Consumer choice related to meat/fish consumption and their possible replacement by plant-based products: results from lab experiments and cost-benefit analysis

Deliverable No. D2.5

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SUSFANS DELIVERABLES

The deliverable D2.5 analyzes results of lab experiments conducted in France and Italy. These results are used for determining a cost-benefit analysis on the basis of a model of diet changes induced by the adoption of nutritional and environmental recommendations. 3 working papers were written for precisely studying the issues of this deliverable.

Version	Release date	Changed	Status	Distribution
V1	30/03/2017		Final	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633692

SUSFANS Deliverable document information

Project name	SUSFANS
Project title:	Metrics, Models and Foresight for European SUStainable Food And Nutrition Security
Project no	633692
Start date:	April 2015
Report:	D2.5. Consumer choice related to meat/fish consumption and their possible replacement by plant-based products: results from lab experiments and cost-benefit analysis
Work package	WP 2
WP title (acronym):	Drivers and data: food consumption and diets
WP leader:	INRA, Stéphan Marette
Period, year:	April, 2017
Responsible Authors:	Stéphan Marette
Participant acronyms:	INRA
Dissemination level:	**Public**
Version	1
Release Date	30/3/2017
Planned delivery date:	30/3/2017
Status	Preliminary
Distribution	

Dissemination level of this report

Public

ACKNOWLEDGMENT & DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 633692. Neither the European Commission nor any person acting on behalf of the Commission is responsible for how the following information is used. The views expressed in this publication are the sole responsibility of the author and do not necessarily reflect the views of the European Commission.

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ABSTRACT

The deliverable D2.5 analyzes the results of lab experiments conducted in France and Italy. We 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. We conducted a lab experiment in France and Italy to elicit hypothetical WTP with a multiple-price list. 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 a very weak impact of successive rounds of messages on WTP for both beef and soy. However, these explanatory messages lead to a significant change in chosen quantities. These results are used for determining a cost-benefit analysis on the basis of a model of diet changes induced by the adoption of nutritional and environmental recommendations. We particularly show how both relative variations in willingness-to-pay (WTP) and relative variations in chosen quantities, following messages revealed in the lab, can be used for a welfare analysis. These variations are integrated in a market equilibrium model, as a possible demand shifter or as a non-internalized damage/benefit when consumers are ignorant. A related cost-benefit analysis studies the welfare impact of a nutritional recommendation or a tax mechanism. Results suggest that these regulatory tools have a significant impact on the variation of welfare and the reduction of beef consumption. 3 working papers provided in annex were written for precisely studying these issues of this deliverable.

INTRODUCTION

This deliverable D2.5 presents the results of the task T2.4. The deliverable is entitled "Consumer choice related to meat/fish consumption and their possible replacement by plant-based products: results from lab experiments and cost-benefit analysis."

The task T2.4 was written as following: "Analysis of consumers' choices related to meat/fish consumption and their possible replacement by plant-based products (INRA). A lab experiment focusing on meat, fish and starchy food will be organized in France and Italy, with messages on environment, nutrition and sustainability delivered to participants. The mechanism of the experiment will focus on substitutions among different products allowing elicitation of willingness to pay (WTP). The relative variations in WTP will be integrated in market equilibrium model as a possible demand shifter or as a non-internalized damage/ benefit when consumers are ignorant. Results of this model will contribute to WP9."

3 working papers were written for precisely studying the issues of this deliverable. The working papers #1 and #2 directly address the issues related the beginning of Task 2.4. The working paper #1 presents the results of the experiment conducted in France. The working paper #2 presents the results of the experiment conducted in Italy. The working paper #3 presents a cost-benefit analysis using results of both experiments.

This deliverable briefly presents the methods and the main results of these 3 working papers. These 3 working papers are provided in annexes.

METHODS

The methodology of the French and Italian experiments consists in (1) the selection of a few products sufficiently representative of purchasing habits, (2) the selection of relevant messages related to these products, (3) the practical organization of experiment(s), (4) the analysis of experimental results with a special attention given to the willingness-to-pay (WTP) for the products, (5) the integration of both WTP variations and quantity variations in a partial-equilibrium model for determining a cost-benefit analysis. These 5 steps provide an applied cost-benefit analysis that is useful for measuring the welfare impact related to new products. We now briefly present these 5 steps.

(1) The selection of a few products sufficiently representative of purchasing habits

The methodology consists in selecting a few products depending on the market configurations and the specificity of 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. Products were shown on pictures (see the second sections of working papers #1 and #2 in the annex).

For guaranteeing credibility, we showed products sold in supermarkets, where ground beef is always sold in France and in Italy. Conversely, finding plant-based products was difficult, since we faced a nascent market in 2015, with very few plant-based products sold in supermarkets.

We selected soy burger meat (200g) offering two steaks, 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.[1] As shown on figures 1 of working papers #1 and #2, 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

[1] At the time preceding the French experiment, 20 visits of supermarkets in the suburbs at the west of Paris search for the direct substitutes of ground beef steaks sold in supermarkets (without considering side dishes such as *Galettes* with cereals that do not have the shape of burger meat). *Sojasun* was the most offered plant-based product in 12 supermarkets offering these products. 8 supermarkets did not offer any plant-based substitutes of ground beef steaks, even if they offered a few *Galettes* of cereals that are side dishes and do not have the shape of burger meat.

participants declared that they never ate vegetarian or soy meat before coming to this experimental session.

Moreover, this soy burger meat offered by *Sojasun* was the only vegetarian burger brand sold in both countries, namely France and Italy. For the consistency across countries, it was important to select a similar brand showed on the picture across both countries. Additionally, in France and Italy, the brand *Sojasun* develops an "integrated supply chain approach" involving farmers with dedicated contracts, an approach that is not promoted for the production of beans or peas. Eventually, an interesting reason for considering soybeans is that soybeans have the highest protein delivery efficiency per energy use and per greenhouse gas emissions (see González et al., 2011). Moreover, from an agronomic point of view, soybean is among the crops that have the most obvious potential for soil health, since it is an excellent preceding crop for wheat or corn, because soybean is a natural source of nitrogen. In the experiment, we revealed a message on this effect related to the soybean as a natural source of nitrogen.

In France, the soy belongs to the "broad" classification of *starchy* food (translated by "féculent"). Under this French classification, starchy foods include the *pulses* (translated by "légumineuses") that integrate the soybean as clearly seen by Schneider and Huyghe (2015). This nomenclature differs from classifications in which soybeans are classified as an *oilseed* rather than a *pulse*, for instance, by the UN Food and Agriculture Organization. Even under this last classification, soy is a close substitute of other starchy foods. Among the group of starchy foods (in the standard nomenclature in France), the soybean burger is a natural meat substitute for animal protein. Other starchy foods like cereals, pasta, beans or peas appear more as a complement of meat than as a direct substitute for regular meals.

We decided to abstract from the fish and to only focus on the case between meat and the soy-based substitutes, for three reasons. First, fish was not replaced by another product in these experiments. The experimental design led us to drastically reduce the number of offered products for being very precise on messages revealed to participants. In other words, by focusing on two products, we provided many precisions in the revealed messages on the substitutions between these products. Adding fish to both beef and soy burger meats was unmanageable when messages were prepared. In particular, both food safety authority, EFSA and ANSES (respectively the European and French agency for food safety and environment), recommend to eat fish twice a week, with many consumers who did not comply with this advice. With fish, meat and a plant-based substitute in one experiment, the messages would have to explain the relative advantages of each product, without forgetting the

recommendation of eating fish twice a week, which would be very challenging to explain. The preparation of the experiment also revealed that the choice of fish species was sensitive and difficult, since there are important differences among fish species regarding environmental and nutritional impacts (see WWF, 2015). It was extremely difficult to select one fish, inside this WWF list detailing the fish to "favor", the fish to "moderate" and the fish to "avoid", regarding a sustainable consumption respecting the environment and the future fish stocks. Second, we restricted our attention on choices between beef and a plant-based substitute appearing as a burger meat. In supermarkets in France and Italy, no fish is sold as a burger "meat". Compared to both soy and beef burger meat, fresh fish or canned fish make the study of substitutions with burger meat less obvious. Third, in all public debates on public health and environment, the development of plant-based substitutes is generally seen as a possible replacement of meat only, and fish is almost never mentioned.

(2) The selection of relevant messages related to these products

For each session, a first round of WTP elicitation was realized without any message. For this first round, explanations about "the multiple-price list" mechanisms were given, with only a few indications describing each product (see working papers #1 and #2 given in appendix).

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 (see 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 revealed 1 message about health and beef, 1 message about health and soy, 1 message about environment and beef, and 1 message about environment and soy. These 4 messages were similar for the French and Italian experiments.

The order of these different messages was precisely controlled by equally varying the order of messages across 4 different groups G1 to G4 of participants. 2 groups started with health messages preceding environmental messages, and 2 other groups started with environmental messages preceding the health messages. 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. This last round #6 with WTP elicitation and quantity choices

was conducted for the beef with the *Red Label* and the soy. For Italy, we introduced a message on the absence of GMO feeding for beef, which is a big issue in Italy.

(3) The practical organization of the experiment(s),

We conducted the experiment in Dijon, of Burgundy in France, in multiple sessions in November 2015. We conducted the similar experiment in Milan, in Italy in multiple sessions in November 2016. For each experiment, a sample of 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.

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.

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 product for prices varying from €2.20 to €3.80 for each product (see working papers #1 and #2 in the annex). 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. This basket of 5 units is generally overlooked by previous approaches.

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.

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. The collected data on paper sheets were entered in computers by the authors.

(4) The analysis of experimental results with a special attention given to the willingness-to-pay (WTP) for the products

Classical statistical tools were used for analysing results. Regarding the WTP analysis, we used a random Tobit model, as 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).

(5) the integration of both WTP variations and quantity variations in a partial-equilibrium model for determining a cost-benefit analysis.

The relative variations in WTP and chosen quantities in the basket were integrated in a market equilibrium model as a possible demand shifter or as a non-internalized damage/ benefit when consumers are ignorant. Information and participants' reaction regarding choices allows to determine the non-internalize characteristics because of consumer's ignorance or lack of awareness. We develop a new methodology for integrating two measures for explaining the demand shifts, namely the variations in WTP following messages and the variation in chosen quantities. This is a new contribution compared to previous approaches developed by Lusk and Marette (2010), Marette et al. (2008 and 2011) and Rousu et al. (2014). We determine a cost-benefit analysis integrating results from the experiments (see the working paper #3).

RESULTS

The results of 3 working papers can be summarized as following.

The working paper #1 in annexes presents the results of the lab experiment conducted in France. Results can be summarized as following. 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 lead to significant 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.

The working paper #2 in annexes presents the results of the lab experiment conducted in Italy. Results can be summarized as following. We evaluate the impact of different types of information on participants' willingness-to-pay (WTP) and quantity choices for both beef and soy burger meat. At this end, we conducted a lab experiment in Italy to elicit hypothetical WTP with a multiple-price list. 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 a very weak impact of successive rounds of messages on WTP for both beef and soy. However, these explanatory messages lead to a significant change in chosen quantities. The relative changes in chosen quantities are larger than the relative changes in WTP. The introduction of a beef with the label "Fed without GMO" underlines a weak impact of this label on changes in participants' preferences.

The working paper #3 in annexes presents a cost-benefit analysis using results of experiments focusing on meat and a plant-based product. Results can be summarized as following. This paper shows how both relative variations in willingness-to-pay (WTP) and relative variations in chosen quantities, following messages revealed in the lab, can be used for a welfare analysis. These variations are integrated in a market equilibrium model, as a possible demand shifter or as a non-internalized damage/benefit when consumers are ignorant

about the products characteristics studied in the lab. This methodology is applied to an experiment focusing on potential substitutions between beef and plant-based substitutes. A related cost-benefit analysis studies the welfare impact of a nutritional recommendation or a tax mechanism for France and Italy. Results suggest that these regulatory tools have a significant impact on the variation of welfare and the reduction of beef consumption. We also show that the omission of one of these two variations coming from the lab lead to important biases in the welfare estimations.

These 3 working papers provide evidences regarding possible changes in meat consumption. These results were used for determining a cost-benefit analysis on the basis of a model of diet changes induced by the adoption of nutritional and environmental recommendations. The model of diet changes presented in the working paper #3 is very simple, with only demands for fresh ground beef and plant-based substitutes. This simplicity allows to underline main mechanisms as shown in figure 1 of the working paper #3. However, the methodology could be extended to a more complete model of consumption and diet.

Results of these papers were determined in a lab context that is useful for eliciting well-informed, thoughtful preferences. However, this advantage is hobbled by limitations stemming from the artificial environment and the limited number of products (or payoffs) at stake, while real-life choices are multi-tasks and imply quick decisions under uncertainty, imperfect information, tasks overload and/or imperfect recall. As underlined by behavioral economists, many factors may sway the determination of preferences. The lab results provide upper bounds regarding the possible shifts in demand coming from revelations of messages (Marette et al., 2011).

In real contexts, the main limit of recommendations, labels, or warnings comes from the imperfect recall by consumers, and their possible confusion between good and bad characteristics related to products, as soon as the information given is technical or complex. Furthermore, a tendency toward the proliferation of labels is observed, with in particular, the multiplication of claims on health, environment and/or sustainability, which may limit the impact of labels for helping consumers (Marette, 2010). The alternative mechanism *of taxation and/or subsidy* is a regulatory option based on a price impact on the consumers' choices, since prices are affected by a tax/subsidy per unit sold (Marette et al., 2008). If taxes aim at limiting the purchases of dangerous or unsustainable products, the revenue that they generate creates a tax resource available for subsidising sustainable products or other actions such as information campaigns. The tax/subsidy are studied in the working paper #3 as a credible possibility.

Results of this deliverable can be taken into account by other WP in Susfans. In T2.4, it was written that "The relative variations in WTP will be integrated in market equilibrium model as a possible demand shifter or as a non-internalized damage/ benefit when consumers are ignorant. Results of this model will contribute to WP9." This deliverable 2.5 directly contributes to the framework for modelling scenarios in WP9 on the replacement scenarios for meat versus other products. The methodology presented in the working paper #3 can be extended to the demands for meat in the model used in the WP9.[2] The relative variations in both WTP and chosen quantities in France and in Italy can be used in this WP9 model. Eventually, the deliverable is also transferred to the WP5 for quantification of innovation pathways on reduced total meat consumption under D5.2.

[2] Beyond these 3 working papers in annexes and the specific experiments about beef versus plant-based, the methodology can be applied with data found on the web or via a meta-analysis. These data often concern the WTP variations only, but the methodology of the working paper #3 can be applied as shown in table 3 of this working paper #3. Additional details will be also found in the following papers, Disdier and Marette (2012), Lusk and Marette (2010), Marette et al. (2008 and 2011), Roosen and Marette (2011) and Rousu et al. (2014).

CONCLUSIONS

The deliverable D2.5 analyzed the results of lab experiments conducted in France and Italy. Results showed a very weak impact of successive rounds of messages on WTP for both beef and soy. However, these explanatory messages led to a significant change in chosen quantities. These results were used for determining a cost-benefit analysis. Results suggest that these regulatory tools have a significant impact on the variation of welfare and the reduction of beef consumption. The deliverable clearly shows that experimental results can be used for determining a cost-benefit analysis.

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ANNEXES

- Working paper #1
  Can Information about Health and Environment Beef Up the Demand for Meat Alternatives?

- Working paper #2
  The Impact of Information on Willingness to Pay and Quantity Choices for Meat and Meat Substitute

- Working paper #3
  Welfare Impact of Information with both Variations in Willingness-to-Pay and Variations in Chosen Quantities coming from a Lab Experiment

Working paper #1

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

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Acknowledgements: We thank Thom Achterbosch for his comments. We thank Fabienne Bouillot and Christophe Martin for the recruitment of participants and their help in the laboratory. The research leading to these results received funding from the European Union's H2020 Program under Grant Agreement number 633692 (SUSFANS: Sustainable food and nutrition security through evidence based EU agro-food policy, details on http://www.susfans.org/). The author only is responsible for any omissions or deficiencies.

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

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 lead to significant 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 lead to significant 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

[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.

beef. The 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 $R = \{1,\ldots,6\}$, 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,...,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

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

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

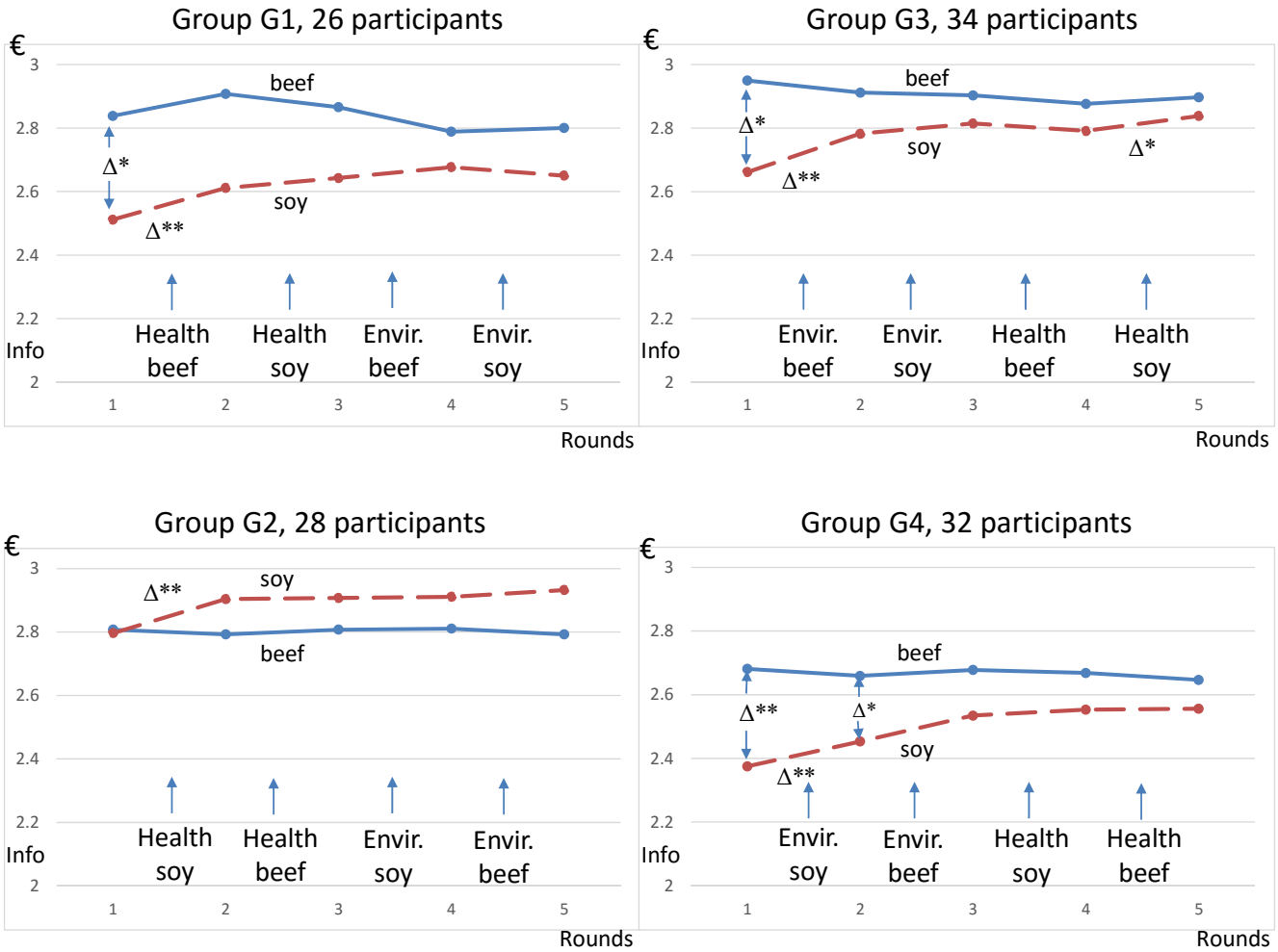
This section presents analysis of both WTP and demands/choices for regular beef and soy. The introduction of the high-quality beef will be only considered at the end of this section.

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,...,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**	2.776**	2.847**	2.675**
	(0.020)	(0.074)	(0.020)	(0.055)
Message received first (1/0) at round #2	−0.005	−0.006		
	(0.026)	(0.022)		
Message received second (1/0) at round #3	−0.008	−0.015		
	(0.026)	(0.022)		
Message received third (1/0) at round #4	−0.034	−0.043		
	(0.026)	(0.022)		
Message received fourth (1/0) at round #5	−0.035	−0.039		
	(0.026)	(0.022)		
Message about health and beef (1/0)			−0.015	−0.016
			(0.026)	(0.023)
Message about health and soy (1/0)			−0.015	−0.022
			(0.026)	(0.023)
Message about environment and beef (1/0)			−0.025	−0.033
			(0.026)	(0.023)
Message about environment and soy (1/0)			−0.026	−0.027
			(0.026)	(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**		−0.075**
		(0.043)		(0.021)
Age [b]		−0.011**		−0.006**
		(0.001)		(0.001)
Education (1: no certificate to 6: PhD) [b]		0.032*		0.128**
		(0.013)		(0.009)
Monthly net income, from 1 for income < €1000 to 7 for income > €6000 [b]		0.084**		−0.022**
		(0.009)		(0.008)
Stand. devi ε	0.205**	0.169**	0.206**	0.175**
	(0.006)	(0.004)	(0.006)	(0.005)
Stand. dev. μ	0.372**	0.328**	0.372**	0.300**
	(0.007)	(0.007)	(0.007)	(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**	3.162**	2.842**	2.462**
	(0.020)	(0.051)	(0.020)	(0.062)
Message received first (1/0) at round #2	0.101**	0.105**		
	(0.021)	(0.024)		
Message received second (1/0) at round #3	0.140**	0.137**		
	(0.021)	(0.024)		
Message received third (1/0) at round #4	0.146**	0.146**		
	(0.021)	(0.024)		
Message received fourth (1/0) at round #5	0.160**	0.159**		
	(0.021)	(0.024)		
Message about health and beef (1/0)			0.132**	0.127**
			(0.021)	(0.024)
Message about health and soy (1/0)			0.150**	0.148**
			(0.021)	(0.024)
Message about environment and beef (1/0)			0.144**	0.144**
			(0.021)	(0.024)
Message about environment and soy (1/0)			0.120**	0.127**
			(0.021)	(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**		−0.061*
		(0.020)		(0.024)
Age [b]		−0.004**		−0.001
		(0.001)		(0.001)
Education (1: no certificate to 6: PhD) [b]		0.017*		0.039**
		(0.007)		(0.009)
Monthly net income, from 1 for income < €1000 to 7 for income > €6000 [b]		0.007		−0.006
		(0.009)		(0.009)
Stand. devi ε	0.169**	0.186**	0.169**	0.185**
	(0.004)	(0.005)	(0.005)	(0.005)
Stand. dev. μ	0.297**	0.401**	0.297**	0.377**
	(0.005)	(0.007)	(0.005)	(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 elicitations 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 26th, 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

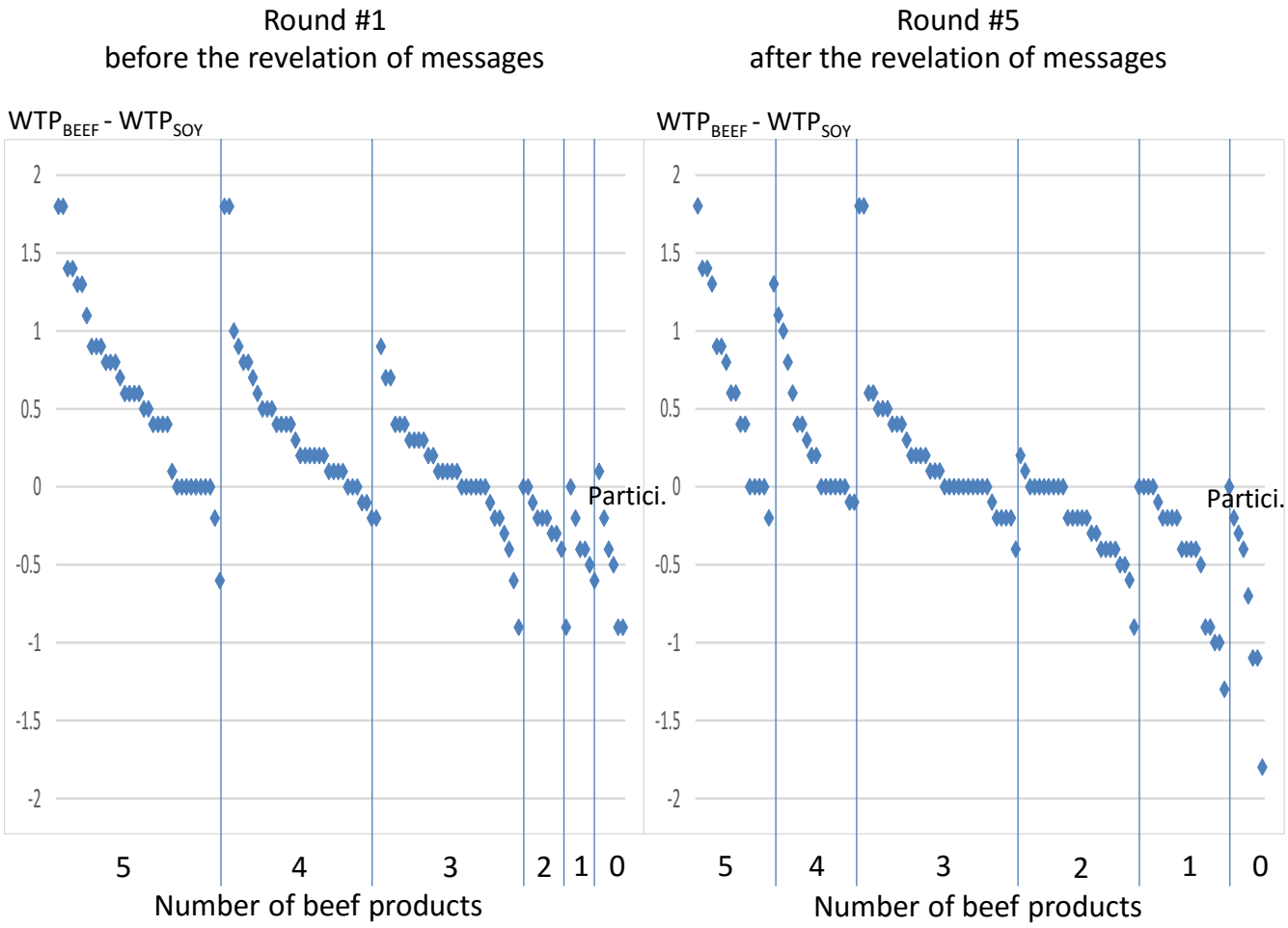
We now turn to the study of the basket of 5 products chosen by participants after the elicited WTP. Recall that for these quantity choices, participants chose a basket of 5 units at each round (see Appendix B). The quantity choices of baskets are made (1) without any posted prices, and (2) for an overall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

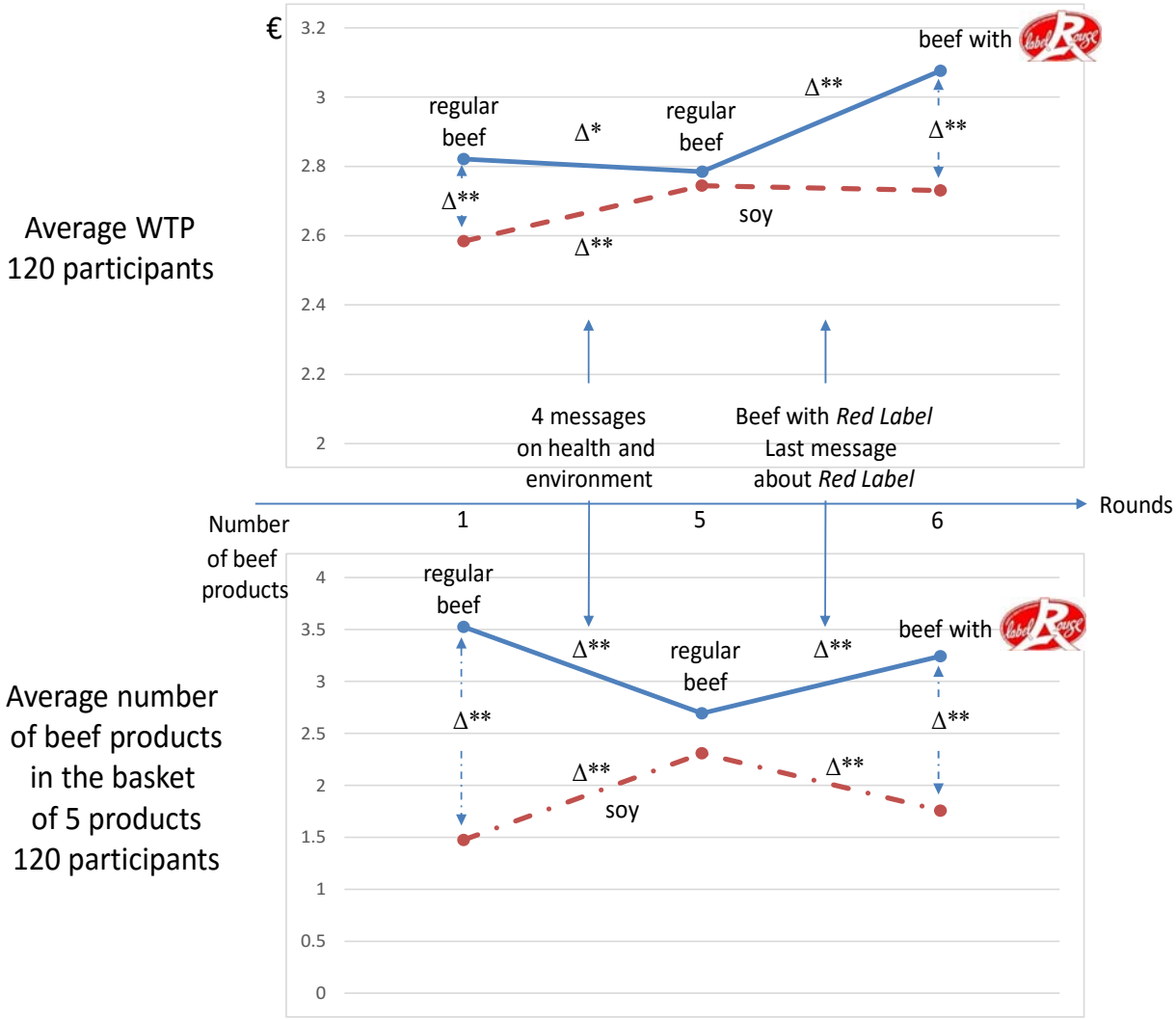


3.3. The introduction of high-quality beef

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	□	□	□
€ 2.30	□	□	□
€ 2.40	□	□	□
€ 2.50	□	□	□
€ 2.60	□	□	□
€ 2.70	□	□	□
€ 2.80	□	□	□
€ 2.90	□	□	□
€ 3	□	□	□
€ 3.10	□	□	□
€ 3.20	□	□	□
€ 3.30	□	□	□
€ 3.40	□	□	□
€ 3.50	□	□	□
€ 3.60	□	□	□
€ 3.70	□	□	□
€ 3.80	□	□	□

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**

Working paper #2

The Impact of Information on Willingness to Pay and Quantity Choices for Meat and Meat Substitute

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The research leading to these results received funding from the European Union's H2020 Program under Grant Agreement number 633692 (SUSFANS: Sustainable food and nutrition security through evidence based EU agro-food policy, details on http://www.susfans.org/). We thank Lavinia Gaia Bulla and Federica Faggioli for their precious assistance in the lab in Milan. The authors only are responsible for any omissions or deficiencies.

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The Impact of Information on Willingness to Pay and Quantity Choices for Meat and Meat Substitute

Abstract

We evaluate the impact of different types of information on participants' willingness-to-pay (WTP) and quantity choices for both beef and soy burger meat. At this end, we conducted a lab experiment in Italy to elicit hypothetical WTP with a multiple-price list. 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 a very weak impact of successive rounds of messages on WTP for both beef and soy. However, these explanatory messages lead to a significant change in chosen quantities. The relative changes in chosen quantities are larger than the relative changes in WTP. The introduction of a beef with the label "Fed without GMO" underlines a weak impact of this label on changes in participants' preferences.

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

1. Introduction

Breeding beef cattle implies an intensive land use and leads to high greenhouse gas emission levels (Westhoek et al., 2014). Moreover, an excess of meat consumption is linked to diets characterized by relatively high intakes of fats, saturated fatty acids and salt, and by relatively low intakes of dietary fiber, vitamins and micronutrients. Ultimately, several studies have found a positive relationship between meat consumption and both cancer and cardiovascular disease mortality (Lock et al., 2010, and Wein, 2012).

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). Many developed countries are characterized by overconsumption of animal-based proteins, while health and environmental benefits coming from plant-based proteins are overlooked by many consumers. Given the persistence in eating habits, the changes towards more sustainable diets, aiming at reducing meat consumption, are difficult to achieve. Besides traditional policies, such as meat taxation, another solution consists in revealing messages on long-term consequences of consumption habits on environment and health.

This paper aims at evaluating the impact of providing some explanatory messages about health and environment on consumers' willingness-to-pay (WTP) for a meat product and a plant-based substitute. Specifically, we conduct a lab experiment to analyse consumers' choices between beef and soy burger meat. We select these two products for several reasons. First of all, given the two products have strong similarities in appearance, they are potentially close substitutes. Another reason is that beef (respectively soybean) is one of the products with the lowest (respectively highest) protein efficiency per greenhouse gas emissions

(González et al., 2011). Last, soy burgers were introduced on the market before and after the time of the experiment.

The lab experiment was run with 127 participants in November 2016 in Milan, Italy. Willingness to pay (WTP) and choices between these different products were elicited providing different rounds of information. Explanatory messages about the impact of beef and soybean on health and environment were sequentially revealed to participants. The order of messages varied across sessions, each 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]

Results show a very weak impact of successive rounds of messages on WTP for both beef and soy based products. Indeed, between the first and the fifth round, we measure a relative decrease of WTP for beef equals to −1.55%, and a relative increase of WTP for soy based product equals to +3.59%. These explanatory messages lead to a significant change in chosen quantities, with an average shift of 0.764 units from beef units towards soy units within a basket of 5 units.

[1] Even if hypothetical WTPs are likely to be upward biased, recent contributions seem 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.

Our results show a larger relative change in chosen quantities than in WTP. From the first to the fifth round, we measure relative variations for the chosen quantity of beef and soy respectively equal to −23.03 % and +45.55%, versus −1.55% and +3.59% for the respective WTP of beef and soy. Eventually, the introduction of a beef with the label "Fed without GMO" underlines a weak impact of this label on changes in participants' preferences.

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, and Graça et al., 2015). However, our present paper focusing on WTP differs from previous non-economic studies focusing on meat replacement without any monetary values. 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 that higher education or higher socio-economic status influence the variations of WTP for beef and soy based product. This last result differs from some previous studies which support significant relationship between socio-demographic variables and consumers' attitudes to reduce meat purchases (Krystallis et al., 2012).

The present paper also differs from many previous economic papers, since we measure the WTP for one unit of different types of products (i.e.; beef and soy burgers). Moreover, previous studies did not compare the impact of information on both WTP and on the number of products chosen (see Lusk and Shogren, 2007, for a complete overview). Conversely, by studying both WTP and quantity choices, we notice that the impact of information is stronger when we refer to relative changes in chosen quantity rather than relative changes in WTP. Indeed, this aspect has been overlooked by previous studies. One

possible explanation is that making choices for a basket of products under different contexts of information is maybe more natural and immediate than determining WTP for products, which can result more artificial.

The paper is organized as follows. In paragraphs two and three we describe the protocol and the results of the experiment. We present discussions and conclusions in paragraph four.

2. The experiment

The sample

We conducted the experiment in Milan, Italy, in multiple sessions in November 2016. A sample of 127 participants was randomly selected based on the quota method, and was representative for age groups and socio-economic status of 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. Participants were compensated with a purchasing coupon of the value of €15. 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.

Because of incomplete replies, observations related to 8 participants were discarded for the rest of this paper. Therefore, the rest of this paper only takes into account the replies of 119 participants.

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

Beef burger meat

Soy burger meat

As shown on figure 1, the two products presented to participants are the following: The first product isa 250 g vacuum packed fresh ground beef with two steaks and no brand indication, since ground beef is a widespread product, sold under different brands including supermarket brands. The other product is a pack of *Sojasun* soy burger (200g) offering two patties. We selected this product, because, before the experiment, several supermarkets visits identified *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 based product was made with soybeans produced in Italy without Genetically Modified Organisms (GMO). One steak contained 63.6% of soy ingredients and the rest was made with various vegetables. 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 had never eaten vegetarian or soy meat before coming to this experimental session.

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.

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 focus the attention to products, messages mentioned either the term “beef” or the term “red meat”, without indicating some other types of meat. For the impacts on environment, both messages insisted on the relative performances of both products. Following González et al. (2011), with figures 2 and 3 p. 568, we underline that soybeans have the highest protein delivery efficiency per energy use and per greenhouse gas emissions, while beef is one of the products with the lowest protein efficiency.

The four messages translated from the Italian 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.
>
> Nutritionists recommend 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 100 g-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 pollution 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 or corn).

- An improvement of the soil structure.

However soybean is little cultivated in Italy 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 Italian 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 1. Groups depending on the order of messages

Messages	Order of messages related to products	
	Beef/Soy	Soy/beef
Health and Environment	**G1**	**G2**
	30 participants	32 participants
Environment and Health	**G3**	**G4**
	29 participants	28 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. Participants were randomly allocated to one of 4 groups before coming to a session. Table 1 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, for a total of 119 participants with valid entries.

Message on GMOs

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 label "Fed without GMO", posted close to the picture and with a few explanations in the following message.

"In Italy most of the animal feed contains genetically modified ingredients (GMOs).

Until now, it has not been shown that the use of GM feed influences animals' health and productivity.

In addition, meat, milk, eggs and other products derived from animals fed with GMOs feed do not have different characteristics than the corresponding products produced by animals fed with conventional feed.

However, some manufacturers have voluntarily decided to strictly avoid GMOs in animal feed destined to become fresh meat of cattle, pigs and poultry."

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 product displayed for prices varying from €2.20 to €3.80 per unit. Prices ranges, for both products, were selected based on a supermarket survey in the Milan area. The average observed price was equal to €2.60 for the beef burger meat and to €2.90 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.

Participants were asked to fill out 17 lines for each product, as shown in the appendix A. For each price, they had to select either "yes", "no" or "maybe" regarding their purchase intents. For each product and each round of choice R with $R = \{1,\ldots,6\}$, 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 price associated to "yes" was recorded as the WTP for the analysis.[2]

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

[2] This paper only considers WTP with the highest "yes" for the 120 participants. Among them, 29 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.

participants. They controlled for this effect by changing the boundaries of the multiple-price 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 provision and after the 2 multiple-price lists, filled in for each product, each participant were asked to compose a basket with 5 units of beef and/or soy, as shown in appendix B. 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.[3].

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 carefully explained that no product would 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

[3] 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.

list for soy, leading to both WTPs of round #1. Then the choice of the basket with 5 products was introduced, explained and filled out by participants.

The following 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" were indicated. At the end of a session, after the round #6, participants filled in an exit questionnaire and received the €15 indemnity.

3. Results

This section presents analysis of both WTPs and demands/choices for regular beef and soy. The introduction of the beef "Fed without GMO" at round #6 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 1 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 in table 1. 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.

Figure 1. Average WTP (in €) for beef and soy meat alternatives

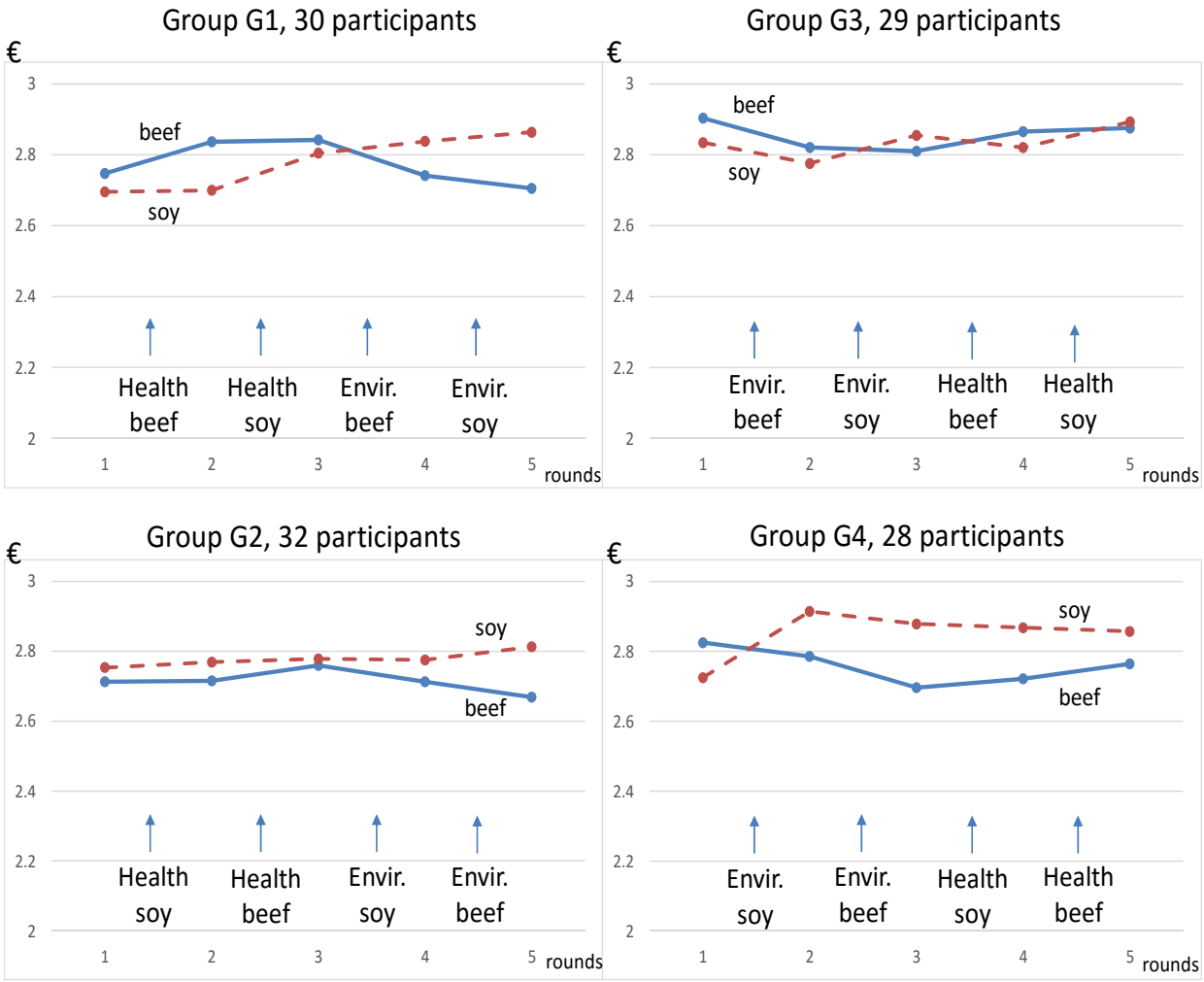

Figure 1 shows that, before the revelation of explanatory messages, namely at round #1, the average WTPs for beef is very close to the average WTPs for soy. It means that the soy burger meat can be seen as a relatively "close" substitute, with a possible extension of its market share if the price of beef substantially increases. Note that, at the time of the experiment, the very low market share of soy/vegetarian burger meat in Italy can be explained by: (1) the pure absence of soy products in many stores; (2) the average price of soy burger (around €3 in Italian store) was higher than the average price of fresh burger beef (around €2.4); (3) the weak knowledge of consumers; (4) their strong rigidity to change dietary habits.

Figure 1 also shows that the impacts of information on WTP for both products are small (recall that the Y-axis starts at €2 for facilitating the views of variations). Indeed, between the first round and the 5th round, and by including the 119 participants, the relative decrease of WTP for beef is equal to −1.55%, and the relative increase of WTP for soy is equal to +3.59%. After the revelation of successive messages (round #5), the average WTP for soy meat becomes a little bit higher than the average WTP for beef (except for group G3). Figure 1 underlines the limited impact of messages on the WTP variations for both products. One possible explanation is the strong attachment to the meat consumption that characterized Italian and Western diet.

Table 2. Estimations of pooled WTP for beef and soy with a Tobit random effects estimator

	WTP for beef		**WTP for soy**	
Constant	2.447**	2.465**	2.834**	2.696**
	(0.077)	(0.068)	(0.051)	(0.046)
Message received first (1/0) at round #2	−0.011		0.038	
	(0.024)		(0.028)	
Message received second (1/0) at round #3	−0.016		0.077**	
	(0.024)		(0.028)	
Message received third (1/0) at round #4	−0.025		0.073**	
	(0.024)		(0.028)	
Message received fourth (1/0) at round #5	−0.051*		0.107**	
	(0.024)		(0.028)	
Message about health and beef (1/0)		0.006		0.042
		(0.024)		(0.031)
Message about health and soy (1/0)		−0.005		0.086**
		(0.024)		(0.031)
Message about environment and beef (1/0)		−0.054*		0.080**
		(0.024)		(0.031)
Message about environment and soy (1/0)		−0.050*		0.106**
		(0.024)		(0.031)
Sex (1: man, 0: woman) [a]	0.125**	0.135**	−0.253**	−0.104**
	(0.032)	(0.041)	(0.035)	(0.028)
Age [a]	0.003**	0.003**		−0.005**
	(0.001)	(0.001)		(0.001)
Education (1: no certificate to 6: PhD) [a]	0.075**	0.076**	0.029*	0.037**
	(0.013)	(0.009)	(0.012)	(0.009)
Monthly net income, from 1 for income <	−0.013	−0.020	0.017	0.082**

€1000 to 7 for income > €6000 [a]	(0.017)	(0.019)	(0.010)	(0.008)
Stand. devi ε	0.186**	0.185**	0.219**	0.241**
	(0.005)	(0.005)	(0.006)	(0.008)
Stand. dev. μ	0.291**	0.291**	0.368**	0.536**
	(0.009)	(0.010)	(0.012)	(0.018)
Observations	N=595	N=595	N=595	N=595
Log likelihood	−7.459	−4.212	−96.882	−164.621

Note: **: significant at 1%; *: significant at 5%. Standard errors in parentheses. [a] Question from the exit questionnaire.

To precisely measure the impact of messages on the WTP for each product, we pooled the participants' WTP elicited in five successive rounds $R=\{1,...,5\}$, and we use a Tobit random effects estimator, with dummy variables for each round of messages. The random effect imposes constraints on the structure of the variance-covariance matrix. Furthermore, WTP cannot be negative and it is left-censored at €2.10 and right-censored at €3.90;this justifies the use of the random effects Tobit estimator.

Our results show a limited impact of successive messages on WTP for beef (Table 2). Only the 4th message (1st column) or the ones on the environment (2nd column) have a significant and negative impact on the WTP for beef. However, the magnitude of these coefficients is very low if compared to the constant, suggesting relatively solid preferences for meat. Results show a stronger effect of information for soy based products rather than for the beef (compare 3rd versus 1st and the 4th and the 2nd columns of Table 2). The messages providing information about environment and health and soy have a significant impact on the WTP for a soy based product, even if the coefficients of these significant variables are also relatively low compared to the constant. The bottom of table 2 shows that socioeconomic variables, as the age or the sex, play a significant but minor role on the WTP.

This result of the weak impact of messages on WTP was also verified with some other specifications, not reported in table 2, including the specification in which the four dummies for the order of information were interacted with the four dummies indicating the type of

messages. As robustness check of econometric estimations of both tables, we also 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. The results of table 2 are consistent with previous results underlining the low impact of sustainability labels on consumers' choices (see Grunert et al., 2014).

3.2. The chosen baskets of 5 products

We now analyze the effect on a basket of 5 products chosen by participants after WTP was elicited. Recall that for these quantity choices, participants chose a basket of 5 units at each round. 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.

Table 3. Variations of selected quantities of products

Between the 1st round and the 5th round	**Beef**	**Soy**
Absolute variation of quantities [a]	−0.764	+0.764
Relative variation of quantities [a]	−23.03 %	+45.55 %
Relative variation of WTP	−1.55 %	+3.59 %

Note: [a] within the basket of 5 products

Table 3 shows that the explanatory messages lead to a relatively significant change in chosen quantity, with an average shift of 0.764 units from beef units towards soy units within this basket of 5 units. However, the relative change in chosen quantities is larger than the relative changes in WTP. Between the first round and the fifth round with last message, the relative variations for the chosen quantity of beef and soy are respectively equal to −23.03 % and +45.55%, versus −1.55% and +3.59% for the WTP of beef and soy. This is an interesting result, since this difference between WTP variations and quantities variations regarding the impact of messages was generally overlooked by previous papers.

Table 4. Estimations of pooled quantity choice for beef with an ordered Probit estimator with random effects

	Quantity of beef	
Constant	2.581**	2.564**
	(0.261)	(0.260)
Message received first (1/0) at round #2	−0.344*	
	(0.136)	
Message received second (1/0) at round #3	−0.466**	
	(0.136)	
Message received third (1/0) at round #4	−0.594**	
	(0.136)	
Message received fourth (1/0) at round #5	−0.682**	
	(0.137)	
Message about health and beef (1/0)		−0.389**
		(0.136)
Message about health and soy (1/0)		−0.488**
		(0.136)
Message about environment and beef (1/0)		−0.621**
		(0.137)
Message about environment and soy (1/0)		−0.581**
		(0.136)
Sex (1: man, 0: woman) [a]	0.512**	0.511**
	(0.089)	(0.089)
Age [a]	−0.004	−0.004
	(0.002)	(0.002)
Education (1: no certificate to 6: PhD) [a]	0.042	0.042
	(0.043)	(0.043)
Monthly net income, from 1 for income < €1000 to 7 for income > €6000 [a]	0.029	0.029
	(0.037)	(0.037)
μ_1 [b]	1.341**	1.329**
	(0.152)	(0.150)
μ_2 [b]	2.257**	2.241**
	(0.158)	(0.156)
μ_3 [b]	2.926**	2.908**
	(0.161)	(0.160)
μ_4 [b]	3.624**	3.606**
	(0.167)	(0.166)
Observations	N=595	N=595
Log likelihood	−915.47	−917.25

Note: **: significant at 1%; *: significant at 5%. Standard errors in parentheses.
[a] Question from the exit questionnaire. [b] Latent variables related to discrete choices of products.

In table 4, an ordered Probit estimation with random effect shows the significant impact of information on the choice of meat units. An ordered Probit model is tailored to our

configuration because the six possibilities of choices between foods selected in the basket correspond to an ordinal dependent variable. We remind the reader that the choice of soy is the complement of the chosen meat relative to five items, which represents the number of products selected in each basket. Every round of information (1st column) and every type of information (2nd column) have a significant impact on the reduction of the chosen quantity of beef and the increase of the chosen quantity of soy. Compared to table 2, this table 4 confirms the higher sensitivity to the information with chosen quantities than with WTP. However, the reader should keep in mind that this measure of 5 units in the basket is useful for complementing WTP, but also fragile since the alternatives of choices are narrow.

3.3. The impact of a beef without GMO feeding

We now turn to the study of the WTP and the basket of 5 products chosen by participants, after the introduction of the beef with the label "Fed without GMO" at the round #6. Table 4 shows how this label sways the WTP and the chosen quantities.

Table 4. Relative variations of WTP and selected quantities

Between the 5th round and the 6th round	Beef	Soy
Relative variation of WTP	+2.33 % **	+0.19 %
Relative variation of quantities [a]	+1.38 %	−1.38 %

Note: [a] within the basket of 5 products, ** denotes significant difference at 1% as tested by the Wilcoxon test for comparing paired sample of WTP or quantities.

Table 4 underlines the weak impact of this last message on participants' preferences. Only the increase of WTP for beef is statistically significant, but this increase is relatively small. For the WTP of beef, the increase of 2.33% offsets the small decrease of 1.55% observed between the 1st round and the 5th round, as shown by the last line of table 3. For other variables of table 4, variations are not statistically significant as tested by Wilcoxon test

for comparing paired sample. Providing a label "Fed without GMO" does not drastically "upset" quantity choices towards more beef compared to soy. In other words, there is no major reversal of preference linked to better feeding of animals and, ultimately, better quality.

5. Conclusions

The explanatory messages on meat and plant-based substitute have a relatively minor impact on products' choices and a very small one on WTP. This underscores an interest for soy burger meat that cannot however replace the habit to eat meat. This paper underlines a relatively strong attachment towards beef that hinders a shift towards a plant-based diet in Italy.

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. While the lab allows a tight control of revealed information and consumers' attention to this revealed information, the main shortcoming of informative campaigns in a real context lies in the imperfect recall of consumers and the possible confusion as soon as the information given is technical or complex. This low impact coming from explanatory messages in real context 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, based on a welfare approximation (as presented by Roosen and Marette, 2011) and using these Italian WTP, simply shows that the optimal Pigouvian per-unit tax is equal to zero, since the impact of information is very low.

Despite limitations coming from our experiment, policies about meat sustainability should take into account the limited impact of information on choices and the relative Italian 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:

[Picture of the product]

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	□	□	□
€ 2.30	□	□	□
€ 2.40	□	□	□
€ 2.50	□	□	□
€ 2.60	□	□	□
€ 2.70	□	□	□
€ 2.80	□	□	□
€ 2.90	□	□	□
€ 3	□	□	□
€ 3.10	□	□	□
€ 3.20	□	□	□
€ 3.30	□	□	□
€ 3.40	□	□	□
€ 3.50	□	□	□
€ 3.60	□	□	□
€ 3.70	□	□	□
€ 3.80	□	□	□

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**

Working paper #3

Welfare Impact of Information with both Variations in Willingness-to-Pay and Variations in Chosen Quantities coming from a Lab Experiment

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Abstract: This paper shows how both relative variations in willingness-to-pay (WTP) and relative variations in chosen quantities, following messages revealed in the lab, can be used for a welfare analysis. These variations are integrated in a market equilibrium model, as a possible demand shifter or as a non-internalized damage/benefit when consumers are ignorant about the products' characteristics studied in the lab. This methodology is applied to an experiment focusing on potential substitutions between beef and plant-based substitutes. A related cost-benefit analysis studies the welfare impact of a nutritional recommendation or a tax mechanism for France and Italy. Results suggest that these regulatory tools have a significant impact on the variation of welfare and the reduction of beef consumption. We also show that the omission of one of these two variations coming from the lab lead to important biases in the welfare estimations.

Keywords: Experimental Economics, Cost-Benefit Analysis, Meat Consumption, Tax

1. Introduction

Many studies elicit consumers' or citizens' willingness-to-pay (WTP) via lab experiments. However, as such a measure is fragile, it can be complemented by other measures. In particular, determining WTP for one unit is not a classical routine for consumers when they purchase goods in supermarkets. Choosing a basket of goods can be a more natural way of choosing products compared to a WTP elicitation for one unit. Getting a quantity measure from the lab can be also precious for improving welfare measures.

This paper focuses on the integration of both WTP and chosen quantities elicited in a lab in a partial equilibrium model, for determining welfare impacts of a regulatory instrument, namely an informative campaign or a tax.

The approach relies on a combination of an elasticity of demand coming from time-series economics and values obtained from experiments. With a partial equilibrium model used for welfare analysis, we show how to take into account the purchased quantity variations with the integration of WTP to evaluate the damage for consumers. In other words, both relative variations in WTP and quantity choices are integrated in a market equilibrium model for measuring a non-internalized damage/benefit when consumers are ignorant. This methodology is a basis for an accurate cost-benefit analysis.

We illustrate how the methodology can be applied with an experiment focusing on choices between meat and plant-based substitutes. The lab experiment was conducted in France and in Italy, 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. Quantity choices are overlooked by many experiments detailing WTP only. 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.

The related cost-benefit analysis studies the welfare impact of a recommendation or a tax mechanism. Results suggest that these optimal regulatory tools have a significant impact on the variation of welfare (+10.5% for France and +9.7% for Italy) and the reduction of beef consumption (-23.6% for France and -23% for Italy). We also show that the omission of one of these two variations coming from the lab lead to important biases in the welfare estimations.

This paper adds to the experimental literature by providing the integration of two variations coming from the lab as demand shifters. This is an important difference with previous papers, in which the welfare impact of information was based on the WTP variation only, as analyzed by Huffman et al. (2007), Lusk et al. (2005), Lusk and Marette (2010), Marette et al. (2008), Masters and Sanogo (2002), Rousu et al. (2007) and Rousu et al. (2014). These previous studies are important for public debate, but relying on two measures as in the present paper may strengthen the robustness of experimental data. Our paper with lab data also differs from the paper by Marette et al. (2011) combining data from lab and field experiments for a cost-benefit analysis, taking into account different knowledge coming from different contexts related to the lab and the field. Conversely, the present paper estimates different variations of the demand curve, namely at different parts of this demand, but for a same context of information. Eventually, the tax studied in the cost-benefit analysis, is based on preferences, and not on a CO2 equivalent tax policy, as computed by many authors, including Bonnet et al., 2016 and Wirsenius et al., 2011.

The next section introduces the theoretical framework used for estimating welfare changes with both market and experimental data. Section 3 describes the experiments focusing on beef and a plant-based substitute. Section 4 details the results detailing the applied welfares estimation linked to different instruments. The last section presents some extensions and concludes.

2. A Simple Model for Integrating some Lab Results

We now present a simple model focusing on consumer's demand for one specific product. Extensions and amendments related to this simple model will be discussed at the end of this paper. We detail the demand of a consumer *i* with *i={1,…, N}*, where *N* is the overall number of consumers. Individual demand of a consumer *i* is derived from a quasi-linear utility function that consists of the quadratic preference for the market good of interest and is additive in the numeraire:

$$U_i(q_i, w_i) = aq_i - (\bar{b} + I_i v_i) q_i^2 / 2 - I_i r_i q_i + w_i \qquad (1)$$

where q_i is the consumption of the specific product. The parameters $a, \bar{b} > 0$ allow to capture the immediate satisfaction from consuming products and w_i is the numeraire good.

The non-internalized effects coming from the product are captured by the terms $-I_i r_i\ q_i$ and $I_i v_i$. The parameter I_i represents the consumer knowledge regarding the benefit/damage (linked to the information revealed to consumers). If the consumer is not aware of characteristic(s) at the time of the purchase, then I_i=0. Conversely, I_i=1 means that the consumer is aware of the characteristic(s) and internalize it in the consumption. The parameters r_i and v_i are the parameters accounting for the benefit/damage linked to the characteristics revealed to consumers. If the consumer is ignorant (I_i=0), characteristics are accounted for in the welfare via the non-internalized benefit/damage.

The maximization of utility defined by (1) with respect to q_i , and subject to the budget constraint with a price *p* , gives the inverse demand

$$p(q_i, I_i) = Max\left[0, a - I_i r_i - (\bar{b} + I_i v_i) q_i\right] \qquad (2)$$

and the demand

$$q_i^D(p, I_i) = Max\left[0, \frac{(a - I_i r_i - p)}{\bar{b} + Iv_i}\right]. \quad (3)$$

Eventually, we only detail the overall demand over the N consumers with $i=\{1,\ldots, N\}$ and under the absence of information (namely with I_i=0). With $b = \bar{b}/N$ the aggregate demands by ignorant consumers (I_i=0) is equal to

$$Q_R(p) = \sum_{i=1}^{N} q_i^D(p, 0) = Max\left[0, \frac{(a - p)}{b}\right]. \quad (4)$$

The supply side with a perfectly competitive industry and price-taking firms is defined by an inverse supply equal to P_R. We assume a perfectly elastic producer supply represented by constant returns to scale technology, implying zero producer profits (under the absence of sunk costs linked to the label, which is a simplifying assumption).

The approach relies on a combination of an elasticity of demand coming from time-series economics and values obtained from experiments. We now provide essential details linked to the approach. This approach first considers a classical calibration of demand with unaware consumers, and then, it integrates results coming from the lab experiment.

We first consider the classical calibration of demand with unaware consumers (I_i=0). The parameters a and b in (4) can be determined by classical calibration methods. The overall demand for the product when all consumers are unaware of the damage is given by (4). Using existing data on the quantity $\hat{Q}_R$ of the product sold over a period for the N consumers, the average price P_R observed over the period, and the direct price elasticity of the demand $\hat{\varepsilon} = (dQ_R / dP_R)(P_R / Q_R)$ obtained from time-series econometric estimates, the calibration leads to estimated values for the demand equal to $1/\tilde{b} = -\hat{\varepsilon}\hat{Q}_R / P_R$ and $\tilde{a} = \tilde{b}\hat{Q}_R + P_R$. This

estimation of parameters of (4) also leads to the estimation of (2) and (3) with the estimation of $\bar{b}$ given by $\bar{b} = N\tilde{b}$ since $b = \bar{b}/N$ before equation (4).

Results coming from the lab experiment are now integrated. Results from the lab are extrapolated to the whole population and are useful for calibrating the shifts in the demand. For the rest of the paper and for simplicity only, we assume $r_i = r$ and $v_i = v$ for all $i=\{1,\ldots, N\}$ in equations (2) and (3). It means that all consumers have the same reaction to the information that is given by the average shifts in WTP and chosen quantity coming from the lab.

First, let us consider values WTP_1^i and WTP_2^i indicating participant i's WTP before and after the revelation of information. The relative variation in average WTP provides a first measure of the inverse demand shift, $\omega = \left[E(WTP_2) - E(WTP_1)\right]/E(WTP_1)$, where $E(.)$ denotes the expected value over all participants. We restrict our estimation to a Marshallian approximation of the effect.[1] A WTP represents the maximum amount of money that a consumer is ready to pay for one unit of product, which means that from equation (2), a WTP gives information about $p(1,I_i)$, namely when one unit is purchased with $q_i = 1$. The relative variation of WTP coming from the revelation of information in the lab gives an estimation of the relative variation of the price $p(1,I_i)$ related to the information. The relative variation in average chosen quantities is $\delta = \left[E(X_2) - E(X_1)\right]/E(X_1)$, where values X_1^i and X_2^i indicating participants i's quantity choice of a product before and after the revelation of information. This relative shift gives information about the shift of the demand given by (3) at the equilibrium price P_R.

The values r and v are given by solving the following system:

[1] Rousu et al. (2014) directly uses the Hicksian definition of the WTP with method combining market data and WTP variations coming from lab experiments.

$$\begin{cases} \dfrac{p(1,1)-p(1,0)}{p(1,0)} = \omega \\ \dfrac{q_i^D(P_R,1)-q_i^D(P_R,0)}{q_i^D(P_R,0)} = \delta \end{cases} \quad (5)$$

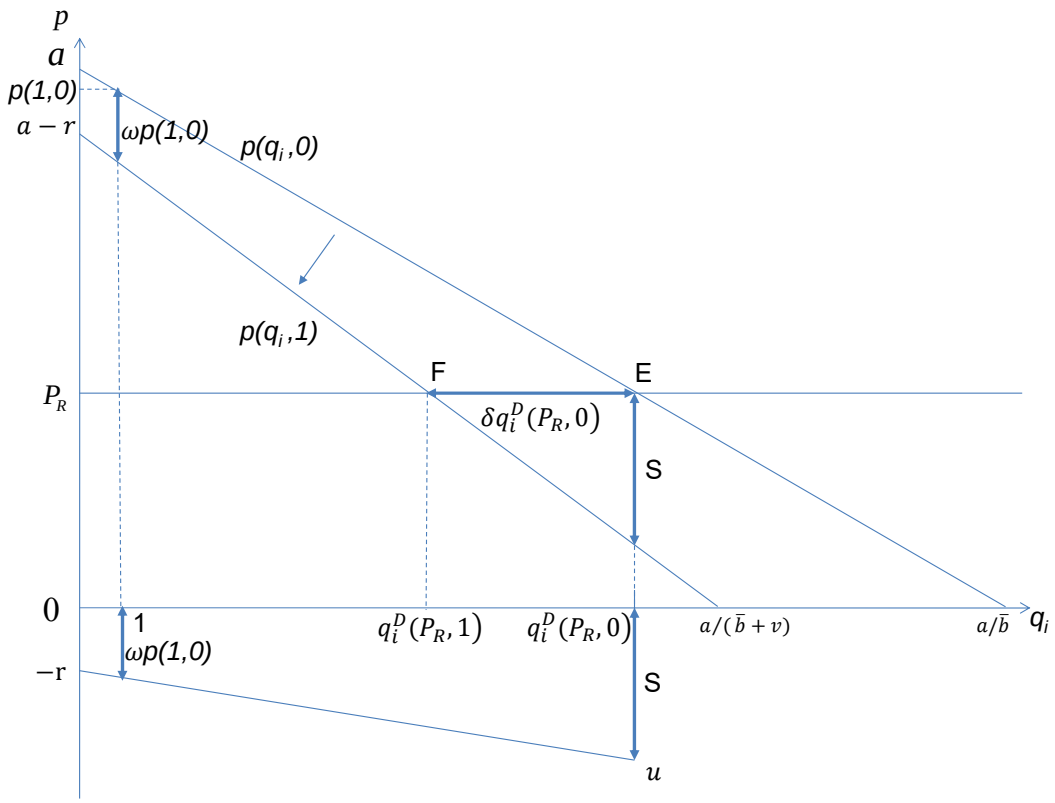
Figure 1 shows the demand shift related to equations of the system (5) when a negative information is revealed. The price is located on the vertical axis and the quantity is shown along the horizontal axis. The supply is represented by P_R. The initial demand is represented by the line *p(qi,0)*. The information leads to a decline of the demand from *p(qi,0)* to *p(qi,1)*. This demand shift is calibrated with the system of equation (5) and detailed on figure 1.

For *I*=0, the purchased quantity by a consumer *i* is $q_i^D(P_R,0)$ represented on Figure 1. For *I*=0, the non-internalized damage incurred by consumers should be accounted for in the welfare calculation. This non-internalized damage is represented by area $0q_i^D(P_R,0)u(-r)$, where $q_i^D(P_R,0)$ is the consumption of the consumer at price P_R. Consumers' surplus (area P_REa) minus the non-internalized damage yields an overall welfare represented by area $P_REa - 0q_i^D(P_R,0)u(-r)$. The revelation of messages leads to a decline of the demand. For *I*=1, the purchased quantity by a consumer *i* is $q_i^D(P_R,1)$. As the damage is fully internalized, there is no more non-internalized damage. The surplus is now $P_RF(a-r)$. The value of information (or welfare variation coming from the revelation of information) is defined by the variation of surplus coming from the revelation of messages. The value of information corresponding to the welfare variation is given by $P_RF(a-r) - [P_REa - 0q_i^D(P_R,0)u(-r)]$. This value will be computed in the next section.

We will also study the impact of a per-unit tax with ignorant consumers. With the per-unit tax added to the market price, namely P_R+t, consumers stay ignorant, but the optimal tax influences the purchasing decisions and, indirectly, the cost of ignorance (see Marette et al.,

2008). Before the computation of welfare variations, we present the lab experiment that elicited WTP and quantity choices.

Figure 1. Impact of information on the demand



3. The Lab Experiment with Beef and the market data

We briefly describe the lab protocol, before presenting the market data that are necessary for calibrating the initial demand of the product.

3.1. The experiment

We conducted the experiment in Dijon, of Burgundy in France, in multiple sessions in November 2015. We conducted the similar experiment in Milan, in Italy in multiple sessions in November 2016. For each experiment, a sample of 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.

In France, a sample of 124 participants was recruited in Dijon. 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. In Italy, a sample of 127 participants was recruited in Milan. Because of incomplete replies, observations related to 8 participants were discarded for the rest of this paper. Therefore, the rest of this paper only takes into account the replies of 119 participants.

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.

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. 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.

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.

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. 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.

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. 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.

We abstract from the order of messages by only considering the WTP at round #1 and at round #5 when all messages are revealed.

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 product for prices varying from €2.20 to €3.80 for each product. 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.

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 $R = \{1,\ldots,6\}$, 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.

Multiple-price lists were employed in this experiment to simplify the task for consumers when evaluating independently two products in several rounds.

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.[2] These chosen quantities are important for our results, but they are omitted by previous contributions.

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.

[2] 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 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.

The rounds #2 to #5 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 5 rounds, participants filled in an exit questionnaire and received the €15 indemnity.

3.2. Market data Calibration

Data necessary for calibrating the welfare are reported in table 1. These data are useful for replicating prices and quantities of fresh ground beef sold in 2015 in the French market (the Italian market will be considered at the end of this paper). We only focus on the consumption of fresh ground beef.

The bottom of table 1 details results coming from the lab experiment experiments. The relative variations ω and δ indicated on figure 1 and in equation (5) come from the revelation of all messages in the lab, namely between the stage #1 and the stage #5 (see the previous subsection). These relative variations consider the WTP or chosen quantities at stage #5 (after

the complete revelation of all information) versus the WTP or chosen quantities at stage #1 (without any information). These relative variations are necessary for calibrating the demand shifts showed in figure 1.

Table 1. Parameters for calibrating the welfare variation in France

Description	Variable	Value
From time series and observed data		
Consumption of fresh ground beef in 2015, number of pack of 250g[a]	$\hat{Q}_R$	333 333 333
Price of fresh ground beef (€/250g)[a]	P_R	2.6
Own-price elasticity of demand[b]	$\hat{\varepsilon}$	- 1.05
From the lab experiment		
Relative variation in the average WTP	ω	- 0.012
Relative changes in chosen quantity	δ	- 0.236

Note: [a] This quantity is given by (4*250 000 000)/3. According to Delvallée (2015), 250 000 tons of ground beef (or beef burger meat) are consumed in France, with only 1/3 of this quantity that is fresh (2/3 is frozen). A pack of ground beef is equal to 250g. [b] Bonnet et al. (2016)

4. The Results: Welfare Impact of Regulation

Table 2 provides the economic impact of different regulatory tools by presenting welfare variations. These welfare variations (calculated with *Mathematica*) are computed by taking into account the welfare under a given scenario minus the welfare under the baseline scenario, which is defined for the year 2015 under the absence of regulation.

We first study the impact of a recommendation that would be perfectly received and understood by all consumers. This recommendation would include the 4 messages revealed in the lab. It is assumed that these consumers would react as participants in the lab. However, the fact that all consumers would perfectly receive and read the recommendation is highly unrealistic compared to real contexts of purchasing. Several field experiments show that imperfect recall, lack of time before purchasing, the great number of purchased products or/and confusion about complex information characterize many consumers in the supermarket

(Marette et al., 2011). This makes complex information relatively useless for consumers in real purchasing context, even if the lab shows a real interest and WTP for a question. The lab context is useful for eliciting well-informed, thoughtful preferences, while this possibility does not happen in real situations. This explained why we turn to a second configuration that is more realistic than this first one, regarding its implementation.

In this second configuration, the lab experiment is useful for defining the non-internalized damage/benefit when consumers are ignorant (see figure 1). In this case, the per-unit tax changes the demand of ignorant consumers and ultimately reduces their cost of ignorance. The per-unit tax is determined in a way that maximizes welfare. Table 2 shows the simulations related to both instruments when the equation (5) is solved.

Table 2. **Changes (in value and in percentage) in welfare compared to the baseline scenario (without regulation) for the year 2015 in France**

Scenarios	Welfare Variations
Recommendation	
Welfare variation per consumer (€)	€ 0.61 (+10.5%)
Welfare Variation for French consumers (€)	€ 30 999 389 (+10.5%)
Per-Unit Tax	
Tax Level (€/250g)	$t^* = 0.58$
Welfare variation per consumer (€)	€ 0.61 (+10.5%)
Welfare Variation for French consumers(€)	€ 30 999 389 (+10.5%)
Variation in beef consumption for French consumers (250g)	-78 666 666 (-23.6%)

Note: relative variation (%) compared to the baseline scenario in parentheses

In table 2, both welfare variations are positive, which means that the regulation increases welfares. Table 2 suggests that these optimal regulatory tools may have a significant impact on the variation of welfare (+10.5%) and the reduction of beef consumption (-23.6%). Note that the tax t^* is relatively high, since it represents 22.3% of the initial beef price P_R= €2.6. Both instruments have similar effects on the welfare variations, because we only consider average variations ω and δ similar for all participants. If we had different types of consumers

(gathered together according different reactions identified in the lab), welfare would have been different under these different regulatory tools (see Disdier et Marette, 2012).

Results of table 2 should be interpreted by being aware of inherent limits coming from the model and the relative variations coming from the lab. The relative variation of chosen quantities is particularly important for explaining results of table 2. The omission of one of these two variations leads to some important biases in the welfare estimations. In particular, table 3 compares the impact of the recommendation when both variations are accounted (top of the table), and the impact of the recommendation when only the variation in WTP is accounted (bottom of the table). In table 3, the welfare variation with the WTP variation only, is much lower than the welfare variation with both variations, since the relative variation ω of WTP is very low, as shown in table 1.

Table 3. **Changes (in value and in percentage) in welfare compared to the baseline scenario (without regulation) for the year 2015 in France**

Scenarios	Welfare Variations
Variations in WTP and Variations in Quantities (from table 2)	
Recommendation	
Welfare variation per consumer (€)	€ 0.61 (+10.5%)
Welfare Variation for French consumers (€)	€ 30 999 389 (+10.5%)
Variations in WTP only	
Recommendation	
Welfare variation per consumer (€)	€ 0.004 (+0.05%)
Welfare Variation for French consumers (€)	€ 213 995 (+0.05%)

Note: relative variation (%) compared to the baseline scenario in parentheses

Eventually, we also consider the welfare variations with the two products, namely the beef burger meat and the soy burger meat. The equations (1) and (4) can be easily extended for taking into account an imperfect substitute as precisely shown by Marette et al., 2008. However, we face the problem of the lack of data, because plant-based products belong to a nascent and tiny market. Some assumptions were made for computing the welfare variations.

We assume that the consumed quantity of plant-based substitutes represents 1% of the consumed quantity of fresh ground beef. Moreover, we assume the same direct-price elasticity for plant-based products as for beef. The cross-price elasticity, namely the effect of the price of one good on the demand of the other product is equal to +0.1. From the lab, the relative variation in WTP is equal to +0.06 and the relative variation in quantities is equal to +0.56. Results of simulations are given in table 4.

Table 4. Changes (in value and in percentage) in welfare compared to the baseline scenario (without regulation) for the year 2015 in France

Scenarios	Welfare Variations
Recommendation	
Welfare variation per consumer (€)	€ 0.64 (+10.7%)
Welfare Variation for French consumers (€)	€ 32,872,226 (+10.7%)
Per-Unit Tax and Per-Unit Subsidy	
Tax Level on Beef (€/250g)	$t^{**} = 0.58$
Subsidy Level on Soy (€/250g)	$s^{**} = 1.68$
Welfare variation per consumer (€)	€ 0.64 (+10.7%)
Welfare Variation for French consumers(€)	€ 32,872,226 (+10.7%)
Variation in beef consumption for French consumers (250g)	78 670 185 (-23.6%)
Variation in soy consumption for French consumers (250g)	2 103 369 (+63.1%)

Note: relative variation (%) compared to the baseline scenario in parentheses

In table 4, both welfare variations are positive, which means that the regulation increases welfares. Table 4 shows close welfare variations compared to the welfare variations of table 2, because the initial consumed quantity of plant-based burgers is very low. Regarding the tax on beef burger meat and the subsidy on the soy burger meat, the welfare maximization leads to a relatively high subsidy s^{**} compared to the tax t^{**}. Interestingly, the decrease in the quantity of beef burger meat is not outweighed by the increase in the quantity of soy burger meat.

Welfare variations for Italy were also estimated. Results are relatively close to the French one. In table 5, we only focus on political tools when the only the fresh ground beef is

considered (as the context of table 2). Table 5 suggests that the regulatory tools could have a significant impact on the variation of welfare (+9.7%), if they were implemented in the future.

Table 5. Changes (in value and in percentage) in welfare compared to the baseline scenario (without regulation) for the year 2015 in Italy

Scenarios	Welfare Variations
Recommendation	
Welfare variation per consumer (€)	€ 0.53 (+9.7%)
Welfare Variation for French consumers (€)	€ 26 004 850 (+9.7%)
Per-Unit Tax	
Tax Level (€/250g)	$t^* = 0.62$
Welfare variation per consumer (€)	€ 0.53 (+9.7%)
Welfare Variation for French consumers(€)	€ 26 004 850 (+9.7%)

Note: relative variation (%) compared to the baseline scenario in parentheses

5. Conclusion

Experimental results provide a useful basis to anticipate consumers' reactions and allow regulatory authorities to consider different options in terms of their costs and benefits including market reactions. Despite the limitations, the methodology can be replicated for helping the public debate, even if no definitive conclusion can be taken. Results suggest that these optimal regulatory tools have a significant impact on the variation of welfare (+10.5% in France and +9.7% in Italy) and the reduction of beef consumption (-23.6% in France and -23% in Italy). Results of tables 2, 4 and 5 should be interpreted by being aware of inherent limits coming from the model and the relative variations coming from the lab.

In order to focus on the main economic mechanisms and to keep the mathematical aspects as simple as possible, the analytical framework and the tools were admittedly simple. In order to fit different problems coming from various contexts, some extensions could be integrated into the model presented here. Robustness of results could/should be presented by altering values of some parameters and/or with a demand specification with a non-linear relationship between the price and the purchase quantity. The welfare variations do not take

into account the administrative costs linked to the design and the implementation of regulation. These costs need to be taken into account for a complete cost-benefit analysis. The analysis could also be refined by considering different subgroups of consumers gathered together according their reactions to the information in the lab (see Disdier and Marette, 2012). The supply side should also be integrated for considering producers and retailers.

Despite the previous limitations, our results clearly show the impact of information and regulation. This methodology supports public debates about the best way to promote an efficient policy. Different regulatory scenarios may be tested *ex ante*, and the methodology renders lab experiments useful for policy analysis, which is an important challenge for experimental economics.

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