

WTP for canned crushed tomatoes

Subjects: Others

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The paper investigated whether information about the health benefit produced by lycopene could influence consumers' willingness to pay (WTP) for canned crushed tomatoes enriched with lycopene. An additional aim was to determine whether the main socio-demographic variable - such as sex, age, income - and selected attitudinal factors affect WTP. A non-hypothetical experimental auction was carried on with five repeated rounds. Results show a relevant impact of information on WTP in the case of lycopene-enriched products, whereas no difference in bids emerges for the conventional product. Previous knowledge seems to have a modest influence on WTP, but it shows a significant interaction with the information shock provided during the experiment: the effect of the latter is more pronounced when previous knowledge is low. In addition, age, sex, food technology neophobia, trust in science, and implicit attitudes towards food technology significantly affect participants' WTP.

Keywords : Quantile regression ; Experimental auction ; Lycopene ; Information

1. Introduction

Functional products are among the most interesting food categories in terms of market opportunities and one of the faster growing food sectors. This global growth is strongly related to the increased consumers' awareness about the role of food in wellbeing, either to help prevent chronic diseases and to optimize health. Despite the considerable success and interest, yet there is not a universally accepted definition for this group of food. On a very general level, they could be defined as food products providing an added health benefit over and above the traditional food nutritional value.

From the production point of view, functional food is a good firm strategy to create differentiated, value-added products, however, many of those innovative products have failed. In Europe the performance of new functional food launched on the market has not always been in line with the optimistic expectations of the producers. People are more reluctant in adopting functional food than in Asia or North America ^{[1][2]}. The last survey of the Spanish government revealed that consumers attach more importance to the origin of the product (i.e., those produced in their own region, or with Protected Denomination of Origin) than functionality ^[3]. Moreover, Backstrom and colleagues ^[4] reported that functional food is associated to a medicine-like representation, evoking quite negative impressions among participants. Furno et al. ^[5] performed experimental auctions on between samples in order to study hypothetical bias. They highlight the role of explicit and implicit attitudes towards food technology. Most of the research on consumers acceptance of functional food and dealing with information and its effects on willingness to pay (WTP) or accept, is limited to investigating whether information and/or different types of information may alter WTP ^{[6][7][8][9]}. To the best of our knowledge, the study of the main factors influencing the change in the willingness to pay due to the administration of information is a topic still understudied.

The products chosen for the present study are canned tomatoes, naturally containing lycopene. Several studies indicate lycopene among the main natural components capable of inhibiting the proliferation of cancer cells in some of the most common types of cancer ^[10]. Yet, it should also be noted that the EFSA (European Food Safety Authority) has not yet approved any health claims related to lycopene considering the scientific evidence still insufficient ^[11]. Given this not yet well-defined scenario on health claims related to lycopene, the focus of the present study is to investigate whether information about the possible health benefits produced by lycopene could influence consumers' WTP for canned crushed tomatoes enriched with lycopene.

Our specific objectives are:

1. To determine whether information on the benefit of lycopene affects the consumers' WTP both on canned tomatoes enriched with lycopene and conventional canned tomatoes (not enriched).
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- References** whether and how several selected variables, namely socio-demographics, attitudinal constructs, and control variables, affect WTP. More in detail, the impact of these variables on WTP will be investigated also in the tails of the bid distribution;
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2. Materials and Methods

2.1. Participants

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Table 1. Summary statistics of the explanatory variables of the model ($n=100$)

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Variable	Mean	Std. Dev.	q25	q50	q75
Age	23.88	4.00	21.0	24.0	25.5
Gender	0.560	0.49	0.00	1.00	1.00
Income	2.300	0.87	2.00	2.00	3.00

11. EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) Scientific Opinion on the substantiation of health claims related to lycopene and protection of DNA, proteins and lipids from oxidative damage (ID1608, 1609, 1611, 1662, 1663, 1664, 1899, 1942, 2081, 2082, 2142, 2374), protection of the skin from UV-induced (including photo-oxidative) damage (ID1607, 1665, 2143, 2262, 2373), contribution to normal cardiac function (ID1610, 2372), and maintenance of normal vision (ID1827) pursuant to Article 13(1) of Regulation (EC) No 1924/2006. *EFSA Journal*, 2011; 9(4), 1-28.
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Control Variables

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	Mean	Std. Dev.	q25	q50	q75
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Consumption Frequency (FREQ)	2.880	0.58	3.00	3.00	3.00
Lycopene Knowledge (KNOW)	2.810	2.87	0.00	2.50	6.00
Measures					
	Mean	Std. Dev.	q25	q50	q75
SC_IAT	-0.068	0.41	-0.40	-0.09	0.25
Social Desirability (SD)	3.975	0.65	3.61	4.00	4.33
FTNS Unnecessary (FTNS1)	3.445	1.12	2.50	3.33	4.33
FTNS Risks (FTNS2)	4.040	1.19	3.37	4.00	4.75
FTNS Benefits (FTNS3)	3.185	1.28	2.50	3.00	4.00
Trust in Science (TISS)	2.31	0.49	1.80	2.20	2.40
Treatment Variable					
	Mean	Std. Dev.	q25	q50	q75
SHOCK	0.500	0.50	0.00	0.50	1.00

2.3. Experimental design and procedure

The experimental auctions were conducted in the computer lab of the Department of Agricultural Science in Portici (Naples) in order to assess WTP for a specific functional product (crushed tomatoes enriched with lycopene). The experimental design was computer administered in order to accelerate data acquisition and to minimize the possibility of error in the collecting the data.

The fifth-price mechanism with a full bidding process was employed. The products in the auction are two packs of three 400-gram cans of crushed tomatoes: conventional crushed tomatoes, and crushed tomatoes enriched in lycopene (50% more). At the end of the 5 rounds, each participant is given a brief note on the nature of lycopene and the potential positive effects on human health. After reading the text, that is the informative shock, the participants take part in a further non-hypothetical auction that takes place in the same conditions as the previous one. Basic socio-demographic characteristics are then collected.

3. Statistical Analysis

3.1. Quantile Regression

The OLS analysis is complemented by the estimates of the regression at various quantiles. While OLS computes the regression at the mean, the quantile regression estimator ^{[15][16]} allows the impact of the explanatory variables to be investigated at different levels of the dependent variable: not only at the center, the mean or the median, but also in the

tails of the distribution, such as the first and third quartiles of the conditional distribution of bids. This is particularly relevant in the case of asymmetry, as is the case in the bid distributions.

3.2. Decomposition analysis

To analyze a data set split in two different subsets, each identified by an index assuming values 0, the bid experiments before information on lycopene, and 1 otherwise, a decomposition approach can be implemented. On average, the Oaxaca ^[17] and Blinder ^[18] decomposition writes the difference between subsets as:

$$E y_1 - E y_0 = (b_1 - b_0) E x_1 + b_0 (E x_1 - E x_0)$$

where expectations are replaced by their sample average and the parameters b_1 , b_0 by their OLS estimates. The result is an average measure of bids difference between the two subsets. We focus on the behavior of $(b_1 - b_0)E x_1$, that would measure for each coefficient the impact of the informative shock on the bids for enriched and for conventional tomatoes.

3.3. Censoring

Since WTP cannot be negative, we also consider Powell ^[19] censored least absolute deviations estimator (CLAD) and the bootstrap estimates of its sampling variance. The CLAD estimator is a generalization of the quantile regression computed at the median.

4. Results

4.1. The model

The model compares the WTP for the enriched and the conventional tomatoes as a function of three main groups of variables: socio-demographic, attitudinal and control variables. The summary statistics of all the study variables are collected in tables 1, 2 and 3.

Table 3. Summary statistics of the dependent variables

Dependent Variable	Mean	Std. Dev.	q25	q50	q75
BIDL50 (n=1000)	2.161	1.58	1.20	1.90	2.80
BIDCONV (n=1000)	1.378	0.87	0.80	1.20	1.80
BIDL50, SHOCK=0 (n=500)	1.977	1.39	1.05	1.80	2.70
BIDCONV, SHOCK=0 (n=500)	1.367	0.88	0.80	1.20	2.70
BIDL50, SHOCK=1 (n=500)	2.346	1.74	1.31	2.10	3.00
BIDCONV, SHOCK=1 (n=500)	1.390	0.87	0.80	1.20	1.80

Note. BIDL50 = bids for the enriched product; BIDCONV = bids for the conventional product; SHOCK = treatment variable that assume value 0 before the information shock and value 1 after the information shock; n = number of observations.

To evaluate if information on the benefit of lycopene affects the consumers' WTP both on canned tomatoes enriched with lycopene and conventional canned tomatoes (not enriched), we compare the bids before and after the informative shock, as reported in Table 4.

Table 4. Summary of Mean and Median (in brackets) WTP by Products and Treatment

	Pre-Shock		Post Shock	
	Conventional	Enriched	Conventional	Enriched
1 st Round, n= 100	1.36 (1.20)	2.00 (1.75)	1.31 (1.20)	2.31 (2.05)
2 nd Round, n= 100	1.37 (1.22)	1.97 (1.80)	1.41 (1.20)	2.35 (2.10)
3 rd Round, n= 100	1.38 (1.20)	1.92 (1.79)	1.37 (1.20)	2.38 (2.05)
4 th Round, n= 100	1.35 (1.20)	1.99 (1.90)	1.48 (1.30)	2.39 (2.10)
5 th Round, n= 100	1.38 (1.20)	2.01(1.85)	1.38 (1.20)	2.30 (2.00)

Informative shock increases the bids for the enriched product, whereas it does not affect their level (mean) for the conventional one, although it affects the dispersion of the average bids.

The second specific objective of the present research is to evaluate whether and how several selected variables, namely socio-demographics, attitudinal constructs, and control variables, affect WTP. To this end two quantile regressions were estimated both for the conventional and enriched products. The estimates of the regression coefficients are reported in Table 5 for the enriched product and in Table 6 for the conventional tomatoes. The last two columns of Table 5 and 6 report the OLS estimated coefficients.

Table 5. OLS and quantile regressions for the enriched tomatoes (n=1000)

Variables	q25		q50		q75		OLS	
	B	SE	B	SE	B	SE	B	SE
AGE	-.018	.013	.036**	.012	.021	.021	.099**	.011
GENDER	.457**	.116	.398**	.105	.432*	.188	.722**	.102
INCOME	-.014	.066	-.020	.060	.025	.108	-.004	.059
FREQ	.143	.092	.285**	.084	.586**	.150	.498**	.082
FTNS1	-.041	.057	.024	.051	-.149	.092	-.064	.050
FTNS2	-.145**	.056	-.247**	.051	-.234*	.092	-.187**	.050
FTNS3	-.003	.044	.146**	.040	.326**	.072	.241**	.039
SD	.041	.085	.065	.077	.243	.138	.182*	.075
TISS	.172	.114	.234*	.104	.627**	.186	.362**	.101
SCIAT	.223	.131	.583**	.119	.381	.214	.418**	.116

SHOCK	.301**	.101	.2*	.092	.403*	.164	.369**	.089
KNOW	-.004	.018	.017	.016	-.002	.030	-.038*	.016
constant	1.02	.618	-.298	.561	-1.78	1.00	-3.37**	.549

Note: Dependent variable: bids for the enriched product. B = estimated coefficients; SE = Standard Error, * = $p < .05$; ** = $p < .01$

Table 6. Estimated regressions for the conventional product (n=1000)

	q25		q50		q75		OLS	
Variables	B	SE	B	SE	B	SE	B	SE
AGE	.004	.008	.006	.007	-.011	.014	-.004	.007
GENDER	.421**	.074	.245**	.065	.498**	.124	.377**	.060
INCOME	-.070	.043	-.120**	.037	.101	.071	-.000	.035
FREQ	.040	.059	.007	.052	.185	.099	.124**	.048
FTNS1	.015	.036	.002	.032	.052	.061	-.018	.029
FTNS2	-.028	.036	-.048	.032	-.157*	.060	-.083**	.029
FTNS3	.067**	.028	.134**	.025	.216**	.047	.093**	.023
SD	-.002	.054	.085	.048	.081	.091	.030	.044
TISS	-.182*	.073	-.182**	.065	.182	.123	.072	.060
SCIAT	.147	.084	.119	.075	.269	.141	.214**	.069
SHOCK	-.016	.065	-.004	.057	.030	.108	.023	.053
KNOW	.024*	.011	.055**	.010	.038*	.019	.025**	.009
constant	.702	.398	.908*	.351	-.046	.662	.661*	.324

Note: Dependent variable: bids for the enriched product. B = estimated coefficients; SE = Standard Error

* = $p < .05$; ** = $p < .01$

The results for the first, second and third quartile regression are reported in the first three columns of Table 5 and 6. Across quartiles the estimated coefficients do change and, depending on the selected quantile, the explanatory variables have a different impact on the dependent variable, a different explanatory power.

The results of the two regressions offer further evidence about the positive effect of the information about the benefit of lycopene on consumers' WTP. Indeed, the informative shock (SHOCK) is statistically relevant at all quantiles and at the conditional mean/OLS in the regression for the enriched product of Table 5. Vice versa, for the conventional product this same variable is not statistically different from zero, as reported in Table 6. About the role played by the socio-demographic variables, gender exerts a positive impact on bids both for the enriched and conventional product, while age and income are mostly not significant.

Overall, attitude toward food technologies exerts a key role in determining bids. The results of the two regressions for the conventional and the enriched canned tomatoes (tables 5 and 6) outline the different role of technophobia in the case of familiar technology. In fact, in the case of conventional crushed tomatoes, which represent a very familiar food product generated by a mature technology, the perception of risks (FTNS2) is significant only at the 75th percentile. In the case of enriched crushed tomatoes, that is an innovative and less familiar food product, the perception of risks is always statistically significant at all quantiles. Moreover, although canned tomatoes are considered by consumers as the result of mature and well-known technologies, it is confirmed that the implicit attitude (SCIAT) reduce WTP for canned tomato pulp. Finally, the two regressions seem to reserve a minor role for self-reported previous knowledge. In fact, previous knowledge does not seem to play any role in the case of enriched products.

Both explicit (FTNS) and implicit attitudes (SCIAT) are significant predictors, particularly at the upper quartile. As expected, the perception of risks linked to technologies decreases WTP while the perception of benefits increases it. The effect of implicit attitude is statistically significant and increases across quantiles. Although significant in the conventional product, the self-reported knowledge provides small estimated coefficients.

The results highlight the existence of different consumers clusters. The clustering suggests the possibility of a fruitful communication and price strategy to build market segmentation.

4.2. Results of the decomposition analysis

The third and final specific objective of the paper was to explore if and how the selected variables affect the possible change in prices after the informative shock; that is, assessing the moderator role of the variables on the WTP. To this end a decomposition approach is implemented and next the relevant variables signalled by the decomposition are added to the main model as interaction terms to measure their additional impact.

Indeed, the variable SHOCK is a dummy that measures the additional explanatory power of information on bids, net of the effect of the informative talk on all the other variables of the equation. It is however possible that the informative talk has affected bids not only directly, but also indirectly through its impact on some/all the other explanatory variables. In order to check if this is the case, we implemented a decomposition analysis.

Table 7 reports the results of the decomposition. The top section of the table reports the overall average decomposition, while the bottom section of the table considers the impact of the informative shock on each regression coefficient as computed on average, by OLS. In the top section, the comparison between bids before and after the informative shock in the enriched product, as computed on average, yields a total difference $Ey_1 - Ey_0 = 0.369$ that is statistically different from zero. The latter is split into endowment effect ($Ex_1 - Ex_0$), that is equal to zero since people characteristics do not change after the informative shock, and coefficient effect that is equal to the total difference, $(b_1 - b_0) Ex_1 = 0.369$. Therefore, there is a significant difference between bids before and after the shock in the enriched product case that cannot be explained by the covariates of the model but must be credited to information. For the conventional product instead, the overall average difference in bids before and after the shock is not statistically relevant.

Table 7: Oaxaca-Blinder decomposition of the total difference due to information (n=1000)

Functional			Conventional		
mean group_0	1.98	.062	mean group_0	1.37	.040
mean group_1	2.35	.078	mean group_1	1.39	.039
mean difference	.369**	.100	mean difference	.023	.056

in endowments	0	.054	in endowments	0	.044
in coefficients	.369**	.091	in coefficients	.023	.035
Variable	B	SE	Variable	B	SE
AGE	1.74**	.56	AGE	.007	.34
GENDER	.094	.11	GENDER	-.065	.06
INCOME	-.018	.26	INCOME	-.040	.16
FREQ	.114	.46	FREQ_CONS	-.226	.28
KNOW	-.241**	.09	KNOW	-.004	.05
FTNS1	.350	.34	FTNS1	.056	.20
FTNS2	-.226	.40	FTNS2	-.148	.24
FTNS3	.290	.25	FTNS3	-.068	.15
SD	.559	.59	SD	.315	.35
TISS	-.182	.42	TISS	-.105	.25
SC_IAT	.005	.01	SC_IAT	.001	.01
Constant	-2.112	1.08	Constant	.299	.64

Note: Dependent variable: bids for the enriched and conventional products. B = estimated coefficients; SE = Standard Error; * = $p < .05$; ** = $p < .01$

Next the impact of the shock on each explanatory variable is reported in the lower section of this table. For the enriched product the informative shock has a relevant impact on the age coefficient, and on the knowledge of the qualities of lycopene. After the briefing on lycopene qualities, the age coefficient increases, while the knowledge coefficient decreases the impact on bids. Vice versa, in the conventional product the knowledge of lycopene properties and age have no relevant impact on any of the variables explaining bids.

4.3. Censoring

Unlike the standard estimators of the censored regression model such as Tobit or other maximum likelihood approaches, the CLAD estimator is robust to heteroscedasticity and is consistent and asymptotically normal for a wide class of error distributions. Bootstrap estimates of the sampling variance are provided using a simple random design. The objective function of Powell estimator is given by $S[y_i - \max(0; x_i'b)]$ and is iteratively estimated. Table 8 reports the results. For comparison sake, the table reports the results of the uncensored median regression (LAD in the table) and of the mean regression (OLS in the table) estimators.

Table 8. Censored and uncensored regression with (Model 1) and without (Model 2) interactions (n=1000)

Model 1	Model 2
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Variable	LAD	SE	CLAD	SE	OLS	SE	LAD	SE	CLAD	SE	OLS	SE
SHOCK	.262	.555	.262	.518	-1.079	1.266	.200*	.092	.200*	.080	.369**	.089
INCOME	-.006	.060	-.006	.125	-.004	.052	-.020	.060	-.020	.124	-.004	.051
AGE	.035*	.017	.035*	.015	.063*	.031	.036**	.012	.036**	.013	.099**	.029
GENDER	.392**	.105	.392**	.015	.722**	.109	.398**	.105	.398*	.157	.722**	.110
FREQ	.299**	.084	.300**	.071	.498**	.085	.285**	.084	.285**	.081	.498**	.086
FTNS1	.005	.051	.005	.073	-.064	.043	.024	.051	.024	.075	-.064	.043
FTNS2	-.252**	.051	-.252**	.049	-.186**	.043	-.247**	.051	-.247**	.049	-.186**	.043
FTNS3	.175**	.040	.175**	.052	.241**	.053	.146**	.040	.146**	.044	.241**	.054
TISS	.329**	.104	.330	.226	.362**	.096	.234*	.104	.234	.210	.362**	.095
SD	.169*	.077	.170	.148	.181*	.073	.065	.077	.065	.152	.181*	.074
SCIAT	.661**	.119	.661**	.193	.417**	.112	.583**	.119	.583**	.175	.417**	.112
KNOW	.062**	.023	.062*	.029	.009	.022	.017	.017	.017	.024	-.038*	.016
Shock*Know	-.089**	.032	-.089**	.023	-.094*	.036						
Shock*Age	.008	.023	.008	.023	.072	.057						

Note: Dependent variable: bids for the enriched product. B = estimated coefficients; SE = Standard Error; * = $p < .05$; ** = $p < .01$

By adding the interactions Shock*Age and Shock*Know, the main effect of the shock variable drops in significance. The negative sign of the know*shock coefficient means that individuals with a low level of previous knowledge are characterized by higher bids as a result of the informative shock. The relevant role played by attitude variables towards technologies, which already emerged in the quantile regression analysis on functionalized products, is fully confirmed.

The LAD estimated coefficients are numerically identical to CLAD results, the sole difference is in the estimated standard errors. The OLS results are not numerically identical to the CLAD estimates, however they fully confirm the CLAD findings.

5. Discussion

5.1. Premium price for lycopene-enriched canned tomato

From our results emerges the higher willingness to pay for the enriched product compared to the conventional one. This premium price that participants are willing to pay for the functionalized product has been confirmed in all five rounds. This means that, even without any specific information about the beneficial properties of lycopene, the WTP changes due to

the label on the package of the enriched product, highlighting the higher content of lycopene.

The higher WTP for the functionalized products confirms previous results obtained in the case of other food products such as bread and yogurt [20]. Second, our study was designed to allow the investigation of participants' attitudes and behavioural reaction to functionalization itself, and the relevance of the attribute is particularly related to the functionalization, which was communicated through an information shock.

5.2. Effect of attitudinal and socio-demographic variables

The second issue discusses the premium price that participants are willing to pay for the enriched product as influenced by the explanatory variables. A significant role of socio-demographic variables emerges. As shown in tables 5 and 6, women are characterized by higher WTP both in the conventional and lycopene-enriched case. Income is not significant at any of the quantiles considered. The influence of age is never significant for the conventional crushed tomatoes, whereas in the case of the enriched products it shows a positive and significant coefficient both on average and at the median. Finally, higher frequency of consumption is associated with higher WTP.

The quantile regression on functionalized products shows the importance of attitudinal variables. The set of variables used to measure the degree of aversion/favour towards food technologies contribute to determine WTP for the functionalized product. While FTNS1, which measures the perceived un-usefulness of new food technology, is never statistically significant, the perception of the risks associated with the use of food-related technologies (FTNS2) has a negative effect on WTP, which is more pronounced in the case of the enriched products. The role played by the perception of benefits (FTNS3) becomes more relevant in the case of higher WTP since the coefficient increases moving from the median to the 75th percentile. The role of the FTNS three dimensions is in line with previous results in the literature considering different food products and food categories. The importance of the attitude towards technologies is also confirmed by the significant role played by implicit attitude, measured through SC-IAT [5][24]. Finally, to complete the set of indicators used to capture the effects of technophobia, the degree of trust towards science also affects WTP for enriched tomatoes: individuals with higher confidence in scientific research show a higher WTP. TISS does not exert any effect in the case of more familiar products like the conventional canned tomatoes. In our best knowledge, this is the first study that show the relevance of explicit and implicit attitudes towards food technology on people's WTP in a non-hypothetical experiment. Findings also suggest that, at least in the case of the cluster of consumers with higher WTP, it may be reasonable to build communicative messages and market segmentation drawing on health benefits associated with functionalized food products [22].

5.3. The role of information and knowledge on WTP for lycopene-enriched canned tomato

To assess the moderator role of the variables on the WTP, the Oaxaca decomposition suggests a potential role of moderator for previous knowledge and age: when the level of knowledge is low, the informative shock produces greater effects in terms of premium price, while the informative shock is associated to higher bids for the enriched product as people grow older. The CLAD regression allows the effects of the informative shock on bidding to be analysed in a censoring context to account for 0 bids (table 7). The CLAD regression is also carried out considering the interactions terms Shock*Knowledge and Shock*Age suggested by the results of the Oaxaca regression. The shock variable is no longer significant when adding interactions; therefore, the variables selected to explain the divergence in the bid before and after the informative shock completely explain the phenomenon. The role of information is already well-known and recently confirmed also in the case of very familiar functionalized food products characterized by an image of naturalness such as apples [23]. However, to the best of our knowledge, this research is the first attempt to identify the factors that are involved in the formation of the premium price resulting from an information shock. The CLAD regression carried out without interaction confirms the results already discussed for the regression with interactions, because in this case the dummy variable on the treatment is significant, confirming the importance of the level of previous knowledge as a moderator of the effect of the informative shock on bids. The OLS regressions confirm these results as well. Finally, since we can interpret the administration of the information shock as an increase in nutritional knowledge, our results also confirm the evidence recently produced by Steinhäuser and Hamm [24] on the positive effect of nutritional knowledge on the intention to purchase.