UNDERSTANDING & MANAGING CONSUMER RISK BEHAVIOR

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Abstract

We present a conceptual framework for policy makers to analyze consumer behavior in times of crisis. The framework provides policy makers and the agricultural industry with a tool to structure the discussion on how to communicate crises to consumers and serves as a basis for concrete marketing policy. The merits of this conceptualization are illustrated in a field study that examines the reactions of German, Dutch, and American consumers to the BSE (Mad Cow Disease) crisis.

Introduction

Both the agricultural industry and governments are increasingly confronted with consumer concerns regarding food-related crises and behavior. The inability to respond swiftly and effectively can devastate an industry. During the Mad Cow crisis in Europe, for example, German beef consumption dropped 60% in the last quarter of 2000, bringing its beef industry to bankruptcy. Crises with an uncertain content and uncertain likelihood of actually being exposed to that content are particularly hard to manage for policy makers. This paper aims to offer policy makers a framework for managing crises.

In order to formulate an effective policy, policy makers need to understand consumer reactions in times of crisis. Two dimensions play a crucial part in consumer reactions to crises like food contamination: the risk content and the likelihood of exposure to that risk

content. The first dimension refers to the content of the crisis, the impact of an event. The second dimension reflects the likelihood that the content of the risk actually becomes manifest. The likelihood of the risk content occurring can be either known or unknown, with the latter case often referred to as "uncertainty" (Knight, Hirshleifer and Riley).[1]

These two dimensions, risk content and the likelihood of exposure, are directly related to the two fundamental drivers of decision behavior under uncertainty: risk attitude and risk perception. Risk attitude and risk perception are two different concepts. Whereas risk attitude deals with the consumer's interpretation of the risk content and how much (s)he dislikes that risk content, risk perception deals with the consumer's interpretation of the chances of becoming exposed to the content of the risk (Pennings and Smidts). *Risk attitude* reflects a consumer's general predisposition to a particular risk in a consistent way, and hence is formed by the content of that risk (i.e., the first dimension). *Risk perception* reflects the consumer's own interpretation of the likelihood of becoming exposed to the content of the risk and may therefore be defined as a consumer's assessment of the uncertainty of the risk content inherent in a particular situation (Pennings, Wansink and Meulenberg). Hence, it is driven by the likelihood of exposure to the risk content (i.e., the second dimension).

Risk attitudes range from extremely risk averse (i.e., refusing any risk under any condition) to extremely risk seeking (i.e., always preferring a risk-carrying outcome), while risk perceptions range from high to none at all. It is the interaction between both concepts that drives decision behavior, as it reflects consumers' predispositions to deal with the risks inherent in the risk content and the risks that their reactions to this risk content generate (Arrow, Pratt, Pennings and Wansink). For example, certain consumers

might be highly risk averse towards food contamination. Yet, whether or not they will actually take precautions depends on their risk perception: if these consumers estimate the likelihood of food contamination at zero, they will not take any precautions. Only when the consumers are both risk-averse and perceive risk at the same time, will they show preventive behavior (towards food contamination).

Thus, the entire behavioral outcome space, which contains all possible behaviors of consumers, is driven by consumers' risk attitudes, risk perceptions and the interaction between them. This can be written as:

$$(1) \qquad BS = \int_{i=1}^{I} B_i = \int_{i=1}^{I} RA_i + RP_i + RA_i * RP_i$$

Where BS is the behavioral outcome space, reflecting the set of consumers' behaviors, B_i is the behavioral outcome of consumer *i*, RA_i the risk attitude of consumer *i*, and RP_i, the risk perception of consumer *i*.

Conceptual Framework

The proposed conceptualization has often been used successfully in economic literature to describe and explain behavior (Holthausen). In that context, however, the risk content is often well understood (e.g., price fluctuations), while the likelihood of exposure to that risk content can often be formulated as concrete probabilities: commodity prices, for example, follow a random walk, as prices can go up or down with equal probability (Cargill and Rausser).

However, risk is not exactly known or estimable in the types of crises that policy makers face increasingly. Consumers, in other words, are unable to form a risk attitude,

since they do not know the exact content of the risk, while they cannot form a risk perception either, as they are incapable of judging the likelihood (i.e., probability) of exposure to the risk content. In terms of Equation 1, this implies that the risk attitude and risk perception of consumer *i* have become uncertain variables in the equation. This results in flatter distribution functions (i.e., larger variances) of risk attitudes and risk perceptions than would have been the case had the risk content and the probability of exposure been known.

Since risk attitudes and risk perceptions span the entire behavioral outcome space, this space will increase in such a situation, theoretically even to infinity. This increases the chances of what might be called extreme, unpredictable, and non-desired behavior within the behavioral outcome space. Extreme, unpredictable, and non-desired behavior may become manifest as individual behavior, such as reluctance to buy the product, or as collective behavior, causing economic phenomena like a stock market crash.

Figure 1 visualizes the relationships between the behavioral outcome space on the one hand and the variation of risk attitudes and risk perceptions and their drivers (information density on the content of the risk and on the chance that the risk content occurs, respectively) on the other hand. Figure 1 shows that the behavioral outcome space is the sum of the behaviors of all individual consumers (written in the figure as B_i).

[INSERT FIGURE 1 ABOUT HERE]

It is of eminent importance to policy makers to keep the behavioral outcome space as small as possible, as this minimizes the chances of extreme, unpredictable, and non-desirable behavior. Policy makers may be able to minimize the behavioral outcome space

by clarifying the risk content and by concretely defining the likelihood of exposure as much as possible (i.e. probabilities or degrees of risk: high, medium, or low) (Anand). Doing so will stimulate the formation of uniform risk attitudes and risk perceptions among consumers, leading to a smaller behavioral outcome space and a reduced chance of extreme, unpredictable, and non-desirable behavior.

The Mad Cow Disease Case

The Bovine Spongiform Encephalopathy (BSE) crisis, often referred to as Mad Cow Disease, fanned out across Europe during 2000/2001, causing consumer panic and disrupted meat markets. For example, BSE caused a dramatic decrease in beef consumption in Germany, when the first BSE case was detected on November 26, 2000. Despite the fact that during this time of the year (holiday season; Christmas time) the German beef consumption is at an annual peak, consumption decreased dramatically (compare the period October- January in 1999 with the same period in 2000). Even outside of Europe the ramifications of the European BSE crisis put intense pressure on foreign government agencies, industries, and policy makers (Wadman).

At the end of 2004, a first case of Mad Cow Disease was detected in the United States. McDonald's Corp. and Wendy's International Inc. stocks fell 6% and 4.5% respectively. While restaurants were only affected for a short while, the U.S.D.A. announced in March 2004 that beef producers could see an estimated $5 billion decline from 2003's figures in revenues resulting from Mad Cow.

One of the biggest concerns with BSE is that contaminated beef can cause the Creutzfeldt-Jacob Disease (CJD) in humans (Abbott). Yet, since the chances of getting

CJD from eating beef are extremely small (the World Health Organization reports only 87 cases of CJD during the period October 1996 to December 2000), it is puzzling that consumers react the way they do (Aldhous).

Our framework is useful in determining whether and to what extent risk perception and risk attitude contribute to consumer reactions. Predicting how consumers will react to a market crisis has important managerial implications. If beef consumption is primarily driven by risk perceptions (i.e., the likelihood of contracting CJD), the solution of the BSE crisis lies in effectively educating consumers about the level of risk involved. This will then reduce the behavioral outcome by reducing the variance in risk perceptions, as a result of an attitudinal regression to greater uniformity. If, however, the consumers' response to the BSE crisis is primarily driven by risk attitude (risk aversion), the beef industry has fewer and costlier options, namely to test all cows for BSE and to slaughter those that test positive. Testing all and slaughtering positive cows reduces the behavioral outcome space by reducing the variance in consumer risk attitudes. In a third case, consumers' responses may be driven by the interaction between risk attitude and risk perception. In this case, some combination of both solutions will be needed to deal with the crisis. The behavioral outcome space reduces, as both the variance in risk perceptions and risk attitudes reduce.

To examine our conceptual framework and investigate the effects of making risk levels explicit, we conducted a natural experiment that will generate behavioral insights that might illustrate the importance of different policy measures. To accomplish this, consumers from Germany, The Netherlands, and The United States were selected, representing a wide range of responses to the BSE crisis.[2] A total of 303 German, 326

Dutch, and 540 American consumers were intercepted while shopping in their home countries and were interviewed during the months of March and April of 2004. [3,4]

The focus of the first part of the study was on BSE risk perceptions, risk attitudes, and beef consumption. We used a scaling procedure to measure risk attitude and risk perception, thereby recognizing that our empirical study did not exactly follow the Pratt and Arrow framework outlined in the conceptual framework.[5] Based on the work of Childers, MacCrimmon and Wehrung, Pennings and Smidts, and Pennings and Garcia, we developed scales that were consistent with our definition of risk perception and risk attitude and that were as closely related to the Pratt and Arrow framework as possible. In two pre-studies we tested several different scales on convergent validity and nomological validity.

Consumer Responses to Mad Cow Disease in the U.S., Germany and the Netherlands

The dramatic differences in consumers' reactions to the BSE crisis are shown in Table 1. Several noteworthy differences are present. First, there are large differences between Germany and the Netherlands, even though both Germany and the Netherlands have had a similar experience with the severity of the disease. However, as shown in Table 1, most of the Dutch perceptions and behavioral responses are much less severe than German ones. A second noteworthy set of differences is that between the Netherlands and the United States. While only one case of BSE has been reported in the United States, against many more in the Netherlands, the perceptions and behavioral responses of the American consumers are more negative than those of the Dutch consumers.

[INSERT TABLE 1 ABOUT HERE]

Table 1 also reveals that, while there are significant differences in risk perceptions, the differences in risk attitudes are insignificant. To find out what drives the differences in behavioral responses, we examine our conceptual framework, that indicates to what extent consumer risk perceptions, risk attitudes, and their interaction drive consumer risk behavior. Logistic regressions show that there are significant variations across countries (see Table 2) in this respect. While *risk perceptions* drive the Dutch decision to decrease beef consumption (γ_2 = 1.422; p <0.01), German behavior is determined by *risk attitudes* (γ_1 = -.609. p <0.00). *Risk attitudes* (γ_2 = -1.060; p < 0.01) and the *interaction between risk perceptions and risk attitudes* (γ_3 = -.161; p <0.02) drive the American decision to reduce beef consumption. The effect of risk attitudes on the decision to reduce beef consumption increases with risk perception.

[INSERT TABLE 2 ABOUT HERE]

Figure 2 shows the behavioral outcome spaces for the three countries, using the variances of consumers' risk perceptions and risk attitudes. Using Levine's test of equality, we find that the national differences in variance of risk attitudes (F(2, 1166) = 29.65, p < .001) and the differences in variance of risk perceptions (F(2, 1166) = 4.28, p < .05) are significant. The behavioral outcome space varies substantially between the three countries,being largest for Germany, followed by the United States and the Netherlands. The vectors in Figure 2 are based on the (rescaled) rank correlations between the decision to reduce beef consumption and consumer risk attitudes and risk perceptions (no value should be attached to the absolute length of the vectors). In line with the percentage of consumers reducing their beef consumption, as well as the

proportion with which these consumers reduced their consumption (see Table 1), we find the shortest behavioral vector for the Dutch consumers, followed by the American and German consumers. We conclude that the larger behavioral outcome space among German consumers results in more extreme and undesirable behavior.

[INSERT FIGURE 2 ABOUT HERE]

The Role of Accurate Information

If consumers in these three countries had equally accurate (and trusted) information, and if they had an equal risk of contracting CJD, would these differences still exist? That is, are the differences between countries circumstantial, or do they represent different ways in which consumers use risk information to modify their behavior? To some extent, this might vary across the level of risk that's involved.

To answer this question, all consumers were presented with the four following scenarios: "Imagine that science had shown with absolute certainty that the chances of getting CJD from eating beef are . . ." 1 in **10 million** (Scenario 1), 1 in **1 million** (Scenario 2), 1 in **100,000** (Scenario 3), 1 in **10,000** (Scenario 4). Following this, the consumers stated whether they would reduce their beef consumption in this scenario, and by how much they would reduce it.

[INSERT TABLE 3 ABOUT HERE]

Table 3 shows that the difference in the percentage of consumers reducing their beef consumption between consecutive scenarios is largest between Scenario 2 and Scenario 3, and that the proportional decrease in beef consumption (per capita) is largest between

Scenario 1 and Scenario 2. This result suggests that when a country faces a mild chance of BSE contamination (e.g., less than 1 in a million), national beef consumption will decrease, because a large number of consumers will reduce their beef consumption somewhat. However, when facing a serious chance of contamination, such as Scenario 4, a radical decrease in per-capita consumption will be the main cause of the decrease in consumption.[6]

To further examine how beef consumption is influenced in a situation where consumers have *accurate* information about the probabilities of contracting CJD, we related risk attitude, risk perception and the interaction between them to the consumer's decision whether or not to reduce beef consumption in a logistic regression framework for each scenario. The results in Table 4 show that risk perception influences beef consumption in all three countries, for all scenarios, either directly or indirectly, through its interaction with risk attitude. Even when accurate information is available, risk attitude remains an important driver of beef consumption in the U.S. and Germany, and becomes important in the Netherlands in high-risk scenarios.

[INSERT TABLE 4 ABOUT HERE]

Table 4 shows that the influence of risk attitude on beef consumption increases with an increasing chance of contamination (going from Scenario 1 through 4), except for Germany. The latter may be caused by the extreme risk aversion of the Germans, leading to homogeneity in the impact of risk attitudes on beef consumption. Depending on the country, the impact of risk perceptions on beef consumption increases or decreases systematically with more risky situations (Scenario 1 through Scenario 4). In the United

States and the Netherlands, the effect of risk perception reduces in more risky situations. In Germany on the other hand, the effect of risk perception actually increases in more risky situations, again confirming the risk aversion of the Germans.

Table 5 shows the variance of consumer risk attitudes and risk perceptions in both the uncertain and the risky scenarios. Recall that we expected the variance of *risk perceptions* to reduce by providing detailed information about the probability of getting CJD by eating beef. This is not the case. Instead, we find that the variance in *risk attitudes* is somewhat reduced. For American consumers, the variance of risk attitude is lower for all scenarios and significantly lower for two of the scenarios. For German consumers, we only find a significant reduction in the most risky scenario. In the two least risky scenarios we actually find a significant increase in variance. Among the Dutch consumers, we only find a directional, but insignificant change in variance for all scenarios.

While for risk attitudes some significant reductions were found, none were found for risk perceptions (with the exception of the Germans in the most risky scenario). The significant changes in variance found for risk perception all involved increases. This suggests that providing detailed information about the probability of getting CJD by eating beef actually polarizes consumers' risk perceptions and probably the related risk behavior by reinforcing existing perceptions.

How to Respond to the BSE Crises?

This research demonstrates that the way policy makers respond to the BSE crisis should take into account whether a country's beef consumption is influenced more by risk

perceptions or by risk attitudes. The relative influence of risk perception and risk attitude on beef consumption depends, among others, on the accuracy of knowing the probability of getting CJD from eating beef.

If the probability of contracting CJD is not accurately known--which is the current situation--this analysis suggests different policy implications for different types of countries. In countries such as the United States and Germany, tough measures are required to prevent a BSE crisis, because risk attitudes drive consumption and little can be done to change consumers' risk attitudes. This means testing all and slaughtering all suspected cows. In contrast to the US and Germany, Dutch consumer behavior is driven mainly by risk perceptions. In this case, honest and consistent communication by both the government and the beef industry is more effective than a mass slaughtering of cows.

If the probability of contracting CJD is accurately known (or becomes more accurate), risk perception becomes a less important driver of beef consumption than risk attitude in low-risk and mildly risky situations (such as Scenarios 1 and 2) in both the US and The Netherlands. In low-risk situations, messages from the government, the beef industry, and the media will have a notable impact on helping consumers respond to the BSE crisis (e.g., Tversky and Kahneman, Slovic). In contrast, in high risk situations (such as Scenario 4) tough measures – recall or elimination – are necessary as well, as the impact of risk attitude increases. Strongly risk-averse consumers, however, treat any level of risk as a high-risk situation. Therefore, both tough measures and information are important, even in low-risk and mildly risky situations. On the production side, an ounce of prevention is worth a pound of cure, but on the policy side, an ounce of information is worth even more.

Discussion & Conclusions

We argue that the behavior of consumers during a crisis can be better understood by de-coupling risk response behavior into the separate components of risk perception and risk attitude. This conceptualization provides information about the tools that might be used to deal with a crisis. We find that behavior toward a risk-related crisis (such as food safety) is driven by different factors for different segments and that the relative influence of these variables depends on the accuracy of knowing the probability that the risky event occurs. We hypothesized that the behavioral outcome space would reduce, as a result of creating greater uniformity by providing accurate information about the probability of getting CJD from eating beef. The results suggest that this kind of information does not result in greater uniformity. Instead, it seems to polarize risk perceptions and risk attitudes, thereby increasing the behavioral outcome space.

A possible explanation for this result may be the fact that risk perception and risk attitude are concepts that are not independent from each other, which the framework introduced here implicitly assumes. Research is called for to identify the drivers of risk attitudes and risk perceptions, and the influence they have on each other.

The empirical application to the BSE crisis illustrates the potential usefulness of the proposed framework. If consumers' reactions are mainly driven by risk perception, effective communication efforts can increase their knowledge about the probabilities of being exposed to the risk (e.g., getting CJD) and may be sufficient. If, however the consumer response to the crisis is mainly driven by risk attitude, the marketer has fewer options. In fact, ultimately, the only tool available is to eliminate the risk (e.g., check every single cow for BSE and slaughter all cows that might have BSE).

The three-country study showed significant differences in consumers' risk attitudes and risk perceptions and, consequently, consumers' reactions. Analyses of beef prices, U.S. beef consumption, and export data suggest that the sharp decline in beef prices after the identification of Mad Cow Disease in the U.S. was driven by a sharp drop in exports. Hence, the agricultural industry and governments should not only take measures that affect domestic demand, but also demand from abroad. The current challenge is that the domestic measures needed may be very different from those needed to save the export markets, as our empirical study indicates. Interestingly, our findings regarding risk attitudes are consistent with the landmark findings of Hofstede some 20 years ago. Understanding cross-cultural differences is particularly critical for managers and public officials who need to predict how consumers in different countries will respond to a crisis and why.

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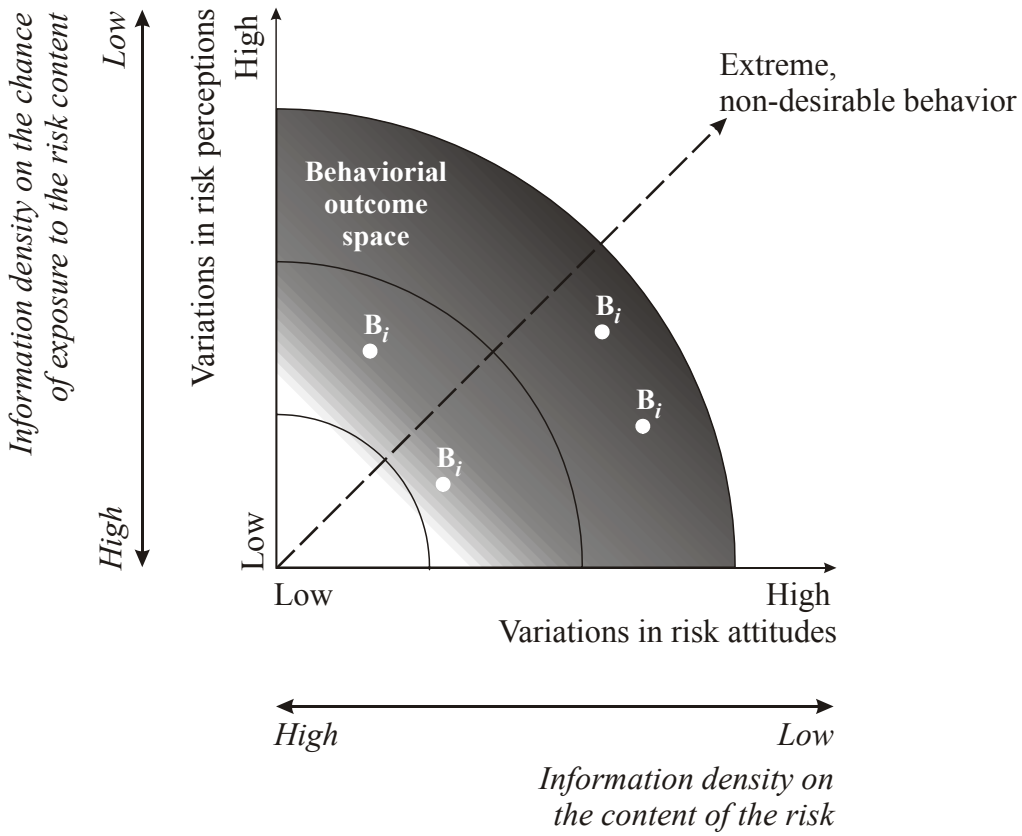

Figure 1. Behavioral Outcome Space in Times of Uncertain Crises.

B_i is the behavioral outcome of consumer *i*. The behavioral outcome space is the set of all individual behavioral outcomes. Figure 1 shows that the behavioral outcome space is spanned by the variations in risk attitudes and risk perceptions. These variations increase as the information density on the content of the risk and on the chance of exposure to the risk content decreases, thereby expanding the behavioral outcome space.

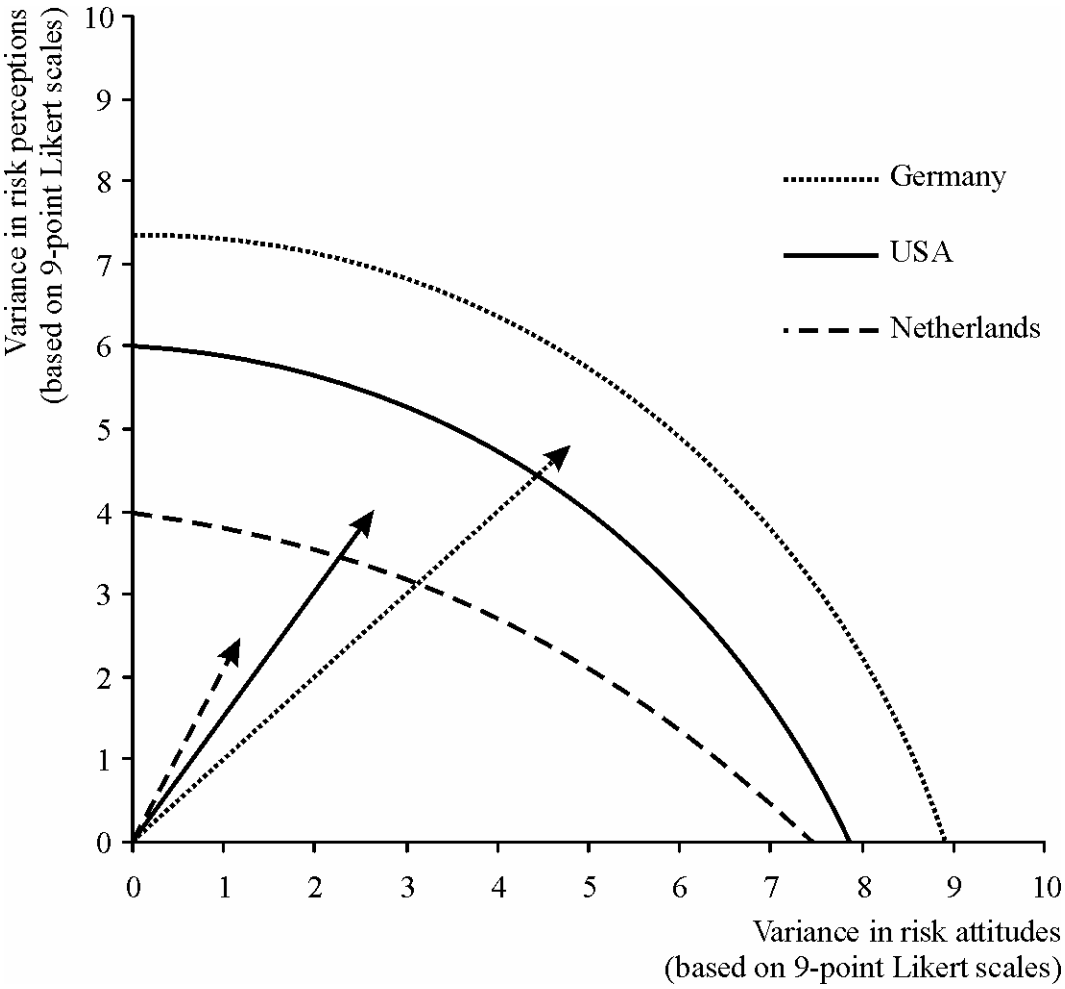

Figure 2. Behavioral Outcome Space in Times of Uncertain Crises.

Table 1. Cross-country differences in knowledge about CJD and beef consumption

	USA	Germany	Netherlands	χ^2 / F-Value
What do you think contracting Creutzfeldt-Jacob Disease (CJD) from eating beef will do to you? (%)				
• I would die; there is no treatment	26.1%	48.5%	35.1%	
• I might die, but there is a chance of surviving	25.0%	29.7%	24.8%	$\chi^2 = 91.62$,
• I would get very ill, the illness would be chronic	20.6%	15.2%	22.9%	$p<.001$
• I would get ill, and will recover after some time	22.2%	4.3%	13.2%	
• I would feel ill, but would recover fast	6.1%	2.3%	3.1%	
risk attitude:				
I think eating beef is risky (1 = disagree, 9 = agree)	3.45 (2.45)	3.99 (2.71)	2.89 (1.99)	F = 16.28, $p<.001$
risk perception:				
I am willing to accept the risk when eating beef (1 = disagree, 9 = agree)	5.66 (2.80)	5.55 (2.98)	5.74 (2.73)	F =.35, $p>.10$
Are you concerned about eating beef? (1= not concerned; 9=very concerned)	3.57 (2.57)	4.93 (3.07)	2.44 (1.93)	F = 68.17, $p<.001$
Do you trust the information that your government provides? (1=do not trust; 9=fully trust)	4.79 (2.28)	3.83 (2.31)	5.90 (2.06)	F = 68.74, $p<.001$
Have you reduced your beef consumption because of the BSE crisis?	18.3%	29.0%	8.9%	$\chi^2 = 42.33$, $p<.001$
By what proportion have you reduced your beef consumption?	49.72% (29.97)	66.80% (26.14)	41.71% (20.60)	F = 13.40, $p<.001$
Have you switched to other meat products and fish products?	17.3%	31.9%	9.6%	$\chi^2 = 51.82$, $p<.001$

Standard deviations are shown in parentheses.

Table 2. Explaining consumer beef reduction with risk attitude, risk perception and their interaction

Did you reduce your beef consumption because of the BSE crisis 0 = no, 1 = yes)?	Risk Attitude (RA)	Risk Perception (RP)	RA x RP	Nagelkerke R^2; Correctly Classified Choice (CCC)
	γ_1	γ_2	γ_3	
United States	**- 1.060***	0.115	**0.161***	R^2 = 0.476; CCC = 86.5 %
Germany	**- 0.609***	0.338	-.038	R^2 = 0.571; CCC= 85.8 %
Netherlands	0.333	**1.442***	-0.131	R2 = 0.295; CCC = 92.3 %
Overall (with country dummies)	**-0.668***	**0.259***	0.048	R2 = 0..473; CCC = 87.4 %

* $p < .05$

Note. Nagelkerke's R^2 is similar to the R^2 in linear regression and measures the proportion of variance of the dependent variable (reduction of beef consumption) about its mean that is explained by the independent variables (risk attitude, risk perception and their interaction).

Table 3. How changes in the probability of contracting CJD will change beef consumption

	Percentage of Consumers that Decide to Reduce their Beef Consumption				Proportion by which Consumers Diminish their Beef Consumption			
Suppose that science had shown with absolute certainty that the chances of getting CJD by eating beef are . . .	USA	Germany	Netherlands	χ^2	USA	Germany	Netherlands	F-Value
Scenario 1: 1 in **10 million** per year	27.3%	36.0%	20.6%	18.56, $p<.05$	51.49% (30.21)	72.31% (28.12)	61.03% (32.13)	17.00, $p<.05$
Scenario 2: 1 in **million** per year	40.2%	50.2%	39.3%	9.75, $p<.05$	60.36% (29.68)	83.83% (23.61)	79.79% (24.61)	22.15, $p<.05$
Scenario 3: 1 in **100,000** per year	62.7%	79.5%	68.1%	25.16, $p<.05$	73.84% (27.92)	93.06% (15.93)	91.27% (16.64)	12.48, $p<.05$
Scenario 4: 1 in **10,000** per year	78.8%	89.8%	81.2%	16.29, $p<.05$	84.20% (26.51)	96.56% (11.64)	96.28% (12.22)	27.25, $p<.05$

Standard deviations are shown between parentheses.

Table 4. How different risk levels influence beef consumption

Did you reduce your beef consumption because of the BSE crisis (0 = no, 1 = yes)?	Risk Attitude (RA)	Risk Perception (RP)	RA x RP	Nagelkerke R^2; Correctly Classified Choice (CCC)
United States	γ_1	γ_2	γ_3	
Scenario 1	-0.077	**0.824***	**-0.050***	R^2 = 0.441; CCC = 83.8 %
Scenario 2	**-0.337***	**0.447***	0.019	R^2 = 0.469; CCC = 78.8 %
Scenario 3	**-0.363***	**0.526***	0.003	R^2 = 0.510; CCC = 76.9 %
Scenario 4	**-0.341***	**0.444***	0.014	R^2 = 0.447; CCC = 83.9 %
Germany				
Scenario 1	**-0.398***	**0.379***	0.002	R^2 = 0.615; CCC = 85.1 %
Scenario 2	**-0.279***	**0.482***	-0.018	R^2 = 0.626; CCC = 81.8 %
Scenario 3	-0.177	**0.549***	-0.052	R^2 = 0.487; CCC = 96.1 %
Scenario 4	-0.030	**0.622***	**-0.074***	R^2 = 0.497; CCC = 91.7 %
Netherlands				
Scenario 1	-0.253	**0.739***	-0.044	R^2 = 0.537; CCC = 88.6 %
Scenario 2	**-0.430***	**0.589***	0.002	R^2 = 0.618; CCC = 82.0 %
Scenario 3	**-0.450***	**0.512***	-0.002	R^2 = 0.585; CCC = 83.0 %
Scenario 4	**-1.167***	0.088	**0.097***	R^2 = 0.637; CCC = 90.7 %
Overall (with country dummies)				
Scenario 1	**-0.195***	**0.667***	**-0.032***	R2 = 0.522; CCC = 85.2 %
Scenario 2	**-0.313***	**0.523***	-0.002	R2 = 0.555; CCC = 80.1 %
Scenario 3	**-0.300***	**0.550***	-0.015	R2 = 0.532; CCC = 80.9 %
Scenario 4	**-0.377***	**0.453***	0.001	R2 = 0.637; CCC = 90.7 %

Scenarios 1 to 4 go from least risky to most risky. An asterisk indicates that each parameter β significantly improves the fit when compared to the null model, which includes only an intercept at the 5% level.

Table 5. Variance of Risk Attitudes and Risk Perceptions in Uncertain and Risky Scenarios

	Uncertain Scenario	Scenario 1 1 in 10 mill.	Scenario 2 1 in 1 mill.	Scenario 3 1 in 100.000	Scenario 4 1 in 10.000	Mauchly's W	Approx. χ^2
United States							
Risk Attitude (RA)	7.86	7.04 (1.55)	**6.79 (2.04)**	**6.88 (1.70)**	7.48 0(.61)	.294	634.67, p<.001
Risk Perception (RP)	5.98	5.60 (1.10)	6.21 (0.60)	**6.76 (1.65)**	6.75 (1.54)	.315	598.76, p<.001
Behavioral Space (RA x RP)	47.00	39.42	42.17	46.51	50.49		
Germany							
Risk Attitude	8.90	9.45 (0.84)	**10.17 (1.67)**	7.77 (1.58)	**5.26 (5.52)**	.385	308.88, p<.001
Risk Perception	7.32	**9.01 (2.64)**	**9.65 (3.32)**	7.21 (0.17)	**4.19 (5.87)**	.376	294.07, p<.001
Behavioral Space (RA x RP)	65.15	85.15	98.14	56.02	22.04		
Netherlands							
Risk Attitude	7.46	6.54 (1.56)	7.44 (0.03)	7.28 (0.25)	7.31 (0.20)	.237	465.32, p<.001
Risk Perception	3.97	**5.52 (3.52)**	**6.83 (5.69)**	**6.88 (5.65)**	**6.11 (4.20)**	.240	461.79, p<.001
Behavioral Space (RA x RP)	29.62	36.10	50.82	50.09	44.66		
Overall							
Risk Attitude	8.01	7.56 (1.31)	7.92 (0.25)	**7.35 (1.72)**	**7.19 (2.02)**	.322	1297.43, p<.001
Risk Perception	5.92	**6.58 (2.49)**	**7.41 (5.03)**	**7.03 (3.50)**	6.15 (0.73)	.309	1344.26, p<.001
Behavioral Space (RA x RP)	47.42	49.74	58.69	51.82	44.22		

In the last two columns, the results of Mauchly's test of sphericity are reported. The results show that for all measures in all countries, variance differs substantially – is not equal. Besides Mauchly's test across all measures, individual tests of equality of variance were conducted against the variance in the uncertain scenario. If s_1^2 and s_2^2 are the two unbiased variance estimates and r_{12} is the correlation between paired observations, the quantity $t = \frac{(s_1^2 - s_2^2)\sqrt{N-2}}{\sqrt{4s_1^2 s_2^2 (1-r_{12})}}$ has a t distribution with N-2 degrees of freedom (Ferguson 1976). These t-values are reported in parentheses.

ENDNOTES

[1] Hirshleifer and Riley disregard Knight's distinction between risk and uncertainty, but make a distinction between hard and soft probability. Other researchers use the term *ambiguity* when referring to the situation when probabilities of the event are not known.

[2] In the Netherlands and Germany several cases of Mad Cow Disease have been reported. Since 1991, the U.S. has banned imports of both cattle and animal feeds from BSE-contaminated countries. In December of 2003, the first mad cow was detected in the U.S.

[3] Since the same content of the questionnaire was being used across countries, the precise wording was modified through backward-translation procedures.

[4] The average age of the consumers ranged from 40 years in the Netherlands to 46 years in Germany and the percentage of women in the three samples ranged from 45% in the United States to 62% in the Netherlands. The average number of children per household (still living at home) ranged from 1.5 in the Netherlands to 1.7 in the United States.

[5] Some researchers have measured the Pratt and Arrow coefficient of absolute risk aversion with the certainty-equivalence technique (i.e., the lottery technique) and measured risk perception by assessing the probability function of respondents with the interval technique (see for an application Smidts, and for a detailed description of these techniques Keeney and Raiffa, Hershey and Schoemaker, and Farquhar). A drawback of these measurements is that they take a lot of effort and time from the respondents, since they can only be obtained by time-intensive experiments. Moreover, these elicitation techniques are extremely costly to conduct on a large scale.

[6] The notion that risk attitude is context specific (March and Shapira), i.e., the attitude toward risk (beyond a general propensity) depends upon the level of risk, is confirmed in this study. The risk attitude score decreased (i.e., consumers become more risk averse) monotonically from scenario 1 to scenario 4 for all consumers across all countries (see also Table 5).