Consumers' Willingness-to-pay for Healthy Attributes in Food Products: A Meta-analysis

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I. Introduction

Assessing potential demand for functional or healthy foods[1] is crucial from several perspectives. First, foods with functional attributes in many cases require more expensive production process than traditional foods, for example, when the functional attribute is provided by enhancing or enriching the products with additional substances. It is necessary, then, to estimate potential demand for functional foods prior to the delivering product to the consumers. However, due to the fact that many functional foods are of innovative character, assessing potential demand is often complicated by non-availability of actual market data (Lusk & Hudson, 2004). Consequently, hypothetical and non-market valuations of novel functional foods by consumers are often employed to obtain the necessary information.

Second, the promotion of healthier food options is related to the fact that an unhealthy diet is among the four main behavioral risk factors of non-communicable diseases (NCD) that are estimated to account for around 36 million deaths in the world each year and are mostly spread in low- and middle-income countries[2]. It has been demonstrated that prices can be a barrier for healthy food consumption, especially among low-income groups of the population (see e.g. Jetter & Cassady, 2006; Steenhuis, Waterlander, & de Mul, 2011). From this perspective, it needs to be clearly stated if consumers indeed are ready to pay price premiums for foods aimed at improving their health.

Third, market introduction of functional foods and foods with health benefits has not always been successful. Despite the importance of a healthy diet in the prevention of some diseases and sustaining well-being in general, economists and marketing researchers observe some uncertainty in consumers' perception and acceptance of foods with health benefits. Due to the intermediate status between food and medicine functional products go beyond the two main purposes of traditional foods: satisfying hunger and giving hedonic pleasure. In the case of functional foods a third perspective, i.e. the potential health benefit is added to the choice decision. Consequently, a specific health benefit provided by a certain food product is assumed to be a significant factor for consumers' acceptance of this food. However, results of previous research indicate that consumers' acceptance of foods with health benefits depends also on a

[1] The ambiguity of the term "functional food" is well-established in the literature. A comprehensive overview of existing definitions across countries is presented in Doyon & Labrecque (2008).

[2] World Health Organization. Fact sheet on non-communicable diseases. http://www.who.int/mediacentre/factsheets/fs355/en/

variety of other factors besides the health benefit itself (see e.g., Siró, Kápolna, Kápolna, & Lugasi 2008, Verbeke, 2006, and Frewer, Scholderer, & Lambert, 2003). In addition to that, consumers' unwillingness to pay higher prices, along with low trustworthiness or knowledge about foods with health benefits and concerns about taste and naturalness have been indicated as the reasons for multiple market failures of functional and novel foods (Onwezen & Bartels, 2011). Increasing the efficiency of functional foods marketing could also be achieved through more precise assessment of potential demand for these products.

Willingness-to-pay (WTP) estimates have been long used in economics as a demand-revealing indicator. WTP is a welfare measure that corresponds to the amount an individual would be willing to pay to secure the change in the quality of a product (Hanemann, 1991). WTP estimates for healthy attributes in foods measure the amount a consumer would be willing to pay to secure the potential benefit for their health that is obtained from consuming the product.

Previous research demonstrates that willingness to pay for healthy attributes in food products can be influenced by a variety of factors. Among socio-demographic characteristics, age, sex, income and educational level were found to be connected with WTP estimates (Bower, Saadat, & Whitten, 2003; Barreiro-Hurlé, Colombo, & Cantos-Villar, 2008; Øvrum, Alfnes, Almli, & Rickertsen, 2012; Teratanavat & Hooker, 2005; Nordström, 2012; Hellyer, Fraser, & Haddock-Fraser, 2012; Hu, Woods, Bastin, Cox, & You, 2011; Markosyan, Wahl, Thomas, & McCluskey, 2007). Mostly, WTP estimates are positively influenced by income and educational level and negatively by age. Besides, female respondents are often willing to pay higher prices. Other important factors influencing consumers' WTP for healthy attributes in foods are: knowledge and awareness about health benefits; liking of the product; familiarity of the product; consumption patterns, attitudes and beliefs; health concerns; presence of children in the household; taste; price and others. A wide range of factors possibly influencing WTP together with uncertainty about the value of the health benefit itself make it difficult to arrive to a definite conclusions relevant for the economic determinants of consumers' choices with respect to health-enhancing foods.

Thus, market or policy decisions about functional foods are complicated by the above-mentioned complexity of factors influencing consumers' choices. Furthermore, WTP estimates are influenced by many factors during the process of data collection and analysis. In the case of willingness to pay for attributes in food products, it has been shown in previous meta-analyses that differences in WTP estimates can be attributed to methodological issues, for example, elicitation method, as well as to factual differences such as for example heterogeneous consumer preferences in different regions of the world (Dannenberg, 2009; Lusk, Jamal, Kurlander, Roucan, & Taulman, 2005).

This paper investigates the body of research that has been performed so far on consumers' valuations of healthy attributes in food products by means of a meta-analysis. It explores if variation in willingness to pay for healthy attributes in foods that have been reported in scientific papers on the topic can be attributed to common factors related to the choice of the methodology, the place and time of data collection, the choice of the carrier product and the health benefit specified. Thus, our study contributes to the existing literature on health-enhancing food by (i) reviewing the existing empirical evidence on consumer valuations of different healthy attributes, (ii) identifying the major underlying drivers of differences in WTP estimates via meta-analysis and (iii) deriving directions of research to be taken into account for the future developments in the field.

The paper is organized as follows: the next section discusses previous meta-analyses of WTP for different attributes in foods. Section 3 describes the data collection process. Section 4 reports the results of the estimations and section 5 discusses the conclusions.

II. Literature review

Although a meta-analysis of research related to WTP for health benefits in foods has not been performed to date, there exist several studies that meta-analyze consumer preferences for other attributes in foods.

A meta-analysis of the valuations of genetically modified (GM) foods has been carried out by Lusk et al. (2005). They study the influence of such factors as place of study, sample characteristics, valuation formats, and product characteristics on the percentage premium for non-GM foods over GM foods. OLS and weighted OLS are used for the estimations, with and without an extreme outlier. Their results indicate that European consumers' valuations for non-GM foods are higher than those of US consumer and hypothetical valuations, i.e. without actual purchases involved are higher than non-hypothetical ones. Moreover, with respect to sample characteristics the authors find no significant differences between a student and a random sample. However, grocery shoppers exhibit significantly lower WTP values than the general population. With respect to product categories the results show that consumers discount GMO meat more strongly than other product categories, whereas so-called second-generation GMO foods, i.e. GMO foods with a potential health benefit are valued positively.

Another meta-analysis of consumer preferences for genetically modified food was performed by Dannenberg (2009). She uses several dependent variables: a) percentage price premium consumers are willing to pay for the absence of GM ingredients; b) classes of aversion to GM food; c) fraction of the population which is “pro-GM”; d) fraction of the population which is “indifferent” to GM-foods; e) fraction of the population which is “contra-GM”. Weighted least squares technique is used for estimations. Her results confirm the result by Lusk et al. (2005) that European consumers are willing to pay higher price premiums for non-GM food than Americans. With respect to elicitation method her results indicate that a dichotomous choice technique as well as payment card and open-ended questions provided lower valuations than choice experiments. However, no significant differences were found between WTP values elicited from choice experiments in comparison to experimental auctions. Thus, in contrast to results by Lusk et al. (2005) her results do not indicate the presence a significant hypothetical bias. Besides, her results do not indicate a significant sample effect as was found by Lusk et al. (2005).

Florax & Nijkamp (2005) analyze the willingness to pay for reductions in pesticide risk exposure. Due to the fact that the literature on pesticide risk reduction is very diverse, they develop taxonomy for different types of pesticide risk exposure, including the effects on consumers, farmers and ecosystems. It is noted that most of the studies are performed on US data and address health effects on consumers. A meta-regression framework is employed for the analysis. The results indicate that geographical location, sampling type and safety enhancing measure type significantly influence WTP estimates.

Lagerkvist & Hess (2011) meta-analyze literature on consumers’ willingness to pay for farm animal welfare. Explanatory variables in this study include: (i) types of farm animal welfare change; (ii) socio-economic characteristics of consumers; and (iii) each study’s categorical and methodological characteristics. According to their results, respondents’ socio-economic characteristics influence WTP with income having a significant positive and age having a significant negative effect. Besides, WTP values are influenced by cross-country differences, with German and French consumers willing to pay larger price premiums for animal welfare measures. With respect to applied methodologies, the results indicate that methodological differences between studies have only little explanatory power. However, the authors find that cheap-talk scripts and double-bounded dichotomous choice reduce stated WTP values.

Deselnicu et al. (2013) provide a meta-analysis of geographical indication valuation studies. They take into account the type of GI scheme, data and methodology used to estimate the price premium as well as different food categories and the degree of processing. Their results highlight that minimally processed foods with short supply chains (e.g., grains, fruits, vegetables) command the highest price premiums. In contrast, premiums are smaller when the products are processed, the supply chain is long, and firm brands are known to consumers (e.g., olive oil, wine). Surprisingly, their results indicate that WTP estimates from hedonic analyses are significantly higher than WTP values derived from other methods. Unfortunately, the authors do not elaborate on this point. However, it needs to be noted that in contrast to GMO foods GI foods already exist for a rather long time on the market and thus a large body of revealed preference evidence is available. Moreover, GI products are often considered premium or even luxury products such as Champagne or Proscuitto di Parma which might explain this finding,

More recently, social responsibility as a product attribute was studied within the framework of meta-analysis by Tully & Winer (2014). A weighted random effects regression is employed for the analysis. In general, their results indicate that a higher WTP for products that benefit humans compared to other categories like environment or animals. Concerning methodological implications, incentive compatible methods provided significantly higher WTP because they mostly included real purchase data. Although this result does not support the evidence form previous studies, the authors argue that higher WTP values obtained from incentive-compatible methods are probably due to the competitiveness of participants that can appear during the auctions and the fact that socially responsible products are normally priced higher than their traditional counterparts.

To sum up, the existing literature on WTP for certain attributes in foods is vast and heterogeneous. Since there is no standardized procedure to set up the research design or report results an array of potential WTP determinants are indicated. Existing meta-analyses try to shed light on underlying commonalities to derive conclusions that are not only study-specific. Even though these meta-analyses itself are rather heterogeneous in terms of included explanatory variables some general points can be withdrawn. All meta-analyses include variables that try to capture both factual and methodological effects. The former refer to differences in WTP values that are due to real market differences such as different consumer preferences across countries whereas the latter ones are due to differences in experimental design and estimation procedures. With respect to methodological effects the results of previous meta-analyses are not clear-cut. Even though most studies conclude that there are significant differences in WTP values due to the elicitation method the directions are not uniform across studies. With respect to factual effects the location of the study, food categories and sociodemographics were found to be important determinants of WTP values. Different nations seem to have different preferences and thus are willing to pay different price premiums.

III. Data collection

Our inquiry focuses specifically on papers related to the valuation of healthy attributes in food products. Thus, studies reporting valuations of organic products or GM-foods with healthy attributes are not included because of the following reasons. First, the organic attribute can be perceived in more dimensions than just as a health benefit. Sensory, ethical or social concerns of the consumers may dominate the valuation of organic foods compared to health concerns. Second, studies reporting valuations for genetically modified foods with health benefits (so-called second-generation GM foods) are not included in this research because of the controversy surrounding the perception of GM foods by consumers. Although there are studies that report consumer valuations of GM foods with health attributes, it is most likely that the value of the health attribute is biased due to the concerns about genetic modification. Third, since we are interested in the valuations of a specific health attribute, we do not consider studies with WTP estimates received from the reduction of potentially harmful content in foods, like insecticides or pesticides.

Due to a certain ambiguity surrounding the terms “functional food” and “health claim”, and different definitions used in different countries – we specify that this study aims at analyzing the variations in WTP for health-enhancing attributes in foods, regardless if they are named in the study as “healthy attributes”, “functional attributes” or “health claims”.

The databases Google Scholar, ScienceDirect, AgEconSearch, Econis, Greenpilot and IDEAS were searched using the following terms: ”willingness-to-pay”, “healthy food”, “functional food”, “health(y) attributes”, “functional attributes”, “health claim” and their combinations. In case a conference paper and a published article concerning the same study were identified, the published version was used for the analysis. The search resulted in 28 studies fitting to our search criteria (table 1, alphabetical order), including 22 journal articles, 3 conference papers, 1 thesis and 1 report published in a period from 2003 to 2014.

Table 1. List of studies (in alphabetical order) selected for meta-analysis

N	Authors (year)	Method	Product	Region
1	Asselin, 2005	Choice experiment	Omega-3 eggs	Canada
2	Barreiro-Hurlé et al., 2008	Choice experiment	Resveratrol-enriched wine	Spain
3	Bechtold & Abdulai, 2013	Choice experiment	Yogurt, cream cheese and ice cream enriched with Omega-3 fatty acids	Germany
4	Bower et al., 2003	Choice experiment	Spread Benecol	UK
5	Cash et al., 2007	Choice experiment	Beef enhanced/enriched with CLA	Canada
6	Chang, Moon, & Balasubramanian, 2012	Choice experiment	Soy burger/cheese/milk/tofu	USA
7	Chowdhury, Meenakshi, Tomlins, & Owori, 2011	Choice experiment	Orange-fleshed sweet potatoes rich in Vitamin A	Uganda
8	Defrancesco & Galvan, 2005	Contingent valuation	Red chicory with antioxidants	Italy
9	De Groote, Kimenju, & Morawetz, 2011	Auction	Fortified maize	Kenya
10	Emunu, McCann-Hiltz, & Hu, 2012	Contingent valuation	Omega-3 beef	Canada
11	Hellyer et al., 2012	Auction	Whole grain/half and half bread sandwich; whole grain granary bread sandwich; bread sandwich with inulin	UK
12	Hu et al., 2011	Survey	Blueberry herbal tea/basil vinegar/syrup	USA
13	Huffman, Jensen, & Tegene 2010	Hedonic price	Spread "Benecol"	USA
14	Krystallis & Chrysochou, 2012	Choice experiment	Snack food enriched with calcium, vitamins and fibers	Greece
15	Marette, Roosen, Blanchemanche, & Feinblatt-Mélèze, 2010	Auction	Yogurt for lowering cholesterol	France
16	Markosyan et al., 2007	Contingent valuation	Apples with antioxidants	Canada
17	Maynard & Franklin, 2003	Contingent valuation	High-CLA milk/butter/yogurt	USA
18	Moro, Veneziani, Sckokai, & Castellari, 2014	Choice experiment	Catechine-enriched and probiotic yogurt	Italy
19	Muth et al., 2009	Hedonic price	Carb-conscious breakfast bars/cereals	USA
20	Munene, 2006	Contingent valuation	Spread for healthy heart/to reduce cholesterol; bread to reduce the risk of heart disease	USA
21	Naico & Lusk, 2010	Choice experiment	Orange-fleshed sweet potatoes rich in Vitamin A	Mozambique
22	Nordström, 2012	Contingent valuation	Wholesome canteen takeaway	Denmark
23	Øvrum et al., 2012	Choice experiment	Cheese low in (saturated) fat	Norway
24	Teratanavat & Hooker, 2005	Choice experiment	Tomato juice with higher level of lycopene/ containing soy	USA

25	Tra, Moritaka, & Fukuda, 2011	Contingent valuation	Bone health and diabetic powder milk	Vietnam
26	Van Wezemael, Caputo, Nayga, Chryssochoidis, & Verbeke, 2014	Choice experiment	Beef with iron claim/fat claim/protein claim	Netherlands, Belgium, France, UK
27	Zaikin & McCluskey, 2013	Contingent valuation	Apples with antioxidants	Uzbekistan

From these 27 studies 155 WTP estimates were extracted. In case a study did not report the price premiums in percent, they were calculated as follows:

$$Premium\ WTP = \left(\frac{WTP^{product\ with\ health\ attribute} - WTP^{base\ product}}{WTP^{base\ product}}\right) * 100. \qquad (1)$$

The distribution of resulting WTP values is presented in Figure 1. It can be observed that the variation in WTP estimates is very high with the lowest WTP value being equal to -39% and the highest value equal to a 400% price premium. In general, most studies report positive valuations of healthy attributes in foods by consumers.

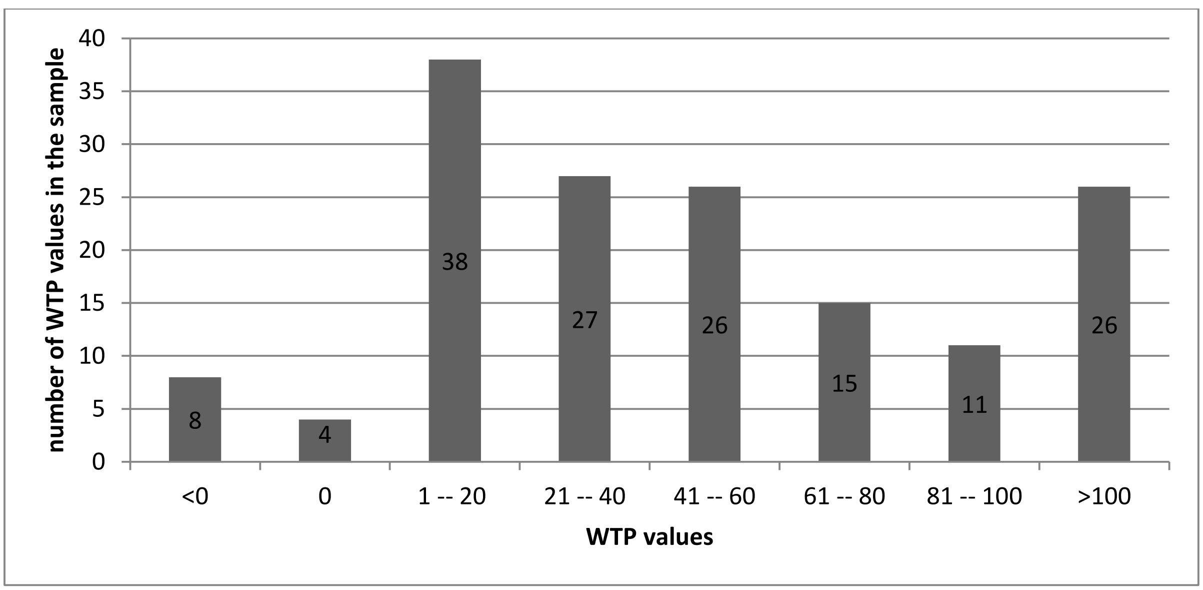

Figure 1. Distribution of willingness to pay values.

Besides high variation in reported values of WTP, studies included in our analysis also differ in sample sizes and the number of WTP values reported per study (see Appendix A). Simple mean of reported price premiums for the whole sample equals 58.42, while the weighted mean is 41.04 (for weighted means in every study see Appendix A).

As we observe a significant overbalance of positive valuations, we test for publication selection following the approach by Stanley (2005). Since not all studies report standard errors, we use the sample size as a determinant of variance (Van Houtven, 2008). Visual investigations of the funnel graph (Fig.2), where price premiums are plotted against the inverse of the square root of the sample sizes demonstrate a significant skewness towards positive willingness to pay values. This might be either due to a publication bias or a real positive valuation of health attributes+. The following analysis is aimed at determining the sources of heterogeneity and possible biases in estimates.

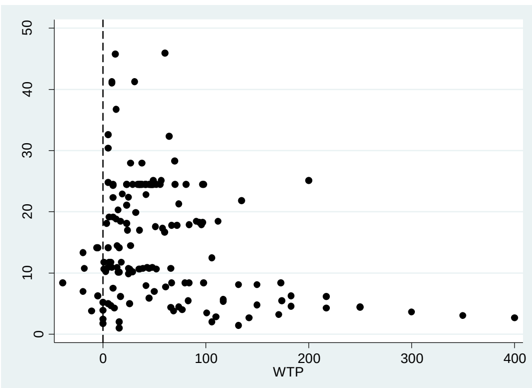

Figure 2. Funnel graph of WTP values

To explain variations in WTP, available information regarding the characteristics of each study was summarized to determine the categories to be included in the meta-analysis. Major differences between studies that could explain the variation in willingness-to-pay estimates were then divided into the following main categories: year and country of data collection; product of interest and health benefit evaluated; and the method of elicitation. From these categories twelve explanatory variables were constructed (table 2).

Table 2. Definitions and means of explanatory variables

Variable	Definition	Mean (std. dev.)
Non_hypothetical	1 if the method used is non-hypothetical valuation; 0 otherwise	0.11 (0.31)
Choice experiment	1 if the method used is choice experiment; 0 otherwise	0.52 (0.50)
Contingent valuation	1 if the method used is contingent valuation; 0 otherwise	0.37 (0.49)
Europe	1 if the place of study is Europe; 0 otherwise	0.50 (0.50)
USA	1 if the place of study is USA; 0 otherwise	0.16 (0.37)
Canada	1 if the place of study is Canada; 0 otherwise	0.10 (0.31)
Region_other	1 if the place of study is other than previous three; 0 otherwise	0.24 (0.43)
Dairy	1 if the product valued is dairy; 0 otherwise	0.26 (0.44)
Fruits/vegetables	1 if the product valued are fruits or vegetables; 0 otherwise	0.17 (0.37)

Product_other	1 if the product valued is other than listed above; 0 otherwise	0.57 (0.50)
Cholesterol	1 if lowering cholesterol is indicated as a health benefit; 0 otherwise	0.14 (0.34)
Attribute_other	1 if the healthy attribute indicated was other than listed above; 0 otherwise	0.86 (0.34)
Year99_07	1 if the data were collected in 1999-2007; 0 otherwise	0.32 (0.47)
Year08_11	1 if the data were collected in 2008-2011; 0 otherwise	0.68 (0.47)

Different types of WTP elicitation methods were used in the studies surveyed: contingent valuation, choice experiments, experimental auctions in different formats, hedonic price regression and one study employed a survey with modified payment card approach. We construct three variables defining the method of research: variable "non-hypothetical" includes studies based on experimental auctions and real-purchase data. The variable "Choice experiment" includes values obtained from choice experiments, and variable "Contingent valuation" includes studies that employed either a contingent valuation method or a survey.

The majority of WTP estimates (89%) were obtained using hypothetical valuations in the form of contingent valuations or choice experiments. Non-hypothetical values account for only 11% of the valuations. Regarding the regional focus of the research, Europe clearly dominates as location for most of the studies (50%), whereas only 16% of the research was performed on data obtained in the USA, and 10% in Canada. Other study regions were Japan, Kenya, Uganda, Mozambique, Vietnam and Uzbekistan. According to the period of data collection, two periods were determined: 1999-2007 and 2008-2011[3] according to the distribution of the studies over time to see if valuations have changed. Products used in the valuations were very heterogeneous; however, it was possible to classify the investigated base products in the groups: dairy products (26%); and fruits/vegetables (17%). All other base products were classified as other foods and include: bread and grain products; meat; spreads with plant-derived ingredients; soy products; wholesome canteen takeaway; and products under the general term "functional food". Despite the heterogeneity in health benefits presented for consumer valuations, we distinguish one attribute that was investigated most frequently: cholesterol. "Reducing cholesterol" as a single health benefit or in combination with other health benefits, was evaluated in 14% of the studies.

[3] It was suggested that certain impact on scientific research could have the implementation of the EU Regulation on Nutrition and Health Claims in December 2006.

IV. Results

Due to the high variation in willingness to pay estimates, an analysis of potential outliers was performed. Potential outliers are first identified through plotting the leverage against the normalized residuals squared. As a result few studies with WTP values having high residuals and higher than average leverage are identified, but study 25 (numbered as in table 1) includes values with especially high residuals. Then, influential values are identified through plotting leverage values against studentized residuals with regard to Cook's distances[4]. Thus, values from Tra et al. (2011) require special attention. A normality plot also indicates this study as having extremely large values.

Tra et al. (2011) report a very high variation of WTP values for diabetes and bone health milk: ranging from 0 to 400% (see Appendix A). Highest valuations were obtained for diabetes milk that is also priced higher than bone health milk at the market. The sample included people living in luxury apartment regions in the city of Hanoi. The authors indicate a direct relationship between the income level and willingness-to-pay estimates for milk with health benefits. Considering substantial evidence that the WTP values from this paper can bias our estimation we run regressions including and excluding observations from this study.

Table 3. Mean WTP values for the total sample and excluding outlier

Variable	Obs	Mean	Std. dev.	Min	Max
WTP total sample	155	58.42	68.40	-39	400
WTP excluding outlier	137	43.95	42.38	-39	200

We estimate initial weighted OLS with percentage price premium as dependent variable and weights equal to squared sample sizes of each study for the total sample (Table 4).

[4] Critical value for Cook's distance is calculated as *4/n*, where *n* is the number of observations; critical value for residuals is |2|; hat values have critical value of *(2k+2)/n*, where *k* is the number of predictors and *n* again is the number of observations.

Table 4. Results of weighted OLS estimations

Variables	OLS (total sample)		OLS (excluding outlier)	
	Coefficient	Std.err.	Coefficient	Std.err.
Choice experiment	25.37	16.82	14.22	10.62
Contingent valuation	61.27***	17.49	29.72***	11.88
Europe	-5.04	23.86	-2.81	14.87
Canada	-50.04***	18.60	-44.41***	11.62
Region_other	78.18***	26.00	-0.25	20.02
Dairy	-8.98	12.19	-35.18***	8.55
Fruits/vegetables	-83.00***	15.73	-28.27**	12.78
Cholesterol	48.43***	14.68	49.45***	9.15
Year08_11	-11.70	22.45	1.09	14.13
Constant	29.15	19.02	36.76***	11.91
Obs	155		137	
R^2	0.41		0.41	
Adj. R^2	0.37		0.37	

*,**,*** refers to statistically significant at the 95%, 99%, 99.9% level.

Following Lagerkvist & Hess (2011) we perform several tests to choose the appropriate model for our meta-regression analysis. A test for variance inflation factors indicate that VIFs for all variables are below 10 and tolerance values are higher than 0.1. Testing for heteroscedasticity with the Breusch-Pagan test results in $chi^2 = 27.90$ with $p = 0.00$. Thus, we reject the assumption of homoscedasticity and estimate a random effects model:

$$WTP_i = \beta X_i + u_i + \varepsilon_i; \qquad (2)$$

with WTP_i being the percent premium WTP elicited from study i, X_i is the vector of independent variables and two error terms: $u_i \sim N(0, \tau^2)$ where τ^2 is the between-study variance and normally distributed $\varepsilon_i \sim N(0, \sigma_i^2)$. We employ the Stata command, meta-regression that is specifically designed for meta-analyses (Harbord & Higgins, 2008) and allows for the analysis of study-level data and estimates the between-study variance and the coefficients by weighted least squares when the outcome variable is continuous. The weights are: $1/(\sigma_i^2 + \tau^2)$, where σ_i^2 is the standard error of the estimated effect in study i.

Results of the meta-regression are reported in table 5. Residual variation due to heterogeneity is measured by I^2 and equals 91.32%, whereby 51.68% of the between-study variance is explained by the included covariates.

Table 5. Results of the meta-regression

Variables	Results of the meta-regression (excluding outlier)				
	Coefficients	Std. err.	p-values	Monte Carlo permutations	
				Unadjusted p-values	Adjusted p-values
Choice	17.43*	9.97	0.083	0.075	0.417
CV	31.92***	11.55	0.007	0.006	0.041
Europe	2.55	13.46	0.850	0.851	1.000
Canada	-42.09***	10.67	0.000	0.000	0.001
Region_other	4.21	18.70	0.822	0.816	1.000
Dairy	-35.53***	8.27	0.000	0.000	0.000
Fruits/vegetables	-26.47**	12.08	0.030	0.029	0.178
Cholesterol	52.10***	8.88	0.000	0.000	0.000
Year08_11	-0.93	12.65	0.942	0.944	1.000
Constant	31.37***	11.78	0.009		
Obs	137				
τ^2	741.4				
I^2	91.32%				
Adj. R^2	51.68%				

*,**,*** refers to statistically significant at the 95%, 99%, 99.9% level.

Monte-Carlo permutations are also employed to avoid type I error and get better assessment of the statistical significance of the observed relationships. The results in “unadjusted p-values” column very closely correspond to the p-values obtained from the initial regression. After adjusting for multiplicity all p-values increase. However, most observed relationships persist.

The results of the meta-regression imply that the elicitation method, the carrier product, the specific health benefit, and the place of the study significantly influence variations in WTP estimates across studies.

First, hypothetical methods of willingness to pay elicitation produce higher valuations compared to non-hypothetical methods like experimental auction and real purchase data. This result corroborates the findings of Lusk et al. (2005) and Dannenberg (2009).

Second, with respect to the base product the results indicate that in case of dairy products (milk, yogurt, cream cheese, cheese, butter and ice cream) and fruits and vegetables the WTP estimates for a specific health attribute are significantly lower than for all other product categories included.

Third, according to our results the specific health attribute “Cholesterol lowering” leads to significantly higher WTP estimates than any other health/nutrition claim. The valuations of this attribute varied from 0% to 200% with the highest values referring to the spread for lowering cholesterol reported in the thesis by Munene (2006).

Finally, the place where the data was collected influences WTP estimates. Our results indicate that there are no significant differences between studies conducted in Europe, the United States and other regions. However, studies conducted with Canadian consumers report statistically significant lower WTP values.

V. Discussion and conclusions

The need for systematical evidence on consumers' valuations of healthy attributes in food products motivated this study. For this purpose 27 publications reporting 155 estimates were analyzed. The results demonstrate that WTP estimates are influenced by the elicitation method, the base product, the place of study and the health attribute.

In general, it can be noticed that despite an established connection between diet and the development of non-communicable diseases, economics and marketing research so far fails to provide systematic view on the consumer valuations of different healthy attributes in food and, consequently, on the perspective demand for these products. Studies reviewed reported very different valuations of healthy attributes in foods. Studies also differ greatly in basically all parameters of the research: data collection, methodology, and analysis of the results. Lack of consistency in scientific research about health claims and health concerns was also emphasized by van Kleef, van Trijp, & Luning (2005). Although it seems rather difficult to draw general conclusions about consumers' willingness to pay for healthy attributes in foods, this research summarizes the efforts performed so far and may be employed to determine the directions for future analysis.

Our analysis confirms the finding of previous studies that hypothetical elicitation methods, i.e. choice experiments as well as contingent valuations lead to higher WTP values than non-hypothetical elicitation methods such as experimental auctions. This finding is most likely due to the so called "hypothetical bias" which has been widely discussed in environmental and agricultural economics (see e.g. Lusk & Hudson, 2004; Lusk & Schroeder, 2004; Murphy, Allen, Stevens, & Weatherhead, 2005). Despite improvements in methodology such as the use of a cheap talk script it seems to be that willingness to pay values obtained from choice experiments and contingent valuations overestimate the true WTP.

In this research choice experiment as a method of elicitation has a positive influence that persists in Monte-Carlo permutations as well. Higher WTP values obtained from hypothetical elicitation methods may refer to the phenomenon called "hypothetical bias" which was widely discussed in environmental economics and refers to the differences between stated and revealed preferences (Murphy et al., 2005). Similar tendencies have also been observed for agricultural products, however, here the differences are usually not as pronounced (see e.g. Lusk & Hudson, 2004; Lusk & Schroeder, 2004). Despite the fact that the results of our research are to be regarded with caution, the willingness to pay values obtained from choice experiments might be misleading in estimating consumer demand.

Willingness to pay is a measure that involves utility levels subjectively estimated by consumers and as such it reflects complex subjective perception and evaluation of different attributes. This study indicates that the base product significantly affects consumers' valuations, consequently only product-specific measures might be truly demand revealing. In attempts to estimate demand prospects for certain products, consumer perceptions of the base product might have a decisive role in the valuation.

Regarding the base product, there is no consistency on the interaction between carrier product and health claim found in previous research. For example Siegrist, Stampfli, & Kastenholz (2008) and Ares, Giménez, & Gámbaro (2008) find that health claims on the products already carrying healthy image are positively perceived by consumers. On the other hand, as is discussed in van Kleef et al. (2005), consumers may ignore health information on foods that meet hedonic needs (like candy) as opposed to health-related needs. In our study, WTP values for a specific health benefit are significantly lower for dairy products and fruits and vegetables than for other product categories *ceteris paribus.* This effect persists in Monte-Carlo permutations. This might be an indication that even if a healthy image of a base product fosters consumers' acceptance of functional ingredients, it might not lead to higher monetary valuations of the functional ingredient itself. In contrast, our results actually indicate that for already healthy products such as fruits and vegetables the WTP for an added health benefit is significantly lower. Unfortunately, due to the limited number of observations it was not possible to include interactions between variables characterizing carrier products and health benefits. This could be done in future research with more data becoming available.

The specific health benefit “lowering cholesterol” leads to significantly higher WTP values than all other health benefits included. This result supports findings by Van Wezemael et al. (2014), who performed a cross-cultural study on valuations of nutritional and health claims. In comparison to other claims, a health claim that included lowering cholesterol levels received highest valuations compared to other claims. This result was true for most countries included in the research. The authors explain this effect with more widespread awareness of the connection between nutrition and cholesterol levels compared to other substances.

However, it needs to be mentioned that among the studies surveyed in this paper, there is no unified way to present the health attribute for valuation. Some studies indicate the healthy substance, like vitamin A or Omega-3 fatty acid. In this case true valuation would require previous knowledge of the substance itself and its’ influence on health by consumers. In other cases, evaluated health claims indicate the health benefit without mentioning the active substances, like for example “cancer-fighting”. All these differences call for better designed studies that are in line with the existing regulatory measures. For example, in European Union health claims on foods are controlled by the Regulation (EC) no. 1924/2006, and recent research may be centered around the claims listed in the document.

A significant negative coefficient of the variable “Canada” indicates that Canadian consumers are willing to pay lower price premiums for health-enhancing foods than consumers in other countries. This has not been reported before. Closer investigation of the studies that report data about Canadian consumers demonstrate that indeed, authors present cautious prognoses for Canadian market of foods with health benefits and emphasize the need for additional evidence about consumer preferences and potential market for foods with health benefits (see e.g. Emunu et al., 2012; Maynard & Franklin, 2003). It was also observed in several studies that proved scientific evidence is necessary for the market success of functional foods in Canada (Hobbs, Malla, Sogah, & Yeung, 2014). Thus, we assume that lower valuations of healthy attributes in Canada are influenced by the lack of proven scientific evidence that would be delivered to consumers through trustful information sources.

As in the case of pesticide risk reduction studies, more primary research is necessary to provide coherent meta-analysis of WTP for healthy attributes. Moreover, heterogeneity among studies that arises from the base product, potential health benefit, communication strategy or consumer characteristics could be reduced by more standardized methodology. This study indicates that despite the need for assessing potential demand for healthy attributes in foods, economic and marketing research so far does not have concise indications of consumers' willingness-to-pay that could be applied for policy implications.

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Appendix A. Number of respondents for each WTP value and weighted means for each study

Study number (according to Table 1)	Reported WTP premiums (%)	Number of respondents	Weighted mean
1	-11	14	0.4
	-5	39	
	0	27	
	5	25	
	11	18	
	16	4	
	16	1	
2	58	300	58
3	24	288	15.7
	19	524	
	10	497	
	23	327	
	23	445	
	17	340	
	13	354	
	5	615	
4	173	70	173
5	27	780	32.5
	38	780	
6	94	333	89.4
	97	333	
	67	317	
	72	317	
	91	340	
	112	340	
	84	321	
	96	321	
7	-18	115	28.35
	45	115	
	25	115	
	66	115	
	39	115	
	43	118	
	5	118	
	48	118	
	14	118	
	9	118	
	26	113	
	1	113	
	52	113	
	36	113	
	35	113	
8	64.5	1045	64.5
9	25	500	25
10	9	1685	9.5
	5	1064	
	13	1351	
	5	924	

	12	2095	
11	6	138	8.3
	18	138	
	1	138	
	8	138	
12	4	327	17.8
	15	412	
	32	395	
13	134.9	477	134.9
14	98	70	58
	84	70	
	67	70	
	80	70	
	-39	70	
15	66	19	39.8
	0	15	
	8	22	
	101	12	
	69	14	
	26	25	
16	6	365	8.0
	10	365	
17	15	103	18.6
	16	103	
	25	98	
18	42	600	32.5
	23	600	
19	57	632	102
	200	632	
	49	632	
20	59.9	278	58.87
	69.7	800	
	49.6	609	
	60.5	2108	
	35.6	289	
21	51.3	308	51.3
22	-19	177	41.9
	10	590	
	42	518	
	74	454	
	106	155	
	132	65	
	174	30	
	10	56	
	42	63	
	74	20	
	106	4	
	132	2	
	171	10	
	-19	48	
	3	105	
	29	104	

	45	35	
	61	59	
	77	16	
	110	8	
	142	7	
23	27	208	15.6
	14	208	
	16	200	
	5	200	
24	31	1704	20
	9	1704	
25	17	38	149.8
	50	48	
	83	30	
	117	29	
	150	23	
	183	21	
	217	18	
	250	19	
	0	3	
	117	32	
	150	65	
	183	39	
	217	38	
	250	20	
	300	13	
	350	9	
	400	7	
	0	6	
26	47	600	47.71
	70	600	
	35	600	
	45	600	
	48	600	
	23	600	
	49	600	
	97	600	
	52	600	
	36	600	
	47	600	
	29	600	
	46	600	
	98	600	
	81	600	
	34	600	
	56	600	
	41	600	
	36	600	
	38	600	
	37	600	
	42	600	
	10	600	
	48	600	

27	-5.8	200	-5.4
	-5.0	200	