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Can Information about Health and Environment Beef Up the Demand for Meat Alternatives?

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Abstract: A lab experiment was conducted in France to evaluate the impact of different types of information on participants' willingness-to-pay (WTP) and quantity choices for both beef burger meat and soy burger meat. Explanatory messages about the impact of beef and soy on health and environment were revealed to participants, before successive rounds of WTP determinations and quantity choices. Results show that the different WTP for beef are not statistically influenced by the successive rounds of messages. Conversely, messages significantly increase the WTP for soy meat, even if this effect is relatively weak. These explanatory messages also lead to weak changes in the chosen quantities of beef and soy. A last round with the introduction of a high-quality beef leads to a statistically significant increase in the WTP for beef. Moreover, the selected quantities between beef and soy almost return to the initial quantities, namely the ones chosen before the revelation of messages. This reversal of chosen quantities towards more beef compared to soy underlines the participants' sensitivity to beef quality, when meat substitutes are considered.

Keywords: experimental economics, meat consumption, sustainability, consumers' preferences.

JEL Classification: C9, D8, I1.

1. Introduction

In many countries, there are intense and passionate discussions regarding the future of meat production and its impact on environment and public health. Regarding the environment, the breeding of cattle implies a large use of land and leads to high greenhouse gas emission levels (Westhoek et al., 2014). Moreover, animal-based foods have higher greenhouse gas emissions than plant-based foods (González et al., 2011, and Tilman and Clark, 2014). Regarding the public health, meat provides amino acids of very good quality and vitamin B12 (Lock et al., 2010). However, excess of meat consumption is one contributor to unhealthy diets characterized by relatively high intakes of fats, saturated fatty acids and salt, and by relatively low intakes of dietary fiber, vitamins and micronutrients. These unhealthy diets ultimately increase risks of both cancer mortality and cardiovascular disease mortality (Lock et al., 2010, and Wein, 2012).

At the end of 2015, debates were revived by the report released by the World Health Organization (WHO), focusing on the link between the excess of meat consumption and some cancers (see WHO, 2015). This widely-broadcast report particularly challenged high levels of meat consumption. Beyond this report, nutritionists recognize that healthy diets should contain large amounts of cereals, vegetables, fruits, and pulses, while limiting the amount of red and processed meat, which raises the question of consumers' behaviors.

Consumers' intentions to reduce meat consumption are often thwarted by entrenched habits, favoring meat consumption in regular diets (see for instance, Grunert, 1997, and Graça et al., 2015). Routines explain the overconsumption of animal-based proteins in many developed country, while health and environment benefits coming from plant-based proteins are overlooked by many consumers (Escalón, 2016). Even if the absence of economic incentives in the supply chain for offering plant-based proteins is a major reason at the origin

of the tiny share of plant-based proteins in diets (Magrini et al., 2016), the lack of familiarity with plant-based alternatives to meat is another reason for explaining this small share (Schösler et al., 2012). However, the evolution of consumers' perceptions could impact long-term demands for both meat and possible substitutes (see Bouwman et al., 2016).

This paper aims at evaluating the impact of explanatory messages about health and environment on consumers' willingness-to-pay (WTP) for meat and plant-based substitutes. This lab experiment focused on consumers' choices between beef burger meat and soy burger meat, because of (a) a similar "burger" appearance making potential substitutions easier, (b) beef (respectively soybean) is one of products with the lowest (respectively highest) protein efficiency per greenhouse gas emissions (González et al., 2011), (c) soy burgers were introduced on the market before and after the time of the experiment (see Monnier, 2016).

However, this experiment did not tackle three types of issues already studied by previous contributions. First, we abstracted from animal welfare and ethical issues, because (a) we developed relative and "symmetric" messages between animal and vegetal meat, leading to difficulty to talk about "vegetal" welfare compared to animal welfare, and because (b) Hoek et al. (2011) underlined the inefficiency of communication relying on ethical arguments for making meat substitutes more attractive to consumers. Second, we also abstracted from the question of vegetarianism per se, because (a) Tobler et al. (2011) and Le Gal (2016) distinguished between ethical motives leading to complete vegetarianism, and health motives (namely, one topic of this paper) leading to a reduction in meat consumption, and because (b) we only recruited meat consumers, representing 97% of French consumers (Le Gal, 2016), for examining their potential cut in meat purchases. Eventually, we abstracted from beef substitutes such as other meats, fish, cheese and eggs, for focusing on plant-based substitutes with very precise messages, since this issue is generally overlooked. We also abstracted from new substitutes like the insects that are not purchased by French consumers,

or the cell-cultured meat that is not authorized for consumption in Europe (see Verbeke, 2015).

The lab experiment was run with 124 participants in November 2015 in Dijon, Burgundy France. Willingness to pay (WTP) and choices between these different products were elicited for different rounds of information revealed to participants. Explanatory messages about the impact of beef and soybean on health and environment were successively revealed to participants. The order of messages varied across different sessions attended by different participants. The set of messages underlined the relative benefits of increasing consumption of soy meat compared to beef.

Because we could not fully guarantee the freshness of products that could be given or sold to consumers at the end of the experiment, we only elicited hypothetical WTP with a multiple-price list. In other words, we did not give or sell any product at the end of the experiment. Despite the risk of hypothetical and upward biases of WTP, the lab is a practical place for eliciting well-informed, thoughtful preferences with a tight control of the revealed information.¹

This paper shows a limited impact of messages on participants' preferences. WTP for beef are not statistically influenced by the different rounds of messages. Conversely, messages significantly increase the WTP for soy meat, even if this effect is relatively weak (namely, +6.1% between the 1st round and the 5th one). These explanatory messages also lead to weak changes in the chosen quantities of beef and soy. A last round with the introduction of a high-quality beef leads to a statistically significant increase in the WTP for beef. The

¹ Even if hypothetical WTP are likely to be upward biased, recent contribution seems to downplay risks of biases for private good. By comparing hypothetical and non-hypothetical responses, Lusk and Schroeter (2004) showed that marginal WTP for a change in quality/characteristic is, in general, not statistically different across hypothetical and real payment settings. By comparing hypothetical and non-hypothetical responses, Taylor et al. (2010) indicate that WTP are not statistically different for private goods, but statistically different for public goods.

selected quantities between beef and soy almost return to the initial quantities chosen, before the revelation of messages. This reversal of chosen quantities towards more beef compared to soy underlines the participants' sensitivity to the beef quality.

By showing a limited impact of messages on participants' preferences, this paper confirms some previous results underlining a relatively strong attachment towards meat that hinders a shift towards a more plant-based diet (see Hoek et al., 2004, Hoek et al., 2011 and Graça et al., 2015). However, unlike previous papers, our experiment was realized after the widely-broadcast report, released in October 2015 by the WHO, showing a link between the excess of meat consumption and some cancers (see the *New York Times*, 2015 and the WHO, 2015). 71.7 % of participants attending our experiment heard about this press release.

The present paper differs from previous non-economic studies focusing on meat replacement. De Boer et al. (2007), Krystallis et al. (2012), and Zur and Klöckner (2014) focused on attitudes and intentions to reduce meat consumption, but they overlooked the revelation of diverse messages under different orders. Conversely, our protocol precisely controls the diversity of messages and the order of these messages. Additionally, our paper does not find influences of higher education or higher socio-economic status on the variations of WTP for beef and soy, which is the opposite of significant influences of socio-demographic variables on attitudes to cut meat purchases, shown by Krystallis et al. (2012), Schösler et al. (2012) and De Boer et al. (2014).

The present paper also differs from previous economic studies determining WTP. In their book on experimental auctions and WTP, Lusk and Shogren (2007) did not mention the reversals of preferences following different rounds of information.² Conversely, our paper underlines a reversal of preferences coming from the introduction of a high-quality beef

² By eliciting monetary WTP for health and environmental characteristics, our paper also differs from economic studies analyzing meat taxations, without integrating any monetary values for health and environmental characteristics (see a recent contribution by Caillavet et al., 2016)

inducing an increase in the chosen quantities of beef, and reversing a previous decrease in the chosen quantities.

The paper is organized as follows. The protocol and the results of the experiment are successively detailed in sections 2 and 3. Section 4 concludes.

2. Method

This section successively details the experiment and the methodology used for the econometric analysis of WTP.

2.1. The experiment

The sample

We conducted the experiment in Dijon, of Burgundy in France, in multiple sessions in November 2015. A sample of 124 participants was randomly selected based on the quota method, and was representative for age groups and socio-economic status for the population of the city.

Participants were recruited by phone. They were informed that the experiment would focus on meat consumption and it would last about one hour with a €15 participation fee. Only participants eating beef and beef burger meat (ground beef), even occasionally, were selected. Each experimental session lasted 50 minutes in average and included between 8 and 16 participants. Table 1 presents the socio-economic profiles of participants.

Because of incomplete replies, observations related to 4 participants were discarded for the rest of this paper. Therefore, the rest of this paper only takes into account the replies of 120 participants.

Table 1. Socio-economic characteristics of 124 participants

Participants Gender (%)	
Male	46.2
Female	53.8
Participants' Age (%)	
< 40	46.1
[40-49]	22.6
≥50	31.3
Mother's Education	
No baccalaureate (BAC) ^a	17.9
BAC or 2 years after BAC	50.4
More than 2 years after BAC	31.6
Monthly net income of the household (€)	
≤ 3000	66.6
]3000-5000[31.6
≥ 5000	1.8

Note: ^a Baccalaureate (BAC) is the French high school diploma.

The products

Because we could not fully guarantee freshness of products, in particular from the lab to the participants' fridge, no products were sold at the end of the experiment. In the absence of products given at the end of the experiment, we elicited hypothetical WTP. With products shown on pictures, people were asked to indicate choices they would make in supermarkets.

Figure 1 shows the pictures of two products presented to participants. First, the experiment focused on 250 g vacuum packed fresh ground beef with two steaks. No brand was indicated, since ground beef is a widespread product, sold under different brands including supermarket brands. Second, the other product was a pack of soy burger meat (200g) offering two steaks. We selected this product, because, before the experiment, several supermarkets visits identified this brand *Sojasun*, as the vegetarian brand that was the most systematically and prominently offered on the various shelves. At the time of the experiment, this soy meat was made with soybeans produced in France without Genetically Modified Organisms. One steak contained 63.6% of soy ingredients and the rest was made with various

vegetables and cereals.³ As shown on figure 1, we explicitly mentioned this well-established brand *Sojasun*, for giving credibility to this relatively unfamiliar product, since, at the end of the first round, 50.9% of participants declared that they never ate vegetarian or soy meat before coming to this experimental session.

Figure 1. The pictures of products shown above the multiple-price lists



Beef burger meat



Soy burger meat

The messages about products

A first round of WTP elicitation was realized without any message. For this first round, explanations about mechanisms were given (as explained below), with only a few indications describing each product (see appendix A).

³ See nutritional information available at <http://www.sojasun.com/nos-produits/tous-nos-plats-et-ingredients-culinaires/steaks/product/fines-herbes.html> (accessed September 2016). New soy burgers were introduced on the market before and after the time of the experiment (Monnier, 2016).

In the following rounds #2 to #5, different types of messages about products were communicated to participants before the WTP elicitations. The 4 messages were written after studying articles coming from the nutrition, agronomic and environmental fields. The messages were relatively short, because previous works underline that a short message is more efficient than a long message with complex information (Wansink et al., 2004).

We restricted our attention to successive messages that focused on both health and environment that are important dimensions of sustainability. We abstracted from the questions related to the animal welfare. In order to pay attention to products of Figure 1, messages mentioned either the term “beef” or the term “red meat”, without indicating some other types of meat. In order to maintain credibility of the message about health and beef, the last part of the message refers to a nutritional advice given by the *Programme National Nutrition Santé* translated as the *National Plan for Nutrition and Health* (see PNNS, 2016). For the impacts on environment, both messages insisted on the relative performances of both products, since González et al. (2011), with figures 2 and 3 p. 568, underline that soybeans have the highest protein delivery efficiency per energy use and per greenhouse gas emissions, while beef is one of products with the lowest protein efficiency.

The 4 messages translated from the French and preceding the WTP determinations were the following.

Message about health and beef

“Excessive consumption of red meat increases the risk of colorectal cancer. Furthermore, red meat is relatively rich in saturated fats and cholesterol.

However, eating meat in reasonable quantities is good for health. Meat provides particular amino acids of very good quality, and vitamin B12 that is not present in plants.

The *National Plan for Nutrition and Health* recommends eating meat (and varying the types of meat), or fish, or eggs, one or two times a day, always with a lower quantity compared to the accompaniment, with a maximum of 100g-150 g of meat per day.”

Message about health and soy

“Soybean is particularly rich in proteins, fiber and minerals. Moreover, soybean contains no cholesterol. The high content in fiber and the absence of cholesterol contribute to limit the risks of cardiovascular diseases.

For adults, soy can partially replace beef.

It is advised to mix up a consumption of soybean, with cereals such as rice or wheat, for a complete supply of essential amino acids.”

Message about environment and beef

“The breeding of beef cattle entails a relatively high level of pollution. Beef production contributes to the emission of greenhouse gases, and uses a lot of natural resources. For example, the production of 1 kg of beef requires 10 to 15 times more water than the production of 1 kg of soybean.

Eating a little less meat would limit some pollutions and would contribute to a reasonable use of resources.”

Message about environment and soy

“The soybean crop entails a relatively low level of pollution.

Soybean crop requires the use of very few pesticides. Moreover, no additional nitrogen fertilizer is necessary for this crop. Soybean is also an excellent preceding crop for the following crops because it allows:

- A 10% yield gain on the next crop (wheat or corn);

- The saving of 20 to 30% of nitrogen fertilizers for the next crop (wheat/corn).
- An improvement in soil structure.

However soybean is little cultivated in France because of a lack of opportunities, a lack of cropping habits by farmers and/or the absence of organization in supply chains.

Eating soybean steaks would increase the soybean share in French crops.”

The order of these different messages was precisely controlled by equally varying the order of messages across 4 different groups of participants. 2 groups started with health messages preceding environmental messages, and 2 other groups started with environmental messages preceding the health messages.

Table 2. Groups depending on the order of messages

Messages	Order of messages related to products	
	Beef/Soy	Soy/beef
Health and Environment	G1	G2
	26 participants	28 participants
Environment and Health	G3	G4
	34 participants	32 participants

. For each type of messages (health and environment), the message on beef was preceding the message on soy for 1 group and vice versa for the other group. These 4 groups of participants allowed us to take into account different orders of messages. Participants were randomly allocated to one of 4 groups before coming to a session. Table 2 presents the order of messages for the groups G1 to G4 revealed in rounds #2 to #5 and the number of participants for each group.

Eventually, a last round #6 was conducted and was similar for all groups G1 to G4. We introduced high-quality beef with the use of a high-quality label, namely the *Label Rouge*, (translated as *Red Label*) that is well-known in France.⁴ We kept the picture of beef shown in figure 1 and added the *Red Label* logo,  beside this picture. We also revealed a last message by insisting on the nutritive and environmental quality of this type of beef. The last message was the following:

“Beef cattle and cows contribute to maintain grassland and natural hedgerows that are important reserves of animal and plant biodiversity. A move towards a more grazing system for feeding beef cattle and cows would increase the grass to the detriment of the corn in their diet. As a consequence, more grassland farms would preserve the maintenance of meadows and limit the extension of corn fields.

Furthermore, when beef cattle and cows are fed with grass, their meat is less rich in saturated fats and is richer in omega 3, compared to the regular meat coming from beef cattle and cows that are mainly fed with corn.

One way to consume a high-quality meat is to turn to meat sold with labels. For example, the *Label Rouge* guarantees beef cattle staying on grass-fed meadows for 7 to 8 months per year, with a more extensive farming respecting grasslands.”

This last round #6 with WTP elicitation and quantity choices was conducted for the beef with the *Red Label* and the soy.

Mechanism for eliciting WTP

A multiple-price list (payment card) was used for eliciting WTP of each product. During each round, participants were asked to choose whether or not they will buy the

⁴ This label is used for various types of foods, including meat. According to OpinionWay (2010), 97% of French consumers have already seen the *Label Rouge* logo in 2010.

product for prices varying from €2.20 to €3.80 for each product (see Appendix A). The prices were based on a supermarket survey regarding the observed prices of both products in Dijon. The average observed price for was equal to €2.60 for the beef burger meat and to €2.9 for the soy burger meat. The multiple price list was characterized by increments of 10 cents between successive prices, with 8 prices lower than €3 and 8 prices higher than €3 (Appendix A).

Participants had to fill out 17 lines for each product and for each choice. For each price, they had to check off either “yes”, “no” or “maybe” regarding their purchase intents. For each product and for each round of choice R with $R = \{1, \dots, 6\}$, the WTP was determined by taking the highest price linked to a choice “yes” (with the following highest price on the paper sheet implying a reply “no” or “maybe”). If one participant only replied “no” or “maybe” to each line, the selected WTP was equal to €2.10 (an alternative configuration with a value equal to €0 was also studied). If one participant only replied “yes” to each line, the selected WTP was equal to €3.90. For respondents switching twice at low and high prices, the highest “Yes” was recorded as the WTP for the analysis.⁵

Multiple-price lists were employed in this experiment to simplify the task for consumers when evaluating independently two products in several rounds. Criticisms against multiple price lists were brought forward by Andersen et al. (2006). One drawback is the interval response eliciting interval data rather than point estimates for WTP. With our experiment, the 10 cents interval guarantees a sufficient degree of precision for the elicited WTP. Another disadvantage mentioned by Andersen et al. (2006) is the framing effect with a psychological bias towards the middle of the multiple-price list for choices made by participants. They controlled for this effect by changing the boundaries of the multiple-price

⁵ This paper only considers WTP with the highest “Yes” for the 120 participants. Among them, 20 participants were also characterized by lower limit, LL, with $LL < WTP$ and for which the reply was “Maybe” or “No” for prices lower than LL. Marette et al. (2013) underscore multiplicity of market equilibria coming from LL.

list. In this paper we did not control this framing effect by changing the boundaries, since we focus on the impact of information and messages revelation.

Choice of the basket with 5 products

After each round of information revelation and after the 2 multiple-price lists, filled in for each product, each participant indicated a basket with 5 units of beef and/or soy. Participants had to choose one combination of these products leading to a total of 5 units, by supposing that these two products were sold at the same price without detailing prices.⁶ The page on which participants filled in this quantity choice is shown in appendix B.

Timeline of the experiment

At the beginning of the experiment, some initial explanations were read, and participants signed a consent form. We insisted on the fact that all their replies were anonymous, since participants were identified by a number. We insisted on the fact that no product will be sold or given at the end of the experiment. We asked participants to indicate choices as if they were in a supermarket. We insisted on the absence of “good” or “bad” replies, but rather on the possibility to freely indicate choices reflecting their preferences.

The round #1 was realized without any messages on health or environment. First, for the beef only, a few explanations about the weight and the beef was given. Explanations were also given about the multiple-price list. Participants filled out this price list for beef only, but the related WTP are not detailed in the paper. Then, we introduce the *Sojasun* product with a few explanations on this product, and participants filled out a price list for beef and a price list for soy, leading to both WTP of round #1. Then the choice of the basket with 5 products was introduced, explained and filled out by participants.

⁶ In the initial explanations at round#1, we carefully explained that six combinations were possible, namely $\{(0 B, 5 S), (1 B, 4 S), (2 B, 3 S), (3 B, 2 S), (4 B, 1 S), (5 B, 0 S)\}$, with notations *B* for beef and *S* for Soy.

The rounds #2 to #6 were organized as following. First, one of the four messages was given to participants on a paper sheet and read by the organizer. Each participant successively filled in one multiple-price list for beef, and another multiple-price list for the soy. After these multiple-price lists, the quantity choices leading to 5 products “selected in the basket” was indicated. A few complementary questions were asked at the end of each round. At the end of a session, after the 6 rounds, participants filled in an exit questionnaire and received the €15 indemnity.

2.2. The methodology

As the high-quality beef signaled with the *Red Label* was only introduced at round #6, a large part of the analysis will only focus on the “regular” beef without a quality label and shown from rounds #1 to #5.

The econometric estimation of WTP

We will use an econometric estimator for precisely testing the impact of information on WTP. Given that each participant i wrote 5 WTP for regular beef and soy, errors related to these WTP are potentially correlated for each participant. The random effect imposes constraints on the structure of the variance-covariance matrix. Furthermore, WTP cannot be negative and is left-censored at €2.10 and right-censored at €3.90, which explains that we use the random effects Tobit estimator. We test for the influence of messages on WTP. The types of messages are identified by a dummy variable equal to 1, when the message is revealed before the WTP elicitation (and 0 otherwise). We first consider the order of messages in model (1), with dummy variables (1/0) taking into account the order of the message. The model (2) also takes into account the four types messages with dummy variables (1/0) linked to the message on *health and beef*, the message on *health and soy*, the message on

environment and beef, and the message on *environment and soy*. We also take into account participants' perceptions and socio-economic characteristics coming from the exit questionnaire.

For a participant i , let $WTP_{B,R}^i$ and $WTP_{S,R}^i$ denote the participant i 's WTP for regular beef and soy as the dependent variable, at round R with $R=\{1,\dots,5\}$. Let $X_{R,i}$ denote the explanatory variables indicating the rounds of information, the socio-demographic, the perception variables. The random Tobit model for the WTP for beef can be written as

$$WTP_{B,R}^i = \beta_0 + \beta_1 X_{R,i} + \varepsilon_{R,i}, \quad (1)$$

with the parameters β_0, β_1 that will be estimated, and $\varepsilon_{R,i}$ being the term of errors. From the multiple-price list explained in subsection 2.1, $WTP_{B,R}^i$ is bound between €2.10 and €3.90. A similar expression can be written for the soy, with $WTP_{S,R}^i$ replacing $WTP_{B,R}^i$ in equation (1).

3. Results

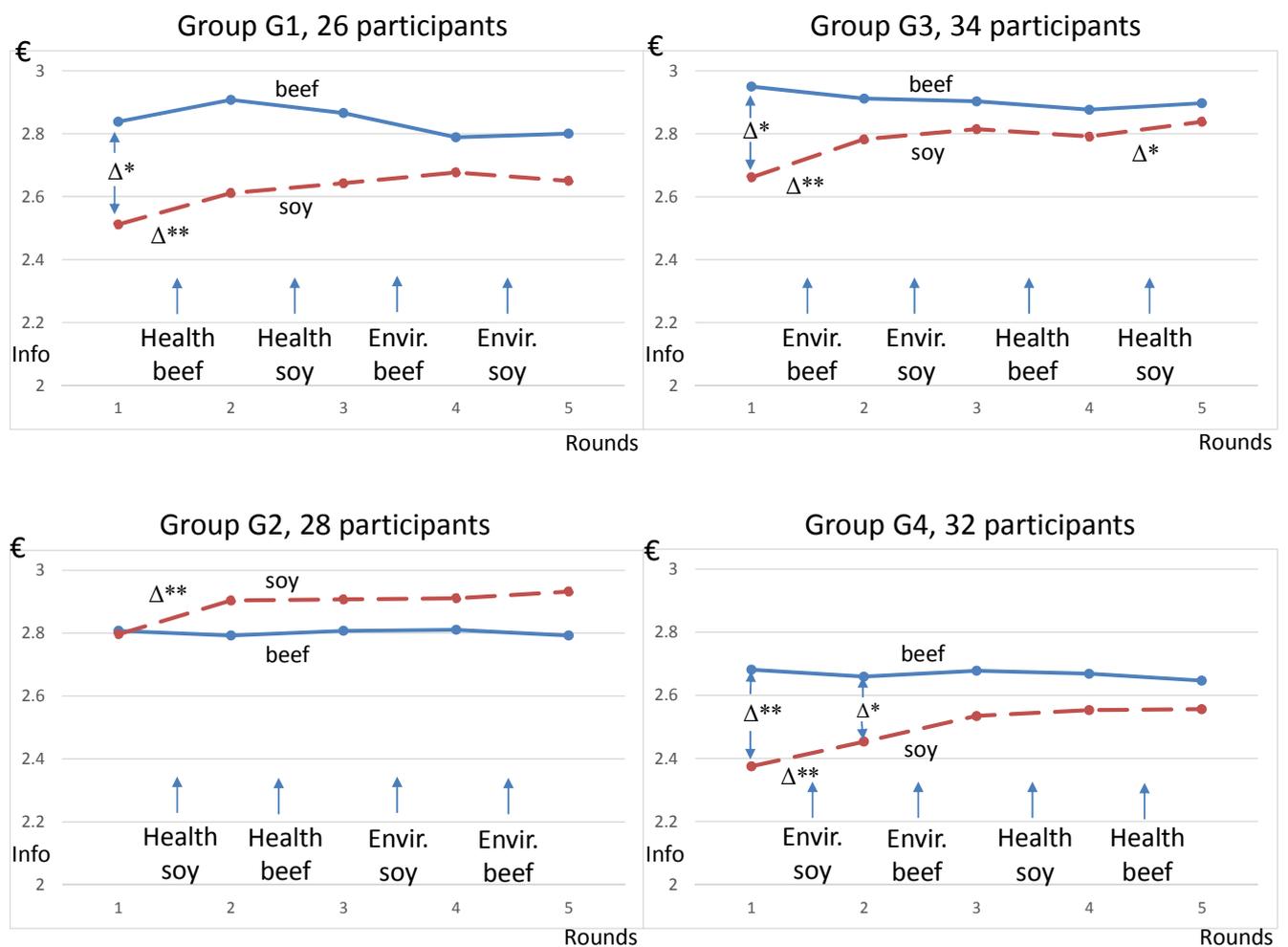
This section presents analysis of both WTP and demands/choices for regular beef and soy. The introduction of the high-quality beef will be only considered at the end of this section.

3.1. The impact of explanatory messages on WTP for products

We start by simply presenting the average WTP for regular beef and soy. Figure 2 shows the average WTP for the beef (plain curves) and the soybean alternative (dash curves). On each chart, the 5 rounds of WTP elicitation are represented on the X-axis, and the WTP are represented on the Y-axis (starting at €2). The different charts correspond to the different groups G1, G2, G3 and G4, in which the order of explanatory messages varied, as explained

with table 2. The types of messages preceding the WTP elicitation are indicated above the X-axis. An average variation in WTP coming from one message is represented by the difference between two successive points. We also test for significant differences in WTP by using the Wilcoxon test for paired samples, and Δ^* and Δ^{**} respectively indicate the significant differences at the 5% and 1% levels.

Figure 2. Average WTP for beef and soy meat alternatives



Notes: Δ^* denotes significant difference at 5% and Δ^{**} denotes significant difference at 1% as tested by the Wilcoxon test for comparing paired sample of WTP. This comparison of WTP was made (1) for each product between successive rounds of messages, and (2) between different products for a same round of message.

Figure 2 shows that, before the revelation of explanatory messages, namely at round #1, the average WTP for beef is significantly higher than the average WTP for soy (except for subgroup G2). Messages significantly increase the WTP for soy meat (see dashed curves), even if this increase is relatively low. Indeed, by including the 120 participants, the relative increase of WTP for soy is equal to 6.1% between the 1st round and the 5th round (recall that the Y-axis starts at €2). The WTP for ground beef are not statistically influenced by the different rounds of messages. After the revelation of successive messages (round #5), the average WTP for soy meat becomes closer to the average WTP for beef, even if it still lower than the average WTP for beef (except for subgroup G2). Even if Wilcoxon tests between rounds do not provide a complete view regarding the impact of information, Figure 2 underlines the significant and limited impact of messages on the WTP variations for soy.

For precisely measuring the impact of messages on WTP for each product, we pool the participants' WTP elicited in the successive rounds R with $R=\{1,\dots,5\}$, and we use a Tobit random effects estimator, with dummy variables related to rounds of messages (see subsection 2.2). These estimations are presented in Table 3 for beef and in Table 4 for soy.

Table 3 confirms the absence of a significant impact of successive messages on WTP for ground beef. No message has a significant impact on WTP for beef, which suggests solid and stable preferences for meat. Models (1a) and (2a) of table 3 clearly show that messages have no impact on WTP for beef. In models (1b) and (2b), the bottom of table 2 shows that socioeconomic variables, as the sex, the age, the income play a significant role on the WTP, but not on the WTP variations. The model (1b) is more precise with a higher value of log-likelihood than model (1a), and a similar conclusion holds for model (2b) compared to model (2a). The results of the absence of impact of messages on WTP was also verified with some other specifications, not reported in table 3. This includes the specification in which the four dummies for the order of information were interacted with the four dummies indicating the

type of messages. The results of table 3 are consistent with previous results underlining the low impact of sustainability labels on consumers' choices (see Grunert et al., 2014).

Table 3. Estimations of pooled WTP for beef with a Tobit random effects estimator

	WTP for beef			
	(1a)	(1b)	(2a)	(2b)
Constant	2.847** (0.020)	2.776** (0.074)	2.847** (0.020)	2.675** (0.055)
Message received first (1/0) at round #2	-0.005 (0.026)	-0.006 (0.022)		
Message received second (1/0) at round #3	-0.008 (0.026)	-0.015 (0.022)		
Message received third (1/0) at round #4	-0.034 (0.026)	-0.043 (0.022)		
Message received fourth (1/0) at round #5	-0.035 (0.026)	-0.039 (0.022)		
Message about health and beef (1/0)			-0.015 (0.026)	-0.016 (0.023)
Message about health and soy (1/0)			-0.015 (0.026)	-0.022 (0.023)
Message about environment and beef (1/0)			-0.025 (0.026)	-0.033 (0.023)
Message about environment and soy (1/0)			-0.026 (0.026)	-0.027 (0.023)
Initial knowledge about excess of meat consumption and health (1: Yes, 0 : No) ^a		0.271** (0.033)		
Sex (1: man, 0: woman) ^b		-0.217** (0.043)		-0.075** (0.021)
Age ^b		-0.011** (0.001)		-0.006** (0.001)
Education (1: no certificate to 6: PhD) ^b		0.032* (0.013)		0.128** (0.009)
Monthly net income, from 1 for income < €1000 to 7 for income > €6000 ^b		0.084** (0.009)		-0.022** (0.008)
Stand. dev. ϵ	0.205** (0.006)	0.169** (0.004)	0.206** (0.006)	0.175** (0.005)
Stand. dev. μ	0.372** (0.007)	0.328** (0.007)	0.372** (0.007)	0.300** (0.006)
Observations	N=600	N=600	N=600	N=600
Log likelihood	-49.491	-7.466	-50.468	-5.586

Note: **: significant at 1%; *: significant at 5%. Standard errors in parentheses.^a Have you ever heard about the impact of the excess of meat consumption on health (Yes or No)? ^a Question asked at the end of the round with the message about meat and health. ^b Question from the exit questionnaire.

Table 4. Estimations of pooled WTP for soy with a Tobit random effects estimator

	WTP for soy			
	(1a)	(1b)	(2a)	(2b)
Constant	2.842** (0.020)	3.162** (0.051)	2.842** (0.020)	2.462** (0.062)
Message received first (1/0) at round #2	0.101** (0.021)	0.105** (0.024)		
Message received second (1/0) at round #3	0.140** (0.021)	0.137** (0.024)		
Message received third (1/0) at round #4	0.146** (0.021)	0.146** (0.024)		
Message received fourth (1/0) at round #5	0.160** (0.021)	0.159** (0.024)		
Message about health and beef (1/0)			0.132** (0.021)	0.127** (0.024)
Message about health and soy (1/0)			0.150** (0.021)	0.148** (0.024)
Message about environment and beef (1/0)			0.144** (0.021)	0.144** (0.024)
Message about environment and soy (1/0)			0.120** (0.021)	0.127** (0.024)
Initial knowledge about excess of meat consumption and health (1: Yes, 0 : No) ^a		-0.504** (0.034)		
Sex (1: man, 0: woman) ^b		0.065** (0.020)		-0.061* (0.024)
Age ^b		-0.004** (0.001)		-0.001 (0.001)
Education (1: no certificate to 6: PhD) ^b		0.017* (0.007)		0.039** (0.009)
Monthly net income, from 1 for income < €1000 to 7 for income > €6000 ^b		0.007 (0.009)		-0.006 (0.009)
Stand. devi ϵ	0.169** (0.004)	0.186** (0.005)	0.169** (0.005)	0.185** (0.005)
Stand. dev. μ	0.297** (0.005)	0.401** (0.007)	0.297** (0.005)	0.377** (0.007)
Observations	N=600	N=600	N=600	N=600
Log likelihood	-60.257	-4.555	-63.088	-6.524

Note: **: significant at 1%; *: significant at 5%. Standard errors in parentheses. ^a Before coming today, have you ever heard about the impact of the excess of meat consumption on health (Yes or No)? ^b Question from the exit questionnaire.

Table 4 shows a significant and positive influence of messages on participants' WTP for soy. Models (1a) and (1b) show that all rounds of information have a significant and positive impact on WTP, which was not visible with Wilcoxon test of Figure 2. Models (2a)

and (2b) show that all types of messages insisting on different topics have a significant and positive impact on WTP, suggesting a similar interest for health and environmental information, with relatively close coefficients. Even the messages focusing on beef have a positive impacts on WTP for soy. Note that the various coefficients related to both order and type of messages are relatively low compared to the coefficient of the *Constant*, which confirms the significant but relatively low impact of messages. Results of Table 4 are robust with alternative specifications, not reported in this table. The robustness is verified if the four dummies for the order of information are interacted with the four dummies indicating the type of messages, with many coefficients that are statistically significant, which confirms results of Table 4.

Regarding the robustness of econometric estimations of both tables, we also re-ran regressions by replacing €2.1, the lower bound of the WTP related to absence of purchase with the multiple price-list, by €0, which leads to similar conclusions to the ones of Tables 3 and 4. To conclude this subsection on the impact of information on WTP, consumers appeared to be more responsive to messages that “pull” them towards the healthy or sustainable choice, represented by the soy, than to messages that “push” them away from unhealthy or environmental hazardous choice, represented by the beef.

These results of tables 3 and 4 mark an interesting difference with previous results coming from prospect theory defined by Kahnman and Tversky (1979), who show that losses and gains can yield different valuations under the “prospect theory”. From a reference point, Kahnman and Tversky (1979) show that utility variations are convex for losses and concave for gains, which corresponds to a steeper impact for losses than for gains. The design of our experiment with successive revelations of positive and negative information can be seen as one variation of the “prospect theory”, with the WTP of the first round serving as a reference point. In our paper, the benefits coming from the additional messages about soy are

significantly and positively valued in table 4, while the losses coming from the additional messages about meat consumption have no impact in table 3. According to the “prospect theory”, the impact from messages implying losses should be higher than the impact of messages implying benefits, which is not the case in this experiment.

Table 5. Participants' knowledge about revealed messages. Questions following the revelation of the message, the WTP elicitation and the choice of 5 products

Before coming to this session did you hear about... % of yes	% of participants who heard about the effect
Problems related to the overconsumption of red meat? ^a	92.5 %
The WHO report published 3 weeks ago (released on October 26 th , 2015)? ^a	71.7 %
Health benefit coming from the consumption of soy? ^b	71.7 %
Pollutions coming from beef cattle? ^b	80.9 %
Environmental benefit coming from soy farming? ^b	21.5 %
Question on consumption	% of participants
Participants who have already eaten vegetarian or soy meat ^c	49.1 %
Participants who regularly eat meat twice a day ^d	13.7 %
Participants who regularly eat meat once a day ^d	37.6 %
Participants who regularly eat meat less than once a day ^d	48.7 %

Notes: ^a Question asked at the end of the round with the message about meat and health. ^b Question asked at the end of the round with the message related to the question. ^c Question asked at the end of the round#1. ^d Question from the exit questionnaire.

There are three potential explanations for explaining this difference with the result underlined by Kahnman and Tversky (1979). First, consumers’ previous knowledge on meat (or their “possible illusion” of knowledge) may limit the surprise and/or the learning coming from messages about beef and soy. Table 5 shows a high level of “previous knowledge” by consumers, with many of them who had already heard arguments related to messages (except for the soy and the environment). However, this fact does not explain the systematic impact of all messages on WTP for soy. Second, the message *on health and beef* presented in section 2.1 balanced negative and positive impacts on health, and focused on the excess of meat consumption. The bottom of Table 5 shows that there are a few participants who declared eating meat twice a day, which implicitly makes them not fully concerned by the excess of

meat consumption. However, WTP for beef did not change with other messages that did not mention any positive effects coming from meat production and consumption. That leaves the third and plausible explanation: a strong preference for meat and/or a deep-rooted routine for meat consumption, impeding any significant impact of messages on WTP for beef.

3.2. The chosen baskets of 5 products

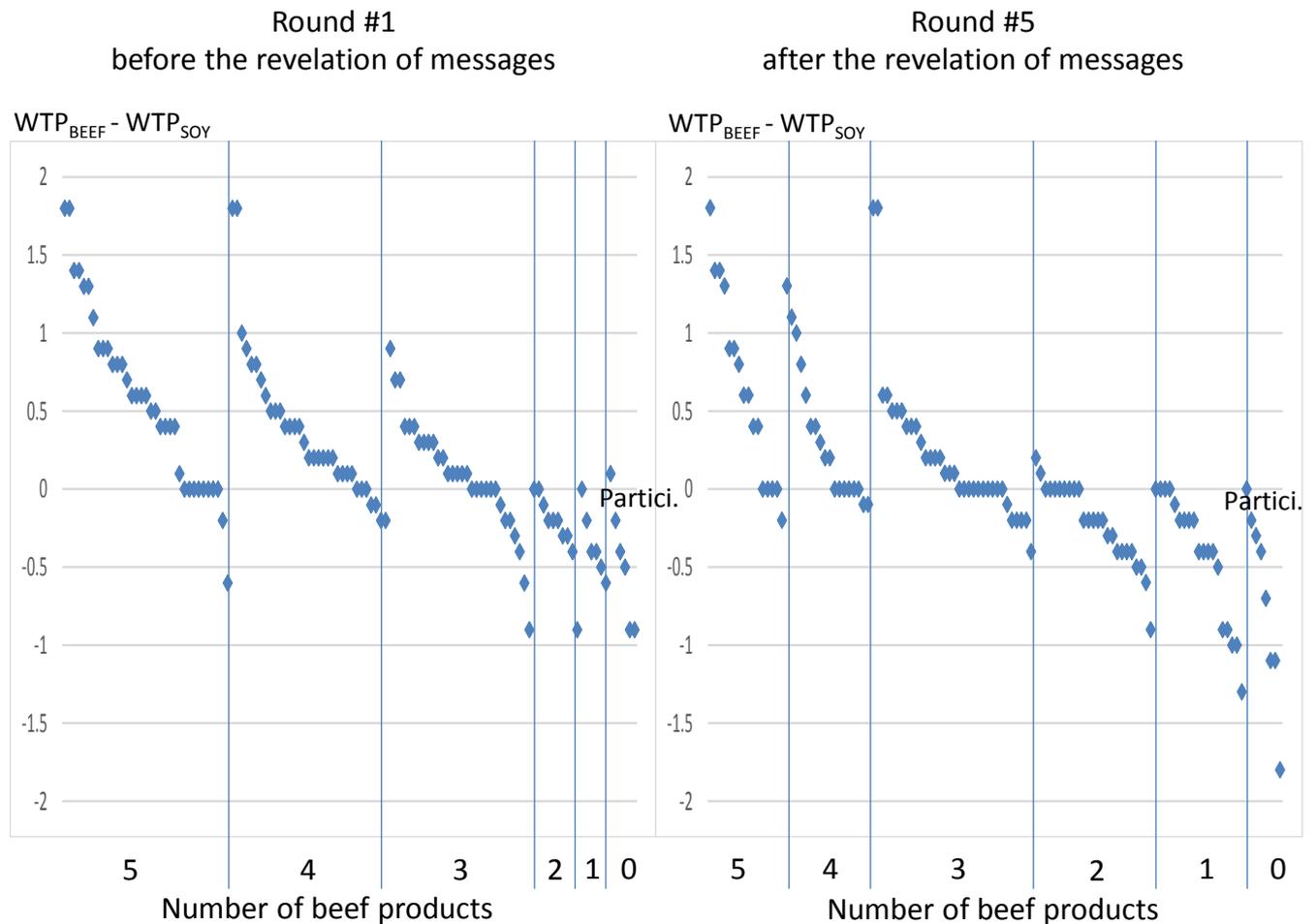
We now turn to the study of the basket of 5 products chosen by participants after the elicited WTP. Recall that for these quantity choices, participants chose a basket of 5 units at each round (see Appendix B). The quantity choices of baskets are made (1) without any posted prices, and (2) for an overall quantity that is fixed and equal to 5.

Figure 3 shows the link between the quantity choices of beef products, with the participants represented on the X-axis, and the differences between the WTP for the beef and the WTP for the soy selected by these participants at the same round. Participants were clustered by chosen quantity on the X axis, with 6 subgroups, representing the possible choices of meat products. On the Y-axis, the WTP differences were ranked by decreasing order for each subgroup of chosen products. The chart on the left shows the situation before the revelation of messages at round #1, while the right chart shows the situation after the revelation of 4 messages at round #5.

Figure 3 shows a strong correlation between the number of chosen beef units and the premium for the beef, given by the WTP for the beef minus the WTP for the soy. The higher the selected quantity of beef products, the higher is the premium for the beef, namely the WTP for the beef minus the WTP for the soy. The complete revelation of messages significantly modifies the choices towards more soybean products, since the right chart of figure 3 shows lower chosen quantities of beef compared to the ones in the left chart. In

average, the chosen quantity of beef significantly declines from 3.52 units to 2.69 units.

Figure 3. The link between the choice of 5 products and the difference in WTP

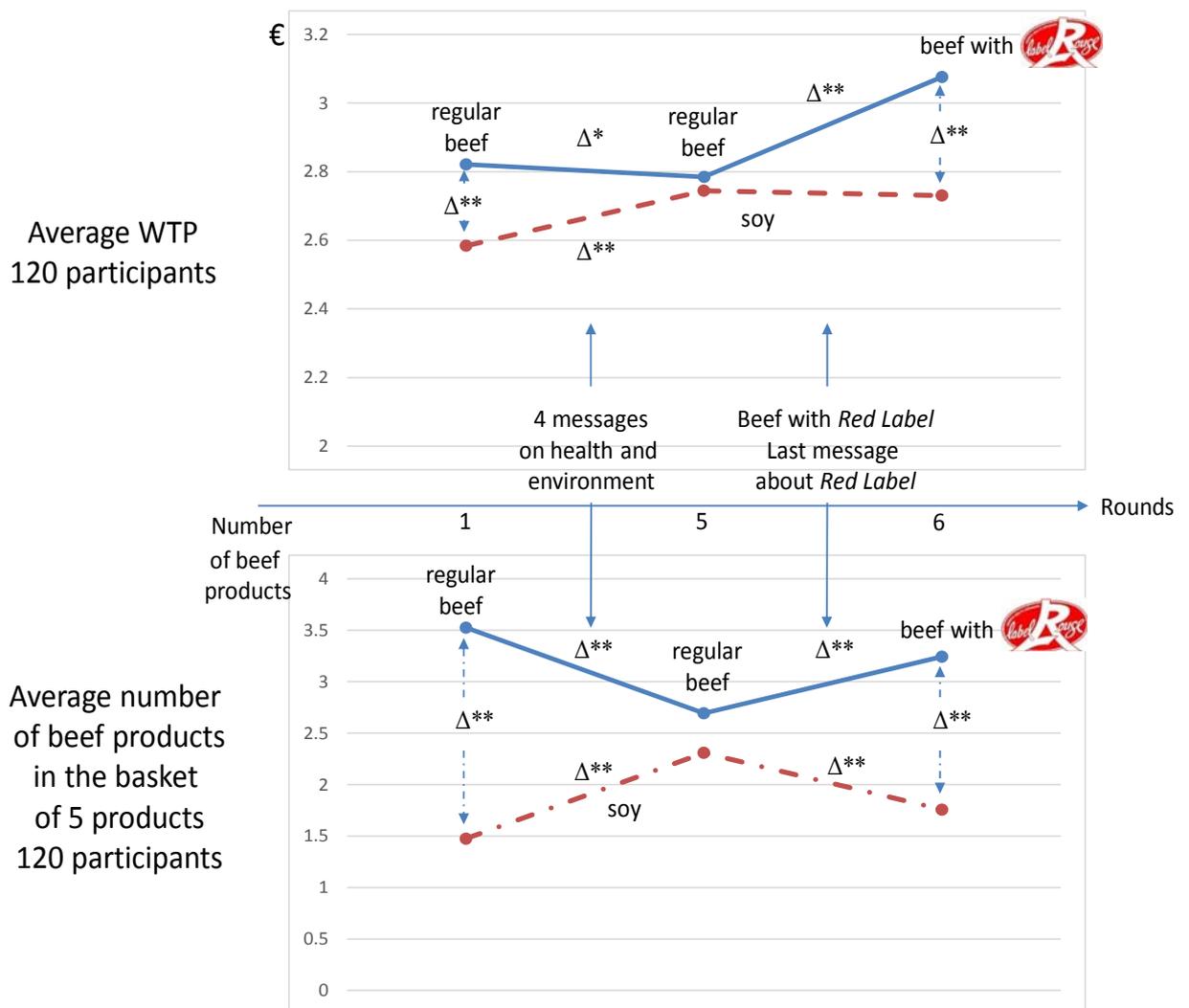


3.3. The introduction of high-quality beef

We now turn to the impact of the introduction of a high-quality beef at round #6, with a message explaining benefits for the environment with the good management of grasslands and benefits for human health with the omega-3 content of this meat. Figure 4 presents the impact of this message linked to the introduction of the beef signaled by a *Red Label*. Both charts represent average values over the 120 participants. For both charts of figure 4, the

rounds #1, #5 and #6 are considered on the X-axis, represented between both charts. These different rounds allow to measure the impact of the introduction of this high-quality beef at round #6, compared to the previous effects of messages on health and environment between the rounds #1 and #5.

Figure 4. The influence of the last message on WTP and quantity choices



Notes: Δ^* denotes significant difference at 5% and Δ^{**} denotes significant difference at 1% as tested by the Wilcoxon test for comparing paired sample of WTP. This comparison of WTP was made (1) for each product between successive rounds of messages, and (2) between different products for a same round of message.

The chart at the top details the average WTP represented on the Y-axis (and starting at €2), while the chart at the bottom details the average quantity of both products selected by participants for the basket of 5 products and represented on the Y-axis. The chart at the top of Figure 4 shows that the last message explaining the environmental and health benefit coming from high-quality beef only leads to a significant increase in the WTP of beef. The WTP for soy is not statistically influenced by this message revealed at round #6. The chart at the bottom of Figure 4 shows that chosen quantities between beef and soy at round #6 almost return to the initial quantities, chosen before the revelation of messages at round #1. However, the chosen quantity of beef at round #6 is slightly and significantly lower than the initial quantity of beef chosen at round #1. This reversal of chosen quantities towards more beef underlines the participants' sensitivity to the beef quality, when meat substitutes are considered by consumers. This confirms the importance of beef quality for consumers paying attention to environmental and health characteristics (see also Verbeke et al., 2010).

5. Conclusion

The explanatory messages on meat have a relatively minor impact on choices and WTP for a soy meat alternative. They significantly lead to a positive but small premium for soy burger meat. However, messages do not significantly change WTP for beef, even if beef is relatively “unsustainable”. This paper underlines a relatively strong attachment towards beef that hinders a shift towards a plant-based diet in France.

As shown in Figures 2, the limited impact of information on choices raises some questions about the opportunity of regulation. Providing generic explanations and recommendations on the impact of beef production and consumption could be useful for developing consumers' knowledge and sensitivity, but this is not the panacea for changing

behaviors. This low impact coming from explanatory messages may lead environmentalists and/or nutritionists in charge of regulation to turn to alternative instruments like a per-unit tax on beef and a per-unit subsidy on soy. Some simulations not detailed in this paper showed that a small prices variation of “+10/-10 cents” without revelation of messages may lead to a consumption similar to the one under perfect information. Obviously, going beyond this “light intervention” with higher prices variations would come from a paternalistic point of view, based on strong nutritionist and/or environmentalist opinions.

The low impact on WTP coming from explanatory messages seems confirmed by some empirical evidences coming from meat markets. Indeed, it is possible to wonder about the impact on meat demand coming from the report released in October 2015 by the WHO, showing a link between the excess of meat consumption and some cancers (see the *New York Times*, 2015 and the WHO, 2015). Recall that 71.7 % of participants attending our experiment heard about this report/press release. Observations of French consumption in 2015 and 2016 seem to show the absence of impact of this WHO report on the (red) meat consumption (Interbev, 2016).

Because of limitations of lab experiments, some extensions are possible for complementing the present paper. One type of extension would consist in changing some or all products that participants could face when choosing their WTP. We could enlarge the choice of both sustainable and unsustainable foods used in the experiment, with alternative offers of poultry, pork, milk or fish. More products to choose would enlarge the possible choices and trade-offs between pleasure and long-term sustainability, thus testing for the robustness of results. An alternative extension should consider field experiments with, for instance, advertising campaigns or booklets with recommendations given to consumers, before their supermarkets visits. Consumers would purchase real products, which should get rid of the hypothetical bias of WTP, elicited with multiple-price list in the present paper.

Despite limitations coming from our experiment, policies about meat sustainability should take into account the limited impact of information on choices and the relative consumers' unwillingness to replace meat.

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Appendix A: The multiple-price list for each product

For each product and each round, a multiple-price list was presented on a new paper sheet. After a brief presentation of the product (weight, content of fat) and one picture of the product (given in figure 1), the multiple-price list for one product was as presented as following:

Would you purchase the products at the following prices?

For each line check off either yes, no or maybe. Please check off only one option for each price.

	YES	NO	Maybe
€ 2.20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.30	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.40	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.50	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.60	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.70	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.80	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 2.90	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.30	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.40	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.50	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.60	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.70	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
€ 3.80	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix B: Quantity choice with the basket of 5 products

At the end of each round, each participant indicated their quantity choice on a new paper sheet. The paper sheet was organized as following:

If the 2 products were sold at the same price and if you should buy 5 products, how many products would you buy?

You are free to choose any combination leading to a total of 5 products.

In the right column, indicate the number of products you would choose:

Products

Number of products



+



Basket

= 5