

# Are risk and time preferences associated with food intake, diet quality and weight status? Results of a French national survey

FETS Seminar

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# Project background

- ▶ Interdisciplinary project linking epidemiology, nutrition, health and behavioural economics to study the role of **behavioural measures on food choices and intakes**.
- ▶ Creation of an original database **at the French population level** through the ELIPSS panel.

# Motivation

# Food consumption and health-related issues

- ▶ Food consumption patterns have changed rapidly in recent decades (Kearney, 2010) alongside with the rise of the rates of overweight and obesity worldwide, generating serious health issues (type 2 diabetes, hypertension, cancer...).
- ▶ A balanced and adequate diet combined with physical activity is a key determinant for good health (Murray et al., 2020).
- ▶ Changes in eating behaviour, induced by this awareness, could contribute to a decrease in diet-related chronic diseases and in health diet-related expenses.
- ▶ Psychological factors have been found to play a role in food consumption decisions.

- ▶ Research in behavioural economics and epidemiology has established a relationship between **health-related behaviours** (e.g. physical activity, smoking, alcohol abuse, drug use, unprotected sex, etc...) and individual **risk attitudes** (Dohmen & al., 2011; Galizzi and Miraldo, 2017; Van Der Pol et al., 2017,...) and **time preferences** (Story & al., 2014; ...).

# Food-related behaviours and risk preferences

- ▶ Studies have shown that **overweight** individuals have **higher reward sensitivity** (Nederkoorn et al. 2006, Carnell et al. 2012) than normal-weight individuals.
  - ▶ Assumption for risk attitudes: a co-variation between **unhealthy behaviours** which are associated with **greater risk tolerance** (Hanoch & al., 2006 ; Anderson & Mellor, 2008 ; Dohmen & al., 2011...).
- ⇒ Sub-research question: Acute debates on the best methods for eliciting risk attitudes in surveys (Mata & al., 2018; Falk & al. 2018):
- ① **Qualitative metrics:** Self-reported personal risk attitudes  
Questions measuring willingness to take risk on a likert scale (0 to 10).
  - ② **Quantitative metrics:** Lottery choice based questions .

# Food-related behaviours and times preferences

- ▶ The tendency of consumers to prefer immediate gratification instead of the future benefits of healthier eating could be limiting in the daily implementation of a healthy diet.
- ▶ Individuals with **greater impatience or impulsivity** are expected to be more likely to have **unbalanced and inadequate diets** (Story et al., 2014)
- ▶ **Positive** association between **BMI and temporal discounting** (Epstein et al. 2010 ; Reinert et al., 2013).
- ▶ The meta analysis of Barlow et al. (2016) shows that there is evidence that high time discounting is a significant factor for unhealthy food behaviour, overweight and obesity (quality of the diet approximated by the body mass index or declared adverse eating behaviorus).

# Food-related behaviours and times preferences

- ▶ Ikeda et al. (2010) found **positive association between BMI and a procrastination measure** for a sample of 2987 Japanese adults.
- ▶ Huston & Finke (2003) found that individuals who **discount less** the future had **healthier diets** (measured through the Healthy Eating Index of Kennedy & al. 1995).
- ▶ However, there are very **few studies** looking at the relationship between an individual's **full diet** and his or her **time preferences**.



- ▶ We **combine** the measurement of the **full diet** at the individual level using a state-of-the-art frequency food questionnaire developed in nutrition epidemiology (Willett et al. 1985, Affret et al. 2017) with a choice based quantitative questionnaire in order to elicit **time preferences** and **risk preferences**.
- ▶ Our aim is to investigate the relationship between those two parameters and **different measures of dietary behaviour** and in particular, energy intake, overall diet quality and BMI.
- ▶ We want to see if risk and time preferences can explain the diet of the **French people**, in a model where they are **simultaneously estimated** from data of a **representative sample**.

## The survey

## General information about the survey

- ▶ The "Psychofood" survey was addressed through the ELIPSS Panel, a web-based longitudinal survey for Social Sciences (Equipex DIME-SHS, ANR-10-EQPX-19-01).
- ▶ Composed of 3300 individuals and built on a true probability sample of households drawn from the population registered by the INSEE.
- ▶ All panel members were provided with a touchscreen tablet (Archos) and a mobile Internet connection (4G).
- ▶ Annual survey which collects each year socio-demographic information (as in the INSEE Household survey)+ surveys the are questionnaires proposed by successful projects selected by the ELIPSS Scientific committee.
- ▶ In this paper, we use data from the 2018 annual survey merged with the "Psychofood" survey. Merging both datasets yields a a total sample size of **2,200 respondents**.

# Behavioural questionnaire

- ▶ Strict time constraint of this module (5-10 minutes) so we only measured risk and time preferences.
- ▶ Design and implementation on tablet devices of an original quantitative elicitation method of risk and time preferences.
- ▶ Exclusive use of binary choices because this is a decision task easy to understand and that requires a minimal cognitive effort for respondents.
- ▶ We extend measurement of risk attitude proposed and validated by Falk & al. (2011) and adapt a methodology developed by Nebout & al. (2018).

⇒ Validation and test of the predictive power of these measures on a representative sample is a research project *per se*.

- ▶ Elicitation of 4 certainty equivalents  $c_{i,j}$  and 4 present values  $pv_{i,j}$  per individual  $i$  via a sequence of 4 binary choices  $j$ .
- ▶ Development of a bisection algorithm in order to minimize the number of binary choices to elicit a certainty equivalent and a present value.

# Risk and time preferences quantitative measures

Parameters of the stimuli are the following:

$c_{i,j} \sim (x_j, p_j; y_j)$ and $(pv_{i,j}; t'_j) \sim (x_j; t_j)$						
<i>Risk</i>				<i>Time</i>		
$j$	$x_j$	$p_j$	$y_j$	$x_j$	$t_j$	$t'_j$
1	80	0.50	0	80	12 months	1 day
2	80	0.25	0	80	6 months	1 day
3	80	0.75	0	80	3 months	1 day
4	100	0.50	20	80	12 months	6 months

We obtain 4 quasi-continuous variables for risk allowing estimating parameters of risk aversion and 4 for time to estimate parameters of DEU.

# Decision tasks for risk

IPSS HTTPS://DEV.EIIPSS.FR

(622 / 2152)

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 50% de chance de gagner 80€ et 50% de chance de gagner 0€.  
L'option B vous donne 40€ de façon certaine.

Option A		Option B	
50%	80€	100%	40€
50%	0€		

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IPSS HTTPS://DEV.EIIPSS.FR

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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 25% de chance de gagner 80€ et 75% de chance de gagner 0€.  
L'option B vous donne 40€ de façon certaine.

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

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# Decision tasks for risk

IPSS HTTPS://DEV.EUPSS.FR

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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€		

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IPSS HTTPS://DEV.EUPSS.FR

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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 50% de chance de gagner 100€ et 50% de chance de gagner 20€.  
L'option B vous donne 60€ de façon certaine.

**Attention :** ici, dans l'option A vous êtes sûr(e) de gagner au moins 20€.

Option A		Option B	
50%	100€	100%	60€
50%	20€		

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# Decision tasks for time

IPSS HTTPS://DEV.EIIPSS.FR

(350 / 2152)

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

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IPSS HTTPS://DEV.EIIPSS.FR

(440 / 2152)

Voici une nouvelle série de questions dans laquelle l'option A (ou B) 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 est un montant de 80€ que vous recevrez dans 12 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

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# Decision tasks for time

4G 18:48

EIPSS HTTPS://DEV.EI.PSS.FR

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Voici une nouvelle série de questions dans laquelle **l'option A (ou B) 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 est un montant de 80€ que vous recevrez dans 6 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	

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4G 18:49

EIPSS HTTPS://DEV.EI.PSS.FR

(575 / 2152)

Voici une nouvelle série de questions dans laquelle **l'option A (ou B) 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 est un montant de 80€ que vous recevrez dans 12 mois.

L'option B est un montant de 40€ que vous recevrez dans 6 mois.

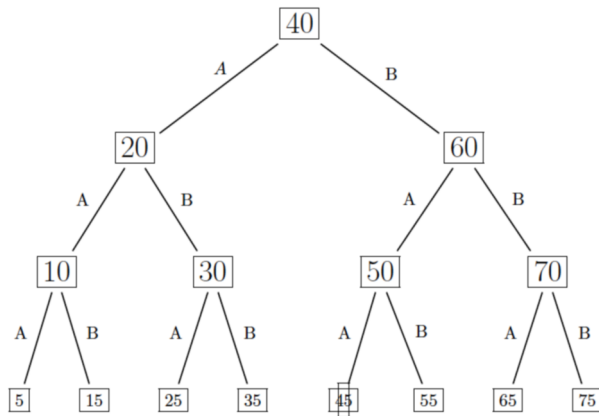
Option A					80€
Demain	3 mois	6 mois	9 mois	12 mois	

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

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# CE elicitation example: bisection algorithm



Example of CE calculation: the first binary choice is between €40 for sure (choice A) and the lottery giving €80 with half a chance and nothing otherwise (choice B). If the respondent chooses A, i.e., €40 for sure, he then has to choose between €20 for sure (choice A) and the same lottery (choice B). Suppose that he chooses B, i.e., the lottery, then the last binary choice is between €30 for sure (choice A) and the lottery (choice B). If he chooses B again, then we consider that CE equals €35, which corresponds to the middle of the interval where the respondent switches from the sure gain to the lottery.

# Notation and model

- ▶ Binary choices between situations involving risk or time.
- ▶ We consider  $(x_t, p, y_t)$  a prospect that gives a monetary amount  $x$  at period  $t$  with probability  $p$  and  $y$  at period  $t$  with probability  $1 - p$ .
- ▶ And  $z_t$  that denotes a monetary outcome received for sure (i.e. with  $p = 1$ ), at time period  $t$ , and notation  $z$  is used when this outcome is received immediately (i.e. at  $t = 0$ ).
- ▶ The benchmark model of rational choice for this object that involves risk and time is Discounted Expected Utility:

$$pD(t)u(x) + (1 - p)D(t)u(y) \tag{1}$$

## Notation and model (2)

- ▶  $u(x) = x^\alpha$ . Parameter  $\alpha$  captures the curvature of the utility
- ▶ Attitudes towards time are characterized by the function  $D(t) = e^{-\rho t}$ , where  $\rho > 0$  is the discount rate, and measures impatience.
- ▶ We call certainty equivalent (CE) the outcome  $c^*$  such that  $c^* \sim (x, p, y)$ . By definition, there is risk aversion (seeking) when  $c^* < xp + (1 - p)y$  ( $c^* > xp + (1 - p)y$ ) where  $xp + (1 - p)y$  is called the expected value (EV) of the risky prospect  $(x, p, y)$ .
- ▶ We consider temporal choices of type  $z_t$  vs  $x_{t+\tau}$ , where  $t \geq 0$  and  $\tau > 0$ . We call sooner equivalent, the outcome  $c_t^*$  such that  $c_t^* \sim x_{t+\tau}$ . When  $t = 0$ , the sooner equivalent is received immediately, and the expression present equivalent is used.

# Converting survey choices into rational-model preferences

- ▶ Our objective is to elicit preference parameters  $\alpha$  and  $\rho$  from survey choices.
- ▶ For each respondent and for each risky prospect, under the DEU, the theoretical certainty equivalent  $\hat{c}^*$  of a risky prospect  $(x, p, y)$  is given by Eq. 2

$$\hat{c}^* = [px^\alpha + (1-p)y^\alpha]^{(1/\alpha)} \quad (2)$$

- ▶ For each respondent and for each time prospect, under the DEU, the sooner equivalent  $\hat{c}_t^*$  of a temporal prospect  $x_{t+\tau}$  is given by Eq. 3

$$\hat{c}_t^* = [e^{-\rho\tau} x^\alpha]^{(1/\alpha)} \quad (3)$$

This equation allows to identify the intertemporal-attitude parameter  $\rho$ , given that  $\alpha$  is identified from Eq. 2

- ▶ To account for decision errors, we further assume that theoretical values ( $c^*$ ) and observed ones ( $c_{i,j}$ ) differ by a Fechner error (Eq. 4).

$$c^* = \hat{c}^* + \epsilon \text{ with } \epsilon \sim N(0, \sigma^2) \quad (4)$$

# Converting survey choices into rational-model preferences (2)

- ▶ To account for individual heterogeneity in preference parameters  $\alpha$  and  $\rho$  we assume that these parameters are distributed across respondents according to log normal distributions.
- ▶ We also account for heteroscedasticity, allowing the variance standard deviation  $\sigma$  to vary between individuals and choice types (risky choices vs inter-temporal choices).
- ▶ This statistical model defines a random coefficient model, that gives the likelihood related to each measured value.
- ▶ The model is estimated by using a MCMC simulation.
- ▶  $\alpha_i$  and  $\rho_i$  characterize risk and time preferences of each participants and will be used as explanatory variables for food consumption.

- ▶ There are a few French epidemiological cohorts and surveys measuring food consumption: INCA3, ESTEBAN, Nutrinet and E3N/E4N.
- ▶ Classical methods for measuring food consumption are:
  - ▶ **Food recording**: very constraining for the respondents.
  - ▶ **24h dietary recall**: gold standard, individual interview ran by a professional nutritionist (30 min)
  - ▶ **Food history questionnaire** (meal by meal): very long.
  - ▶ **Biomarkers**: very expensive and invasive.
  - ▶ **Food Frequency questionnaire** (FFQ, Willet 1998): average item consumption over one year (Illner,2010), semi quantitative if portion sizes are measured.

⇒ We use an adapted version of the reduced FFQ developed by the team "générations et santé" (Affret et al. 2018, CESP, UMR-S 1018, INSERM)



# Food Questionnaire (1)

A two-step measurement of the frequency of consumption of 28 food items grouped in 9 main categories:

- ▶ **Cereals**

- ▶ Bread
- ▶ Breakfast cereal

- ▶ **Starchy food**

- ▶ pasta, rice, quinoa, wheat, boulghour, etc..
- ▶ pulses (lentils, beans, flageolet, ...)
- ▶ fried potatoes and tubers
- ▶ boiled or cooked potatoes and tubers

- ▶ **Vegetables and fruits**

- ▶ cooked vegetables
- ▶ raw vegetables
- ▶ fruits.

- ▶ **"Junk food"**

- ▶ pizza, sandwiches, kebab, hot-dog, burgers, wrap, panini,...
- ▶ breaded meat or fish (nuggets, nems, cod fish cake,...)
- ▶ charcuterie (sausage, merguez, cold pork meat, bacon, ...)

# Food Questionnaire (2)

## ▶ **Animal proteins (except milk)**

- ▶ Poultry and rabbit (chicken, turkey, duck, ...)
- ▶ Red meat and offal (beef, veal, pork, lamb, ...)
- ▶ Eggs (boiled, cooked, scrambled, omelettes, ...)
- ▶ Fish and seafood (fresh, smoked, frozen, ...)

## ▶ **Dairy products**

- ▶ Milk (drink or with cereal, all types,...)
- ▶ Yoghurt (nature, aromatized, cottage cheese, ...)
- ▶ Cheese (Camembert, Comté, .....)

## ▶ **Fat**

- ▶ Butter, mayonnaise, margarine, cream
- ▶ Oil (olive, tournesol, arachide, colza, nuts,...)

## ▶ **Snacks**

- ▶ Savoury snacks (chips, biscuits, peanut, popcorn,...)
- ▶ Sweet snacks (Chocolate and cereal bars, pastry, cake, biscuits)
- ▶ Desserts (pudding, chocolate mousse, dessert cream, floating island)

# Food Questionnaire (3)

And finally the liquids!

- ▶ **Drinks**

- ▶ Water
- ▶ Coffee, tea, infusion
- ▶ Juice and soda (fresh fruits, colas, limonade, energy drinks, sirop,...)
- ▶ Alcoholic beverages

- ▶ For those there were these additional questions

- ▶ Do you consume more often coffee, tea, as much coffee as tea?
- ▶ Do you consume more often light drinks, non-light drinks, as much light as non light, only fruit juices?
- ▶ Do you consume more often wine, other alcoholic beverages?

⇒ This questionnaire allows us to elicit the respondents' full diet.

# Example for meat and animal protein declaration

## Category level

EVIPSS HTTPS://DEV.ELIPSS.FR

(1119 / 2152)

Au cours des 12 derniers mois, à quelle fréquence avez-vous **consommé** les aliments suivants ?

	Tous les jours	Toutes les semaines	Tous les mois	Plus rarement voire jamais
De la volaille et/ou du lapin (dinde, poulet, poule, canard, cane, lapin, etc.)	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
De la viande de boucherie (bœuf, veau, porc hors saucisses, agneau, mouton) et/ou des abats (foie, gésier, rognons, langue, cervelle, etc.)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Des œufs (omelettes, œufs sur le plat, œufs pochés, œufs durs, etc.)	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Des poissons (poissons frais, surgelés, en conserve, fumés, salés ; hors poisson pané) et/ou d'autres produits de la mer (coquillages, crustacés, mollusques, etc.)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

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## Item level

EVIPSS HTTPS://DEV.ELIPSS.FR

(1124 / 2152)

En moyenne sur les 12 derniers mois, combien de fois par **semaine** avez-vous consommé de la viande de boucherie (bœuf, veau, porc hors saucisses, agneau, mouton) et/ou des abats (foie, gésier, rognons, langue, cervelle, etc.) ?

fois par semaine

À chaque fois que vous avez consommé de la viande de boucherie au cours des 12 derniers mois, en quelle quantité les avez-vous consommées, en moyenne ?



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# Example for vegetables and fruits declaration

## Category level

EVIPSS HTTPS://DEV.ELIPSS.FR

(1099 / 2152)

Au cours des 12 derniers mois, à quelle fréquence avez-vous **consommé** les aliments suivants ?

	Tous les jours	Toutes les semaines	Tous les mois	Plus rarement voire jamais
Des légumes cuits (y compris mangés en salade comme les poireaux ou consommés sous forme de soupe ou de bouillon)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Des légumes crus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Des fruits (fruits frais, fruits au sirop, compotes, etc. hors fruits secs/fruits à la coque)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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## Item level

EVIPSS HTTPS://DEV.ELIPSS.FR

(1100 / 2152)

En moyenne sur les 12 derniers mois, combien de fois par **jour** avez-vous consommé des légumes cuits (y compris mangés en salade comme les poireaux ou consommés sous forme de soupe ou de bouillon) ?

fois par jour

À chaque fois que vous avez consommé des légumes cuits au cours des 12 derniers mois, en quelle quantité les avez-vous consommées, en moyenne ?



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# Diet indicators (1)

- ▶ Daily Energy intake (in kc)
- ▶ BMI provided by ELIPSS panel. Based on self-declared height and weight. In our analysis we use a 4-categories BMI variable (Underweight, Normal weight, Overweight, Obese).

## Diet indicators (2)

- ▶ General Diet Index (GDI): Dietary quality of the respondents was summarized through three indexes of quality which were combined to produce an aggregated categorical variable that reflects the overall nutritional quality of individual diets.

- ① Mean Adequacy Ratio (MAR) is an indicator of % of daily recommended intakes for 20 key nutrients.:

$$MAR = \frac{1}{20} \sum_{i=1}^{20} ratio_i * 100 \quad (5)$$

where  $ratio_i = \frac{intake_i}{DRI_i}$  if  $<1$ , 1 otherwise.

- ② Mean Excess Ratio (MER) is an indicator of bad nutritional quality. It is the mean daily percentage of maximum recommended values (MRV) for 3 nutrients that should not be excessively consumed (saturated fats, salt, added sugars).

$$MER = \frac{1}{3} \sum_{i=1}^3 ratio_i * 100 \quad (6)$$

where  $ratio_i = \frac{intake_i}{Maximal\ recommended\ quantity_i} - 1$  if  $> 0$ , 0 otherwise.

- ③ Energy Density (ED): in kcal for 100 grams.

## Diet Indicators (3)

- ▶ Each index is ordered according to median value observed in the men and women population, separately. Then, diets with the highest nutritional quality are defined as those simultaneously fulfilling three nutritional goals: a MAR above the median, a MER below the median, and an ED below the median.
- ▶ Using this median criterion we define an additional variable, the general diet index (GDI), that summarizes the diet quality and which was computed such that:
  - ▶ if the diet of a respondent meets with 3 of those goals (GDI=3) it is considered as high
  - ▶ if the diet of a respondent meets with 2 of those goals (GDI =2) it is considered as intermediary+
  - ▶ if the diet of a respondent meets with 1 of those goals (GDI =1) it is considered as intermediary-
  - ▶ if the diet of a respondent meets with 0 of those goals (GDI =0) it is considered as low.



## Preliminary results

	N	Frequ.
<b>Gender (=male)</b>	992	48.69%
<b>Age</b>		
18-22yo	55	7.49%
23-34yo	249	19/08%
35-44yo	467	17.56%
45-54yo	518	19.57%
55-64yo	455	17.37%
65-75yo	314	14.96%
76-79yo	32	3.97%
<b>Education</b>		
None/CEP/BEPC	273	27.27%
CAP/BEP	464	15.69%
Bac/Bac+2	786	33.84%
Bac+3 et plus	567	23.20%
<b>Nationality</b>		
French	1882	88.71%
Acquired French nationality	73	5.65%
Foreigner	135	5.64%
<b>Living area</b>		
Paris Basin	280	19.09%
Center east	367	16.41%
East	90	6.20%
Mediterranean	200	8.65%
North	373	14.03%
West	260	10.90%
City of Paris and suburbs	284	12.12%
South west	236	12.59%

## Descriptive statistics

# Risk and time parameters

Prospect		mean	median	sd	% RA
Lottery 1	0.25	17.78	17.50	16.81	0.71
Lottery 2	0.50	27.31	27.50	18.69	0.80
Lottery 3	0.75	36.35	37.50	21.66	0.85
Lottery 4	0.50	44.88	42.50	18.81	0.79
Time 1	3.00	52.96	57.50	21.02	
Time 2	6.00	49.40	52.50	22.53	
Time 3	12.00	42.81	37.50	23.68	
Time 4	6.00	51.85	57.50	21.05	

## Descriptive statistics on Certainty Equivalents and Time Equivalents

- ▶ For all lotteries, the majority of respondents are risk averse.
- ▶ In terms of time preferences, we find that as the time horizon increases, participants are less likely to wait for the future payment.

	Mean	SD	Min	Max
<b>Enerkc</b>	1943.79	749.34	724.39	4475.58
<b>General diet index</b>				
Low	10.06%			
Intermediary -	39.94%			
Intermediary +	40.00%			
High	10.00%			
<b>BMI</b>				
Underweight (<18)	3.05%			
Normal weight [18;25[	53.08%			
Overweight [25;30[	33.13%			
Obese $\geq 30$	10.73%			

Summary statistics on variables of interest

# Average consumed quantities (in g.) and nutritional quality indicators according to the General Diet Index categories

	General Diet Index:				p-value	p-value trend
	Low (1)	Intermediate- (2)	Intermediate + (3)	High (4)		
N	213	799	867	212		
<b>Fruit and vegetables</b>	<b>167.36</b>	<b>213.22</b>	<b>449.63</b>	<b>674.26</b>	<.0001	<.0001
Cooked vegetables	66.14	74.74	156.90	198.73	<.0001	<.0001
Raw vegetables	36.22	44.12	96.95	167.03	<.0001	<.0001
Fruit	65.00	94.36	195.78	308.51	<.0001	<.0001
<b>Cereal-based products and tubers</b>	<b>199.97</b>	<b>268.87</b>	<b>254.18</b>	<b>260.82</b>	<.0001	0.0098
Bread	82.24	120.05	91.44	85.72	<.0001	0.5701
Pasta, rice	69.99	89.14	96.70	93.24	0.0016	0.0224
Breakfast cereals	2.64	7.68	5.41	9.03	<.0001	0.0183
Potatoes	45.10	52.01	60.62	72.93	<.0001	0.0294
<b>Meat, fish, eggs and pulses</b>	<b>122.40</b>	<b>175.00</b>	<b>190.84</b>	<b>208.41</b>	<.0001	<.0001
Poultry	32.51	48.78	44.34	52.24	0.0007	0.0039
Meat	25.78	40.44	34.76	29.60	<.0001	0.6005
Fish	19.24	23.47	28.38	35.14	<.0001	<.0001
Eggs	26.15	33.87	36.97	32.41	0.0660	0.1268
Pulses	18.71	28.43	46.38	59.03	<.0001	<.0001
<b>Dairy products</b>	<b>279.04</b>	<b>324.70</b>	<b>292.58</b>	<b>263.15</b>	0.0355	0.5579
Milk	132.50	175.56	128.07	103.05	0.0010	0.2671
Yogurt	95.72	107.49	135.19	143.21	<.0001	<.0001
Cheese	50.82	41.66	29.32	16.89	<.0001	<.0001
<b>High fat, sugar, salt processed foods</b>	<b>151.96</b>	<b>173.13</b>	<b>115.44</b>	<b>76.74</b>	<.0001	<.0001
Fries	10.05	14.43	12.60	8.45	0.0007	0.3846
Pizza, quiches, lasagna	38.21	40.49	25.60	17.36	<.0001	<.0001
Breaded	10.70	17.36	10.66	6.66	<.0001	0.0022
Savory snacks	5.63	6.18	4.68	3.47	<.0001	0.0099
Sweet snacks	36.89	30.72	14.99	9.98	<.0001	<.0001
Sweetened desserts	23.70	32.43	24.21	15.35	<.0001	0.0143
Processed meat	26.77	31.51	23.29	15.47	<.0001	0.0002
<b>Added fats</b>	<b>52.26</b>	<b>43.36</b>	<b>27.21</b>	<b>22.37</b>	<.0001	<.0001
Vegetable oils	32.33	25.39	16.57	17.21	<.0001	0.0003
Other fats	19.93	17.97	10.64	5.16	<.0001	<.0001
<b>Beverages</b>	<b>1787.82</b>	<b>1863.33</b>	<b>1855.94</b>	<b>1856.54</b>	0.7196	0.5757
Water	1063.70	1133.62	1214.37	1232.82	0.0017	0.0453
Hot beverages	396.68	431.57	403.50	452.28	0.2864	0.4370
Other beverages	226.07	192.36	159.09	107.43	0.0026	0.0425
Alcohol	101.37	104.03	78.99	63.92	0.0006	0.0372
<b>Nutritional quality indicators</b>						
Total energy intakes	1884.20	2124.35	1823.94	1762.86	<.0001	0.0016
MAR	73.80	79.79	80.47	89.68	<.0001	<.0001
MER	21.34	26.52	12.73	1.0634	<.0001	<.0001
Energy density	200.80	187.17	140.41	120.44	<.0001	<.0001
Solid quantity*	840.49	1022.72	1201.80	1402.81	<.0001	<.0001
Total quantity excluding Beverages	972.99	1198.28	1329.87	1505.85	<.0001	<.0001
<b>Attitudinal parameters</b>						
Risk	0.606	0.698	0.659	0.667	0.4243	0.5404
Time	0.096	0.107	0.095	0.081	0.0020	0.1376

\* solid quantity as defined in the energy density estimation

# Econometric Analysis

	<i>Dependent variable:</i>					
	log(Energykcal) OLS		General Diet Index Ordered Logit		BMI categories Ordered logit	
	(1)	(2)	(3)	(4)	(5)	(6)
Rank $\alpha$	0.025	0.068*	0.776	0.737*	0.757	1.010
	(-0.030, 0.081)	(0.012, 0.123)	(0.497, 1.055)	(0.448, 1.025)	(0.470, 1.045)	(0.707, 1.312)
Rank $\rho$	0.114***	0.103***	0.670***	0.723*	1.349*	1.438*
	(0.058, 0.171)	(0.047, 0.158)	(0.389, 0.952)	(0.433, 1.012)	(1.059, 1.640)	(1.133, 1.743)
Constant	7.430***	7.479***				
	(7.383, 7.477)	(7.391, 7.567)				
CONTROLS	NO	YES	NO	YES	NO	YES
Observations	2,091	2,091	2,091	2,091	2,091	2,091
R <sup>2</sup>	0.007	0.085				
Adjusted R <sup>2</sup>	0.007	0.076				

*Note:* Columns (1) and (2) correspond to an OLS on the continuous variable of kcal consumed per day. Columns (2) and (3) correspond to the OR of an ordered logit on the General Diet Index, the higher the better the diet. Controls include gender, age categories, education, nationality (French or not), living area. 95% confidence intervals are reported between brackets.

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

## Diet analysis

- ▶ For all three nutritional quality scores, impatience plays a statistically significant role on the diet quality. More impatience is associated with higher energy intake, higher BMI and worse diet quality.
- ▶ This all means that the more impatient, the worse the diet of the individual.
- ▶ We find a positive relationship between the daily calories intake and risk seeking, such that the more risk seeker you are, the higher are your total calories intake (significant at a 5% level). This relationship is also found with the General Diet Index but not with the BMI variable.
- ▶ We hence show that within a same model, risk and time parameters play a significant role in the diet quality of the French population. Time preferences to a bigger extent.

- ▶ Replication of the study within an online-lab experiment with treatments on the incentives.
- ▶ 4 groups: no incentive, all incentivised,  $p=1/2$ ,  $p=1/10$ .
- ▶ Methodological questions raised by the comparisons of both of those studies.



Thank you!

# Additional table

Group	Item $y$	(1) % $y = 0$	Risk		Time	
			(2) $y > 0$ (logit)	(3) $y$ (OLS)	(4) $y > 0$ (logit)	(5) $y$ (OLS)
Fruits and vegetables	Cooked vegetables	0.04	0.68 <sup>0</sup>			
	Raw vegetables	0.10	0.30 <sup>0.003</sup>			-0.05 <sup>0.012</sup>
	Fruit	0.04				
Cereal-based products and tubers	Bread	0.03		0.06 <sup>0.027</sup>		
	Pasta rice	0.03			-0.76 <sup>0</sup>	
	Breakfast cereals	0.70				
	Potatoes	0.05				
Meat, fish, eggs and pulses	Poultry	0.06	0.41 <sup>0.002</sup>			
	Meat	0.09	0.35 <sup>0.001</sup>			
	Fish	0.12				
	eggs	0.06	0.24 <sup>0.049</sup>	0.06 <sup>0.027</sup>		0.05 <sup>0.008</sup>
	Pulses	0.10	0.47 <sup>0</sup>		-0.13 <sup>0.044</sup>	0.04 <sup>0.023</sup>
Dairy products	Milk	0.40				-0.08 <sup>0.01</sup>
	Yogourt	0.09			0.24 <sup>0</sup>	
	Cheese	0.07				
High fat, sugar, salt processed foods	Fries	0.20				0.04 <sup>0.021</sup>
	Pizza, quiches, lasagna	0.15			-0.14 <sup>0.012</sup>	
	Breaded	0.34			0.15 <sup>0</sup>	
	Savory snack	0.25				
	Sweet snack	0.20				
	Sweetened desserts	0.33	0.15 <sup>0.022</sup>		0.15 <sup>0</sup>	
	Cured meat	0.13		0.08 <sup>0.005</sup>		0.05 <sup>0.005</sup>
Added fats	Vegetable oils	0.17		0.08 <sup>0.029</sup>		
	Other fats	0.06	0.41 <sup>0.002</sup>	0.13 <sup>&lt;0.001</sup>		
Beverages	Water	0.00				0.02 <sup>0.005</sup>
	Hot beverages	0.08				0.04 <sup>0.038</sup>
	Other beverages	0.21	0.17 <sup>0.023</sup>		0.14 <sup>0.003</sup>	
	Alcohol	0.32	0.27 <sup>0</sup>	0.18 <sup>&lt;0.001</sup>		