduction \times Agr. spec. subgroups		-20.30**	
Agricultural support \times Agr. spec. subgroups		(8.864) (8.864)	
No impact on food prices \times Agr. spec. subgroups		25.28*** (8.864)	

Socioeconomic and locational variables

	Income			0.008****
	Tax burden			-20.65*
				(12.07)
	Dptmt. agricultural surface share			0.566**
	• • • • • • •			(0.234)
	Local population density			0.002***
	(1.1)	0-0	0=0	(0.001)
N	(Ind.)	972	972	972



ANALYSIS BY CLUSTERS $W_{n,k}^{l} = \alpha_n + \gamma D_{n,k}^{l} + \underline{\lambda Z_n} + \epsilon_{n,k}^{l}$

	Scénario A	Scénario B	Statu Quo
Sontribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole francaise.: Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à affet de serre par resport au laisearburant actual	-20%	-50%	0%
Impact sur les prix alimentation du certains pris elimentaties	Oui	Non	Non

Table 5: Panel regression for both area

		Livestock farming, market		Biofuel	crops, viticul	ture and	
		gardening and poly-culture areas		non agricultural areas			
indicator for attribut	te level	22.00***	33 00***	22.00***	95 40***	25 40888	25 40888
	30%	(5.207)	(5 207)	(5 205)	(7.005)	(7.005)	(7.015)
	reduction	(5.397)	(5.397)	(0.390)	(7.225)	(7.225)	(7.215)
	30%	(5.207)	(5.207)	(5.205)	(7.005)	(7.005)	(7.015)
	reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
	Agricultural	-3.330	-3.330	21.04	-18.82***	-18.82***	-10.76
	support	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Food price	-20.54	-20.54	3.497	-45.82	-45.82	-35.22
	impact	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Constant	35.91	55.16**	88.47	32.99	47.95	54.48
		(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
Socioeconomic variat	oles						
	Tax burden	-33.37**	-32.84**	-33.86**	-10.47		
	Decision de la	(16.58)	(16.54)	(16.56)	(17.70)		
	Dptmt. agricultural	0.720**	0.625**		0.423		
	surface share	(0.311)	(0.304)		(0.352)		
In interaction with	Agricultural			-0.470*			
	support			(0.259)			
	Food price			-0.463*			
	impact			(0.259)			
	Income	0.005			0.011**	0.011**	0.012***
		(0.004)			(0.004)	(0.004)	(0.004)
	Local population	0.003			0.002**	0.001**	
	density	(0.003)			(0.001)	(0.001)	
In interaction with	Agricultural						-0.001**
	support						(0.001)
	Food price						-0.001***
	impact						(0.001)
	N (Ind.)	527	527	527	445	445	445
	N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225



ANALYSIS BY CLUSTERS $W_{n,k}^l = \alpha_n + \gamma D_{n,k}^l + \underline{\lambda Z_n} + \epsilon_{n,k}^l$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par cheagus ménage par an pendiant 3 ans	15€	0€	0€
Appui à la filière agricole francaise. Itanase de l'antivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par resport au laiscarburant actual	-20%	-50%	0%
Impact sur les prix alimentaires Augmentation de cartains pris alimentaires	Oui	Non	Non

Table 5: Panel regression for both area

		Livestock farming, market		Biofuel	crops, viticul	ture and	
Indicator for attribut	ta laval	gardening	and poly-cui	ture areas	non	agricultural a	areas
indicator for attribu	te level	33 00***	33 00***	22 00***	95 46***	25 46***	95 46***
	advetion	(5 207)	(5 207)	(5 205)	(7.995)	(7.995)	(7.215)
	Feduction 50%	62.20***	62.20***	62 20***	82 50***	82 50***	82 50***
	reduction	(5.307)	(5 307)	(5 305)	(7.225)	(7 225)	(7 215)
	Aminultural	(3.357)	(3.357)	21.04	10 00000	10 00###	10.76
	Agricultural	(5.307)	(5.307)	(14.45)	(7.225)	-10.02	(8.27)
	East price	20.54***	20.54***	3.407	45 82***	45 99***	95 00***
	Food price	(5.907)	(5.207)	(14 45)	(7.995)	(7.995)	(9.97)
	impace	(5.597)	(5.397)	88 47***	32.00	47.05***	54 48***
	Constant	(26.02)	(22.70)	(16.02)	(22.55	(14 69)	(14.98)
g	1	(20.03)	(22.10)	(10.03)	(20.13)	(14.00)	(14.26)
Socioeconomic variat	Dies	00 0 7 ##	****	99 02**	10.47		
	Tax burden	-33.3(-32.84	-33.60	(17.70)		
	Destant anni-ultural	0.720**	0.625**	(10.50)	(17.70)		
	Dptmt. agricultural	(0.211)	(0.204)		(0.959)		
In interaction with	Agricultural	(0.311)	(0.304)	0.470*	(0.352)		
in interaction with	Agricultural			-0.470			
	Englaster			(0.259)			
	Food price			-0.465*			
	Impact	0.005		(0.259)	0.011**	0.011**	0.010***
	Income	(0.005			(0.001)	(0.004)	(0.004)
	I and a soulation	(0.004)			(0.004)	(0.004)	(0.004)
	Local population	(0.000)			(0.002	(0.001)	
T	density	(0.003)			(0.001)	(0.001)	0.001.00
in interaction with	Agricultural						-0.001**
	Bupport						(0.001)
	Food price						-0.001***
	impact	505	505	5.05			(0.001)
	N (Ind.)	527	527	527	445	445	445
	N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225



ANALYSIS BY CLUSTERS $W_{n,k}^{l} = \alpha_n + \gamma D_{n,k}^{l} + \underline{\lambda Z_n} + \epsilon_{n,k}^{l}$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole francaise. Hansas de l'antivité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gaz à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires Augmentaires pris alimentaires	Oui	Non	Non

Table 5: Panel regression for both area

	Livestock farming, market		Biofuel	crops, viticul	ture and	
	gardening	and poly-cui	ture areas	non agricultural areas		
Indicator for attribute level						
30%	33.92	33.92	33.92	35.46	35.46***	35.46
reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
50%	62.29	62.29	62.29	82.59	82.59	82.59
reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
Agricultural	-3.330	-3.330	21.04	-18.82	-18.82	-10.76
support	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
Food price	-20.54***	-20.54	3.497	-45.82***	-45.82***	-35.22***
impact	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
Constant	35.91	55.16**	88.47***	32.99	47.95***	54.48***
Constant	(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
Socioeconomic variables						
Tax hurden	-33.37**	-32.84**	-33.86**	-10.47		
Tax burden	(16.58)	(16.54)	(16.56)	(17.70)		
Dptmt. agricultural	0.720**	0.625**		0.423		
surface share	(0.311)	(0.304)		(0.352)		
In interaction with Agricultural			-0.470*			
support			(0.259)			
Food price			-0.463*			
impact			(0.259)			
	0.005			0.011**	0.011**	0.012***
Income	(0.004)			(0.004)	(0.004)	(0.004)
Local population	0.003			0.002**	0.001**	
density	(0.003)			(0.001)	(0.001)	
In interaction with Agricultural					· · · · ·	-0.001**
support						(0.001)
Food price						-0.001***
impact						(0.001)
N (Ind.)	527	527	527	445	445	445
N (Obe.)	2.625	2.625	2.625	2 225	2 225	2 225



ANALYSIS BY CLUSTERS $W_{n,k}^{l} = \alpha_n + \gamma D_{n,k}^{l} + \underline{\lambda Z_n} + \epsilon_{n,k}^{l}$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montart payé par cheque ménage par an pendent 5 ans	15€	0€	0€
Appulà la filière agricole française : transcella la filière agricultaure des agricultaure	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par repport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentalies du certains pris alimentalies	Oui	Non	Non

Table 5: Panel regression for both area

:		Livest	ock farming 1	narket	Biofuel	crops_vitical	ture and
		gardening	and poly-cul	ture areas	non	agricultural a	areas
	Indicator for attribute level	00	,			Q.	
	30%	33.92***	33.92***	33.92***	35.46***	35.46***	35.46***
	reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
	50%	62.29***	62.29***	62.29***	82.59***	82.59***	82.59***
	reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
	Agricultural	-3.330	-3.330	21.04	-18.82***	-18.82***	-10.76
	support	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Food price	-20.54***	-20.54***	3.497	-45.82***	-45.82***	-35.22***
	impact	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Constant	35.91	55.16**	88.47***	32.99	47.95***	54.48***
	Constant	(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
	Socioeconomic variables						
	Tax burden	-33.37**	-32.84**	-33.86**	-10.47		
The mere conjusting lie		(16.58)	(16.54)	(16.56)	(17.70)		
The more agricultural is	Dptmt. agricultural	0.720**	0.625**		0.423		
the Département, the	surface share	(0.311)	(0.304)	0.4708	(0.352)		
loss supportivo	In interaction with Agricultural			-0.470*			
less supportive	support E - 1 i -	1		(0.259)			
	rood price			-0.465*			
	mpace	0.005		(0.208)	0.011**	0.011**	0.012***
	Income	(0.004)			(0.004)	(0.004)	(0.004)
	Local population	0.003			0.002**	0.001**	(0.004)
Citv dwellers are less	density	(0.003)			(0.001)	(0.001)	
	In interaction with Agricultural	(0.000)			(0.001)	(0.001)	-0.001**
supportive	support						(0.001)
	Food price	`]					-0.001***
	impact						(0.001)
	N (Ind.)	527	527	527	445	445	445
	N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225



$W_{n,k}^{l} = \alpha_{n} + \gamma D_{n,k}^{l} + \underline{\lambda Z_{n}} + \epsilon_{n,k}^{l}$ ANALYSIS BY CLUSTERS

	Scénario A	Scénario B	Statu Quo
Sontribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole francaise.: Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à affet de serre par resport au laisearburant actual	-20%	-50%	0%
Impact sur les prix alimentaries ; Augmentation du certains pris elimentaires	Oui	Non	Non

Table 5: Panel regression for both area

			· · · · · · · · · · · · · · · · · · ·			(
			Livesto	ock farming, r	narket	Biofuel	crops, viticul	ture and
			gardening	and poly-cult	ture areas	non	agricultural :	areas
	Indicator for attribut	te level						
		30%	33.92***	33.92***	33.92***	35.46***	35.46***	35.46***
		reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
		50%	62.29***	62.29***	62.29***	82.59***	82.59***	82.59***
		reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
		Agricultural	-3.330	-3.330	21.04	-18.82***	-18.82***	-10.76
		support	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
		Food price	-20.54***	-20.54***	3.497	-45.82***	-45.82***	-35.22***
		impact	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
		0	35.91	55.16**	88.47***	32.99	47.95***	54.48***
		Constant	(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
	Socioeconomic variab	oles						
		The burden	-33.37**	-32.84**	-33.86**	-10.47		
		Tax burden	(16.58)	(16.54)	(16.56)	(17.70)		
		Dptmt. agricultural	0.720^{**}	0.625**		0.423		
		surface share	(0.311)	(0.304)		(0.352)		
The more aaricultural is	In interaction with	Agricultural			-0.470*			
the Dénantement the		support			(0.259)			
the Departement, the		Food price			-0.463*			
less sensitive		impact			(0.259)			
		Income	0.005			0.011**	0.011**	0.012***
		Income	(0.004)			(0.004)	(0.004)	(0.004)
	(Local population	0.003			0.002**	0.001**	
		density	(0.003)			(0.001)	(0.001)	
City dwallars are loss	In interaction with	Agricultural						-0.001**
City uwellers ure less		support						(0.001)
sensitive		Food price						-0.001***
		impact						(0.001)
		N (Ind.)	527	527	527	445	445	445
		N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225



The more a

Introduction

•The *Discret Choice Experiment* approach

- The survey: an example of a choice card
- Choice of attributes and levels
- Experimental design
- The questionnaire and data collection

OA two-stage estimation procedure

- 1. Random Parameter Logit model
- 2. Panel data analysis of the WTP (Random-effects model)

Results of the second step: analysing spatial preference heterogeneity

Conclusion

GRAPHICAL CCL

$$W_{n,k}^{l} = \alpha_{n} + \gamma D_{n,k}^{l} + \lambda Z_{n} + \epsilon_{n,k}^{l}$$

	Scénario Scénario A B		Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendant S ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par rapport au biocarburant actuel	-20%	-50%	0%
Impact sur les prix alimentaires : Augmentailon de certains prix alimentaires	Oui	Non	Non

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CONCLUSION

- Renewable fuels development is an integral part of the public policies mix highlighted by policy makers to decarbonize the transportation sector.
- •We believe that wide-spread deployment of energy transition technologies will largely depend on the attitudes of consumers and citizens.
- This article investigates French population's motivations and obstacles to finance new biofuels development in the transportation sector.
- It uses a two-step approach based on a nation-wide discrete choice experiment to
 - (i) identify the influencing factors in individual preferences concerning a new biofuel development; and
 - (ii) analyze the determinants of the **spatial heterogeneity of preferences**, with a special attention to the types and importance of agricultural activities around respondents location.



CONCLUSION

- On the whole, there is a relative equality in the parameter linked to the GHG emissions reduction. Reduction in GHG emissions impacts all respondents' utility in a similar way.
 - The mean of mWTP are 71, 105 and 142 euros per year for a reduction of respectively 20%, 30% and 50% in GHG emissions.
- We show that French citizens can be split into two categories depending on the agricultural specialization of their location.

Figure 3: Respondents' location



Heterogeneity in respondents' behavior is more linked to biofuel characteristics than to the fight against climate change through reduction in GHG emissions.



CONCLUSION

Respondents living in area specialized in livestock farming, poly-culture and market gardening (<u>54%</u>) have greater mWTPs to support agricultural sector and to avoid food price increase compared to French citizens coming from area with crops or viticulture specialization or without agricultural activity (<u>46%</u>).

• They are :

- less willing to pay for a reduction of 50% in GHG and
- negatively impacted by the perception of tax burden.

Insights for policy makers:

Our results confirm a strong preference for second-generation biofuels (no impact on food prices) allowing agricultural support, whatever the cluster under consideration.

biofuels from wheat straw* > wood residues > food crops

*co-products without any impact on food prices.

59 Caution on the way to finance the energy transition (tax burden).



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ÉCHANTILLON REPRÉSENTATIF

Statistiques descriptives de l'échantillon

Table 2: Selected characteristics of study sample

Characteristics	French population	Sample
Size	-	972
Gender (% female)	51.1%	51.0%
Age		
Young (18 to 29)	19.8%	20.7%
Young adult (30 to 44)	26.8%	28.3%
Adult (45 to 59)	28.6%	26.1%
Old (60 to 75)	24.8%	24.9%
Professional activity		
Top socio-professional category	15.7%	16.2%
Middle socio-professional category	16.4%	16.2%
Low socio-professional category	33.7%	32.2%
Retired	20.0%	23.1%
Inactive	14.2%	12.2%



PRINCIPAUX RÉSULTATS W_1

$$\alpha_{n,k}^{l} = \alpha_n + \gamma D_{n,k}^{l} + \underline{\lambda Z_n} + \epsilon_{n,k}^{l}$$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant payé par chaque ménage par an pendiant S ana	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par rapport au laiscarburant actual	-20%	-50%	0%
Impact sur les prix alimentalies de certains pris alimentaties	Oui	Non	Non

Table 5: Panel regression for both area

		Livestock farming, market			Biofuel	crops, viticul	ture and
		gardening	and poly-cul	ture areas	non agricultural areas		
Indicator for attribute lev	vel						
	30%	33.92***	33.92***	33.92***	35.46***	35.46***	35.46***
	reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
	50%	62.29***	62.29***	62.29***	82.59***	82.59	82.59
	reduction	(5.397)	(5.397)	(5.395)	(7.225)	(7.225)	(7.215)
	Agricultural	-3.330	-3.330	21.04	-18.82***	-18.82***	-10.76
	support	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Food price	-20.54***	-20.54***	3.497	-45.82***	-45.82***	-35.22***
	impact	(5.397)	(5.397)	(14.45)	(7.225)	(7.225)	(8.27)
	Constant	35.91	55.16**	88.47***	32.99	47.95***	54.48***
	COMPUTE	(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
Socioeconomic variables							
	Tax burden	-33.37**	-32.84**	-33.86**	-10.47		
		(16.58)	(16.54)	(16.56)	(17.70)		
DF	otmt. agricultural	0.720**	0.625**		0.423		
	surface share	(0.311)	(0.304)		(0.352)		
In interaction with	Agricultural			-0.470*			
	support			(0.259)			
	Food price			-0.463*			
	impact			(0.259)			
	Income	0.005			0.011**	0.011**	0.012***
	income.	(0.004)			(0.004)	(0.004)	(0.004)
	Local population	0.003			0.002**	0.001**	
	density	(0.003)			(0.001)	(0.001)	
In interaction with	Agricultural						-0.001**
	support						(0.001)
	Food price						-0.001***
	impact						(0.001)
	N (Ind.)	527	527	527	445	445	445
	N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225



PRINCIPAUX RÉSULTATS

$$\alpha_{n,k}^{l} = \alpha_n + \gamma D_{n,k}^{l} + \underline{\lambda Z_n} + \epsilon_{n,k}^{l}$$

	Scénario A	Scénario B	Statu Quo
Contribution monétaire : Montant peut per chaque ménage per an pendiant 5 ans	15€	0€	0€
Appui à la filière agricole française : Hausse de l'activité des agriculteurs	Non	Oui	Non
Variation des émissions : Réduction des émissions de gas à effet de serre par resport au biscarburant actual	-20%	-50%	0%
Impact sur les prix alimentalien de Augmentalien de cartains pris alimentalies	Oui	Non	Non

Table 5: Panel regression for both area

		Livestock farming, market gardening and poly-culture areas		Biofuel	crops, viticul agricultural :	ture and areas	
Indicator for attribut	Indicator for attribute level					-0-	
	30%	33.92***	33.92***	33.92***	35.46***	35.46***	35.46***
	reduction	(5, 397)	(5.397)	(5, 395)	(7.225)	(7.225)	(7.215)
	50%	62.29***	62.29***	62.29***	82.59***	82.59***	82.59***
	reduction	(5.397)	(5, 397)	(5.395)	(7.225)	(7.225)	(7.215)
	Agricultural	-3.330	-3.330	21.04	-18.82***	-18.82***	-10.76
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	Food price	-20.54***	-20.54***	3,497	-45.82***	-45.82***	-35.22***
	impact	(5.397)	(5, 397)	(14.45)	(7.225)	(7.225)	(8.27)
		35.91	55.16**	88.47***	32.99	47.95***	54.48***
	Constant	(26.03)	(22.70)	(16.03)	(28.73)	(14.68)	(14.28)
Socioeconomic varial	oles	()	(/		(/		
		-33.37**	-32.84**	-33.86**	-10.47		
	Tax burden	(16.58)	(16.54)	(16.56)	(17.70)		
	Dptmt, agricultural	0.720**	0.625**		0.423		
	surface share	(0.311)	(0.304)		(0.352)		
In interaction with	Agricultural	(-0.470*			
	support			(0.259)			
	Food price			-0.463*			
	impact			(0.259)			
	· ·	0.005			0.011**	0.011**	0.012***
	Income	(0.004)			(0.004)	(0.004)	(0.004)
	Local population	0.003			0.002**	0.001**	
	density	(0.003)			(0.001)	(0.001)	
In interaction with	Agricultural						-0.001**
	support						(0.001)
	Food price						-0.001***
	impact						(0.001)
	N (Ind.)	527	527	527	445	445	445
	N (Obs.)	2,625	2,625	2,625	2,225	2,225	2,225

