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Full Research Article

Consumers' rationality and home-grown values for healthy and environmentally sustainable food

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Abstract. Consumers' food choices often deviate from rationality. This paper explores whether deviations from rationality impact home-grown values elicited using either bid- or choice-based value elicitation techniques. The paper focuses on second-price Vickrey auctions and discrete choice experiments, which are widely used to value innovative private goods and the welfare benefits of policy interventions. The paper reports the results of an experiment that combines induced value and home-grown value elicitation procedures. Home-grown values are elicited for a public food policy. The experiment has two treatments that differ in the elicitation technique: second-price Vickrey auction and discrete choice experiment. For each technique, induced-value elicitation procedures are used to measure subjects' deviations from rationality. Deviations from rationality are more likely in the second-price Vickrey auction. Subjects who behave irrationally have higher home-grown values than rational subjects in the second-price Vickrey auction. The impact of deviations from rationality is weaker in the discrete choice experiment.

Keywords. Home-grown value, induced value, rationality, experimental auction, discrete choice experiment.

JEL codes. C91, D12, Q18, Q51.

1. Introduction

Second-price Vickrey auctions (SPVAs) (Vickrey, 1961) and discrete choice experiments (DCEs) (Lancaster, 1966) are widely used to determine the demand for innovative multi-attribute goods in marketing research and estimate welfare benefits of new agri-food, environmental, health and transportation policy interventions in public pol-

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icy research. Such value elicitation techniques are based on standard economic theory's assumptions. One of the most stringent assumption is that economic agents behave rationally and always make decisions that maximize a given utility function (Becker 1962; Simon 1986). Empirical evidence from disciplines, such as psychology, suggests that economic behavior often deviates from this definition of rationality (e.g., Camerer 1995; Camerer 1999). This is a problem in non-market valuation because departure from rational behavior "undercuts […] the non-market valuation methods used to evaluate private choice and public policies […]" (Cherry *et al.*, 2007, Scarpa *et al.*, 2007; Burton *et al.*, 2009).

This paper contributes to this literature in several ways. The main aim of this paper is to empirically test whether respondents deviate from rational choice behavior and whether deviations from rationality have an impact on respondents' home-grown values (HGVs) elicited via SPVA and DCE. HGVs are genuinely formed by people without any direct interference from researchers about the value of the good under study (Rutsröm, 1998). Our empirical application focuses on consumers' evaluations of an information-based public policy (i.e., labelling-based intervention) aiming to shift consumers choices towards healthier and more environmentally sustainable food products. More specifically, HGVs for healthier and more environmentally sustainable versions of a ready meal (i.e., beef-based lasagne) are elicited using SPVA and DCE.

In this paper, individual deviations from rationality are investigated using induced value (IV) elicitation procedures. The value is said induced because the experimenter provides subjects with the value of the fictitious good under study during the experiment (Smith, 1976). Irrationality (or rationality) is measured investigating subjects' deviations from the payoff maximizing strategy in IV settings. Rational subjects are those who consistently make demand revealing choices (DCE) or submit demand revealing bids (SPVA) in the IV experiments. Subjects who behave irrationally are those who fail to do so. The effect of departure from rational behavior on HGVs is explored within treatment.

Second, this paper aims to test if deviations from rational behavior and the impact of such deviation on elicited HGVs depend on the nature of the elicitation mechanism: bid- or choice-based (SPVA or DCE). The framing of bid- and choice-based elicitation mechanism are different and this may have an impact on behavior in IV and HGV settings (Lusk and Schroeder, 2006; Gracia *et al.*, 2011). Third, this paper aims to test if underbidding and overbidding in the IV setting is related to bidding behavior in the HGV setting. In particular, we investigate whether underbidding and overbidding behavior in the IV setting spills over to the HGV setting. For example, subjects who tend to underbid in the IV setting bid lower than others in the HGV setting. There is empirical evidence that rationality spills over from different settings, more specifically from market-like contexts to non-market ones (Cherry *et al.*, 2003; Cherry and Shogren, 2007). Here, we aim to test whether underbidding or overbidding are behavioral phenomena that are linked more to the specific individual than the type of task. Finally, in this paper, we develop and estimate a behavioral model to identify main determinants of subjects' rationality in IV settings. To the best of our knowledge, we are not aware of other studies performing this analysis in the literature.

By using the same dataset used in Cerroni *et al.* (2019), this paper generates new insight into the link between rationality, bidding and choice behavior. The study provides new evidence on whether rationality is affected by the use of bid- and choice-based value elicitation mechanisms and whether potential deviations from rationality have an impact on HGVs across mechanisms. This evidence can generate new knowledge regarding the reliability and accuracy of HGVs elicited via SPVA and DCE and have important implications for businesses and policy makers who need reliable evidence in order to predict people's behavior and allows making cost-effective decisions (Kassas *et al.*, 2018; Ortega *et al.*, 2018).

2. Background

2.1 Healthier and more environmentally sustainable food choices

Consumers' food choices contribute to the high prevalence of diet-related diseases and climate change (e.g., Tilman and Clark, 2014). A shift towards more sustainable diets is needed to reduce the cost that obesity and climate change are having on the economy (e.g., Bryngelsson *et al.*, 2016; Santini *et al.*, 2017). Sustainable diets are very complex and were defined as: "those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources." (FAO, 2012).

A relatively substantial amount of research has focused on identifying the main traits of sustainable diets from a nutrition and environmental point of view (e.g., Macdiarmid *et al.* 2012). However, few studies have investigated consumers' acceptability of proposed sustainable diets (e.g., Macdiarmid *et al.*, 2016). The present study contributes to this literature investigating acceptability of sustainable diets by exploring consumers' trade-offs between two food attributes, namely healthiness and carbon footprint. The vast majority of research generally focused on one attribute or the other (e.g., Drichoutis *et al.*, 2006; Belcombe *et al.*, 2010; Caputo *et al.*, 2013; Akaichi *et al.*, 2017; Castellari *et al.*, 2019), but failed to investigate whether and to what extent consumers compromise between healthiness and environmental sustainability of food products when they make purchasing decisions (a noticeable exception is Koistinen *et al.* 2013). The understanding of such trade-offs is important to design information-based policy intervention aiming to promote the uptake of sustainable diets.

2.2 Home-grown values elicited via SPVA and DCE

SPVA and DCE are widely used to elicit HGVs for innovative food products and estimate net benefits of new public policies. Elicitation procedures used in SPVA and DCE are very different (Lusk and Schroeder, 2006; Gracia *et al.*, 2011). In SPVA, subjects are asked to bid for a series of goods. The bidder who submit the highest bid buys a good, which is randomly selected at the end of the experiment, at a price equal to the second highest bid for that good. In DCE, subjects are asked to make repeated purchasing choices in a series of choice scenarios that generally present a couple of goods and an opt-out alternative. Subjects buy the good that they have chosen (if any) in one choice scenario that is selected at random. They pay the price that is associated to the chosen good.[1]

Economic theory predicts that HGVs elicited for the same good should be equal across methods when a proper incentive scheme is used (i.e., isomorphism). However, empirical evidence does not support this prediction. Lusk and Schroeder (2006) showed that WTP estimates elicited via SPVA are lower than those elicited via DCE. Grebitus *et al.* (2013) suggested that personality traits partially explain this difference.[2] Cerroni *et al.* (2019) found that this difference is due to value-formation and value-elicitation issues. Subjects form their preferences differently across mechanisms and the SPVA is less empirically demand revealing than DCE.

Differences in value formation may be driven by the fact that SPVA and DCE expose subjects to very different valuation environments and framings (Lusk and Schroeder, 2006; Gracia *et al.*, 2011). While, in DCE, subjects are asked to make private purchasing choices and each subject's outcome is independent from others' decisions, in SPVA, subjects are asked to place bid in a competitive environment and each subject's outcome depends on others' bidding behavior. While, in DCE, the price of goods is provided in the choice scenarios and represents only one additional attribute of the presented goods, in SPVA, subjects are asked to formulate the price that they are willing to pay for the auctioned good without having any reference.

2.3 Rationality in SPVA and DCE

Standard economic theory suggests that SPVA and DCE are theoretically demand revealing (incentive compatible) under a proper monetary incentive scheme. Value elicitation issues (or empirical demand revelation) can be tested by using IV experimental procedures (Smith, 1976). Experimental evidence shows that subjects often deviate from rational behavior in IV experiments. In SPVA, the weakly dominant strategy is to bid the IV associated to the fictitious good under valuation. Empirical evidence suggests that bidding behavior often deviates from the weakly dominant strategy in SPVA (e.g., Kaegel *et al.*, 1987; Kaegel and Levine, 1993; Shogren *et al.*, 2001; Lusk and Shogren, 2007; Drichoutis *et al.*, 2015). Overbidding is the most common form of departure from rationality (e.g., Kaegel *et al.*, 1987; Georganas *et al.*, 2017), however a number of studies reported underbidding (e.g., Shogren *et al.* 2001; Hong and Nishimura, 2003; Noussair *et al.*, 2004). Subjects deviate from rational behavior for two reasons. First, they fail to understand the incentives for truthful value revelation. Kagel, Harstad and Levine (1987) and, more recently, Ausubel (2004) argued that subjects find SPVAs difficult to understand. Li (2017) differentiated "obviously strategy-proof" and "not obviously strategy-proof" elicitation mechanisms. A mechanism is obviously strategy-proof when the best

[1] We acknowledge that DCE has been mostly used in hypothetical settings. In this paper, we only focus on research using DCE in incentivised and non-hypothetical settings.

[2] Other studies showed that isomorphism is not satisfied when HG preferences are elicited using other institutions. For example, Rutström (1995) compared English auction, Vickrey auction and the Becker-DeGroot-Marschak mechanism (BDM); Gracia *et al.* (2011) compared random nth auction and DCE; Lusk *et al.* (2004) compared SPVA, English auction, random nth auctions and BDM; Akaichi *et al.* (2013) compared choice-based DCE and ranking-based DCE.

outcome that subjects can obtain by deviating from the dominant strategy is never superior to the worst outcome they can obtain by sticking to the dominant strategy. SPVA is not obviously strategy-proof and therefore becomes cognitively demanding for subjects (Lee *et al.*, 2017). Second, SPVA is not necessarily incentive compatible when subjects behave accordingly to some non-standard expected utility theories (Horowitz, 2006). For example, reference-dependent preference models such as those formulated by Kőszegi and Rabin (2006).

Demand revelation in DCEs has received less scrutiny. Nevertheless, deviations from the dominant strategy, which is choosing the payoff maximizing alternative in each choice scenario, seems to be less systematic (Collins and Vossler, 2009; Luchini and Watson, 2014; Bazzani *et al.*, 2018). Collins and Vossler's (2009) found a high level of demand revelation in referenda-style DCEs. However, Luchini and Watson (2014) provided less encouraging results in a DCE for a private good. Bazzani *et al.* (2018) showed that demand revelation at individual level depends on assumptions made about the distribution of estimated marginal willingness to pay (WTP). Recently, Cerroni *et al.* (2019) found that DCEs are more empirically demand revealing than SPVAs and showed that value-elicitation issues contribute to differences in HGVs elicited via the two mechanisms in their artefactual field experiment (Harrison and List, 2004) that combines HGV and IV procedures.

3. Material and methods

3.1 Empirical application

The paper focuses on HGVs for a new food policy that aims to inform consumers about the healthiness (measured in terms of saturated fat content) and environmental sustainability (measured in terms of carbon footprint) of food products. This information is delivered using a traffic light system (TLS) related to food's carbon footprint, where red stands for high, amber for average, and green for low carbon footprint. This TLS is presented alongside a standard TLS indicating the healthiness of food products: where red stands for unhealthy, amber for average, and green for healthy food (Department of Health, 2016).[3] The experimental product is a popular ready meal in the UK: frozen beef lasagne.

During the experiment, subjects are presented with nine different lasagne that vary in terms of healthiness (3 levels) and carbon footprint (3 levels). These parameters are varied across lasagne by changing the proportions of the traditional lasagne's ingredients (e.g. beef, pasta, sauce, cheese, etc.). All lasagne have similar appearance and portion size (400 grams). Recipes were developed by nutritionists, lasagne were pre-cooked by professional cooks and kept frozen at the Rowett Institute (University of Aberdeen). The experiment was conducted at the Scottish Experimental Economics Laboratory (SEEL, University of Aberdeen).

[3] More information on how the three different levels of healthiness and carbon footprint were generated is provided in the online supplementary appendix A.

3.2 Recruitment and sample characterization

The pool of sample subjects is the same included in the study by Cerroni *et al.* (2019) and consists of 128 consumers recruited from the general population of Aberdeen and surroundings (Scotland, UK). Subjects were recruited using a variety of methods, including posters and flyers distributed in the city (e.g. University campus, community centers, local workplaces, retail outlets, community events) as well as snowball sampling. This means that we have a non-probability sample. An information sheet describing the study was sent to people who responded to the adverts. They were told that the aim of the study was to understand the decisions people make when choosing food (in this case a beef lasagne) and they would have the chance to buy one of the lasagne based on the choices they made in the experiment.

Subjects aged 18 or older were recruited. The average age was 36 years, the minimum and maximum age were 19 and 70 respectively. The sample consisted of 64% females and the average annual income was approximately £38,000. Subjects were given a show-up fee of £10 for participating to the study. Those who purchased food paid in cash and left the experiment with £10 minus the price they paid. Subjects who purchased the food were given a cooling bag to keep the food frozen during the remaining part of the day. The study received ethical approval from the Rowett Institute Ethics Committee at the University of Aberdeen.

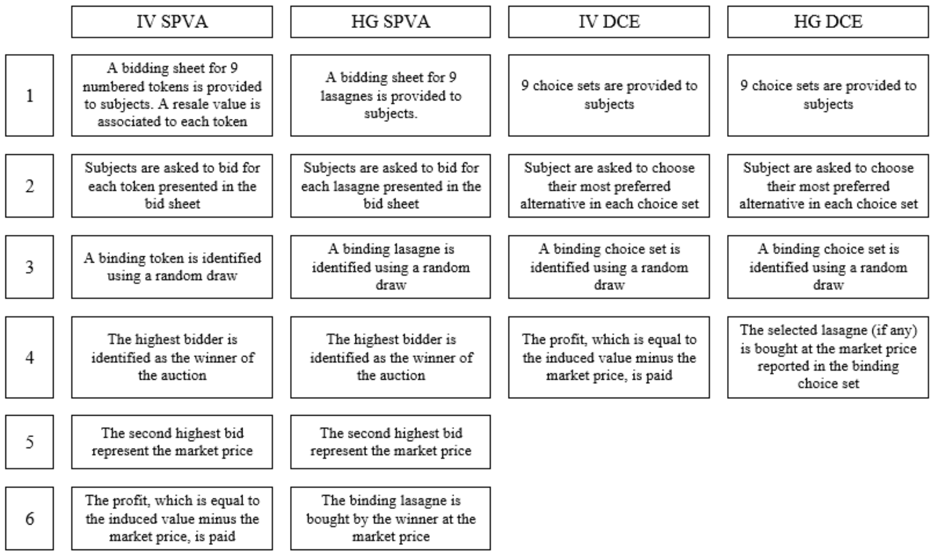
3.3 Experimental design

The experimental design consists of two treatment groups, one for each value elicitation mechanism: SPVA or DCE. In each treatment, both IVs and HGVs are elicited. HGVs were elicited for the multi-attribute lasagne described above. The SPVA treatment consists of 63 subjects, the DCE treatment of 65. Subjects who signed up for the study were randomly assigned to treatments. Subjects were asked to complete a number of tasks in the following order: a warm-up questionnaire on self-reported level of hunger and satiety, IV task, HGV task and a questionnaire on consumption habits and socio-economic status. To avoid biases such as the earning effect, subjects were informed about earning (or losses) from the IV task at the very end of the experiment. In total, eight sessions were conducted between January 2015 and September 2017, eight for the SPVA and five for the DCE. Four of the SPVA sessions hosted eight subjects, two sessions hosted nine subjects, one session hosted seven subjects and the remaining session hosted six subjects. Two of the DCE sessions hosted nine subjects, the remaining three sessions hosted ten, eighteen and nineteen subjects. Sessions took place either at 1.30pm or 5.30pm to control for possible time and hunger effects.

3.3.1 SPVA in the induced value setting

In the IV setting, each subject participates in nine SPVAs for nine different tokens (see the supplementary online appendix B). Each token is associated with a different IV, which ranges from £1.00 to £5.00 in £0.50 increments.[4] Subjects are informed that their profit depends on their bids for one specific token, called the binding token. The binding token is randomly draw at the end of the experiment. The highest bidder buys the binding token at a price, which is equal to the second highest bid. The profit made by the highest bidder is the difference between the IV associated to the binding token and the buying price. If the profit is positive, this is paid in addition to the show-up fee at the end of the experiment. If the market price is higher than the IV, the subject incurs a loss that is subtracted from the show-up fee. Standard economic theory suggests that the weakly dominant strategy is to place a bid equal to the IV of the token. Subjects who constantly follow the weakly dominant strategy are considered rational. The others' behavior departs from rationality. All steps faced by subjects during the experiment are reported in Figure 1.

Figure 1. All steps faced by subjects during the experiment.



3.3.2 SPVA in the home-grown value setting

In the HGV setting, each subject bids for the nine different lasagne (all possible combinations of lasagne's healthiness and carbon footprint levels) (see the supplementary online appendix B). The order in which lasagne were presented was randomized across subjects to minimize order learning and fatigue effects. Subjects can purchase only one lasagne, the binding lasagne. They were informed that the binding lasagne is randomly draw at the end of the study. As standard in SPVA, the highest bidder buys the binding

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[4] Each subject faces the whole range of induced values, but the order of induced values varied across subjects.

lasagne at a price, which is equal to the second highest bid. This amount of money is subtracted from the show-up fee. All steps faced by subjects during the experiment are reported in Figure 1.

3.3.3 DCE in the induced value setting

In the IV setting, each subject faces nine choice sets that are generated using a fractional factorial design (ChoiceMetrics 2012) (see the supplementary online appendix B for an example). Each choice set contains two tokens plus an opt-out alternative. Tokens are described using two attributes: the market price and the IV. The market prices and the IV range from £1.00 to £5.00 in £0.50 increments. Subjects are informed that their profit depends on the option they chose in the binding choice set. The binding choice set is randomly drawn at the end of the experiment. The profit is the difference between the IV and the market price associated to the chosen token in the binding choice set. If the profit is positive, this is paid in addition to the show-up fee at the end of the experiment. If the market price is higher than the IV, the subject incurs a loss that is subtracted from the initial show-up fee. The order of choice sets was randomized across subjects. Standard economic theory suggests that subjects should always choose the alternative that maximizes their payoff. Subjects who constantly follow this strategy are considered rational. The others' behavior departs from rationality.

This experimental design differs from previous studies (Collins and Vossler, 2009; Luchini and Watson, 2014; Bazzani *et al.*, 2018) where tokens with multiple attributes (i.e., color and shape) were used and marginal IVs were associated with attribute levels. While in previous studies, subjects are asked to compute the final IV of tokens mathematically, in this experiment, subjects are provided with that. This typology of design was chosen because it mirrors the design of a standard SPVA conducted in an IV setting. In the IV SPVA literature, subjects are not asked to compute the IVs of tokens, instead, they are directly provided with these.[5] All steps faced by subjects during the experiment are reported in Figure 1.

3.3.4 DCE in the home-grown value setting

In the HGV setting, each subject is presented with nine choice sets created by using a D-efficient design (ChoiceMetrics, 2012) (see the supplementary online appendix B for an example).[6,7] Each choice set contains two lasagne and an opt-out alternative. Lasagne are described by three attributes: healthiness, carbon footprint and market price. Healthiness and carbon footprint can be green, amber or red (3 levels per attribute). The market price ranges from £1.00 to £5.00 in £0.50 increments. The order of choice sets was randomized across subjects. Subjects are informed that they buy the selected option in the binding

[5] An alternative design would involve the provision of tokens with multiple attributes (i.e., colour and shape) and marginal IVs associated with attribute levels. Subjects would be asked to mathematically compute the IVs for each token and place their bids. This design will make the SPVA mirroring the DCE as designed by Collins and Vossler (2009) and Luchini and Watson (2014).

[6] Priors were estimated using data collected from a pilot study with 10 subjects.

[7] Data from the additional nine choice sets that are presented to subjects after being provided with additional information on saturated fat and carbon footprint are not included in our analyses to avoid confounding.

choice set. The binding choice set is randomly selected at the end of the experiment. If they chose a lasagne, they buy the lasagne at the corresponding price. This amount of money is deducted from the show-up fee. If they selected the opt-out alternative, they do not purchase the lasagne. All steps faced by subjects during the experiment are reported in Figure 1.

4. Testable hypotheses, model specifications, results and discussion

4.1 Deviations from rationality and home-grown values elicited via the SPVA

4.1.1 Overview of deviations from rationality

Subjects' bidding behavior and deviations from rationality in the IV SPVA are reported in Table 1a and 1b. Subjects are considered rational if and only if they submit only demand revealing bids in the IV task, meaning that 9 demand revealing bids (out of 9) are submitted. Bids are demand revealing, if and only if, these are equal to IVs. In fact, the payoff maximizing strategy is to submit bids that are equivalent to tokens' IVs. Subjects who fail to submit only demand revealing bids deviate from rational behavior. In our sample, we have 14 rational subjects (22.22%) and 49 subjects (77.80%) who deviate from rationality (Table 1a). It is interesting to note that there are no subjects who submit 7 or 8 (out of 9) demand revealing bids. This may indicate that subjects do not make random mistakes, they simply understand the experimental procedure (when they submit 9 demand revealing bids out of 9) or not (when they submit 6 or less demand revealing bids out 9). Overall, these results seem to suggest that subjects do not easily identify the payoff maximizing strategy of SPVA as already argued by Kagel *et al.* (1987), Ausubel (2004) and Li (2017).

Among subjects who deviate from rationality, we have 22 (34.92%) who constantly underbid (9 underbids out of 9 bids) and only 2 (3.17%) who constantly overbid (9 overbids out of 9 bids). A subject underbids (overbids) when submits a bid that is lower (higher) than the associated IV. The remaining sample has a mixed behavior (25 subjects, 39.68%). In the "mixed behavior" category we have: i) those who underbid and overbid (5 subjects, 20.00%), ii) those who underbid and submit demand revealing bids (7 subjects, 28.00%), iii) those who overbid and submit demand revealing bids (6 subjects, 24.00%) and iv) those who underbid, overbid and submit demand revealing bids (7 subjects, 28.00%) (Table 1b). Despite the bulk of research reports overbidding (e.g, Kaegel *et al.*, 1987; Georganas *et al.*, 2017), there are a number of empirical studies that provide evidence for underbidding (e.g., Shogren *et al.*, 2001; Noussair *et al.*, 2004). Previous research has conjectured that overbidding arises when subjects understand that high bids increase the probability of winning, but fail to realize that high bids may generate negative payoffs (Georganas *et al.*, 2017). Our subjects seem to overestimate the additional cost of overbidding on the final payoff.

4.1.2 Testable hypotheses and model specifications

The influence of departures from rational behavior on HGVs for lasagne is explored by estimating Model 1 using a feasible generalized least-square regression with correction

Table 1a. Categorization of subjects' bidding behavior[a].

Consistent rational behavior[b]	Consistent underbidding[c]	Consistent overbidding[d]	Mixed behavior[e]
14 (22.22%)	22 (34.92%)	2 (3.17%)	25 (39.68%)

Table 1b. Categorization of subjects' bidding behavior within the mixed behavior category[a].

Underbidding and Overbidding[f]	Underbidding and rational behavior[g]	Overbidding and rational behavior[h]	Underbidding, overbidding and rational behavior[i]
5 (20.00%)	7 (28.00%)	6 (24.00%)	7(28.00%)

[a] Number of subjects per category.
[b] Consistent rational behavior = 9 demand revealing bids out of 9 submitted bids.
[c] Consistent underbidding behavior = 9 underbids out of 9 submitted bids.
[d] Consistent overbidding behavior = 9 overbids out of 9 submitted bids.
[e] Mixed behavior = all the other subjects.
[f] Underbidding and overbidding = subjects who underbid and overbid.
[g] Underbidding and rational behavior = subjects who underbid and submit demand revealing bids.
[h] Overbidding and rational behavior = subjects who underbid, overbid and submit demand revealing bids.
[i] Underbidding, overbidding and rational behavior = subjects who overbid and submit demand revealing bids.

for heteroscedasticity. This model tests whether HGVs differ between subjects who consistently submit demand-revealing bids in the IV SPVA (i.e., subjects who behave rationally) and the others (i.e., subjects whose behavior deviates from rationality).[8] Main statistics of all variables used in Model 1 are described in Table 2.[9] Model 1 takes the functional form in Equation 1:

$$BID\_HG_{i,q} = \alpha + \beta_{HEA\_A}\, HEA\_A_{i,q} + \beta_{HEA\_G}\, HEA\_G_{i,q} + \beta_{CF\_A}\, CF\_A_{i,q} + \beta_{CF\_G}\, CF\_G_{i,q} + \beta_{HEA\_A\_IRR}\, HEA\_A_{i,q} * IRR_{i,q} + \beta_{HEA\_G\_IRR}\, HEA\_G_{i,q} * IRR_{i,q} + \beta_{CF\_A\_IRR}\, CF\_A_{i,q} * IRR_{i,q} + \beta_{CF\_G\_IRR}\, CF\_G_{i,q} * IRR_{i,q} + \varepsilon_{i,q} \quad (1)$$

The dependent variable ($BID\_HG_{i,q}$) is each subject i's bids for lasagne $q\neq1$ ($BID\_HG_{i,q\neq1}$) minus subject i's bid for the lasagne, which is red in healthiness and carbon footprint, $BID\_HG_{i,q=1}$. Therefore, $BID\_HG_{i,q} = BID\_HG_{i,q\neq1} - BID\_HG_{i,q=1}$.

The coefficients β_{HEA_A} and β_{HEA_G} indicate the average marginal willingness to pay ($mWTP$) for lasagne that are amber ($HEA\_A_{i,q}$) and green ($HEA\_G_{i,q}$) in healthiness, respectively. The coefficient β_{CF_A} and β_{CF_G} denote the average $mWTPs$ for lasagne that are

[8] This estimation procedure was used because we tested and rejected normality and homoscedasticity conducting a Shapiro-Wilk test and a Log-likelihood ratio-test, respectively. A random-effect model for panel data was not used because less efficient.

[9] Detailed summary statistics of marginal bids for each lasagne type are provided in Tables C1 in the online supplementary appendix C.

Table 2. Summary statistics of variables included in the SPVA-related Models.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
BID_HG	Marginal bid for healthy and low carbon footprint lasagne[a]	504	0.794	1.447	-4.000	5.000
HEA_R	= 1 if health is red = 0 otherwise	504	0.250	0.433	0.000	1.000
HEA_A	= 1 if health is amber = 0 otherwise	504	0.375	0.485	0.000	1.000
HEA_G	= 1 if health is green = 0 otherwise	504	0.375	0.485	0.000	1.000
CF_R	= 1 if carbon footprint is red = 0 otherwise	504	0.250	0.433	0.000	1.000
CF_A	= 1 if carbon footprint is amber = 0 otherwise	504	0.375	0.485	0.000	1.000
CF_G	= 1 carbon footprint is green = 0 otherwise	504	0.375	0.485	0.000	1.000
IRR	= 1 if subject behaves irrationally = 0 otherwise	504	0.778	0.416	0.000	1.000
UND	= 1 if subject consistently underbids = 0 otherwise	504	0.349	0.477	0.000	1.000

[a] A marginal bid is the difference between any lasagne other than a red in health and red in carbon footprint (in £) and the bid for a red in health and red in carbon footprint lasagne.

amber ($CF\_A_{i,q}$) and green ($CF\_G_{i,q}$) in carbon footprint, respectively. These *mWTP*s are estimated with respect to red levels of healthiness and carbon footprint, respectively.

The variable *IRR* is equal to 1 if subject *i* fails to submit only demand revealing bids in the IV task, meaning that less than 9 demand revealing bids (out of 9) are submitted. Hence, the variable *IRR* is equal to 1 if subject *i* behaves irrationally. The coefficient $\beta_{HEA\_A\_IRR}$, $\beta_{HEA\_G\_IRR}$, $\beta_{CF\_A\_IRR}$ and $\beta_{CF\_G\_IRR}$ measure the difference in *mWTPs* for healthy and environmental sustainable lasagne between subjects who behave irrationally (those who fail to submit only demand revealing bids in the IV task) and rationally (those who submit only demand revealing bids in the IV task).

4.1.3 Results and discussion

Results from the estimation of Model 1 are reported in Table 3. The positive and statistically significant coefficients $\beta_{HEA\_A\_IRR}$ (0.255, $p<0.05$), $\beta_{HEA\_G\_IRR}$ (0.546, $p<0.01$), $\beta_{CF\_A\_IRR}$ (0.279, $p<0.05$) and $\beta_{CF\_G\_IRR}$ (0.520, $p<0.01$) indicate that subjects who deviates from rational behavior have higher *mWTP*s for lasagne's attributes than rational ones. A Wald Test rejects the null hypothesis that coefficients $\beta_{HEA\_A\_IRR}$, $\beta_{HEA\_G\_IRR}$, $\beta_{CF\_A\_IRR}$, $\beta_{CF\_G\_IRR}$ are jointly equal to zero (100.130, $p<0.01$).[10,11] If we are willing to assume that bids

[10] Other models were estimated to test the consistency of our results. These models incorporate the rate of submitted non-demand revealing (irrational) bids. Estimation results are provided in the online supplementary appendix D.

[11] As Model 1 is estimated using feasible generalized least squares (FGLS), R^2 is not an appropriate indicator of explanatory power. Here, we report the Wald $\chi 2$ which is equal to 282.88 and is significant level at $p<0.01$. We also estimated Model 1 using the iterated GLS estimator (IGLS), which allows estimating the log-likelihood.

submitted by rational subject are most accurate, these results suggest that failure to submit demand revealing bids in the IV setting generate upwardly biased HGV estimates. This assumption appears to be reasonable, if we consider that irrational subjects are those who failed to consistently identify the payoff maximizing strategy in the IV setting. Deviations from rationality can therefore have an important impact on the evaluation of innovative food products and welfare benefits produced by new agri-food policies.

Table 3. Generalized least-square regression models with correction for heteroscedasticity for SPVA data.

Dep. Var: *BID_HG*	
Coefficients	Model 1
β_{HEA_A}	0.710***
	(0.096)
β_{HEA_G}	1.254***
	(0.0961)
β_{CF_A}	0.578***
	(0.0961)
β_{CF_G}	0.873***
	(0.0961)
$\beta_{HEA\_A\_IRR}$	0.255**
	(0.126)
$\beta_{HEA\_G\_IRR}$	0.546***
	(0.126)
$\beta_{CF\_A\_IRR}$	0.279**
	(0.126)
$\beta_{CF\_G\_IRR}$	0.520***
	(0.126)
α	-0.298***
	(0.099)
Wald Test [b]: χ^2	100.130***
Obs.	504
Subjects	63

Note: ***p<0.01; **p<0.05; *p<0.10
[a] Standard Errors in parentheses
[b] H_0: $\beta_{FAT\_A\_IRR}=\beta_{FAT\_G\_IRR}=\beta_{CF\_A\_IRR}=\beta_{CF\_G\_IRR}=0$

4.2 Underbidding and home-grown values elicited via SPVA

4.2.1 Testable hypotheses and model specifications

Model 2 is estimated to investigate whether underbidding in the IV setting spills over to the HGV setting. Model 2 is equivalent to Model 1, except for the addition of the interaction variable *IRR_UND = IRR * UND*. The variable *UND* denotes subjects who constantly underbid (9 underbids out of 9 bids) and hence the interaction variable *IRR_UND* denotes those subjects who consistently underbid among those categorized as irrational. A subject underbids when submits a bid that is lower than the associated IV. The subjects who constantly underbid are 22 (34.92%) (Table 1a). We refrain to investigate whether overbidding spills over from the IV to the HGV setting because only 2 subjects (3.17%) in our sample constantly overbid (9 overbids out of 9 bids) in the IV task (Table 1a).

Model 2 is estimated using a feasible generalized least-square regression with correction for heteroscedasticity and inform on whether subjects who constantly underbid in the IV task have lower HGVs for lasagne's attributes than the other subjects whose behavior deviates from rationality. Others are those who constantly overbid and those who have a mixed behavior.

Model 2 takes the form below (Equation 2):

$BID\_HG_{i,q} = \alpha + \beta_{HEA\_A}\, HEA\_A_{i,q} + \beta_{HEA\_G}\, HEA\_G_{i,q} + \beta_{CF\_A}\, CF\_A_{i,q} + \beta_{CF\_G}\, CF\_G_{i,q} + \beta_{HEA\_A\_IRR}\, HEA\_A_{i,q} * IRR_{i,q} + \beta_{HEA\_G\_IRR}\, HEA\_G_{i,q} * IRR_{i,q} + \beta_{CF\_A\_IRR}\, CF\_A_{i,q} * IRR_{i,q} + \beta_{CF\_G\_IRR}\, CF\_G_{i,q} * IRR_{i,q} + \beta_{HEA\_A\_IRR\_UND}\, HEA\_A_{i,q} * IRR\_UND_{i,q} + \beta_{HEA\_G\_}$

The latter is equal to – 676.632.

$_{IRR\_UND}\ HEA\_G_{i,q} * IRR\_UND_{i,q} + \beta_{CF\_A\_IRR\_UND}\ CF\_A_{i,q} * IRR\_UND_{i,q} + \beta_{CF\_G\_IRR\_UND}\ CF\_G_{i,q} * IRR\_UND_{i,q} + \varepsilon_{i,q}$ (2)

4.2.2 Results and discussion

Results from the estimation of Model 2 are shown in Table 4 and suggest that underbidding spills over from the IV to the HGV task. Subjects who consistently underbid in the IV setting have lower HGVs than the other subjects who behave irrationally. The coefficients $\beta_{HEA\_A\_IRR\_UND}$, $\beta_{CF\_A\_IRR\_UND}$ and $\beta_{CF\_G\_IRR\_UND}$ are not statistically significant. However, the coefficient $\beta_{HEA\_G\_IRR\_UND}$ is negative and statistically significant (-0.361, $p<0.05$). A Wald test rejects the hypothesis that all these coefficients are jointly equal to zero (11.940, $p<0.05$).[12,13] These results are consistent with previous finding by Cherry *et al.* (2003) and Cherry and Shogren, (2007) and indicate that underbidding may be an intrinsic individual-specific behavior that does not depend on the type of task (IV or HGV). Further research is needed to investigate further this intriguing hypothesis.

4.3 Deviations from rationality and home-grown values elicited via the DCE

4.3.1 Overview of deviations from rationality

Subjects are considered rational when they submit only demand revealing choices (9 out of 9 choices) in the IV DCE task. A choice is demand revealing when it maximizes the subjects' payoff that subjects can obtain in the choice set. In other words, when it maximizes the difference between the IV and the market price. Deviations from rational choice behavior occur when subjects fail to submit only demand revealing choices. In our sample, 40 subjects out of 65 (61.50%) deviate from rational choice behavior, while 25 subjects (38.50%) are rational. Similar to the SPVA, we found that no subjects submit 7 or 8 demand revealing choices which may indicate that subjects do not make random mistakes.

4.3.2 Testable hypotheses and model specification

We estimate random-parameter logit models in WTP space to test whether HGVs elicited from subjects who behave irrationally in the IV DCE task differ from those elicited from rational subjects. Models in WTP space reduce possible biases due to the confounding of variation in scale and WTP (Train and Weeks, 2005). Some studies have shown that models in WTP space fit data better than those in preference space (e.g., Scarpa *et al.*, 2008)

In Model 3, the indirect utility function is specified as in Equation 3:

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[12] Other models were estimated which incorporate the rate of underbidding and exclude those subjects who constantly overbids (just two) from the analyses, considering them as outliers. Results are provided in the online supplementary appendix E.

[13] Models 2 is estimated using feasible generalized least squares (FGLS) and R^2 is not an appropriate indicator of explanatory power. Here, we report the Wald $\chi 2$ which is equal to 297.140 and is significant level at $p<0.01$. We also estimated Model 2 using the iterated GLS estimator, which allows estimating the log-likelihood. The latter is equal to – 660.525.

$$V_{i,j,k} = -\lambda_i PR_{i,j,k} + (\lambda_i + \boldsymbol{\omega_i})\boldsymbol{x_{i,k,j}} \quad (3)$$

In Equation 3, $\lambda_i = \alpha_i / \mu_i$, where α_i indicates subjects' preferences for the price of lasagne $PR_{i,j,k}$ and μ_i is the scale parameter. The coefficient vector $\omega_i = \theta_i / \alpha_i$ is the ratio of the vector of coefficients θ_i that are associated to the vector of non-price attributes $\boldsymbol{x_{i,j,k}}$ and the coefficient α_i. The vector ω_i indicates the *mWTPs* associated to the vector of non-price attributes $\boldsymbol{x_{i,j,k}}$.

The coefficient $\omega_{opt\text{-}out}$ is an alternative specific constant related to the opt-out alternative. The coefficients $\omega_{HEA\_A,i}$ and $\omega_{HEA\_G,i}$ denote *mWTPs* for lasagne that are amber ($HEA\_A_{i,j,k}$) and green ($HEA\_G_{i,j,k}$) in the health dimension, respectively. The coefficients $\omega_{CF\_A,i}$ and $\omega_{CF\_G,i}$ indicate *mWTPs* for lasagne that are amber ($CF\_A_{i,j,k}$) and green ($CF\_G_{i,j,k}$) in carbon footprint, respectively. These *mWTP*s are estimated with respect to red levels of healthiness and carbon footprint, respectively. To account for unobserved heterogeneity, we assume that the coefficients ω_{HEA_A}, ω_{HEA_G}, ω_{CF_A} and ω_{CF_G} are normally distributed, while the α_i is log-normally distributed with means and standard deviations to be estimated.

The variable *IRR* is equal to 1 if subject *i* behaves irrationally in the IV DCE task, meaning that she/he fails to submit only demand revealing choices (9 out of 9 choices). The coefficients $\omega_{HEA\_A\_IRR}$, $\omega_{HEA\_G\_IRR}$, $\omega_{CF\_A\_IRR}$ and $\omega_{CF\_G\_IRR}$ inform on whether *mWTPs* differ between subjects whose behavior deviates from rationality in the IV task and the others (i.e., rational). Models 3 is estimated by using methods of maximum simulated likelihood relying on 1,000 Halton draws (Train, 2009). Summary statistics of variables used in Model 3 are presented in Table 5.

4.3.3 Results and discussion

Results from estimation of Model 3 are reported in Table 6. We find that coefficients $\omega_{HEA\_A\_IRR}$ and $\omega_{HEA\_G\_IRR}$ are not statistically significant. The coefficient $\omega_{CF\_A\_IRR}$ is positive and statistically significant (0.433, $p<0.05$), which suggests that subjects who behave irrationally (in the IV DCE task) are willing to pay more than others (i.e., rational subjects) for lasagne that are amber in carbon footprint. In contrast, $\omega_{CF\_G\_IRR}$ (-0.317, $p<0.01$) is negative and statistically

Table 4. Generalized least-square regression models with correction for heteroscedasticity for SPVA data.

Dep. Var: *BID_HG*	
Coefficients	Model 2
β_{HEA_A}	0.457***
	(0.116)
β_{HEA_G}	0.710***
	(0.116)
β_{CF_A}	0.301***
	(0.116)
β_{CF_G}	0.355***
	(0.116)
$\beta_{HEA\_A\_IRR}$	0.186
	(0.142)
$\beta_{HEA\_G\_IRR}$	0.704***
	(0.142)
$\beta_{CF\_A\_IRR}$	0.245*
	(0.142)
$\beta_{CF\_G\_IRR}$	0.582***
	(0.142)
$\beta_{HEA\_A\_IRR\_UND}$	0.141
	(0.150)
$\beta_{HEA\_G\_IRR\_UND}$	-0.361**
	(0.150)
$\beta_{CF\_A\_IRR\_UND}$	0.0654
	(0.150)
$\beta_{CF\_G\_IRR\_UND}$	-0.155
	(0.150)
α	-0.300***
	(0.0980)
Wald Test [b]: χ^2	98.330***
Wald Test [c]: χ^2	11.940**
Obs.	504
Subjects	63

Note: ***p<0.01; **p<0.05; *p<0.10

[a] Standard Errors in parentheses

[b] H_0: $\beta_{FAT\_A\_IRR} = \beta_{FAT\_G\_IRR} = \beta_{CF\_A\_IRR} = \beta_{CF\_G\_IRR} = 0$

[c] H_0: $\beta_{FAT\_A\_IRR\_UND} = \beta_{FAT\_G\_IRR\_UND} = \beta_{CF\_A\_IRR\_UND} = \beta_{CF\_G\_IRR\_UND} = 0$

Table 5. Summary statistics of variables included in the DCE Model.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
CH_HG	= 1 if alternative A is selected = 0 otherwise	585	1.099	0.800	0.000	2.000
HEA_R[a]	= 1 if health is red in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
HEA_A	= 1 if health is amber in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
HEA_G	= 1 if health is green in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
CF_R[a]	= 1 if carbon footprint is red in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
CF_A	= 1 if carbon footprint is amber in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
CF_G	= 1 if carbon footprint is green in alternative A and B = 0 otherwise	585	0.333	0.472	0.000	1.000
PR[b]	Price of alternative A and B	585	3.000	1.292	1.000	5
IRR	= 1 if subjects behave irrationally = 0 otherwise	585	0.615	0.486	0.000	1.000

[a] Health and environmental sustainability are not defined in the not-buy alternative (C).

[b] Price ranges from £1 to £5, it is =0 for the not-buy alternative (C).

significant which indicates that subjects who behave irrationally (in the IV DCE task) are willing to pay less than others (i.e., rational subjects) for lasagne that are green in carbon footprint. A Wald Test rejects the null hypothesis that coefficients $\beta_{HEA\_A\_IRR}$, $\omega_{HEA\_G\_IRR}$, $\omega_{CF\_A\_IRR}$, $\omega_{CF\_G\_IRR}$ are jointly equal to zero (9.570, $p<0.05$). Overall, these results show that deviations from rationality in the IV task affect estimated HGVs far less in the DCE than in the SPVA treatment group.[14] Such results may be related to the fact that DCE does not require any strategic interaction among subjects participating to the experiment and expose subjects to decision tasks that resemble "real-life" purchasing situations. These factors may lower the impact that deviations from rationality investigated using IV procedures have on HGVs elicited for lasagne.

4.4 Determinants of irrational bidding and choice behavior

A behavioral model aiming to capture variables explaining irrational bidding and choice behavior is developed (Model 4). Data from the SPVA and DCE treatment groups are pooled. The dependent variables *IRR* is a binary variable, indicating if subjects' bidding or choice behavior deviates from rationality in the IV settings. We included only independent variables that potentially affect the probability of submitting/making demand

[14] To test the consistency of estimation results, an alternative model was estimated. In this model, we incorporate the rate of non-demand revealing choices made per subjects. This variable indicates the rate of irrationality. Estimation results are provided in Tables F2 and F3 of the supplementary online appendix F.

revealing bids/choices. These are: *DCE* which indicates whether the subject belong to the DCE treatment or not; *TIME* which indicates whether the subjects participated to the 13.30 or 18.30 session; *HUNGRY* which indicates the self-reported level of hunger of subjects at the beginning of the experiment (from a minimum of 1 to a maximum of 7), *FEMALE* which indicate if the subject is female or not; *AGE* indicating each subject's age; *INCOME* which indicates each subjects' annual net income.

Summary statistics of variables incorporated in our behavioral models are provided in Table 7. The estimation results of Model 4 are presented in Table 8. We find that the coefficient β_{DCE} is negative and statistically significant (-2.282; $p<0.01$) which indicates that irrational behavior is more likely in the SPVA than in the DCE. We also find that subjects' hunger level (β_{HUNGRY}) has a negative and statistical significant (-0.260, $p<0.10$) effect on being irrational. This might indicate that subjects who were hungrier paid more attention to the tasks as they knew lasagne were at stakes during the experiment.[15]

5. Conclusions

Second-price Vickey auctions and discrete choice experiments are widely used to evaluate welfare benefits of new food policies that are not implemented yet. These evaluations are often used in benefit-cost analysis to decide whether to operationalize food policies or not. Therefore, it is important to explore the reliability and robustness of evaluations that are conducted using these value elicitation techniques. This paper contributes to this literature by testing if subjects behave rationally when exposed to these value-elicitation procedures and if deviations from rational choice behavior affect policy evaluation.

Psychologists and behavioral economists have challenged the main underlying assumption of neoclassical economics: economic agents always behave rationally to maximize utility. Simon's notions of sat-

[15] An alternative model in which the dependent variable is the rate of irrational bids/choices submitted is estimated. Results are provided in the online supplementary appendix G.

Table 6. WTP-space Multinomial Logit Models for DCE Data[a,b].

Dep. Var.: *CHOICE*	
Coefficients	Model 3
$\omega_{opt\text{-}out}$	2.332***
	(0.417)
$\omega_{HEA\_A,mean}$	0.497***
	(0.143)
$\omega_{HEA\_G.mean}$	1.583***
	(0.152)
$\omega_{CF\_A,mean}$	0.691***
	(0.145)
$\omega_{CF\_G,mean}$	1.772***
	(0.164)
$\omega_{HEA\_A,sd}$	1.051***
	(0.0981)
$\omega_{HEA\_G.sd}$	1.115***
	(0.121)
$\omega_{CF\_A,sd}$	0.547***
	(0.0589)
$\omega_{CF\_G,sd}$	1.341***
	(0.0954)
$\omega_{HEA\_A\_IRR}$	-0.193
	(0.223)
$\omega_{HEA\_G\_IRR}$	-0.590
	(0.414)
$\omega_{CF\_A\_IRR}$	0.433**
	(0.174)
$\omega_{CF\_G\_IRR}$	-0.317***
	(0.190)
λ_{mean}	-0.393
	(0.286)
λ_{sd}	2.018***
	(0.463)
Wald Test [c]: χ^2	9.570**
Log-likelihood	-433.913
Obs.	1,755
Subjects	65

Note: ***p<0.01; **p<0.05; *p<0.10
[a] Standard Errors in parentheses
[b] 1,000 Halton Draws
[c] H_0:$\omega_{HEA\_A\_IRR} = \omega_{HEA\_G\_IRR} = \omega_{CF\_A\_IRR} = \omega_{CF\_G\_IRR} = 0$

Table 7. Summary statistics of variables included in the behavioral model.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
IRR	= 1 if subjects behave irrationally = 0 otherwise	128	0.719	0.451	0.000	1.000
DCE	= 1 DCE treatment = 0 otherwise	128	0.508	0.502	0.000	1.000
TIME	= 1 if lunch session = 0 otherwise	128	0.516	0.502	0.000	1.000
HUNGRY	Reported level of hunger from 1 (not hungry at all) to 5 (extremely hungry)	128	4.102	1.502	1.000	6.000
FEMALE	= 1 female = 0 otherwise	128	0.637	0.482	0.000	1.000
AGE	Age in years	128	36.466	13.616	19.000	70.000
INC	Yearly net income in £	128	38,578.740	29,334.850	5,000.000	150,000.000

Table 8. Behavioral Binary Logit Model[a].

Model 6	
Dep. Var.: *DM*	**Coefficients**
β_{DCE}	-2.282***
	(0.509)
β_{TIME}	0.310
	(0.442)
β_{HUNGRY}	-0.260*
	(0.153)
β_{FEMALE}	0.334
	(0.475)
β_{AGE}	0.017
	(0.016)
β_{INCOME}	1.08e-05
	(1.12e-05)
α	2.069*
	(1.125)
Log-likelihood	-61.935
Obs.	128
Subjects	128

Note: ***p<0.01; **p<0.05; *p<0.10
[a] Standard Errors in parentheses

isficing and bounded rationality are classic examples (1955; 1986). Kahneman and Tversky have based part of their research on economic decision making on the idea that two types of cognitive processes exist, the well-known systems 1 and 2. The former is characterized by speed, intuition, associations, heuristics and emotions. The latter by slowness, reasoning, rules, logic and self-control. It is possible to argue that system 2 is dominated by rationality, while system 1 does not.

This paper explores the impact of deviations from rationality on the evaluation of new public policies interventions and focuses on an information-based food policy which aims to promote consumption of healthy and environmentally sustainable food products. These are two of the pillars of the notion of sustainable diets. Specifically, this study investigates the impact of deviations from rationality on consumers' home-grown values for ready meals (i.e., frozen lasagne) that are labelled using nutritional and carbon footprint labels. Home-grown values are elicited via bid- (i.e. second-price Vickey auctions) and choice-based methods (i.e. discrete choice experiments). Deviations from rationality are explored using induced value procedures.

Our results suggest that deviations from rationality are more likely to occur in second-price Vickey auctions than discrete choice experiments: 77.78% of the sample deviates from rational behavior in second-price Vickey auctions, only the 61.50% of the sample in discrete choice experiments. This result suggests that choice-based value elicitation techniques, such as discrete choice experiments, induce rationality more than bid-based methods, such as second-price Vickey auctions. This result seems to support Li's (2017) argument that second-price Vickey auction is not an obviously strategy-proof technique and hence identification of the payoff maximizing strategy is not obvious. Which method predict choice behavior better in real settings remains an open question.

The impact of irrationality on home-grown values in second-price Vickey auctions is rather substantial and systematic. Subjects whose behavior deviates from rationality have higher home-grown values for lasagne than rational ones. Also, our results indicate that underbidding spills over from induced-value to home-grown value settings, meaning that subjects who consistently underbid in the induced-value setting, tend to submit lower bids than the others in the home-grown setting. This is a very intriguing result, indicating that underbidding may be an intrinsic individual-specific behavior. Future research could explore cognitive processes or personal traits driving this phenomenon. On the other hand, deviations from rationality do not seem to follow a clear pattern and barely affect home-grown values elicited via discrete choice experiments. These results may be due to the fact that subjects are exposed to rather different valuations environments and framings in the second-price Vickery auctions and discrete choice experiments. For example, subjects may perceive the second-price Vickrey auction as a competitive institution and they may tend to adopt a strategic bidding behavior which is consistently used in both induced value and home-grown value settings. In contrast, in the discrete choice experiments, subjects make individual choices that do not generally depend on other consumers' decisions. Hence, strategic behavior is very limited in discrete choice experiments and this may explain why deviations from rationality in induced value setting have little impact on elicited home-grown values. Additionally, in second-price Vickrey auctions, subjects are asked to form their own home-grown values for different food products, while, in discrete choice experiments, subjects are asked to make choices among food products and market prices are given to subjects in each choice set. The former is a rather unusual situation for a consumer, while the latter is very familiar. Hence, it is reasonable to argue that irrationality may play a more substantial role in home-grown values elicited via second-price Vickery auctions than discrete choice experiments.

Overall, we conclude that home-grown values elicited via discrete choice experiments are rather robust. These results may be significant for policy makers who wish to use findings from second-price Vickrey auctions and discrete choice experiments in *ex ante* benefit-cost analyses of new policy interventions.

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Appendix A

Healthiness was based on the amount of saturated fat in the lasagne. The criteria for the saturated fat content of the different lasagne was based on the UK Food Standard Agency guidance; green ≤1.5g/100g, amber >1.5 to ≤5.0g/100g, red >5.0g/100g (FSA 2013). A second TLS was used for the carbon footprint. The carbon footprint was the sum of GHGE (kgCO_2e) for each ingredient in the lasagne (GHGE data published by Audsley *et al.* (2009)). The system boundaries for these data are from primary production to the point of the regional distribution centre. This does not include food processing, retail, household use and waste but these would be similar for all the lasagne as only the ingredients varied. There are no standardised guidelines for labelling GHGE for foods therefore the three levels were set by the researchers; green ≤0.26 kgCO_2e/100g, amber >0.26 to <0.4 kgCO_2e/100g, red ≥0.4 kgCO_2e/100g. The range of meat content between the lasagne was similar to commercially pre-prepared lasagne at the time of the study (7% to 20% meat).

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Appendix B

Induced value SPVA

	Token	Token	Token	Token	Token	Token	Token	Token	Token
	1	2	3	4	5	6	7	8	9
RESALE VALUE	£3.50	£5.00	£3.00	£1.00	£4.00	£1.50	£2.50	£4.50	£2.00
YOUR BID	£_____	£_____	£_____	£_____	£_____	£_____	£_____	£_____	£_____

Home-grown value SPVA

	Lasagne 1	Lasagne 2	Lasagne 3	Lasagne 4	Lasagne 5	Lasagne 6	Lasagne 7	Lasagne 8	Lasagne 9
Healthiness									
Carbon footprint									
YOUR BID	£_____	£_____	£_____	£_____	£_____	£_____	£_____	£_____	£_____

Induced value DCE

CHOICE SITUATION 1	TOKEN	TOKEN	NO TOKEN
	2	5	-
RESALE VALUE	£4.50	£3.50	£0.00
MARKET PRICE	£3.00	£4.00	£0.00
I want to buy:	☐	☐	☐

Home-grown value DCE

CHOICE SITUATION 1	LASAGNE 3	LASAGNE 5	NO LASAGNE
Healthiness			-
Carbon Footprint			-
MARKET PRICE	£3.50	£4.00	£0.00

Appendix C

Table C1. Summary statistics of marginal bids in the SPVA treatment[a].

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
$BID\_HG_{HEA\_R\_CF\_A}$	Marginal bid for red health and amber carbon footprint lasagne	63	0.237	0.707	-3.000	1.500
$BID\_HG_{HEA\_R\_CF\_G}$	Marginal bid for red health and green carbon footprint lasagne	63	0.240	0.981	-4.000	1.950
$BID\_HG_{HEA\_A\_CF\_R}$	Marginal bid for amber health and red carbon footprint lasagne	63	0.321	1.025	-4.000	2.000
$BID\_HG_{HEA\_A\_CF\_A}$	Marginal bid for amber health and amber carbon footprint lasagne	63	0.773	1.407	-3.500	3.350
$BID\_HG_{HEA\_A\_CF\_G}$	Marginal bid for amber health and green carbon footprint lasagne	63	0.764	1.459	-4.000	3.500
$BID\_HG_{HEA\_G\_CF\_R}$	Marginal bid for green health and red carbon footprint lasagne	63	1.086	1.508	-3.500	4.000
$BID\_HG_{HEA\_G\_CF\_A}$	Marginal bid for green health and amber carbon footprint lasagne	63	1.325	1.581	-4.000	4.500
$BID\_HG_{HEA\_G\_CF\_G}$	Marginal bid for green health and green carbon footprint lasagne	63	1.606	1.922	-4.000	5.000

[a] A marginal bid is the difference between any lasagne other than a red in health and red in environmental sustainable lasagne (in £) and the bid for a red in health and red in environmental sustainable lasagne.

Appendix D

In Model 1a, we replace the variable *IRR* with *IRR_FREQ*. The latter indicates the percentage of non-demand revealing bids submitted in the IV setting by each subject. Main summary statistics of the variable *IRR_FREQ* is reported in Table D1. Results from the estimation of Model 1a indicate similar to Model 1, but weaker effects (Table D2). While, the coefficients $\beta_{HEA\_A\_IRR\_FREQ}$ and $\beta_{CF\_A\_IRR\_FREQ}$ are not statistically significant, the coefficient $\beta_{HEA\_G\_IRR\_FREQ}$ and $\beta_{CF\_G\_IRR\_FREQ}$ are positive and significant (0.422, $p<0.01$ and 0.338, $p<0.05$). This suggests that *mWTP* for healthiest and low carbon footprint lasagne (i.e., green) increases when the rate of irrational IV bids increases (i.e., the degree of irrational behavior). A Wald Test rejects the null hypothesis that coefficients $\beta_{HEA\_A\_IRR\_FREQ}$, $\beta_{HEA\_G\_IRR\_FREQ}$, $\beta_{CF\_A\_IRR\_FREQ}$, $\beta_{CF\_G\_IRR\_FREQ}$ are jointly equal to zero (37.800, $p<0.01$).

Table D1. Summary statistics of variables included in the SPVA-related Models.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
IRR_FRQ	Rate of non-demand revealing bids per subject	504	0.681	0.394	0.000	1.000

Table D2. Generalised least-square regression models with correction for heteroscedasticity for SPVA data.

Dep. Var: *BID_HG*	
Coefficients	Model 1a
β_{HEA_A}	0.525***
	(0.126)
β_{HEA_G}	0.833***
	(0.126)
β_{CF_A}	0.383***
	(0.126)
β_{CF_G}	0.483***
	(0.126)
$\beta_{HEA\_A\_IRR\_FREQ}$	0.196
	(0.146)
$\beta_{HEA\_G\_IRR\_FREQ}$	0.422***
	(0.146)
$\beta_{CF\_A\_IRR\_FREQ}$	0.175
	(0.146)
$\beta_{CF\_G\_IRR\_FREQ}$	0.338**
	(0.146)
α	-0.297***
	(0.105)
Wald Test [c]: χ^2	37.800***
Obs.	504
Subjects	63

Note: ***p<0.01; **p<0.05; *p<0.10

[a] Standard Errors in parentheses

[b] H_0: $\beta_{FAT\_A\_IRR\_FREQ} = \beta_{FAT\_G\_IRR\_FREQ} = \beta_{CF\_A\_IRR\_FREQ} = \beta_{CF\_G\_IRR\_FREQ} = 0$

Appendix E

Three variations of Model 2 are estimates:

i) Model 2a: We estimate Model 2 while excluding from the sample the two subjects who constantly overbid in the IV task. These are considered as outliers.
ii) Model 2b: We specify the variable *UND* as percentage of underbids (per subject) in the IV setting. This variable measures the rate of underbidding. The main statistics for this variable are provided in Table E1.
iii) Variation 2 (Model 2c): We estimate Model 2b while excluding from the sample the two subjects who constantly overbid in the IV task.

Table E1. Summary statistics of variables included in the SPVA-related Models.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
UND_FREQ	Percentage of underbidding per subject	504	0.681	0.394	0.000	1.000

Results from the estimation of Models 2a, 2b and 2c are provided in Table E2. Results are consistent across specifications. The coefficient $\beta_{HEA\_G\_IRR\_UND}$ is always negative and statistically significant. We always reject the null that coefficients $\beta_{HEA\_A\_IRR\_UND}$, $\beta_{HEA\_G\_IRR\_UND}$, $\beta_{CF\_A\_IRR\_UND}$ and $\beta_{CF\_G\_IRR\_UND}$ are jointly equal to zero.

Table E2. Generalised least-square regression models with correction for heteroscedasticity for SPVA data.

Dep. Var: *BID_HG*			
Coefficients	Model 2a	Model 2b	Model 2b
β_{HEA_A}	0.451***	0.547***	0.531***
	(0.116)	(0.124)	(0.124)
β_{HEA_G}	0.703***	0.703***	0.786***
	(0.116)	(0.116)	(0.124)
β_{CF_A}	0.294**	0.294**	0.373***
	(0.116)	(0.116)	(0.124)
β_{CF_G}	0.348***	0.348***	0.456***
	(0.116)	(0.116)	(0.124)
$\beta_{HEA\_A\_IRR}$	0.211	0.211	0.127
	(0.143)	(0.143)	(0.184)
$\beta_{HEA\_G\_IRR}$	0.730***	0.730***	0.763***
	(0.143)	(0.143)	(0.184)
$\beta_{CF\_A\_IRR}$	0.267*	0.267*	0.135
	(0.143)	(0.143)	(0.184)
$\beta_{CF\_G\_IRR}$	0.594***	0.594***	0.420**
	(0.143)	(0.143)	(0.184)
$\beta_{HEA\_A\_IRR\_UND}$	0.114	0.114	0.116
	(0.151)	(0.151)	(0.174)
$\beta_{HEA\_G\_IRR\_UND}$	-0.388**	-0.388**	-0.507***
	(0.151)	(0.151)	(0.174)
$\beta_{CF\_A\_IRR\_UND}$	0.0435	0.0435	0.0936
	(0.151)	(0.151)	(0.174)
$\beta_{CF\_G\_IRR\_UND}$	-0.166	-0.166	-0.102
	(0.151)	(0.151)	(0.174)
α	-0.290***	-0.290***	-0.285***
	(0.0984)	(0.0984)	(0.104)
Wald Test [b]: χ^2	105.360***	105.360***	46.230***
Wald Test [c]: χ^2	13.18**	13.18**	13.490***
Obs.	488	488	488
Subjects	61	61	61

Note: *p<0.01; **p<0.05; ***p<0.10

[a] Standard Errors in parentheses

[b] H_0:$\beta_{HEA\_A\_IRR}=\beta_{HEA\_G\_IRR}=\beta_{CF\_A\_IRR}=\beta_{CF\_G\_IRR}=0$

[c] H_0: $\beta_{HEA\_A\_IRR\_UND}=\beta_{HEA\_G\_IRR\_UND}=\beta_{CF\_A\_IRR\_UND}=\beta_{CF\_G\_IRR\_UND}=0$

Appendix F

Detailed summary statistics of the choice variable (*CH_HG*) are provided in Table F1 below.

Table F1. Summary statistics of DCE choices.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
CH_HG_A	= 1 if alternative A is selected = 0 otherwise	585	0.275	0.446	0	1
CH_HG_B	= 1 if alternative B is selected = 0 otherwise	585	0.350	0.477	0	1
CH_HG_C	= 1 if alternative C is selected = 0 otherwise	585	0.374	0.485	0	1

Model 3a replaces the variable *IRR* in Model 3 with *IRR_FREQ*. This variable indicates the rate of irrational choice made by each subject. Main statistics of this variable are presented in Table F2. Results from the estimation of Model 3a are reported in Table F3. None of the coefficients $\beta_{HEA\_A\_DM\_FREQ}$, $\beta_{HEA\_G\_DM\_FREQ}$, $\beta_{CF\_A\_DM\_FREQ}$ and $\beta_{CF\_G\_DM\_FREQ}$ is statistically significant and a Wald test fails to rejects the hypothesis that these coefficients are jointly equal to zero (0.840). These results indicates that the rate of irrationality does not affect HGV elicited via DCE.

Table F2. Summary statistics of variables included in the DCE Model.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
DM_FREQ	Percentage of non-demand revealing choices	585	0.376	0.252	0.000	1.000

Table F3. WTP-space Multinomial Logit Models for DCE Data[a,b].

Dep. Var.: *CHOICE*	
Coefficients	Model 3a
$\omega_{opt\text{-}out}$	1.884***
	(0.416)
$\omega_{HEA\_A,mean}$	0.233
	(0.277)
$\omega_{HEA\_G,mean}$	1.209***
	(0.194)
$\omega_{CF\_A,mean}$	0.626***
	(0.225)
$\omega_{CF\_G,mean}$	1.526***
	(0.192)
$\omega_{HEA\_A,sd}$	0.969***
	(0.0796)
$\omega_{HEA\_G,sd}$	1.548***
	(0.114)
$\omega_{CF\_A,sd}$	0.0816*
	(0.0450)
$\omega_{CF\_G,sd}$	1.416***
	(0.105)
$\omega_{HEA\_A\_IRR\_FREQ}$	-0.333
	(0.414)
$\omega_{HEA\_G\_IRR\_FREQ}$	0.204
	(0.298)
$\omega_{CF\_A\_IRR\_FREQ}$	0.262
	(0.353)
$\omega_{CF\_G\_IRR\_FREQ}$	-0.052
	(0.305)
λ_{mean}	-0.505
	(0.319)
λ_{sd}	1.963***
	(0.350)
Wald Test [d]: χ^2	0.840
Log-likelihood	-431.878
Obs.	1,755
Subjects	65

Note: *p<0.01; **p<0.05; ***p<0.10
[a] Standard Errors in parentheses
[b] 1,000 Halton Draws
[c] H_0:$\omega_{HEA\_A\_IRR\_FREQ} = \omega_{HEA\_G\_IRR\_FREQ} = \omega_{CF\_A\_IRR\_FREQ} = \omega_{CF\_G\_IRR\_FREQ} = 0$

Appendix G

In Model 4a, the dependent variable is *IRR_FREQ* which indicates the rate of irrational bids/choices submitted per subject. Summary statistics for this variable are presented in Table G1.

Table G1. Summary statistics of variables included in the behavioral model.

Variable	Description	Obs.	Mean	St.Dev.	Min	Max
DM_FREQ	Percentage of non-demand revealing observations	128	0.588	0.345	0.000	1.000

Results from the estimation of Model 4a suggests that the rate of irrationality is higher in the SPVA treatment as compared to the DCE treatment (Table G2). The coefficient β_{DCE} is negative and statistically significant (-1.731; p<0.01). We find that females (β_{FEM}) are more likely to act irrationally (0.492, p<0.10). Interestingly, the coefficient β_{INCOME} is positive and statistical significant (1.05e-05, p<0.10). This may suggest that monetary payoffs in the IV tasks were not high enough to incentivise higher income subjects.

Table G2. Behavioral Binary Logit Model[a].

Generalized Linear Model	
Dep. Var.: *DM_FREQ*	Coefficients
β_{DCE}	-1.731***
	(0.260)
β_{TIME}	0.318
	(0.243)
β_{HUNGRY}	-0.048
	(0.076)
β_{FEMALE}	0.492*
	(0.279)
β_{AGE}	0.02
	(0.00827)
β_{INCOME}	1.05e-05*
	(6.31e-06)
α	0.203
	(0.578)
Log-likelihood	-60.347
Obs.	128
Subjects	128

Note: ***p<0.01; **p<0.05; *p<0.10
[a] Standard Errors in parentheses