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Willingness to Pay for Traceable Meat Attributes: A Meta-analysis

Gianni Cicia[1], Francesca Colantuoni[2]

[1]*University of Naples, Italy,* [2]*University of Massachusetts, USA*
[1]*cicia@unina.it ;* [2]*fcolantu@resecon.umass.edu*

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ABSTRACT

Several researches evaluated consumers' Willingness To Pay (WTP) for each meat traceable attribute, generating a great deal of information in this regard, although specific to the conditions of each study. In light of this, WTP estimates for traceability characteristics differ across the literature, leading sometimes to contrasting interpretations. Seeking a full, meaningful statistical description of the findings of a collection of studies, the meta-analysis allows us to analyze consistency across studies and control for factors thought to drive variations in WTP estimates. The meta-analysis has been conducted using 23 studies that, in aggregate, report 88 valuations for WTP. Our results, aside from releasing unconditional information on the WTP for single meat traceable attributes, show how certain study-specific characteristics, like the base price and the country where the study has been conducted, have a significant impact on WTP estimates.

Keywords: Meta-analysis, food traceability, Willingness to Pay

1 Introduction

Economic literature is rich with contributions that evaluate, through different methodologies, benefits linked to food safety policies and other quality attributes, especially for specific food products. In particular, a plethora of studies have examined consumers' preferences and Willingness To Pay (WTP) for mandatory and voluntary labeling programs associated with credence attributes related to preferences for traceability assurances. In fact, different levels of traceability are implemented to guarantee credence attributes, which have captured the public attention in the last decades. Modern societies care about food safety, which has to be viewed from the peremptory perspective, and many other attributes, such as animal welfare, respect for the environment, labor conditions, production technologies (GMO presence/absence, γ-rays irradiation, organic production, etc.) and country of origin. Several researches evaluated consumers' WTP for each attribute mentioned above, generating a great deal of information on this issue. Notwithstanding, this information is specific to the conditions of each study. WTP estimates for traceability characteristics largely differ across the literature, leading sometimes to contrasting interpretations.

A meta-analysis has been conducted in this study with the objective of seeking a full, meaningful statistical description of the findings presented in a collection of studies. The meta-analysis on the body of literature on consumer's behavior with respect to meat traceability allows us to analyze consistency across studies and control for factors thought to drive variations in WTP estimates. The goal is to generate a set of findings about consumer WTP that are not conditional on the particulars of a single study, and to provide researchers and policy makers with a concise summary of the extant work. The next section reviews some of studies on traceability benefits estimates, classified on the basis of the method adopted. This is important for highlighting the differences in results due to study conditions. Afterwards we discuss the method of selecting papers and describe the data from these specific studies. To the comprehension

of traceability effects, a series of several methodological and conceptual factors are considered for inclusion in the proposed models. A description of the models is then presented. We conclude with remarks on obtained results

1.1 WTP estimations on traceable meat attributes

Consumer attitudes towards traceability along the production chain of the meat sector have been discussed extensively, starting in the 1990s. The most common benefits estimation techniques used are the stated preferences methods (contingent evaluation, conjoint analysis, choice modeling) and revealed preferences methods (hedonic pricing). Regarding the use of the latter method, a notable example is given by Ward et al. (2008). This study on unobservable characteristics of ground beef and steak, conducted in US, reveals that quality grade signals do not significantly influence ground beef prices. But steak shows significant price premiums for quality signals when compared to products with no quality grade designation. Consumers would expect to pay more for higher quality grade steaks and less for lower graded products (Ward et al., 2008). But steaks labeled as "no hormones added" were priced lower than steaks with no special labels. This result contradicts with the estimates attained by Lusk et al. (2003) through a choice model. They find that consumers in France, Germany, UK and USA are willing to pay significant premiums for steaks produced without growth hormones. According to the authors, this may be caused by the fact that the model already controls for other attributes, like brand name, and thus "no hormones added" has secondary importance.

Mennecke et al. (2007) apply a conjoint analysis to estimate relative utilities associated with beef steak characteristics. The analysis reveals that the most important characteristic for U.S. consumers is the region of origin, followed by the breed, on-farm traceability and type of feeding. The ideal steak for the national sample comes from a locally produced choice Angus, fed with a mixture of grain and grass that is traceable to the farm of origin (Mennecke et al., 2006).

Concerning the use of choice models in studies about traceability of poultry and beef, we can refer to Loureiro and Umberger (2004; 2005; 2007). In the last two studies, the country of origin label seems to be the most important attribute of meat, while in the 2004 study, where a comparison with additional safety cues are considered, safety elicits the highest premium. Angulo and Gil (2007) offer an example about the use and findings attained for this topic trough the contingent evaluation. Results show that safety perception is one of the most important determinants of Spanish consumers' WTP for beef certifications.

Another class of techniques aimed at estimating food safety policies benefits are the ones based on experimental markets. These try to overtake the limits of methods based on willingness to pay, which is the use of a hypothetical scenario. Indeed, in experimental auction markets, interviewees deal with actual money and actual foodstuffs. This difference might lead to significant divergences with regards to benefits estimates. An example of the use of this class of technique is given by Dickinson and Bailey (2002), who conducted experimental auctions to asses US consumers' preferences and WTP for traceability, additional assurances for food safety and animal welfare (including non use of growth hormones) for beef and pork products. This study reveals that consumers are willing to pay a premium for on-farm traceability and that such a premium is higher for a multi-attribute traceability. Dickinson and Bailey's results are consistent with Hobbs' findings (2003) from an experimental study with a Canadian sample. Although in this study on-farm traceability elicited the lowest willingness to pay, the highest bid was for beef or pork products characterized by on-farm traceability plus ex-ante assurances on "quality" (animal welfare and food safety). This result is due to the fact that traceability alone does not reduce information asymmetry about credence attributes. Hence it becomes a necessary but not a sufficient condition for the control of unobservable attributes such as animal welfare or environmental friendly productions (Hobbs, 2003).

In general, what can be observed from literature on meat traceability is that same attributes are differently ranked across studies and sometimes even contrast each other. This may depend on how WTP estimates are elicited, the country where the analysis is conducted, the set of attributes considered and their relative importance, etc. Thus, all information we have now regarding meat traceable attributes represent only a partial picture.

A more complete review of studies on meat traceability is available in the table 1.

Table 1.
Summary of studies on meat traceability

Study	Location of study	Sample size	Nature of valuation method[1]	Product	Meat traceable attribute	Base_price ($/lb)[2]
Alfnes (2004)	Norway	106	hypothetical	Beef	Food_safety, Country_of_origin	5.00
Alfnes and Rickertsen, (2003)	Norway	106	non-hypothetical	Beef	Food_safety, Country_of_origin	5.00
Angulo and Gil (2007)	Spain	650	hypothetical	Beef	Food_safety	9.12
Baley et al. (2005)	US	104	hypothetical	Beef	Food_safety	13.47
Bolliger and Réviron (2008)	Swizerland	450	hypothetical	Poultry	Country_of_origin	7.50
Checketts (2006)	US	264	hypothetical	Beef	Food_safety, on-farm traceability	6.66
Dickinson and Bailey (2002)	US	112	non-hypothetical	Beef	Food_safety, Country_of_origin, on-farm traceability, animal welfare	[3]3.00
Dickinson and Bailey (2002)	US	112	non-hypothetical	Pork	Food_safety, Country_of_origin, on-farm traceability, animal welfare	[3]3.00
Dickinson and Bailey (2003)	US, Canada, UK	14	non-hypothetical	Beef	Animal welfare	3.02
				Pork	Animal welfare	2.65
Dickinson et al. (2003)	US, Canada	56	non-hypothetical	Beef	Food_safety, on-farm traceability, animal welfare	3.00
				Pork	Food_safety, on-farm traceability, animal welfare	4.00
Enneking (2004)	Germany	321	hypothetical	Pork	Food_safety	1.50
Hobbs (2003)	Canada	204	non-hypothetical	Beef	Food_safety, on-farm traceability, animal welfare	2.62
Hobbs (2003)	Canada	204	non-hypothetical	Pork	Food_safety, on-farm traceability, animal welfare	2.64
Loureiro and Umberger (2003)	US	243	hypothetical	Beef	Country_of_origin	4.00
Loureiro and Umberger (2004)	US	632	hypothetical	Beef	Food_safety, Country_of_origin, on-farm traceability	8.00
Loureiro and Umberger (2005)	US	632	hypothetical	Beef	Country_of_origin	6.90
Loureiro and Umberger (2005)	US	632	hypothetical	Pork	Country_of_origin	3.60
Loureiro and Umberger (2005)	US	632	hypothetical	Poultry	Country_of_origin	2.00
Loureiro and Umberger (2007)	US	632	hypothetical	Beef	Country_of_origin, on-farm traceability	4.85
Lusk et al. (2003)	France, Germany, UK, US	360, 210, [4]450, 725	hypothetical	Beef	Food_safety	6.88
Meuwissen et al. (2007)	The Netherlands	1199	hypothetical	Pork	Food_safety, Country_of_origin, on-farm traceability, animal welfare	5.53
Menozzi et al. (2009)	Italy	160	hypothetical	Poultry	Country_of_origin	1.90
Sanchez et al. (2001)	Spain	[5]247, 235	hypothetical	Lamb	Country_of_origin	7.58
Sanchez et al. (2001)	Spain	[5]247, 235	hypothetical	Beef	Country_of_origin	6.00

Study	Location of study	Sample size	Nature of valuation method[1]	Product	Meat traceable attribute	Base_price ($/lb)[2]
Stainer and Yang (2007)	US, Canada	214	hypothetical	Beef	Food_safety	3.54
Ubilava and Foster (2009)	Republic of Georgia	159	hypothetical	Pork	On-farm traceability	5.33
Umberger et al. (2003)	US	273	non-hypothetical	Beef	Country_of_origin	4.00
Umberger et al. (2009)	US	866	hypothetical	Beef	Country_of_origin	7.89

[1] By hypothetical nature of valuation method is meant all the benefits estimation techniques based on the stated preferences (contingent evaluation, conjoint analysis, choice modelling) and revealed preferences (Hedonic pricing), while by non-hypothetical is meant experimental auctions.

[2] The base price is the market baseline price of the product to the *status quo*.

[3]The value of the sandwich in both beef and ham auction is roughly the same (Dickinson, Baley, 2002).

[4] Sample size with respect to each country, respectively.

[5]Sample size with respect to the type of meat.

2 Testing the robustness of empirical findings on meat traceability: Meta-analysis

A meta-analysis of meat traceability research helps answer the following research questions:

- *Is there empirical evidence that WTP for meat traceability is positive and increases when specific attributes are considered (Country of origin, food safety, type of meat, etc.)?*
- *What is the attribute certified by traceability that systematically elicits the highest WTP?*
- *What are the studies' characteristics that influence WTP estimates?*

In fact, meta-analysis allows us to examine the extent of traceability effects despite different study conditions, like different research designs, country of study, etc. Although the meta-analysis technique is common to many fields of Science and Economics, to the best of our knowledge, this is the first meta-analysis concerning the consumer behavior in regard to meat. Another meta-analysis concerning food attributes is contained in Lusk et al. (2005). This study, though, is centered on genetically modified food and considers many types of food, including meat, vegetables, fish and other food products like cornflakes, cookies, vegetable oil, etc.

Our analysis consists of three consecutive steps, following the procedure already tested by Farley and Lehmann (1994) and Varlegh and Steenkamp (1999):

1. A prior collection of empirical studies concerning WTP estimations with respect to meat traceable attributes
2. The identification of study factors thought to drive variations in WTP estimates
3. Model setting by using dummy variables to codify those factors

2.1 Sample selection process

Our sample is given by findings from empirical studies about meat traceable attributes for the period 2000-2008. Those studies have been collected and selected through research databases, such as:

AgEcon Search (agriculture economics and applied economics),

Blackwell Journals (interdisciplinary),

EconLit (paper from economics journals);

Emerald Insight (interdisciplinary),

Google Scholar (interdisciplinary),

ScienceDirect (technical, medical scientific literature, but also on business and economics).

These databases offer numerous papers and government reports on applied economics, consumer's behavior, chain management, marketing and business.

From the six databases twenty-three separate studies have been selected on the basis of their specific

connection to the topic. Studies in which consumers' WTP for meat characterized by certain traceability systems has been estimated (Table 1) were selected. The 23 studies collectively provide 88 estimates of consumers' values for meat traceable attributes, giving a reasonably large sample for the analysis. Most of them are already published papers; a few are working papers. We do not have reasons to doubt the trustworthiness of the latter ones. However we conducted statistics on the estimates we gathered and found that the sample is indeed consistent (Table 2).

2.2 Impact indicators for meat traceable attributes

Aimed at enabling a comparison among meat traceable attributes impact, the indicator adopted is the associated premium, or WTP, as it results from collected studies. Each WTP estimate has been converted in percentage of the product's base price, so that problems like different currencies and different ways to express price premium (i.e. with respect to the weight unit, product unit) are overcome.

In some studies, we have several WTP estimates, depending on the specific meat traceable attribute and meat product considered in the study (e.g. beef, pork). Consequently, the number of WTP estimates is greater than the number of collected studies. Each observation in our meta-analysis includes, as the dependent variable, the estimate of the mean willingness to pay (MWTP) as percentage of the base price.

2.3 Study factors

Factors that are hypothesized to have a systematic impact on WTP estimates have been identified in selected studies. Because they are likely to moderate the impact, those factors are considered moderator variables (Varlegh, Steenkamp, 1999), and tested in the proposed model. A discussion on factors is reported below:

Country. The country where the single study was conducted is considered a factor that may affect consumer willingness to pay. In fact, due to cultural differences and other macroeconomics variables (e.g. GDP, inflation, per-capita income, unemployment rate) the WTP for food safety and other traceable attributes may differ. Also, we need to consider that consumers' sensitivity to some food attributes is somehow related to the emphasis given by governments, vis-à-vis advertising campaigns and regulatory restrictions.

Research design. Because individuals tend to overstate the amount they are willing to pay in hypothetical valuation tasks as compared to when real money is on the line (Lusk et al., 2005), we included whether the valuation task was hypothetical or non-hypothetical.

Sampling nature. Whether the sample was comprised of students or randomly recruited subjects may embody a crucial aspect. Use of student subjects in experimental markets is more convenient and less costly than standard subject pools, and according to some authors, there is ample evidence that students perform equally as well as professionals in economic experiments (Smith et al. 1988). Notwithstanding, those type of sample might not be representative of the general population either in terms of demographics or purchasing habits (Nalley et al., 2006). Hence, the debate concerning students being actual consumers and their decisions being representative of market decisions is still open.

Sample size. Sample size can be an important factor affecting the reliability of single study's findings.

Base_price. This factor is thought to influence the premium price, in the sense that the additional amount of money that consumers may be willing to pay for credence attributes depends on the original price of the meat. In fact, firstly, higher prices are quality cues *per se*; secondly, the percentage of WTP tends to decrease with higher prices, as consequence of a greater incidence on the total expenditure.

Type of meat. Different types of meat, meaning the animal species like pork, beef, poultry, etc., might affect consumer WTP due to different degrees of trust about rearing systems and control along the production chain (use of hormones, disease incidence potentiality). Type of meat may also be important because several scandals have involved those meat sectors, seriously affected quantity and price as well as leading consumers to search for product guarantees.

Type of cut. As underlined in several studies, the type of cut of meat (steak, ground meat, ham, etc.) can make a difference in the WTP estimates.

Food_safety. This category includes WTP for additional assurances on Food_safety, such as USDA inspection label, BSE-free label, hormone-free label, GMO-free label.

Country_of_origin. It considers WTP for a label declaring the country or the region where meat has been produced.

On-farm traceability. WTP for a label stating that meat is traceable to the farm of origin.

Animal welfare. It considers WTP for a label that declares respect for animal welfare.

Multi-attribute traceability. This includes WTP for a level of traceability implementation able to assure several meat attributes concurrently.

The way in which moderator variables were defined into the model is shown in Table 2.

Table 2.
Summary statistics and definitions of variables

Variable	Definition	Mean
	Dependent variable	
MWTP%	Marginal Willingness To Pay percentage per each meat traceable attribute	22.702 (3.221)
	Independent variables	
Food_safety	1 if the related WTP was estimated; 0 otherwise	0.505 (0.052)
Country_of_origin	1 if the related WTP was estimated; 0 otherwise	0.258 (0.046)
Animal welfare	1 if the related WTP was estimated; 0 otherwise	0.355 (0.050)
Multi_ attribute_trac	1 if the related WTP was estimated; 0 otherwise	0.258 (0.046)
On_farm_trac	1 if the related WTP was estimated; 0 otherwise	0.258 (0.045)
Non_hyp_scen	1 if valuation involved actual scenario; 0 otherwise	0.591 (0.051)
Beef	1 if the type of meat was beef; 0 otherwise	0.581 (0.051)
Poultry	1 if the type of meat was poultry; 0 otherwise	0.064 (0.026)
Lamb	1 if the type of meat was lamb; 0 otherwise	0.011 (0.011)
Pork	1 if the type of meat was pork; 0 otherwise	0.344 (0.050)
Ham	1 if product valued was ham; 0 otherwise	0.123 (0.048)
Roast_beef	1 if product valued was roast beef; 0 otherwise	0.215 (0.044)
Ground_meat	1 if product valued was ground meat; 0 otherwise	0.032 (0.018)
Steak	1 if product valued was steak; 0 otherwise	0.344 (0.049)
Sausage	1 if product valued was sausage; 0 otherwise	0.011 (0.011)
Europeans	1 if data from Europe; 0 otherwise	0.269 (0.046)
US_Americans	1 if data from United States; 0 otherwise	0.452 (0.052)
Canadians	1 if data from Canada; 0 otherwise	0.236 (0.044)
Sampling_nature	1 if sample comprised of students only; 0 otherwise	0.000
Sample	Number of observations in each subsample (study)	218.463 (28.226)
Base_price	Baseline price per each study and each meat product	4.026 (0.401)

2.4 Analysis

Multiple linear regression modeling is used the most in meta-analysis studies when considering WTP estimates as dependent variable (Loomis, White, 1996; Lusk et al., 2005; Jacobsen, Hanley, 2009; Richardson, Loomis, 2008).

Our initial model is:

$$MWTP\%_i = \alpha_0 + \alpha_1*Food\_safety_i + \alpha_2*Multi\_attribute\_trac_i + \alpha_3*Country\_of\_origin_i + \alpha_4*Non\_hyp\_scen_i + \alpha_5*On\_farm\_trac_i + \alpha_6*Animal\_welfare_i + \alpha_7*Base\_price_i + \alpha_8*Sample_i + \alpha_9*Poultry_i + \alpha_{10}*Lamb_i + \alpha_{11}* Pork_i + \alpha_{12}*Ham_i + \alpha_{13}*Roast\_beef_i + \alpha_{14}* Ground\_meat_i + \alpha15*Sausage_i + \alpha_{16}*Europeans_i + \alpha_{17}* Canadians_i + u_i$$

We originally hypothesized our model as described above and included all the variables we considered important in explaining the variation in consumers' WTP. Our model considers the problem of traceability as well as the variables typically included in meta-analysis such as "Sample" and "Non_hypothetical_scenario." As such, we are confident that our model is well-specified.

Regressors in our model can be grouped as "type of meat" (beef, poultry, lamb and pork), "type of cut" (steak, ground meat, roast beef, ham and sausage), "nationality of interviewees" (European, US, and Canadian) and the rest as "traceable meat attribute." The criterion with which variables defined in the Table 2 enter the model is aimed at avoiding the "dummy variable trap." That is why, for example, for variables like "nationality of interviewees," since the most numerous were the US Americans (45.2%), we did not include this variable in the model and considered it a benchmark. We included the others to compare with the reference variable. Similarly, we used beef as a reference variable for "type of meat" and steak as benchmark for "type of cut." The variable "Sampling_nature" could not be tested because there were no observations in our sample with studies whose sample was comprised of only students.

2.4.1 Expectations

We expect the coefficient of the variable "Food_safety" to have a positive sign because the WTP should increase with food safety cues. For the variable "Multi_attribute_traceability," we expect a negative sign since there can be a decreasing marginal utility with respect to the amount of information provided as well confusion resulting from too much information. We anticipate a positive sign for "Country_of_origin," given the evidence in literature about consumers' concern on the country where meat originates. People may be willing to pay more for meat produced in their country in order to either support the domestic industry and/or reduce the pollution due to the transportation on long distance, etc. The coefficient of the variable "Non_hypothetical_scenario" is supposed to be negative because it should reflect the idea that people might overstate their bids when hypothetic money is involved. The coefficients of "On_farm_traceability" and "Animal_welfare" are both expected to show a positive sign since they can be desirable attributes for meat.

"Base_price" is thought to influence the WTP in a negative manner. Additional amount of money that consumers may be willing to pay for credence attributes depends on the original price of the meat. In fact, higher prices are already quality signals and the percentage of WTP tends to decrease with higher prices as consequence of a greater incidence on the total expenditure. Although we do not have an expectation for the sign of "Sample_size," we believe that it is important for the reliability of the estimates. We also do not have any expectations for the set of variables "type of meat," but we are interested in determining if they are statistically significant. We do have expectations for the cuts of meat; specifically we expect that consumers are willing to pay more for the more processed meats. This reflects not only the fact that there is added value but also that consumers may look for further assurances about the quality itself, the absence of preservatives, additives, etc. For "nationality of interviewees" we hypothesize that Europeans are willing to pay more for meat traceable attributes than North Americans. This is evident in the recent European trend of banning products that contain growth-hormones and genetically modified organisms.

2.4.2 Results

Our original model exhibits signs of multicollinearity as seen in the high variance inflation for the variables "Base_price," "Pork," "Ham," "Roast-beef" and "Canadians." Moreover, the classic signs indicating multicollinearity are also present. We observe a high R^2 (for cross-sectional data) and an F-calc value that is significant at the 1% level or better, suggesting that our regressors explain a statistically significant portion of the variation in our dependent variable, WTP. These two results contradict our low t-calc values, which suggest that only a few of our parameters are statistically significant. To address this issue we calculated the pair wise correlation matrix and determined which of the variables were offensive. We considered pair-wise correlation and found high degree of correlation between the following pairs: "Beef" and "Ham," "Pork" and "Ham," "Canadians" and "Base_price," and "Beef" and "Pork." We also considered the issue of heteroskedasticity since the data comes from different papers and consequently we should expect them to exhibit different variances. White's test-result, χ^2-value, make us fail to reject the null—the absence of heteroskedasticity—at the 5% significance level. Tests for model misspecification, at the 5% significance level, support the idea that our model is correctly specified in regard to the choice of the variables.

To address multicollinearity, though, we re-specified the model by re-aggregating some of the variables. As such we did not lose any of the information; we merely reorganized how we considered the data. We reclassified the type of cut by degree of processing—we defined ground-meat and sausage as one variable (GS) and roast-beef and ham as another (HRB). We also reclassified nationality as Europeans and North Americans, by adding the two variables "US-Americans" and "Canadians." We then used this modified database for our analysis. We changed our benchmarks for the two variable groups referred above. We compared "Steak" and "GS" to the most processed meat "HRB," which we utilized as the reference variable. Similarly, the benchmark for the group "Nationality of interviewees" is now "North-Americans." Our model now is:

$$MWTP\%_i = \alpha_0 + \alpha_1*Food\_safety_i + \alpha_2*Multi\_attribute\_trac_i + \alpha_3*Country\_of\_origin_i + \alpha_4*Non\_hyp\_scen_i + \alpha_5*On\_farm\_trac_i + \alpha_6*Animal\_welfare_i + \alpha_7*Base\_price_i + \alpha_8*Sample_i + \alpha_9*Poultry_i + \alpha_{10}*Lamb_i + \alpha_{11}*Pork_i + \alpha_{12}*GS_i + \alpha_{13}*Steak_i + \alpha_{14}*Europeans_i + u_i$$

We again conducted White's test for the presence of heteroskedasticity (SPEC test) and we found that our results do not indicate heteroskedasticity at the 5% significance level. Again, tests for model misspecification at the 10%, as well as the 5%, significance level, state that our model is correctly specified. We present the results in table 3.

Table 3.
Results from model 2

	Parameter estimate	**Standard error**	**t-value**	**VIF**
Constant	-7.02972	11.393	-0.62	0
Food_safety	22.09159	5.10538	4.33***	3.08527
Multi_ cues_trac	-21.92097	7.87242	-2.78***	4.54039
Country_of_origin	3.01212	5.01484	0.6	2.43638
Non_hyp_scen	5.85944	8.50597	0.69	7.16897
On_farm_trac	16.71379	4.17481	4***	2.32533
Animal welfare	14.0649	5.44877	2.58***	7.13103
Base_price	-0.42237	0.21098	-2.0**	6.02813
Sample size	0.01169	0.01131	1.03	2.23173
Poultry	13.95939	10.92267	1.28	3.09827
Lamb	-2.80164	5.95347	-0.47	1.13291
Pork	-5.94306	2.65098	-2.24**	1.4448
Steak	14.62895	7.99507	1.83**	9.1619
GS	29.89204	11.76735	2.54***	2.56644
Europeans	15.50501	5.93293	2.61***	1.75317
Adj R^2	0.2899			
F	3.54***			
Spec test	65.53 (χ^2-stat)*			

[1]* =10% significance; **=5% significance; ***=1% significance or better.

2.5 Results interpretation

Our model explains 28.99% of the variation in our dependent variable, MWTP%, consumers' willingness to pay, this percentage is indeed consistent with the cross-sectional nature of the database. The regression model also explains a statistically significant portion of the variation in our dependent variable. The F-calc value is 3.54, which is significant at the 1% level or better. Signs of the estimated coefficients for each regressor match well with our expectations, especially for variables like "Food_safety," "Multi_attribute_traceability," "On_farm_traceability," "Animal welfare," "Base_price," "GS" and "Europeans."

Consumers are willing to pay 22.09% above the base price for the attribute "Food_safety," holding all other variables constant. This result confirms to our expectations and shows that "Food_safety" is statistically significant.

"Multi_attribute_traceability" is statistically significant, and when present the marginal WTP decreases by 21.92% as the number of attributes increases, holding all variables constant. This matches our expectations as well.

The estimate for "Country_of_origin" is not statistically significant, ceteris paribus. This may be due to the fact that "On-farm traceability" and "Animal welfare" may offset the importance of meat's country of origin to some extent.

"Non-hypothetical scenario" does not appear to have a significant influence on the WTP.

The other attribute that is statistically significant and appears to be very important for consumers is the "On-farm traceability." When this attribute is available, consumers are willing to pay a premium of 16.71% over the base price, holding all other variables constant. This result confirms to our expectations and implies that consumers are willing to pay more in order to be fully informed about the "meat's production path" from the farm to the table.

Another attribute which embodies particular importance to consumers, ceteris paribus, is a further assurance on "Animal welfare." This attribute is statistically significant and, when present, elicits a premium of 14.06% over the base price, showing consumers' interest about the life quality of domestic animals.

In keeping with our expectations, the variable "Base_price" is statistically significant and the sign is negative, holding all other variables constant. A 1% increase in the base price yields a 0.42% decrease in WTP. The variable "Sample size" is not statistically significant. The variables "Poultry" and "Lamb" are also not statistically significant probably because our database includes only a few observations for these "types of meat."

The variable "pork," however, is statistically significant and its estimate has a negative sign. This suggests that consumers purchasing pork are willing to pay 5.94% less for traceable attributes of the pork meat when compared to their willingness to pay for beef, holding all other variables constant. This may mean that they value beef more than pork and/or they are more concerned with the safety of beef. In fact, our database includes samples from a period of time in which consumers were aware of multiple "mad cow disease" outbreaks. So, it is probable that newer studies would find more concerns about pork meat because of the recent "swine flu" outbreak, which the media has covered extensively.

"Steak" and "GS" are both statistically significant and they reflect the grade of processing. The signs of their coefficients suggest that consumers are in fact willing to pay less and less as the degree of processing decreases, ceteris paribus. Specifically, they are willing to pay a premium of 14.63% for steak and 29.89% for "GS" when compared to "HRB," which is our benchmark.

The coefficient for the variable "Europeans" both confirms to our expectations and is statistically significant, showing that European consumers are, on average, willing to pay more for meat traceable attributes than North American consumers, ceteris paribus.

3 Conclusions

The meta-analysis on the body of literature on consumer behavior with respect to meat traceability allowed us to analyze consistency across studies and control for factors thought to drive variations in WTP estimates. Results from this study help summarize effectively the extant literature on consumers' WTP for meat traceability and permit us to make inferences that are not conditional on the results of one particular study.

For instance, our study clearly shows that consumers from different countries are placing an increasing importance on traceable meat attributes. In particular, "Food_safety," "Multi_attribute_traceability," "On_farm_traceability" and "Animal welfare" appear to be the most requested attributes. As suggested by Caracciolo et al. (2010) in a recent contribution on Pork meat attributes requested by European consumers, those credence attributes could be linked as direct and indirect indicators to food safety. While the food industry sector is increasing the amount of information on products sold, consumers look for easily understandable cues that allow them to buy meat with high levels of safety.

Finally, at least part of information released by this study is meant to be a useful tool for Industry, because results correspond to realistic premiums for each meat traceable attribute. This can be very

useful to achieve an efficient voluntary traceability program. Also this information is reliable to policy makers, during cost-benefit evaluations, for the implementation of mandatory meat traceability programs.

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