Consumer Food Safety Perceptions: Do they Differ across Products, Species, and Specific Risks?

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There is a growing literature evaluating the impact of media coverage on consumer choices of food products. Underlying these analyses is an evaluation of how media coverage impacts perceived quality of food products. Existing research has used aggregate meat demand models to examine spillover effects of food safety information on one meat product on the demand for competing meats (i.e., Piggott and Marsh, 2004). However, no known research has directly evaluated the relationship between perceived risk on a particular food safety issue and perceptions of other risks (e.g., H1N1 perceptions and E-Coli O157:H7 perceptions). Similarly, no known study has evaluated the appropriateness of assuming perceived food safety risks are equivalent for all products of a given species (i.e., perceived risk of E-Coli O157:H7 in ground beef and beef steak). Given the complex realm in which consumers receive information from a range of different sources on a host of food safety issues, an improved understanding of these perception relationships is needed. Moreover, the ability and marginal costs of mitigating food safety risks can vary across meat products and specific risks; accordingly management of risks may optimally vary across products. However, to make improved risk management decisions enhanced insights into the perceptions consumers hold of individual food safety risks on different meat products is needed. Accordingly the focus of this paper is to shed new light on these previously unevaluated issues.

To gather data on consumer food safety risk perceptions we conducted an on-line computer survey of 404 households located in the United States in early January 2010. Online surveys are increasingly being used by marketing and economic researchers as they provide comparatively low costs and fast completion times (Louviere et al., 2008; Hu, Adamowicz, and Veeman, 2006; Gao and Schroeder, 2009). Moreover, Hudson et al. (2004) found that Internet surveys do not exhibit non-response bias. Furthermore Fleming and Bowden (2009) and Marta-Pedroso, Freitas, and Domingos (2007) found similar results from applying a web-based survey with a conventional mail and in-person interview survey, respectively. The survey gathered information on a host of food safety issues. Table 1 presents a summary of select demographic variables indicating the participant sample is rather consistent with national average characteristics of the U.S. population. Table 1 also presents information regarding consumer experiences with illnesses where food safety causes were suspected. In particular, 21% (26%) indicated either personally or having a family member (knowing a non-family member) being sick in the last four years from spoiled, tainted, or improperly cooked meat. The majority of these sicknesses are suspected to either originate from ground beef or poultry products.

A particular interest in this analysis is consumer perceptions of different meat safety risks. Accordingly the survey included a series of 16 Likert scale (1=Very Low, … , 5=Very High) questions asked as: "*To what degree is each of the following food safety risks present in the presented meat products?"* where the questions were asked for four different meat products (ground beef, beef steak, pork sausage, and pork chops) and for four different food safety risks [E-Coli. (O157:H7 bacteria), BSE ("mad cow"), Salmonella, and H1N1 ("swine flu")]. These 16 questions were asked to gather information on existing risk perceptions. Summary statistics on these risk perception responses are provided in table 2. Simply looking at mean responses one

observes for all four meat products examined higher {lower} risk perceptions exist for E-coli (0157:H7) {H1N1, "swine flu"}. We sought to test equivalency in risk perceptions across products for a particular risk as well as examine equivalency of different risks for a given product. Tables 3 and 4 present both *t*-tests and Wilcoxon signed-rank tests of the hypothesis of equal risk perceptions (Lusk et al, 2004).

A review of table 3 quickly reveals risk perceptions vary notably across the four meat products examined. In particular, of the 24 pair-wise comparisons in table 3, the null hypothesis of equal risk perceptions is rejected (.10 level) in 19 cases (79.2%). The test results suggest perceptions of E-Coli (O157:H7) risks are highest in ground beef, lowest in pork chops, and are equivalent for beef steak and pork sausage. While finding perceptions of E-Coli risks to be highest in ground beef was expected, the finding of significantly lower risk perceptions in beef steak than ground beef has several implications. For instance, future E-Coli management may consist (at least partially) on post-harvest treatment of beef primals or individual products. In this case, the differential perceptions of risk by consumers between ground beef and beef steak may call for different levels or investment in post-harvest mitigation strategies of E-Coli risks. Conversely, table 3 suggests consumers hold equivalent perceptions of BSE ("mad cow") risks in ground beef and beef steak products. Accordingly, this would support the notion of treating beef products the same in developing BSE mitigation strategies as no differential consumer WTP likely exists (because of no quality perception differences) across beef products.

Table 4 presents results of evaluating the hypothesis of equal risk perceptions of different food safety risks for a given meat product. As in table 3 we largely reject this null hypothesis and in particular at the .10 significance level reject the hypothesis in 23 of 24 pair-wise cases examined. For all four examined meat products, E-Coli and Salmonella risks are distinctly (and

statistically significantly) ranked as the highest and second-highest risks. As expected, the risks of H1N1 ("swine flu") were lowest for all four products although the difference from BSE ("mad cow") risks in pork chops was not significant.

To better understand what drives different levels of risk perception we estimated a series of ordered probit models which consider the impacts of demographic and food safety experience factors. Tables 5 and 6 present results of multivariate models estimated to explain E-Coli risk perceptions in beef products and H1N1 risk perceptions in pork products, respectively. In each model, a multivariate approach was identified as preferred to univariate, single-risk evaluating approaches. In particular, the estimation of significant cross-equation correlation error term coefficients suggests unobservable drivers of risk perceptions appear to exist for each evaluated food safety risk. Moreover, following Tonsor, Schroeder, and Pennings (2009) we found including risk attitudes in the analysis was necessary.[1] This suggests unobservable factors omitted from our model (e.g., familiarity with meat production practices) impact both risk perceptions and attitudes.

Results presented in table 5 indicate E-Coli risk perceptions in ground beef are higher for females, households with more adults, and those with direct meat safety suspected illnesses in the last four years. Conversely and as expected, individuals consuming beef more frequently possess lower risk perceptions. In contrast, the only significant driver of E-Coli risk perceptions in beef steak was the number of adults in each household. To more formally examine if the same underlying drivers of E-Coli risk perceptions exist for ground beef and beef steak we conducted Wald tests of parameter equivalence (last column of table 5). We find statistically different (.10

[1] Consumer risk perceptions and risk attitudes have been succinctly defined by Schroeder et al. (2007).

level) impacts of college education, direct food safety illness experiences, and beef consumption frequency on E-Coli risk perceptions of ground beef and beef steak. However we fail to reject the hypothesis of gender, age, number of adults and kids, perceived food safety control, and indirect food safety illness experiences each having equal impacts on E-Coli risk perceptions in ground beef and beef steak.

Table 6 presents results of a parallel assessment of what drives H1N1 ("swine flu") risk perceptions in pork chops and sausage. Being female is found to increase H1N1 risk perceptions of both pork products. Being college educated and perceiving higher levels of control over food safety outcomes each reduce H1N1 risk perceptions for pork chops and sausage. Moreover, for each evaluated risk perception driver we fail to reject the null hypothesis of equivalent impacts on perceptions of H1N1 risks in pork chops and sausage. This differs from the findings in table 5 where drivers of E-Coli perceptions in beef products differed.

In summary, the preliminary findings of this working paper analysis suggests that food safety perceptions differ across meat products (both within and across livestock species) as well as across specific risks. While this finding needs to be further examined both in an expansion of the current analysis and with additional studies of U.S. consumers, these differential risk perceptions may be important for industry and policy makers to note. In short, differential risk perceptions increase the need for detailed analyses of specific risks and products as well as open the door to seriously considering risk and product specific food safety management strategies.

References:

Fleming, C.M. and M. Bowden. "Web-Based Surveys as an Alternative to Traditional Mail Methods." *Journal of Environmental Management*. Vol. 90 (2009), pp. 284-292.

Fox, J.A., D.J. Hayes, and J.F. Shogren. (2002). "Consumer Preferences for Food Irradiation: How Favorable and Unfavorable Descriptions Affect Preferences for Irradiated Pork in Experimental Auctions." *The Journal of Risk and Uncertainty*. 24:75-95.

Gao, Z. and T.C. Schroeder. "Effects of Label Information on Consumer Willingness-to-Pay for Food Attributes." *American Journal of Agricultural Economics*. In press 2009.

Hudson, D., L.Seah, D. Hite, and T. Haab. "Telephone Presurveys, Self-Selection, and Non-Response Bias to Mail and Internet Surveys in Economic Research." *Applied Economics Letters*. Vol. 11 (2004), pp. 237-240.

Marta-Pedroso, C., H.Freitas, and T. Domingos. "Testing for the Survey Mode Effect on Contingent Valuation Data Quality: A Case Study of Web Based *versus* In-Person Interviews." *Ecological Economics*. Vol. 62 (2007), pp. 388-398.

Louviere, J.J., T. Islam, N. Wasi, D. Street, and L. Burgess. "Designing Discrete Choice Experiments: Do Optimal Designs Come at a Price?" *Journal of Consumer Research*. Vol. 35 (2008), pp. 360-375.

Lusk, J.L., L.O. House, C. Valli, S.R. Jaeger, M. Moore, J.L. Morrow, and W.B. Traill. (2004). Effect of Information about Benefits of Biotechnology on Consumer Acceptance of Genetically Modified Food: Evidence from Experimental Auctions in the United States, England, and France. *European Review of Agricultural Economics*. 31:179-204.

Piggott, N.E. and T. Marsh. (2004). Does Food Safety Information Impact U.S. Meat Demand? *American Journal of Agricultural Economics*. 86:154-174.

Schroeder, T.C., G.T. Tonsor, J.M.E. Pennings, and J. Mintert. (2007). "Consumer Food Safety Risk Perceptions and Attitudes: Impacts on Beef Consumption across Countries." *The B.E. Journal of Economic Analysis & Policy*. Vol. 7 (Contributions): Article 65.

Tonsor, G.T., T.C. Schroeder, and J.M.E. Pennings. (2009). "Factors Impacting Food Safety Risk Perceptions." *Journal of Agricultural Economics*. 60:625-644.

Viscusi, W.K. "Prospective Reference Theory: Toward and Explanation of the Paradoxes." *Journal of Risk and Uncertainty*. Vol. 2 (1989), pp. 235-263.

Viscusi, W.K. and C. O'Connor. "Adaptive Responses to Chemical Labeling: Are Workers Bayesian Decision Makers?" *American Economic Review*. Vol. 74 (1984), pp. 942-956.

Table 1. Summary Statistics of Selected Demographic Variables

Gender	Mean	Std. Dev.
Female (%)	0.500	0.501
Age		
Average age (years)	47.413	15.848
College		
= 1 if graduated; 0 otherwise	0.500	0.501
Adults		
= number of adults in household	1.946	0.849
Kids		
= number of children in household	0.498	0.878
Control of Food Safety		
= Perceived own control (5 point Likert question: 1 = very little; 5 = very high)	3.082	1.029
Beef Consumption		
Times per month consumed	7.969	4.962
Pork Consumption		
Times per month consumed	4.475	3.671
Been sick from spoiled, tainted, or improperly cooked meat (personally or family)		
= if yes within last 4 years; 0 otherwise	0.210	0.408
= 1 if ground beef was suspected; 0 otherwise	0.079	0.270
= 1 if beef steak was suspected; 0 otherwise	0.005	0.070
= 1 if other beef products were suspected; 0 otherwise	0.012	0.111
= 1 if pork sausage was suspected; 0 otherwise	0.012	0.111
= 1 if pork chops were suspected; 0 otherwise	0.012	0.111
= 1 if other pork products were suspected; 0 otherwise	0.025	0.156
= 1 if poultry products were suspected; 0 otherwise	0.092	0.289
= 1 if other meat products were suspected; 0 otherwise	0.017	0.131
Known somebody who has been sick from spoiled, tainted, or improperly cooked meat		
= if yes within last 4 years; 0 otherwise	0.265	0.442
= 1 if ground beef was suspected; 0 otherwise	0.089	0.285
= 1 if beef steak was suspected; 0 otherwise	0.020	0.139
= 1 if other beef products were suspected; 0 otherwise	0.007	0.086
= 1 if pork sausage was suspected; 0 otherwise	0.022	0.148
= 1 if pork chops were suspected; 0 otherwise	0.012	0.111
= 1 if other pork products were suspected; 0 otherwise	0.032	0.177
= 1 if poultry products were suspected; 0 otherwise	0.106	0.309
= 1 if other meat products were suspected; 0 otherwise	0.027	0.163
Total Respondents	404	

Table 2. Summary Statistics of Risk Perceptions across Risks and Products

	Mean	Std. Dev.
Degree of Food Safety Risk Present in Ground Beef		
Ecoli (O157:H7 bacteria)	3.322	1.134
BSE ("mad cow") related diseases	2.634	1.250
Salmonella	3.092	1.212
H1N1 ("swine flu")	1.869	1.103
Degree of Food Safety Risk Present in Beef Steak		
Ecoli (O157:H7 bacteria)	3.101	1.165
BSE ("mad cow") related diseases	2.614	1.238
Salmonella	2.814	1.253
H1N1 ("swine flu")	1.847	1.076
Degree of Food Safety Risk Present in Pork Sausage		
Ecoli (O157:H7 bacteria)	3.069	1.155
BSE ("mad cow") related diseases	2.178	1.244
Salmonella	2.891	1.191
H1N1 ("swine flu")	1.988	1.161
Degree of Food Safety Risk Present in Pork Chops		
Ecoli (O157:H7 bacteria)	2.928	1.192
BSE ("mad cow") related diseases	2.042	1.173
Salmonella	2.772	1.197
H1N1 ("swine flu")	1.970	1.170

Note: Risk perceptions were assessed with a 5 point (1= very low, …, 5 = very high) Likert scale question: "To what degree is each of the following food safety risks present in the presented meat products?" Moreover, the presented order of risks and products varied randomly across participants to mitigate order effects.

Table 3. Differences in Risk Perceptions across Products

	Difference	p-value[a]	p-value[b]
Differences in Ecoli (O157:H7 bacteria)Risk Perceptions			
Ground Beef vs Beef Steak	0.220	0.000	0.000
Ground Beef vs Pork Chops	0.394	0.000	0.000
Ground Beef vs Pork Sausage	0.252	0.000	0.000
Beef Steak vs Pork Chops	0.173	0.000	0.000
Beef Steak vs Pork Sausage	0.032	0.340	0.371
Pork Chops vs Pork Sausage	-0.141	0.000	0.000
Differences in BSE ("mad cow") related diseases Risk Perceptions			
Ground Beef vs Beef Steak	0.020	0.503	0.549
Ground Beef vs Pork Chops	0.592	0.000	0.000
Ground Beef vs Pork Sausage	0.455	0.000	0.000
Beef Steak vs Pork Chops	0.572	0.000	0.000
Beef Steak vs Pork Sausage	0.436	0.000	0.000
Pork Chops vs Pork Sausage	-0.136	0.000	0.000
Differences in Salmonella Risk Perceptions			
Ground Beef vs Beef Steak	0.277	0.000	0.000
Ground Beef vs Pork Chops	0.319	0.000	0.000
Ground Beef vs Pork Sausage	0.200	0.000	0.000
Beef Steak vs Pork Chops	0.042	0.282	0.405
Beef Steak vs Pork Sausage	-0.077	0.036	0.018
Pork Chops vs Pork Sausage	-0.119	0.000	0.000
Differences in H1N1 ("Swine flu") Risk Perceptions			
Ground Beef vs Beef Steak	0.022	0.398	0.422
Ground Beef vs Pork Chops	-0.101	0.010	0.009
Ground Beef vs Pork Sausage	-0.119	0.001	0.001
Beef Steak vs Pork Chops	-0.124	0.000	0.000
Beef Steak vs Pork Sausage	-0.141	0.000	0.000
Pork Chops vs Pork Sausage	-0.017	0.443	0.440

[a] p-values for two-tailed *t*-tests of Ho: No difference in risk perception across products.
[b] p-values for two-tailed Wilcoxon signed-rank test of Ho: No difference in risk perception across products.

Table 4. Differences in Risk Perceptions across Risks

	Difference	p-value[a]	p-value[b]
Differences in Ground Beef Risk Perceptions			
Ecoli (O157:H7) vs BSE ("mad cow")	0.688	0.000	0.000
Ecoli (O157:H7) vs Salmonella	0.230	0.000	0.000
Ecoli (O157:H7) vs H1N1 ("Swine flu")	1.453	0.000	0.000
BSE ("mad cow") vs Salmonella	-0.458	0.000	0.000
BSE ("mad cow") vs H1N1 ("Swine flu")	0.765	0.000	0.000
Salmonella vs H1N1 ("Swine flu")	1.223	0.000	0.000
Differences in Beef Steak Risk Perceptions			
Ecoli (O157:H7) vs BSE ("mad cow")	0.488	0.000	0.000
Ecoli (O157:H7) vs Salmonella	0.287	0.000	0.000
Ecoli (O157:H7) vs H1N1 ("Swine flu")	1.255	0.000	0.000
BSE ("mad cow") vs Salmonella	-0.200	0.001	0.001
BSE ("mad cow") vs H1N1 ("Swine flu")	0.767	0.000	0.000
Salmonella vs H1N1 ("Swine flu")	0.978	0.000	0.000
Differences in Pork Chops Risk Perceptions			
Ecoli (O157:H7) vs BSE ("mad cow")	0.886	0.000	0.000
Ecoli (O157:H7) vs Salmonella	0.156	0.000	0.000
Ecoli (O157:H7) vs H1N1 ("Swine flu")	0.958	0.000	0.000
BSE ("mad cow") vs Salmonella	-0.730	0.000	0.000
BSE ("mad cow") vs H1N1 ("Swine flu")	0.072	0.158	0.130
Salmonella vs H1N1 ("Swine flu")	0.802	0.000	0.000
Differences in Pork Sausage Risk Perceptions			
Ecoli (O157:H7) vs BSE ("mad cow")	0.891	0.000	0.000
Ecoli (O157:H7) vs Salmonella	0.178	0.000	0.000
Ecoli (O157:H7) vs H1N1 ("Swine flu")	1.082	0.000	0.000
BSE ("mad cow") vs Salmonella	-0.713	0.000	0.000
BSE ("mad cow") vs H1N1 ("Swine flu")	0.191	0.000	0.000
Salmonella vs H1N1 ("Swine flu")	0.903	0.000	0.000

[a] p-values for two-tailed *t*-tests of Ho: No difference in risk perception across risks.
[b] p-values for two-tailed Wilcoxon signed-rank test of Ho: No difference in risk perception across risks.

Table 5. Multivariate Ordered Probit Model of E-Coli O157:H7 Risk Perceptions

Variable	*Risk Perception* *Ground Beef*	*Risk Perception* *Beef Steak*	*Risk Attitude* *Ground Beef*	*Risk Attitude* *Beef Steak*	*p-value*
Intercept	1.417**	1.237**	0.954**	1.160**	
	(0.327)	(0.320)	(0.262)	(0.264)	
Female	0.177*	0.079	0.142	0.220**	0.175
	(0.106)	(0.105)	(0.106)	(0.106)	
Age	0.000	-0.002	0.008**	0.005	0.429
	(0.004)	(0.004)	(0.004)	(0.004)	
College	0.151	-0.011	0.071	0.060	0.026
	(0.107)	(0.106)	(0.106)	(0.106)	
Adults	0.189**	0.132**	-0.013	-0.038	0.207
	(0.066)	(0.064)	(0.062)	(0.062)	
Kids	0.049	0.069	0.002	-0.012	0.572
	(0.063)	(0.063)	(0.062)	(0.062)	
Control of Food Safety	-0.056	-0.040			0.674
	(0.051)	(0.051)			
Direct Sickness	0.293**	0.120			0.078
	(0.138)	(0.138)			
Indirect Sickness	0.131	0.087			0.595
	(0.125)	(0.126)			
Beef Consumption	-0.024**	-0.009			0.049
	(0.011)	(0.011)			
Limit2	0.980**	0.823**	0.692**	0.759**	
	(0.098)	(0.078)	(0.073)	(0.077)	
Limit3	1.899**	1.697**	1.342**	1.414**	
	(0.112)	(0.095)	(0.088)	(0.091)	
Limit4	2.553**	2.383**	2.110**	2.156**	
	(0.125)	(0.111)	(0.106)	(0.109)	
Correlation Coefficients					
Risk Perception - Beef Steak	0.845**				
	(0.018)				
Risk Attitude - Ground Beef	0.275**	0.229**			
	(0.053)	(0.054)			
Risk Attitude - Beef Steak	0.268**	0.236**	0.940**		
	(0.053)	(0.054)	(0.008)		

Note: * and ** denote significance at the .10 and .05 levels, respectively. Standard errors are presented in parentheses. Log likelihood = -1,896. The presented *p*-values correspond to Wald tests of equal parameter estimates explaining ground beef and beef steak risk perceptions.

Table 6. Multivariate Ordered Probit Model of H1N1 Risk Perceptions

Variable	*Risk Perception* *Pork Chops*	*Risk Perception* *Pork Sausage*	*Risk Attitude* *Pork Chops*	*Risk Attitude* *Pork Sausage*	*p-value*
Intercept	0.581**	0.527**	1.389**	1.223**	
	(0.266)	(0.257)	(0.217)	(0.241)	
Female	0.201**	0.203**	0.114*	0.164**	0.958
	(0.103)	(0.108)	(0.067)	(0.065)	
Age	-0.001	-0.001	0.004	0.009**	0.982
	(0.003)	(0.003)	(0.004)	(0.004)	
College	-0.270**	-0.277**	0.100	0.065	0.898
	(0.100)	(0.098)	(0.098)	(0.102)	
Adults	-0.021	0.007	0.001	-0.011	0.384
	(0.056)	(0.057)	(0.063)	(0.067)	
Kids	0.076	0.009	-0.004	-0.037	0.021
	(0.065)	(0.065)	(0.062)	(0.062)	
Control of Food Safety	-0.132**	-0.111**			0.385
	(0.045)	(0.046)			
Direct Sickness	-0.105	-0.116			0.865
	(0.148)	(0.148)			
Indirect Sickness	-0.135	-0.090			0.455
	(0.136)	(0.136)			
Pork Consumption	-0.008	-0.009			0.900
	(0.015)	(0.014)			
Limit2	0.643**	0.619**	0.990**	0.842**	
	(0.055)	(0.054)	(0.153)	(0.134)	
Limit3	1.177**	1.204**	1.535**	1.500**	
	(0.077)	(0.077)	(0.173)	(0.160)	
Limit4	1.576**	1.680**	2.296**	2.220**	
	(0.102)	(0.106)	(0.199)	(0.199)	
Correlation Coefficients					
Risk Perception - Pork Sausage	0.960**				
	(0.006)				
Risk Attitude - Pork Chops	-0.050	-0.073			
	(0.049)	(0.050)			
Risk Attitude - Pork Sausage	-0.109**	-0.106**	0.943**		
	(0.050)	(0.051)	(0.009)		

Note: * and ** denote significance at the .10 and .05 levels, respectively. Standard errors are presented in parentheses. Log likelihood = -1,639. The presented *p*-values correspond to Wald tests of equal parameter estimates explaining pork chop and sausage risk perceptions.