Meta-analysis of consumers' willingness to pay for sustainable food products

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Abstract: There is a continuous increasing number of studies dealing with consumers' willingness to pay (WTP) price premiums for sustainable food products. This research focused on a broad area of sustainable food products, including different sustainable attributes using a meta-analysis of 80 worldwide studies. Overall average WTP was estimated using the forest plot, showing the existence of a high level of heterogeneity. The publication bias was also verified using the funnel plot and Egger's test. Finally, the subgroup analysis and meta-regression were applied to classify the source of heterogeneity. The results suggest that the overall WTP a premium for sustainability (in percentage terms) is 29.5% on average. Furthermore, gender, region, sustainable attributes and food categories influence the average WTP estimates and their heterogeneity. Results also indicate that the WTP estimate conducted by hypothetical approach (choice experiment and contingent valuation method) is higher than non-hypothetical one due to hypothetical bias. Results also highlight that Asian WTP estimates, in percentage terms, are higher than those obtained in America and similar to those from Europe. In addition, positive WTP estimates are shown independent of the food categories, region or methods. This outcome denotes the presence of great market potential for sustainable products worldwide, which can provide a reference for relevant stakeholders to better understand market trends and the government to give more support to sustainable policies.

Keywords: willingness to pay (WTP), sustainable food products, meta-analysis, meta-regression

1. Introduction

In recent years, food products produced by unsustainable and intensive production methods have had negative impacts on human well-being, society and the environment. Therefore, the demand towards more sustainable food production systems and sustainable food consumption is becoming fundamental to sustainable development. The United Nations firstly put forward the concept of sustainable development, including sustainable agriculture in the 1990s, and the goal of sustainable agriculture is to meet society's food and textile needs without compromising the ability of future generations to meet their own needs (Brundtland, 1987). The concept of sustainable food is complex and encompasses issues relating to biophysical, social, and economic environments (Brklacich et al., 1991). Sustainable agricultural production is a systematic concept, which integrates three main objectives: a healthy environment, economic profitability, social & economic equity. More specifically, food should be safe, delicious, naturally ripened, healthy, nutritious, acceptable, and affordable for consumers. It should also guarantee fair profits for farmers, workers, and retailers, enabling a high welfare state and wellbeing. In addition, sustainable food production should be beneficial to the environment, by reducing energy consumption, respecting animal welfare, using environmentally friendly agricultural technology that reduces the use of chemicals, protecting citizens' health and maintaining human and rural communities.

Consumers are demanding products with high sustainable standards. Thus, the sustainability concept within the food systems is becoming a prominent and politically complex issue that has received attention from policymakers and researchers. In fact, consumers have increasingly paid attention to the wider ethical issues and sustainable food products. Local products, animal welfare products, fair-trade products, seasonal agricultural products, and more globally, carbon footprints products are just a few examples of this growing trend (Codron et al., 2006). Measuring willingness to pay (WTP) is an acceptable tool to understand consumers' attitudes and opinions towards sustainable attributes in food products. The WTP estimates represent the price premium or the maximum amount that a current or potential consumer is willing to pay for a product or good (Tully and Winer 2014). Understanding consumers' WTP will allow policymakers and multi-agents stakeholders to carry out and design more socially acceptable policy actions that ensure sustainable food production. The changes in consumers' attitudes towards sustainable food will also bring changes in consumers' behavior and consumption patterns. Changes in human behavior could encourage, attain or maintain sustainable systems (Brklacich et al., 1991).

As a result, to promote sustainable agriculture, an abundance of empirical studies has attempted to investigate consumers' WTP for sustainable food products. The main results showed that the majority of consumers were willing to pay a premium price for sustainable products (Laroche, Bergeron, and Barbaro 2001). For example, a study showed that the premium that Chinese consumers WTP for sustainable milk reached an additional 40% on the average conventional milk price (Gao et al., 2016). Another study revealed that most Spanish consumers were willing to pay a higher price for sustainable wines (Sellers, 2016), while the WTP values were heterogeneous depending on market segments. Additionally, some studies showed that the consumers who were willing to pay more for environmentally friendly products were more likely to be females, married and with at least one child living at home (Laroche, Bergeron, and Barbaro 2001). Vecchio and Annunziata (2015) indicated that female consumers were willing to pay more for sustainable chocolate bars than male respondents, with a premium of 14, 13 and 9 cents respectively for Fair-trade, Rain Forest certified and Carbon Footprint products.

In this context, there are some literature reviews focusing on consumers' WTP for sustainable food products (Katt & Meixner, 2020; Schäufele & Hamm, 2017). However, integrating different literature adopting systematic review and meta-analysis for consumers' WTP towards sustainable food products from a wider range has not been conducted. In addition, meta-analyses literature of WTP for animal welfare products (Clark et al., 2017) and organic food (Xia & Zeng, 2008) have been studied, but focusing on only one specific sustainable attribute. To fill this gap, this research helps to broaden the study of WTP for sustainable food products from a broad area, including different sustainable attributes simultaneously, by extracting data from the previous literature using a meta-analysis. Furthermore, the result will be more accurate using meta-analysis and provide reliable evidence for policymakers and sustainable food producers.

In this context, the main objective of this study is twofold: firstly, to synthesize consumers' WTP studies regarding sustainable food products; and secondly, to measure and compare the average WTP towards sustainable food products worldwide and its heterogeneity.

This paper is organized as follows. Section 2 is Data and Method and it presents the concept of meta-analysis, selection criteria related to the empirical studies, and how the data collected for the analysis. Section 3 describes the empirical results of descriptive statistics, overall estimates, subgroup analysis and meta-regression models. Section 4 is the discussion and conclusion.

2. Data and Method

2.1 Meta-analysis

Glass (1976) defined meta-analysis for the first time as "the statistical analysis of a large collection of analysis results from individual studies to integrate the findings". Meta-analysis is widely used by researchers in many fields, such as psychology, education, marketing and social sciences. In addition, meta-analysis is a good method of understanding variation in WTP across different products and types of social responsibility (Tully and Winer 2013). This study made a broader generalization about WTP for sustainable products using meta-analysis from a wider perspective by jointly including different sustainable attributes.

2.2 Strategy of literature search

The available studies relevant to consumer's preferences and WTP for sustainable food products (from 2000 to 2020) were identified from the electronic databases of Google Academic search and the Web of Science. We used the following keywords: "consumer preferences", "willingness to pay", "WTP", "consumer behavior", and "sustainable food products". In order to reduce publication bias (Rothstein et al., 2006; Stanley, 2011), we also searched unpublished literature by scanning some researchers' and institution websites. Included studies were based on "English", "mainly a choice experiment (CE) or contingent valuation method (CVM)", "willingness to pay or price premium or preferences". The CE method is a valuation method based on Lancastrian consumer theory and random utility theory (Lancaster, 1966). It consists of several choice sets with two or more alternative goods described by their attributes and the respondents are asked to choose one of the alternatives hereby, revealing trade-offs between the attributes of the goods (Holmes et al., 2017; Koistinen et al., 2013). CVM is a survey-based method, which is often used to evaluate the monetary value of environmental goods and services that are not traded in the market (Carson, 2000). In the CVM, researchers develop a survey for a hypothetical market and ask a survey participant to make an economic decision (i.e., to buy or not to buy) (Yi, 2019). CE and CVM are both stated preference approaches, and concerns about strategic behavior or hypothetical bias arise (Holmes et al., 2017). Finally, 80 papers were included based on three criteria: firstly, the topic of research was consumers' WTP for sustainable food products or sustainable attributes. Secondly, the study reported the average consumers' WTP value for sustainable food, whether it was in monetary form or percentage form. Thirdly, studies adopting stated-preferences methods and revealed-preferences both were included. The flow chart for the exclusion /inclusion process was presented in Fig. 1.

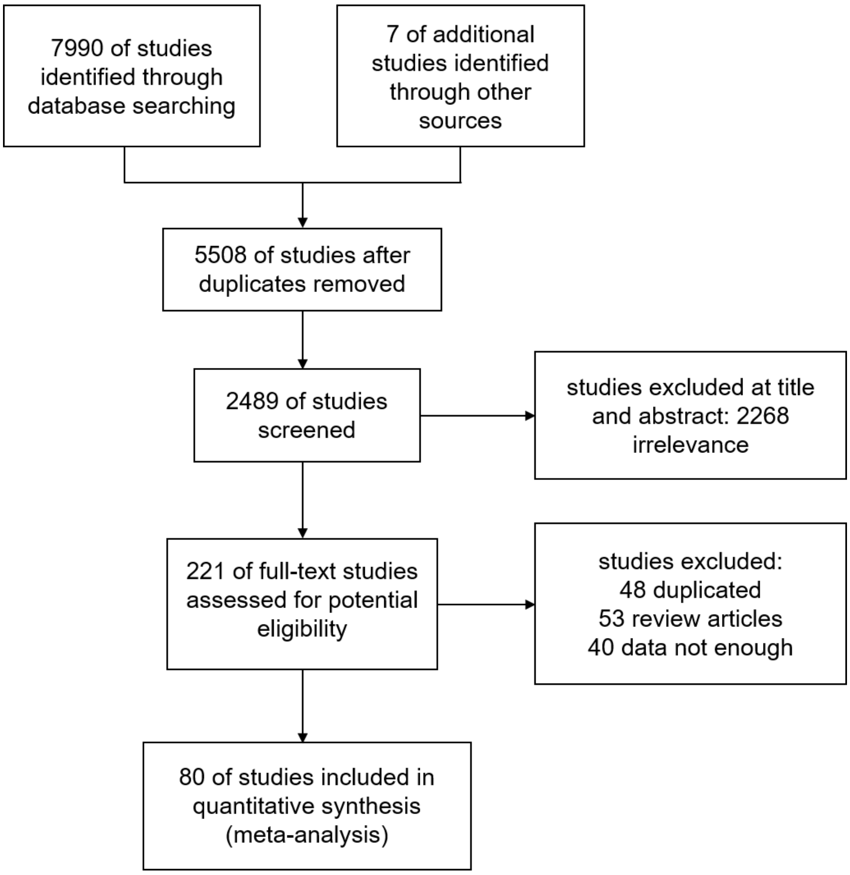

Fig.1 The flow diagram of the search and selection process

2.3 Data extraction and critical analysis Information

In this meta-analysis, standardized average WTP value in included studies was taken as effect size. This was in agreement with the study of Xia and Zeng (2008). Mean WTP is a measure that involves utility levels subjectively estimated by consumers, which reflects complex, subjective perceptions (Dolgopolova & Teuber, 2018). 53 studies reported WTP estimates in the percentage form, but the others reported WTP in monetary terms. In order to tackle the currency difference issues and different WTP formats (i.e., the weight unit, product unit and category), all WTP estimates were presented in percentage form. The WTP value, represented as the dependent variable in this analysis, was the price premium which meant the percent payment increased over conventional food price (Lagerkvist & Hess, 2011). Therefore, all WTP values in the 80 included papers were presented in the percentage form. For the monetary WTP, the transformation was as follows:

$$\text{WTP (\%)} = \frac{WTP\ sustainable\ -\ P\ conventional}{P\ conventional} \times 100\%$$

"*P conventional*" denoted the price of conventional food products. Some papers did not mention the price of conventional food product, the value of conventional products were searched, based on the year of data collection (Clark et al., 2017). Moreover, we extracted moderator variables to explain heterogeneity within the data. These were average values (income, age), percentages of the population (female, more than university education) and categorical moderators (sustainable food categories, region of study, sustainable attributes and study method). Income was the annual household income, expressed in dollars, because most papers provided income data in dollars.

The data was collected, analyzed and checked according to the requirements of meta-analysis using Review manager 5.3 (Revman 5.3), provided by the Cochrane Collaboration (Higgins & Green, 2011; Leontiadis et al., 2005), and Stata 14.0 software for the econometric modeling and analysis. We adopted the random-effects model rather than the fixed-effects model in Stata to calculate the effect size because of the heterogeneity among the population effects of studies included in the analysis (Hedges & Vevea, 1998).

The Egger's test and the funnel plot were conducted to measure the publication bias. Publication bias is a term for what occurs whenever the study that appears in the published literature is systematically unrepresented of the population of completed studies (Rothstein et al., 2006) and it may lead to the overestimation and some unreliable conclusions, so it is vital to test for (Clark et al., 2017). In the absence of publication selection bias, the plot looks like a symmetrical funnel (Dolgopolova & Teuber, 2018). Meta-analysts attempted to minimize the publication bias because of including working papers and any other unpublished reports (Stanley, 2011).

Furthermore, subgroup analysis was adopted to test deeper heterogeneity of the data. Seven subgroup analyses were conducted according to the year of publication, sustainable food categories, sustainable attributes, method types, region of study and socio-demographic characteristics (age and income). In order to make the subgroup analysis results more visually, two plots were drawn using the Tableau software. The size of the circle means the WTP value of each variable.

Finally, the meta-regression was used on a study-level summary data and estimated the between-study variance and coefficients, using weighted least squares when the outcome variable is continuous (Dolgopolova & Teuber, 2018; Harbord & Higgins, 2008). Meta-regression can conduct more complex analyses considering all significant moderators. It also benefits to detecting whether collinearity might provide an alternative explanation for some of the significant results (Xia & Zeng, 2008). In this meta-regression analysis, eight covariates (percentage of female, more than university education, the year of publication, income, region, methods, sustainable attributes and food categories) were introduced so the Monte Carlo permutation test was conducted to reduce Type I error and improve the accuracy of the p-value. In this analysis, dummy variables were used to quantify categorical variables. "Year 1" meant papers published before 2008 (including 2008), and accordingly, "year 2" denoted papers published after 2008. "Income 1, 2 and 3" were those with average annual household income of included papers under $30,000, $30,001-60,000 and more than $60,001, respectively. In addition, methods were classified into two types, hypothetical approaches and non-hypothetical methods, coded as "method 1" and "method 2". The "food category 1" meant dairy and "food category 2" represented drinks (wine, beer, coffee). As for "food category 3, 4 and 5", they were fruit & vegetable, meat and seafood, respectively. "Region 1, 2, 3, 4" denoted America, Asia, Europe and Oceania. "Attribute 1, 2, 3, 4 and 5" meant environmentally friendly (EF), local, organic, fair-trade and animal welfare. It was worth noting that year 1 (before 2008), income 3 (more than $60,000), method 2 (non-hypothetical methods), region 4 (Oceania), attribute 4 (fair-trade) and food category 5 (seafood) were dropped because of collinearity. In order to make the results more visually, two visual plots were drawn using the Tableau software to be better understood. Tau2 estimated the size of the variance component between-study. The smaller the value was, the better the model fitted.

3. Results

3.1 Descriptive statistics

In 80 included studies, 34 were from Europe, 21 were conducted in Asia, 21 were from America and the remaining 4 were from Oceania. Diverse WTP estimates for sustainable food products and attributes were measured. The sample sizes of individual literature were also different. The maximum size was 4103, which was studied in 8 European countries. Whereas, the minimum size was only 60 studied in Ukraine. The typical sample sizes ranged from 200 to 400 (Xia & Zeng, 2008). Regarding valuation methods, 31.3% of the studies were CE, with 2 papers using non-hypothetical CE and 33.8% were CVM. Only 8.8% of papers were using an auction experiment. 23.8% of the studies were other valuation methods. The lowest mean percentage WTP was 1.7% from Loureiro (2003), who studied sustainable wine in America, while the highest one was 91.0%, studied in Iran for organic milk by Amirnejad and Tonakbar (2015), followed by tomato, which was studied by Cicia et al. (2006) in Italy and Skreli et al. (2017) in Albania with 86.0% and 85.0% WTP premium respectively. These results are clearly related to the baseline of the conventional product category. Wine is more expensive than milk and tomatoes and therefore, the percentage of expensive products is lower compared with the cheaper ones. Annex 1 presented the characteristics of the studies included in the research.

3.2 Overall results

It showed that the overall quality was high in the included papers, according to the graph of quality assessment (Fig. 2), which denoted the risk of bias item for each included study.

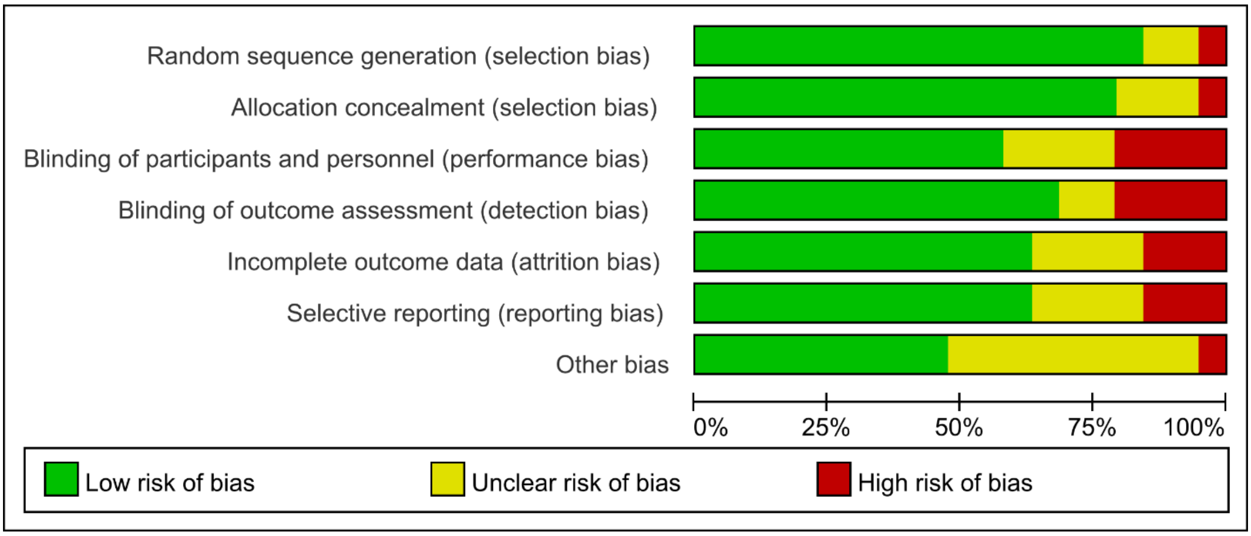

Fig. 2 Risk of bias across included studies

Note: It was judgements about each risk of bias item for each included study. This figure was generated in Revman, which denoted the risk of bias of included papers, according to criteria of quality assessment from Cochrane. It showed that the overall quality was high of the included papers.

In addition, we also checked for publication bias using Egger's test method (Table 2). The existence of publication bias in favor of studies with positive WTP for sustainable food products was confirmed by visual inspection of the funnel plot (Fig.4) and results of the Egger's tests (Table 2) ($p = 0.00 < 0.01$). Whereas, this asymmetry might be caused by true empirical effects observed in the literature (Dolgopolova & Teuber, 2018).

Table 2 Result of Egger's test (N = 80)

Std_Eff	Coef.	Std. Err.	t	P>|t|	Lower 95% CI	Upper 95% CI
slope	0.03	0.04	0.87	0.39	-0.04	0.11
Bias	13.12	2.64	4.96	0.00***	7.82	18.38

Note: *** Significance level: 0.01. $P = 0.00 < 0.01$, denoting that there is a significant difference, which means significant existence of publication bias.

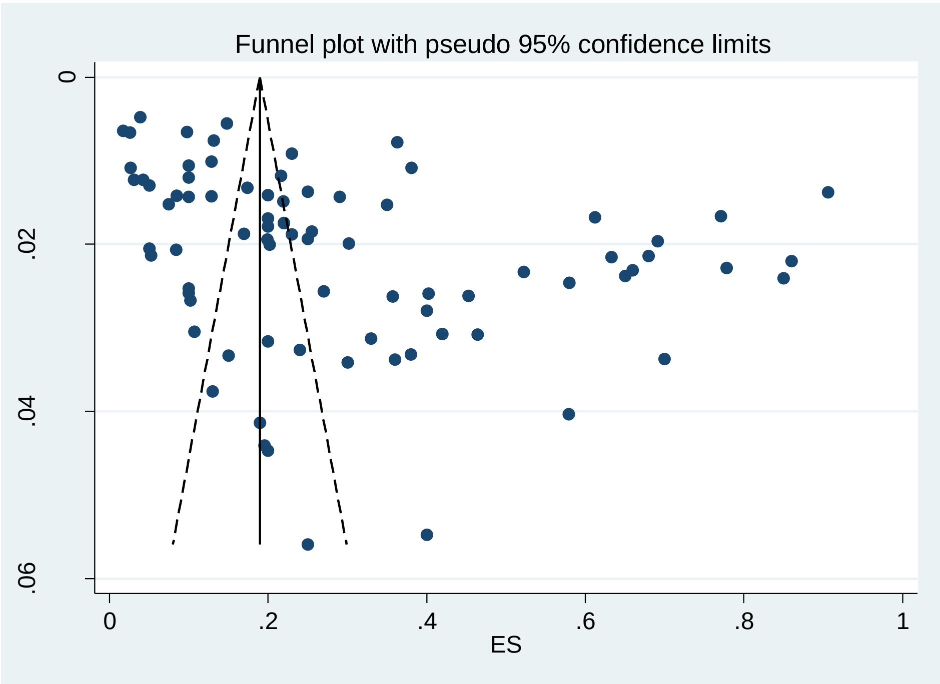

Fig. 4 Funnel plot of study

Note: ES means effect size (standardized average WTP value in this research) and s.e. of ES denotes standard error of effect size. In the absence of publication selection bias, the plot looks like a symmetrical funnel. This funnel is not symmetrical, indicating the existence of publication bias.

3.3 Subgroup results

The summary of results for different subgroup analyses could be found in Table 3, Fig. 5 and Fig. 6. As can be seen, the WTP estimates of all subgroups were positive. The overall WTP estimate was 0.295 (29.5%), with 95% CI (0.251, 0.338). With regard to the results of the subgroups for socio-demographic characteristics (age, income) and the date of publication, it should be noted that the average age of only 2 articles was over 56. The results of age showed that the younger generation had a higher WTP value with 34.6%, while the 56 and older had the lowest WTP with 29.5%. Fig.5 clearly proved the result. Regarding the results of the subgroup for average annual household income, it demonstrated that those whose income was over $60,001 had the highest WTP with 30.7%, while those whose income was between $30,001 and 60,000 got the lowest WTP with 25.5%. With respect to the subgroup of date of publication, it showed that the WTP value of papers published before 2008 was lower (21.6%) than those after (31.0%). It should be noted that there were only 13 papers before 2008 (including 2008) (the financial crisis), meaning that the results should be interpreted with caution. The I^2 values of all three subgroups were over 90.0%, which demonstrated the existence of high heterogeneity.

Table 3 Summary of the results from subgroup analysis

Subgroup	WTP estimate	Lower 95% CI	Upper 95% CI	Study Numbers	p-value	I^2	
18-30 years old	0.298	0.250	0.346	7	0.015	99.7%	Subgroup of age (excluding outlier)
31-55 years old	0.346	0.067	0.625	61	0.000	99.4%	
56 and older	0.295	0.251	0.338	2			
< $30,000	0.275	0.159	0.390	25	0.301	90.6%	Subgroup of annual income
$30,001-60,000	0.255	0.168	0.341	18	0.000	99.2%	
> $60,001	0.307	0.206	0.409	6	0.047	98.1%	
Year < 2008	0.216	0.137	0.296	13	0.000	99.2%	Subgroup of date of publication
> 2008	0.310	0.259	0.360	67	0.000	99.5%	
America	0.255	0.175	0.335	21	0.010	99.5%	Subgroup of region
Europe	0.319	0.256	0.382	34	0.000	99.3%	
Asia	0.318	0.206	0.431	21	0.020	99.7%	
Oceania	0.172	0.049	0.295	4	0.006	98.0%	
drinks	0.253	0.183	0.322	19	0.000	99.2%	Subgroup of food categories
seafood	0.166	0.111	0.221	10	0.023	82.3%	
dairy	0.349	0.145	0.553	8	0.001	99.2%	
fruit & vegetable	0.388	0.266	0.511	20	0.062	99.6%	
meat	0.294	0.198	0.391	15	0.000	99.3%	
EF	0.213	0.165	0.261	25	0.030	98.9%	Subgroup of sustainable attributes
Local	0.211	0.122	0.300	11	0.000	98.2%	
Organic	0.381	0.282	0.480	29	0.028	99.6%	
Fair-trade	0.305	0.164	0.446	9	0.006	99.6%	
Animal welfare	0.295	0.252	0.339	6	0.104	98.9%	
CE	0.383	0.284	0.481	25	0.009	99.7%	Subgroup of methods types
CVM	0.279	0.207	0.351	27	0.000	99.5%	
non-hypothetical	0.267	0.165	0.370	9	0.001	94.9%	
others	0.213	0.147	0.280	19	0.000	98.9%	
Overall	0.295	0.251	0.338	80	0.000	99.5%	Overall estimate

Note: I^2 means the variation in ES (effect size) attributable to heterogeneity and all values are more than 80.0%, indicating the existence of high heterogeneity. EF: environmentally friendly. There are 7 subgroups, with age, annual income, date of publication, region, food categories, sustainable attributes and methods types, excluded outlier because of the limitation of numbers included papers. The subgroup analysis is conducted in Stata.

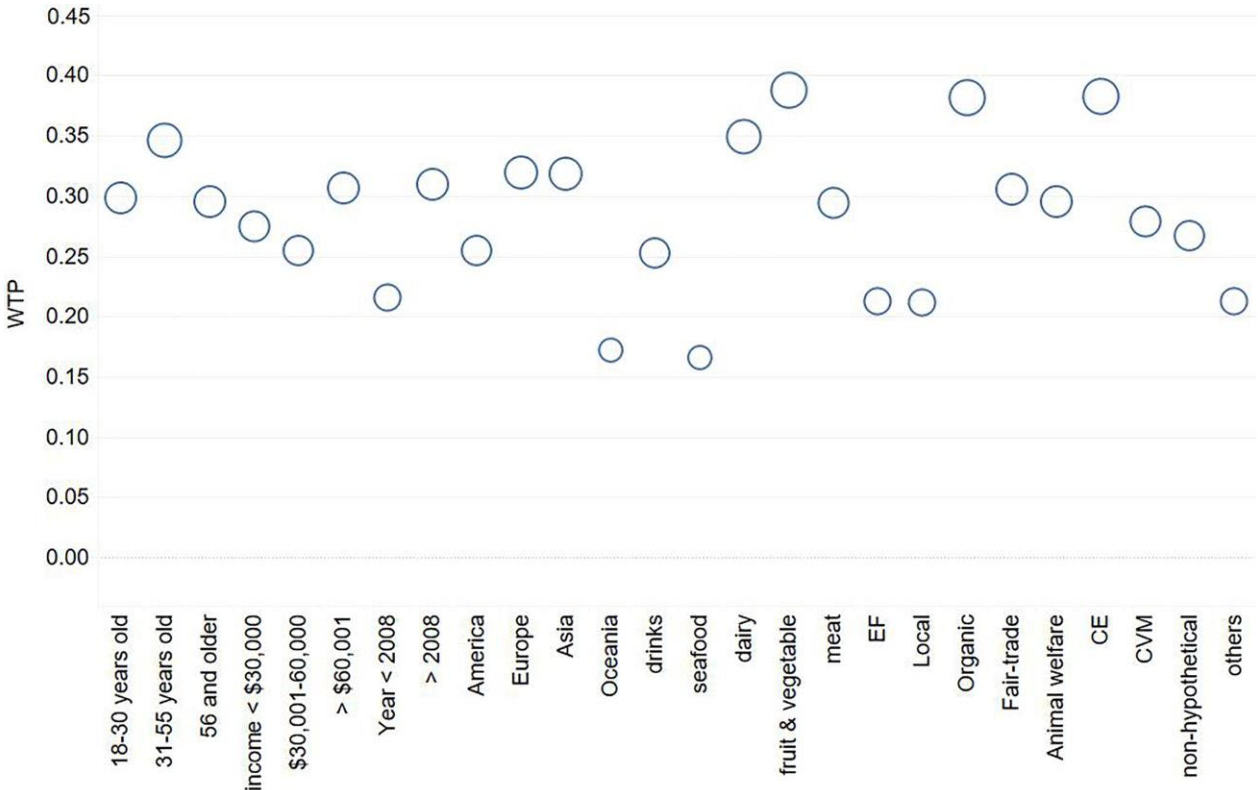

Fig. 5 Results of subgroup analysis

Note: The y-axis represents the size of WTP estimates and the x-axis shows each subgroup. The size of the circle means the WTP value of each variable. The figure was drawn using the Tableau software.

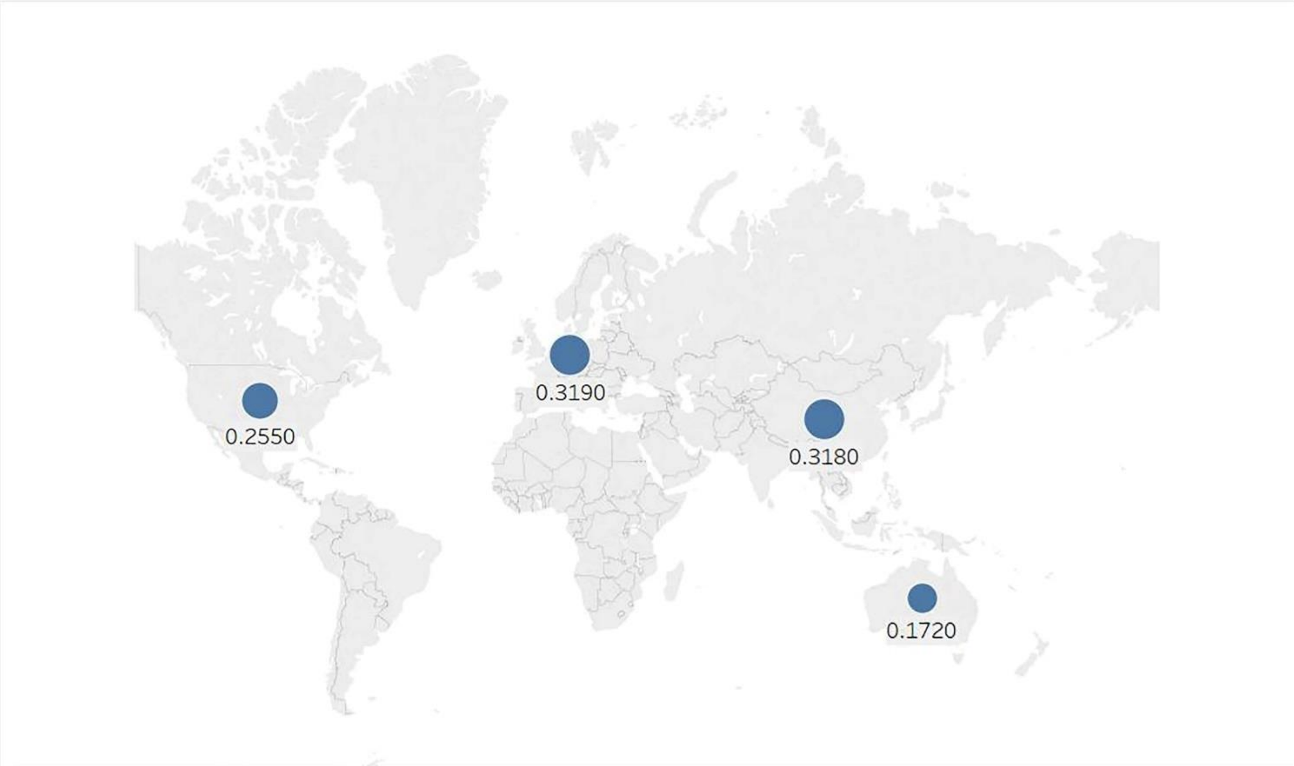

Fig. 6 WTP estimates of Regions

Note: Circle sizes demonstrate the overall combined WTP value of studies in each region. This map indicates that WTP estimates from highest to lowest are Europe (0.319), Asia (0.318), America (0.255) and Oceania (0.172). The figure was drawn using Tableau software.

As for the results of the subgroup for region, almost half of the research (42.5%) was conducted in Europe. While it should be noted that only 4 studies were from Oceania so the evidence was not conclusive. The results of the region subgroup (Table 3 and Fig. 6) demonstrated that the lowest WTP was in Oceania (0.172, 98.0%), followed by America (0.255, 99.5%) and Asia (0.318, 99.7%), and the largest in Europe (0.319, 99.3%). The Asian WTP estimate was very similar to Europe both higher than America. Additionally, a large heterogeneity existed among studies because I^2 were above 98% for all four regions.

With respect to food categories, the data of dairy was only obtained from 8 studies. Analysis showed that seafood with 16.6%, obtained the lowest WTP estimate and the highest one was for fruit & vegetable, with 38.8%. The WTP estimates of drinks, meat and dairy was 25.3%, 29.4% and 34.9%, respectively. I^2 value (82.3%) of seafood was the lowest, indicating that the heterogeneity was less compared with other food categories.

As for the result of sustainable attributes, the WTP estimates of EF (environmentally friendly) attribute and local attribute were similar, with 21.3% and 21.1%, respectively. The highest one was for organic attribute with 38.1%, followed by fair-trade and animal welfare attributes with 30.5% and 29.5%.

Regarding the subgroup analysis of method types, the result indicated that the WTP estimate of CE, was the highest (0.383), followed by CVM (0.279). Non-hypothetical methods (e.g., non-hypothetical choice experiment, auction experiment and real buying data) got 0.267. The category of Others has the lowest estimate, with 0.213. I2 of CE and CVM were more than 99.5%, indicating relatively high heterogeneity in the data, while the heterogeneity of non-hypothetical methods and others were a little lower (94.9% and 98.9%).

In addition, Table 3 showed that the overall effect size was 0.29 (95% CI 0.251, 0.338), which was considered as a medium estimate in the sustainable food products. The overall I2 statistics was 99.5%. I2 statistics indicated the percentage of variance due to heterogeneity (Dolgopolova & Teuber, 2018). If this value is higher, it means heterogeneity is more significant. 99.5% demonstrated that significant heterogeneity indeed existed within studies in this research. In general, the source of high heterogeneity did not be found using subgroup analysis.

3.4 Meta-regression results

Meta-regression was conducted to further identify the source of heterogeneity. The results were presented in Table 4. Results indicated the Coefficient (Coef.), standard error (Std. Err.), p-value and Monte Carlo permutation adjusted p-value of included variables. The overall p-value equaled $0.042 < 0.05$, which denoted significant differences at the significance level of 0.05. I^2 equaled 96.26% and it measured residual variation due to heterogeneity, while 81.73% was the proportion of between-study variance explained. Tau^2 equaled 0.008, demonstrating the regression model fitted well. Monte Carlo permutations were also conducted to avoid Type I error and to get a more reliable assessment. The results reported that all p-values increased compared with unadjusted p-values and it meant that Type I error existed.

Table 4 Results of the Meta-Regression (excluding outlier)

				Monte Carlo permutation test	
	Coef.	Std. Err.	P>|t|	Unadjusted p-value	Adjusted p-value
female	0.467**	0.226	0.044**	0.045	0.048**
university	-0.100	0.212	0.652	0.662	0.744
Year < 2008	-0.002	0.145	0.991	0.991	0.100
< $30,000	-0.082	0.160	0.617	0.701	0.756
$30,001-60,000	0.008	0.129	0.954	0.954	0.988
hypothetical	-0.029	0.092	0.757	0.768	0.798
dairy	0.183*	0.108	0.095*	0.095	0.098*
drinks	-0.618**	0.062	0.012**	0.012	0.014**
fruit & vegetable	0.222**	0.088	0.014**	0.016	0.018**
meat	0.128	0.093	0.171	0.244	0.262
America	0.614**	0.326	0.034**	0.034	0.038**
Asia	0.571**	0.257	0.022**	0.032	0.042**
Europe	0.644**	0.259	0.044**	0.044	0.048**
EF	-0.314**	0.122	0.017**	0.025	0.034**
local	-0.312	0.156	0.058	0.058	0.076
organic	-0.137	0.135	0.322	0.322	0.412
animal welfare	-0.150	0.150	0.329	0.436	0.488
_cons	0.221	0.366	0.570		
Number of obs	80				
Tau^2	0.008				
I^2	96.26%				
Adj R^2	81.73%				
Prob > F	0.042**				

Notes：*** Significance level: 0.01; ** Significance level: 0.05; * Significance level: 0.1.

The joint test gives a p-value of 0.042 < 0.05, denoting there is a significant difference, which means some evidence for an association of at least one of the covariates. I^2 equaled 96.26% and it measured residual variation due to heterogeneity, while 81.73% was the proportion of between-study variance explained. Tau^2 equaled 0.008, demonstrating the regression model fits well. The results of the meta-regression indicated that the percentage of female, region, sustainable attributes and food categories were the sources of high heterogeneity in this study and they significantly influenced variations in WTP estimates across studies.

Female & university: the percentage of female and more than university education.

Year < 2008: it was coded as year 1 in this regression.

< $30,000: it was coded as Income 1. $30,001-60,000: it was coded as Income 2.

hypothetical: codes as Method 1.

dairy, drinks, fruit & vegetable, meat: coded as Food category 1, 2, 3 and 4, respectively.

America, Asia, Europe: coded as Region 1, 2 and 3 in the meta-regression.

EF means environmentally friendly, coupled with local, organic and animal welfare, coded as attribute 1, 2, 3 and 5.

The results of the meta-regression indicated that the percentage of female, region, sustainable attributes and food categories were the sources of high heterogeneity and they significantly influenced variations in WTP estimates across studies. However, we found non-significant differences among the percentage of more than university education, income, date of publication and methods of studies. First, the percentage of females ($p = 0.048 < 0.05$) highlighted a significant difference, showing that it was the source of heterogeneity. Second, regarding food categories, the results demonstrated that for drinks products ($\beta = -0.618$), WTP estimates were significantly lower than dairy and fruit & vegetable products. This was in line with the result of the subgroup analysis above. Third, the p-values of America, Asia and Europe were 0.038, 0.042 and 0.048, showing significant differences among studies and confirming this subgroup as a source of heterogeneity. This result corroborated the findings of (Clark et al., 2017), who found significant differences across regions, especially Europe, America and Asia. Finally, the environmentally friendly attribute ($\beta = -0.314$) reported statistically significant lower WTP values, which was also similar to the result of the subgroup analysis above. However, results indicated non-significant differences among studies for local, organic and animal welfare attributes.

4.Discussion and conclusion

It is necessary to find systematic evidence on consumers' WTP for sustainable food products. For this purpose, 80 publications are included and analyzed using meta-analysis. This study is focused on a broad area of sustainable food products and attributes. It is, to our knowledge, the first meta-analysis jointly assessing different sustainable attributes and the number of included papers is the largest in this field. The meta-analysis focuses on the literature of consumer behavior with respect to average WTP estimates towards sustainable food products and it attempts to fill the gaps in meta-analysis for consumers' WTP for sustainable food products. Although high heterogeneity exists, this research summarizes the efforts performed so far and provides some stylized facts that may be employed to determine the directions for future analysis (Dolgopolova & Teuber, 2018).

Firstly, our results show that the WTP value of the studies adopting hypothetical approaches (CE and CVM) is higher than non-hypothetical methods. This was consistent with the conclusion of Dolgopolova and Teuber (2018), who suggested that hypothetical elicitation methods resulted in higher WTP than non-hypothetical approaches. This result also coincided with the research of Martínez-

Carrasco et al. (2015), who found CVM yielded higher values for WTP than the auction because of the hypothetical bias. This is because hypothetical bias leads to overestimation of values. The hypothetical bias was discussed and studied by many researchers in the social and economics.

Secondly, the subgroup analysis showed that the younger generation had a higher WTP value, while the 56 and older had the lowest WTP. It was consistent with some studies, which indicated that organic consumers were likely to be younger (Krystallis et al., 2006; Van Loo et al., 2013), and also in line with Carley and Yahng (2018), who found that younger were willing to pay more for sustainable beer. However, it was opposite to the study of Bellows et al. (2008), indicating that older people tended to buy organic food regularly. This divergence could be related to the fact of considering organic products as an environmentally friendly alternative or as a healthy one.

Interestingly, Asian WTP estimates, in percentage terms, are higher than those obtained in America and similar to those from Europe, which was different from our expectation. A possible explanation for it might be that sustainable labeling in products is an incomplete marketing tool for products perceived as low quality in America, so there is a need to improve quality perceptions and knowledge for sustainable labels to obtain a premium in differentiated food markets (Loureiro, 2003). Furthermore, this outcome is also related to the fact that the price of American products is more expensive than Asian countries. As for Asia, evidence can be found in the study of Wang and Huo (2016), who indicate food safety certification has increasingly received much attention by Chinese consumers since the melamine milk crisis in 2008. As a result, Chinese consumers had a higher WTP for ensuring food safety compared with any of the other attributes resulting from Chinese poor food safety record, coupled with a low level of trust in government safety certification schemes (Liu et al. 2010; Tait et al. 2016). Another study also suggests that Asian consumers are concerned about food safety and are willing to pay more to assure that their daily food is safe. Accordingly, they are willing to pay a higher premium for environmentally certified products that had reduced levels of pesticides (Aye et al., 2019). In addition, European WTP is similar to the studies conducted in Asia, which is in line with the study of Tait, Saunders, and Guenther (2015), who suggest preferences are very similar towards sustainable food for both UK and Japanese consumers. A similar result is also found in Tait et al. (2016) which indicates that the WTP value of Chinese consumers (7%) for water minimization sustainable food is similar to the UK (6%). The findings of this research can be used as a guide by food producers, marketers and policymakers when making decisions related to the sustainability of food products. Regarding the region, Europe and Asia have high WTP estimates, followed by America and Oceania, suggesting that sustainable food marketing departments could put more sustainable products in Europe and Asia.

The subgroup analysis also indicates that fruit &vegetables has the highest WTP estimate while the seafood has the lowest one. The low WTP estimate of seafood (e.g., salmon) could be related to its price, which was more expensive than fruit & vegetable. It also could be related to the presence of many substitutes, which led to a lower price premium for these products particularly consumers who were sensitive to price. As far as it concerns the high WTP value of fruit & vegetable, the main factors for high WTP mostly relied on a perceived increase in food safety and quality, especially for fresh and perishable products (Marchesini et al., 2007). Moreover, Moser, Raffaelli, and Thilmany-McFadden (2011) indicated that consumers perceived sustainable fruit & vegetable as being natural, with higher vitamin and nutrient content, and containing fewer or no pesticides and additives compared to conventional fruit & vegetable. Therefore, they were willing to pay more for fruit & vegetable. The high WTP estimate for fruit & vegetables means the sellers could focus on this food category and advertise more to attract consumers. Also, they could put fruit & vegetables in a conspicuous place in the supermarket or shop. Seafood has the lowest WTP value. For the fishermen, transportation personnel and sales departments engaged in the seafood industry, the price of seafood could be appropriately reduced, so as to encourage consumers to consume seafood and improve their WTP for seafood.

In addition, organic food has the highest WTP estimate. It was in line with the study of Zander and Feucht (2018), who concluded that consumers' WTP for organic production (14.8%) was higher than animal welfare (14.0%) and local products (12.6%). Van Loo et al. (2015) also found that WTP of organic food (27.0%) was the highest, followed by Rainforest Alliance (19.5%) and fair-trade products (15.8%). The high WTP value for organic food indicates a clear market consumption potential, which inspires food producers to produce more organic food and marketing strategies should be targeted towards increasing consumption for organic food. For retailers, they could put organic food especially organic fruit & vegetables in the obvious placement (e.g., at the entrance of the supermarket or shops) to sell more organic food and maximize profits. Conversely, they can put local seafood in the far corner of the supermarket. Also, retailers could promote seafood especially local seafood based on ensuring profits to attract more consumers. Van Loo et al. (2011) pointed that a product label is a quality signal for the consumer. Thus, organic labels should be emphasized on the package to attract consumers who care about labels. Also, policymakers could give more subsidies and incentives to organic food producers, which can attract more ordinary food producers to change from conventional agricultural production mode to organic agriculture. The result shows that the WTP estimate for local food is the smallest. As a result, it is necessary to increase consumers' knowledge about local food products and consider how to differentiate them in the market.

The results of this meta-regression suggest that female, region, sustainable attributes and variety of studying products influence average WTP estimates and represent major sources of WTP heterogeneity. The overall WTP is 29.5% for sustainable food products, which is consistent with the study of Vecchio and Annunziata (2013), who indicate that consumers' WTP is between 23% and 57%. It is also in line with Yi (2019), who concludes that consumers' average WTP towards sustainable products is 29%. Nevertheless, our result shows significantly lower values than those obtained in Y. C. Yang (2018) in Taiwan, with 254.0% and Skreli et al. (2017), who suggests that the widespread positive preferences is 85% of Albanian consumers for sustainable products. The existence of differences may be explained by the fact that Taiwan and Albanian consumers are mainly concerned about food safety and sustainable food can reduce their health risks, so they are willing to pay high premiums to tackle safety and health issues. In all cases, the results of this study show that overall WTP estimates may vary according to specific countries.

Additionally, the WTP estimates from our meta-analysis also suggest that positive WTP estimates are shown independent of the food categories, region or methods. This outcome denotes the presence of great market potential for sustainable products worldwide, which can provide a reference for relevant stakeholders to better understand market trends and the government to give more support to sustainable policies.

Finally, there are some limitations in this research. While it is relevant to measure consumers' average WTP for sustainable food products, this study mostly focuses on the European countries because many of the previous studies are conducted in Europe. The numbers of research from other regions are not enough to draw a clear differentiation according to region, especially Oceania. In addition, the results explain some of the heterogeneity and maybe there are other factors influencing heterogeneity that have not been considered, measured or studied. Although heterogeneity exists in some data, meta-analysis is still useful for analyzing the data, which provides a more transparent assessment of the consistency of the effect compared to a simple summary of the literature (Clark et al., 2017). In order to improve policies for sustainable food products and obtained more evidence, the research scope and quantity of studies need to be expanded. With the emergence of related papers in the future, more comprehensive and representative papers will be collected for further research and will be better analyzed the WTP heterogeneity.

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Annex 1

Table 1 Characteristics of the studies included in the research

No.	Study	Country	Sample	Food products	Method	Sustainable attributes	Annual Income ($)	university	age	female
1	Forbes et al.（2009)	New Zealand	109	wine	CE	EF		0.41		0.64
2	Loureiro（2003)	U.S. A	406	wine	CVM	EF	50000-70000		41	0.43
3	Vecchio (2013)	Italy	80	Wine	Bid functions	EF		1.00	23	0.60
4	De-Magistris and Gracia（2016)	Spain	171	Almonds	Non-hypothetical CE	local	31670	0.37	46	0.52
5	Vecchio and Annunziata (2015)	Italy	80	Chocolate	BDM auction	EF		0.53	25	0.56
6	Xu et al. (2012)	China	386	Seafood	Face-to-face interviews	EF	8257	0.60		0.61
7	Gao et al. (2016)	China	307	Milk	CVM	EF	21714	0.49	27	0.59
8	Denver and Jensen (2014)	Denmark	637	Apples	CE	organic		0.19	41	0.52
9	De Pelsmacker et al. (2005)	Belgium	808	Coffee	CE	fair-trade		0.84	31	0.54
10	Olesen et al. (2010)	Norway	115	Salmon	Non-hypothetical CE	organic	61339		39	0.58
11	Van Osch et al.（2017)	Ireland	500	Salmon	CE	EF		0.45	42	0.56
12	Aye, Takahashi, and Yabe (2019)	Myanmar	332	Tomatoes	CE	EF	10667-53333		40	0.86
13	Vanhonacker et al. (2013)	Belgium	221	Meat alternatives	Online survey	EF		0.78	41	0.64
14	Van Loo et al. (2011)	U.S. A	976	chicken breast	CE	organic	48230	0.61	39	0.73
15	Skreli et al. (2017)	Albania	220	Tomatoes	CE	organic			46	0.53
16	Tait et al. (2016)	China, India, UK	2067	Lamb meat	CE & CVM	EF		0.38	39	0.44
17	Zander and Feucht (2018)	8 European countries	4103	Seafood	CVM	EF		0.38	44	0.65
18	Van Loo et al.（2015)	U.S. A	81	Coffee	CE	EF	43600	0.66	36	0.53
19	Isengildina-Massa (2009)	U.S. A	500	Meat	CVM	local				0.51
20	Howard and Allen (2008)	U.S. A	476	Strawberry	CE	fair-trade	44137	0.70	52	0.54
21	Akgüngör et al. (2010)	Turkey	202	Fruit & vegetable	CVM	organic	11091	0.15	36	0.75
22	Miranda-de la Lama et al. (2017)	Mexico	843	Meat	interviews	animal welfare		0.30	39	0.56
23	Chang et al. (2013)	U.S. A	103	Beef	CE	local	49875	0.81	36	0.78

24	Darby et al. (2006)	U.S. A	530	Strawberry	CE	local	81891	0.78	50	0.72
25	Gallenti et al. (2016)	Italy	420	Coffee	CE	fair-trade		0.32	47	0.62
26	Makdisi and Marggraf (2011)	German	300	Broiler	CVM	animal welfare	15482	0.31	34	0.50
27	Van Loo et al. (2014)	Belgium	359	chicken breast	CE	animal welfare		0.29	43	0.60
28	Sans and Sanjuán-López (2015)	Spain, France	1213	Beef	CVM	animal welfare		0.35	38	0.54
29	Sarma and Raha (2016)	Bangladesh	180	Beef	questionnaires	organic				
30	Ogbeide et al. (2015)	Australia	2099	Wine	CVM	organic	66625	0.40	49	0.39
31	S.H. Yang et al. (2012)	China	564	Coffee	face-to-face survey	fair-trade	9872		24	0.61
32	Van Loo et al. (2013)	Belgium	774	Yogurt	cross-sectional survey	organic		0.31	42	0.62
33	Yaowarat et al. (2015)	Thailand	502	kale, rice, pork	CVM	organic	20492	0.80	41	0.79
34	Kavoosi Kalashami et al. (2016)	Iran	269	Vegetable	CVM	organic	3743	0.47	43	0.22
35	Sellers-Rubio et al. (2016)	Spain	553	Wine	CVM	EF	17512		33	0.37
36	Carley and Yahng (2018)	U.S. A	1094	Beer	Online survey	EF	37300	0.54	35	0.43
37	Smed (2005)	Denmark	2000	Dairy	panel study	organic				
38	Wolf and Tonsor (2017)	U.S. A	2001	Dairy	CE	animal welfare	43625	0.34	51	0.7
39	Cicia et al. (2006)	Italy	248	Tomato	CE	organic				
40	Napolitano et al. (2010)	Italy	150	Cheese	Auction	organic		0.43	48	0.56
41	Hu, Woods, and Bastin (2009)	U.S. A	557	Strawberry	CE	organic	52926		43	0.67
42	Haghjou et al. (2013)	Iran	423	Food	CVM	organic	1523		41	0.46
43	Liu, Chen, and Chen (2019)	Taiwan, China	568	Coffee	CE	fair-trade	6864	0.72	44	0.48
44	Schollenberg (2012)	Sweden	214	Coffee	Panel study	fair-trade				
45	Vitale et al. (2020)	Italy	560	Seafood	face-to-face survey	EF	23609		49	0.51
46	Schott and Bernard (2015)	U.S. A	128	Milk	Experimental auctions	organic	61875		39	0.57
47	Drichoutis et al. (2017)	Greece	3800	Strawberry	CVM	fair-trade		0.69	40	0.66
48	Salladarré et al. (2016)	France	626	Seafood	CVM	EF				
49	Yooyen et al. (2012)	Thailand	400	Pork	CVM	organic	9897	0.43	47	0.56
50	Haghiri et al. (2009)	Canada	141	Fruit & vegetable	face-to-face survey	organic	42482	0.4	41	0.44
51	Amirnejad and Tonakbar (2015)	Iran	450	Milk	CVM	organic	2525		30	0.57

52	Hai et al. (2013)	Vietnam	185	Vegetables	CVM	organic	5791	0.68	35	0.75
53	Güney and Giraldo (2019)	Turkey	552	Egg	CE	organic	772	0.25	39	0.57
54	Uchida et al. (2014)	Japan	160	Salmon	auction experiment	EF	59004		50	0.96
55	Aryal et al. (2009)	Nepal	180	Products	questionnaires	organic				
56	Rousseau and Vranken (2011)	Belgium	226	Apple	CE	organic	42439	0.78	42	0.62
57	Berghoef and Dodds (2011)	Canada	401	Wine	questionnaires	EF	79100	0.35	44	0.52
58	Kucher et al. (2019)	Ukraine	60	Product	questionnaires	EF		0.30	35	0.55
59	Cagalj et al. (2016)	Croatia	258	Apples	auction experiment	organic	14021	0.53	36	0.51
60	Galati et al. (2019)	Italy	262	Wine	CE	EF	29818	0.33		
61	Yi (2019)	Korea	1000	Aquaculture	CVM	EF	51616	0.64	44	0.50
62	Yip, Knowler, and Haider (2012)	Canada	1631	Aquaculture	CE	EF				
63	Xia and Zeng (2006)	China	300	Milk	CVM	EF		0.64	28	0.51
64	Berg and Preston (2017)	New Zealand	114	Product	interview	local			47	0.63
65	Mugera et al. (2016)	Australia	333	Breast	CE	local	59316	0.51	33	0.69
66	Everett et al. (2017)	U.S. A	458	Wine	CE	local	58390	0.38	40	0.73
67	Fan et al. (2019)	U.S. A	80	Broccoli	BDM auction	local	48550	0.34	49	0.73
68	Loureiro et al. (2002)	Portland	285	Apple	in-store survey	EF	60000	0.63	46	0.79
69	Gil Roig et al. (2000)	Spain	800	Product	CVM	organic			42	0.55
70	Solgaard and Yang (2011)	Denmark	1000	Fish	CVM	animal welfare	70316	0.51	44	0.51
71	Carpio and Olga (2008)	U.S. A	500	Meat	CVM	local	57400		58	0.52
72	Barber et al. (2009)	U.S. A	820	Wine	questionnaires	EF	83800	0.79	45	0.49
73	Brugarolas et al. (2005)	Spain	400	Wine	CVM	organic	21711	0.36	41	0.52
74	S. H. Yang et al. (2013)	China	564	Coffee	face-to-face survey	fair-trade	10284		24	0.40
75	Corsi and Novelli (2002)	Spain	402	Beef	CVM	organic	21464		50	0.82
76	Díaz et al. (2012)	Spain	361	Tomato	CVM	organic	32747	0.62	39	0.65
77	Piyasiri et al. (2002)	Sri Lanka	90	Vegetables	questionnaires	organic	2169		41	
78	Rotaris and Danielis (2011)	Italy	135	Coffee	CE	fair-trade		0.31	47	0.89
79	George (2010)	Dominica	200	Fruit & vegetable	CVM	local	10433	0.60	36	0.56

80	Loureiro and Hine (2002)	U.S. A	437	Potato	CVM	local	50000	44	0.60